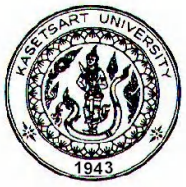

THESIS APPROVAL

GRADUATE SCHOOL, KASETSART UNIVERSITY

Master of Science (Botany)

DEGREE

Botany	Botany
FIELD	**DEPARTMENT**

TITLE: Fagaceae in Southeastern Thailand

NAME: Miss Kanokon Bunpha

THIS THESIS HAS BEEN ACCEPTED BY

..... **THESIS ADVISOR**

(Associate Professor Sumon Masuthon, M.S.)

..... **COMMITTEE MEMBER**

(Mr. Chamlong Phengklai, Ph.D.)

..... **COMMITTEE MEMBER**

(Assistant Professor Suvit Sangtongpraow, Ph.D.)

..... **DEPARTMENT HEAD**

(Associate Professor Sureeya Tantiwiwat, Ph.D.)

APPROVED BY THE GRADUATE SCHOOL ON .....

..... **DEAN**

(Associate Professor Gunjana Theeragool, D.Agr.)

THESIS

FAGACEAE IN SOUTHEASTERN THAILAND

KANOKON BUNPHA

A Thesis Submitted in Partial Fulfillment of
the Requirements for the Degree of
Master of Science (Botany)
Graduate School, Kasetsart University
2009

Kanokon Bunpha 2009: Fagaceae in Southeastern Thailand.
Master of Science (Botany), Major Field: Botany, Department of Botany.
Thesis Advisor: Associate Professor Sumon Masuthon, M.S. 128 pages.

The taxa of Fagaceae in Southeastern Thailand were studied from October 2003 to March 2009 by searching literature, surveying in Southeastern Thailand. Morphological characters, distribution and taxonomic characters were investigated, described, and supported by photos and drawings. A key to genera and species based on the bark, leaf, flower, acorn and nut is included and comparing herbarium specimens.

Three genera and 19 species of Fagaceae were identified, i.e., *Castanopsis acuminatissima* (Blume) A. DC., *C. pierrei* Hance, *C. piriformis* Hickel & A. Camus, *Lithocarpus cantleyanus* (King ex Hook. f.) Rehder, *L.* cf. *dealbatus* (Hook. f. & Thomson) Rehder, *L. elegans* (Blume) Hatus. ex Soepadmo, *L. eucalyptifolius* (Hickel & A. Camus) A. Camus, *L. harmandii* (Hickel & A. Camus) A. Camus, *L. thomsonii* (Miq.) Rehder, *L. wallichianus* (Lindl. ex Hance) Rehder, *L. wrayi* (King) A. Camus, *Quercus auricoma* A. Camus, *Q.* cf. *lineata* Blume, *Q. oidocarpus* Korth., *Q. poilanei* Hickel & A. Camus, *Q. quangtriensis* Hickel & A. Camus, *Q. rex* Hemsl., *Q.* cf. *saravanensis* A. Camus and *Q. thorelii* Hickel & A. Camus.

One species, *Q. thorelii* Hickel & A. Camus, is a new record for Thailand. Eight species are new records for Southeastern Thailand, namely, *Lithocarpus cantleyanus* (King ex Hook. f.) Rehder, *L.* cf. *dealbatus* (Hook. f. & Thomson) Rehder, *Quercus auricoma* A. Camus, *Q.* cf. *lineata* Blume, *Q. oidocarpus* Korth., *Q. poilanei* Hickel & A. Camus, *Q. rex* Hemsl. and *Q. thorelii* Hickel & A. Camus. Three species, i.e., *Q. poilanei* Hickel & A. Camus, *Q. rex* Hemsl. and *Q. thorelii* Hickel & A. Camus are more likely to be endangered than the others because they are less common in both the Southeast and throughout Thailand.

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Student's signature Thesis Advisor's signature

ACKNOWLEDGEMENTS

I am deeply grateful to Associate Professor Sumon Masuthon, my thesis advisor, for her great advice and providing many things during the course of my thesis. I wish to extend my thanks to Dr. Chamlong Phengklai and Assistant Professor Dr. Suvit Sangtongpraow, the thesis committee members, for their suggestions and encouragement. I wish to express my deep gratitude to Assistant Professor Pattana Srifah Huehne, the Graduate School representative, for her guidance and suggestions for my thesis.

I gratefully acknowledge Mr. Phongsak Phonsena, for much support in field work, some literature, photographs and many valuable suggestions. I wish to thank Miss Sasithorn Siriseree, Mr. Yutthana Banchong, Mr. Montri Tanaros, Mr. Chalearmphon Suwanphakdee and Mr. Thamarat Putthai for their kind help in field work and some photographs. I am grateful to Miss Ratikan Worasit, Miss Lukkhana Tangchai, Mr. Damrongsak Chusithong, Dr. Voradol Chamchumroon and other colleagues at Khao Hin Son Botanic Garden for understanding and help in many ways. Many thanks to Bob Harwood for kind help and support both in field work and understanding of English. Sincere thanks to officers at the Forest Herbarium (BKF) for their hospitality, especially Mrs. Orathai Kerdkaew for all the beautiful illustrations. Special thanks to my friends, Miss Phradorn Samsungneon, Miss Kammarin Phomratrak, Miss Nantanit Numnuan, Miss Orporn Phueakkhai, Miss Nongnooch Anuruktrakul and taxonomic members for their support of my work all the time. Lastly, many thanks to my beloved family for warm support and encouragement.

This research was funded by the Graduate School Kasetsart University. I would like to thank the Department of Botany, Faculty of Science, Kasetsart University, for providing some laboratory facilities.

Kanokon Bunpha

March, 2009

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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
BSKU	=	Herbarium of Botany Department, Faculty of Science, Kasetsart University, Bangkok, Thailand
cf.	=	*confer* (compare)
ca.	=	*circa* (about)
diam.	=	*diametro* (diameter)
e.g.	=	*exempli gratia* (for example)
et al.	=	*et alii* (and others)
i.e.	=	*id est* (that is)
s.n.	=	*sine nomine* (without name)
sp.	=	species

FAGACEAE IN SOUTHEASTERN THAILAND

INTRODUCTION

The Southeastern region of Thailand sits on 2 floristic elements, namely the Indo-Chinese element and the Malaysian element. As most of the area is lowland adjacent to the sea, it is strongly influenced by the Southwestern and Northeastern monsoons which cause the average rainfall per year in this area to be as high as that of the South. In addition, this region has a high mountain range sitting in the central area of it, the Chanthaburi Mountain Range and in the east of the region, Bunthat Mountain Range, which continue down from Phanom Krawan Mountain Range in Cambodia and block the monsoon, resulting in the area facing the monsoon having more rain than that of the other side of the mountain. From the influence of rainfall and nature of the area, vegetation types differ from those in other parts of the country. Vegetation types of the Southeastern region are mainly evergreen rain forest and dry evergreen forest which are suitable for Fagaceae.

The family Fagaceae is one of the large dicotyledon family, consisting of 8 genera (*Nothofagus, Fagus, Castanea, Chrysolepis, Castanopsis, Lithocarpus, Quercus* and *Trigonobalanus*) and about 620–750 species (Kubitzki, 1993). Their ranges of distribution are both in the temperate up to 62 °N and 33°S and tropical regions, but mostly in the Northern hemisphere (Soepadmo, 1972). This family is challenging because it is very difficult to identify to species level. Although taxonomic study of Fagaceae in Thailand has been thorough, still there is lack of complete specimens because of different periods of flowering and fruiting. Complete collections of specimens including leaf, staminate flower, pistillate flower, fruit and cupule at the same time is not possible, so many species are still not well known.

This study can be of benefit by adding more information to our knowledge about Fagaceae and will provide a basis for plant identification which will help to identify species in Southeastern Thailand, and enlarge the database of Fagaceae in Thailand.

OBJECTIVES

1. A new approach using the morphology to support the classification of the closely related species characters.

2. To clarify the number of genera and species of Fagaceae in Southeastern Thailand.

3. To construct an identification key of Fagaceae for ecotourism in the study area.

4. To show phenology and distribution of Fagaceae in Southeastern Thailand.

LITERATURE REVIEW

1. The characters of the family Fagaceae

1.1. Habit and bark

Mostly monoecious trees (Porter, 1967; Hickey and King, 1981), rarely shrubs (Soepadmo, 1972; Brandis, 1978; Keng *et al.*, 1993), dioecious in *Nothofagus* (Lawrence, 1951), evergreen or deciduous (Lawrence, 1951; Hutchinson, 1967; Kubitzki, 1993; Woodland, 2000), sometimes buttressed, bark usually smooth (Soepadmo, 1972; Cockburn, 1976), often lenticellate, sometimes deeply fissured, inner bark darkening rapidly on exposure from pale yellow to dull purple (Cockburn, 1976) (Figure 1).

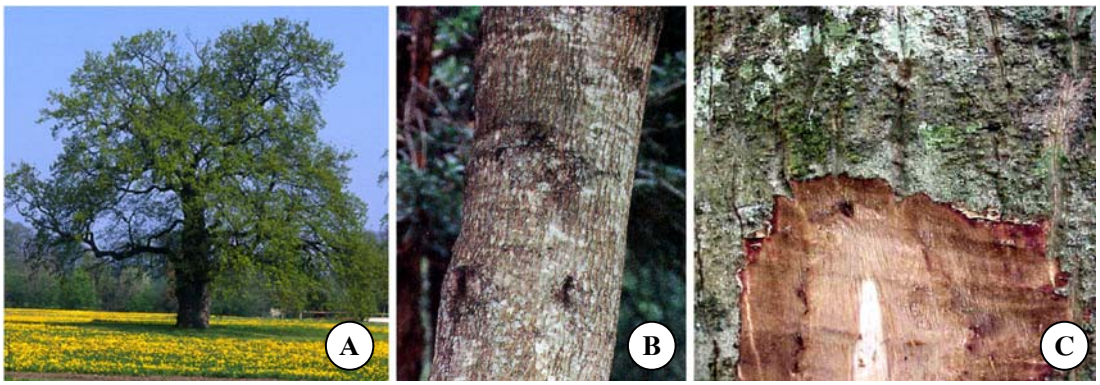

Figure 1 Habit and bark

A. tree; B. bark smooth; C. inner bark or blaze.

Sources: A. Spichiger *et al.* (2004); B. Samuelson and Hagan (2003); C. Conn and Damas (2009)

1.2. Leaves

Simple, spiral or alternate (Cockburn, 1972; Soepadmo *et al.*, 2000) rarely whorled (Bateman and Dod, 1979; Kubitzki, 1993), margin entire to pinnately lobed (Brandis, 1978; Bateman and Dod, 1979), texture usually leathery (Porter,

1967); pinnately veined (Soepadmo *et al*., 2000); stipules caducous. (Lawrence, 1951; Hutchinson, 1967; Kubitzki, 1993) (Figure 2).

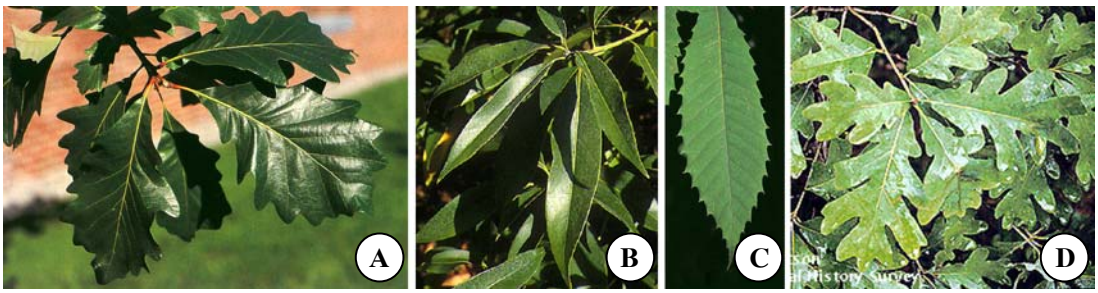

Figure 2 Leaf characters

A. simple leaf; B. entire margin; C. serrate margin and pinnately veined; D. pinnately lobed.

Sources: A, C. Kirkman *et al*. (2007); B. Tournay (2009); D. Robertson (2009a)

1.3. Inflorescences

Inflorescences are axillary or terminal, erect to pendulous catkins or racemes, sometimes branched; flower arrange solitary or in few-flowered dichasia, the dichasia mostly combined into heads or simple (Backer and Bakhuizen van den Brink, 1965); male, female, androgynous, or mixed (Soepadmo *et al*., 2000) (Figure 3).

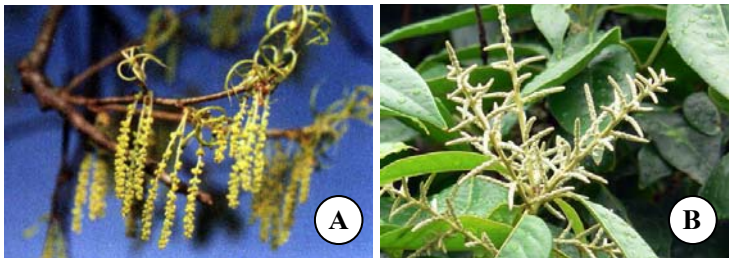

Figure 3 Inflorescences

A. catkins; B. panicle.

Source: A. Samuelson and Hogan (2003); B. JC Raulston Arboretum (2007)

1.4. Florets

Unisexual, male flowers sessile; perianth campanulate or tubular (Soepadmo, 1972; Kubitzki, 1993), (4–)6(–9)-lobed (Lawrence, 1951; Soepadmo *et al.*, 2000); stamens (4–)6–12(–90); filaments filiform, free or rarely connate at the base; anthers linear to reniform, dorsifixed or basifixed, 2-locular, longitudinally dehiscent; pistillode present or absent (Soepadmo, 1972; Kubitzki, 1993); female flowers sessile and within an involucre of often numerous imbricate scales; single flowers surrounded by involucral scales, the scales connate, forming a cup (cupule) surrounding part or whole of the fruit (Backer and Bakhuizen van den Brink, 1965), perianth 4–6-lobed, staminodes 6–12 or absent; ovary inferior, 3–6(–9)-loculed, ovules 2 per locule; styles as many as ovary locules (Hutchinson, 1967; Soepadmo *et al*., 2000); stigmas capitate or punctiform. (Soepadmo *et al*., 2000) (Figure 4).

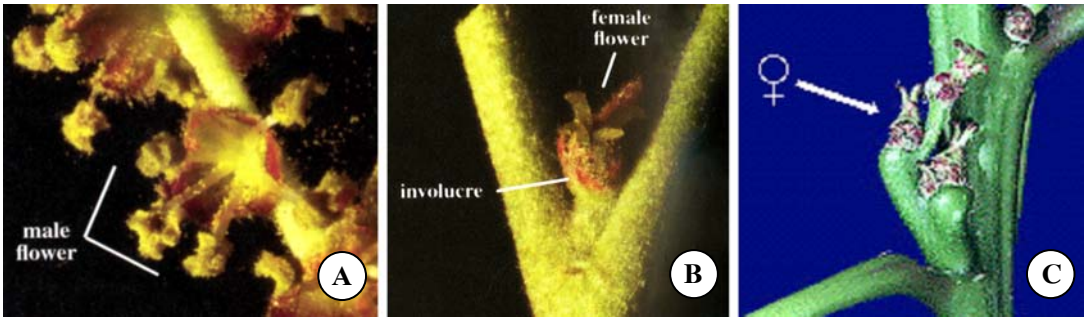

Figure 4 Florets

A. single male; B. single female and involucre; C. dichasium female.

Sources: A-B. Simpson (2006); C. Robertson (2009b)

1.5. Acorns

Acorn is one example of the great variety of forms shown by the cupule, surrounding 1 or more fruits (Figure 5) which is a unique feature of the family and the origin of which has been controversial. Only with the discovery of *Trigonobalanus* in 1961, restricted to Sulawesi, Northern Borneo, Malaysia and Northern Thailand, has it

been possible to suggest firmly that the cupule is derived from a 3-lobed extension of the pedicel below each flower, which has been variously fused around single flowers or groups of flower. It is possible that the cupule provides a link with the pteridosperm ancestors of the flowering plants. The tremendous various of scales and spines on the cupules appears to be derived from branched spines. (Heywood *et al.*, 2007).

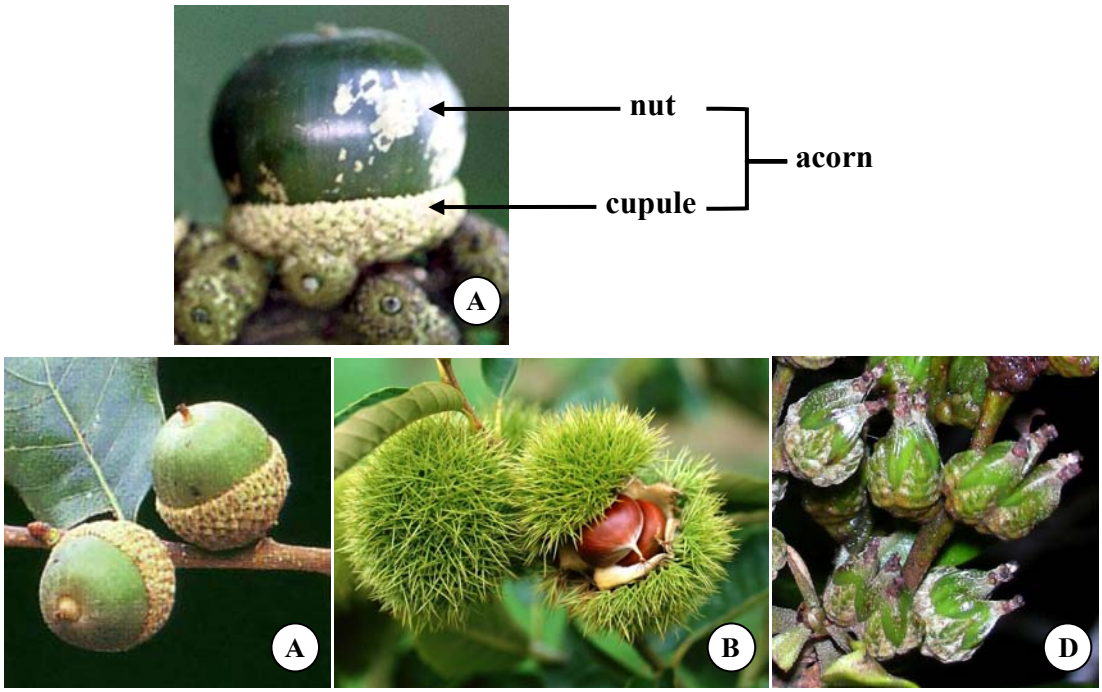

Figure 5 Acorns

A. acorn structure; B. completely covered cupule; C. partly covered cupule; D. cupule covering tri-angular nut.

Sources: A. Kirkman *et al.* (2007); B. Anonymous (2009a); C. Anonymous (2009b)

1.6. Fruits and seeds

Fruits are indehiscent nuts, 1–3-loculed, rounded to sharply 3-angular in cross-section (Soepadmo *et al*., 2000), free from or adnate to the involucre, sometimes completely surrounded by the nut which opens like a pericarp; seed usually one by abortion, without endosperm. (Hutchinson, 1967) (Figure 6).

Figure 6 Fruits and seeds

A. nuts and seeds; B. nut in long-section.

1.7 Pollen grains

Pollen grains are colpate, colporoidate or colporate, 3–6(–7)-aperturate. Pollen shape is peroblate-prolate which longest axis 15–50(–65) μ (Erdtman, 1952) (Figure 7).

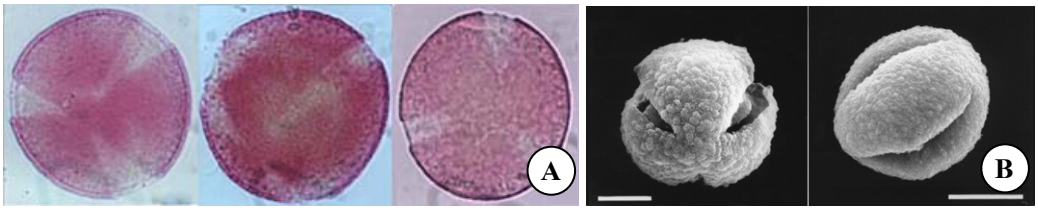

Figure 7 Tricolporate pollen grains

A. under LM; B. under SEM.

Sources: A. Shah *et al*. (2005); B. Jones *et al*. (1995)

2. Distribution and ecology

2.1. Distribution

Fagaceae has about 8 genera with 620–750 spp. (Kubitzki, 1993) distributed from temperate to tropical regions (Hutchinson, 1967), mostly in the northern hemisphere, in South-East Asia crossing the equator (Kubitzki, 1993) but absent from tropical Africa southwards (Jones and Luchsinger, 1987) except the genus *Nothofagus* that is distributed in the southern hemisphere, in South America, New Zealand, Australia, New Guinea and New Caledonia. (Soepadmo, 1972; Kubitzki, 1993) (Figure 8).

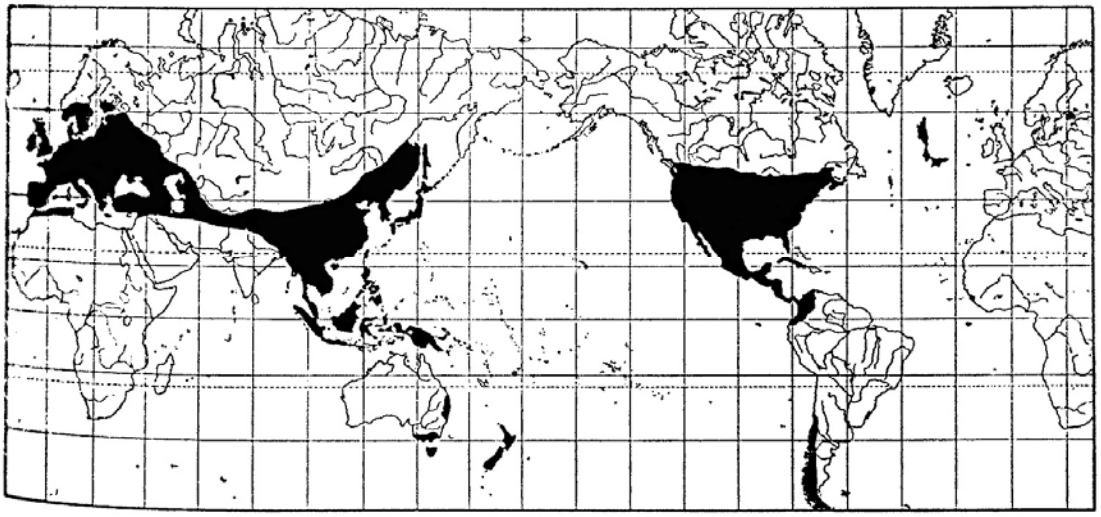

Figure 8 Distribution of Fagaceae

Source: Soepadmo (1972)

In South-East Asia, Fagaceae can be found in Laos, Myanmar, Vietnam, Cambodia, Thailand, Malaysia, Philippines, Indonesia and various islands, e.g. d'Entrecasteaux, New Britain, and the Louisiades. (Soepadmo, 1972) (Table 1).

Thailand is separated into 7 floristic regions following Smitinand (The Forest Herbarium, 2001). The Flora of Thailand treatment by Phengklai (2008) reported that there are 119 Fagaceae species, distributed in all of floristic regions, i.e., 60 spp. in Northern, 39 spp. in Northeastern, 18 spp. in Eastern, 10 spp. in Central, 18 spp. in Southwestern, 25 spp. in Southeastern and 48 spp. in Peninsular.

Table 1 Fagaceae in Asia and other countries

Study site	Number of genera	Number of species	References
Philippines	3	41	Merrill, 1923
Indo-China	3	157	Hickel and Camus, 1928
Burma	2	15	Scott and Parkinson, 1930
Sumatra	2	9	Merrill, 1934
Laos	4	122	Xaydala, 1998
Java	3	23	Backer and Bakhuizen van den Brink, 1965
Japan	5	20	Ohwi, 1965
Eastern Himalaya	3	6	Kanai, 1975
Malaya	4	64	Cockburn, 1972
Malesia	5	171	Soepadmo, 1972
Sabah	4	77	Cockburn, 1976
Taiwan	8	43	Liu and Liao, 1975
India	2	46	Brandis, 1978
Singapore	3	18	Keng, 1990
Australia	1	3	Elliot and Jones, 1992
Vietnam	5	214	HÔ, 1993
China	7	294	Chengjiu *et al*., 1999
Thailand	4	119	Phengklai, 2008

2.2. Ecology

Fagaceae can be found from sea level to about 3000 m altitude in lowland to montane forests (Soepadmo *et al*., 2000) and are very common in primary rain forest, lowlands to mountain tops, and rare in secondary forest (Cockburn, 1972). Most species are found in lower montane forests or mixed dipterocarp (Cockburn, 1972; Soepadmo *et al*., 2000; Santisuk, 2007) at altitudes ranging from 500 to 1800 m, on a variety of soils, rarely found in peatswamp forests and limestone. In *Castanopsis*, *Lithocarpus* and *Trigonobalanus* pollination are effected by insects, while in *Quercus* it is by wind (Soepadmo *et al*., 2000). Dispersal of fruits is carried out by pigs, rats and monkeys, (Cockburn, 1972) and squirrels (Cockburn, 1972; Soepadmo *et al*., 2000).

3. Classification

Jones and Luchsinger (1987) placed Fagaceae in the Order Fagales. Hutchinson (1967) separated it into 3 subfamilies and 8 genera based on inflorescence characters:

1. Subfamily Fagoideae has an inflorescence consisting of a 1- many-flowered axillary dichasial cluster; contains 2 genera, *Fagus* L. and *Nothofagus* Blume.

2. Subfamily Castaneoideae has the inflorescence catkin-like; stigmas minute and punctiform; male inflorescence rigid; male flowers with vestige of an ovary usually present; stamens usually 12; anthers minute; contains 4 genera, *Castanea* Miller, *Castanopsis* Spach, *Chrysolepis* Hjelmqvist and *Lithocarpus* Blume.

3. Subfamily Quercoideae has the inflorescence catkin-like; stigma dilated and covering the more or less recurved upper face of the style; male flowers without a vestige of an ovary; stamens usually 6; anthers large; contains 2 genera, *Quercus* L. and *Trigonobalanus* Forman.

Genera morphology of the Fagaceae (Hutchinson, 1967; Kubitzki, 1993)

1. *Chrysolepis* Hjelmqvist

Evergreen trees up to 40 m. high; leaves lanceolate or oblong, coriaceous, margin entire, revolute, obscurely pinnately nerved; stipules oblong, scarious, caducous; male catkin in a short panicle terminal on the branches; sometimes the catkins androgynous male flower in fascicles of 3 in the axils of large, ovate, mucronate bracts; perianth 5–6 lobed; stamens 12, rudimentary ovary tomentose; female flowers with a perianth of short rounded tomentose lobes; styles 3, stout; cupule subglobose, sessile, with 5 outer valves free from early development, covered outside with elongated spines and branch hairs; fruit separated by the inner cupule-lobes, maturing during the second season, ovoid-trigonous; pericarp rather hard, glabrous, brownish, shining; cotyledons not ruminate. Two species are found in Western N America.

2. *Castanea* Mill.

Trees with furrowed bark; leaves deciduous, alternate, elliptic or oblong-elliptic, pinnately nerved, sharply serrate; stipules 2, usually caducous or herbaceous; inflorescences spike-like, unisexual or androgynous, male inflorescences cylindric, more or less erect, in the axils of the lower leaves of the annual shoots, caducous, the upper androgynous; male flowers at the top; 3–7 in contracted cymes in the axils of small bracts perianth campanulate, deeply 6-lobed, lobes imbricate; stamens 6–20, exserted; filaments filiform, free; anthers small, ovoid or subglobose, dorsifixed, 2-locular, loculi contiguous, dehiscing lengthwise; rudimentary ovary present or absent; female flower usually 1–3 in a common involucre furnished with branched spines and scaly bracts; perianth 6–8-toothed; ovary incompletely 6–9-locular; styles 6–9; cupule subspherical, dehiscing into 4 valves and enclosing 3 nuts or cupule 2-valved and enclosing 1 nut; cotyledons undulate-ruminate. About 10 species are found in temperate regions of the Northern hemisphere.

3. *Castanopsis* Spach

Trees or rarely shrubs; leaves evergreen or deciduous, entire, toothed or lobed; flowers monoecious; spikes mostly unisexual, erect; bract small; calyx of both sexes cup-shaped, lobes usually 6; male flowers with mostly 12 stamens, at the base of the calyx; anthers ovate or globose; rudimentary ovary present; female flowers with 3-locular ovary; styles 3, stigma a terminal pore; cupule irregularly opening and covered with clusters of spines or tubercles in ± cyclic arrangement, rarely almost smooth, enclosing 1–4 ovoid or plano-convex nuts; pericarp coriaceous; seed usually 1 to each nut; cotyledons plano-convex. Hundred and one species, probably less, are found in S and SE Asia.

4. *Lithocarpus* Blume

Trees; leaves usually evergreen, mostly entire; flower monoecious or dioecious, often androgynous; terminal buds solitary; spikes erect, often androgynous, with the female in the lower part, the male above, sometimes a few bisexual flower between them; flowers solitary or in clusters of 3 or more; calyx cupular; male flowers usually with 12 stamens; female flowers surrounded by an involucre of many imbricate or annular scales; ovary 3-loculear; styles 3; cupules solitary or in dichasial clusters, never with vertical sutures, squamose, muricate, or lamellate, enclosing 1 female flower only; fruit ovoid, globose or turbinate; pericarp crustaceous, coriaceous or woody, tipped by the persistent styles, adherent at the base to the cupule or sometimes entirely; seed 1, cotyledons plano-convex or sinuous, sometimes indented by protuberances of the endocarp. About 100 species from NE India through China and Malesia to New Guinea, 1 species are found in Southwestern USA.

5. *Trigonobalanus* Forman

Trees; leaves evergreen, alternate or in whorls of 3, entire or partly crenate; stipules interpetiolar and connate in pair, or in the alternate leaves free; inflorescence spike-like, unisexual or androgynous, often branched, pendulous or erect; male flowers in fasicles of 3–7; perianth lobes 6, imbricate; stamens 6; anther large; rudimentary ovary

absent; female flowers single or in fascicles on the rachis, each flower with 6 staminodes; ovary 3-locular; ovules 2 in each locules, pendulous from the inner angle; styles 3; stigma capitate; cupules open, usually 3-or 5-lobed, outside covered with transverse dentate lamellae or scales; fruit trigonous, the edges winged or rounded; cupule open, but adaxial lobe always reduced, covered outside with transverse dentate lamellae or scales containing (1–)3–7 per cupules. Three species. are found in Columbia, N Thailand, Laos and Yunnan, N Sumatra and Malay Peninsula to Celebes.

6. *Quercus* L.

Trees or shrubs; leaves deciduous or evergreen, toothed or lobed, rarely entire; flowers monoecious, male flowers solitary or 1–3 together in pendulous spikes, the females solitary in erect few-flowered spikes; male calyx 3–6-lobed, subtended by small bracteoles, stamens usually 6; female flowers with smaller calyx, surrounded by an involucre of many imbricate or annular scales; ovary 3-locular; styles usually 3, short, recurved; stigmas broad, lining the inner faces of the styles; fruit (acorn) inserted on or partly enclosed by a cup-shaped or saucer-shaped cupule, the involucral scales hardened into teeth or tubercles or annular lamellae; pericarp crustaceous or coriaceous, tipped by an umbo composed of the persistent styles; seed 1, with fleshy cotyledons plano-convex. About 350–450 species are found in the northern temperate and subtropical regions with extensions into the tropics in W Malesia and northwestern S America.

7. *Fagus* L.

Trees; bark smooth; winter-buds elongate, acute; leaves deciduous, dentate, plicate in bud, with parallel pinnate nervation; male flowers numerous, in slender pedunculate heads; calyx 4–7-lobed, stamens 8–16; female flowers usually 2, surrounded by numerous bracts united below into a 4-partile pedunculate involucre; styles 3, slender, recurved; fruit an ovoid-triangular nut, (1–)2 in a 4-valved woody cupule which on the outside is covered with prickly or bract-like, or rarely short and deltoid appendages. About 10 species are found in temperate regions of northern hemisphere.

8. *Nothofagus* Blume

Trees or shrubs, leaves evergreen or deciduous, usually small, mostly plicate in bud; serrate or entire; stipules usually peltately attached; flowers monoecious or rarely dioecious; either solitary or in groups of three; male flowers in sessile to shortly pedunculate 1–3-flowered dichasia; perianth splitting irregularly, campanulate, 4–6-lobed; stamen 8–40 per flower; female flower (7–)3–1 in a sessile or shortly stalked involucre; styles short; involucre in fruit covered outside with bristly deltoid or foliaceous sometimes gland-tipped processes; fruits surrounded by a 4(–2–1)-valved cupule with lamellar appendages, the cupule lobes sometimes largely fused or missing; nuts 3- or 2-angled, generally winged; endocarp glabrous; seeds without endosperm. About 35 species are found in temperate S America, New Zealand, Tasmania and SE Australia, New Guinea and New Caledonia.

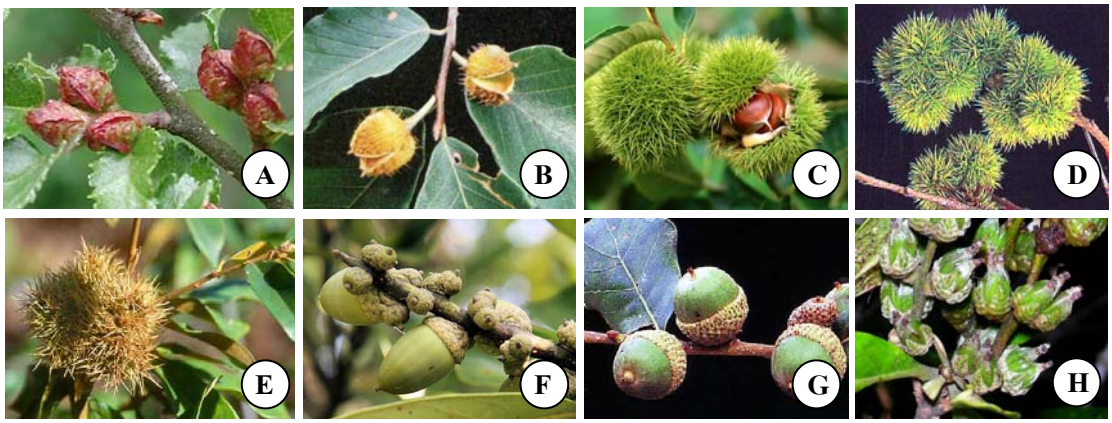

Figure 9 Acorn forms

A. *Nothofagus*; B. *Fagus*; C. *Castanea*; D. *Castanopsis*; E. *Chrysolepis*; F. *Lithocarpus*; G. *Quercus*; H. *Trigonobalanus*.

Source: A. Markowski (2009); B. Samuelson and Hogan (2003); C. Anonymous (2009a); D. Gardner *et al*. (2000); E. Oregon State University (2009); F. Shu Suehiro (2009); G. Kirkman *et al.* (2007); H. Anonymous (2009b)

Heywood *et al.* (2007) placed Fagaceae in Subclass Rosidae and moved *Nothofagus* into its own family, based on a cladistic analysis of morphology and molecular studies. The remaining genera were separated into 3 subfamilies based on inflorescence characters:

1. Subfamily Fagoideae; inflorescences a 1- to many-flowered axillary cluster; contains 1 genus, *Fagus* L. (male inflorescences long-stalked, many-flowered; style long).

2. Subfamily Castaneoideae; inflorescence catkin-like, flowers usually with 12 stamens and dorsifixed anther about 0.25 mm long; contains 4 genera, *Castanea* Miller (cupule valves joined when young; style 6 or more; leaves deciduous), *Castanopsis* Spach (cupule valves joined when young; style 3; leaves evergreen), *Chrysolepis* Hjelmqvist (cupule devided into free valves) and *Lithocarpus* Blume (cupule without valves).

3. Subfamily Quercoideae; inflorescence catkin-like, flowers usually with 6 stamens and more or less basifixed anthers 0.5–1 mm long; contains 2 genera, *Quercus* L. (female flowers borne singly in the inflorescences; fruit round in transverse section, cupule not lobed) and *Trigonobalanus* Forman (female flowers in clusters of 3, sometimes up to 7; fruit 3-angled; cupule lobed).

In Thailand 4 genera occur (Chayamarit, 2002; Phengklai, 2008). Chayamarit (2002) placed Fagaceae in Order Amentiferae and made a key to the genera by using inflorescence, cupule, nut and leaf characters but Phengklai (2008) made 3 keys to the genera, the first key using the inflorescence characters, the second key using the acorn characters and the third key using the vegetative and bark characters.

4. A brief history of Fagaceae research in Thailand

Paulsen (1902) surveyed in Ko Chang and found 3 Fagaceae species, *Quercus semiserrata* Roxb., *Q. lanceæfolia* Roxb. and *Castanopsis armata* (Roxb.) Spach.

Kerr (1911) surveyed at Doi Suthep, Chiang Mai province and found *Quercus* spp. and *Castanopsis* spp. at elevations about 2000 feet and higher, so called this type of forest 'oak jungle'.

Craib (1911) studied dried specimen of Fagaceae from Thailand which were stored in Kew Herbarium and reported that there were 16 species, *Castanopsis* 3 spp. and *Quercus* 13 spp. Included were 4 new species, *Q. garrettiana* Craib, *Q. kerrii* Craib, *Q. kingiana* Craib and *Q. sootepensis* Craib. This report did not combine the species from Ko Chang found by Paulsen (1902).

Barnett (1940) studied the Fagaceae in Asia and found in Thailand 64 species, in 3 genera, *Castanopsis* 15 spp., *Lithocarpus* 27 spp. and *Quercus* 22 spp.

Forman (1964) changed the scientific name of *Quercus doichangensis* A. Camus to *Trigonobalanus doichangensis* (A. Camus) Forman thus adding a new genus to the family Fagaceae in Thailand.

