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RESEARCH ARTICLE

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A taxonomic revision of *Glossocarya* (*Lamiaceae*: *Ajugoideae*) in Thailand

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Key words

carpophore
mericarp
Rotheceae
Verbenaceae

Abstract The genus *Glossocarya* (*Lamiaceae*: *Ajugoideae*) in Thailand is revised. Descriptions, typifications, taxonomic key to species, geographical map and conservation status of the five species in Thailand are provided. Fruit morphology is also discussed and illustrated.

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INTRODUCTION

Glossocarya Wall. ex Griff. is a small tropical genus in the family *Lamiaceae* with 13 species distributed in Southeast Asia, Papua New Guinea and Australia (Northern Queensland) (Munir 1990, Harley et al. 2004, Zhao et al. 2021). It is characterised by having a schizocarpic fruit, with elongated schizocarps or nutlets, which are winged or slightly flattened at base and apically usually pubescent, scandent shrub habit, and inflorescence of corymboid thyrse. Taxonomic work in *Glossocarya* has been limited and it is poorly represented in herbaria (Bramley & Davies 2019, Zhao et al. 2021). The recent phylogenetic study of the family suggests that the genus belongs to the tribe *Rotheceae* C.L.Xiang, Bo Li & Olmstead, subfamily *Ajugoideae* Kostel., forming a moderately supported clade with *Karomia* Dop, *Discretitheca* P.D.Cantino and *Rotheca* Raf. (Li et al. 2016, Zhao et al. 2021).

Fletcher (1938b) revised the genus *Glossocarya* in Thailand and reported five species, i.e., *G. crenata* H.R.Fletcher (1938a: 205), *G. longiflora* H.R.Fletcher (1938a: 205), *G. mollis* Wall. ex Griff. (Griffith 1843: 366), *G. premnoides* Ridl. (Ridley 1911: 157) and *G. siamensis* Craib (1922: 240), the first two of which are endemic in Thailand. In 1976, Moldenke described two infraspecific taxa from Thailand: *G. siamensis* var. *pubescens* Moldenke (1976a: 19) and *G. mollis* var. *maxwellii* Moldenke (1976b: 111). Later on, Moldenke (1982) published taxonomic notes of *Glossocarya*, with seven taxa reported from Thailand. However, some errors in this work were discussed by Munir (1990), i.e., the presence of a carpophore in 'a tentative key to the accepted taxa' and flower indumentum. Moldenke (1982) mistakenly reported that a carpophore is only found in *G. hemiderma* (F.Muell. ex Benth.) Benth. ex B.D.Jacks. (Jackson 1893: 1035), but all three Australian species and *G. mollis* actually have the carpophore. Furthermore, the description of flower indumentum of *G. calcicola* Domin (1928: 558) is contradictory to that described by Munir (1990). In 1990, Munir revised *Glossocarya* in Australia for the first time and reported three species from Northern Australia: *G. calcicola*, *G. coriacea* Munir (1990: 21), and *G. hemiderma* (Munir 1990). Recently, the taxonomic account of *Glossocarya* in the Malesian region was updated by Bramley & Davies (2019) recognising four species, including *G. hemiderma*, *G. mollis*, *G. premnoides*, *G. scandens* (L.f.) Trimen (1885: 69) (Bramley & Davies 2019).

Since Fletcher (1938b) and Moldenke (1982), no further taxonomic revision has been produced for *Glossocarya* in Thailand. This study forms the basis for the taxonomic account of *Glossocarya* for the Flora of Thailand Project.

GENERIC CLASSIFICATION

In 1992, Cantino et al. provided a generic level account of the *Lamiaceae* s.lat. including several genera previously placed in the *Verbenaceae*. Seven subfamilies were presented, i.e., *Ajugoideae*, *Lamioideae* Harley, *Nepetoideae* (Dumort.) Luerss., *Prostantheroideae* Luerss., *Scutellarioideae* (Dumort.) Caruel, *Symphorematoideae* Briq. and *Viticoideae* Briq., and some genera were assigned to *Insertae sedis.* Cantino et al. (1992) placed *Glossocarya* in the subfamily *Teucrioideae* (Dumort.) Caruel. Harley et al. (2004) moved *Glossocarya* to the subfamily *Ajugoideae* with no tribal level assigned. Finally, in a tribal classification of the family Zhao et al. (2021) placed *Glossocarya* into subfamily *Ajugoideae*, tribe *Rotheceae*, noting the relationships within the tribe need to be clarified.

In 2001, Vestri Alvarenga et al. conducted a chemotaxonomic study of the *Lamiaceae* using a computerised approach and diterpenoids compounds were used as taxonomic markers. Thirteen common diterpenoid skeletons have been identified from the *Lamiaceae* (Vestri Alvarenga et al. 2001). *Glossocarya calcicola* was the only species of the genus for which phytochemical work has been carried out. Three diterpenoid compounds with a clerodane skeleton were elucidated, i.e., calcicolin A–C (Rasikari et al. 2005a). Clerodane diterpenoids

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are found abundantly in some genera of the subfamily *Ajugoideae*, e.g., *Ajuga* L., *Teucrium* L., *Clerodendrum* L., *Caryopteris* Bunge (Vestri Alvarenga et al. 2001, Harley et al. 2004, Hanson 2006). The affinity of the *Glossocarya* with other *Ajugoideae* genera is supported by the diterpenoid evidence.

MORPHOLOGY

We discuss the morphology of *Glossocarya* in Thailand under subheadings, with reference to variation within the genus as a whole.

Habit and habitat

Typically, the plants are scandent shrubs, sprawling on other plants (Fig. 1a), or prostrate or ascending woody climbers (Fig. 2a, 3a). *Glossocarya crenata* has a sprawling stem and an ascending stem when it grows unsupported. The genus is mostly found in seasonal habitats and dry areas, e.g., mixed deciduous forest, dry evergreen forest, often on limestone. *Glossocarya mollis* is a common species found in limestone areas. Contrastingly, *G. crenata* and *G. premnoides* commonly grow in moist habitats such as freshwater swamp forest or near the riverbanks.

Fig. 1 *Glossocarya crenata* H.R.Fletcher. a. Habit, indicated by red arrows; b–c. inflorescence; d. infructescence. — Photos: a, c. Bhanubong Bongcheewin, b, d. Jakrapong Thangthong.

Leaf

The leaf shape within *Glossocarya* is mostly ovate or elliptic-ovate. Leaf margins are entire or undulate except *G. crenata* has a variable leaf margin, including crenate, shallowly crenate or subentire-undulate margins. The presence or absence of glandular punctate dots is taxonomically informative, a character easily recognised by using a 10× hand lens. Two species in Thailand have glandular punctate dots on the lower leaf surface, i.e., *G. crenata* and *G. premnoides*. *Glossocarya longiflora* has sessile glands on the lower surface, which are dark brown in dried specimens but the other species, *G. mollis* and *G. siamensis*, have neither glandular punctate dots nor glands. Leaf indumentum is variable in terms of the hair density; however, it was used by Moldenke (1959, 1976a, b) to recognise his new specific and infraspecific taxa, i.e., *G. puberula* Moldenke (1959: 81), *G. siamensis* var. *pubescens* and *G. mollis* var. *maxwellii*.

