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Two New Species of *Jasminum* (Oleaceae) from Peninsular Thailand

RUTH KIEW

ABSTRACT

Two new species from the Peninsular Region of Thailand, *Jasminum peninsulare* Kiew from Ranong, Phangnga, and Pattani Provinces and *J. ranongense* Kiew from Ranong Province, are described and illustrated. Previously, they had both been confused with *J. kedahense* (King & Gamble) Ridl. from Malaysia and included under this name in the Flora of Thailand.


Published online: 31 March 2017

INTRODUCTION

Green (2000) in his account of the Oleaceae in Flora of Thailand described some Thai specimens as *Jasminum kedahense* (King & Gamble) Ridl. Examination of the specimens at BK, BKF and K identified by him shows that they comprise two distinct species, both different from Malaysian *J. kedahense* (King & Gamble) Ridl. The specimens with tripliveined leaves illustrated in Flora of Thailand Figure 31 (Green, 2000) are here described as *J. ranongense* Kiew, and those listed by Kerr (1939) under *J. smilacifolium* Griff. ex C.B.Clarke and *J. subtriplinerve* Blume that were included in *J. kedahense* by Green (2000) are here described as *J. peninsulare* Kiew. *Jasminum kedahense* does not occur in Thailand.

These new species bring the total number of jasmines recorded for Thailand to 34 species. Thirty one were included in Green’s 2000 account, Srisanga et al. (2004) reported *J. rufohirtum* Gagnep. as a new record, and Chalermglin & Kiew (2013) described *J. bhuminobolianum* Chalermglin as a new species. Further additions to the Thai jasmine flora can be expected as botanical exploration of poorly known areas proceeds and also because Green for some taxa adopted a very broad interpretation.

NEW SPECIES


It is different from *J. kedahense* in being glabrous (not densely tomentose), its leaves less coriaceous, the margin is not thickened and recurved, and the apex is attenuate (not acute to acuminate), the inflorescence is a few-flowered cyme (not a many-flowered corymbose cyme), the calyx lobes subulate (not filiform), and the fruit lobes smaller (8 × 6 mm vs. 15 × 10 mm). From *J. adenophyllum* Wall. ex C.B.Clarke, it is distinct in its leaves with 2–3 pairs of lateral veins that lack domatia (not 4–5 pairs of veins with domatia), in the longer corolla tube 22–30 mm and wider corolla lobes 13–18 × 4–6 mm (not with a tube 9–20 mm and lobes 15–20 × 2–3.5 mm). Type: Thailand, Phangnga Province, Khao Katakwam, ca 1000 m, climbing on low herbage on peak, 8 Mar. 1930, *Kerr 18458* (holotype K; isotype BK). Fig. 1.

Woody climber. Twigs terete, glabrous, light brown, ca 5 mm thick. Leaves: unifoliolate, glabrous;
petioles twisted, slender, 0.7–2 cm long; lamina broadly ovate, (6.5–)9–14.5 × (4–)5–7.5 cm, thinly coriaceous, sometimes bullate, base rounded, margin not recurved, apex attenuate, tip mucronate; venation pinnate, lateral veins 2(–3) on either side of the midrib, ascending strongly and forming a submarginal vein ca 5–7 mm from margin, slightly prominent above, prominent beneath; intercostal veins obscure; without domatia. Inflorescences terminal on side shoots, few-flowered cymes, peduncle 1.7–2.3 cm long; bracts leafy, 23 × 9 mm, caducous. Flowers: pedicels 3–4 mm long; calyx glabrous, tube funnel-shaped, 2–3 mm long, lobes 5–7, subulate, 5–9 mm long; corolla white, glabrous, tube 22–30 mm long, ca 3 mm wide, lobes 7–9, oblong, 13–18 × 4–6 mm, apex acute, tip apiculate; stamen: filaments ca 1 mm long (in short-styled flower); anthers ellipsoid, ca 7 mm long, connective broad, apex mucronate; ovary globose, ca 1 mm diam, glabrous, style (in short-styled flower) ca 4 mm long, stigma spear-shaped, ca 5 mm long. Fruits: lobes ellipsoid, ca 8 × 6 mm; fruit stalk 5–7 mm long.