Eiadthong (1993) studied the family Fagaceae in Huai Kha Kheng Wildlife Sanctuary and found 15 species in 3 genera; *Castanopsis* 2 spp., *Lithocarpus* 9 spp. and *Quercus* 4 spp., 2 varieties.

Lencham (1998) studied the family Fagaceae in Kaenoy Royal Project, Chiang Mai, and found 25 species and 3 genera; *Castanopsis* 8 spp., *Lithocarpus* 8 spp. and *Quercus* 9 spp.

Phengklai (2008) surveyed Fagaceae in Thailand using both his own specimen collections and dried specimen from herbaria and found 119 species from 4 genera;

Castanopsis 33 spp., *Lithocarpus* 56 spp., *Quercus* 29 spp., 1 subspecies and 1 variety and *Trigonobalanus* 1 species (*T. doichangensis* (A. Camus) Forman).

5. Uses

Wood: Oak is the most important of all the hardwoods. The wood is hard and heavy, it is suitable for medium to heavy construction under cover, such as house posts, beams and flooring. If quarter-sawn, it produces the characteristic beautiful silver figure from the large ray so that it is also suitable for furniture, cabinet making, interior fitting, paneling, and for manufacturing plywood and slice veneers. Locally the wood is used for fence posts, mining props, shingles, boat building, and for making tool handles, rice panders, poles for carts and for firewood and charcoal. Branches and stems are used as bed logs in mushroom cultivation, i.e., *Lithocarpus* spp., *Quercus* spp. (Tonanon, 1996; Soepadmo *et al*., 2000).

Bark: Commercial Cork is obtained mostly from the Cork Oak, *Quercus suber* L. Cork consists of the outer bark of the tree (Hutchinson, 1967; Wickens, 2001). The bark of most species contains a high percentage of tannin and is occasionally used to tan leather and dye rattan and cotton fabrics, but now it has become obsolete (Soepadmo *et al*., 2000).

Leaves: Mature leaves of *Quercus robur* L. may be fed to animals and likewise mature leaves of several oaks are used as fodder (Burkill, 1966). Leaves of *Q.* aliena Blume and *Q. acutissima* Carruth. are fed to caterpillars of moths (genus *Attacus*) (Smitinand, n.d.).

Gall: There is more tannin in this part, tannic acid is extracted from the nut gall of oak species *Quercus alba* L., *Q. lamellosa* Sm., *Q. pachylla* Kurz and *Q. infectoria* Oliv. (Simpson and Ogorzaly, 1995; Smitinand, n.d.), and has been used for both dyeing and medicine. In the Chinese pharmacies, they are used in several preparations given for imperfectly diagnosed complaints of the stomach, increasing appetite, treating sapraemia and leucorrhoea, for sore throat and ulcers by an infusion in vinegar applied to a gumboil, and a lotion recommended for skin complaint (Burkill, 1966).

Nut: The nuts of some species of *Castane*a, i.e., *C. mollissima* Blume (Chestnut), *C. sativa* Mill and *C. crenata* Sieb & Zucc are edible, the contain protein, starch and fat. They also are a source of vitamin C and magnesium, calcium and phosphorus (Ciesla, 2002). In Europe they are used in candies, pastries, pureed as a vegetable, and eaten as a plain or roasted nut (Simpson and Ogorzaly, 1995). In Kuala Lumpur, the nuts of *Castanopsis inermis* (Lindl.) Benth. & Hook.f. can be found occasionally in the markets (Cockburn, 1972). In Thailand has several edible native nuts such as *Castanopsis acuminatissima* (Blume)A. DC., *C. wallichii* King ex Hook. f. and *C. diversifolia* (Kurz) King & Hook. f. (Eiadthong, 2002). Beside a human food, it is also an animal food for cows, pigs, bears, etc. Nuts have been mentioned as a possible source of industrial alcohol (Burkill, 1966).

Figure 10 Uses

A. furniture from oak; B. corks from bark; C. nut gall; D. chestnuts roasted.

Source: A. Anonymous (2009c); B. Cuyamaca college (2009); C. Phichiansunthon and Jirawong (2004); D. Achromatic (2003)

MATERIALS AND METHODS

Materials

1. Materials for collecting specimens include a plant press, pruning knife, secateurs, plastic bags, newspapers, corrugated cardboards, spirit bottles, rope, tags and altimeter.

2. Materials for recording include a camera and digital camera, color films, field notebook and pencil.

3. Materials for preserving and mounting specimens include alcohol 70%, various sized bottles, mounting paper (paper of 300 gram, 42 x 26.5 cm, which 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.

4. Instruments for identifying specimens include a stereo microscope together with scale, ruler, calipers, petri dish, dissecting needles, forceps and razor blade.

Methods

1. Data of Fagaceae from floras, journals and reports on the survey of this family from various areas were collected and compiled. The herbarium specimens deposited in the Forest Herbarium (BKF), National Park Wildlife and Plants Conservation Department and Bangkok Herbarium (BK), Department of Agriculture were also studied.

2. Collections of Fagaceae were made in sets of three to ten, from the natural habitats in various regions of southeastern Thailand. Photographs and notes were also taken. The specimens were mounted on herbarium sheet and some of the flowers and fruits were preserved in alcohol 70 % for further study.

3. Morphological characteristics of the Fagaceae were observed from fresh materials and from herbarium specimens deposited at BKF, BK, BSKU and Herbarium of Khao Hin Son Botanic Garden, Chachoengsao Province. Flowers were dissected and examined under a stereo microscope and also photographs as well as measurements of various parts of plants were taken. This study defined shapes of the cupule by the ratio of cupule to the length of the acorn as follow: <1/8 = dish-shaped; ≥1/8-1/4 = saucer-shaped and the height of the >1/4 = cup-shaped.

4. Identification of plants into species was done by observing morphological characteristics, checking references and comparing with herbarium specimens at BKF and BK. Then, the names were verified to be the correct botanical names by taxonomic study. Detailed description of each species as well as line drawing were done, followed by the construction of a key to the species.

5. The identified specimens were kept as references at BKF, BSKU and Herbarium of Khao Hin Son Botanic Garden, Chachoengsao Province for future study and research.

Places and Duration

Places

This study covered several areas as follows;

1. Natural forests in 8 areas of Southeastern Thailand; Khao Yai National Park, Prachin Buri province; Pang Sida National Park, Sa Kaeo province; Khao Ang Rue Nai Wildlife Sanctuary, Chachoengsao province; Khao Chamao-Khao Wong National Park, Rayong province; Khao Khitchakut National Park, Chanthaburi province; Khao Soi Dao Wildlife Sanctuary, Chanthaburi province; Nam Tok Khlong Kaeo National Park, Trat province and Mu Ko Chang National Park, Trat province.

2. Botany Department, Faculty of Science, Kasetsart University.

3. Forest Herbarium (BKF), National Park Wildlife and Plants Conservation Department.

4. Bangkok Herbarium (BK), Department of Agriculture.

5. Herbarium of Khao Hin Son Botanic Garden, Chachoengsao Province.

Duration

The study was done from October 2003 to May 2009.

RESULTS AND DISCUSSION

1. Morphological Characters

1.1. Habit

All species of Fagaceae in Southeastern Thailand are evergreen trees (Figure 11), monoecious; buttresses are sometimes present; bark is mostly smooth with shallow fissures, sometimes with distinct lenticels, rarely flaky and deeply fissured (Figure 12). Mostly the blaze of *Lithocarpus* and *Quercus* has rather distinct furrows, while *Castanopsis* has thin and elongated furrows (Figure 13).

Figure 11 Habit: Evergreen tree

Figure 12 Bark characters

A. shallowly fissured; B. distinct lenticels; C. flaky; D. deeply fissured. Photographed by B. Harwood (C&D).

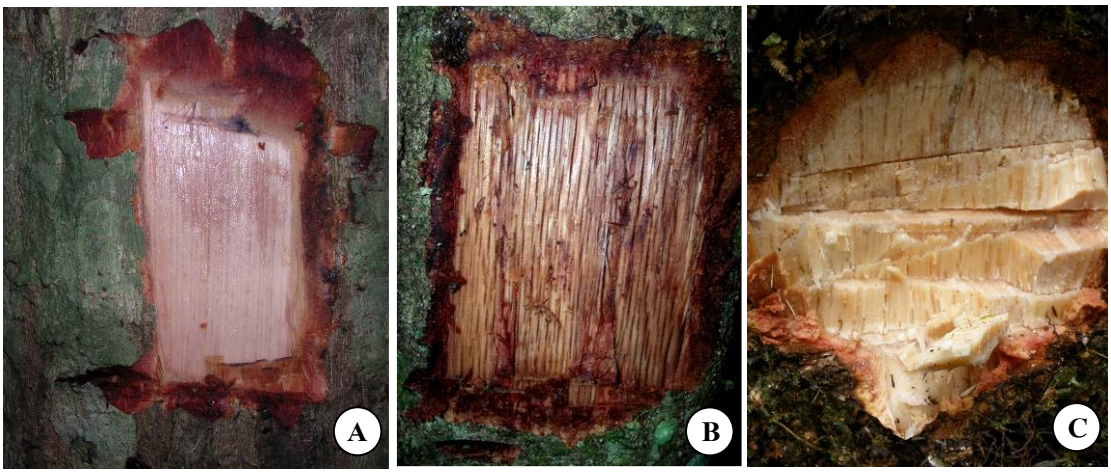

Figure 13 Blaze characters

A. thin and elongated furrows; B–C. distinct furrows. Photographed by B. Harwood (C).

1.2. Leaves

The leaves are simple, spiral or alternate, rarely pseudo-whorled, stipules usually caducous; margin entire, serrate or undulate, rarely dentate; veins pinnate, cross veins scalariform; texture subcoriaceous to coriaceous, sometimes chartaceous; surfaces usually hairy when young then glabrescent (Figure 14); leaf shapes vary; but always with the apex and base acute to some degree (Figure 15).

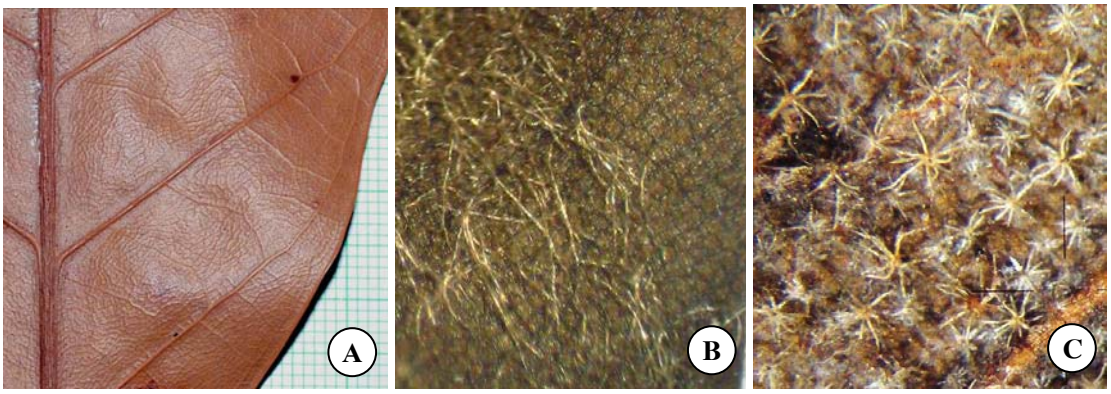

Figure 14 Leaf surfaces

A. glabrous; B. simple hairs; C. stellate hairs.

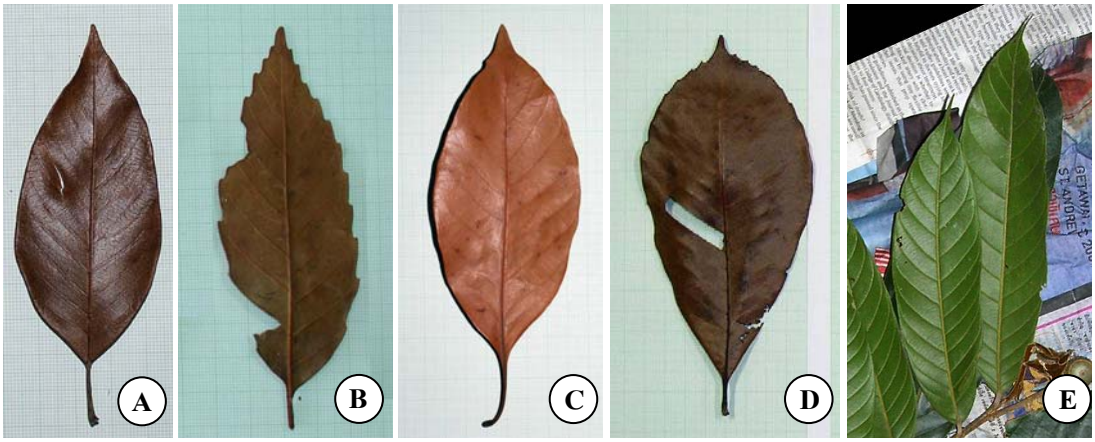

Figure 15 Leaf forms

A. margin entire; B. margin serrate; C. shape elliptic; D. shape obovate; E. shape oblong.

1.3. Inflorescences

Inflorescences of Fagaceae are catkins or panicles, male and female separate or mixed. Male inflorescences of *Castanopsis* and *Lithocarpus* always are erect panicles or catkins, while *Quercus* has pendulous catkins. Female inflorescences of *Castanopsis* and *Lithocarpus* usually had long erect catkins or panicles, while *Quercus* had short erect catkins. Mixed inflorescences, with both the male and female florets arranged in the same axis, can be found in *Castanopsis* and *Lithocarpus* (Figure 16).

1.4. Flowers

The flowers of Fagaceae are unisexual. Florets are single or in clusters of 3 to numerous. The texture of the perianth is usually membranous. Male florets of *Castanopsis* and *Lithocarpus* look the same, including similar pistillode, number of stamens and small anthers which contrasts with *Quercus*, which lack a pistillode, has less stamens and bigger anthers (Figure 17).

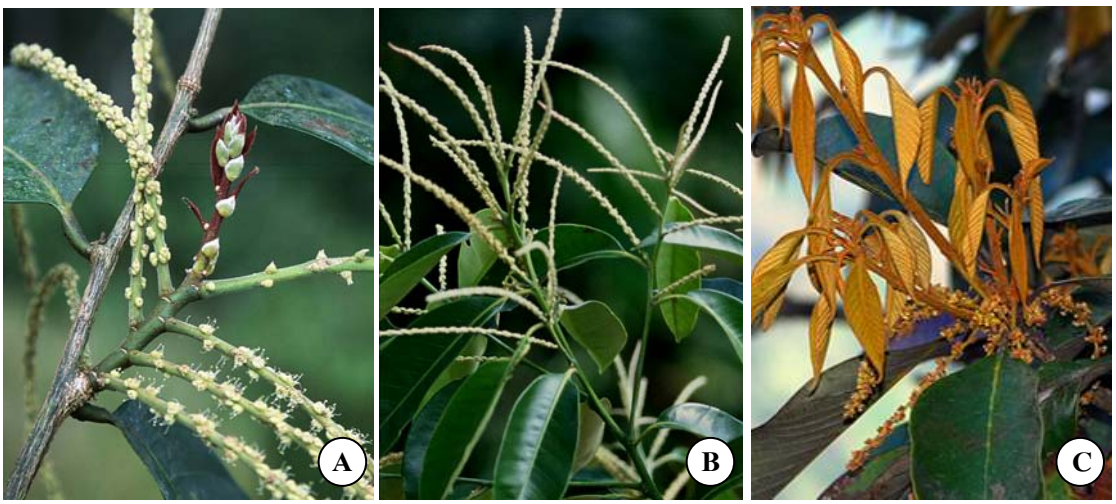

Figure 16 Inflorescence types
A. panicles; B. erect catkins; C. pendulous catkins. Photographed by P. Phonsena (C).

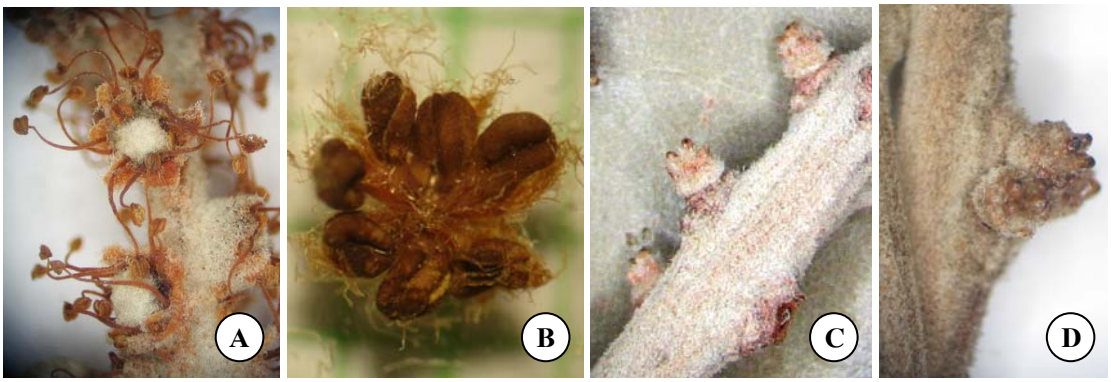

Figure 17 Florets on rachis
A. male florets with pistillode; B. male florets without pistillode; C. female florets single; D. female florets dichasium.

1.6. Acorn

An acorn is the nut and the surrounding or cupule formed by the involucral bracts. The cupule is the structures enclosing the base of the nut, single or united with other cupules at the base, covering part or all of the nut, stalked or sessile

(Figure 18). Cupule surface is covered with hard or soft spines, scales or lamellae; hard spine shape of the cupule has 3 forms: single, clustered or branched spines (Figure 19). Cupule characteristics are useful for classifying species of Fagaceae.

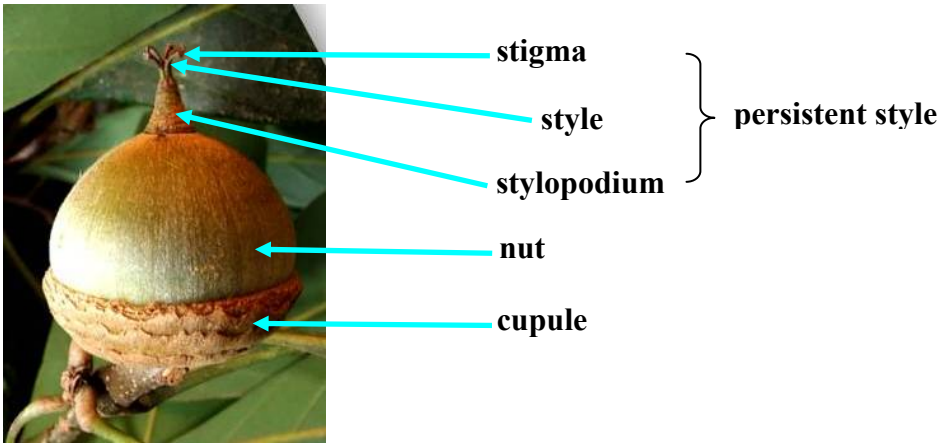

Figure 18 Structure of acorn

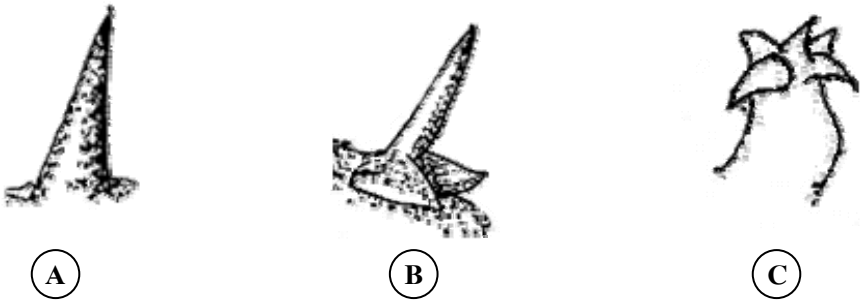

Figure 19 Hard spine shape

A. single spine; B. clustered spines; C. branched spine.

1.6. Fruits

The fruit of Fagaceae is an indehiscent nut; the size and the shape are different in each species such as ovate, depressed globose, subglobose, obovate, semicircular or wedge-shaped. The bottom of the nut is concave or convex and this is good character for classifying species of Fagaceae.

2. Distribution of Fagaceae in Southeastern of Thailand

Fagaceae in Southeastern Thailand comprises 3 genera, 19 species, widespread within 8 studied areas of Southeastern Thailand; 7 species in Khao Yai National Park, 4 species in Pang Sida National Park, 4 species in Khao Ang Rue Nai Wildlife Sanctuary, 3 species in Khao Chamao-Khao Wong National Park, 8 species in Khao Khitchakut National Park, 12 species in Khao Soi Dao Wildlife Sanctuary, 3 species in Nam Tok Khlong Kaeo National Park and 6 species in Mu Ko Chang National Park (Table 2, Figure 20).

Lithocarpus has the most widespread distribution and can be found in every studied area, *Castanopsis* is not found in Khao Chamao-Khao Wong National Park, and *Quercus* was rather common in Khao Soi Dao Wildlife Sanctuary and sparse in other areas except Khao Ang Rue Nai Wildlife Sanctuary and Nam Tok Khlong Kaeo National Park, where it does not occur at all (Figure 20).

Member of Fagaceae in Southeastern Thailand occur at various altitudes from sea level to 1500 m. (Table 3). Three species, *Quercus auricoma* A. Camus, *Q. oidocarpus* Korth and *Q. poilanei* Hickel & A. Camus are specific to high altitude in hill evergreen forest, altitude over 1100 m, and 3 species are specific to low altitude evergreen forest, often near streams, i.e., *Castanopsis pierrei* Hance, *Lithocarpus* cf. *dealbatus* (Hook. f. & Thomson) Rehder and *L. wallichianus* (Lindl. ex Hance) Rehder., altitude under 100 m.

Comparision with the distribution reported by Phengklai (2008) which found 25 species of Fagaceae in Southeastern Thailand that match with this study for 11 species and there are new location for 8 species, *Lithocarpus cantleyanus* (King ex Hook. f.) Rehder, *L.* cf. *dealbatus* (Hook. f. & Thomson) Rehder, *Quercus auricoma* A. Camus, *Q.* cf. *lineata* Blume, *Q. oidocarpus* Korth, *Q. poilanei* Hickel & A. Camus, *Q. rex* Hemsl. and *Q. thorelii* Hickel & A. Camus. One species is a new record in Thailand; *Q. thorelii* Hickel & A. Camus is known from Khao Soi Dao Wildlife Sanctuary at altitude from 300–800 m (Table 3). Two of these species, *Q. poilanei* Hickel & A. Camus and *Q. rex* Hemsl. were previously only found in Northern Thailand.

Table 2 Distribution of Fagaceae in Thailand compare with studied areas in SE

Species	Thailand Florestic Regions[1/]							Studied Sites in SE[2/]							
	N	NE	E	SW	C	SE	PEN	1	2	3	4	5	6	7	8
C. acuminatissima	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓		
C. pierrei		✓				✓	✓					✓		✓	✓
C. piriformis		✓	✓			✓	✓		✓	✓		✓	✓	✓	✓
L. cantleyanus		✓	✓				✓						✓		✓
L. cf. *dealbatus*	✓	✓	✓	✓								✓			
L. elegans	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		
L. eucalyptifolius			✓		✓	✓	✓	✓	✓	✓		✓	✓		
L. harmandii	✓	✓	✓	✓		✓		✓							
L. thomsonii	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓		✓
L. wallichianus	✓			✓		✓	✓								✓
L. wrayi	✓	✓				✓	✓							✓	
Q. auricoma	✓	✓	✓					✓							
Q. cf. *lineata*	✓	✓					✓					✓			✓
Q. oidocarpus	✓	✓					✓						✓		
Q. poilanei	✓												✓		
Q. quangtriensis	✓	✓		✓	✓	✓	✓				✓	✓	✓		
Q. rex	✓												✓		
Q. cf. *saravanensis*						✓		✓	✓				✓		
*Q. thorelii**													✓		

Notes [1/]Source: Phengklai (2008); N= Northern; NE= Northeastern; E= Eastern; SW= Southwestern; C= Central; SE= Southeastern; Pen= Peninsular.

[2/]1= Prachin Buri, Khao Yai National Park, 2= Sa Kaeo, Pang Sida National Park, 3= Chachoengsao, Khao Ang Rue Nai Wildlife Sanctuary, 4= Rayong, Khao Chamao-Khao Wong National Park, 5= Chanthaburi, Khao Khitchakut National Park, 6= Chanthaburi, Khao Soi Dao Wildlife Sanctuary, 7= Trat, Nam Tok Khlong Kaeo National Park, 8= Trat, Mu Ko Chang National Park.

* new record of Thailand.

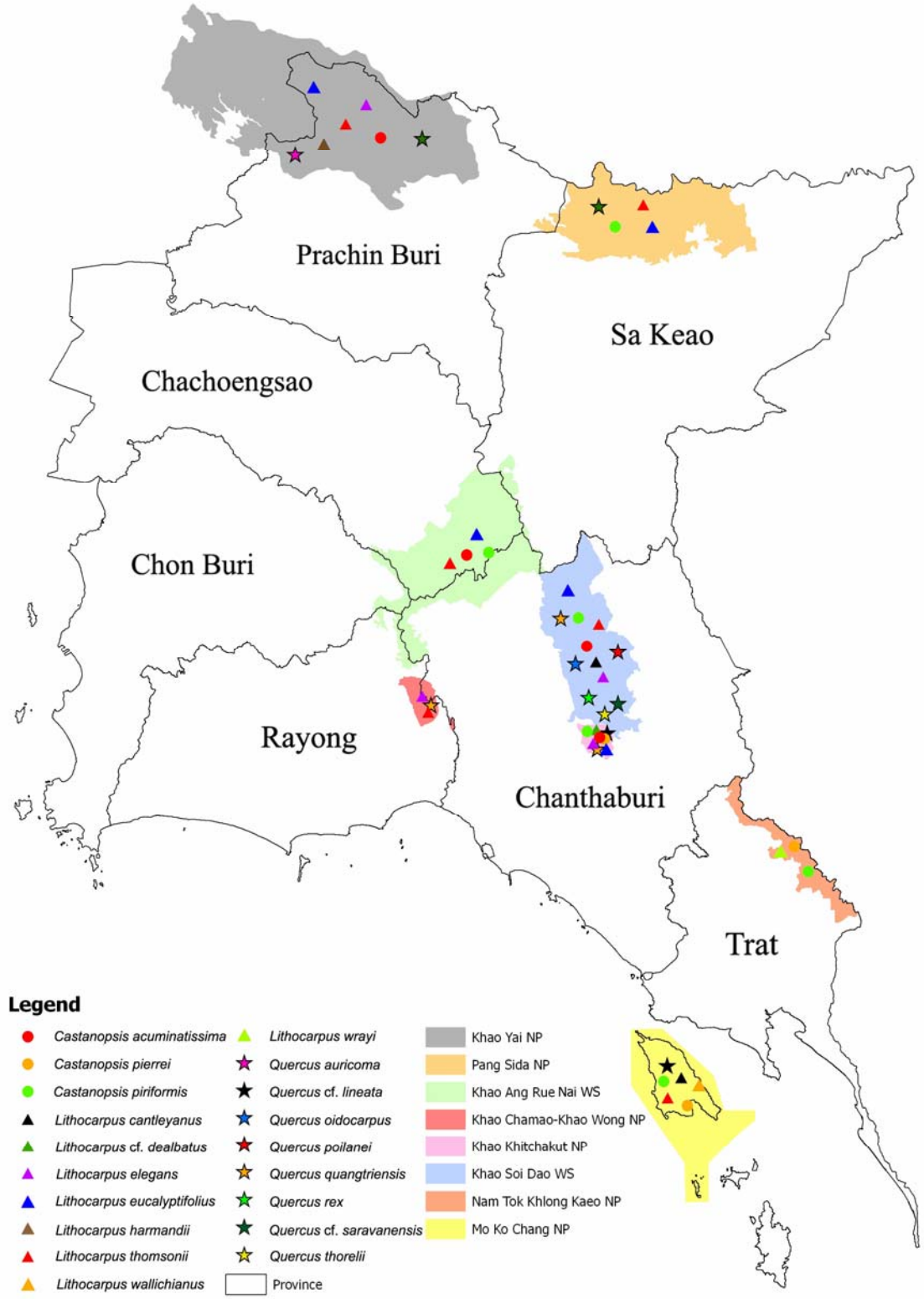

Figure 20 Distribution of Fagaceae in Southeastern Thailand

Table 3 Ecology of Fagaceae in studied areas

Species	Ecology	Alt. (m)
C. acuminatissima	Dry evergreen to hill evergreen forest	100–1500
C. pierrei	Evergreen forest	0–30
C. piriformis	Dry evergreen and evergreen forest	100–410
L. cantleyanus	Evergreen forest, near streams	0–920
L. cf. *dealbatus*	Lowland evergreen forest, often near streams	30–100
L. elegans	Evergreen and hill evergreen forest, limestone	915–1400
L. eucalyptifolius	Dry evergreen to hill evergreen forest, often near streams	150–1040
L. harmandii	Evergreen and hill evergreen forest	750–1260
L. thomsonii	Dry evergreen and evergreen forest	30–740
L. wallichianus	Evergreen forest, often near streams	0–70
L. wrayi	Lowland evergreen forest, often near streams, on limestone	100–200
Q. auricoma	Hill evergreen forest, open areas along cliffs	1100–1180
Q. cf. *lineata*	Evergreen forest, shaded and open areas	100–620
Q. oidocarpus	Hill evergreen forest, growing on exposed ridge near cliffs	1250–1500
Q. poilanei	Hill evergreen forest, near rocky cliff areas	1300–1470
Q. quangtriensis	Evergreen and hill evergreen forest, shaded and open areas	880–1100
Q. rex	Evergreen and hill evergreen forest	900–1100
Q. cf. *saravanensis*	Evergreen forest, near streams	290–630
*Q. thorelii**	Evergreen forest on mountain slopes	300–800

Note * new record of Thailand.

3. Taxonomic Characters

FAGACEAE

Monoecious, evergreen trees; bark mostly smooth and shallowly fissured, sometimes distinct lenticels, rarely flaky or deeply fissured, buttresses sometimes present. Indumentum of simple hairs, stellate hairs or lacking; scales or pits on the leaf underside. Stipules mostly caducous, rarely persistent. Leaves simple, spiral or alternate, pinnately nerved, margin entire or serrate; petiolate. Inflorescences catkins or panicles, male and female separate or mixed. Male inflorescences erect or pendulous catkins or panicles; male florets single or in clusters, perianth 4–6-lobed, connate; stamens 6–12, filaments filiform, basifixed or dorsifixed, anther opening by longitudinal slits; hairy pistillode frequently present. Female inflorescences erect catkins or panicles; female florets single or in clusters, individually or collectively by a cupule formed from numerous fused bracts, perianth as in male but usually smaller; ovary inferior; style and carpels as many as locules, stigmas capitate or punctate, terminal pore; staminodes 6(–12) or absent. Mixed inflorescences panicles both male and female flowers on the same axis, female flowers arranged individually or in small groups along an axis or mixed in the same axis or on a separate axis. Fruit a nut, 1–3 nuts surrounded or enclosed by a cupule formed by the involucral bracts. Cupule partly or completely covering the nut, indehiscent or dehiscent. Seed usually solitary by abortion, without endosperm. This study found 19 species 3 genera separated to 3 species of *Castanopsis*, 8 species of *Lithocarpus* and 8 species of *Quercus*.

Key to genera of Fagaceae in Southeastern Thailand

1. Blaze thin and elongated furrows; cupule completely covered, irregular vertical dehiscence……..……..……..…….....***Castanopsis***
1. Blaze distinct furrows; cupule partly covered, indehiscent
   2. Stigma punctiform; male floret with pistillode……...…...… ***Lithocarpus***
   2. Stigma capitate; male floret without pistillode…….……...…..…. ***Quercus***

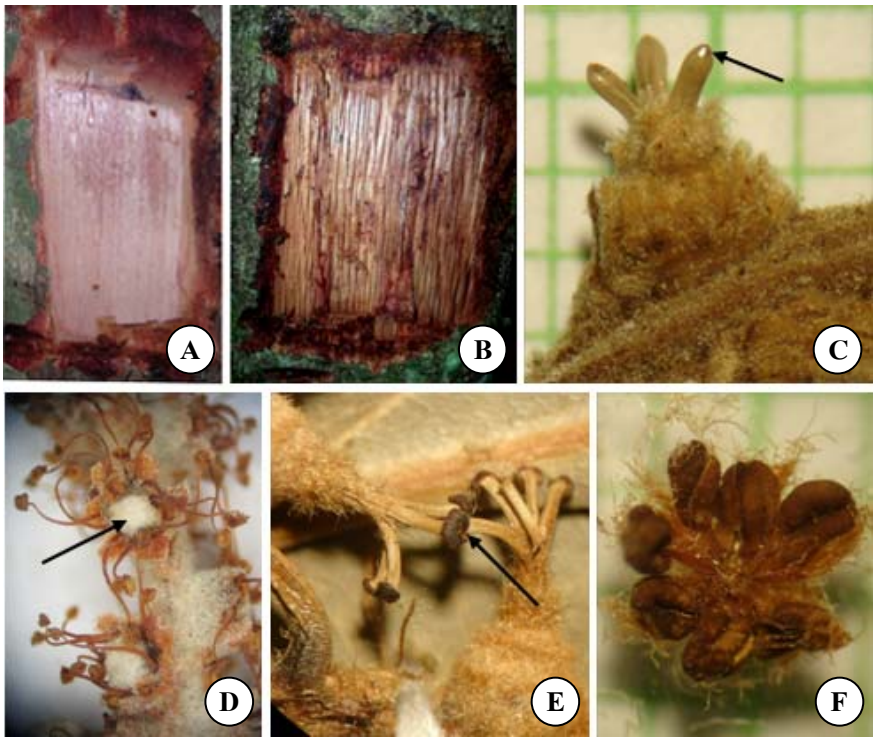

Figure 21 Details of each part used in key to genera

A. blaze thin and elongated furrows; B. blaze distinct furrows; C. stigma punctiform; D. male foret with pistillode; E. stigma capitate; F. male foret without pistillode.

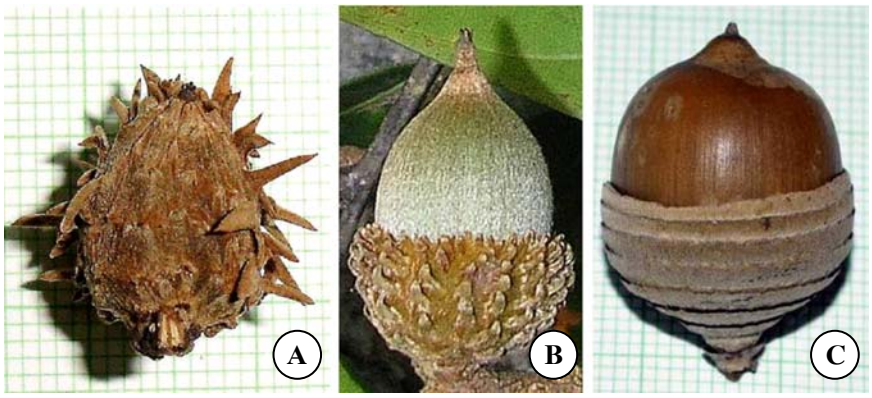

Figure 22 Acorns of *Castanopsis, Lithocarpus* and *Quercus*

A. cupule completely covering nut, surface with spines:*Castanopsis*;

B. cupule partly covering nut, surface with scales: *Lithocarpus*;

C. cupule party covering nut, surface with lamellae: *Quercus.*

Castanopsis Spach

Evergreen tree, blaze thin and elongated furrows. Leaves spiral or alternate; margin entire or serrate on the upper half to apex; cross veins scalariform; petioles thickened at base. Inflorescences panicles or catkins, erect, rachis hairy. Male florets in clusters or single; perianth 6–lobed, stamen (8–)10–12, filaments free, filiform; anther rather small, 0.2–0.3(–0.5) mm long, dorsifixed, longitudinally dehiscent; pistillode ca. 0.5–1 mm in diam. Female florets single or in clusters; perianth 4–6-lobed, styles 3, stigmas punctiform. Acorns ovoid, globose, two lobes or pear-shaped. Cupule completely covering nut, outer surfaces with hard spines, rarely smooth, irregularly dehiscence. Nuts 1 or 1–3 per cupule, subglobose, ovate, rarely semicircular or wedge–shaped. This study found 3 species of *Castanopsis* in Southeastern Thailand.

Key to species of *Castanopsis* in Southeastern Thailand

1. Cupule smooth or with undulate lines……...…..……...……..**3. *C. piriformis***
1. Cupule with spines
   2. Leaf serrate; acorn diameter 0.8–2 cm; nut 1 per cupule……..……..…
   ……..……..**1. *C. acuminatissima***
   2. Leaf entire; acorn diameter 3–5 cm; nut 1–3 per cupule……..…....**2. *C. pierrei***

1. Castanopsis acuminatissima (Blume) A. DC., J. Bot. 1: 182. 1863; Hickel & A. Camus in H. Lecomte, Fl. Indo-Chine 5: 1012. 1930; Barnett, Quer. Rel. Fag. Asia: 162. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 336. 1944; Hjelmq., Dansk Bot. Ark. 23: 494. 1968; Soepadmo in Fl. Males. 7(2): 307. 1972; Soepadmo, Julia & Go, Fl. Sabah, 3: 7. 2000; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 185. 2008. Figure 23, 24.

Vernacular.— **Ko dueai (ก่อเดือย)**.