Fig. 2 *Glossocarya mollis* Wall. ex Griff. a. Habit; b. inflorescence; c. infructescence. — Photos: Bhanubong Bongcheewin.

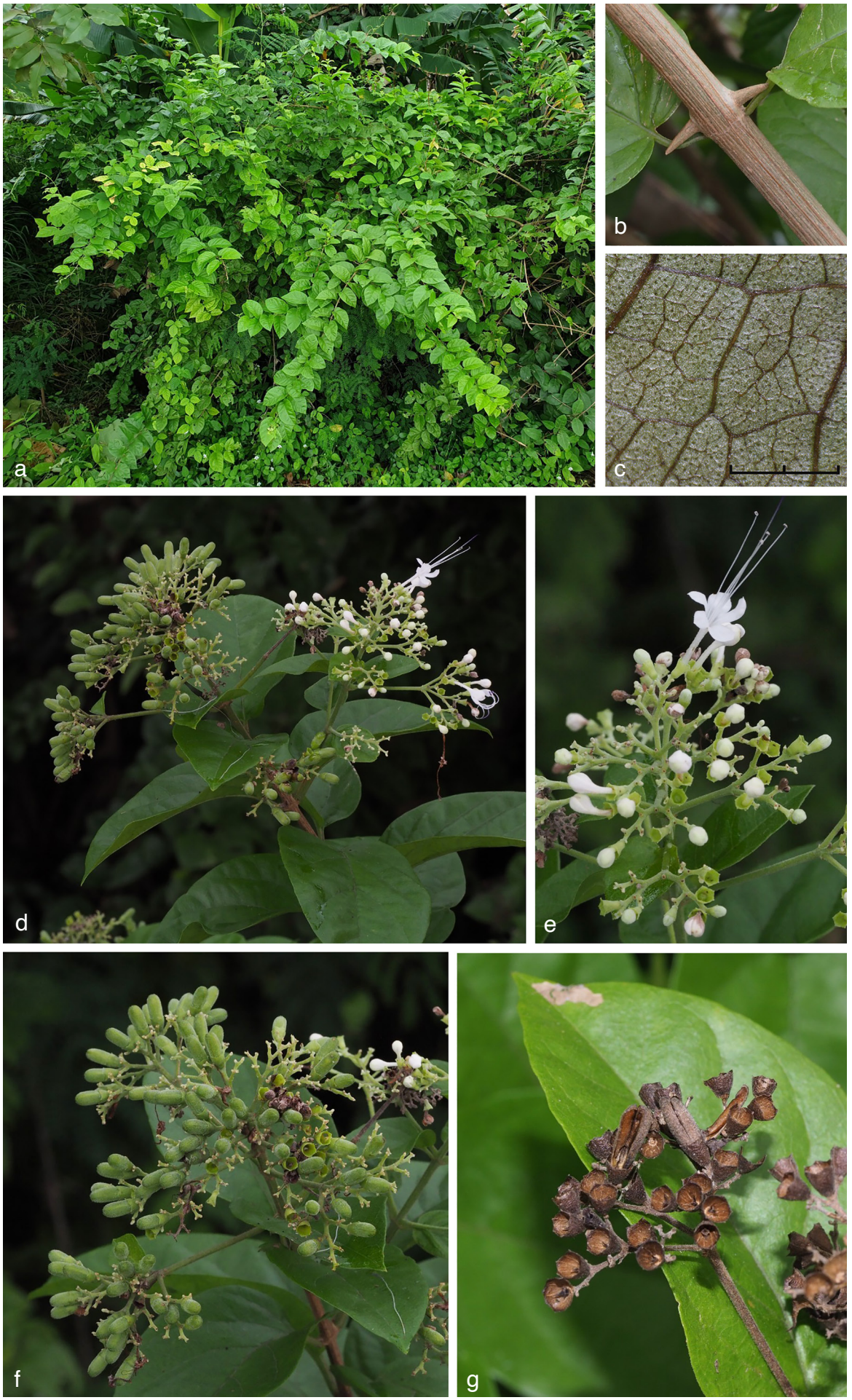


Fig. 3 *Glossocarya premnoides* Ridl. a. Habit; b. petiolar spines; c. glandular punctate dots on lower leaf surface; d. inflorescence and infructescence; e. inflorescence; f–g. Infructescence. — Scale bar = 2 mm. — Photos: a–b, d–g. Suppachai Tiyaworanant, c. Bhanubong Bongcheewin (under a microscope).

Inflorescence, bracts and bracteoles

The inflorescence of *Glossocarya* is a corymbose, highly branched, condensed, indeterminate thyrse. The corymbose inflorescence is subtended by opposite leaf-like structures along the main axis, here termed inflorescence subtending bracts. These are usually slightly smaller than the lower stem leaves. The structures which subtend the opposite pedunculate, dichasial cymes on the inflorescence branches are called bracts and those subtending branches within the cymes are called bracteoles (Harley et al. 2004). Bracts and bracteoles are usually different in shape and much smaller than the leaf-like inflorescence subtending bracts.

Flowers

The calyx is gamosepalous with five minute, equal lobes. The fruiting calyx is persistent but hardly accrescent. The lobes are only distinct in *G. mollis.* In the other species, they are reduced to just a small apiculate apex. The corolla is tubular and slightly 2-lipped. The anterior lobe can be clearly larger than the others or lobes are subequal. The flower orientation is variable, sometimes the large anterior lobe being the uppermost (resupinate) or the lowermost (not resupinate). Stamens are much-exserted with straight filaments.

Fruit

The fruit is hard, elongate and undivided when immature, separating at maturity into four one-seeded mericarps. Mericarps originate from a bicarpellate ovary, in which each carpel is subsequently partitioned by a false septum (Fig. 4). Based on the fruit morphology, *Glossocarya* may be classified into two artificial groups, i.e., 1) carpophore present, which is a central column in which the mericarps are inserted and mericarps are basally winged (see Fig. 4, 5c); 2) carpophore absent with mericarps slightly flattened basally (Fig. 5a, 5d) or unflattened (Fig. 5b, 5e). The first group includes species with a carpophore: the seed and a false septum are much shorter than the pericarp due to the present of the carpophore, and therefore the mericarps are basally winged. Four species in this group are distributed mainly in Northern Australia and the Malesia, i.e., *G. calcicola*, *G. coriacea*, *G. hemiderma* and *G. mollis*. *Glossocarya mollis* is the only species of this group in continental South East Asia, and is found from Northern Myanmar in the north to Papua New Guinea in the south. The second group has no carpophore or a very short stalk, with seeds and false septa as long as the mericarps. This group includes five species: *G. crenata*, *G. longiflora*, *G. premnoides*, *G. scandens* and *G. siamensis.* This group is found mainly in continental South East Asia, except *G. scandens* which has a disjunct distribution in Sri Lanka and Papua New Guinea (Bramley & Davies 2019).