Thailand.— PENINSULAR: Ranong [Khao Pota Luang Kao (Kao Pawta Luang Keo) ca 1300 m, flowers white, climbing on bushes on ridge, 2 Feb. 1929 Kerr 16966 (BK, K); ibid, ca 1300 m, flowers white, climbing in open evergreen forest, 1 Feb. 1929 Kerr 17539 (K)]; Phangnga [Khao Katakwam, ca 1000 m, climbing on low herbage on peak, 8 Mar. 1930, Kerr 18458 (BK, K)]; Pattani [Khao Kalakiri ca 800 m, woody climber, flowers white, evergreen forest, 2 Apr. 1918 Kerr 14989 (BK, K)].

Distribution.— Endemic in Peninsular Thailand (Pattani, Phangnga and Ranong Provinces).

Ecology.— Open evergreen forest, on ridges or summits at 800–1300 m elevation.

Etymology.— It is named for the region where it occurs.

Conservation status.— DD (Data Deficient). The species has not been collected for eighty years.

Notes.— Kerr (1939) identified Kerr 14989 and Kerr 16966 as J. milacifolium and Kerr 17539 and Kerr 18458 as J. subtriplinerve. Neither of these species occurs in Thailand (Green, 2000). Jasminum peninsulare has pinnate venation and is distinct from both J. milacifolium (from Peninsular Malaysia and Sumatra) and J. subtriplinerve (from India and Sikkim), those species having triliveined leaves. While these Thai specimens superficially resemble J. kedahense in leaf shape (they have ovate leaves), they are, as Green (2000) noted, different in being glabrous. In addition they also differ in leaf texture, inflorescence type and fruit size, so are here recognised as a distinct new species.

Among the Thai species with leaves with pinnate venation, J. peninsulare most resembles J. adenophyllum in its few-flowered inflorescences, glabrous calyx with filiform lobes longer than the tube, but is distinct from this species in its leaves that have fewer veins and no domatia and its larger corollas with broader lobes.

Jasminum ranongense Kiew, sp. nov.— 1. kedahense auct. non (King & Gamble) Ridl.: Green, Fl. Thailand 7(2): 337. 2000, fig. 31.

Among Thai jasmines with tripliveined leaves, few-flowered inflorescences and calyx lobes 5–12 mm long, J. ranongense is most similar to J. nervosum Lour., but differs in its 3–5-flowered cymes (not 1-(rarely 3-flowered) cymes) and longer corolla tube 22–25 mm with broader lobes 17–19 × 4–4.5 mm (not with a corolla tube 12–20 mm long and lobes 12–20 mm × 1.5–2 mm). Type: Thailand, Ranong Province, Khao Pota Luang Kao (Kao Pawta Luangkaeo), shrubby ridge on top area alt. 1200–1300 m. 60 cm shrub 10 Dec. 1979, Shimizu, Toyokuni, Koyama, Yahara & Niyomdhan T 26883 (holotype BKF). Fig. 2.

Woody climber to 60 cm, main stem to 4–5 mm diam., young stems minutely pubescent, soon becoming glabrous, drying brown, 2–3 mm diam. Leaves: petioles 1.5–1.7 cm long, slender, 1–1.3 mm thick; lamina narrowly to broadly lanceolate, 9.5–11.5 × 2.7–4.7 cm, base cuneate or rounded, margin slightly thickened, apex in narrow leaves long attenuate, in broader leaves less so, glabrous, slightly or moderately coriaceous; venation tripliveined, with one basal pair of main veins arising ca 4–5 mm above base, with 3–4 pinnate veins on both sides of the midrib in the upper third of the lamina, veins impressed above, slightly prominent beneath; intercostal veins obscure; without domatia. Inflorescences terminal on slender side shoots, few-flowered cymes with 3–5 flowers, glabrous; peduncle 0.8–4 cm long, bracts narrowly lanceolate, ca 5 mm long. Flowers: pedicels 5–8 mm; calyx glabrous, tube 2–3 mm,
TWO NEW SPECIES OF JASMINUM (OLEACEAE) FROM PENINSULAR THAILAND (R. KIEW)