Tree 8–30 m high; bark smooth, greenish brown to brown; twigs glabrous, densely lenticellate. **Leaves** spiral, subcoriaceous, lanceolate, 5.5–14 by 1.3–5.3 cm, apex acuminate to caudate, base cuneate to obtuse, margin mostly serrate on the upper half, upper surface glossy green, lower surface golden brown, both surfaces glabrous; midrib strongly raised on lower surface; lateral vein 9–13 pairs, flat on upper and raised on lower surface; cross veins indistinctly scalariform. **Petioles** 0.8–1.6 cm long, glabrous. **Inflorescences** panicles, terminal or in upper axils; rachis sparsely hairy. **Male inflorescences** 5–8 cm long; bracts 3.3 by 3 mm and bracteoles ca. 1 mm long; male florets single; perianth 6-lobed, ovate, 1.2–1.4 by 0.5–0.9 mm, connate, inside hairy and outside glabrous; stamens 10–12, 2–3 mm long, glabrous; anther 0.2–0.5 mm long; pistillode ca. 0.5 mm in diam. **Female inflorescences** 3–7 cm long; bracteoles 1.5 by 0.8–1 mm; female florets single, ca. 1–2 mm in diam.; perianth 6-lobed, ovate, ca. 0.5–1 mm long, connate; style 3, ca. 0.9 mm long, glabrous, tomentose at base; staminodes 6. **Infructescences** 4–8.6 cm long, erect. **Acorns** ovate, 1–1.4 by 0.9–1.2 cm, sessile. **Cupule** completely enclosing the nut and fused to the nut at base; wall 0.2 mm thick; outer surface with sparse single or clustered hard spines; spines 2–5 mm long. **Nuts** 1 per cupule, ovate, 0.9–1.3 by 1–1.1 cm, hairy or glabrescent, base truncate.

Ecology.— Common in dry evergreen to hill evergreen forest at Khao Yai National Park, Khao Ang Rue Nai Wildlife Sanctuary, Khao Khitchakut National

Park and Khao Soi Dao Wildlife Sanctuary; alt. 100–1500 m. Flowering: January–March; fruiting: July–September.

Uses.— Nut edible.

Notes.— This species is very similar to *C. tribuloides* (Sm.) A. DC. but to leaf margin of *C. acuminatissima* is serrate while *C. tribuloides* is entire.

Specimens examined.— *P. Phonsena & K. Bunpha* 3582, 20 Dec. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena & K. Bunpha* 3665, 15 Feb. 2003, Prachin Buri, Khao Yai National Park, Khao Khiao (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena* 3828, 5 Jul. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena* 3829, 5 Jul. 2003, Prachin Buri, Khao Yai National Park, Khao Khiao (BKF); *P. Phonsena* 3882, 22 Aug. 2003, Prachin Buri, Khao Yai National Park, Khao Khiao (BKF); *P. Phonsena et al.* 3397, 20 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 3553, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 3559, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3560, 13 Dec. 2002, Prachin Buri, Khao Yai National Park, Khao Khiao (BKF); *P. Phonsena et al.* 3877, 22 Aug. 2003, Prachin Buri, Khao Yai National Park, Khao Khiao (BKF); *P. Phonsena et al.* 3881, 15 Feb. 2003, Prachin Buri, Khao Yai National Park, Khao Khiao (BKF, Herbarium of Khao Hin Son Botanic Garden).

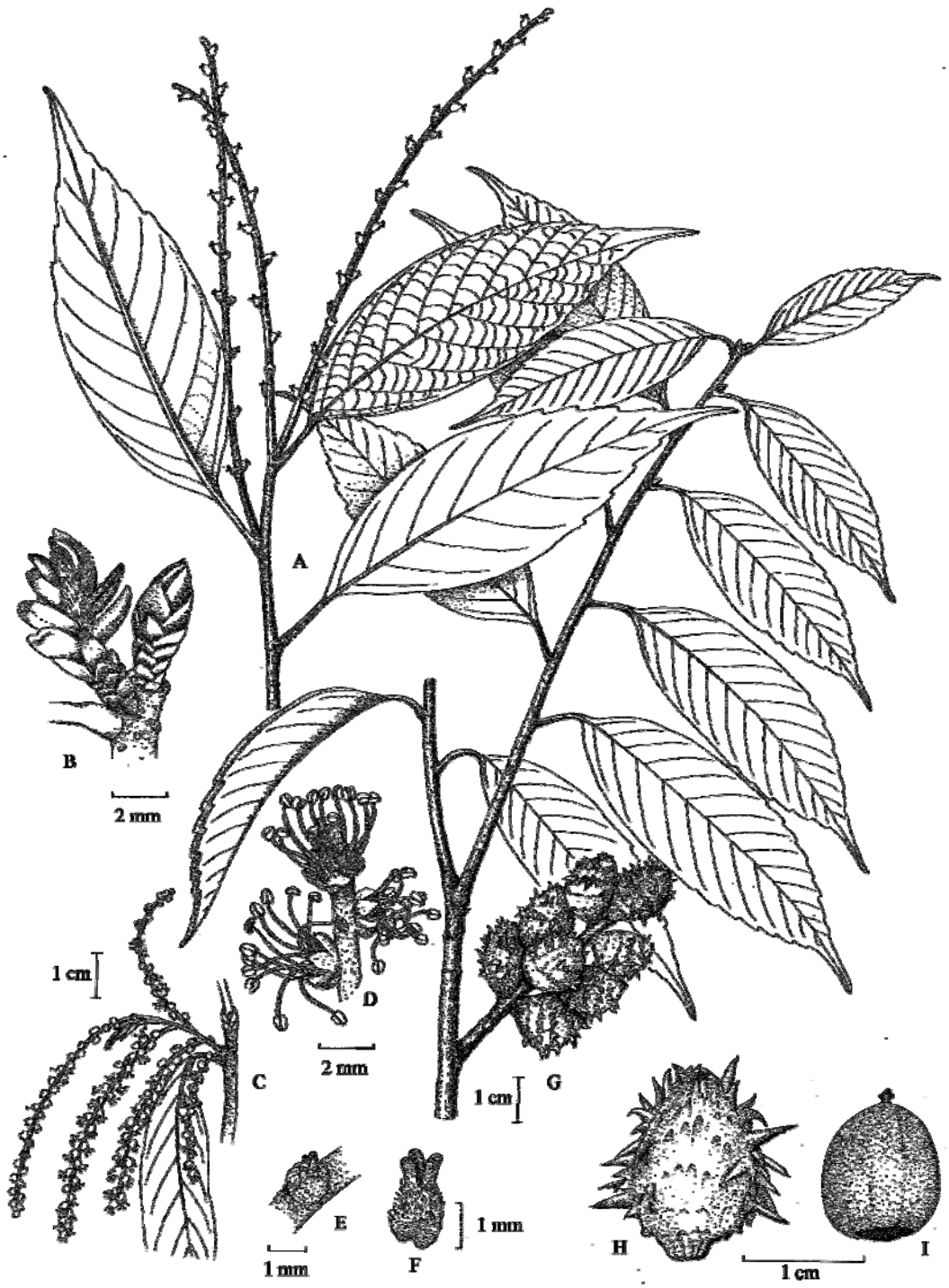

Figure 23 *Castanopsis acuminatissima* (Blume) A. DC. (ก่อเดือย)

A. branch with female inflorescence; B. buds; C. male inflorescences; D. male florets; E. female floret; F. female floret without perianth; G. branch with mature infructescence; H. acorn; I. nut. Drawn by O. Kerdkaew.

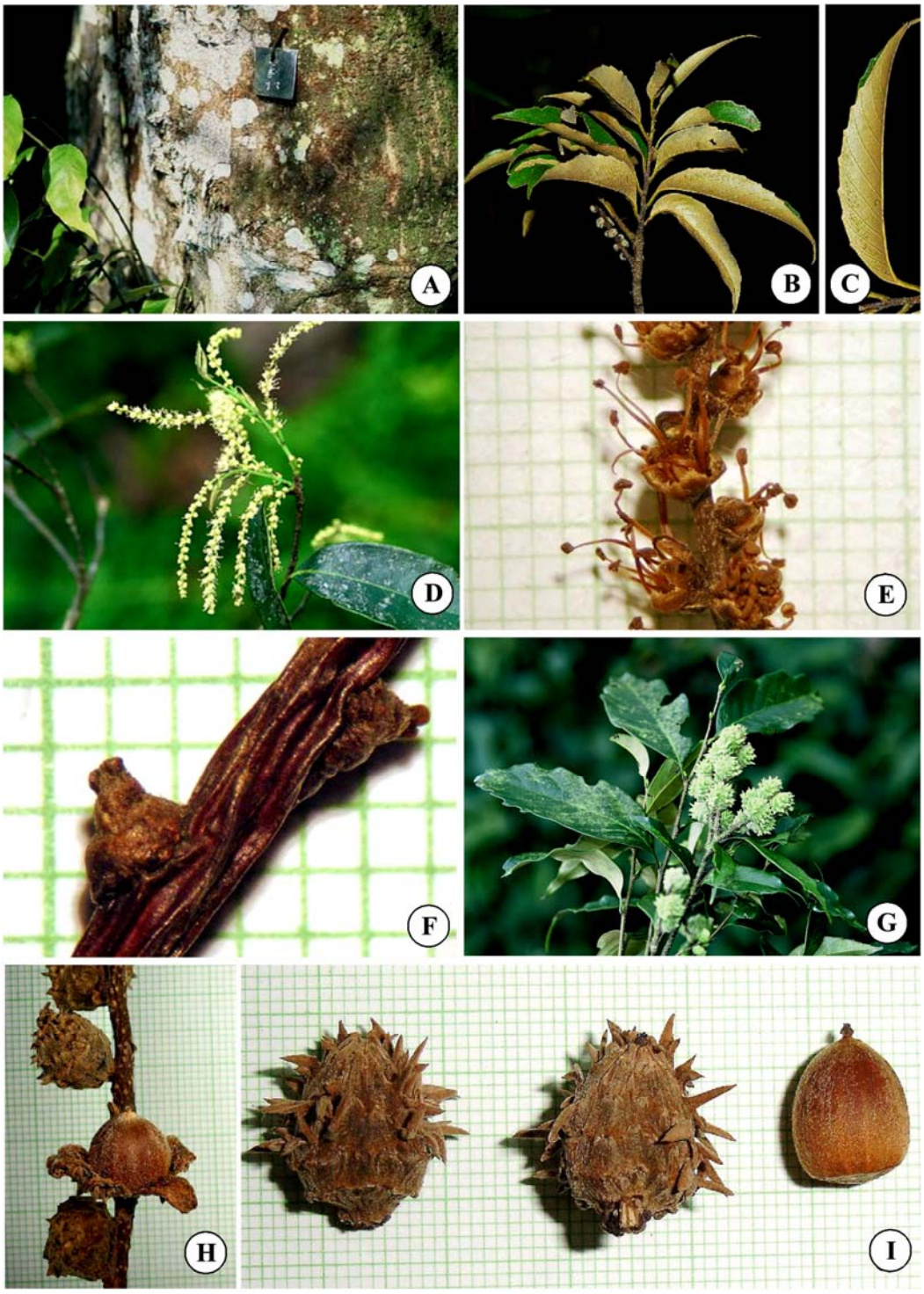

Figure 24 *Castanopsis acuminatissima* (Blume) A. DC.

A. bark; B. leaves; C. leaf: lower surface; D. male inflorescences; E. male florets; F. dried female florets; G-H. infructescences; I. acorns (left) and nut (right). Photographed by P. Phonsena (A, D, G).

2. Castanopsis pierrei Hance, J. Bot. 13: 369. 1875; Hickel & A. Camus in M.H. Lecomte, Fl. Indo-Chine 10: 1031. 1931; Barnett, Quer. Rel. Fag. Asia: 182. 1940, et Trans. Proc. Bot. Soc. Edinb. 33: 336. 1942, 34: 187. 1944; Hjelmq., Dansk Bot. Ark. 23: 498. 1968; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 225. 2008. Figure 25, 26.

Vernacular.— **Ko khi mu (ก่อขี้หมู)**.

Tree 18–23 m high; bark smooth or shallowly fissured, whitish grey, densely lenticellate. **Leaves** alternate, subcoriaceous, narrowly ovate to lanceolate, 11–15 by 3.5–6.3 cm, apex acuminate, base obtuse or round and slightly oblique, margin entire, surface glabrous on both sides, upper glossy green and lower golden brown; midrib raised on lower and slightly raised at base on upper; lateral veins 11–15 pairs, conspicuous on both sides; cross veins indistinctly scalariform. **Petioles** 0.9–1.7 cm long, ca. 1 mm in diam., glabrous. **Inflorescences** panicles or catkins, erect, yellowish, terminal or in upper axils; rachis with densely stellate hair. **Male inflorescences** 5.5–16 cm long; bracts and bracteoles ca. 1 mm long; male florets cluster of 3–5 or single; perianth (5–)6-lobed, ovate, ca. 1 mm long, connate, outer surface hairy than inner surface; stamens (8–)10–12, ca. 2 mm long, glabrous; anther 0.2–0.3 mm; pistillode ca. 1 mm in diam. **Female inflorescences** up to 14 cm long; female florets cluster (3 florets in dichasium); perianth 6-lobed, ovate, ca. 1 mm long, connate; style 3, ca. 1.5 mm long, glabrous; staminodes absent. **Infructescences** pendent by weight of fruits, 12–14 cm long. **Acorns** globose or two lobes, 2.7–4 by 3.3–5.5 cm, sessile. **Cupules** completely enclosing and free from fruit; wall 1–2 mm thick; outer surface with sparse 2–6 branched spine mixed with single spine; spines 2–7 mm long, sturdy recurve. **Nuts** 1–3 per cupule, subglobose, semicircular or wedge, 2–2.9 by 1.6–2.2 cm, glabrescent.

Ecology.— Evergreen forest at Khao Khitchakut National Park, Nam Tok Khlong Kaeo National Park, Mu Ko Chang National Park; alt. 0–30 m. Flowering: July–August; fruiting: March–May.

Uses.— Nuts edible.

Specimens examined.— *K. Bunpha* s.n., 6 Apr. 2004, Trat, Mu Ko Chang National Park, Salak Phra (BSKU); *K. Bunpha* KC-2, 28 Mar. 2005, Trat, Mu Ko Chang National Park, Salak Phret (BSKU); *P. Phonsena & K. Bunpha* 4506, 3 Feb. 2005, Trat, Mu Ko Chang National Park, Salak Phret (BKF); *P. Phonsena* 3753, 29 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Boy Scout Station (BKF); *P. Phonsena et al.* 3894, 29 Aug. 2003, Chanthaburi, Khao Khitchakut National Park (BKF).

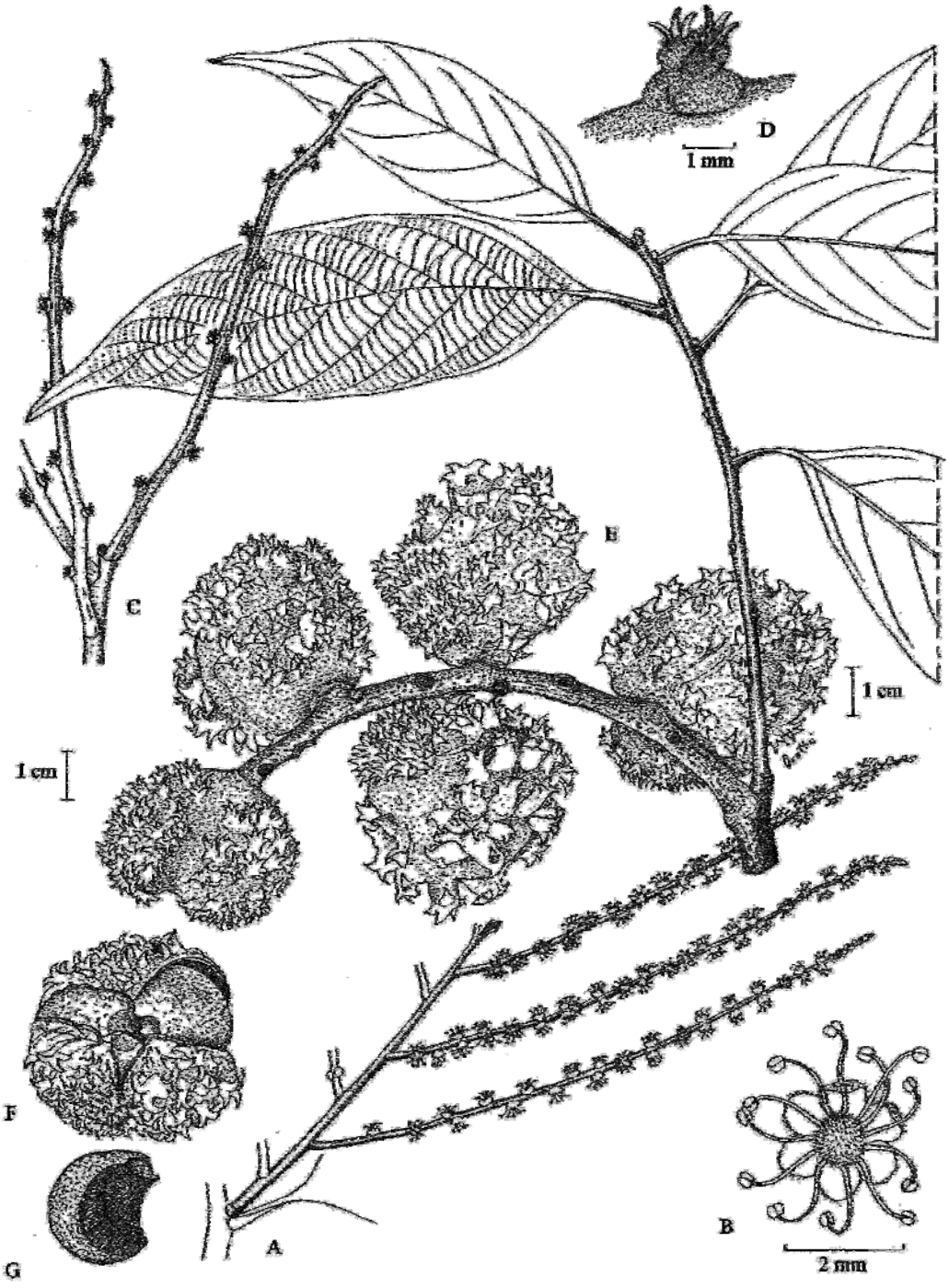

Figure 25 *Castanopsis pierrei* Hance (ก่อขี้หมู)

A. male inflorescences; B. male floret; C. female inflorescences; D. female florets; E. branch with infructescence; F. acorn; G. nut. Drawn by O. Kerdkaew.

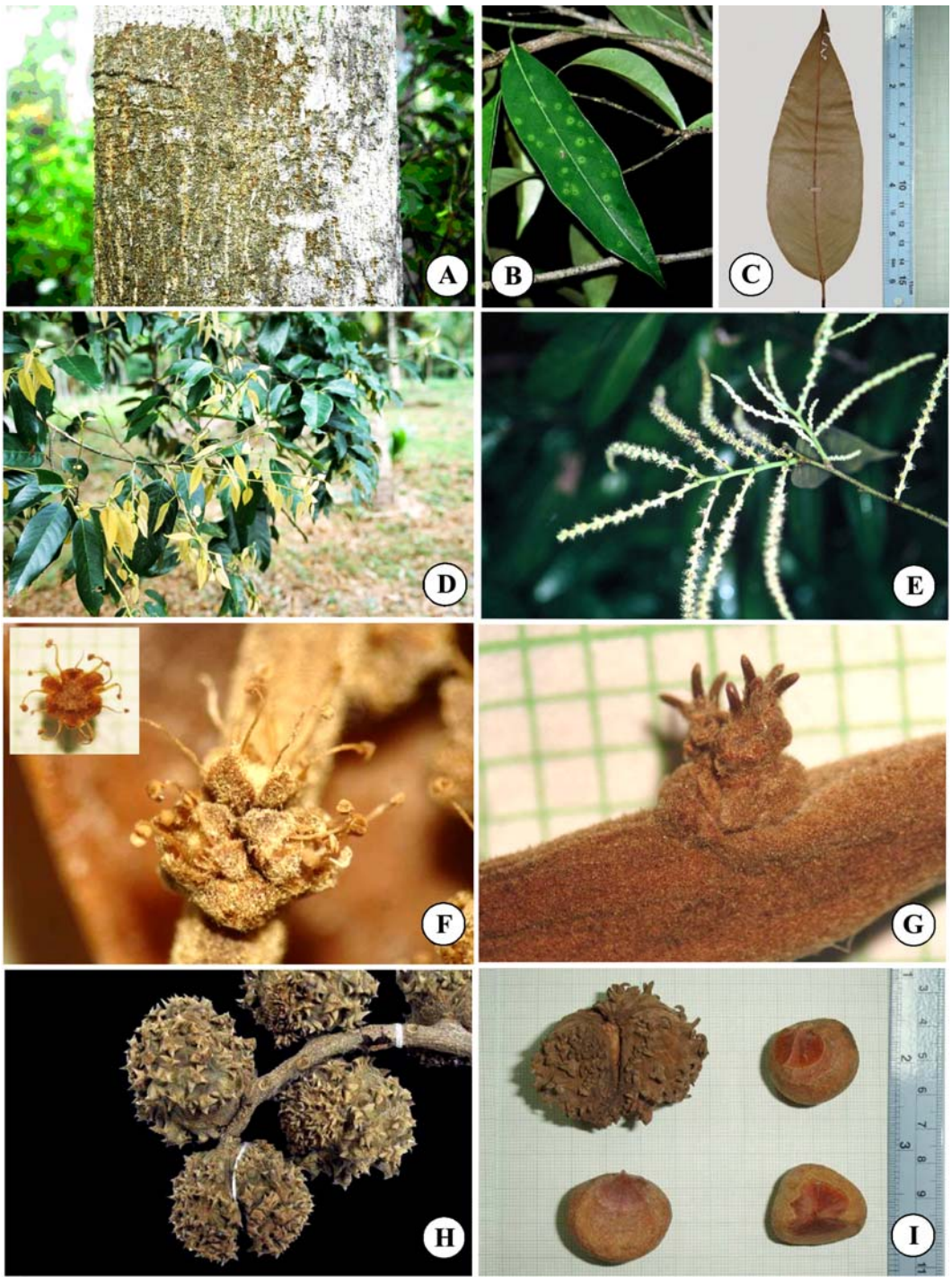

Figure 26 *Castanopsis pierrei* Hance

A. bark; B. leaf: upper surface; C. leaf: lower surface; D. young shoot; E. inflorescences; F. male florets in dichasium; G. female florets in dichasium; H. infructescence; I. acorn (upper left) and nuts. Photographed by P. Phonsena (A, D, E).

3. Castanopsis piriformis Hickel & A. Camus, Bull. Soc. Bot. Fran. 68: 395. 1922; Barnett, Quer. Rel. Fag. Asia: 188. 1940, et Trans. Proc. Bot. Soc. Edinb. 33: 336. 1942; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 227. 2008. Figure 27, 28.

Vernacular.— **Ko hin (ก่อหิน)**.

Tree 18–25 m high, 22–46 cm in diam.; bark smooth or shallowly fissured, greenish grey or greenish brown; twigs initially hairy and later glabrescent, densely lenticellate. **Leaves** spiral, subcoriaceous, narrowly elliptic or elliptic, 8–16 by 3–6 cm, apex acute to acuminate, base cuneate, margin undulate or entire, upper surface glossy green, lower surface pale brown to golden brown, both surfaces glabrous; midrib strongly raised on lower and slightly raised at base on upper surface; lateral veins 8–12 pairs, conspicuous on both sides; cross veins indistinctly scalariform. **Petioles** 1–1.5 cm long, glabrous. **Inflorescences** panicles, yellowish, terminal or in upper axils; rachis with densely stellate hair. **Male inflorescences** 5–15 cm long; bracts and bracteoles ca. 1 mm long; male florets single or cluster of 3–7; perianth 6-lobed, ovate, ca. 1 mm long, connate, outer surface densely hairy than inner surface; stamens 9–12, 2–3 mm long, glabrous; anther 0.2–0.5 mm long; pistillode ca. 0.5 mm in diam. **Female inflorescences and mixed inflorescences** up to 15 cm long; female florets single, ca. 2.5 mm in diam., perianth 4–6-lobed, ovate, ca. 1 mm long, connate; style 3, ca. 1.8 mm long, glabrous; staminodes 12. **Infructescences** erect, 10–15 cm long. **Acorns** pear-shaped, 2.5–3 by 2–3 cm, stalked 0.5–1 cm long. **Cupules** completely enclosing and free from fruit; wall 1 mm thick; outer surfaces smooth and hairy with conspicuous 3–4 undulate lines. **Nuts** 1 per cupule, subglobose, 1.8–2.5 cm in diam.

Ecology.— Common in dry evergreen and evergreen forest in all areas except Khao Yai National Park and Khao Chamao-Khao Wong National Park; alt. 300–410 m. Flowering: September–January; fruiting: July–September.

Uses.—Nuts edible.

Specimens examined.— *K. Bunpha et al.* KB62, 3 Sep. 2006, Sa Kaeo, Pang Sida National Park (BSKU, Herbarium of Khao Hin Son Botanic Garden); *K. Bunpha et al.* KB64, 3 Sep. 2006, Sa Kaeo, Pang Sida National Park (BSKU); *K. Bunpha et al.* KB-E309, 27 Nov. 2005, Sa Kaeo, Pang Sida National Park (BSKU, Herbarium of Khao Hin Son Botanic Garden); *K. Bunpha et al.* KB-E311, 26 Nov. 2005, Sa Kaeo, Pang Sida National Park (BSKU); *K. Bunpha et al.* KB-E312, 26 Nov. 2005, Sa Kaeo, Pang Sida National Park (BSKU); *K. Bunpha et al.* KB-E316, 27 Nov. 2005, Sa Kaeo, Pang Sida National Park (BSKU, Herbarium of Khao Hin Son Botanic Garden); *K. Bunpha et al.* KC-33, 14 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KC-34, 14 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KC-35, 14 Jan. 2006, Trat, Mu Ko Chang National Park, HQ (BSKU); *K. Bunpha et al.* KC-36, 14 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *P. Phonsena* 3791, 30 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena* 3795, 30 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena* 3796, 30 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 3430, 3 Nov. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF, Herbarium of Khao Hin Son Botanic Garden).

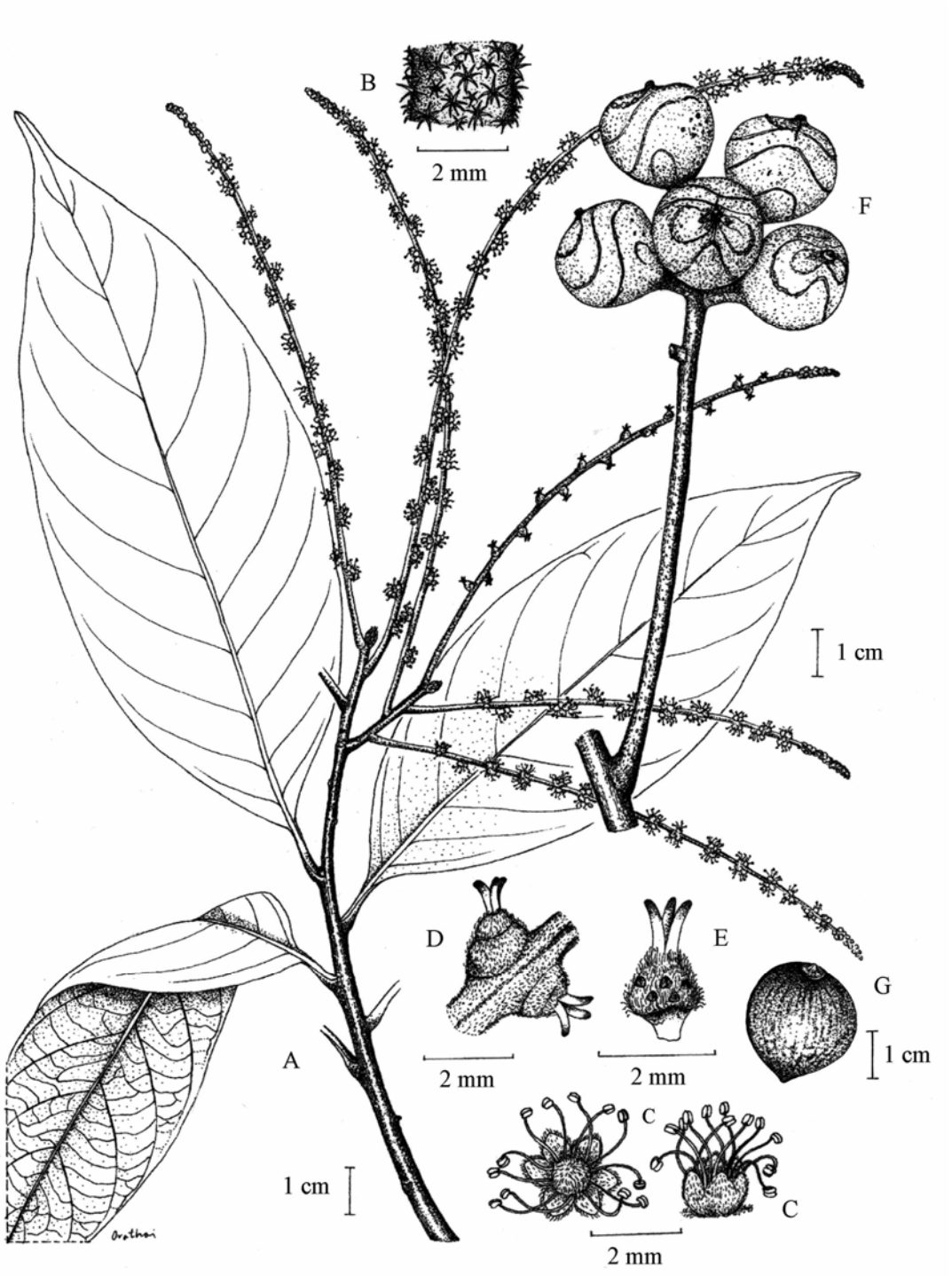

Figure 27 *Castanopsis piriformis* Hickel & A. Camus (ก่อหิน)

A. branch with inflorescences; B. stellate hairs on axis of inflorescence; C. male florets; D. female florets; E. female floret without perianth; F. infructescence; G. nut. Drawn by O. Kerdkaew.

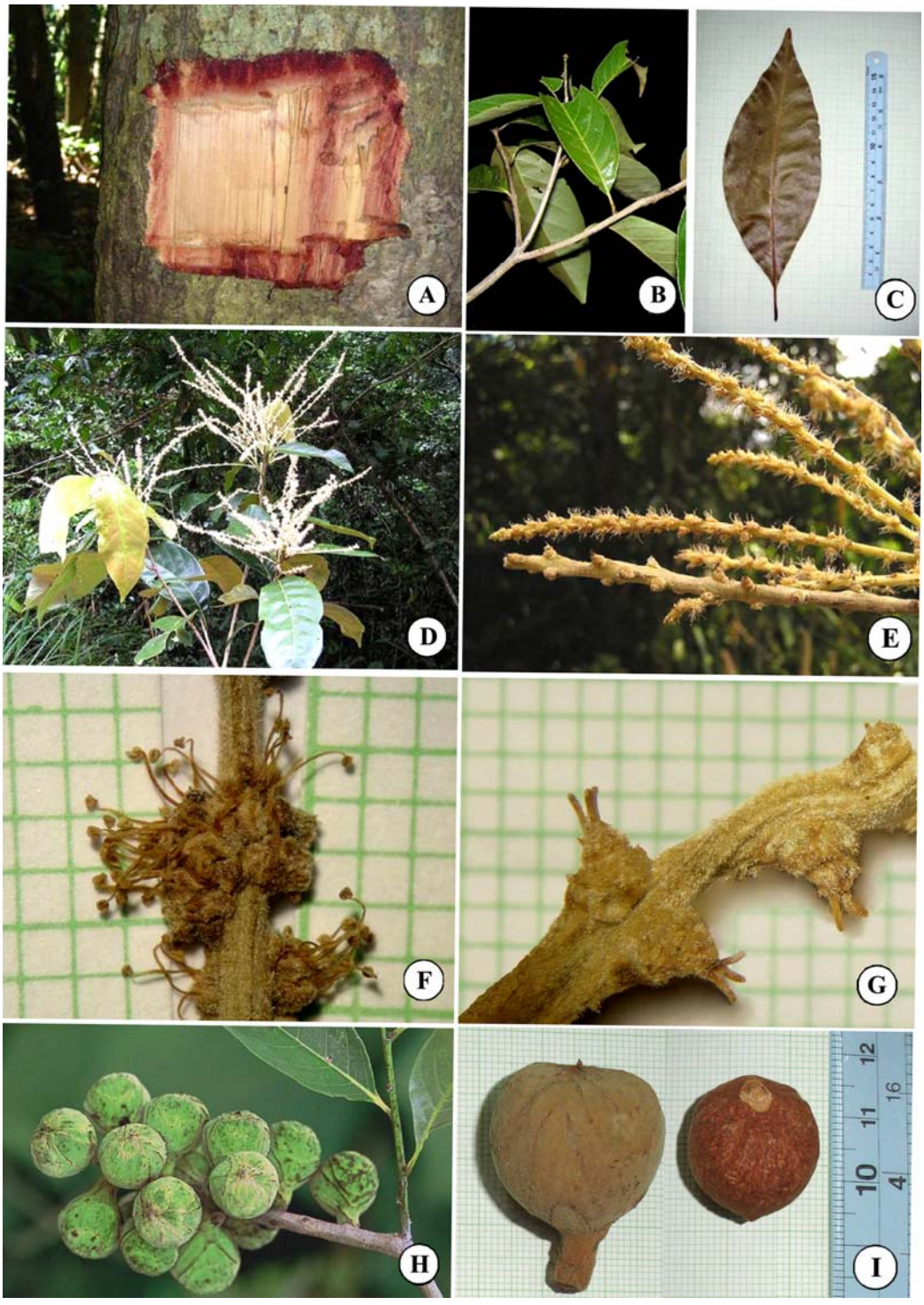

Figure 28 *Castanopsis piriformis* Hickel & A. Camus

A. blaze; B. leaves; C. leaf: upper surface; D-E. inflorescences; F. male florets; G. female florets; H. infructescence; I. acorn (left) and nut (right).

Photogpaphed by Y. Banchong (D); P. Phonsena (H).

Lithocarpus Blume

Evergreen tree, blaze with distinct furrows. Leaves spiral or alternate; margin entire, rarely serrate; cross veins scalariform; petioles mostly thickened throughout its length. Inflorescences panicles or catkins, erect, rachis hairy. Male florets in clusters or single; perianth 6-lobed, stamen 10–12, filaments free, filiform; anther rather small, 0.2–0.4 mm long, dorsifixed, longitudinally dehiscent; pistillode ca. 1 mm in diam. Female florets in clusters or single; perianth 4–6-lobed, styles 3, stigmas punctiform. Acorns ovate, depressed globose or ellipsoid. Cupule partly covering nut, outer surfaces with scales, soft spines, rarely lamella, indehiscent. Nut 1 per cupule, ovate, depressed globose, subglobose or obovate. This study found 8 species of *Lithocarpus* in Southeastern Thailand.

Key to species of *Lithocarpus* in Southeastern Thailand

1. Cupules single
   2. Cupule without spines, saucer-shaped, stalk ≥ 4 mm….....**1. *L. cantleyanus***
   2. Cupule with soft spines, cup-shaped, stalk < 4 mm or sessile
      3. Nut ovate; acorn base slightly truncate; branchlets, petiole and midvein hairy……....……..……..…**8. *L. wrayi***
      3. Nut oblong; acorn base obtuse; branchlets, petiole and midvein glabrescent or glabrous……..…....…**4. *L. eucalyptifolius***
1. Cupules 3–7, united at base or mature cupule uniting rudimentary acorns at base
   4. Nut glabrous
      5. Nut depressed globose; diameter ≥ 1.5 cm…….....…..……**3. *L. elegans***
      5. Nut ovate, diameter < 1.5 cm…….……..…..…….**5. *L. harmandii***
   4. Nut hairy
      7. Cupule scales distinct, nut sparsely hairy or glabrescent, shining, dark green (fresh specimen)…...…….....……**2. *L.* cf. *dealbatus***
      7. Cupule scale inconspicuous, nut densely hairy, greenish grey (fresh specimen)
         8. leaf obovate, margin serrate or dentate…....…**7. *L. wallichianus***
         8. leaf elliptic, margin entire……..…….....……**6. *L. thomsonii***

1. Lithocarpus cantleyanus (King ex Hook. f.) Rehder, J. Arnold Arbor. 1: 122. 1919; Barnett, Quer. Rel. Fag. Asia: 141. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 334. 1944; Hjelmq., Dansk Bot. Ark. 23: 488. 1968; Soepadmo, Fl. Males. 7(2): 352. 1972; Soepadmo, Julia & Go in E. Soepadmo & L.G. Saw, Tree Fl. Sabah & Sarawak 3: 44. 2000; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 261. 2008. Figure 29, 30.

Vernacular.— **Ko chaeng (ก่อแจง)**, Ko lap nuea rieo (ก่อหลับเนื้อริ้ว).

Tree 25–30 m high, 15–20 cm in diam.; bark smooth or shallowly fissured, greyish to greyish brown; twigs densely red scales, sparse lenticels. **Stipules** ovate, ca. 1 mm long, caducous. **Leaves** spiral, subcoriaceous, elliptic to elliptic-oblong, 10–20 by 3–7.4 cm, apex acuminate, base cuneate to obtuse, margin entire, upper surface glossy green, lower surface pale green, both surfaces glabrescent or glabrous; midrib strongly raised on both surfaces or impressed on upper surface (groove in the middle of midrib), glabrescent or glabrous; lateral veins 14–18 pairs, flat on upper and raised on lower surface; cross veins scalariform. **Petioles** 0.8-1.4 cm long, thickened throughout its length, glabrescent or glabrous. **Inflorescences** panicles or catkins, erect, axillary or in upper axils; rachis hairy. **Male inflorescence** 7–13.5 cm long; bract ca. 1 mm long; male florets cluster of 3–7or single, ca 1.2 mm in diam.; perianth 6-lobed, connate, outer surface densely hairy than inner surface; stamen 10–12, ca. 1.2–1.5 mm long, glabrous; anther ca. 0.2 mm long; pistillode ca. 1 mm in diam. **Mixed inflorescences** 12–18 cm long; bracteoles ca. 0.8 mm long; female florets single or in dichasium; ca. 1 mm in diam., perianth 6-lobed, hairy, style 3 hairy at base, stigma punctiform, stigma tip black, glabrous. **Infructescences** 5–15 cm long, 1–12 acorns, erect. **Acorns** ovate, 1.5–2 by 1.5–2.1 cm, stalked ca. 0.4–0.6 cm long. **Cupules** saucer-shaped or cup-shaped with 4-6 concentric ring, enclosing 1/5 to1/4 of the nut, 0.7–1 cm high, 1.4–2 cm in diam., base truncate, wall ca. 0.5 mm thick, hairy and glaucous. **Nuts** 1(–3) per cupule, subglobose or ovate, 1.3–1.8 cm high (excluding persistent style), 1.9–2.1 cm in diam., hairy, apex acuminate with persistent styles ca. 1 mm high, base truncate; scar concave ca. 1–1.3 cm in diam.