The upper half of mericarps, which are exserted from the calyx, usually have hairs. The mericarp of *G. mollis* is pilose with long patent hairs (Fig. 2c, 4, 5c) on the upper and glabrous on the lower half, which is included in the calyx. *Glossocarya premnoides* has short adpressed hairs (Fig. 4f–g, 5d). The indumentum on the mericarp is rather fluffy or subadpressed in *G. crenata* (Fig. 1c, 5a), *G. longiflora* (Fig. 5b) and *G. siamensis* (Fig. 5e).

PHYTOCHEMISTRY AND ETHNOBOTANICAL USE

Of the few studies focusing on the chemistry of *Glossocarya*, most have focused on cytotoxic activities. Leaf extracts of *G. calcicola*, an endemic species of Queensland, Australia, showed cytotoxic activity against insect and human carcinoma cell lines whereby the clerodane diterpenes, calcicolin A–C, are responsible for the activity (Rasikari et al. 2005a, b, Hanson 2006).

The stem of *G. siamensis* is prepared as a decoction to relieve muscular pains by folk healers in Thailand (Chuakul 2010). *Glossocarya crenata* has been recorded as a folk medicine in Khon Kaen (*Boonma s.n.*, BKF, SN104037) and its young leafy shoot is edible as a vegetable with local food in Sakon Nakhon Provinces (Poopath et al. 2018). Local people in Prachuap Khiri Khan Province use stems of *G. mollis* to make charcoal and grow this species as an ornamental plant (Chansuwanit & Chanprasert 1994).

MATERIALS AND METHODS

The revision is based on the herbarium materials deposited at AAU, BK, BKF, BM, E, K, K-W, L, NY, P, PBM, S and SING (Thiers 2021, continuously updated), and field observation. We have examined all materials of *Glossocarya* in Thailand studied by Fletcher (1938b) and Moldenke (1982), except a collection of *G. mollis* deposited at UC (Moldenke 1982). All specimens listed were seen, except where 'n.v.' is indicated. Digitised specimens seen were indicated by 'photo' in the 'specimens examined' section. For accepted names, a lectotype has been selected when a particular herbarium was not specified as such in the protologue (McNeill 2014). Distribution maps were prepared using the SimpleMappr: http://www.simplemappr.net/. Conservation status assessment was conducted following the IUCN Red List Categories and Criteria v. 15.1 (IUCN Standards and Petitions Committee 2022). Assessments were carried out

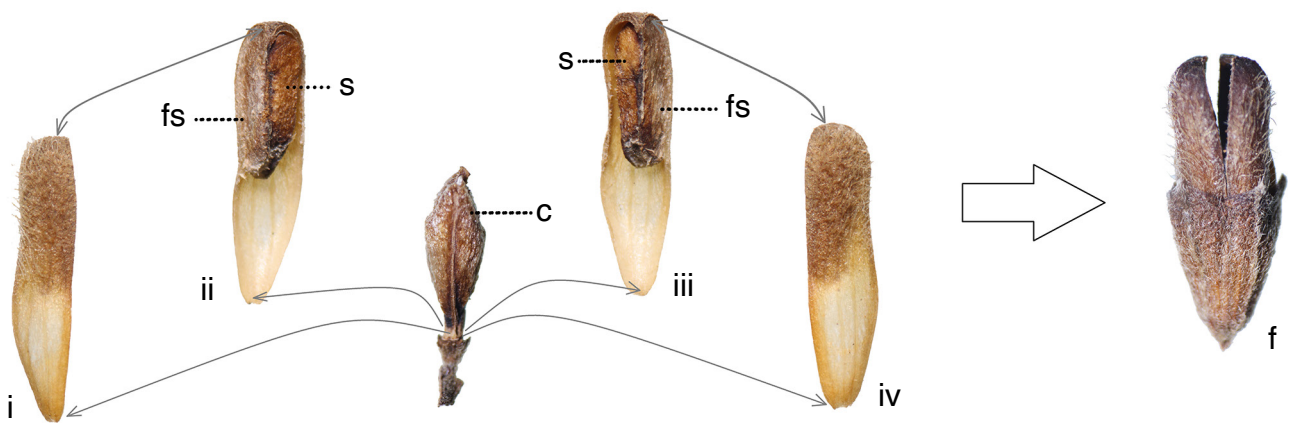


Fig. 4 A schematic insertion of mericarps of *Glossocarya mollis* on a carpophore indicated by one-headed arrows. i–ii, iii–iv are formed from the two carpels indicated by two-headed arrows; c. carpophore (side view), f. fruit with persistent calyx, fs. false septum, i–iv. mericarps, s. seed (i–iv: *Bongcheewin 1129*, PBM; f: *Maxwell 73-694*, BK).

Fig. 5 Fruit morphology of *Glossocarya* showing fruits and mericarps. a. *G. crenata* H.R.Fletcher; b. *G. longiflora* H.R.Fletcher; c. *G. mollis* Wall. ex Griff. with carpophores showing front view (left), side view (right); d. *G. premnoides* Ridl.; e. *G. siamensis* Craib (a: *Tangthong 1121*, BKF; b: *Lakshnakara 284*, BK; c: *Bongcheewin 1129*, PBM; d. *Maxwell 87-234*, BK; e. *Kerr 4502*, BK). — Scale bars: 5 mm.

using GeoCat: https://geocat.kew.org/ (Bachman et al. 2011), last accessed 7 March 2022, and the status of and threat to habitats is also described.

TAXONOMIC TREATMENT

Glossocarya Wall. ex Griffith

Glossocarya Wall. ex Griff. (1843) 366. — Type: *Glossocarya mollis* Wall. ex Griff.