Figure 1. The holotype specimen, Kerr 19458, of Jasminum peninsulare Kiew, from Khao Katakwam, Phangnga Province. (Image reproduced with the consent of the Royal Botanic Gardens, Kew).
Figure 2. *Jasminum ranongense* Kiew. Flowering branch (Shimizu et al. T 26883); fruiting branch (Niyomdham & Kubat 1427). (Figure 31, Fl. Thailand 7(2): 338. 2000), reproduced with permission from the Forest Herbarium, Department of National Parks, Wildlife and Plant Conservation, Bangkok.)
TWO NEW SPECIES OF JASMINUM (OLEACEAE) FROM PENINSULAR THAILAND (R. KIEW)

lobes narrowly lanceolate, 6–8 mm long; corolla white; tube 22–25 mm long, lobes 7–8, lanceolate, 17–19 × 4–4.5 mm, apex narrowed to an apiculum ca 2 mm long. Fruit (only one lobe developed) 12–14 × 9–10 mm.

Thailand. — PENINSULAR: Ranong [Mueang Chon Tin Mine, Khao Pota Luang Kaeo ca 1300 m. climber fruits green, evergreen forest, Niyomdham & Kubat 1427 (BKF)]; ibid (Khao Pawta Luangkaeo), shrubby ridge on top area alt. 1200–1300. 60 cm shrub, 10 Dec. 1979, Shimizu et al. T 26883 (BKF).

Distribution. — Endemic in Thailand, rare and known only from Ranong Province (Khao Pota Luang Kaeo).

Ecology. — Evergreen forest, sometimes on ridges at 1200–1300 m elevation.

Etymology. — Named for the province where the two specimens were collected.

Conservation. — DD (Data Deficient). The species has not been collected for twenty years.

Notes. — Figure 31 in Green (2000) (Fig. 2 here) illustrates specimens held in BKF: Shimizu et al. T 26883 with flowers and Niyomdham & Kubat 1427 with fruits. They are completely different from Malaysian J. kedahense. J. asminum ranongense is a slender, glabrescent climber to 60 cm (not a robust bushy, densely tomentose climber to 2 m tall as in J. kedahense), it has tripliveined, narrower lanceolate leaves, 9.5–11.5 × 2.7–4.7 cm (not pinnate, ovate leaves, 8–12 × 4–6 cm), few-flowered cymes (not many-flowered corymbose cymes), and the corolla is smaller with the tube 22–25 mm long and lobes 17–19 × 4–4.5 mm (not with a tube 25–30 mm long and broader lobes 14–19 × 5–6 mm).

ACKNOWLEDGEMENTS

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REFERENCES


A new species of *Hibiscus* (Malvaceae-Malvoideae) from Thailand

LEENA PHUPHATHANAPHONG¹ & SIMON GARDNER²

ABSTRACT


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INTRODUCTION

*Hibiscus* L. comprises approximately 200 species distributed almost worldwide, mostly in the tropics and subtropics, with a few species in temperate regions (Bayer & Kubitzki, 2003). The Thai species of *Hibiscus* were enumerated by Phuphathanaphong et al. (1989), totalling 17 species (7 exotic species), and recently 19 species (9 exotic species) were recognized by Pooma & Suddee (2014). Further study of Malvaceae-Malvoideae for the Flora of Thailand by the first author found interesting fertile material of *Hibiscus* from Surat Thani and Songkhla provinces, southern Thailand, which we describe here as *H. contortus* Phuph. & S.Gardner. Borssum Waalkes (1966) recognized 9 sections of tribe Hibisceae and this new species belongs to section Azanza. Most species in this section are trees with broad stipules and palminerved leaves. *Hibiscus contortus* is most similar to *Hibiscus fistococcus* Mast. which occurs in Peninsular Malaysia and Yala, the southernmost province of Thailand.