Ecology.— In evergreen forest, near streams, at Khao Soi Dao Wildlife Sanctuary and Mu Ko Chang National Park; alt. 0–920 m. Flowering: December–February, fruiting: May–August.

Notes.— This species is similar to *L. reinwardtii* (Korth.) A. Camus but different in nut shape. The nut of *L. reinwardtii* is conical and cross veins distinct (Phengklai, 2008) while nut shape of *L. cantleyanus* (King ex Hook. f.) Rehder is subglobose and cross veins obscure. Because the 2 species are so similar, mature acorns and leaves of both species should be collected and compared to confirm that they are different species. This species is new record for Southeastern Thailand.

Specimens examined.— *K. Bunpha et al.* KC1, 28 Mar. 2005, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KC3, 28 Mar. 2005, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KC6, 28 Mar. 2005, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KB45-E339, 15 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KB46-E340, 15 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KB47-E341, 15 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *P. Phonsena et al.* 4497, 3 Feb. 2005, Trat, Mu Ko Chang National Park, Salak Phret (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 4499, 3 Feb. 2005, Trat, Mu Ko Chang National Park, Salak Phret (BKF); *P. Phonsena et al.* 4502, 3 Feb. 2005, Trat, Mu Ko Chang National Park, Nam Tok Than Mayom (BKF, Herbarium of Khao Hin Son Botanic Garden).

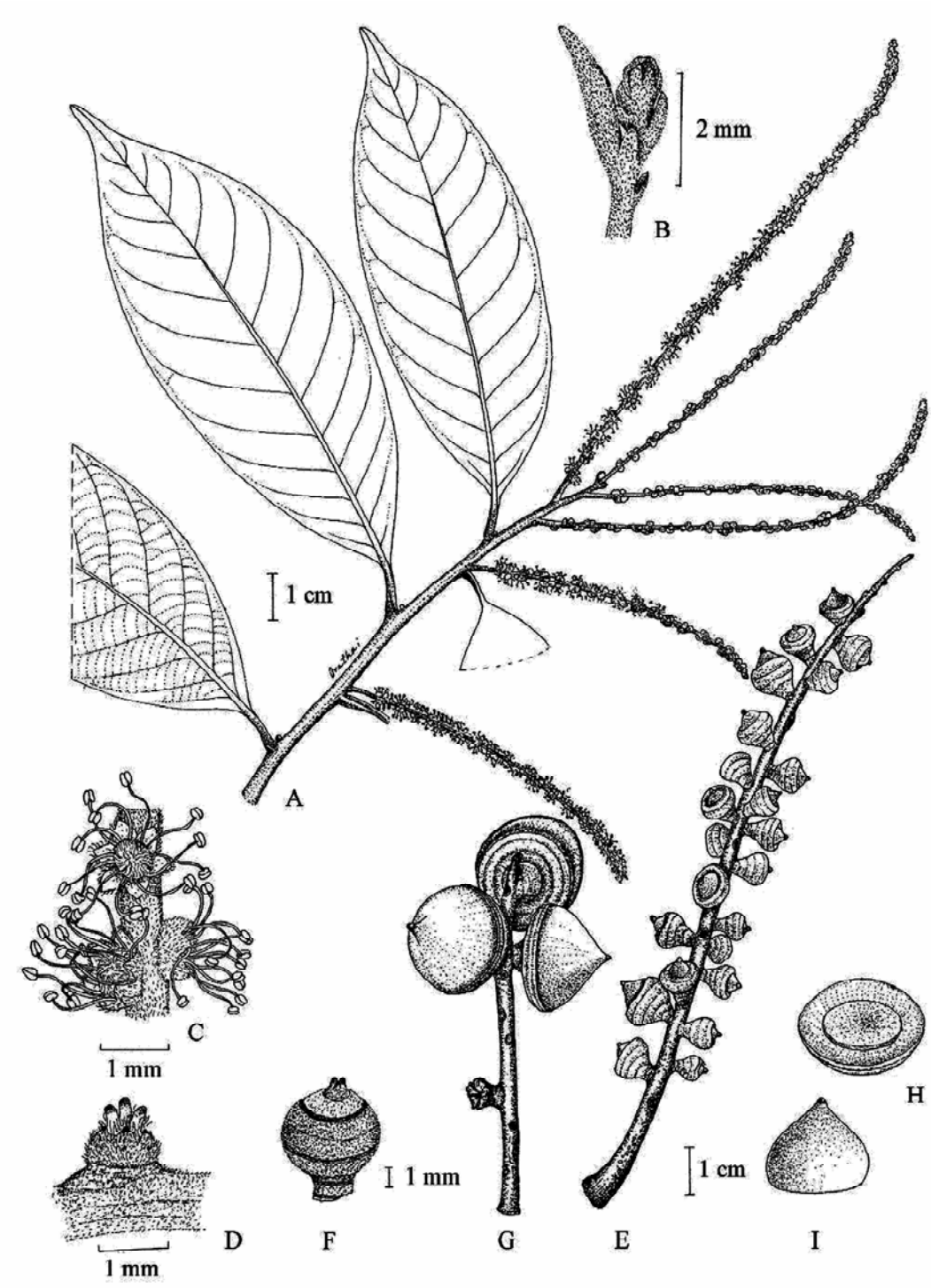

Figure 29 *Lithocarpus cantleyanus* (King ex Hook. f.) Rehder (ก่อแจง)

A. branch with inflorescences; B. bud; C. male florets; D. female floret; E. young infructescence; F. young acorn; G. mature infructescence; H. cupule; I. nut. Drawn by O. Kerdkaew.

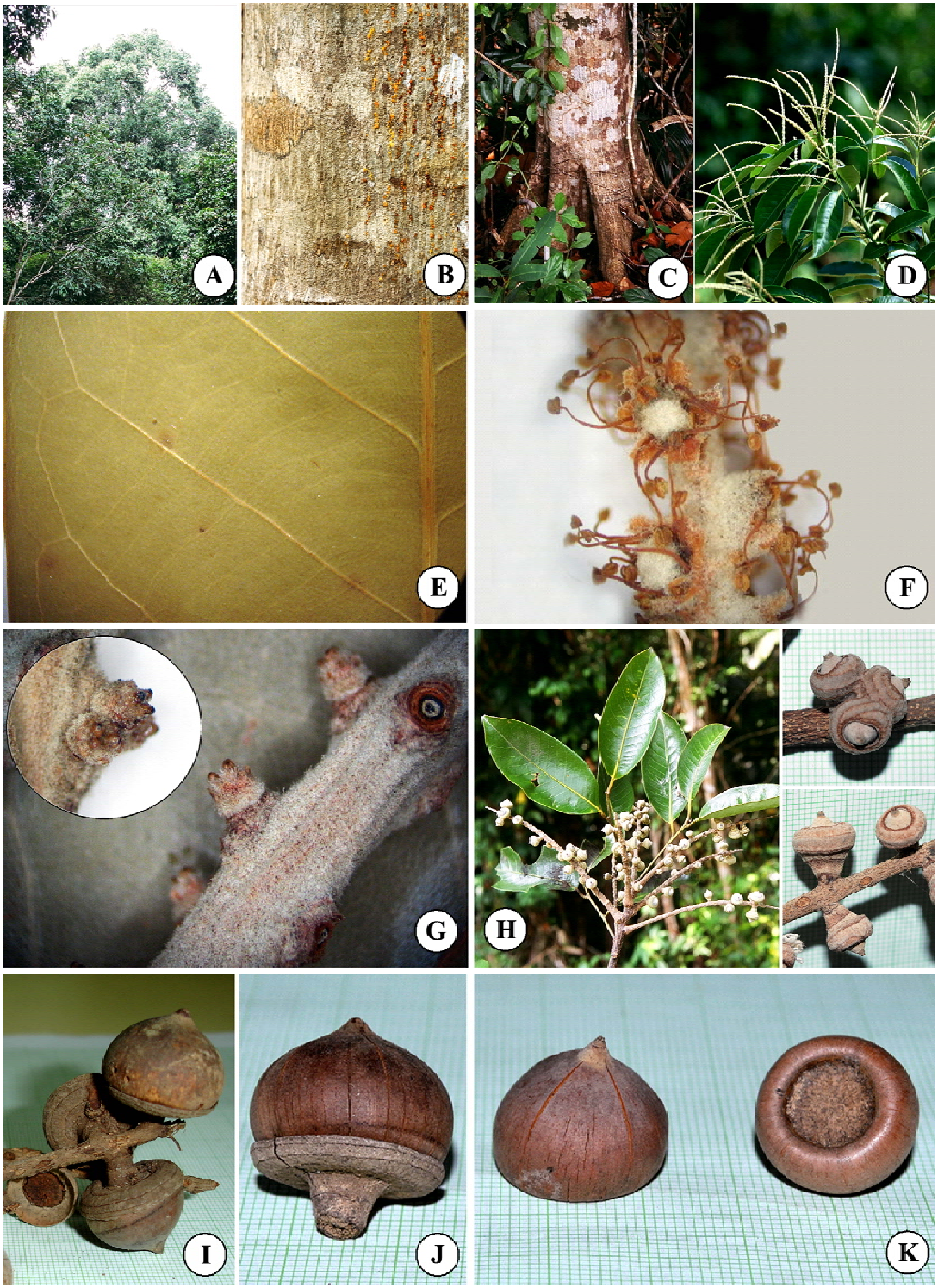

Figure 30 *Lithocarpus cantleyanus* (King ex Hook. f.) Rehder

A. habit; B-C. bark; D. inflorescence; E. leaf: lower surface; F. male florets; G. female florets; H. young infructescences; I. infructescence; J. acorn; K. nuts. Photographed by Y. Banchong (A, D, H).

2. Lithocarpus cf. dealbatus (Hook.f. & Thomson ex Miq.) Rehder, J. Arnold Arbor. 1: 124. 1919; Barnett, Quer. Rel. Fag. Asia: 129. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 33: 334. 1941; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 334. 1944; C.C. Huang, Y.T. Chang & B.M. Bartol. in C.Y. Wu & P.H. Raven, Fl. China 4: 346. 1999; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 271. 2008. Figure 31, 32.

Vernacular.— **Ko pao** (ก่อผ๊ัวะ).

Tree 12–15 m high, 20–30 cm in diam.; bark smooth or shallowly fissured, grey; twigs sparse lenticels. **Stipules** caducous. **Leaves** spiral, coriaceous, elliptic, 10.5–25.5 by 4–10 cm, apex acuminate to acute, base cuneate or slightly attenuate, margin entire, upper surface glossy green, lower surface pale yellowish green, both surfaces glabrescent or glabrous; midrib strongly raised on lower surfaces and slightly raised or flat on upper surface (groove in the middle of midrib), glabrescent; lateral veins 9–16 pairs, impressed on upper and strongly raised on lower surface; cross veins distinct scalariform. **Petioles** 1.5–3 cm long, slender and swollen at base, glabrescent or glabrous. **Inflorescences** panicles or catkins, erect, axillary or in upper axils; rachis hairy and densely stellate hairy. **Male inflorescences** 8.8–14.5 cm long; bracts ca. 3 mm long and bracteoles ca. 1 mm long; male florets cluster of 3 to numerous, ca. 2 mm in diam.; perianth 6-lobed, ovate, connate, outer surface densely hairy than inner surface; stamen 10–12, 1.3–2 mm long, glabrous; anther ca. 0.2–0.3 mm long; pistillode ca. 1 mm in diam. **Mixed inflorescences** 11–13 cm log; bracts ca. 3 mm long and bracteoles ca. 1 mm long; female florets cluster of 3–5(–7), ca. 1 mm in diam., perianth 6-lobed, hairy, style 3, stigma punctiform, glabrous. **Infructescences** 15–22 cm long, 1–4 acorns, erect. **Acorns** sessile, ovate, 1.9–2.2 by 1.7–2.1 cm. **Cupules** cup-shaped, clusters of 3-5 united at base or mature cupule uniting rudimentary acorns at base, covered with alternate triangle scales, enclosing ⅓ to ½ of the nut, 0.9–1.2 cm high, 1.7–2.1 cm in diam., base obtuse, wall ca. 1–2.1 mm thick, all part hairy. **Nuts** 1 per cupule, ovate, 1.4–1.6 cm high (excluding persistent style),

1.2–1.5 cm in diam., apex obtuse, protruding persistent styles ca. 1 mm high, base truncate; scar concave ca. 7–9 mm in diam., sparsely hairy then glabrescent.

Ecology.— Lowland evergreen forest, often near stream at Khao Khitchakut National Park; alt. 30–100 m. Flowering: January–February; fruiting: March–August.

Notes.— The acorn shape of this species is similar to *L. dealbatus* (Hook. f. & Thomson ex Miq.) Rehder but *L. dealbatus* is densely hairy on midvein, the scales of the cupule are fine and thin and the female florets in the dichasium usually all develop to mature acorns in each group. This species has glabrous midveins, the scales of the cupule are rough and thick and the female florets in the dichasium usually only one developing in each group.

Specimens examined.— *P. Phonsena* 3672, 27 Feb. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena* 3673, 22 Feb. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena* 3751, 29 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena* 3752, 29 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena & Y. Banchong* 4852, 23 Mar. 2006, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena & Y. Banchong* 4853, 23 Mar. 2006, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena et al.* 3662, 13 Feb. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena et al.* 3890, 29 Aug. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF).

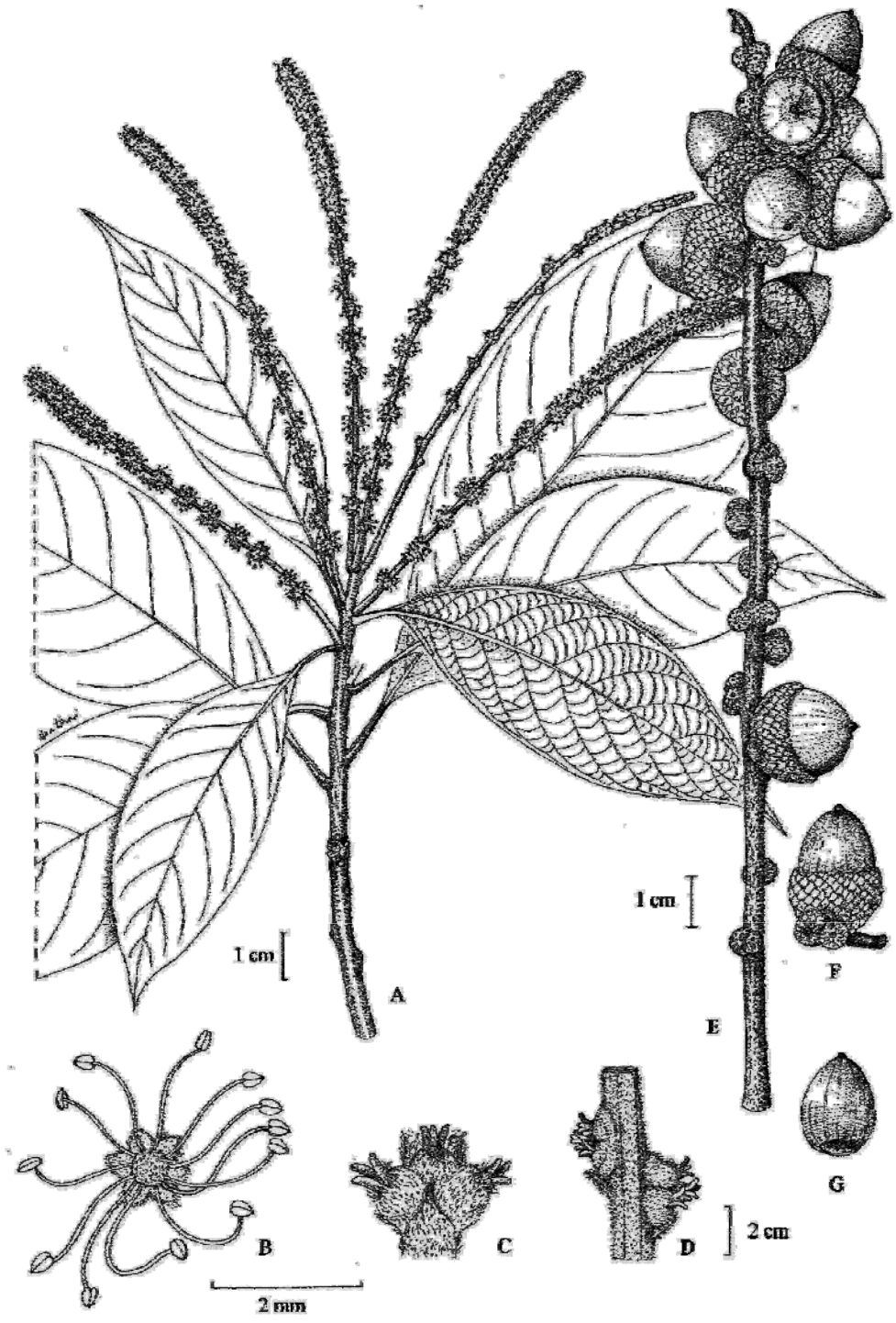

Figure 31 *Lithocarpus* cf. *dealbatus* (Hook. f. & Thomson) Rehder (ก่อผั๊วะ)

A. branch with inflorescences; B. male floret; C-D. female florets;
E. mature infructescence; F. acorn; G. nut. Drawn by O. Kerdkaew.

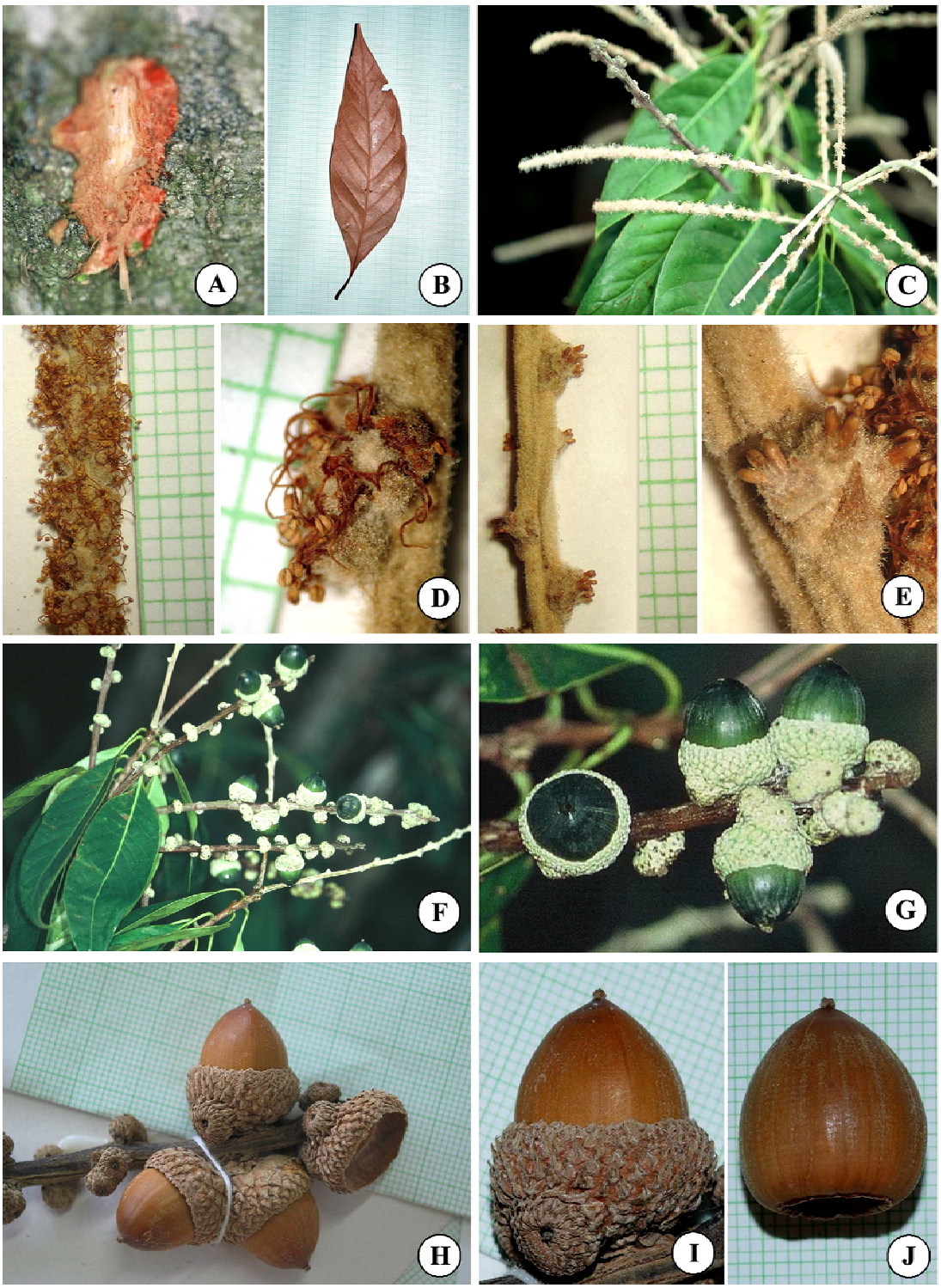

Figure 32 *Lithocarpus* cf. *dealbatus* (Hook. f. & Thomson) Rehder
A. blaze; B. leaf: lower surface; C. inflorescences; D. male florets; E. female florets; F-H. infructescences; I. acorns; J. nuts.
Photographed by P. Phonsena (A, C, F, G).

3. Lithocarpus elegans (Blume) Hatus. ex Soepadmo, Reinwardtia 8: 236. 1970; Soepadmo, Fl. Males. 7(2): 366. 1972; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 279. 2008.— *Quercus elegans* Blume; Backer & Bakh.f., Fl. Java 2: 7. 1965. — *Lithocarpus intermedius* Barnett, Bull. Misc. Inform. Kew 1938. 101; Barnett, Quer. Rel. Fag. Asia: 114. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 333. 1944.— *L. grandifolia* (D. Don) Biswas; C.C. Huang, Y.T. Chang & B.M. Bartol. in C.Y. Wu & P.H. Raven, Fl. China 4: 364. 1999. Figure 33, 34.

Vernacular.— **Ko neng (ก่อเหน่ง)**.

Tree 5–30 m high, bark mostly smooth and numerous lenticels, greenish grey; twigs glabrescent. **Stipules** caducous. **Leaves** spiral, subcoriaceous to coriaceous, elliptic or elliptic-oblong, 7.8–19.5 by 3.6–7.0 cm, apex acuminate, base cuneate or obtuse, margin entire, upper surface green, lower surface pale green, both surfaces glabrous, midrib strongly raised on both surfaces or impressed on upper surface (groove in the middle of midrib), glabrous; lateral veins 7–11 pairs, slightly raised on upper and strongly raised on lower surface; cross veins scalariform. **Petioles** 8–25 mm long, thickened throughout its length, glabrous. **Inflorescences** were not collected. **Infructescences** 7.5–21 cm long, 3–6 acorns, erect. **Acorns** depressed globose, 1.5–1.9 by 2–2.4 cm, sessile. **Cupules** saucer-shaped, clusters of 3 united at base or mature cupule uniting rudimentary acorns at base, scales distinct, enclosing ¼ of the nut, 0.4–0.7 cm high, 1.7–2.1 cm in diam., base truncate or obtuse, wall ca. 1 mm thick, all part hairy. **Nuts** 1 per cupule, depressed globose, 1.2-1.5 cm high (excluding persistent style) 1.8-2.4 cm in diam., apex round or obtuse with protruding persistent styles, ca. 0.5–1.0 mm high, base truncate; scar concave ca. 1.2–1.5 cm in diam., glabrous.

Ecology.— Evergreen and hill evergreen forests, limestone, at Khao Yai National Park, Khao Chamao-Khao Wong National Park, Khao Khitchakut National Park and Khao Soi Dao Wildlife Sanctuary; alt. 915–1400 m. Fruiting: November–February.

Notes.— The acorn of *L. elegans* (Blume) Hatus. ex Soepadmo is similar to *L. auriculatus* (Hickel & A. Camus) Barnett but differ in leaf shape and leaf base. The leaf of *L. auriculatus* is obovate or oblanceolate and the base is auriculate while this species is elliptic or elliptic-oblong and the base is cuneate or obtuse. This study did not collect inflorescences so there is a need to collect them in the future.

Specimens examined.— *P. Phonsena* 3400, 29 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena & K. Bunpha* 3500, 22 Nov. 2002, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3612, 6 Feb. 2003, Chantaburi, Khao Chamao-Khao Wong National Park, Air Force Station (BKF); *P. Phonsena & K. Bunpha* 3618, 6 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Air Force Station (BKF); *P. Phonsena & K. Bunpha* 3650, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3655, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3658, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3807, 21 May 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3809, 21 May 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3812, 21 May 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3813, 21 May 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3880, 22 Aug. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 4711, 10 Dec. 2005, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Pha Sam (BKF); *P. Phonsena et al.* 4797, 22 Feb. 2006, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai (BKF).

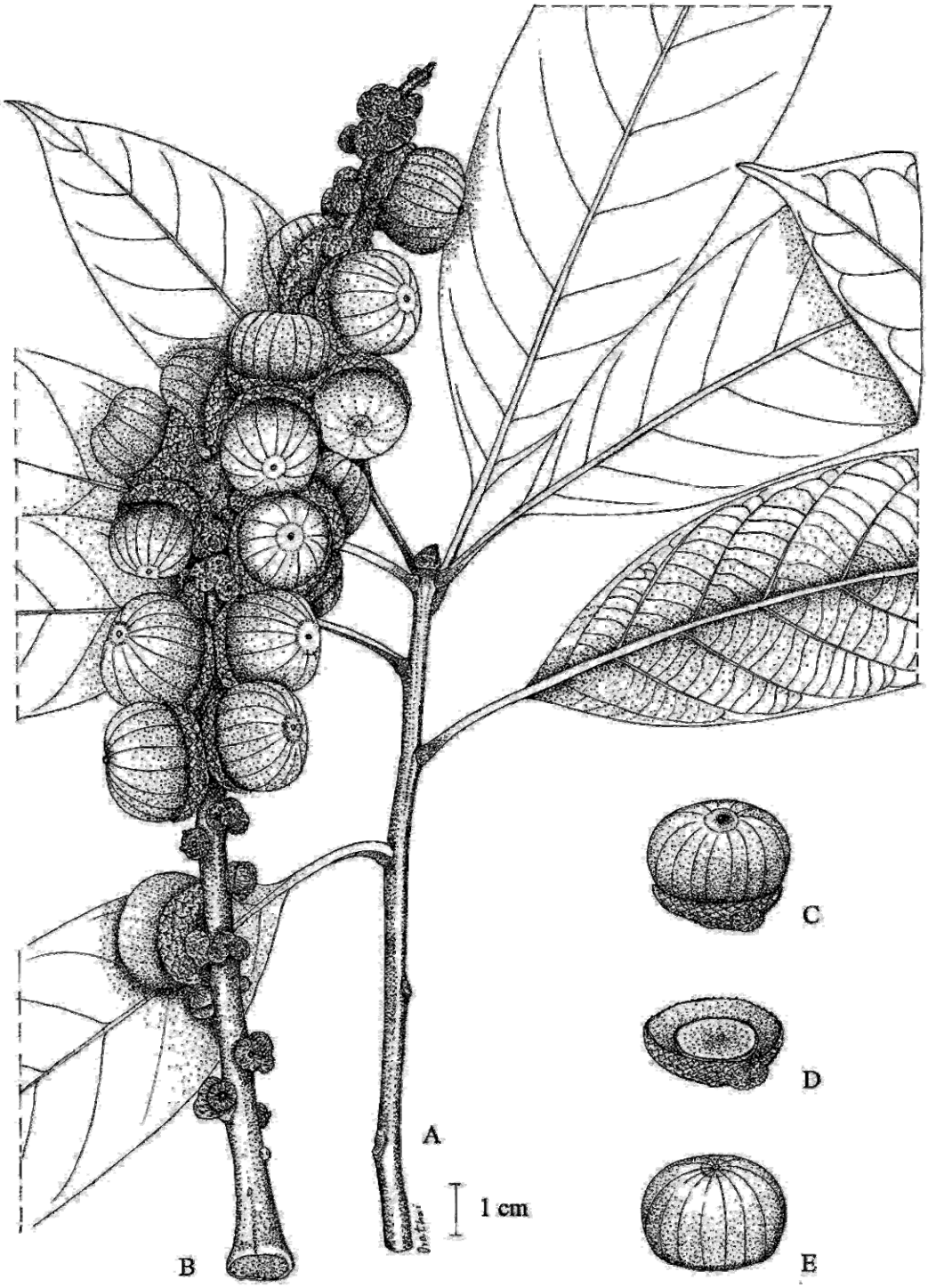

Figure 33 *Lithocarpus elegans* (Blume) Hatus. ex Soepadmo (ก่อเหน่ง)

A. branch with leaves; B. infructescence; C. acorn; D. cupule; E. nut. Drawn by O. Kerdkaew.

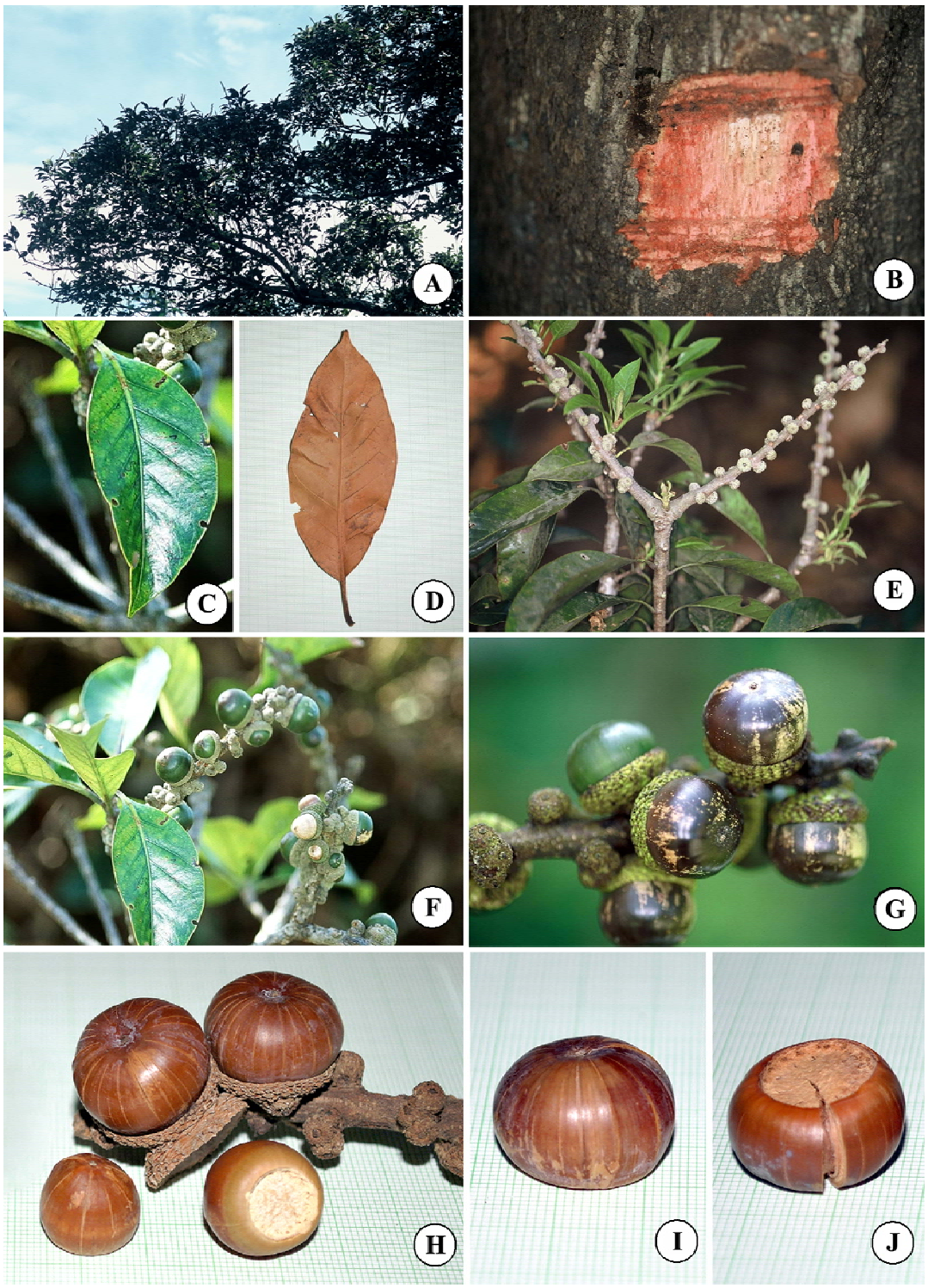

Figure 34 *Lithocarpus elegans* (Blume) Hatus. ex Soepadmo
A. habit; B. blaze; C. leaf: upper surface; D. leaf: lower surface;
E. young infructescences; F-H. infructescences; I-J. nuts.
Photographed by P. Phonsena (A-C, E-G).

4. Lithocarpus eucalyptifolius (Hickel & A. Camus) A. Camus, Rivièta Sci. 18: 40. 1931; Barnett, Quer. Rel. Fag. Asia: 307. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 173. 1944; Hjelmq., Dansk Bot. Ark. 23: 478. 1968; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 285. 2008.— *Lithocarpus rodgerianus* A. Camus, Bull. Mus. Natl. Hist. Nat., II 3: 690. 1931; Barnett, Quer. Rel. Fag. Asia: 286. 1940; Hjelmq., Dansk Bot. Ark. 23: 477. 1968. Figure 35, 36.

Vernacular.— **Ko mun (ก่อหมุน)**.

Tree 6–25 m high, 20–30 cm in diam.; bark smooth, brownish grey; twigs densely red scales then glabrescent, young leaves pale red or purple (covered with red scales) turn green with age. **Stipule** ovate, ca. 4–6 by 2–3.5 mm long, caducous. **Leaves** alternate, subcoriaceous, lanceolate to oblong-lanceolate, 13.5–21.5 by 4.5–6.5 cm, apex acute to acuminate, base cuneate to round, margin entire, upper surface green, lower surface pale yellowish green, both surfaces glabrescent; midrib strongly raised on lower surfaces and slightly raised on upper surface (groove in the middle of midrib), glabrescent; lateral veins 9–12 pairs, impressed on upper and strongly raised on lower surface; cross veins scalariform. **Petioles** 0.7–1 cm long, thickened throughout its length, glabrescent. **Inflorescences** panicles or catkins, erect, axillary or in upper axils; rachis hairy. **Male inflorescence**s 10–32 cm long; bract and bracteoles ca. 2 by 1 mm; male florets cluster or single; perianth 6-lobed, ovate, ca. 1 mm long, connate, outer surface densely hairy than inner surface; stamen (9–)10–12, 3–4.5 mm long, glabrous; anther ca. 0.3–0.4 mm long; pistillode ca. 1 mm in diam. **Female and mixed inflorescences** 9–30 cm long; bracteoles ca. 1.5 mm long; female florets mostly single, rarely in dichasium; ca. 1.2 mm in diam., perianth 6-lobed, hairy, style 3, stigma punctiform, stigma tip black, glabrous. **Infructescences** 6–17 cm long, 1–7 acorns, erect. **Acorns** ovate to oblong, 2.2–2.7 by 1.9–2.2 cm, stalked ca. 0.1–0.2 cm high. **Cupules** cup-shaped, covered with soft spines 1–2 mm long, enclosing ½ to ¾ of the nut, 1.6–2.2 cm high, 1.9–2 cm in diam., base obtuse, wall ca. 0.5–1 mm thick, all part hairy. **Nuts** 1 per cupule, mostly oblong, 2–2.5 cm high (excluding persistent style), 1.5–1.8 cm in diam., apex obtuse with protruding

persistent styles, ca. 2–2.5(–3) mm high, base truncate; scar concave ca. 6–9 mm in diam., hairy.

Ecology.— Commom in dry evergreeen to hill evergreen forest, often near streams, at Khao Yai National Park, Pang Sida National Park, Khao Ang Rue Nai Wildlife Sanctuary, Khao Khitchakut National Park and Khao Soi Dao Wildlife Sanctuary; alt. 150–1040 m. Flowering: August–November; fruiting: April–October.

Specimens examined.— *K. Bunpha et al.* BK63, 3 Sep. 2006, Sa Kaeo, Pang Sida National Park (BSKU); *K. Bunpha et al.* E310, 25 Nov. 2005, Sa Kaeo, Pang Sida National Park (BSKU); *P. Phonsena* 3733, 20 Apr. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena* 3768, 30 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena* 3770, 30 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena* 3825, 5 Jul. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena & K. Bunpha* 3587, 20 Dec. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena & K. Bunpha* 3669, 15 Feb. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3393, 29 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 3396, 29 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 3408, 30 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 3411, 30 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 4675, 13 Nov. 2005, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 4676, 13 Nov. 2005, Prachin Buri, Khao Yai National Park (BKF).