Woody climber or scandent shrubs. *Young stems* quadrangular, prostrate or ascending climbing or scandent, rarely ascending, hairy, usually glabrous at base. *Mature stems* occasionally armed with petiolar spines. *Leaves* petiolate, simple, opposite-decussate, chartaceous, glands dots and sessile glands present or absent; petioles canaliculate above, hairy. *Inflorescence* terminal or axillary, forming a branched, usually condensed corymboid thyrse, with leaf-like subtending bracts usually slightly smaller than lower leaves; cymes opposite, shortly pedunculate, dichasial; bracts and bracteoles similar in shape to the leaves but smaller. *Flowers* numerous, zygomorphic, bisexual, hypogynous. *Flowering calyx* obconical, hairy outside, glabrous inside; lobes minute, equally 5-toothed and 10-veined, 5 veins at the centre of the lobes, more prominent than the 5 veins between the lobes. *Fruiting calyx* persistent, hardly accrescent, obconical or campanulate. *Corolla* white or creamy white, sometimes held in various orientations, occasionally resupinate; tubular, hairy outside, glabrous inside; lobes 5, spreading, unequal, obovate, the anterior lobe larger, imbricate in bud. *Stamens* 4, epipetalous, exserted from the tube, unequal, all inserted at corolla throat; filaments filiform, straight, glabrous; anthers dorsifixed, 2-celled, oblong, longitudinally dehiscent. *Style* bifid at apex, filiform, subterminal, exserted, glabrous; branches subequal. *Fruit* dry, oblong, elliptic-oblong or obovate-oblong, much-exserted from the calyx tube, apex rounded, hairy, dividing into 4 mericarps at maturity; mericarps basally winged with seed much shorter than the pericarp or basally flattened or not winged; seeds mostly erect, ventrally angled; carpophore absent or present.

Distribution — Nine species: Sri Lanka, Myanmar, Cambodia, Thailand, Vietnam, Malaysia, New Guinea and Australia. Five species are found in Thailand.

Note — We treated *G. puberula* and *G. siamensis* var. *pubescens* as synonyms with *G. siamensis*, and *G. mollis* var. *maxwellii* with *G. mollis*.

KEY TO THE SPECIES IN THAILAND

1. Glandular punctate dots or sessile glands on the lower leaf surface absent 2
1. Glandular punctate dots or sessile glands on the lower leaf surface present 3
2. Lower leaf surface pubescent with long soft hairs. Fruit pilose with long patent hairs on the upper part, glabrous on the lower part; mericarps basally winged; carpophore present . . . . . 3. *G. mollis*
2. Lower leaf surface glabrous or sparsely pubescent with short and long hairs. Fruit strigose with short and long subadpressed hairs; mericarps not winged; carpophore absent . . . . . 5. *G. siamensis*
3. Leaf margins crenate or shallowly crenate or subentire-undulate, usually less than 40 mm long, rarely longer, upper leaf surface with yellow sessile glands. Mericarps basally flattened. — North-eastern and Eastern Thailand . . . . . 1. *G. crenata*
3. Leaf margins entire or sometimes slightly undulate, leaf more than 40 mm long, upper leaf surface glabrescent or pubescent with short hairs on major veins, lacking sessile glands. Mericarps not winged or conspicuously flattened. — Central and Peninsular Thailand 4
4. Lower leaf surface with dark brown sessile glands. Corolla tube 10–12 mm long. Fruit strigose with short and long subadpressed hairs. — Central Thailand . . . . . 2. *G. longiflora*
4. Lower leaf surface with dark brown glandular punctate dots. Corolla tube 8–10 mm long. Fruit strigose with short adpressed hairs. — Peninsular Thailand . . 4. *G. premnoides*

1. ***Glossocarya crenata*** H.R.Fletcher — Fig. 1, 5a; Map 1

Glossocarya crenata H.R.Fletcher (1938a) 205. — Lectotype (designated here): *Lakshnakara 1053* (lecto E [E01121762]; isolecto BK [SN267567], BM [BM000950229], LL n.v.), Thailand, Kon Ken (Khon Kaen).

Woody climber, up to 5 m high. *Stems* quadrangular with fine longitudinal grooves, dark brown, pubescent with short soft hairs. *Leaves* broadly ovate or ovate, 25–40(–70) by 20–35(–45) mm, apex obtuse, base subcordate or rounded, margins crenate or shallowly crenate or subentire-undulate; upper surface pubescent with short hairs on major veins and with yellow sessile glands; lower surface with glandular punctate dots; petioles 7–9 mm long, densely pubescent with short brownish hairs. *Inflorescence* terminal, 40–110 by 70–120 mm, cymes slightly compact, few-flowered; bracts obovate, 5–15 mm long, pubescent with short hairs and yellow punctate dots on both surfaces; bracteoles lanceolate or linear, 2–5 mm long. *Flowering calyx* obconical, 3–3.5 mm long, pubescent with short hairs on veins and yellow glandular punctate dots outside, glabrous inside; tube 2–2.5 mm diam at top; lobes equal, triangular, c. 0.5 mm long, apex acute or broadly acute. *Fruiting calyx* triangular-obconical, 3.5–4 mm long; tube c. 3.5 mm diam at top, densely tomentose with short and long white hairs and pale yellow glandular punctate dots outside, glabrous inside; lobes truncate with minutely apiculate apex. *Corolla* white, tube whitish brown; tube 7–8 mm long, sparsely pubescent with short hairs and yellowish glands outside, glabrous inside; lobes 5, almost regular, obovate, subequal, densely pubescent with short soft white hairs and yellowish hairs outside, glabrous inside; anterior lobe c. 4 by 2 mm, apex rounded, margins entire or slightly undulate; other lobes c. 3 by 2 mm, apex rounded or broadly acute, margins entire or slightly undulate. *Stamens* inserted at corolla throat; filaments 13–15(–17) mm long, glabrous above, sparsely pubescent with short hairs at base; anthers oblong, c. 0.8 mm long, purple. *Style* 15–18 mm long; branches slender, c. 0.8 mm long. *Fruit* obovate-oblong, 6–8 by 2.5–3 mm, strigose with long, subadpressed hairs and yellowish white glands on the upper part and short, hispid hairs on the lower part; mericarps basally flattened with seeds only slightly shorter than the pericarp; seeds 4–6 mm long; carpophore absent.

Distribution — Thailand (North-eastern: Nakhon Phanom, Khon Kaen; Eastern: Surin, Ubon Ratchathani). See also under Habitat & Ecology.

Habitat & Ecology — *Glossocarya crenata* is found in freshwater swamp forest or in mixed deciduous forest near the riverbanks in North-eastern and Eastern Thailand. The species is endemic but it is expected to be found in Laos, Cambodia and Vietnam, as the downstream rivers in the Northeast Thailand are connected to the Mekong River. Flowering and fruiting: July to September.

Conservation status — *Glossocarya crenata* is known from several localities in Northeast Thailand and is regularly collected and observed from the natural habitat. The category of Least Concern is recommended for this species.

Specimens examined. *Bongcheewin 978* (BKF, PBM), Ubon Ratchathani, Sirindhorn, Kaeng Tana National Park; *Boonma s.n.* (BKF [SN104037, SN064647]), Khon Kaen, Mueang, Tha Phra, Ban Wang Hin; *Pradit 443* (BK), Nakhon Phanom, That Phanom; *Sutheesorn 2050* (BK), Surin, Tha Tum, Thung Kula Ronghai; *Thangthong 1211* (BKF, K, PBM), Ubon Ratchathani, Warin Chamrab, Ban Nong Kin Phen.