*Hibiscus contortus* Phuph. & S.Gardner, sp. nov.

Allied to *Hibiscus fistococcus* Mast. but differs in leaves not lobed, not scabrous (vs angular or lobed, scabrous); pedicel 2–2.5 cm long, jointed (vs 0.5–1 cm long, without joint); petals pale pink to pale orange with darker pink base (vs yellow to orange with red veins from base); stamen filaments 5–7 mm long (vs 2–2.5 mm long). Type: Thailand, Surat Thani, Don Sak, alt. 5 m, 19 Dec. 2006, Pooma et al. 6460 (holotype BKF; isotypes A, BKF, E, L). Figs. 1–2.

Tree 5–13 m tall, branching low down. Bark pale grey, slightly flaking in irregular patches. Branches covered with fimbriate scales. Leaves broadly ovate, 10–15 cm by 9–13 cm, chartaceous, reddish when young; apex shortly acuminate; base truncate to shallowly cordate; margins irregularly shallowly serrate, crenate or undulate; basal nerves 5; lateral nerves 2–3 on each side of midrib; tertiary veins scalariform, slender; blade with scattered minute brownish fimbriate scales on both surfaces, denser on the nerves near base; lower surface with simple hairs at base of basal nerves and with a linear gland 2.5–6 mm long on midrib near base. Petioles 5–6.5 cm long, covered with fimbriate scales, denser near apex. Stipules lanceolate, 5–5.5 cm by 1–1.5 mm, with fimbriate scales, caducous. Flowers axillary, solitary or several near the end of twigs, often giving a corymbose appearance. Pedicels 2–2.5 cm long, articulation 5–7 mm from apex, from the articulation to base of epicalyx stout, covered with brownish fimbriate scales. Epicalyx broadly campanulate, 1–1.5 cm long, lower 2/3 connate, upper 1/3 divided into 5–6 triangular lobes; lobes recurved, projecting from epicalyx, outside yellowish green with dense brownish fimbriate scales, inside green with scattered minute fimbriate scales. Calyx campanulate, 2.5–3 cm long, base connate, apex divided into 5 triangular lobes, 1–1.2 cm long; calyx tube outside

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A NEW SPECIES OF HIBISCUS (MALVACEAE-MALVOIDEAE) FROM THAILAND (L. PHUPHATHANAPHONG & S. GARDNER)

Figure 1. *Hibiscus contortus* Phuph. & S.Gardner: A. flowering branch (Pooma et al. 6460); B. fruit; C. seed. (B–C. Gardner & Sidisunthorn ST2251). Drawn by Orathai Kerdkao.
yellowish green with dense brownish fimbriate scales, inside with minute crispy hairs and some minute fimbriate scales; calyx lobes outside yellowish green with dense brownish fimbriate scales, inside with dense fimbriate scales, margins wing-like in bud. Corolla pale orange to pale pink, centre darker pink, petals twisted together. Petals 5, obliquely obovate, 4–5 by 1.5–2.5 cm, apex rounded, base narrow, margin irregularly crenulate, outside with fimbriate scales, inside gland dotted. Staminal column 5–7 cm long, protruding 1.5–4.5 cm beyond the twisted petals; filaments 5–7 mm long; anthers in upper 2/3 of the tube, reniform, ca. 1 mm long. Utrary ovoid, densely golden hairy, 5 locules; style slender enclosed within the staminal tube, style branches 5, hairy, protruding 5–6 mm beyond the staminal column; stigma discoid. Capsules obovoid 2.5–2.8 by 1.8–2 cm, thinly woody, outside densely golden hairy, inside glabrous, 5-loculed. Seeds reniform, ca 4 by 3 mm, hairy.