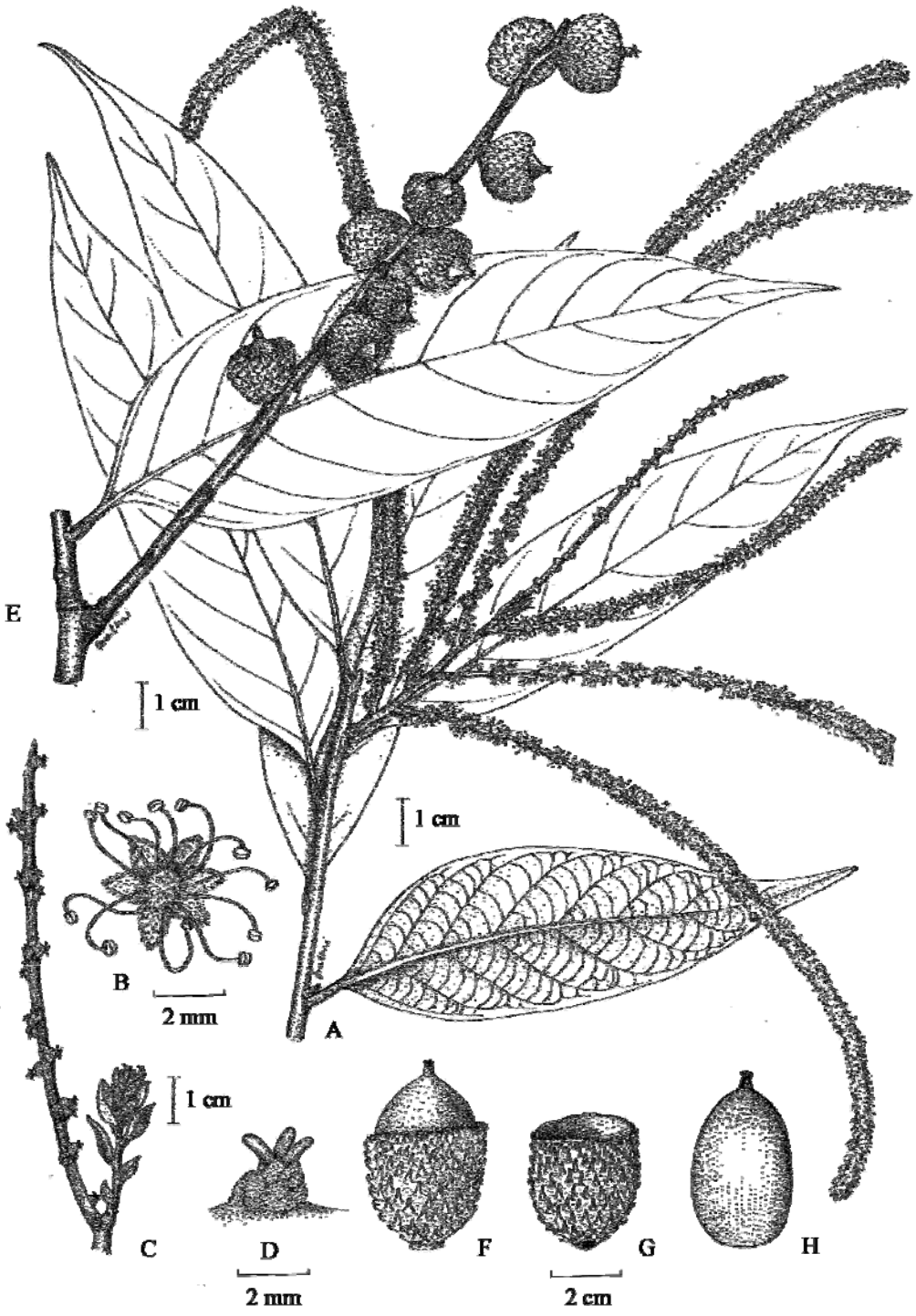

Figure 35 *Lithocarpus eucalyptifolius* (Hickel & A. Camus) A. Camus (ก่อหมุน)

A. branch with inflorescences; B. male floret; C. female inflorescence; D. female floret; E. young infructescence; F. acorn; G. cupule; H. nut. Drawn by O. Kerdkaew.

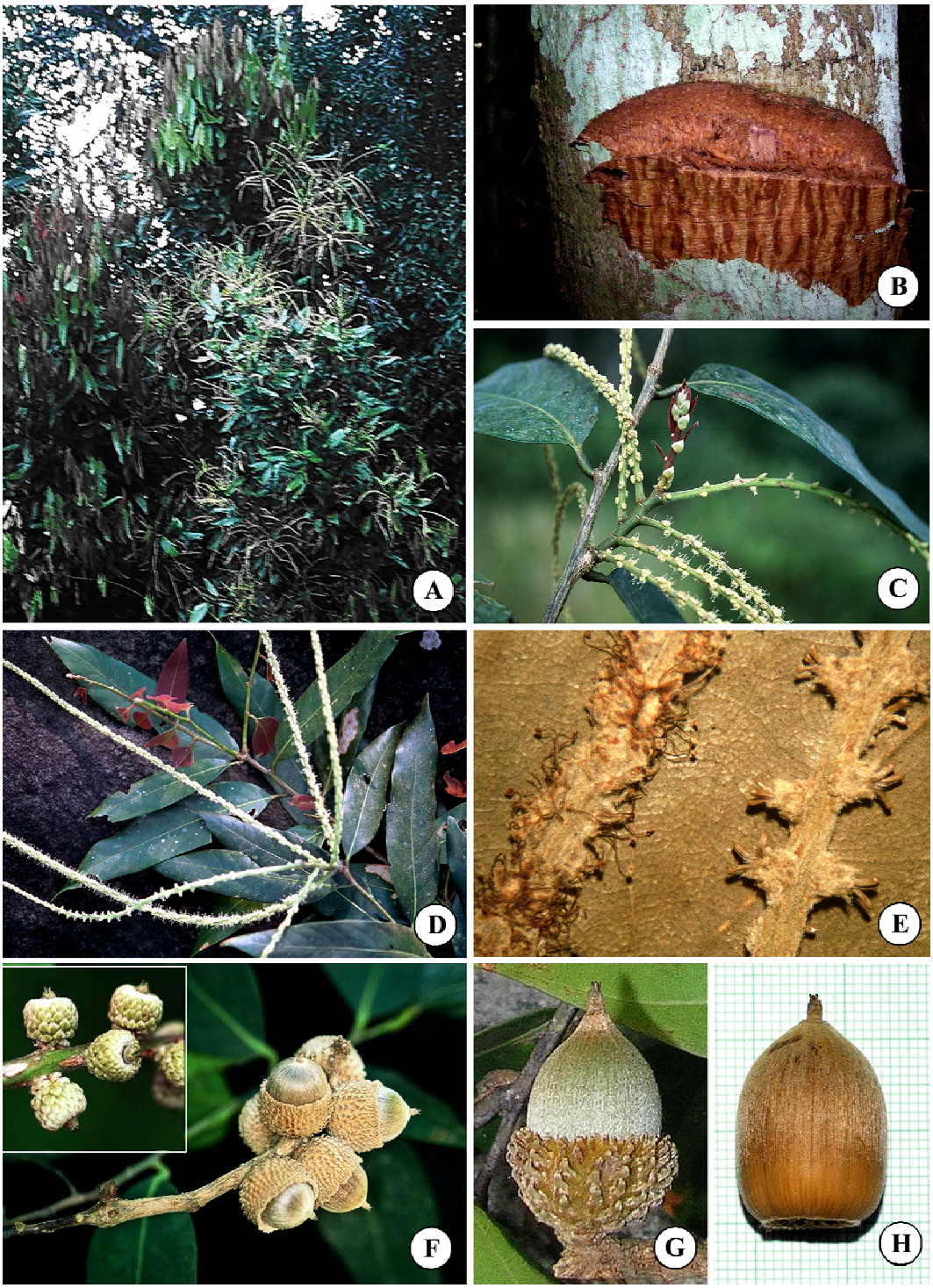

Figure 36 *Lithocarpus eucalyptifolius* (Hickel & A. Camus) A. Camus
A. habit with inflorescences; B. blaze; C–D. inflorescence; E. male (left) and female florets (right); F. young (left) and mature (right) infructescence; G. acorn; H. nut. Photographed by P. Phonsena (B-D, F).

5. Lithocarpus harmandii (Hickel & A. Camus) A. Camus, Rivièta Sci. 18: 40. 1932; Barnett, Quer. Rel. Fag. Asia: 124. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 33.3: 334. 1942; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 334. 1944; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 295. 2008. Figure 37, 38.

Vernacular.— **Ko khi kwang (ก่อขี้กวาง)**.

Tree 10–18 m high; bark smooth, greyish or greyish brown; twigs densely to disperse lenticels, glabrescent. **Stipules** caducous. **Leaves** spiral, coriaceous, elliptic, 14–25 by 6.5–12.5 cm, apex acute to slightly acuminate, base attenuate to cuneate, margin entire or slightly undulate, upper surface green, lower surface pale green, both surfaces glabrescent or glabrous; midrib strongly raising on lower surfaces and impressed on upper surface (groove in the middle of midrib), glabrescent; lateral veins 9–12 pairs, flat or impressed on upper and strongly raising on lower surface; cross veins scalariform. **Petioles** 0.9–1.2 cm long, slender and swollen at base, glabrescent to glabrous. **Inflorescences** were not collected. **Infructescences** 24–42 cm long, 7–16 acorns, erect. **Acorns** ovate to ellipsoid, 1.3–2.1 by 1.1–1.4 cm, stalked ca. 2–3 mm high. **Cupules** cup-shaped, clusters of 3 united at base or mature cupule uniting rudimentary acorns at base, scales obscure, enclosing ¼ to ⅓ of the nut, 0.5–0.9 cm high, 1.1–1.5 cm in diam., wall ca. 1–2 mm thick, all part hairy. **Nuts** 1 per cupule, ovate, usually bend to one side, 1.2–1.6 cm high (excluding persistent style), 0.8 –1.4 cm in diam., glabrous, apex obtuse or acute, base truncate; scar concave ca. 6–8 mm in diam.

Ecology.— Evergreen and hill evergreen forests, only in Khao Yai National Park; alt. 750–1260 m. Fruiting: July–September.

Notes.— This species is similar to *Lithocarpus* cf. *dealbatus* in size of nut, leaf texture (coriaceous) and mature acorn with rudimentary acorn. *Lithocarpus harmandii* (Hickel & A. Camus) A. Camus differs by its glabrous nut, the scales of

the cupule being indistinct and the petiole less than 1.5 cm. This study did not collect inflorescences so there is need to collect them in the future.

Specimens examined.— *P. Phonsena* 3672, 27 Feb. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena* 3673, 22 Feb. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena* 3751, 29 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena* 3752, 29 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena & Y. Banchong* 4852, 23 Mar. 2006, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena & Y. Banchong* 4853, 23 Mar. 2006, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena et al.* 3662, 13 Feb. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF); *P. Phonsena et al.* 3890, 29 Aug. 2003, Chanthaburi, Khao Khitchakut National Park, Visitor Center (BKF).

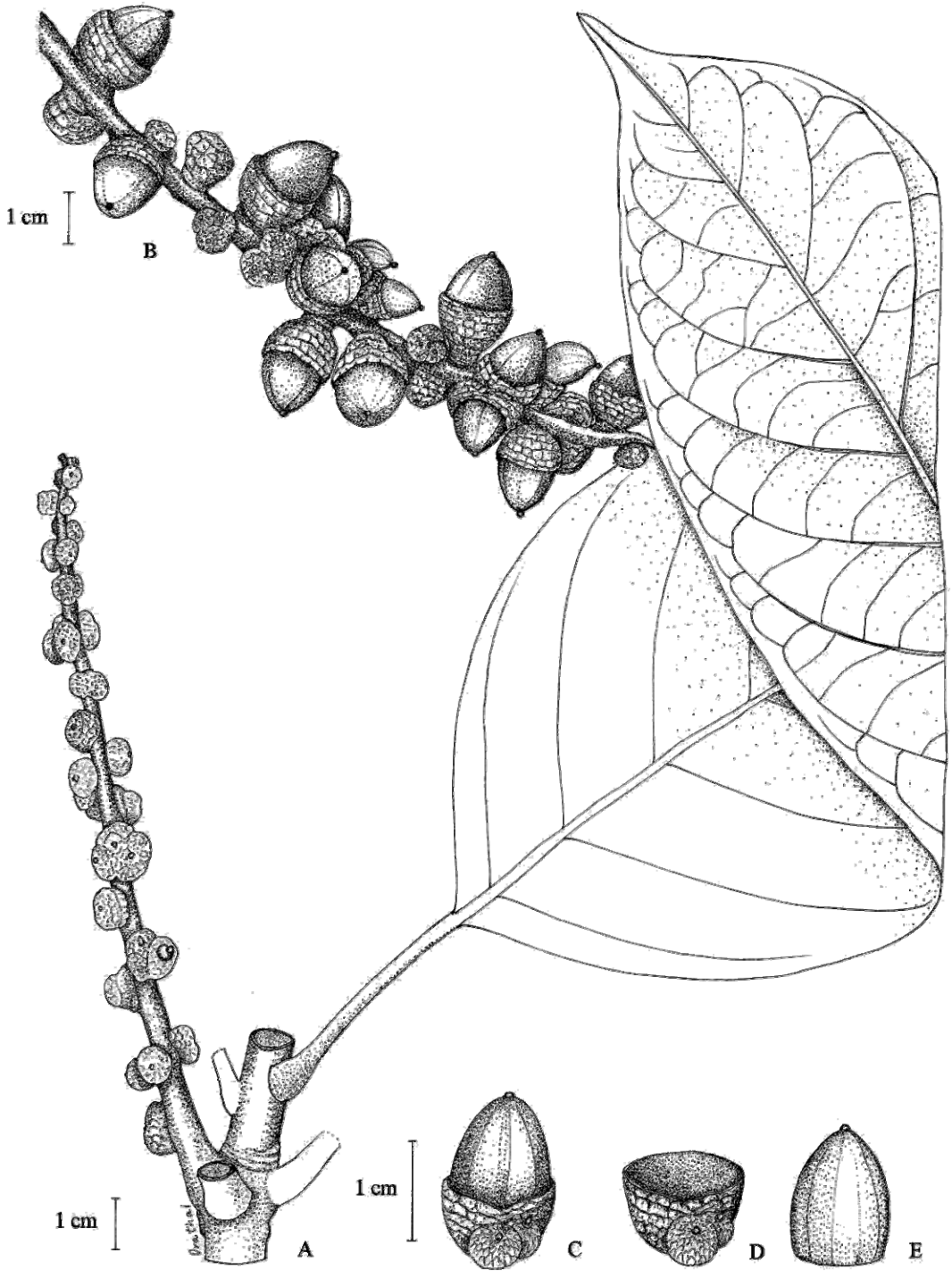

Figure 37 *Lithocarpus harmandii* (Hickel & A. Camus) A. Camus (ก่อขี้กวาง)

A. branch with young infructescence; B. mature infructescence; C. acorn; D. cupule; E. nut. Drawn by O. Kerdkaew.

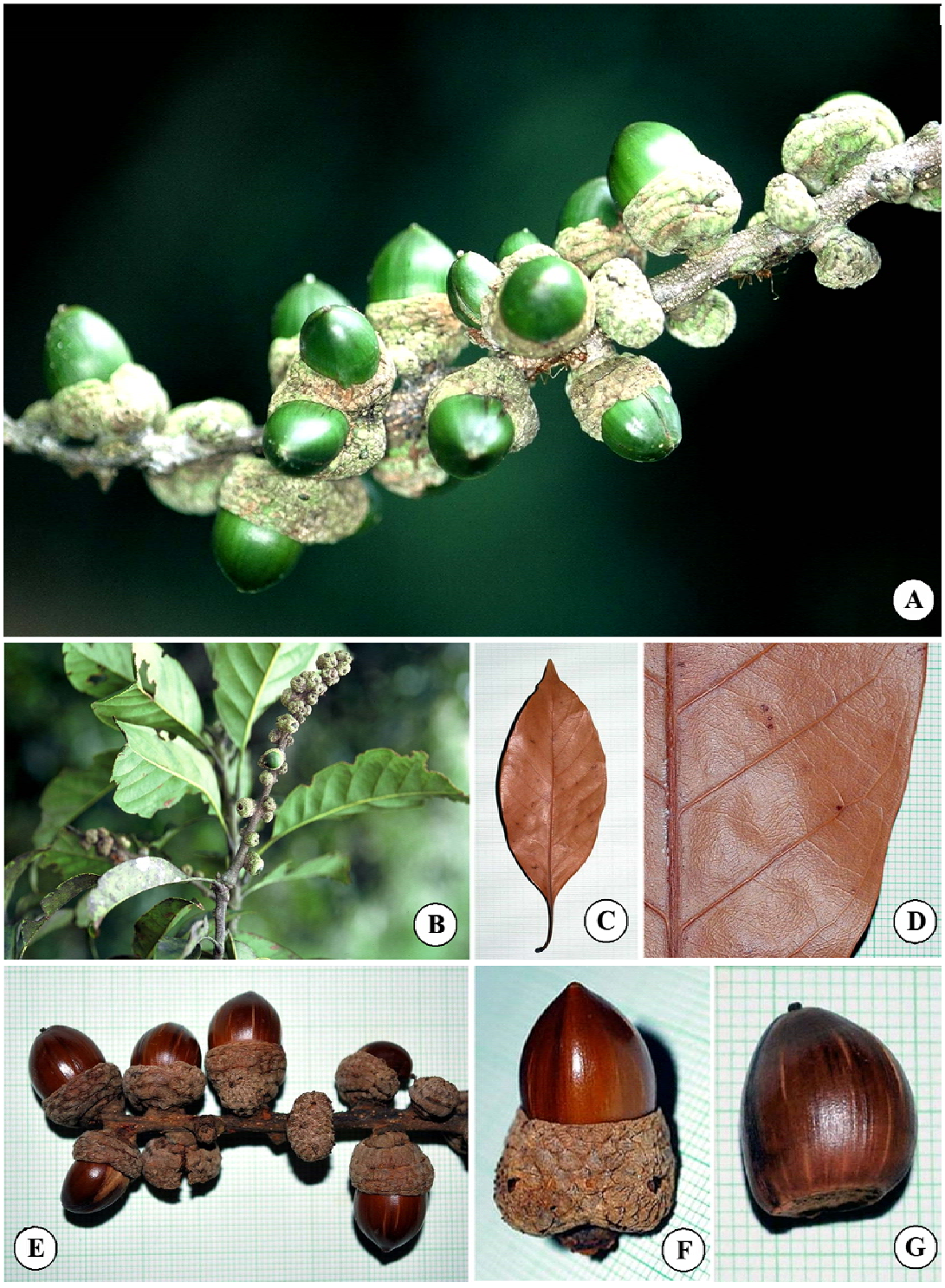

Figure 38 *Lithocarpus harmandii* (Hickel & A. Camus) A. Camus
A. infructescence; B. young infructescences; C. leaf: upper surface; D. leaf: lower surface; E. infructescence; F. acorn; G. nut.
Photographed by P. Phonsena (A, B).

6. Lithocarpus thomsonii (Miq.) Rehder, J. Arnold Arbor. 1: 132. 1919; Barnett, Quer. Rel. Fag. Asia: 102. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 333. 1944; Hjelmq. Dansk Bot. Ark. 23: 485. 1968; C.C. Huang, Y.T. Chang & B.M. Bartol. in C.Y. Wu & P.H. Raven, Fl. China 4: 346. 1999; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 337. 2008. Figure 39, 40.

Vernacular.— **Ko khao (ก่อข้าว)**.

Tree 16–28 m high, 30–40 cm in diam.; bark smooth or shallowly fissured, greyish white or greenish grey; twigs covered with scales then glabrous, lenticellate. **Stipules** lanceolate, 2–3.5 by 0.7–1 mm, caducous. **Leaves** spiral, subcoriaceous, elliptic to elliptic-oblong or obovate-oblong, 7.5–20.5 by 3–5.9 cm, apex acuminate or acute, base cuneate or slightly attenuate, margin entire, undulate or slightly serrate, upper surface green, lower surface glaucous, both surfaces glabrous; midrib slightly raised or flat on upper surface (groove in the middle of midrib), raised on lower surface, glabrous; lateral veins 10–16 pairs, flat or impressed on upper and raised on lower surface; cross veins scalariform. **Petioles** 0.6–1.1 cm long, thickened throughout its length, sparse red scales or glabrous. **Inflorescences** panicles or catkins, terminal or in upper axils; rachis hairy. **Male inflorescences** 5.5–16 cm long; bracteoles ca. 0.5 mm long; male florets cluster or single, ca. 2 mm in diam.; perianth 6-lobed, connate, densely hairy; stamen 10-12, ca. 2 mm long, glabrous; anther ca. 0.3 mm long; pistillode ca. 1 mm in diam. **Female or mixed inflorescences** were not collected. **Infructescences** 8–13 cm long (without exist dried male florets part over acorns, ca. 8–10 cm), 3–10 acorns, erect. **Acorns** sessile, ovoid, 1.6–1.9 by 1.5–1.8 cm. **Cupules** saucer-shaped or cup-shaped, enclosing ¼ to ⅓ of the nut, 0.5–0.7 cm high, 1.2–1.5 cm in diam., base obtuse, usually 3 united at base or mature cupule uniting rudimentary acorns at base, wall ca. 0.5 mm thick, all part hairy. **Nuts** 1 per cupule, depressed globose, 1.4–1.6 cm high (excluding persistent style), 1.6–1.9 cm in diam., hairy, apex protude with 3 persistent styles, ca. 1.2 mm high, base truncate; scar concave, ca. 0.8–1 cm in diam.

Ecology.— Common in dry evergreen and evergreen forest in all areas except Khao Khitchakut National Park and Nam Tok Khlong Kaeo National Park; alt. 30–740 m. Flowering: November–January; fruiting: January–August.

Notes. — This species is the most variable and similar to *L. wallichianus* (Lindl. ex Hance) Rehder but different in leaf and cupule shape. The leaf margin of *L. wallichainus* is serrate at the upper part and the cupule dish-shaped while the leaf margin of *Lithocarpus thomsonii* (Miq.) Rehder is entire and the cupule saucer-shaped or cup-shaped. Althought, this study is did not collect female or mixed inflorescences it is known that this species has mixed inflorescences because male florets are usually found at the upper part of infructescences.

Specimens examined.— *K. Bunpha et al.* KB42, 15 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KB43, 15 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KB44, 15 Jan. 2006, Trat, Mu Ko Chang National Park (BSKU); *P. Phonsena* 3726, 20 Apr. 2003, Prachin Buri, Khao Yai National Park, Nam Tok Heao Suwat (BKF); *P. Phonsena* 3729, 20 Apr. 2003, Prachin Buri, Khao Yai National Park, Nam Tok Heao Suwat (BKF); *P. Phonsena & K. Bunpha* 3667, 15 Feb. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3562, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3563, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3569, 13 Dec. 2002, Prachin Buri, Khao Yai National Park, Nam Tok Heao Suwat (BKF); *P. Phonsena et al.* 3571, 13 Dec. 2002, Prachin Buri, Khao Yai National Park, Nam Tok Heao Suwat (BKF); *P. Phonsena et al.* 4673, 13 Nov. 2005, Prachin Buri, Khao Yai National Park, Nam Tok Heao Suwat (BKF).

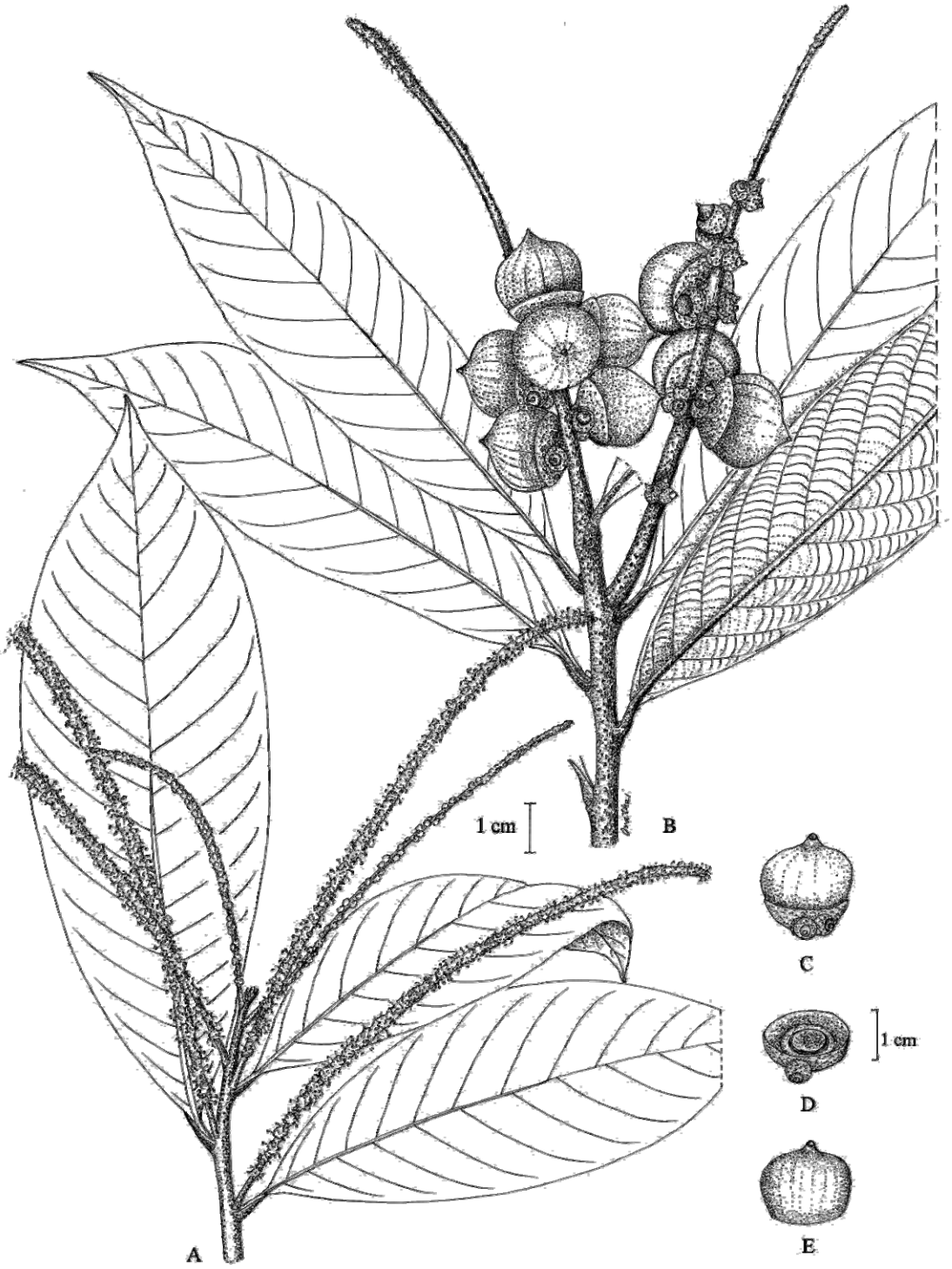

Figure 39 *Lithocarpus thomsonii* (Miq.) Rehder (ก่อข้าว)

A. branch with inflorescences; B. branch with infructescences; C. acorn; D. cupule; E. nut. Drawn by O. Kerdkaew.

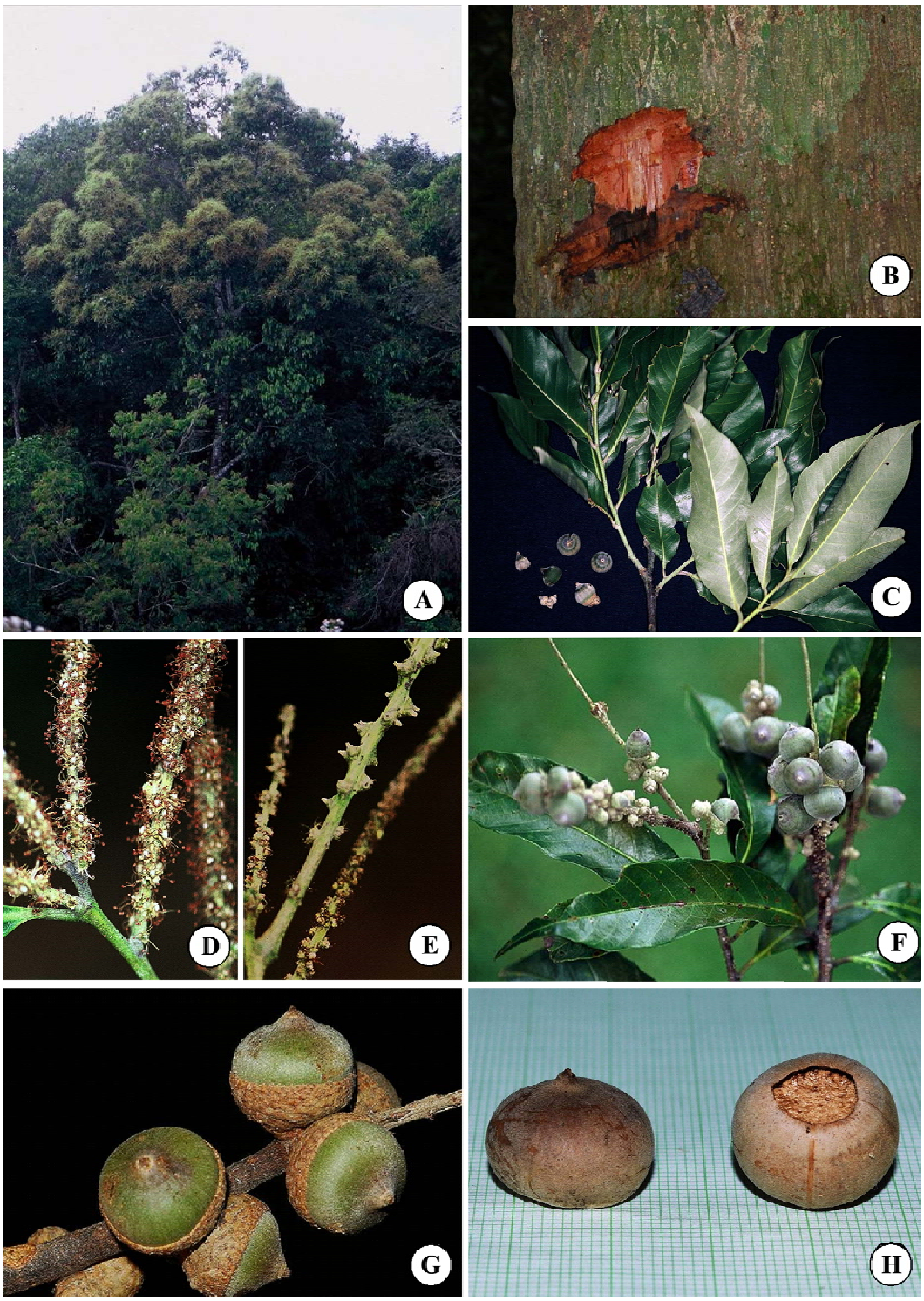

Figure 40 *Lithocarpus thomsonii* (Miq.) Rehder
A. habit; B. blaze; C. leaves; D. male inflorescences; E. female inflorescence; F-G. infructescences; H. nuts. Photographed by P. Phonsena (A, C-F); D. Chusithong (B, G).

7. Lithocarpus wallichianus (Lindl. ex Hance) Rehder, J. Arnold Arbor. 1: 132. 1919; Barnett, Quer. Rel. Fag. Asia: 100. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh, 33: 333. 1942; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 333. 1944; A. Camus, Chênes, Texte 3: 1102, t. 503. 1954; Soepadmo, Reinwardtia 8: 287. 1970; Soepadmo, Fl. Males. 7(2): 368. 1972; Soepadmo, Julia & Go in E. Soepadmo & L.G. Saw, Tree Fl. Sabah & Sarawak 3: 94. 2000; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 347. 2008. Figure 41, 42.

Vernacular.— **Ko mu (ก่อหมู)**.

Tree 15–18 m high; bark smooth or shallowly fissured, greenish grey; twigs glabrous, lenticellate. **Stipules** linear, 4–5 mm long, caducous. **Leaves** spiral, subcoriaceous, obovate, oblong or elliptic-oblong, 12–18.2 by 3.6–7.1 cm, apex acuminate, base cuneate, margin undulate and serrate ⅕–⅓ from apex, upper surface green, lower surface glaucous, both surfaces glabrous; midrib raised on lower and slightly raised or flattened on upper surface (groove in the middle of midrib), glabrous; lateral veins 12–18 pairs, impressed or flat on upper and strongly raised on lower surface; cross veins scalariform. **Petioles** 0.8–1 cm long, thickened throughout its length, sparsely red scales or glabrous. **Inflorescences** were not collected. **Infructescences** 10–23 cm long, 2–9 acorns, erect. **Acorns** ovate or depressed globose, 1.5–1.9 by 1.7–2 cm, sessile. **Cupules** dish-shaped, enclosing only base of the nut (ca. ⅙ of the nut), 0.3–0.4 cm high, 1.4–1.6 cm in diam., base slightly truncate or round, usually 3 united at base or mature cupule uniting rudimentary acorn at base, wall ca. 0.5 mm thick, all part hairy. **Nuts** 1 per cupule, ovate or obovate or depressed globose, 1.7-2 cm high (excluding persistent style), 1.4-1.8 cm in diam., hairy, apex protrude with 3 or 4 persistent styles, ca. 1 mm high, base truncate; scar concave, ca. 0.8–1 cm in diam.

Ecology.— Evergreen forest, often near streams, only Mu Ko Chang National Park; alt. 0–70 m. Fruiting: January–April.

Specimens examined.— *K. Bunpha* KB41, 15 Jan. 2006, Trat, Mu Ko Chang National Park, Nam Tok Khlong Plu (BSKU); *P. Phonsena et al.* 4206, 7 Apr. 2004, Trat, Mu Ko Chang National Park, Nam Tok Khlong Plu (BKF).

Figure 41 *Lithocarpus wallichianus* (Lindl. ex Hance) Rehder (ก่อหมู)

A. young infructescence; B. branch with mature infructescence;
C. cupule; D. nut. Drawn by O. Kerdkaew.

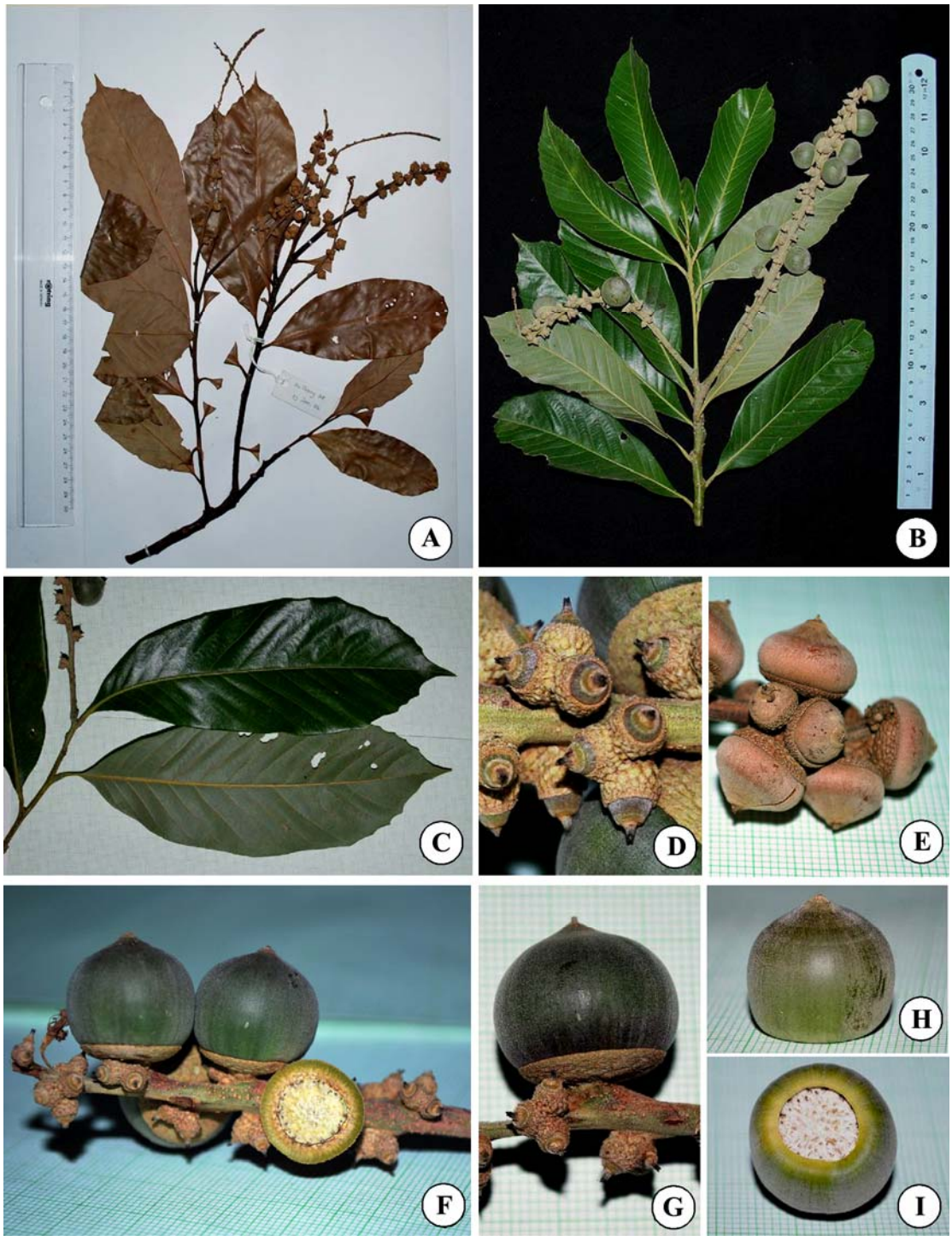

Figure 42 *Lithocarpus wallichianus* (Lindl. ex Hance) Rehder

A. branch with leaves and young infructescences; B. branch with leaves and mature infructescences; C. leaves; D-E. young infructescences; F-G. infructescence; H-I. nuts.