Notes — 1. *Glossocarya crenata* is an easily distinguished species by having broadly ovate or ovate leaves with crenate or shallowly crenate or subentire-undulate margins and glandular punctate dots on the lower surface. The crenate margins are seen from two collections (*Lakshnakara 1053*, the type specimen, and *Sutheesorn 2025*), which were collected from seasonally dry habitats, but the other collections with shallowly crenate or subentire-undulate margins are collected from freshwater swamp forests or near the riverbanks.

2. Fletcher (1938a) did not specify which herbarium specimen he used in the protologue, however, Fletcher worked at E. Therefore, the specimen at E is selected as the lectotype. The collector number of the type is actually *Lakshnakara 1053* not *1083* as mistakenly mentioned in the protologue.

2. *Glossocarya longiflora* H.R.Fletcher — Fig. 5b; Map 1

Glossocarya longiflora H.R.Fletcher (1938a) 205. — Lectotype (designated here): *Lakshnakara 284* (lecto E [E00284135] photo; isolecto K [K000509687], BK [SN257568], SING [SING0111619]), Thailand, Saraburi, Keng Koi (Kaeng Khoi).

Woody climber. *Stems* obtusely quadrangular with finely longitudinal grooves, dark brown, pubescent with reddish brown short hairs, glabrous at base. *Leaves* elliptic-ovate or ovate, 60–90 by 50–70 mm, apex acute or obtuse, base subcordate, margins entire or sometimes slightly undulate, upper surface glabrescent, lacking sessile glands, lower surface with dark brown, sessile glands and pubescent with short soft hairs; petioles 5–10 mm long, densely pubescent with short brownish hairs. *Inflorescence* terminal, 40–60 by 70–90 mm, cymes slightly compact; bracts oblanceolate, 4–5 mm long, pubescent with short hairs and sessile glands; bracteoles linear or oblanceolate, 1–3 mm long. *Flowering calyx* obconical, 3–3.5 mm long; tube 2–2.5 mm diam at top, pubescent with short hairs outside, glabrous inside; lobes equal, broadly triangular. *Fruiting calyx* obconical, 3–3.5 mm long; tube 3–4 mm diam at top, pubescent with short hairs outside, glabrous inside; lobes truncate with apiculate apex. *Corolla* white with tube darker in colour than lobes; tube 10–12 mm long, sparsely pubescent with long straight hairs and yellowish glands outside, glabrous inside; lobes unequal, densely pubescent with long subadpressed hairs and yellowish glands outside, glabrous inside; anterior lobe 3–4 by 2.5–3 mm, apex rounded, margins undulate; other lobes 2.5–3 by 1.5–2 mm, apex rounded, margins undulate or sometimes entire. *Stamens* all inserted at corolla throat; filaments 18–20 mm long, glabrous; anthers oblong, c. 0.8 mm long. *Style* 25 mm long; branches subequal. *Fruit* oblong, 6–10 by 2–2.5 mm, strigose with short and long subadpressed hairs and yellowish glands; mericarps not winged; seeds 5–7 mm long; carpophore absent.

Distribution — Endemic to Thailand.

Habitat & Ecology — In limestone area, at 100 m elevation. Flowering and fruiting: October.

Conservation status — The species is only known from the type specimen collected from Kaeng Khoi, Saraburi in 1926. This area has been dramatically changed by urban and industrial development. This species is at least Critically Endangered, CR B1 a,b(i,iii,iv) + 2 a,b(ii,iii,iv), though it may be Extinct in the wild. The location was visited and no sign of the species exist and the habitat is now heavily impacted by the neighbouring town and cement factory.

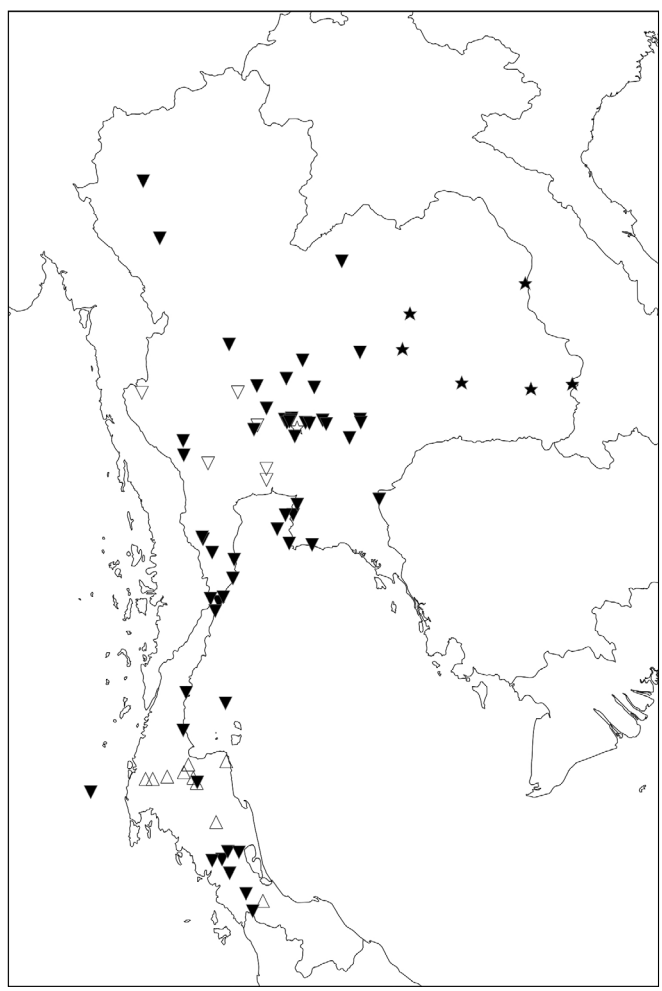
Note — *Glossocarya longiflora* has a longer corolla that distinguishes it from other species. The species is similar to *G. siamensis* based on leaf shape and fruit morphology, but it is recognised by having minute sessile glands on the lower leaf surface and the longer corolla, 13–16 mm long.

3. *Glossocarya mollis* Wall. ex Griff. — Fig. 2, 4, 5c; Map 1

Glossocarya mollis Wall. ex Griff. (1843) 366. — Lectotype (designated here): *Wallich, Numerical List nr. 1741* (lecto K-W [K001114034]), Myanmar, Sagaing, Segacu Hills.

Glossocarya mollis Wall. ex Griff. var. *maxwellii* Moldenke (1976b) 111. — Type: *Maxwell 75-889* (holo AAU; iso BK [SN232892], C n.v., L [L0414200]), Thailand, Trang, Khao Chong.