Thailand.— Peninsular: Surat Thani, Don Sak, alt. 5 m, 19 Dec. 2006, Pooma et al. 6460 (A, BKF, E, L); Songkhla (road between Hat Yai and Satun), alt. 100 m, 25 Jan. 2006, Gardner & Sidisunthorn ST2251 (BKF, K).

Distribution.— Endemic to peninsular Thailand.

Ecology.— Secondary forest at foot of limestone hills or open secondary growth along roadside, 5–100 m alt.

Phenology.— Flowering and fruiting: December–January.

Vernacular.— Chaba hup (ชบาหุพ).

Etymology.— The specific epithet ‘contoertus’ is derived from Latin, in reference to the overlapped and twisted petals.

IUCN conservation assessment.— This new species is only known from an area < 500 km². The species is known from small populations in Surat Thani and Songkhla provinces in secondary growth not in protected areas, and thus may be impacted from road construction and human activities. We therefore suggest the conservation assessment ‘Vulnerable’ (VU B2ab(iii)) (IUCN, 2001).

Notes.— Field notes for Gardner & Sidisunthorn ST2251 were “Bark: pale grey, slightly flaking in irregular patches. Flower: epicalyx and calyx yellow-green with golden-brown glands; petals pale pink, tinged darker pink towards base inside”. Field notes for Pooma et al. 6460 were “Small tree 5–7 m tall, low branching; young leaves reddish; calyx greyish brown; corolla very pale pinkish, reddish at base, staminal column creamy; anthers yellow”.

Figure 2. Hibiscus controertus Phuph. & S.Gardner. Photo: R. Pooma.
REFERENCES


A revision of *Dorcoceras* (Gesneriaceae) in Thailand

CARMEN PUGLISI1 & DAVID J. MIDDLETON2

ABSTRACT

The genus *Dorcoceras* Bunge in Thailand is revised. There are four species, including two new species, *Dorcoceras brunneum C.Puglisi* and *Dorcoceras glabrum C.Puglisi*. A key, descriptions, and proposed IUCN assessments are presented.

KEYWORDS: *Boea*, conservation assessments, new species.

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INTRODUCTION

*Dorcoceras* was described by Bunge in 1833 from a plant collected in China. It was initially included in the ‘Lentibulariaceae’, but associated nonetheless with *Boea*, the genus of Gesneriaceae in which it was synonymised a few years later (Brown, 1839 & 1840). Brown did not provide any explanation in support of this synonymisation, either in the main publication of Plantae Javanicae Rariores (Brown, 1840), nor in its preprint (Brown, 1839). Despite the meticulous work carried out by Clarke (1883) in his monograph of the Old World Gesneriaceae, the extent of the morphological variation within *Boea* was questioned only much later by Schlechter (1923). In his opinion, *Boea*, as defined by Clarke (1883), was too heterogeneous and needed to be divided into at least three natural groups: 1. the "proper" *Boea*, i.e. the species from New Guinea, the Solomon Islands and Australia, including the type *B. magellanica* Lam.; 2. the Indo-Malay species, currently ascribed to *Paraboza* (C.B.Clarke) Ridl. and *Kaisupeea* B.L.Burtt; 3. the Chinese group, for which the old generic name *Dorcoceras* was resurrected. Schlechter’s work was not followed by Pellegrin (1926), who wrote a synopsis of the Indochinese Gesneriaceae with no mention of *Dorcoceras*, and by all other authors thereafter. More recently, Burtt (1984) redefined *Boea* and *Paraboza* and abandoned the traditional distinction based on the fruit (twisted in *Boea*, straight in *Paraboza*) in favour of new generic boundaries based on the type of indumentum: simple hairs in *Boea*, ‘arachnoid’ hairs, sometimes intermixed with branched hairs, in *Paraboza*. With this change, many species of *Boea* were transferred to *Paraboza*, a conclusion supported by the molecular phylogenetic work by Puglisi et al. (2011). Studies focusing on the species of *Boea* and *Paraboza* in Malaysia and Thailand, led to the establishment of the segregate genera *Emarhendia* Kiew, A.Weber & B.L.Burtt (Kiew et al., 1997), *Senyamia* Kiew, A.Weber & B.L.Burtt (Kiew et al., 1997) and *Kaisupeea* (Burtt, 2001). *Boea* was eventually left as a genus with two distinct groups: *Boea sensu stricto*, centred in Australasia and including the type *B. magellanica*, and a small group of species from China and the Indochinese region, including Bunge’s *Dorcoceras*. Puglisi et al. (2016) tackled the morphological and genetic diversity observed in *Boea*, leading to the resurrection of *Dorcoceras* to accommodate the distinctive Chinese and Indochinese species with a corolla which is pale lilac, obliquely campanulate, ventricose, with reflexed upper lobes and a broad throat.