8. Lithocarpus wrayi (King) A. Camus, Rivièta Sci. 18: 42. 1931; Soepadmo, Reinwardtia 8: 288. 1970; Soepadmo, Fl. Males. 7(2): 334. 1972; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 349. 2008. Figure 43, 44.

Vernacular.— **Ko kriap (ก่อเกรียบ)**.

Tree 8–18 m high, 30–40 cm in diam.; bark numerous distinct lenticels, greenish grey; twigs densely brown hairy then glabrescent, young leaves densely brown hairy. **Stipules** ovate, ca. 4–5 by 2–4 mm, persistent. **Leaves** alternate, subcoriaceous, ovate, elliptic-oblong or oblong, 15–39 by 4.4–15 cm, apex acuminate to caudate, base cuneate or obtuse, margin entire, upper surface green, lower surface pale green, both surfaces densely hairy then glabrescent; midrib strongly raised on both surfaces or impressed on upper surface (groove in the middle of midrib), hairy; lateral veins (13–)15–19 pairs, impressed on upper and strongly raised on lower surface; cross veins scalariform. **Petioles** 0.6–0.8 cm long, thickened throughout its length, hairy. **Inflorescences** catkin, in upper axils; rachis hairy. **Male inflorescence** were not collected. **Mixed inflorescences** 6–7 cm long; bracteoles ca. 1–1.5 mm long; female florets single; ca. 1–1.2 mm in diam., perianth 6-lobed, hairy, style 3, stigma punctiform, stigma tip black, glabrous. **Infructescences** 6.5–13.7 cm long, 1–5 acorns, erect. **Acorns** ovate, 1.5–1.8 by 1.7–2.4 cm, stalked ca. 0.2–0.3 cm high. **Cupules** cup-shaped, covered with soft spines ca. 1–2 mm long, enclosing ⅓ to ¾ of the nut, 0.9–1.2 cm high, 1.7–2.4 cm in diam., base truncate or obtuse, wall ca. 0.5 mm thick, all part hairy. **Nuts** 1 per cupule, ovate or depressed globose, 1.4–1.7 cm high (excluding persistent style), 1.7–2.1 cm in diam., hairy, apex obtuse to round with protruding persistent styles, ca. 2–3 mm high, base truncate; scar concave ca. 1–1.2 cm in diam.

Ecology.— Lowland evergreen forest, often near streams, on limestone only in Nam Tok Khlong Kaeo National Park; alt. 100–200 m. Flowering: December; fruiting: April–September.

Specimens examined.— Previous descriptions of *Lithocarpus wrayi* (King) A. Camus always had the cupule completely covering the nut, but several locations were found mature acorns had cupules covering less than ¾ of the nut.

Specimens examined.— *K. Bunpha et al.* 51, 15 Apr. 2006, Trat, Nam Tok Khlong Kaeo National Park, Nam Tok Khlong Kaeo, limestones (BSKU, Herbarium of Khao Hin Son Botanic Garden); *K. Bunpha et al.* 52, 15 Apr. 2006, Trat, Nam Tok Khlong Kaeo National Park, Nam Tok Khlong Kaeo, near streams (BKF, Herbarium of Khao Hin Son Botanic Garden); *K. Bunpha et al.* 53, 15 Apr. 2006, Trat, Nam Tok Khlong Kaeo National Park, Nam Tok Khlong Kaeo, near head office (BKF, BSKU); *K. Bunpha et al.* 54, 15 Apr. 2006, Trat, Nam Tok Khlong Kaeo National Park, Nam Tok Khlong Kaeo, near head office (BSKU, Herbarium of Khao Hin Son Botanic Garden); *K. Bunpha et al.* 112, 9 Jun. 2006, Trat, Nam Tok Khlong Kaeo National Park, Nam Tok Khlong Kaeo, near streams (BSKU, Herbarium of Khao Hin Son Botanic Garden); *K. Bunpha, Y. Banchong* and *R. Keaokhao* 49, 28 Jan. 2006, Trat, Nam Tok Khlong Kaeo National Park, Nam Tok Khlong Kaeo (BKF, BSKU).

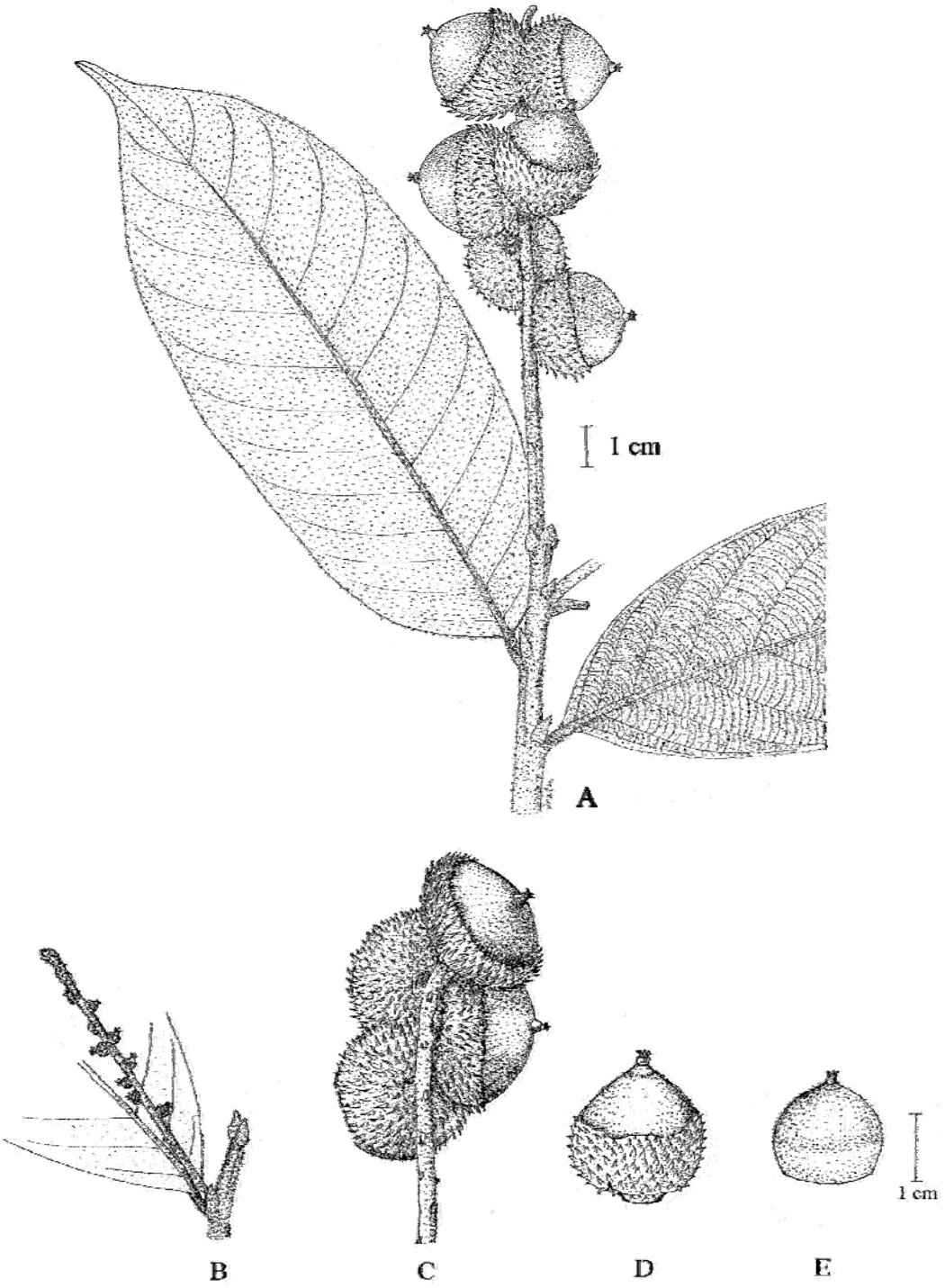

Figure 43 *Lithocarpus wrayi* (King) A. Camus (ก่อเกรียบ)

A. branch with mature infructescence; B. young infructescence;
C. mature infructescence; D. acorn; E. nut. Drawn by O. Kerdkaew.

Figure 44 *Lithocarpus wrayi* (King) A. Camus

A. habit; B. bark: lenticels; C. blaze; D. leaf and young shoot; E. stipules; F-G. female inflorescence; H-I. infructescence; J. nut. Photographed by Y. Banchong (A-C).

Quercus L.

Evergreen tree, blaze with distinct furrows. Leaves spiral or often closely crowded of 3–6; margin mostly serrate, rarely entire; cross veins scalariform; petioles thickened at base. Inflorescences catkins, pendulous or erect, rachis hairy. Male florets clusters or single; perianth 6-lobed, stamen 6–8, filaments free, filiform; anther 0.5–1 mm long, basifixed, longitudinally dehiscent; pistillode lacking. Female florets in clusters or single; perianth 4–6-lobed, styles 4–6, stigmas capitate. Acorns ovate, depressed globose, subglobose, oval or dorsiventral compressed. Cupule partly covering nut, outer surface with lamella, indehiscent. Nut 1 per cupule, ovate, obovate, oblate, depressed globose, or dome-shaped. This study found 8 species of *Quercus* in Southeastern Thailand.

Key to species of *Quercus* in Southeastern Thailand

1. Acorn diameter ≥ 3 cm (usually 3–4 cm)
   2. Leaf mostly obovate; cupule enclosing ≤ ½ of the nut, lamellae ≤ 10 layers…..... ...……..……..…….….**6. *Q. rex***
   2. Leaf elliptic to elliptic-oblong; cupule enclosing the nut, lamellae 13–14 layers…….……..…….……..…….**8. *Q. thorelii***
1. Acorn diameter < 3 cm
   3. Cupule enclosing ≥ ½ of the nut, cupule height > 1 cm (1.2–1.7 cm)
      4. Nut glabrous; leaf apex caudate…….....…...…..…....**7. *Q.* cf. *saravanensis***
      4. Nut hairy or glabrescent; leaf apex acuminate, acute or obtuse
         5. Leaf base mostly symmetric, lower surface glaucous; cupule cover densely brown hairy; nut slightly obovate or depressed globose……...… ……..……...……..……**1. *Q. auricoma***
         5. Leaf base mostly asymmetric, lower surface pale green; cupule cover densely grey hairy; nut ovate or ovate-oblong……...…… …….……..……...….…….**3. *Q. oidocarpus***
   3. Cupule enclosing < ½ of the nut, cupule height ≤ 1 cm (0.4–0.8 cm)
      6. Stylopodium height 3–6 mm; leaf distinctly serrate, lower surface glabrescent
         7. Petiole length 0.8–1.2 cm; lamellae edge denticulate; nut bottom convex or flat……..…..…….…..…..…..….**5. *Q. quangtriensis***
         7. Petiole length 1.3–2.5 cm; lamellae edge dentate; nut bottom concave……..…...…….…..…...……..…**2. *Q.* cf. *lineata***
      6. Stylopodium height ca. 1 mm; leaf entire or slightly serrate, lower surface densely stellate hair……...……...…….,,……..….**4. *Q. poilanei***

1. Quercus auricoma A. Camus, Chênes, Atlas 2: 122. 1935. Fig. 104; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 361. 2008. Figure 45,46.

Vernacular.— **Ko daeng (ก่อแดง)**.

Tree 8–28 m high, 30–40 cm in diam.; bark smooth and greyish; twigs densely brown hairy then glabrous. **Stipules** linear, caducous. **Leaves** spiral or often closely to crowded of 3–6, subcoriaceous, elliptic or elliptic-oblong, sometimes slightly obovate, 6–14 by 1.8–4.2 cm, apex acute, slightly acuminate or obtuse, base cuneate or obtuse, margin shallowly serrate or undulate ¼–½ from apex, both surfaces glabrescent, lower surface glaucous; midrib and lateral veins strongly raised on lower and slightly impressed on upper surface; lateral veins 8–11 pairs; cross veins scalariform. **Petioles** 1.2–2.2 cm long, thickened at base, densely brown hairy. **Inflorescences** catkins; in upper axils; rachis densely brown hairy. **Male inflorescences** 3–10 cm long, male florets clusters or single; perianth 6-lobed, ovate, ca. 2 mm long, hairy; anther ca. 0.5 mm long. **Female inflorescences** 1–2.5 cm long, female florets single, densely brown hairy, 4 by 2 mm, styles mostly 4–6, ca. 2 mm long, stigma capitate. **Infructescences** ca. 1.6–2 cm long, 3–5 acorns. **Acorns** ovate, 1.9–2.3 by 1.6–2 cm, sessile. **Cupules** cup-shaped, enclosing up to ½ of the nut, 1.2–1.4 cm high, 1.6–2 cm in diam., base obtuse, wall 1.8–2 mm thick, all part densely brown hairy, lamellae 7–11 layers, ca. 1–3 mm apart, rim denticulate and not dilated. **Nuts** 1 per cupule, obovate, 1.5–1.9 cm high (excluding persistent style), 1.4–1.7 cm in diam., hairy, apex round with protruding persistent styles, ca. 2–2.2 mm high, base slightly truncate; scar slightly convex ca. 0.7–1 cm in diam.

Ecology.— In hill evergreen forest, open areas along cliffs, only in Khao Yai National Park; alt. 1100–1180 m. Flowering: March–May; fruiting: July–September.

Note.— This species is similar to *Q. ramsbottomii* A. Camus but differs in acorn shape and cupule characters. The acorn of *Q. ramsbottomii* is broader than long, the acorn is stalked and its rim is dilated.

Specimens examined.— *P. Phonsena* 3737, 20 Apr. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena* 3738, 20 Apr. 2003, Prachin Buri, Khao Yai National Park (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena* 3739, 20 Apr. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena* 3741, 20 Apr. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena* 3823, 5 July 2003, Prachin Buri, Khao Yai National Park (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena* 3862, 16 Aug. 2003, Prachin Buri, Khao Yai National Park (BKF, BSKU); *P. Phonsena* 3885, 23 Aug. 2003, Prachin Buri, Khao Yai National Park (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena* 3886, 23 Aug. 2003, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3554, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3555, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3556, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 3557, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 3558, 13 Dec. 2002, Prachin Buri, Khao Yai National Park (BKF); *P. Phonsena et al.* 3875, 22 Aug. 2003, Prachin Buri, Khao Yai National Park (BKF).

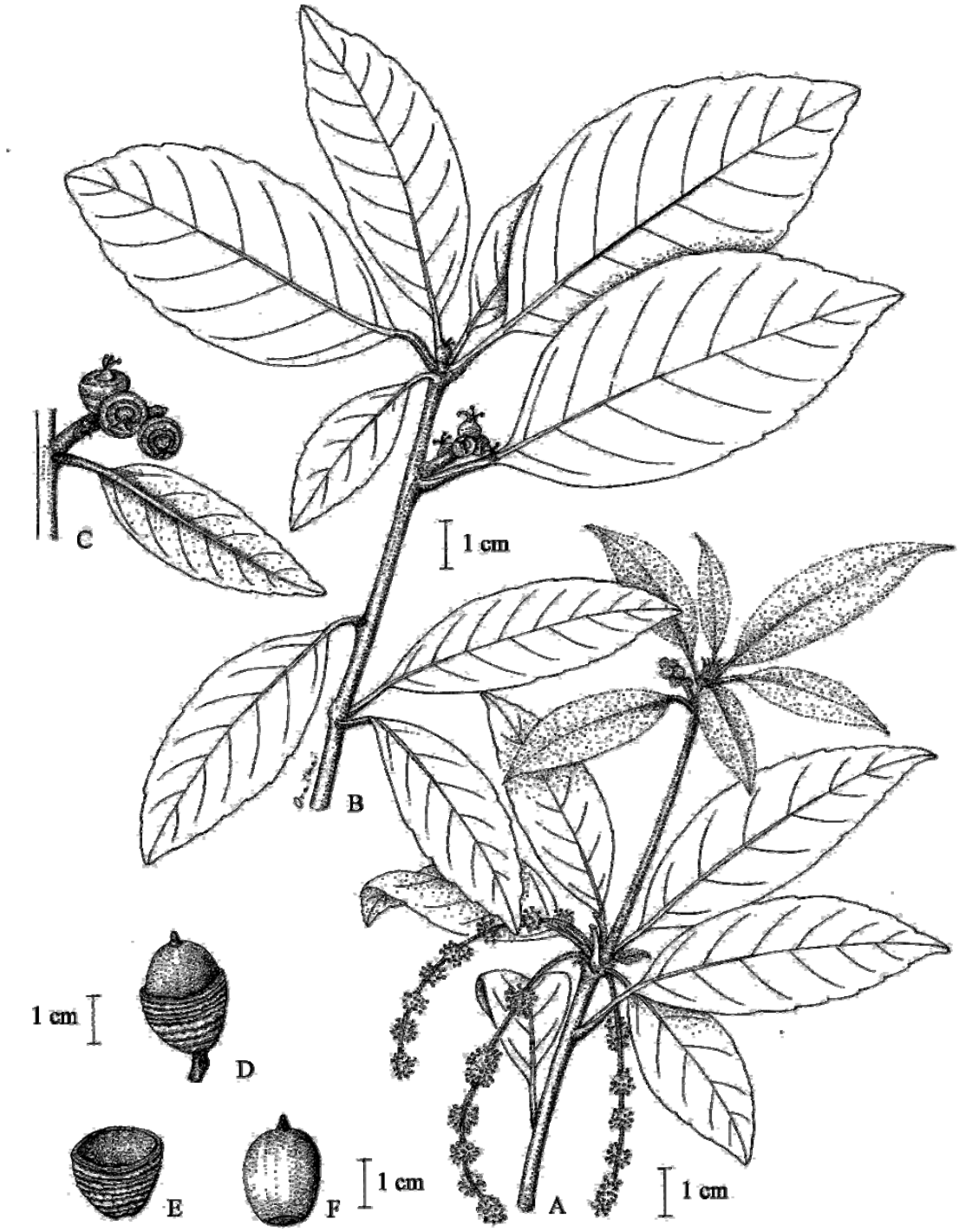

Figure 30 *Quercus auricoma* A. Camus (ก่อแดง)

A. branch with male inflorescences; B-C. branch with young infructescence; D. acorn; E. cupule; F. nut. Drawn by O. Kerdkaew.

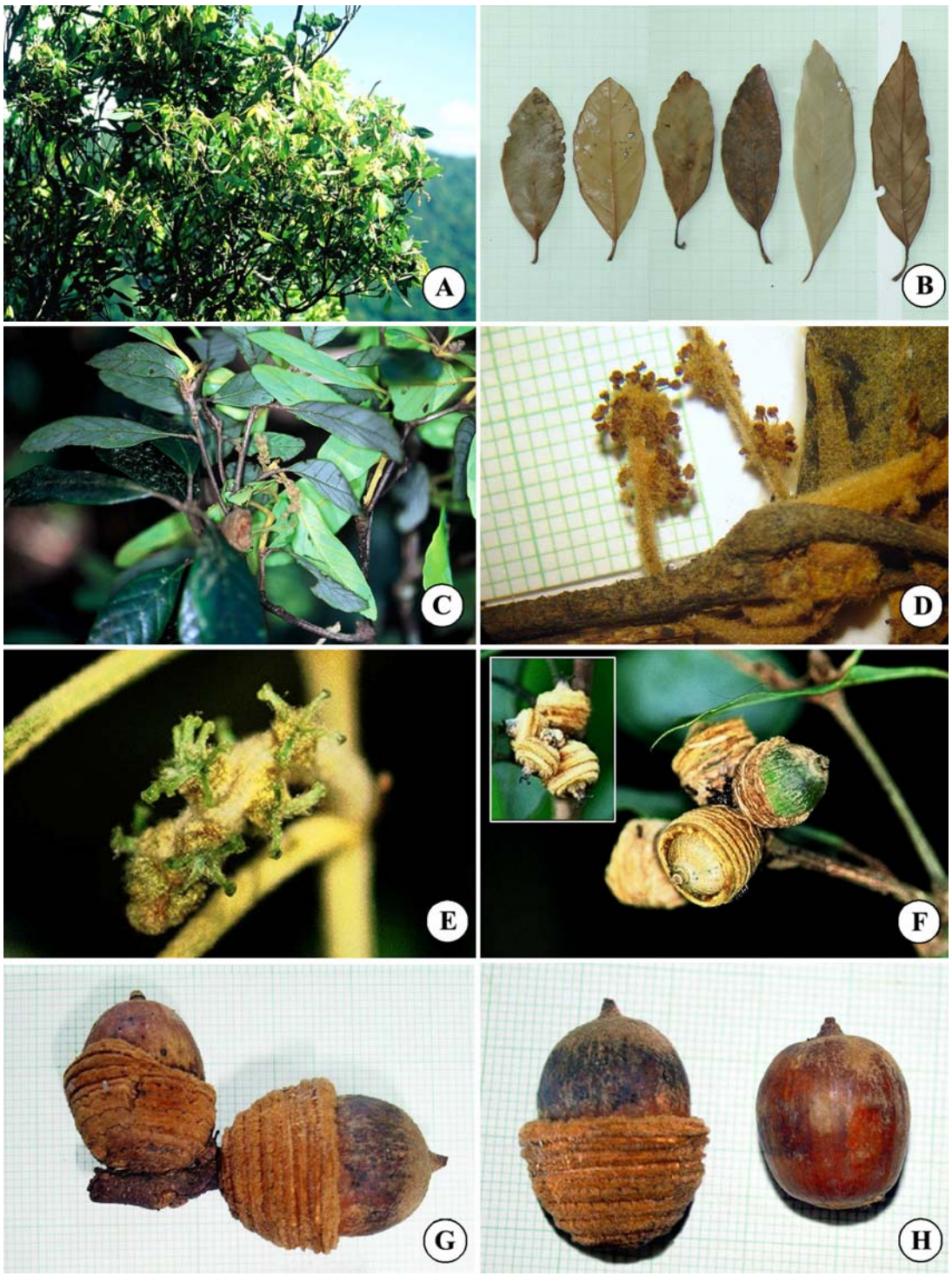

Figure 31 *Quercus auricoma* A. Camus

A. habit; B-C. leaves; D. male inflorescences; E. female inflorescence; F. young (left) and mature (right) infructescences (left); G. infructescence; H. acorn and nut. Photographed by P. Phonsena (A, C, E, F).

2. Quercus cf. lineata Blume, Bijdr.: 523. 1826; Barnett, Quer. Rel. Fag. Asia: 57. 1940. Soepadmo, Fl. Males. 7(2): 396. 1972; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 381. 2008. Figure 47,48.

Vernacular.— **Ko khitchakut (ก่อคิชฌกูฏ)**, Ko muak (ก่อหมวก).

Tree 15–28 m high, 30–50 cm in diam.; bark smooth and greyish brown; twigs densely brown hairy then glabrous, young leaves reddish-brown. **Stipules** linear, ca. 7–10 mm long, caducous. **Leaves** spiral, subcoriaceous, elliptic-oblong or lanceolate, 9.5–20 by 2.2–4.4 cm, apex acuminate or acute, base cuneate, margin serrate ⅓–½ from apex or slightly undulate, both surfaces glabrescent and glaucous on lower surface; midrib strongly raised on lower and flattened or slightly raised on upper; lateral veins 12–15 pairs, slightly raised on lower and obscured on upper; cross veins scalariform. **Petioles** (1–)1.3–2.5 cm long, thickened at base, glabrescent. **Inflorescences** catkins, in upper axils; rachis glabrescent. **Male inflorscences** 3.2–8 cm long, male florets clusters or single; perianth 6-lobed, membranous, obovate, ca. 1.5 mm long, hairy; stamen 6–8, ca. 3–4 mm long, anther ca. 0.8–1 mm long. **Female inflorescences** 4.5–6 cm long, female florets dichasium, 2–3 florets per cluster, style 4–6, stigma capitate, densely brown hairy. **Infructescences** ca. 1.1–2.4 cm long, 1–3 acorns. **Acorns** ovate, 1.5–2.2 by 1.8–2.5 cm, sessile. **Cupules** saucer-shaped or cup-shaped, enclosing up to ⅓ of nut, 0.5–0.7 cm high, 1.8–2.3 cm in diam., base truncate, wall 0.9–1 mm thick, all part densely brown hairy, lamellae 6–7 layers, ca. 1–3 mm apart, rim denticulate. **Nuts** 1 per cupule, ovate, 1.2–2.3 cm high (excluded persistent style), 1.68–2.1 cm in diam., hairy, apex obtuse with protrude persistent styles, ca. 0.3–0.7 cm, base slightly truncate with scar concave ca. 1 cm in diam.

Ecology.— In evergreen forest, shaded and open areas, only in Khao Khitchakut National Park and Mu Ko Chang National Park; alt. 100–620 m. Flowering: February–April; fruiting: March–May.

Notes.— This species is similar to *Quercus lineata* Blume (Phengklai, 2008) but differ from the isotype of *Q. lineata* at Singapore Botanic Garden in leaf shape, and lateral veins. The leaf of isotype is broadly elliptic, lateral veins up to 18 pairs and closely spaced while this species is elliptic-oblong or lanceolate, lateral veins up to 15 pairs and less closely spaced. If it is possible, it should be compared with the type specimen to confirm to species.

Specimens examined.— *K. Bunpha et al.* KB4, 28 Mar. 2005, Trat, Mu Ko Chang National Park (BSKU); *K. Bunpha et al.* KB39, 14 Jan. 2006, Trat, Mu Ko Chang National Park, Nam Tok Than Mayom (BSKU); *P. Phonsena* 3774, 30 Apr. 2003, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 3410, 30 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 3412, 30 Oct. 2002, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena et al.* 4194, 3 Apr. 2004, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 4503, 3 Feb. 2005, Trat, Mu Ko Chang National Park, Nam Tok Than Mayom (BKF).

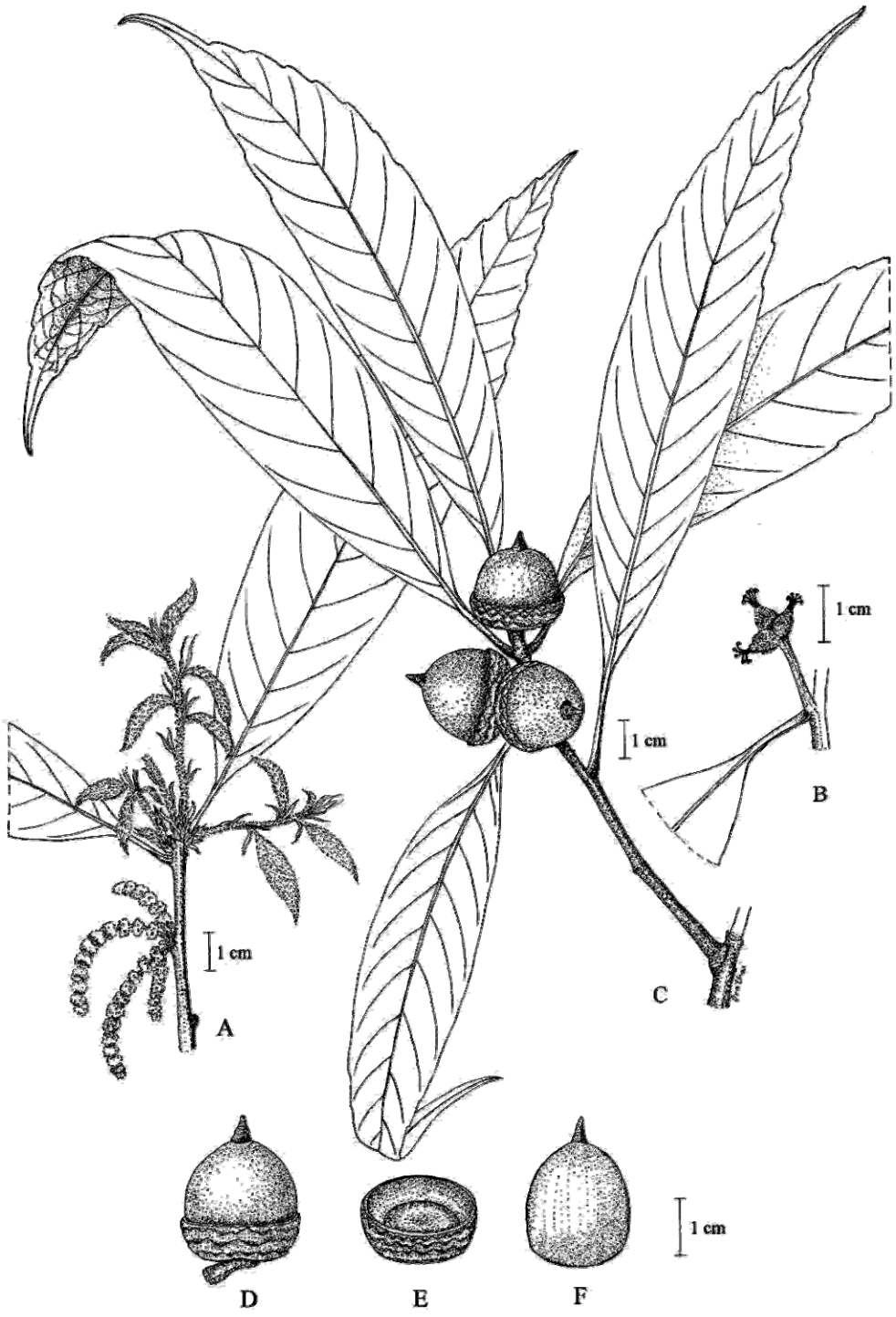

Figure 47 *Quercus* cf. *lineata* Blume (ก่อคิชฌกูฏ)

A. young shoots with male inflorescences; B. young infructescence; C. branch with infructescences; D. acorn; E. cupule; F. nut. Drawn by O. Kerdkaew.

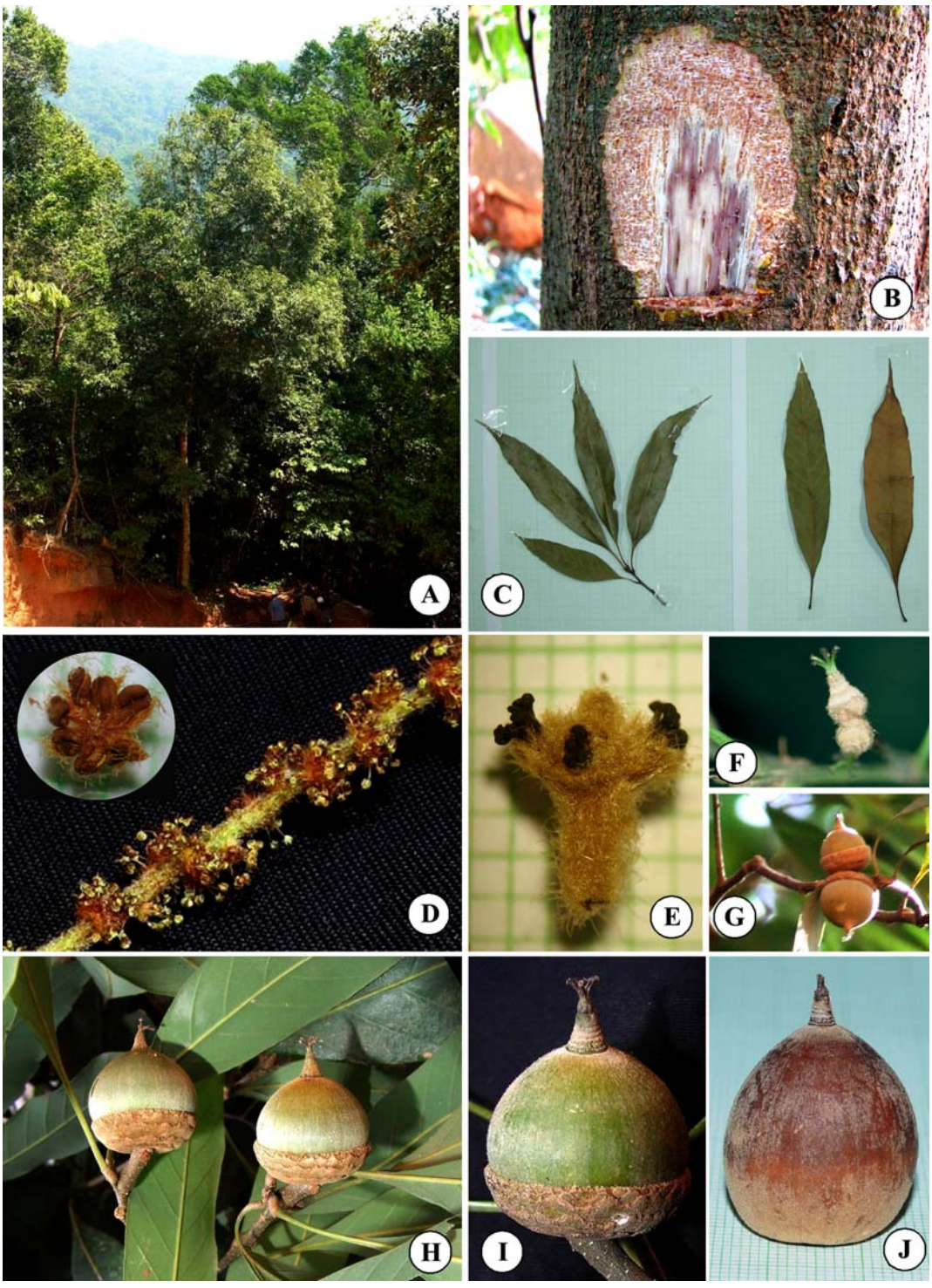

Figure 48 *Quercus* cf. *lineata* Blume

A. habit; B. blaze; C. leaves; D. male inflorescence and floret (left); E. female inflorescence; F. young infructescence; G-I. infructescences; J. nut. Photographed by Y. Banchong (A, B, G); P. Phonsena (F).

3. Quercus oidocarpus Korth., Verh. Nat. Gesch. Ned. Bezitt., Bot.: 216, t. 47, fig. 18. 1844; Hickel & A. Camus in H. Lecomte, Fl. Indo-Chine 5: 952. 1930; Ridl., Fl. Malay Penins. 3: 373. 1967; Barnett, Quer. Rel. Fag. Asia: 64. 1940; Soepadmo, Fl. Males. 7(2): 392. 1972; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 389. 2008. Figure 49, 50.

Vernacular.— **Ko muak (ก่อหมวก)**.

Tree 4–10 m high, 10–30 cm in diam.; bark smooth and greyish brown; twigs hairy. **Stipules** linear, ca. 7–10 mm long, caducous. **Leaves** spiral, subcoriaceous, ovate, 8.3–11.3 by 3–3.4 cm, apex acuminate, base cuneate, margin serrate ⅓–⅔ from apex, both surfaces glabrescent and glaucous on lower surface; midrib strongly raised on lower and flattened or slightly raised on upper; lateral veins 10–12 pairs, slightly raised on lower and obscured on upper; cross veins scalariform. **Petioles** ca. 0.5 cm long, hairy. **Inflorescences** catkin, in upper axil; rachis hairy. **Male inflorscences** 3.2–5 cm long, male florets clusters or single; perianth 6-lobed, membranous, obovate, hairy; stamen 6–8, ca 3–4 mm long, anther ca. 0.8–1 mm long. **Female inflorescences** ca. 0.5-0.8 cm long, female florets dichasium, 2–3 florets per cluster, style 4–6, stigma capitate, densely brown hairy. **Infructescences** ca. 1.1–2.4 cm long, 1–3 acorns. **Acorns** ovate, 1.9–2.8 by 1.8–2.2 cm, sessile. **Cupules** cup-shaped, enclosing up to ½ of nut, 1.2–1.7 cm high, 1.8–2 cm in diam., base convex or truncate, wall 1–2 mm thick, all part densely brown hairy, lamellae 6–7(–9) layers, ca. 2–3 mm apart, rim denticulate. **Nuts** 1 per cupule, ovate, 1.8–2.3 cm high (excluded persistent style), 1.7–1.9 cm in diam., glabrescent, apex obtuse with protrude persistent styles, ca. 3 mm, base slightly truncate; scar ca. 1 cm in diam.

Ecology.— Common in hill evergreen forest, growing on exposed ridges near cliffs, only in Khao Soi Dao Wildlife Sanctuary; alt. 1250–1500 m. Flowering: January–April; fruiting: January–April.

Notes.— This species is similar to *Q. oidocarpus* Korth. but there are some problems when using the key to species of Phengklai (2008). In the key to species of *Quercus,* cupule with stalk separates *Q. oidocarpus* but in this study the cupule lacked a stalk. This species is a new record for Southeastern Thailand.

Specimens examined.—. *B. Harwood* 2037, 12 Jan. 2009, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai, cliff 1 (BSKU); *K. Bunpha et al*. 17, 10 Dec. 2005, Chanthaburi, Khao Soi Dao Tai, ciff 2 (BSKU, KHS); *P. Phonsena, D. Chusithong, W. Chansook & N. Loetsombunsuk* 5817, 27 Jan. 2008, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai, cliff 1 (BKF, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena, D. Chusithong, W. Chansook & N. Loetsombunsuk* 5818, 27 Jan. 2008, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai, cliff 1 (BKF, BSKU); *P. Phonsena et al.* 4782, 21 Feb. 2006, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai, (BKF, BSKU, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 4804, 22 Feb. 2006, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai, (Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 4807, 22 Feb. 2006, Chanthaburi, Khao Soi Dao Wildlife Sanctuary (BKF); *Phonsena et al.* 4812, 23 Feb. 2006, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai (BKF);.