Woody climber or scandent-sprawling shrub, to 6 m tall. *Stems* obtusely quadrangular with finely longitudinal grooves, brown or yellowish brown, pubescent with long subadpressed hairs, glabrous at base. *Leaves* oblong-ovate or elliptic-ovate, 50–100(–130) by 40–80(–100) mm, apex acute, base obtuse or cordate, margins entire, upper surface glabrescent or sparsely pubescent with soft short or long hairs on midrib and lateral veins, lower surface pubescent with long soft hairs, sessile glands or gland dots absent; petioles 5–10(–13) mm long, canaliculate above, densely pubescent with long hairs. *Inflorescence* terminal, much-branched, 50–160 by 80–300 mm, cymes compact, many-flowered; bracts ovate, 10–20 mm long, upper surface pubescent with short hairs, lower surface pubescent with dense short hairs; bracteoles linear or lanceo-



Map 1 Distribution of *Glossocarya crenata* H.R.Fletcher (★), *G. longiflora* H.R.Fletcher (☆), *G. mollis* Wall. ex Griff. (▼), *G. premnoides* Ridl. (△) and *G. siamensis* Craib (▽) in Thailand.

late, 2–5 mm long. *Flowering calyx* obconical, 2–3 mm long; tube 2–2.5 mm diam at top, pubescent with long whitish subadpressed hairs outside, glabrous inside; lobes equal, triangular-ovate, 0.3–0.5 mm long, apex apiculate. *Fruiting calyx* campanulate, 4–5 mm long; tube 3–4 mm diam at top, strigose with short subadpressed hairs outside, glabrous inside; lobes broadly triangular, 0.3–0.5 mm long, with apex apiculate. *Corolla* white; tube 7–9 mm long, sparsely pubescent with short adpressed hairs outside, glabrous inside; lobes subequal, densely pubescent with outside, glabrous inside; the anterior lobe c. 4 by 2 mm, apex rounded, margins undulate; other lobes c. 3 by 2.5 mm, apex rounded or broadly acute, margins undulate. *Stamens* inserted at corolla throat; filaments 12–15 mm long, glabrous; anthers oblong, 0.7–0.8 mm long, base sagittate. *Style* 23–25 mm long; branches subequal, 0.9–1.1 mm long. *Fruit* oblong or elliptic-oblong, 7–9 by 2.5–3 mm, pilose with long patent hairs and sparsely yellowish white glands on upper half, exserted from the calyx, glabrous on lower half within in the calyx; mericarps basally winged; seeds 4–5 mm long; carpophore present, obconical, (3–)4–5 mm long.

Distribution — Myanmar, Vietnam, Thailand (Northern: Chiang Mai, Tak, Nakhon Sawan. North-eastern: Phetchabun, Loei; Eastern: Chaiyaphum, Nakhon Ratchasima; South-western: Kanchanaburi, Ratchaburi, Phetchaburi, Prachuap Khiri Khan; Central: Lop Buri, Saraburi; South-eastern: Sa Kaeo, Chon Buri; Peninsular: Chumphon, Surat Thani, Phangnga, Phatthalung, Trang, Songkhla), Papua New Guinea.

Habitat & Ecology — On limestone hills and in secondary dry evergreen forest; at 30–170(–400) m elevation. Flowering and fruiting: March to December.

Conservation status — *Glossocarya mollis* is a widespread species collected from various habitats in Thailand and the Least Concern (LC) category is applied. There are no obvious threat leading to decline. Both AOO and EOO exceed the threshold for threatened categories.

Specimens examined. *Annandale 1832* (SING photo), Lower Siam, Kao Koh Sawan; *Anonymous s.n.* (BK [SN260123]), Nakhon Ratchasima, Pak Chong; *Bongcheewin 1124* (PBM), Saraburi, Chaloem Phra Kiat, Na Phra Lan, Wat Bencha Kiri Nakhon; *Bongcheewin 1129* (PBM), Saraburi, Phra Phutthabat, Khun Khlon, Tham Makak; *Bourke-Burrowes s.n.* (BK), Phetchabun, Pasak River; *Chermsirivathana 105* (BK), Prachuap Khiri Khan, Khlong Wan; *Collins 26* (BM, K); *Collins 39* (BM, K); *Collins 658* (K), Chon Buri, Si Racha; *Damrongsak 378* (BKF), Nakhon Ratchasima, Pak Thong Chai, Wang Nam Khiao; *Hosseus 5* (BM, K, L, M n.v., MO n.v., NY n.v., W n.v.), Bangkok, Menam, Bang-Ma-Loon; *Kaew 16* (BKF), Prachuap Khiri Khan, Khao Chong Krachok; *Kerr 3061* (BM, K), Tak, Kaeng Um La, Me Ping rapids; *Kerr 4541* (AAU, ABD n.v., BK, BM, E n.v., P), Nakhon Sawan, Banphot Phisai, Ban Daen, Khao Sang; *Kerr 7047* (BK, BM, E n.v., K, SING photo), Saraburi, Menam Pa Sak; *Kerr 8770* (AAU, ABD n.v., BK, BM, K), Loei, Wang Saphung; *Kerr 9135* (BK, BM, E n.v., K, P), Saraburi, Hin Lap; *Kerr 10963* (BK, BM, K), Prachuap Khiri Khan, Sam Roi Yot; *Kerr 11147* (AAU, B n.v., BK, BM, K), Surat Thani, Ko Tao; *Kerr 19279* (BK, BM, K, SING photo), Phatthalung, Khao Hua Tek; *Larsen et al. 1501* (AAU, L, LL n.v., P), Ratchaburi, Huai Yang; *Larsen et al. 42121* (AAU, BKF), Songkhla, Ton Nga Chang, 20 km West of Hat Yai; *Larsen et al. 45351* (AAU), Phetchaburi, Kaeng Krachan National Park, Khao Pa Karang; *Marcan 1890* (BK, BM, E n.v.), Saraburi, Muak Lek; *Maxwell 05-488* (BKF, L), Kanchanaburi, Sai Yok, summit of a ragged limestone hill at Wat Trai Rattanaram; *Maxwell 05-700* (L), Saraburi, Mueang, Sam Lan National Park, Summit of Khao Krok; *Maxwell 72-605* (AAU, BK), Chon Buri, Sattahip, Thung Prong; *Maxwell 73-694* (AAU, BK), Saraburi, Mueang, Sam Lan; *Maxwell 86-456* (BKF, L), Songkhla, Sadao, Padang Besar, Khao Rup Chang; *Maxwell 86-505* (BKF, L), Phatthalung, Si Banphot, Khao Pu Khao Ya National Park; *Maxwell 86-594* (BKF, L), Songkhla, Sadao, Padang Besar, Khao Rup Chang; *Maxwell 92-686* (L, P), Chon Buri, Ko Sichang; *Maxwell 93-139* (BKF, L), Chon Buri, Si Racha, south-east side of Ko Kwang; *Middleton et al. 2214* (BKF, L), Prachuap Khiri Khan, Kaeng Krachan National Park; *Niyomdham 3322* (BKF), Phangnga, Similun National Park, Ko 6; *Niyomdham 3397* (BKF), Phangnga, Similun National Park, Ko 9; *Noopakdee 7* (BKF), Saraburi, Phrabaht, Khao Nok Yung; *Phengklai & Smitinand 6158* (BKF), Chiang Mai, Inthanon, Saithong Waterfall; *Phonsena et al. 3535* (BKF), Sa Kaeo, Khlong Hat, Khao Lueam, *Phonsea et al. 6244* (BKF), Lop Buri, Tha Wung, Khao Samo Khon; *Pooma et al. 2975* (BKF), Lop Buri, Chai Badan, Na Som, Wat Khao Tambon; *Pooma et al. 3089* (BKF), Prachuap Khiri Khan, Hua Hin, Pran Buri Forest Park, in front of Khao Lot spirit house; *Pooma et al. 4668* (BKF, E n.v., K, L, P, SING photo), Lop Buri, Bandai Samsaen temple; *Pooma et al. 5717* (BKF), Saraburi, Phra Phutthabat, Khun khlon, Tham Makak; *Pooma et al. 6427* (BKF, E n.v.), Surat Thani, Ban Nasan, Phraphothisat Kuan-im; *Pooma et al. 6640* (BKF, E n.v., L), Phatthalung, Mueang, Chai Buri, Roadside to Mueang Kao Chai Buri Forest Park; *Pradit 526* (BK), Nakhon Ratchasima, Pak Thong Chai; *Put 236* (ABD n.v., BK, BM, K), Prachuap Khiri Khan; *Put 996* (BK, BM, K), Chumphon, Siepyuan; *Put 4127* (BK, BM, E n.v., K, SING photo), Surat Thani, Kantuli; *Robinson 6456* (K), Trang; *Sangkhachand 1058* (BKF, K, L, P), Prachuap Khiri Khan, Khao Sam Roi Yot; *Seelanan et al. 397* (BCU), Chon Buri, Ko Sichang; *Shimizu et al. T-7603* (AAU, BKF, L), Prachuap Khiri Khan, Khao Chong Krachok; *Smitinand 4829* (BKF, K, LL n.v.), Nakhon Ratchasima, Pak Chong; *Smitinand & Fraser 42* (BKF), Prachuap Khiri Khan, Sam Roi Yot National Park; *Smitinand & Sleumer 1092* (BKF, L), Nakhon Sawan, Takhli, Khao Takhli; *Smitinand & Sleumer 1356* (BKF, K, L), Saraburi, Khao Song Phi Nong; *Sutheesorn 673* (BK), Chaiyaphum, Khao Kong, *2736* (BK), Prachuap Khiri Khan, Sam Roi Yot, *3154* (BK), Nakhon Sawan, Khao Takhli; *Tagane et al. T-2329* (BKF), Phetchaburi, Kaeng Krachan National Park, Ban Krang Camp; *Van Beusekom & Smitinand 2045* (AAU, BKF, E n.v., L, P), Chon Buri, Si Racha, Ko Sichang; *Van Beusekom et al. 3325* (BKF, K, L), Nakhon Ratchasima, Sakaerat; *Van Beusekom et al.3874* (BKF, K, L, P), Kanchanaburi, Erawan National Park; *Van Steenis 19597* (L), North of Bangkok, near Ban Doen; *Wongprasert s.n.* (BKF [SN090758]), Lop Buri, Khok Charoen, Wangmanora; *Wongprasert et al. s.n.* (BKF [SN120796]), Chon Buri, Pattaya, Ko Phai.