The floral characters are very stable across the genus, however species can be easily identified

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through their vegetative features and especially the indumentum. All of the species of Dorcoceras are rosulate and can exhibit one or more of three main types of indumentum: gland-tipped multicellular hairs, eglandular multicellular hairs (both of these hair types variable in length and thickness), and sessile glands. While the sessile glands are characteristic of and exclusive to Dorcoceras wallichii, the multicellular hair types can be hard to distinguish as the tips easily break off in dry specimens.

Towards a revision of the Gesneriaceae for the Flora of Thailand, the genus Dorcoceras in Thailand has been revised. Two new species are described.

MATERIALS AND METHODS

Specimens of Dorcoceras were studied from the herbaria AAU, ABD, BK, BKF, BM, C, E, G, K, K-W, L, MO, P, QBG, SING, TI (codes from Thiers, continuously updated). Additionally, living and spirit material from the Royal Botanic Garden Edinburgh was examined. Measurements of the vegetative parts and of the fruit were taken from dry specimens, while flowers were measured, whenever possible, from fresh, pickled or rehydrated samples. Measurements should be considered accurate to 0.1 mm. Collections without GPS coordinates were georeferenced using Google Earth v. 7.1.1.1580 beta (Google Inc., 2013) or other online resources and gazetteers. Estimated AOO and EOO for the proposed IUCN assessment were calculated in Geocat (Bachman et al., 2011).

TAXONOMIC TREATMENT


Rosulate herbs. Leaves spirally arranged (or opposite in China), petiolate or sessile; lamina with a glandular or eglandular indumentum on the abaxial surface, adaxial surface eglandular hairy or sometimes glabrous. Inflorescence axillary, cymose or at least ending in a cyme. Calyx with five sepals, almost free. Corolla pale purple to purple, obliquely campanulate, ventricose, with a broad throat; upper lobes reflexed. Stamens 2, filaments straight, anthers attached to filaments at point of thecae divergence, coherent; staminodes 3, reduced. Ovary glabrous or with some indumentum, unicellular with 2 parietal placentae, ovules many; stigma bilabiate or capitate. Fruit a twisted capsule, orthocarpic, bivalved, dehiscing longitudinally. Seeds small, brown and elliptic.

Six species from India, Myanmar, China, Thailand, Laos, Cambodia, Vietnam, Philippines and Indonesia. In Thailand four species.