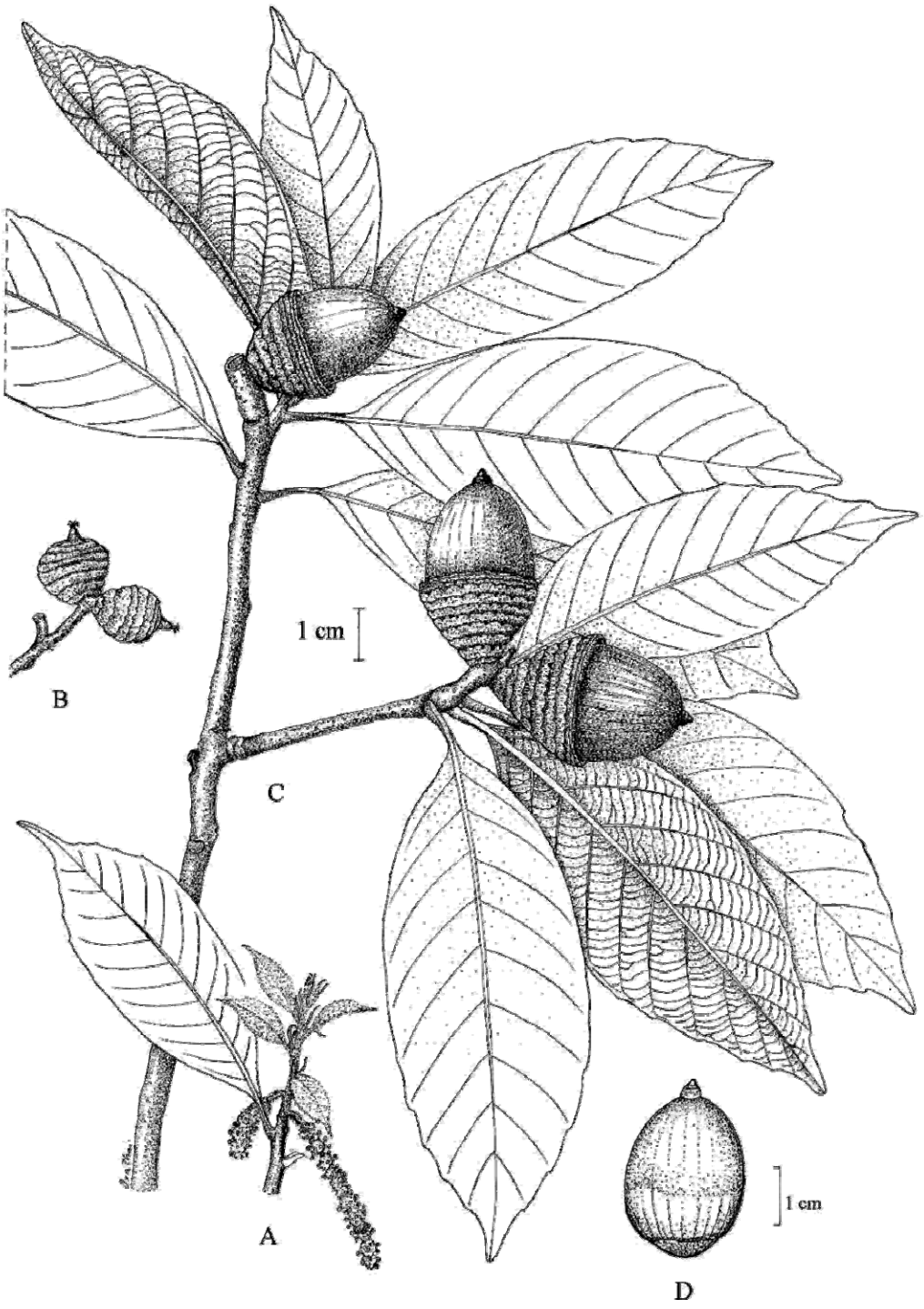

Figure 49 *Quercus oidocarpus* Korth. (ก่อหมวก)

A. branch with male inflorescences; B. young infructescence;

C. branch with mature infructescence; D. nut. Drawn by O. Kerdkaew.

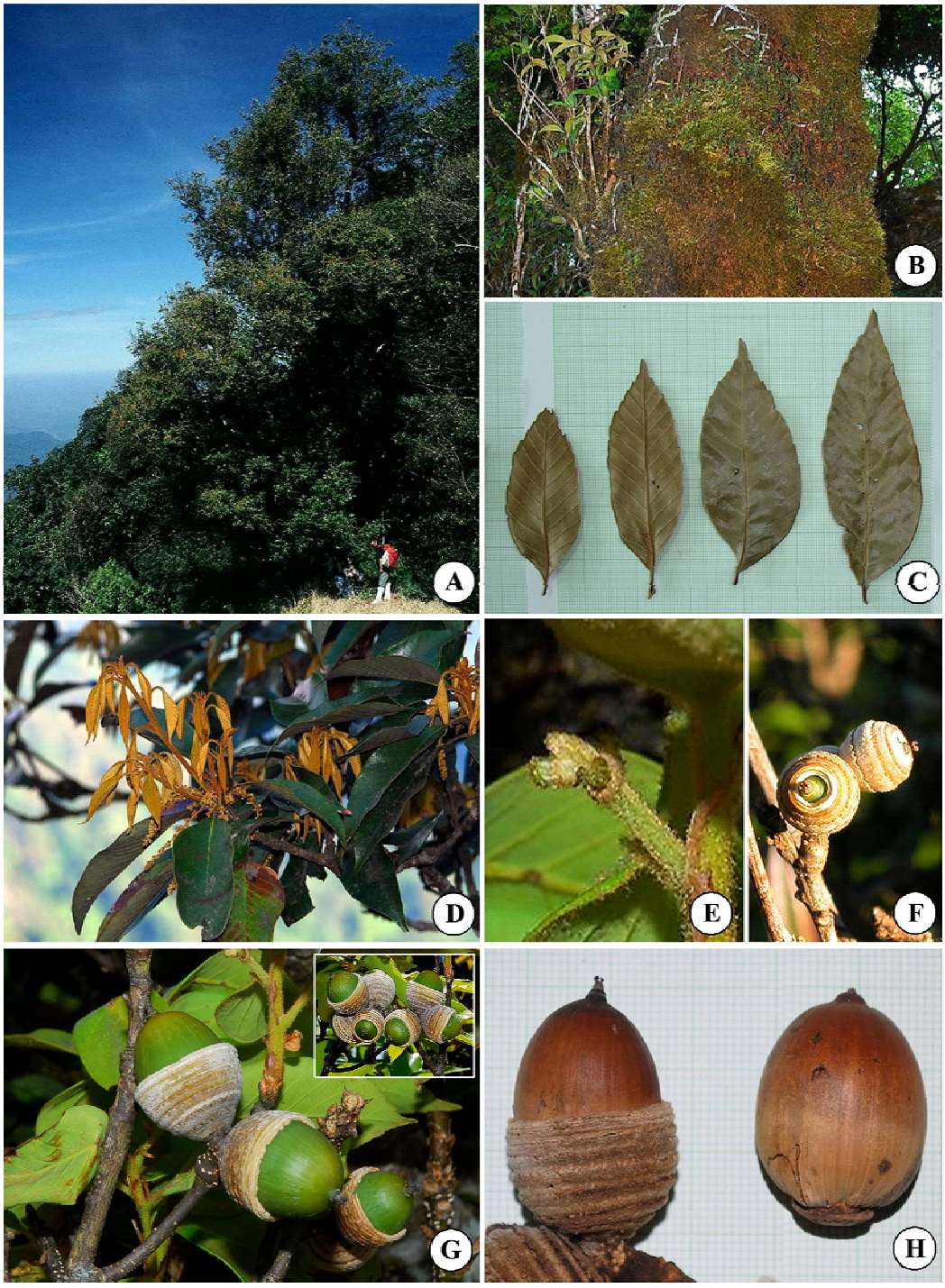

Figure 50 *Quercus oidocarpus* Korth.

A. habit; B. bark cover with bryophytes; C. leaves; D. young shoot with male inflorescences; E. female inflorescence; F. young infructescence; G. mature infructescences; H. acorn and nut. Photographed by P. Phonsena (A-B, D-G).

4. Quercus poilanei Hickel & A. Camus, Ann. Sci. Nat., Bot., X, 3: 384. 1921; Hickel & A. Camus in H. Lecomte, Fl. Indo-Chine 5: 961. 1930; Barnett, Quer. Rel. Fag. Asia: 273. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 169. 1944; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 393. 2008.— *Cyclobalanopsis poilanei* (Hickel & A. Camus) Hjelmq., Dansk. Bot. Ark. 23(4): 508. 1968; C.C. Huang, Y.T. Chang & B.M. Bartol. in C.Y. Wu & P.H. Raven, Fl. China 4: 399. 1999. Figure 51, 52.

Vernacular.— **Ko si siat (ก่อสีเสียด)**.

Tree 10–12 m high; bark smooth and greyish brown; twigs densely lenticellate, brown hairy then glabrous. **Stipules** linear, caducous. **Leaves** spiral, often closely crowded of 3–6, subcoriaceous, brittle when dry, ovate, 7.5–11.5 by 2.4–4.8 cm, apex acute or acuminate, base obtuse, margin entire, upper surface glabrecent, lower surface densely stellate hair; midrib and lateral veins strongly raised on lower and depressed on upper; lateral veins 13–16 pairs; cross veins scalariform. **Petioles** 1.2–2 cm long, thickened at base, hairy. **Inflorescences** catkin, in upper axils. **Male inflorscences** 2.5–12.5 cm long, florets single; perianth 6-lobed, ca. 1.5 mm long, hairy; stamen 6–8, ca. 3–4 mm long, anther ca. 0.8–1 mm long, hairy. **Female inflorescences** were not collected. **Infructescences** 2–4.5 cm long, 1–2(–4) acorns. **Acorns** depressed globose or ovate, 1.5–2.8 by 1.72–2 cm, sessile. **Cupules** saucer-shaped, enclosing ¼–⅓ of the nut, 0.3–0.4 mm high, 1.5–1.9 cm in diam., base truncate or concave, wall 0.9–1 mm thick, all part densely hairy, lamellae 6–8 layers, ca. 1–3 mm apart, rim denticulate. **Nuts** 1 per cupule, ovate or dome-shaped, 1.2–1.4 cm high (excluded persistent style), 1.5–1.8 cm in diam., hairy, apex obtuse with protrude persistent styles, ca. 1–3 mm, base slightly truncate or concave; scar 0.8–1 cm in diam.

Ecology.— In hill evergreen forest, near rocky cliff areas, only in Khao Soi Dao Wildlife Sanctuary, alt. 1300–1470 m. Flowering: February–March; fruiting: September–December.

Notes.— This species is similar to *Quercus poilanei* Hickel & A. Camus of Flora of China (Huang *et al.*, 1999) in acorn shape (ovate), leaf shape (ovate), leaf texture (coriaceous), indumentum of leaf (stellate hairs). Mostly the description of *Quercus poilanei* in Flora of Thailand (Phengklai, 2008) is like this species but there is one problem when using the key to species. The key to species of *Quercus,* uses leaf shape (obovate) to separate this species. The leaf of this species is ovate and densely yellow stellate hairy. This species is a new record for Southeastern Thailand.

Specimens examined.— *B. Harwood* 2027, 23 Sep. 2008, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai (BSKU); *K. Bunpha et al*. 17, 10 Dec. 2005, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai (BSKU, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena et al.* 4805, 22 Feb. 2006, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai (BKF).

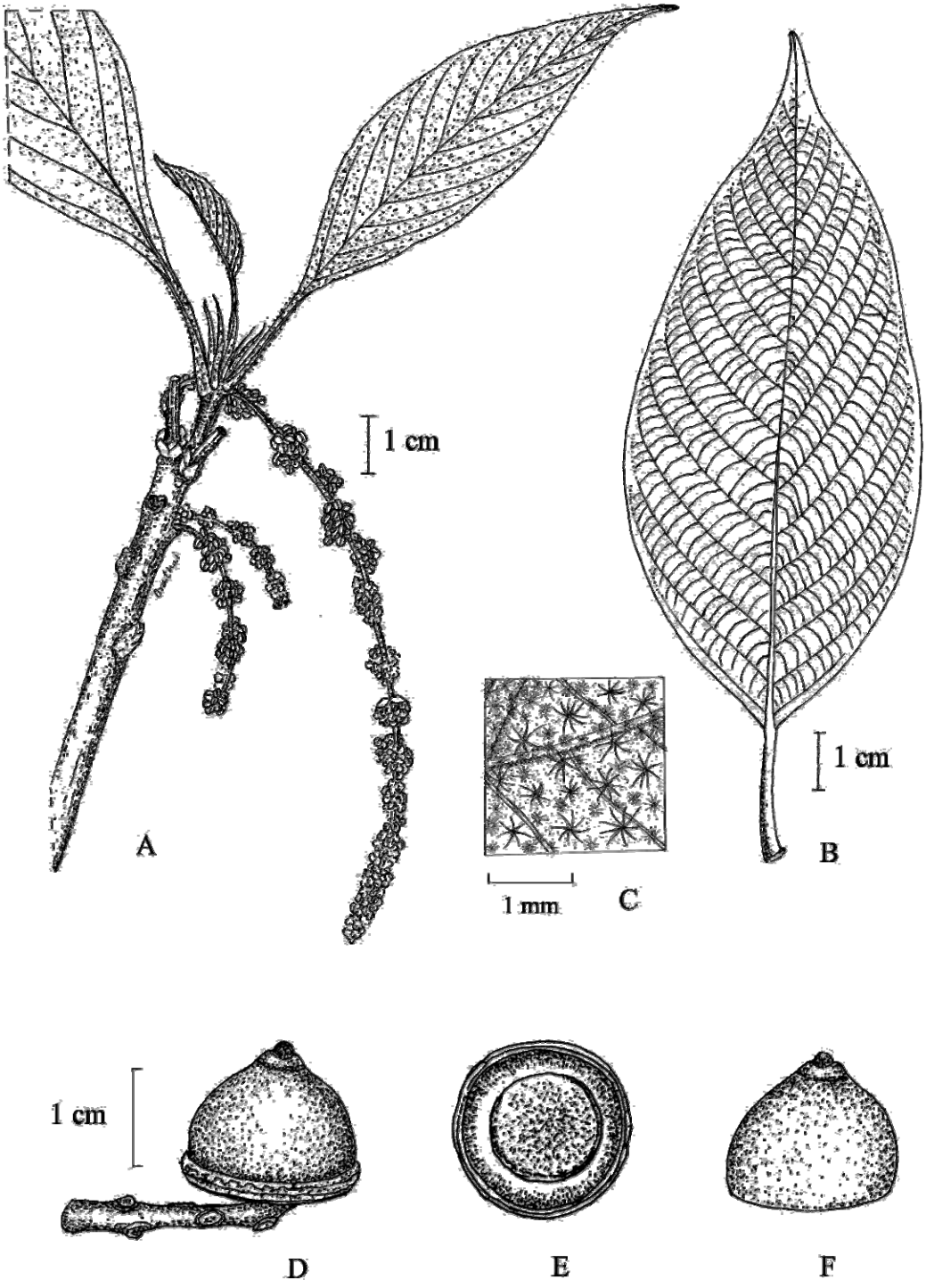

Figure 51 *Quercus poilanei* Hickel & A. Camus (ก่อสีเสียด)

A. branch with male inflorescences; B. leaf: lower surface; C. stellate hair on lower surface; D. acorn; E. cupule; F. nut. Drawn by O. Kerdkaew.

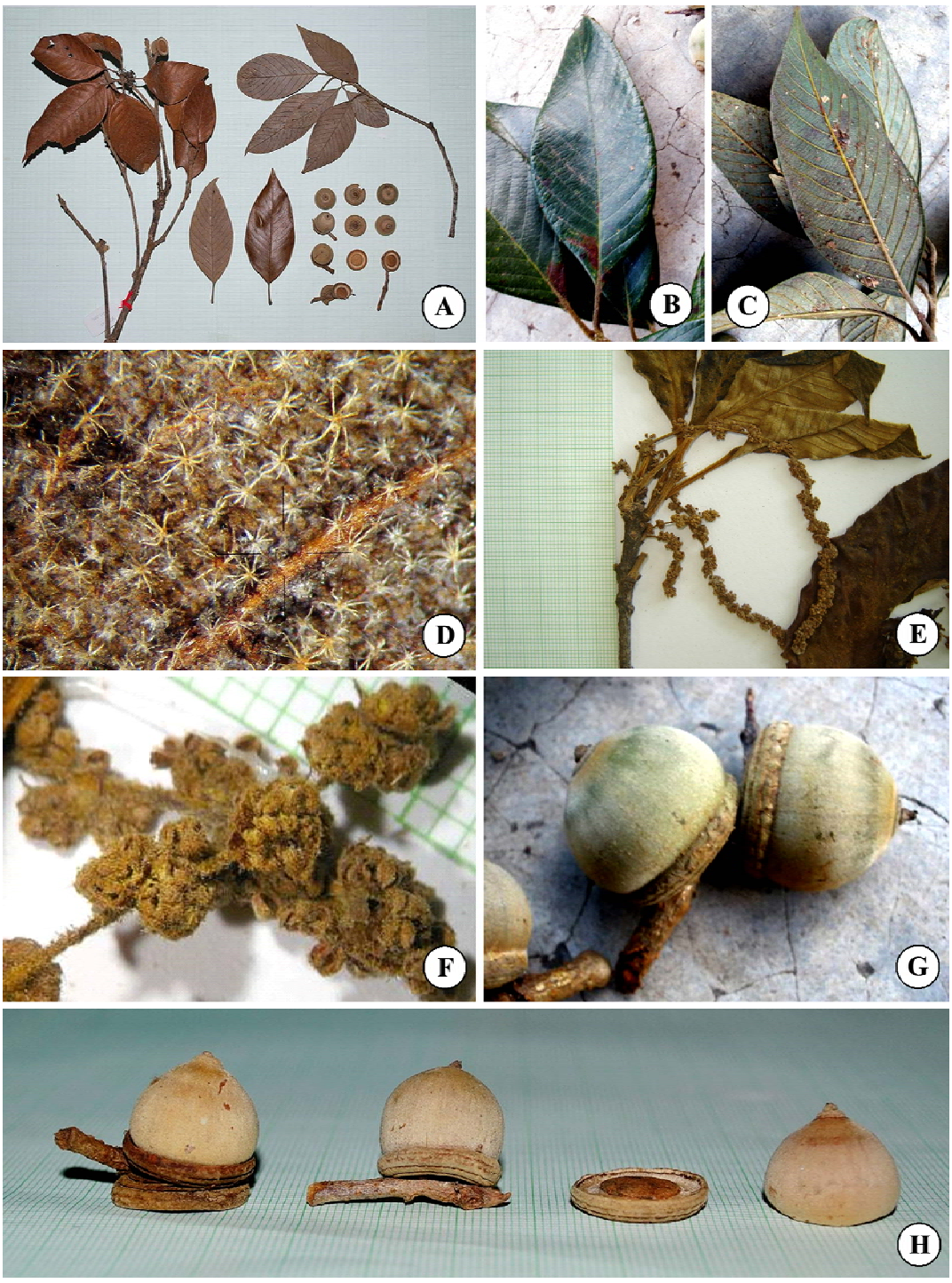

Figure 52 *Quercus poilanei* Hickel & A. Camus

A. leaves and acorns; B. leaves: upper surface; C. leaves: lower surface; D. stellate hairs on lower surface of leaf; E-F. male inflorescences; G. infructescence; H. infructescences, cupule and nut. Photographed by B. Harwood (B, C, G).

5. Quercus quangtriensis Hickel & A. Camus, Bull. Mus. Natl. Hist. Nat. 32: 400. 1926; Hickel & A. Camus in H. Lecomte, Fl. Indo-Chine 5: 949. 1930; Barnett, Quer. Rel. Fag. Asia: 393. 1940; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 389. 2008..— *Q. longistyla* Barnett; Barnett, Quer. Rel. Fag. Asia: 75. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 34: 332. 1944.— *Q. wangsaiensis* Barnett; Barnett, Quer. Rel. Fag. Asia: 68. 1940; Barnett, Trans. & Proc. Bot. Soc. Edinburgh 33: 331. 1942. Figure 53, 54.

Vernacular.— **Ko sa thit (ก่อสาทิต)**.

Tree 13–30 m high, 30–40 cm in diam.; bark smooth and greyish brown; twigs glabrous, densely lenticellate. **Stipules** linear, 5–9 mm long, caducous. **Leaves** spiral, subcoriaceous, elliptic or ovate, 4.7–15.3 by 2.2–4.5 cm, apex acute, base cuneate or obtuse, margin serrate ⅓–¾ from apex, both surfaces glabrescent; midrib and lateral veins strongly raised on lower and flattened or slightly raised on upper; lateral veins (8–)9–13(–14) pairs; cross veins scalariform. **Petioles** 0.8–1.7 cm long, thickened at base, glabrescent. **Inflorescences** were not collected. **Infructescences** ca. 0.5–2.2 cm long, 1–4 acorns. **Acorns** ovate to oval, 2.4–3 by 1.7–2.4 cm, sessile. **Cupules** cup-shaped or saucer-shaped, enclosing up to ⅕–⅓ of nut, 0.8–1.1 cm high, 1.6–2.4 cm in diam., base obtuse or round, wall 1.2–1.8 mm thick, all part dense brown hairy, lamellae 5–7(–8) layers, ca. 1–3 mm apart, rim denticulate. **Nuts** 1 per cupule, ovate, 1.8–2.7 cm high (excluded persistent style), 1–2.2 cm in diam., hairy, apex obtuse with protrude persistent styles, ca. 3–4 mm, base obtuse or slightly truncate; scar convex, 0.8–1.3 cm in diam.

Ecology.— In evergreen forest and hill evergreen forest, shaded and open areas on ridge, at Khao Chamao-Khao Wong National Park, Khao Khitchakut National Park and Khao Soi Dao Wildlife Sanctuary; alt. 880–1100 m. Fruiting: August–March.

Specimens examined.— *B. Harwood* 2019, 27 Aug. 2008, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai (BSKU); *P. Phonsena* 3677, 22 Feb. 2003, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF); *P. Phonsena & K. Bunpha* 3484, 22 Nov. 2002, Rayong, Khao Chamao-Khao Wong National Park, Near peak (BKF); *P. Phonsena & K. Bunpha* 3498, 22 Nov. 2002, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3499, 22 Nov. 2002, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3501, 12 Nov. 2002, Rayong, Khao Chamao-Khao Wong National Park, Trial between air force station to HQ (BKF); *P. Phonsena & K. Bunpha* 3600, 6 Feb. 2003, Chantaburi, Khao Chamao-Khao Wong National Park, Near peak (BKF); *P. Phonsena & K. Bunpha* 3640, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3643, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3647, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3656, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & K. Bunpha* 3657, 7 Feb. 2003, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & Y. Banchong* 3498, 22 Nov. 2002, Rayong, Khao Chamao-Khao Wong National Park, Trial between peak to HQ (BKF); *P. Phonsena & Y. Banchong* 4846, 23 Mar. 2006, Chanthaburi, Khao Khitchakut National Park, Khao Phra Bat (BKF).

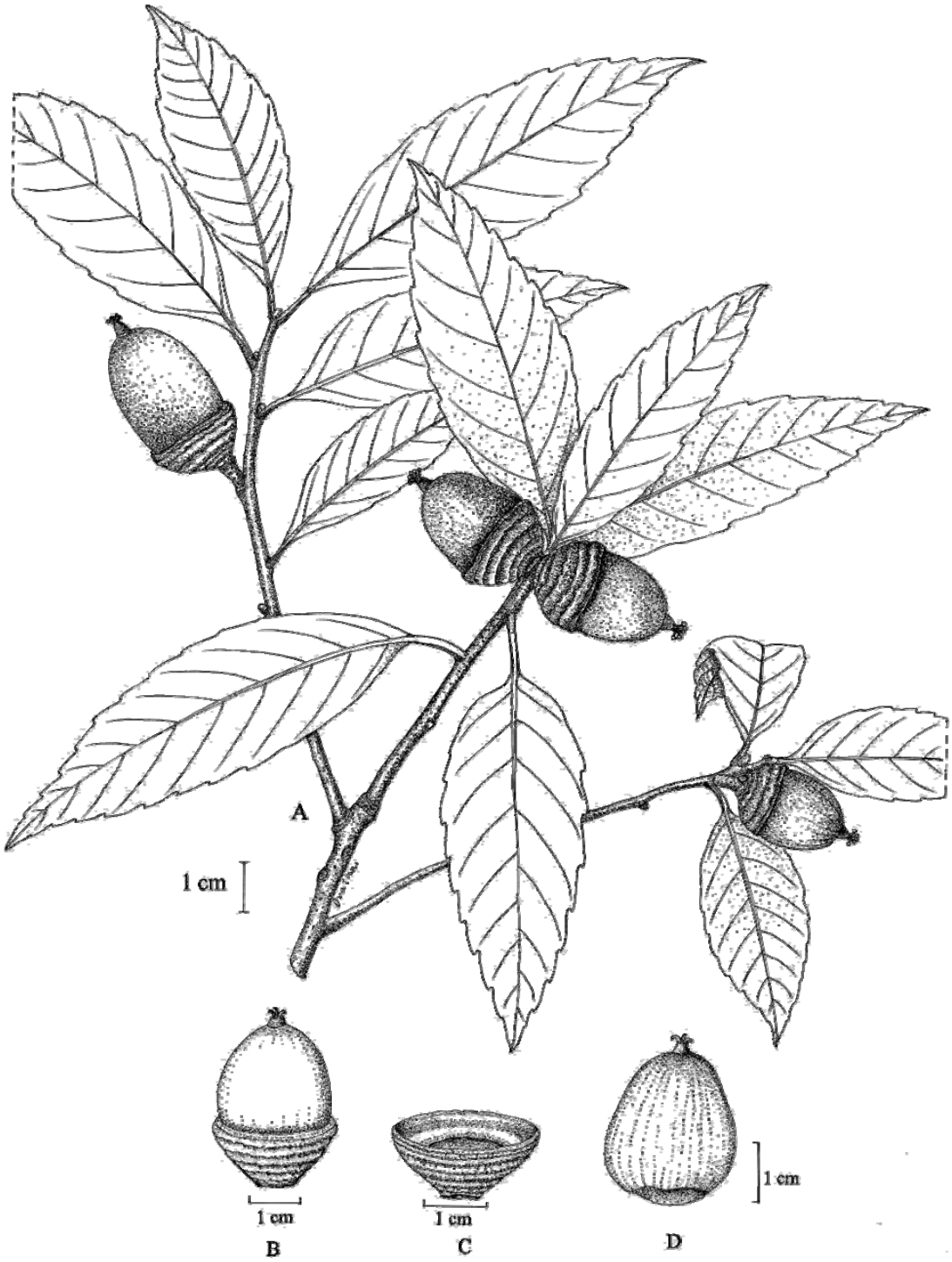

Figure 53 *Quercus quangtriensis* Hickel & A. Camus (ก่อสาทิต)

A. branch with infructescence; B. acorn; C. cupule; D. nut.

Drawn by O. Kerdkaew.

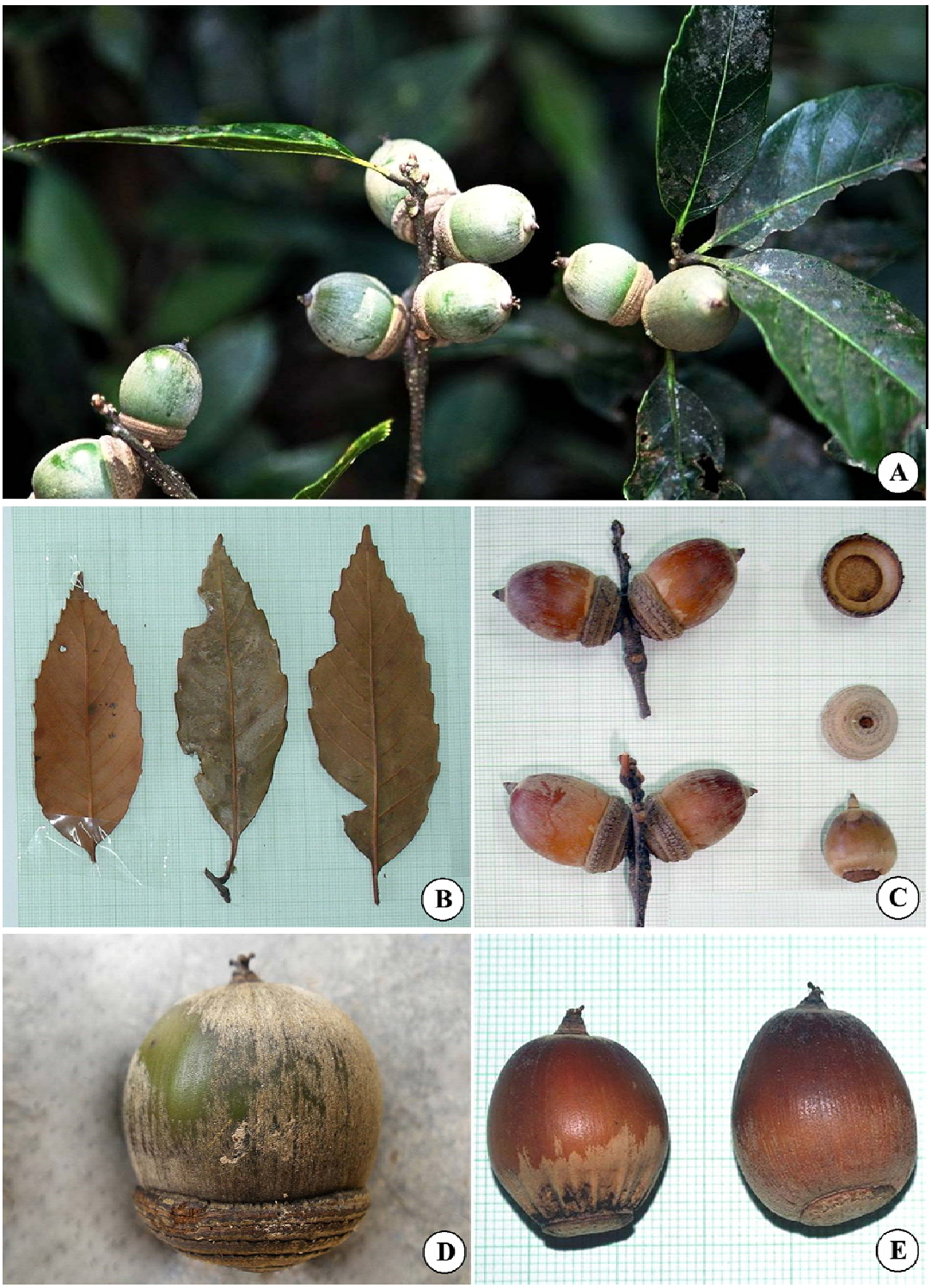

Figure 54 *Quercus quangtriensis* Hickel & A. Camus

A. infructescences and leaves; B. leaves; C. infructescences, cupules and nut; D. acorn; E. nuts. Photographed by P. Phonsena (A); B. Harwood (D).

6. Quercus rex Hemsl., Hooker's Icon. Pl. 27: t. 2663. 1899. *Cyclobalanopsis rex* (Hemsl.) Schottky, Bot. Jahrb. Syst. 47: 651. 1912; C.C. Huang, Y.T. Chang & B.M. Bartol. in C.Y. Wu & P.H. Raven, Fl. China 4: 390. 1999; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 397. 2008. Figure 55, 56.

Vernacular.— **Ko plai chak (ก่อปลายจัก)**.

Tree ca. 30 m high, 70 cm in diam.; bark flaky, brownish or greyish. **Stipules** linear, 6–9 mm long, caducous. **Leaves** spiral, subcoriaceous, mostly obovate, 15–27 by 6–13 cm, apex acuminate or cuspidate, base cuneate, margin spinose serrate ca. ⅓–¼ from apex, both surfaces densely stellate hair when young and finally glabrescent; midrib and lateral veins strongly raised on lower and depressed on upper surface; lateral veins 16–24 pairs; cross veins scalariform. **Petioles** 0.5–1.5 cm long, thickened at base with sparse persistent stellate hairs. **Inflorescences** were not collected. **Infructescences** ca. 3 cm long, 1–2 acorns. **Acorns** spheroidal-oblate, 1.9–3 by 3.1–3.7 cm, sessile. **Cupules** cup-shaped or saucer-shaped, enclosing up to ½ of nutt, 0.7–1.1 by 3–4 cm, base truncate, wall 1.5–1.7 mm thick, all part hairy except inside of the base (scar ca. 1–3 cm in diam.), lamellae 7–9 layers, ca. 2–4 mm apart, rim denticulate. **Nuts** 1 per cupule, oblate, 2–2.4 cm high (excluded persistent style), 3.2–4 cm in diam., glabrescent, apex mostly truncate with slightly protruded persistent minute style, base truncate and concave; scar broadly central concave ca. 1.8–2.2 cm in diam.

Ecology.— In evergreen forest and hill evergreen forest, at Khao Soi Dao Wildlife Sanctuary; alt. 900–1100 m. Fruiting: December–February.

Specimens examined.— *B. Harwood* 2018, 5 Jul. 2008, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Tai (BSKU); *K. Bunpha et al.* 21, 10 Dec. 2005, Chanthaburi, Khao Soi Dao Wildlife Sanctuary (BSKU); *P. Phonsena et al.* 4716, 10 Dec. 2005, Chanthaburi, Khao Soi Dao Wildlife Sanctuary (BSKU, Herbarium of Khao Hin Son Botanic Garden); *P. Phonsena and K. Bunpha* 4792, 22 Feb. 2006, Chanthaburi, Khao Soi Dao Wildlife Sanctuary (BKF, BSKU).

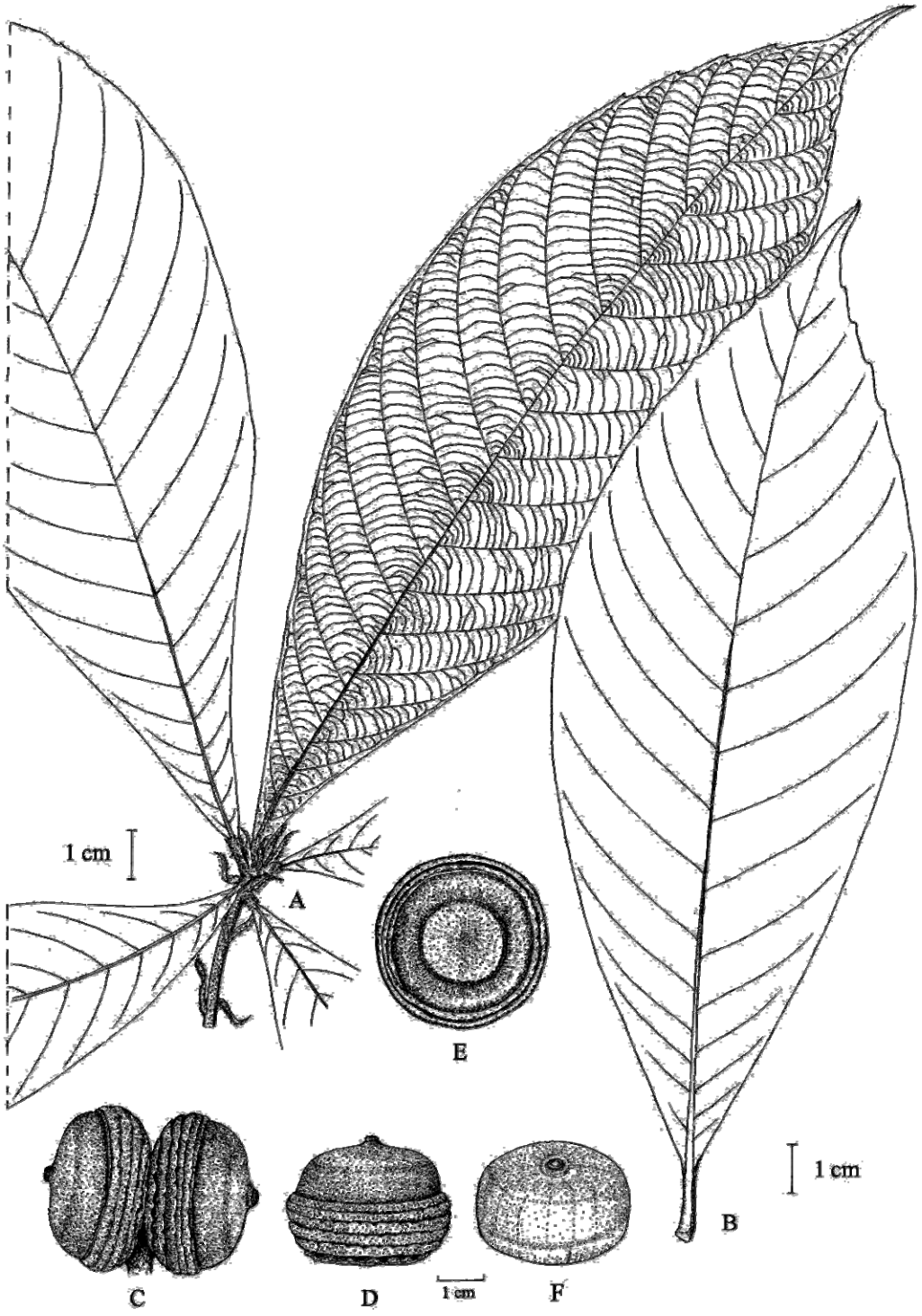

Figure 38 *Quercus rex* Hemsl. (ก่อปลายจัก)

A. branch with leaves; B. leaf; C. infructescence; D. acorn; E. cupule; F. nut. Drawn by O. Kerdkaew.

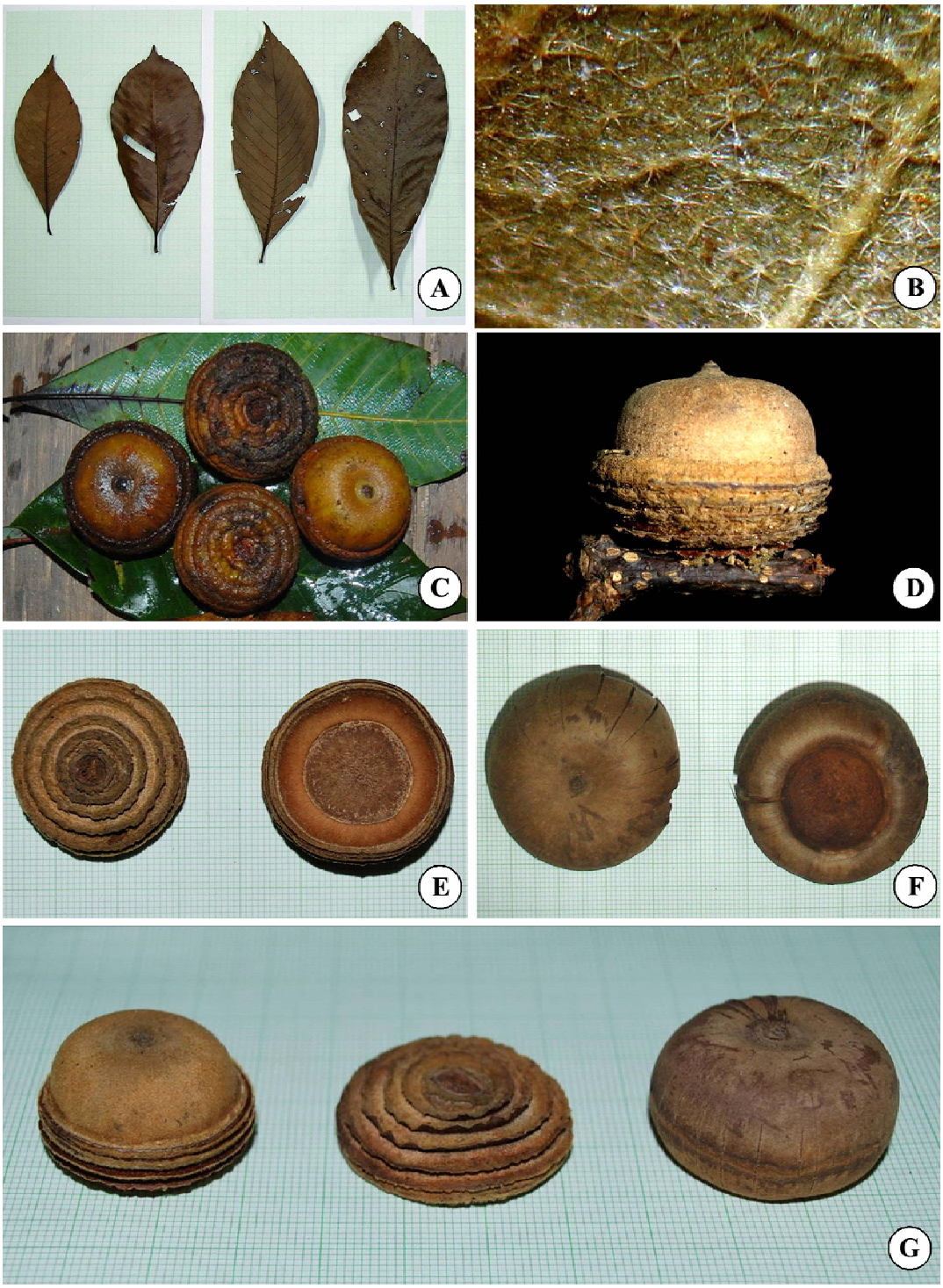

Figure 39 *Quercus rex* Hemsl.