Notes — 1. *Glossocarya mollis* is distinct from other species in Thailand by having a carpophore and a pilose fruit with long spreading hairs on the upper half, exserted from the calyx. However, the hair density on the leaf surfaces is very variable; *G. mollis* var. *maxwellii* was described from a single collection with hairs restricted only to the midrib and lateral veins, but this variation is commonly observed from other collections of *G. mollis*. Therefore, we treated *G. mollis* var. *maxwellii* as a new synonym of *G. mollis.*

2. The collection *Annandale 1832* was cited by Fletcher (1938a) as *G. longiflora*, but his annotation on the herbarium sheet at SING, done in 1935, mentioned the specimen as *G. mollis.* The examination of *Annandale 1832* at SING clearly reveals that it is *G. mollis* by having the carpophore and long patent hairs on the upper half of mericarps.

4. *Glossocarya premnoides* Ridl. — Fig. 4, 5d; Map 1

Glossocarya premnoides Ridl. (1911) 157. — Lectotype (designated here): *Ridley 15149* (lecto K [K000509686]; isolecto BM [BM000958063], SING [SING0068013]), Malaysia, Perlis, Besih Hangit Hill.

Woody climber or shrub. *Stems* obtusely quadrangular with finely longitudinal grooves, dark brown, strigose with long subadpressed hairs. *Leaves* elliptic-ovate, oblong-elliptic or ovate, 40–100 by 30–90 mm, apex acute or sometimes attenuate, base subcordate or sometimes obtuse, margins entire, upper surface pubescent with short hairs on major veins, lower surface with dark brown glandular punctate dots and pubescent with short hairs on major veins; petioles 5–10 mm long, densely pubescent with short hairs. *Inflorescence* terminal, 30–50 by 50–70 mm, cymes compact; bracts oblanceolate 3–5 mm long, pubescent with short hairs; bracteoles linear or narrowly oblanceolate, 1–3 mm long. *Flowering calyx* obconical, 2–2.5 mm long; tube c. 2.5 mm diam at top, pubescent with short hairs and occasionally with glands outside, glabrous inside; lobes equal, triangular-ovate, 0.3–0.5 mm long, apex apiculate. *Fruiting calyx* obovate, 3–4 mm long; tube 3–4 mm diam at top, sparsely hispid outside, glabrous inside; lobes truncate with minutely apiculate apex. *Corolla* white; tube 8–10 mm long, pubescent with long adpressed and whitish glands outside, glabrous inside; lobes unequal, pubescent with short hairs outside, glabrous inside; the anterior lobe c. 3 by 2–2.5 mm, cucullate; other

lobes c. 2.5 by 1.5–2 mm, apex rounded or broadly acute, margins undulate. *Stamens* inserted near corolla throat; filaments 14–18 mm long, glabrous; anthers oblong, c. 0.8 mm long. *Style* 18–22(–24) mm long; branched subequal, c. 1 mm long. *Fruit* oblong, 6–11 by 3 mm, strigose with short adpressed hairs and whitish glands; mericarps basally flattened; seeds 4–6 mm long; carpophore absent.

Distribution — Restricted to the Malay Peninsula, mainly found in Peninsular Thailand (Peninsular: Surat Thani, Nakhon Si Thammarat, Songkhla).

Habitat & Ecology — In disturbed evergreen forest and on riverbanks in dense thickets with bamboo forest at (10–)50–150 m elevation. Flowering and fruiting: February to September.