KEY TO THE THAI SPECIES OF DORCOCERAS

1. Lamina glabrous adaxially; inflorescence with paired flowers along the main axis
2. Sessile glands present on the abaxial leaf surface; lamina 6 cm long
3. Rusty brown indumentum on the abaxial leaf surface; lamina 3–11 times as long as wide
4. D. wallichii
3. D. glabrum
1. D. brunneum
2. D. geoffrayi

1. Dorcoceras brunneum C.Puglisi, sp. nov.

Most similar to Dorcoceras wallichii in general facies and particularly in leaf shape but differs in the indumentum colour and lack of glands on the lower surface of the leaf. Also similar to Dorcoceras geoffrayi in the distribution of indumentum on the plant and inflorescence structure, but differing in the rusty brown indumentum on the abaxial leaf surface (pale in D. geoffrayi) and the generally longer, narrower leaves. Type: Thailand, Kanchanaburi, Sai Yok, Wat Phrom Moli Lok, 130 m, 14°12’12”N, 99°8’0”E, 7 Aug. 2012, fl., fr., Middleton, Karaket, Suddee & Triboun 5283 (holotype E; isotypes BK, BKF, E, SING). Fig. 1.

Rosulate herb. Leaves sessile or shortly petiolate, with petiole up to 1 cm long; lamina 4–10 × 0.5–2 cm, 3–11 times as long as wide, narrowly elliptic to spathulate, apex acute, base attenuate, margin irregularly serrulate or finely serrate; adaxial surface mid-green with scattered multicellular, colourless to brown eglandular hairs; abaxial side paler, with an eglandular indumentum of a rusty-brown colour, especially abundant along the veins and by the apex; 2–4 pairs of secondary veins,
smooth or depressed on the adaxial surface, raised on the abaxial, tertiary venation seldom visible. Inflorescence a cyme, 3–12-flowered, with an indumentum of mixed eglandular and gland-tipped hairs; peduncles 9–15 cm long, brown; bracts 2–3 mm long, 0.3–0.5 mm wide, narrowly lanceolate, apex rounded, hisrate on the abaxial surface, glabrous on the adaxial; pedicels 0.3–3 cm long, white, predominantly with gland-tipped hairs and sporadic eglandular indumentum. Calyx with free, lanceolate sepals, 1.5–3 × 0.5–1 mm, apex finely obtuse, with sparse glandular and eglandular hairs on the outer side, glabrous on the inside. Corolla broadly campanulate, thickened at the base of the two upper lobes, pale purple, with the ventral surface white, externally glandular hairy especially laterally and ventrally, glabrous inside; tube 4–6 mm long; upper two lobes rounded, ca 4 × 3.5–4 mm, lateral lobes elliptic, 4–5 × 5–8 mm, ventral lobe elliptic, ca 6 × 9.5 mm. Stamens with filaments arising ca 1.5 mm above the corolla base, white, ca 1 mm long; anthers yellow, more or less rounded, ca 1 mm long and 2.5 mm across; staminodes 3, the laterals less than 0.5 mm long, the central ca 1 mm long. Ovary pale green, ca 3 mm long, with gland-tipped hairs; style white, ca 4 mm long, slightly bent downwards, glabrous; stigma capitate. Capsule strongly twisted, 1.5–2.5 cm long, with scattered glandular hairs. Seeds not seen.

Thailand.—SOUTH-WESTERN: Kanchanaburi [Mueang Kanchanaburi, 2 June 2000, Trīboun 1669 (E); Sadong Game Reserve, ca 100 m, 18 Nov. 1970, Smitinand 11360 (BKf, E)]; Wongkanui, 16 June 1927, Kerr 12948 (cult) (BK, BM); Sai Yok, Wat Phrom Moli Lok, 130 m, 7 Aug. 2012, Middleton et al. 5283 (BKf, E)].

Distribution.—Endemic to Thailand (but not far from the Myanmar border).

Ecology.—On limestone, in mixed deciduous forest.

Figure 1. Dorcoceras bruneum C. Puglisi. A. Habit; B. Flower, front view; C. Flower, side view. Photos of Middleton et al. 5883 by Preecha Karaket (A, C) and David Middleton (B).
Proposed IUCN conservation assessment.—Endangered ENB1ab(iii). The EOO is less than 4000 km², including the uncertain plants mentioned below, or only around 130 km² excluding these. In both cases this EOO would place the distribution into the range for Endangered. Several of the localities are not in protected areas and are subject to disturbance from human activities.