A. leaves; B. stellate hairs on lower surface of young leaf; C. acorns; D. infructescence; E. cupules; F. nuts; G. acorn, cupule and nut. Photographed by P. Thiphayasri (C).

7. Quercus cf. saravanensis A. Camus, Chênes, Atlas. 1: 19. 1934; C.C. Huang, Y.T. Chang & B.M. Bartol. in C.Y. Wu & P.H.Raven, Fl. China 4: 389. 1999; C. Phengklai in T. Santisuk & K. Larsen, Fl. Thailand 9(3): 399. 2008. Figure 57, 58.

Vernacular.— **Ko kliang (ก่อเกลี้ยง)**.

Tree 10–25 m high, 42–59 cm in diam.; bark smooth and shallowly fissured, dark grey or greyish; blaze reddish; twigs glabrescent (young shoot lilac, sparsely white simple hair ca. 0.5–0.8 mm long). **Stipules** linear, 7–8 mm long, lower surface with sparse hair at the apex, upper surface glabrous, caducous. **Leaves** spiral, chartaceous to subcoriaceous, elliptic-oblong or oblanceolate, 8.5–23 by 4–7.4 cm, apex caudate, base obtuse or oblique or cuneate, margin serrate from ½–⅓ to apex, sometimes crenate, both serfaces glabrescent, upper surface vernicous, lower surface pale green; midrib strongly raised on lower and flattened or depressed on upper; lateral veins 7–12 pairs, flattened on upper and raised on lower; cross veins scalariform. **Petioles** 0.8–3 cm long, thickened at base, glabrous. **Inflorescences** were not collected. **Infructescences** erect, 3.8–5 cm long, 2–8 acorns. **Acorns** ovate, 2.1–2.3 by 1.6–2.1 cm, stalked ca. 0.3–0.5 cm high. **Cupules** cup-shaped, 1.1–1.7 cm high, 1.6–2.1 cm in diam., base obtuse or almost cuneate, wall 0.3–1.2 mm thick, inside densely silvery or whitish hairy except base (whitish scar, glabrous, 0.9–1 cm in diam.), outside glaucous (densely silvery or whitish hairy), lamellae 7-9 layers, ca. 1.5–2 mm apart, rim denticulate. **Nuts** 1 per cupule, obovate or globose, 1.8–2.2 cm high (excluded persistent style), 1.4–1.7 cm in diam., glabrous, apex convex ca. 0.2 cm high with persistent style 0.1–0.2 cm high, base truncate or convex scar (whitish) ca. 1 cm in diam.

Ecology.— In evergreen forest, near steams, at Khao Yai National Park, Pang Sida National Park and Khao Soi Dao Wildlife Sanctuary; alt. 290–630 m. Fruiting: July–September.

Notes.— The acorn of this species is similar to *Quercus saravanensis* A. Camus and *Q. myrsinaefolia* Blume but compared to the descriptions of Flora of China (Huang *et al.*, 1999) and Flora of Thailand (Phengklai, 2008) it is more like *Q. saravanensis*. This study did not collect inflorescences, they should be collected in the future and try methods such as palynology or molecular study to make a decision. This species is a new record for Southeastern Thailand.

Specimens examined.— *K. Bunpha et al.* KB 60, 23 Apr. 2006, Sa Kaeo, Pang Sida National Park (BSKU); *K. Bunpha et al.* KB 61, 3 Sep. 2006, Sa Kaeo, Pang Sida National Park (BSKU); *K. Bunpha & Y. Banchong* KB 1, 26 Oct. 2005, Sa Kaeo, Pang Sida National Park (BSKU); *K. Bunpha & Y. Banchong* KB 2, 26 Oct. 2005, Sa Kaeo, Pang Sida National Park (BSKU); *P. Phonsena* 3887, 23 Aug. 2003, Prachin Buri, Khao Yai National Park, Nam Tok Heao Suwat (BKF, Herbarium of Khao Hin Son Botanic Garden).

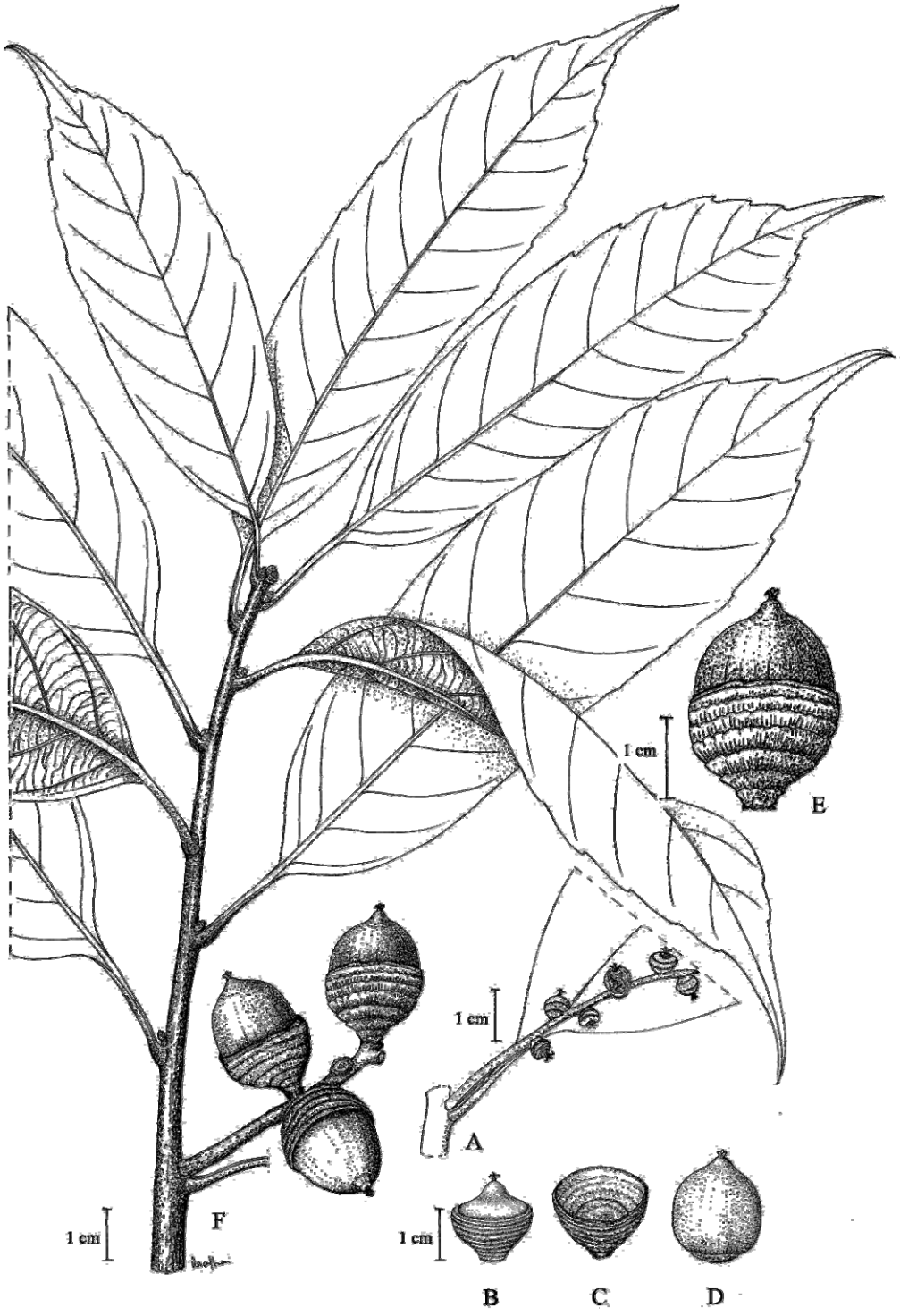

Figure 57 *Quercus* cf. *saravanensis* A. Camus (ก่อเกลี้ยง)

A. young infructescence; B. young acorn; C. cupule; D. nut; E. mature acorn; F. branch with mature infructescence. Drawn by O. Kerdkaew.

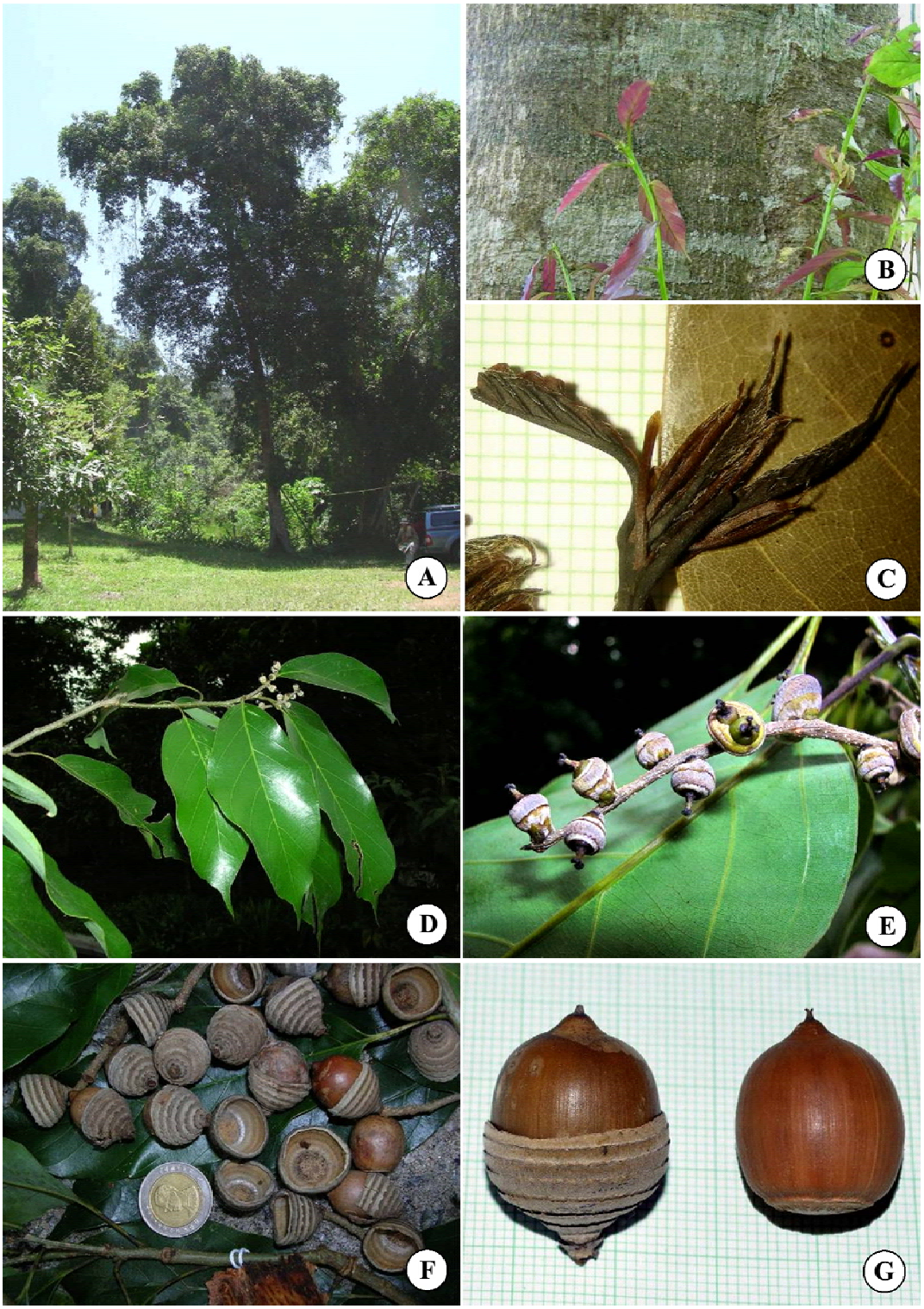

Figure 58 *Quercus* cf. *saravanensis* A. Camus

A. habit; B. bark and young leaves; C. buds; D-E. leaves and young infructescences; F. acorns and cupules; G. acorn (left) and nut (right).

8. Quercus thorelii Hickel & A. Camus, Bull. Mus. Natl. Hist. Nat. 29: 599. 1923.— *Cyclobalanopsis thorelii* (Hickel & A. Camus) Hu, Bull. Fan Mem. Inst. Biol. 10: 106. 1940; C.C. Huang, Y.T. Chang & B.M. Bartol. in C.Y. Wu & P.H. Raven, Fl. China 4: 394. 1999. Figure 59, 60.

Vernacular.— **Ko soi dao (ก่อสอยดาว)**.

Tree ca. 20 m high, 50 cm in diam.; bark smooth with broad shallowly fissured or deeply fissured, grey. **Leaves** subcoriaceous, elliptic to elliptic-oblong, 11.3–22 by 4.4–8.6 cm, apex mostly acute, base obtuse, rarely oblique, margin serrate ½–⅓ from apex, both surfaces glabrescent (still some stellate hair); midrib and lateral veins strongly raised on lower and depressed on upper; lateral veins 14–19 pairs; cross veins scalariform. **Petioles** 1.2–1.5 cm long, thickened at base, with sparsely persistent stellate hair. **Inflorescences** catkin, in upper axils. **Male inflorescences** 8–10 cm long, florets single or clusters; perianth 6-lobed, membranous, ovate, ca. 1.2–1.6 mm long, hairy; stamen 6–8, ca. 2–2.8 mm long, anther ca. 0.8–1 mm long, densely hairy. **Infructescences** ca. 2.2 cm long, 1–2 acorns. **Acorns** dorsiventral compressed, 1.7–2 by 3–3.5 cm, sessile. **Cupules** short cylindrical, enclosing over the fruit, sizes as same as acorns, base truncate, wall 2–4.5 mm thick, all part hairy except inside of base glabrous (scar ca. 1.9 cm in diam.), lamellae 13–14 layers, ca. 1.5–3 mm apart, rim denticulate. **Nuts** 1 per cupule, oblate, 1.2–1.5 cm high (excluded persistent style), 2.7–2.8 cm in diam., hairy, apex mostly truncate with slightly protrude persistent style, stigma 6, very short, ca. 0.5 mm, base truncate and broadly central concave ca. 1.9 cm in diam.

Ecology.— In evergreen forest on mountain slopes, only in Khao Soi Dao Wildlife Sanctuary; alt. 300–800 m. Flowering: February–March; Fruiting: June–August.

Notes.— This species is similar to *Quercus thorelii* Hickel & A. Camus because of the cupule being the same height as the nut, and the acorn size (>3 cm in

diam.). The young acorn and the leaf of this species are very similar to *Q. austrocochinchinensis* Hickel & A. Camus if this species is correctly identified, it is a new record for Thailand but need to confirm by comparing with type specimen abroad.

Specimens examined.— *B. Harwood* 2015 (BSKU), 29 July 2008, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Nam Tok Khao Soi Dao, (BSKU); *B. Harwood* 2043, 7 Feb. 2009, Chanthaburi, Khao Soi Dao Wildlife Sanctuary, Khao Soi Dao Nuea, (BSKU).

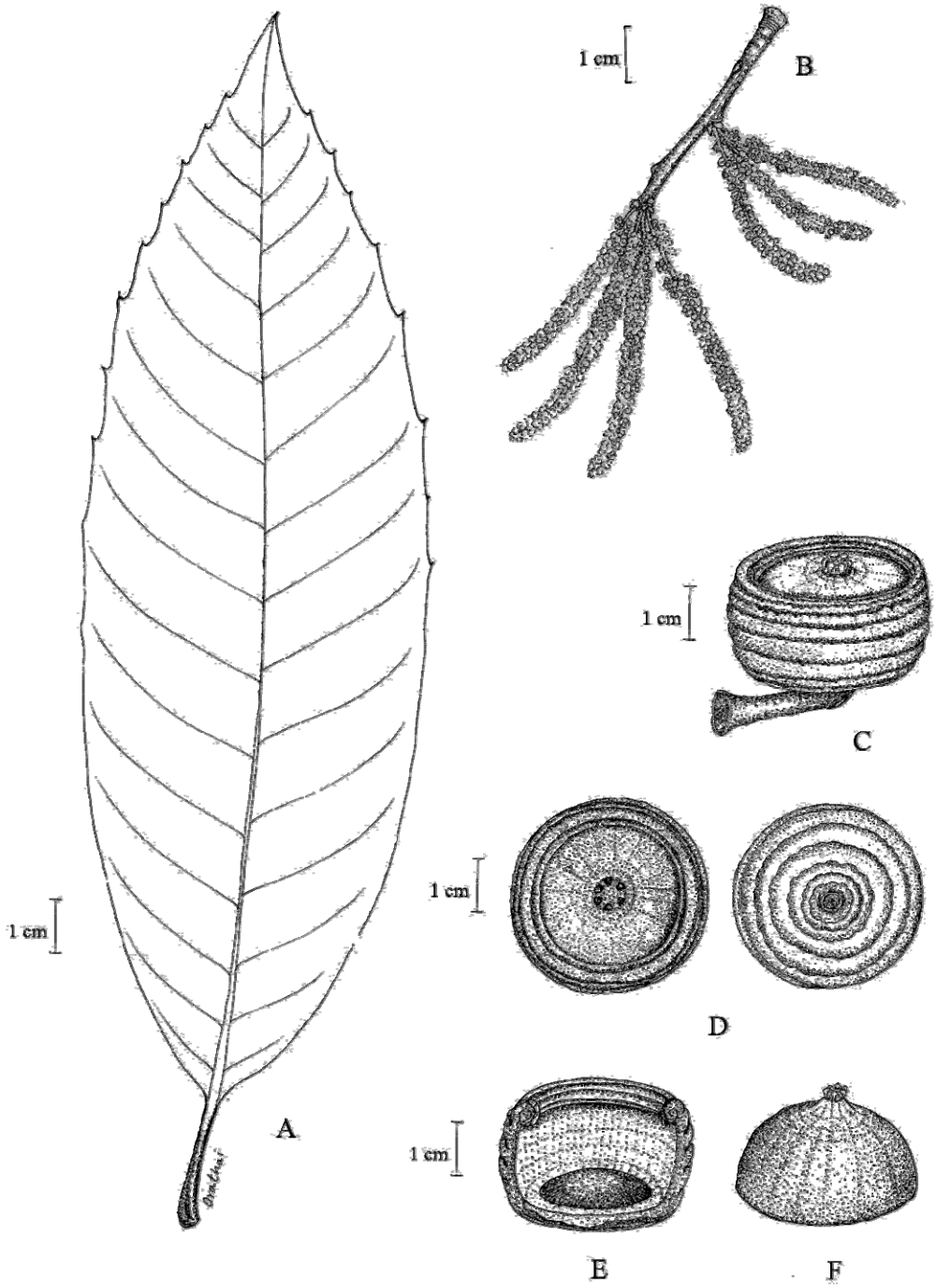

Figure 59 *Quercus thorelii* Hickel & A. Camus (ก่อสอยดาว)

A. leaf; B. inflorescences; C. acorns: side view; D. acorns: top and bottom view; E. cupule; F. nut. Drawn by O. Kerdkaew.

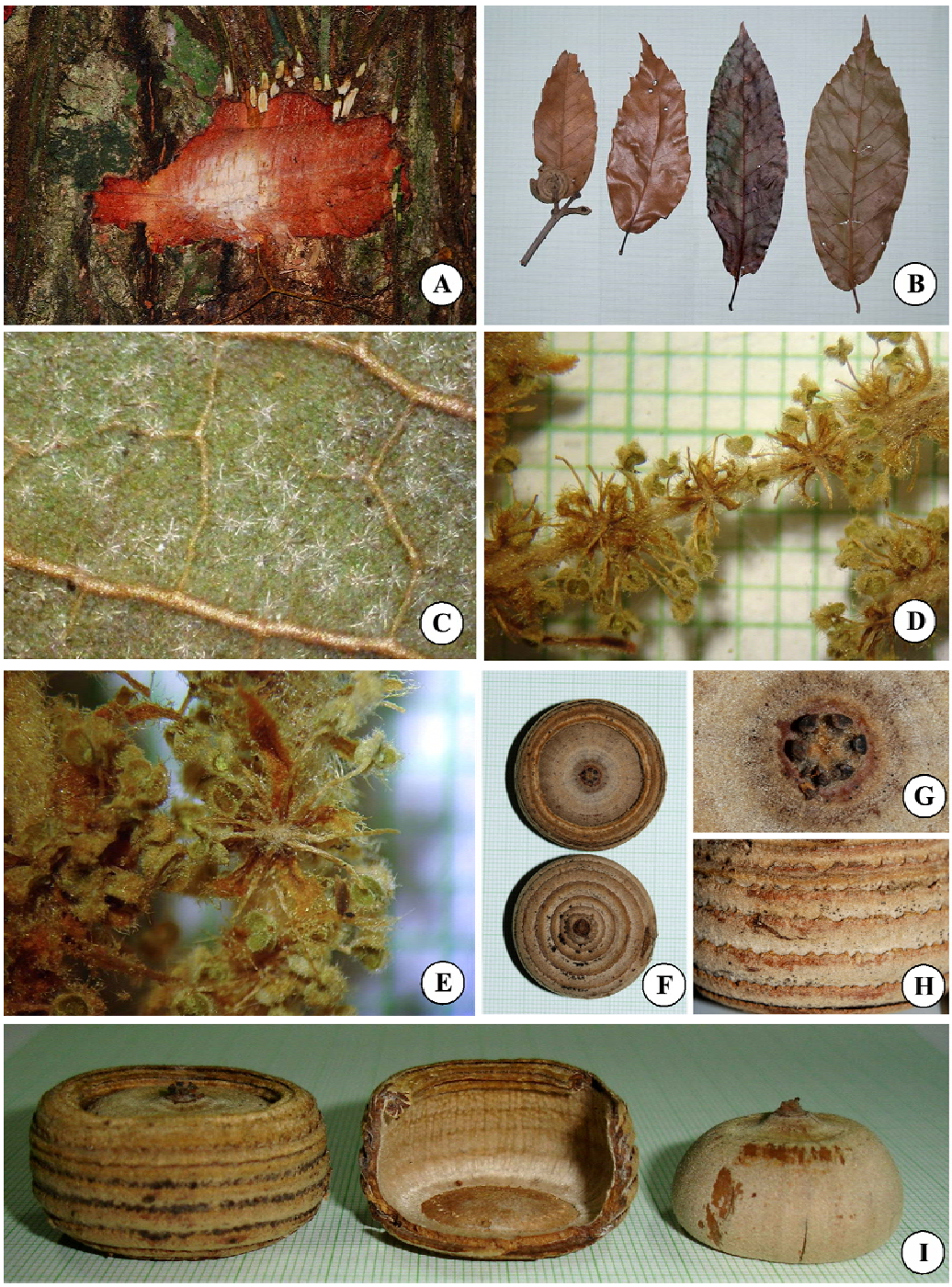

Figure 60 *Quercus thorelii* Hickel & A. Camus

A. blaze; B. leaves; C. stellate hairs on lower surface of young leaf; D-E. male inflorescences; F. acorns; G. nut with persistent style; H. outside cupule with lamellae; I. acorn, cupule and nut.

Photographed by D. Chusrithong (A).

CONCLUSION AND RECOMMENDATION

The family Fagaceae in Southeastern Thailand was studied by searching literature, surveying in Southeastern Thailand, describing, identifying and comparing herbarium specimens. The study provides identification keys to genera and species based on bark, leaf, flower, acorn or nut characteristics. Full descriptions of species, including the distribution range, ecology, vernacular names and uses are given, supported by line drawings and color plates of individual species.

Three genera were found, *Castanopsis* Spach, *Lithocarpus* Blume and *Quercus* L. Nineteen species of Fagaceae were identified, i.e., *Castanopsis acuminatissima* (Blume) A. DC., *C. pierrei* Hance, *C. piriformis* Hickel & A. Camus, *Lithocarpus cantleyanus* (King ex Hook. f.) Rehder, *L.* cf. *dealbatus* (Hook. f. & Thomson) Rehder, *L. elegans* (Blume) Hatus. ex Soepadmo, *L. eucalyptifolius* (Hickel & A. Camus) A. Camus, *L. harmandii* (Hickel & A. Camus) A. Camus, *L. thomsonii* (Miq.) Rehder, *L. wallichianus* (Lindl. ex Hance) Rehder, *L. wrayi* (King) A. Camus, *Quercus auricoma* A. Camus, *Q.* cf. *lineata* Blume, *Q. oidocarpus* Korth, *Q. poilanei* Hickel & A. Camus, *Q. quangtriensis* Hickel & A. Camus, *Q. rex* Hemsl., *Q.* cf. *saravanensis* A. Camus and *Q. thorelii* Hickel & A. Camus.

Eight species are new records for Southeastern Thailand, namely, *Lithocarpus cantleyanus* (King ex Hook. f.) Rehder, *L.* cf. *dealbatus* (Hook. f. & Thomson) Rehder, *Quercus auricoma* A. Camus, *Q.* cf. *lineata* Blume, *Q. oidocarpus* Korth, *Q. poilanei* Hickel & A. Camus, *Q. rex* Hemsl. and *Q. thorelii* Hickel & A. Camus. One species is a new record in Thailand; *Q. thorelii* Hickel & A. Camus from Khao Soi Dao Wildlife Sanctuary at altitude from 300–800 m. Three species, i.e., *Q. poilanei* Hickel & A. Camus, *Q. rex* Hemsl. and *Q. thorelii* Hickel & A. Camus were more likely to endangered than the others because they are less common in both the Southeast and throughout Thailand.

The study raises many questions about the correct identification of several species found, and recommends that much more time be spent collections more

complete flowering and fruiting material. This material then needs to be compared with type material (Appendix Table 1). This study is still lacking inflorescences in some species, they should be collected in the future and try methods such as pollen or molecular study to make a decision.

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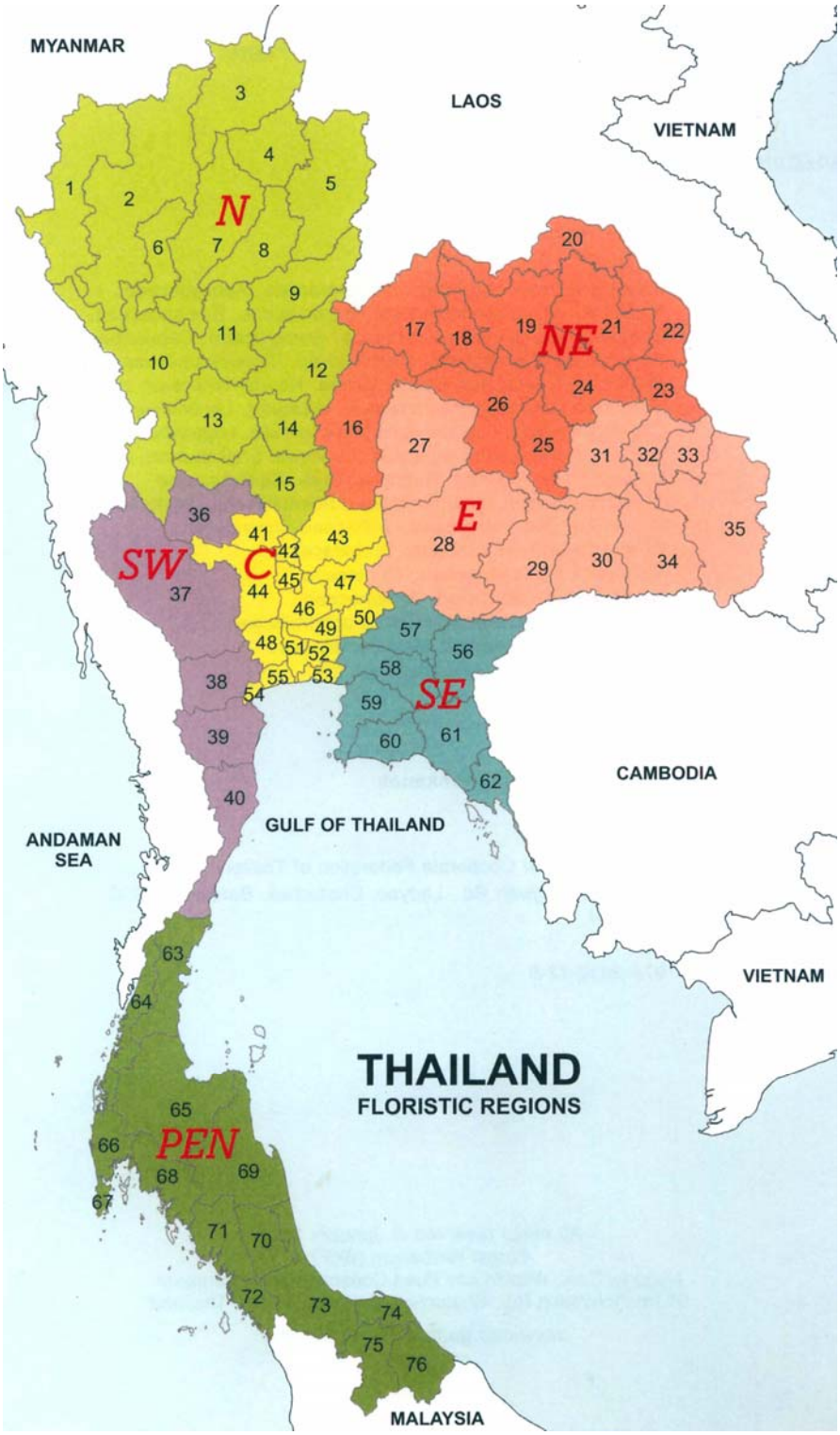
APPENDIX



Appendix Figure 1 Floristic regions and provinces of Thailand

Source: Pooma *et al.* (2005)

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)

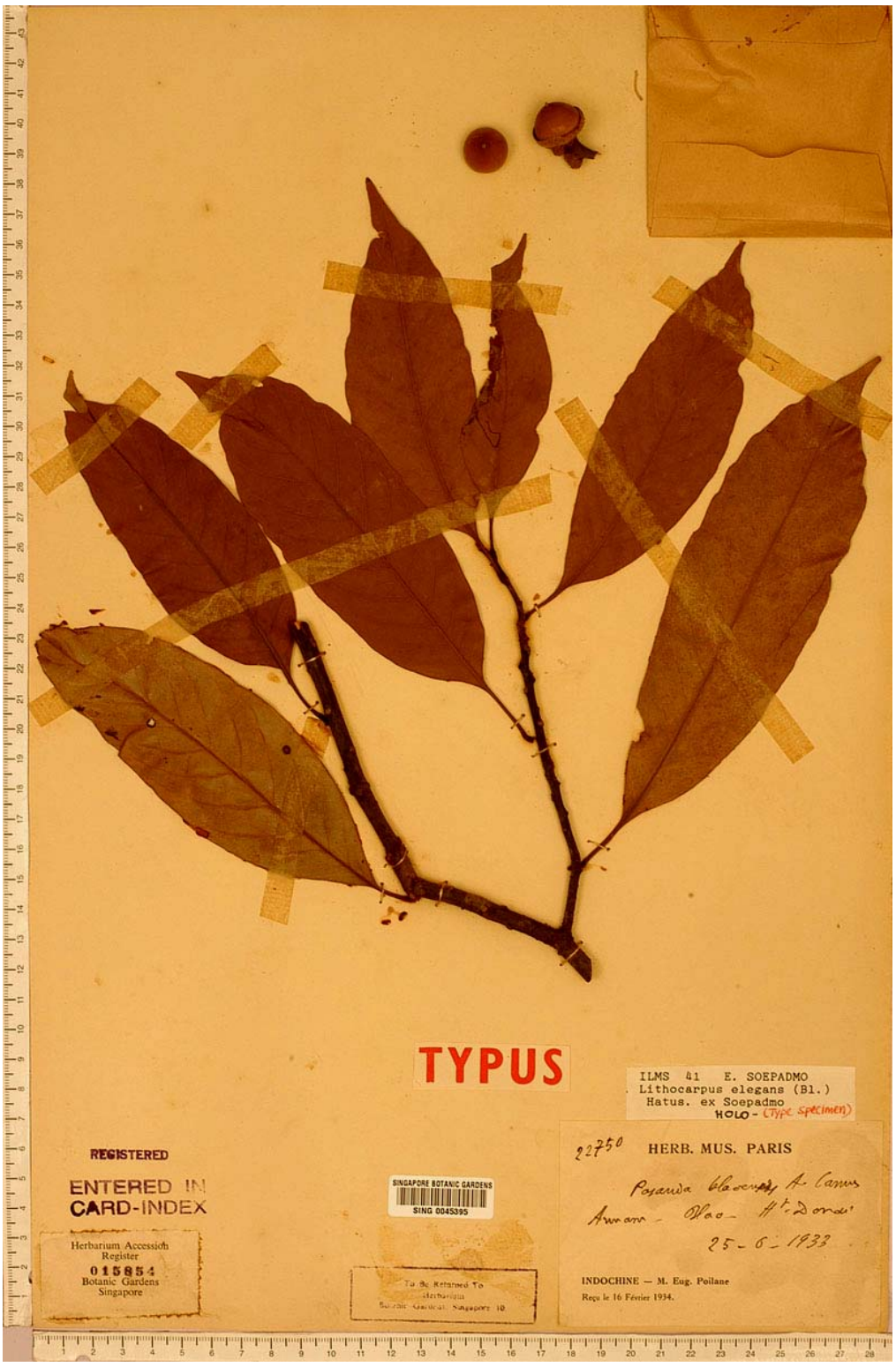
52 Krung Thep Maha Nakhon (Bangkok)
53 Samut Prakan
54 Samut Songkhram
55 Sumut Sakhon

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 Type specimen of *Lithocarpus elegans* (Blume) Hatus. ex Soepadmo (In Singapore Botanic Gardens, Singapore)

Appendix Table 1 Flowering and fruiting of Fagaceae (2005–2009)

Species	Months											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
C. acuminatissima	·····	·····	·····				———	———	———			
C. pierrei			———	———	———		·····	·····				
C. piriformis	·····						———	———	·····	·····	·····	·····
L. cantleyanus	·····	·····			———	———	———	———				·····
L. cf. *dealbatus*	·····	·····	———	———	———	———	———	———				
L. elegans	———	———									———	———
L. eucalyptifolius				———	———	———	———	·····	·····	·····	·····	
L. harmandii							———	———	———			
L. thomsonii	·····	———	———	———	———	———	———	———			·····	·····
L. wallichianus	———	———	———	———								
L. wrayi				———	———	———	———	———	———			·····
Q. auricoma			·····	·····	·····		———	———	———			
Q. cf. *lineata*		·····	·····	·····	———							
Q. oidocarpus	·····	·····	·····	·····								
Q. poilanei		·····	·····						———	———	———	———
Q. quangtriensis	———	———	———					———	———	———	———	———
Q. rex	———	———										———
Q. cf. *saravanensis*							———	———	———			
Q. thorelii		·····	·····			———	———	———				

Notes ····· flowering

——— fruiting

CIRRICULUM VITAE

NAME : Miss Kanokon Bunpha

BIRTH DATE : July 21, 1980

BIRTH PLACE : Bangkok, Thailand

EDUCATION :	**YEAR**	**INSTITUTE**	**DEGREE/DIPLOMA**
	2001	Kasetsart Univ.	B.Sc. (Biology), Botany

POSITION/TITLE : Research Assistants

WORK PLACE : Khao Hin Son Botanic Garden,
Forest Herbarium, National Park Wildlife
and Plants Conservation Department, BKF

SCHOLARSHIP/AWARDS : The Graduate School, Kasetsart University
Scholarship