Conservation status — *Glossocarya premnoides* is known from ten collections in Thailand and one collection, the type collection, from Peninsular Malaysia. The habitat is undergoing conversion by human activities, e.g., farming, road expansion. The species has an EOO of 19 967.977 km^2. Although EOO for the species is just under 20 000 km^2 and there is some evidence of decline due to habitat change, there are more than 10 locations (at least 12). Therefore the species is assessed as Least Concern using IUCN Red List Criterion B.

Specimens examined. *Bongcheewin 1148* (BKF, K), Surat Thani, Phun Phin District, Tha Kham; *Gardner et al. ST1876* (BKF), Surat Thani, Phanom, Khlong Phanom National Park, 'Rafflesia' nature trail; *Gardner et al. ST1726* (BKF), Surat Thani, Phanom, Khao Sok River, upstream of Tham Kaew (Crystal Cave); *Kerr 12312* (BK, BM, K, SING photo), Surat Thani, Tha Kanawn; *Maxwell 87-234* (AAU, BKF, E n.v., L 2 shts, P), Nakhon Si Thammarat, Thung Song, Huai Kahn, Ban Thung Kamin, Moo 3; *Maxwell 84-14* (BKF), Songkhla, Hat Yai, Khlong Pom, off of Highway 4; *Samanwanakij 106* (BKF), Surat Thani, Ban Na, Ban Paknoon; *Sanan 462* (BKF), Surat Thani, Ban Na San, Krachum; *Smitinand 2886* (AAU, BKF, K, LL n.v.), Surat Thani, Bangbao; *Smitinand 2941* (AAU, BKF, K, LL n.v.), Surat Thani, Tha Kham, *Smitinand s.n.* (BKF [SN121949]), Surat Thani, Yan Ta Khun, Khlong Saeng, Bang Kaeo; *Winit 545* (K), Kanchanaburi.

Note — *Glossocarya premnoides* is a distinct species by having the remarkable glandular punctate dots on the lower leaf surface (Fig. 3c) and it is only found in Peninsular Thailand and the Malay Peninsula.

5. *Glossocarya siamensis* Craib — Fig. 5e; Map 1

Glossocarya siamensis Craib (1922) 240. — Lectotype (designated here): *Kerr 4502* (lecto K [K000509688]; isolecto BK [SN257569], BM [BM000950230], P [P00615004, P00614984]), Thailand, Bangkok.

Clerodendron squiresii Merr. (1938: 64). — Syntypes: *Squires 858* (BO n.v., G [G00366330] photo, LL n.v., K [K000910180], M n.v., NY [NY00137427] photo, P n.v., S photo), Vietnam, Southern Annam, Dalat.

Glossocarya puberula Moldenke (1959) 81. — Type: *Pierre 1208* (holo NY [NY00137547] photo; iso P [P00615001, P00615002]), Cambodia, Pinlysap (Tonle Sap).

Glossocarya siamensis Craib var. *pubescens* Moldenke (1976a) 19. — Type: *Maxwell 71-487* (holo AAU), Thailand, Ang Thong, Howa Pie.

Woody climber or shrub. *Stems* obtusely quadrangular with finely longitudinal grooves, reddish brown, pubescent with dense brownish subadpressed and fluffy hairs. *Leaves* elliptic-ovate or oblong-ovate, 50–90 by 35–55 mm, apex acute or acuminate, base subcordate or sometimes rounded, margins entire, upper surface pubescent with sparse hairs on major veins or glabrescent, lower surface glabrous or sparsely pubescent with short and long hairs on midrib and lateral veins, sessile glands or gland dots absent; petioles 5–8 mm long, pubescent with dense long brownish subadpressed or fluffy hairs. *Inflorescence* terminal, 20–60 by (20–)40–110 mm, cymes compact; bracts ovate, 5–10 mm long, pubescent with short hairs; bracteoles narrowly oblanceolate, 2–5 mm long. *Flowering calyx* obconical, 3–3.5 mm long; tube 2–2.5 mm diam at top, pubescent with short hairs outside, glabrous inside; lobes equal, triangular, c. 0.3 mm long, apex minutely apiculate. *Fruiting calyx* obovate, 3–3.5 mm long; tube 3–4 mm diam at top, pubescent with white short hairs outside, glabrous inside; lobes broadly triangular with minutely apiculate apex. *Corolla* white; tube 8–9 mm long, sparsely pubescent with long adpressed hairs outside, glabrous inside; lobes subequal, densely pubescent with long adpressed hairs and yellowish white glands outside, glabrous inside; the anterior lobe 5–6 by 2.5–3 mm, cucullate; other lobes 4–5 by 2–3 mm, apex rounded, margins entire or sometimes slightly undulate. *Stamens* inserted at corolla throat; filaments 16–19 mm long, glabrous; anthers lilac, oblong, c. 0.8 mm long. *Style* 20–22 mm long; branches subequal, 1–1.3 mm long. *Fruit* oblong, (5–)6–9 by 2–3 mm, strigose with short and long subadpressed hairs and brownish glands; mericarps not winged; seeds 5–8 mm long; carpophore absent.

Distribution — Cambodia, Vietnam, Thailand (South-western: Kanchanaburi; Central: Ang Thong, Chai Nat, Nonthaburi, Bangkok).

Habitat & Ecology — Commonly found in dense thickets along the woodland or on the riverbanks. Flowering and fruiting: June to January.

Conservation status — *Glossocarya siamensis* was collected from outside protected areas. Most habitats are likely to be urbanised, which impacts the available habitat. Besides, no new collections have been made for more than 50 years. The range of EOO is 19 537.622 km^2 and the Vulnerable (VU) category is applied. The EOO is just under the threshold for VU status (< 20 000 km^2). Ten localities are recorded and there is some evidence of habitat decline due to urbanisation suggesting the number of localities is fewer than the historic record suggests. For example, the type locality is in Bangkok and the species no longer occurs there. Therefore the species is assessed as Vulnerable B1 a, b(i,iii).

Specimens examined. *Den Hoed & Kostermans 969* (K, L), Kanchanaburi, Brangkasi, c. 100 km South of Wangka; *Kerr 19530* (BK, BM, K, SING photo), Kanchanaburi, Tha Salao; *Marcan 924* (BM), Kanchanaburi; *Marcan 1439* (BM), Nonthaburi, Pak Kret; *Maxwell 72-389* (AAU), Ang Thong; *Maxwell 71-489* (BK, L), Ang Thong, Mueang, Howa Pie, Wat Glang; *Put 2575* (BK, BM, E n.v.), Ang Thong; *Put 2673* (BK, BM, E n.v., K, SING photo), Chai Nat.

Note — *Glossocarya puberula* was described based on a duplicate of inferior quality, with only flowering buds kept at NY. Two other duplicates kept at P are complete with both mature flowering and fruiting characters and clearly recognised as *G. siamensis*. Likewise, *G. siamensis* var. *pubescens* was described based on a variation of hair density on the inflorescence and on the midrib and lateral veins, which are variable characters. Hence, they are synonymised here.

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