Note.—Two collections from Kanchanaburi and Prachuap Khiri Khan provinces are very similar to Dorcoceras brunnneum, except that, crucially, they both lack the distinctive rusty brown indumentum on the abaxial side of the leaf. They cannot be assigned to Dorcoceras wallichii as they do not present the glands on the lower surface of the leaf which characterise the species. Both collections also differ from Dorcoceras geoffrayi in having a denser and longer leaf indumentum, in the lower leaf ratio and in the generally more oblancoate shape of the leaf. They could be ecological variants of Dorcoceras brunnneum, or perhaps a different species. One of these, the collection Kerr 13506 (BM) from Kao Sai, is the only collection of Dorcoceras made in Prachuap Khiri Khan. The collection Marcán 935 (BM) was collected in Kanchanaburi but no data are available to determine the exact locality.


Rosulate herb. Leaves petiolate, petiole inconspicuous or up to 4 cm long, with a white, long and eglandular indumentum; lamina 2.3–15 × 1.2–6 cm, 1.5–4 times as long as wide, lanceolate, elliptic to oblanceolate, apex acute to broadly acute, base acute to attenuate, margin entire to minutely serrulate; adaxial surface green with hispid, colourless eglandular hairs; abaxial side pale green, with the same indumentum, more abundant along the veins and the margin; 3–5 pairs of secondary veins, sunken in living plants but smooth and invisible in dried specimens on adaxial surface, slightly raised on the abaxial, tertiary venation seldom visible. Inflorescence a cyme, 1–8-flowered, with an indumentum of mixed eglandular and gland-tipped hairs; peduncles 5–12 cm long, with mixed glandular and eglandular hairs; bracts inconspicuous or 1–3 mm long, to ca 0.5 mm wide, ligulate, apex obtuse, tomentose; pedicels 0.3–1.5 cm long, brown, eglandular and glandular hairy, with glandular hairs reaching up to the receptacle; receptacle slightly slanted. Calyx with free, lanceolate to triangular sepals, 1–2 × 0.4–1 mm, apex thickened and narrowly obtuse, eglandular hairy (mixed hair types at the base) outside, glabrous inside. Corolla broadly campanulate, ventricose, thickened at the base of the two upper lobes, pale purple, paler in the throat, glandular hairy outside, glabrous inside; tube 4–6.5 mm long dorsally, 4–6 mm laterally, 4.8–8 mm ventrally; upper two lobes reflexed, elliptic, ca 3–5.5 × 4.5–6 mm, lateral lobes almost round to elliptic, ca 3–7 × 4.5–7.5 mm, ventral lobe round, 4–7 × 4.5–7 mm. Appendages between lips 0.6–1 mm long. Stamens with filaments arising 1–2.5 mm above the corolla base, pale yellow-green, slightly arching, 1–2.2 mm long, 0.4–0.6 mm diameter, with some glandular hairs at the anther’s insertion or glabrescent; anthers yellow, triangular to rounded, ca 1.3–2.5 × 1.8–2.5 mm, coherent at the apex, thecae slightly divergent; staminodes 2, 0.2–0.5 mm long, arising 0.4–1.6 mm above corolla base. Utrik absent or reduced to a 0.1 mm ring. Ovary pale green, 3.3–6 mm long, 1–1.2 mm diameter, with a dense indumentum of predominantly gland-tipped hairs, except at the very base which is glabrous; style pale green, 3–5 mm long, straight, with the same indumentum as the ovary at the base, otherwise glabrous; stigma shallowly lobed, with the lower lip bilobed (thus overall appearing trilobed). Capsule twisted, 1.5–3 cm long, pubescent. Seeds brown, elliptic, ca 0.2 × 0.3 mm.

Thailand.—NORTHERN: Sukhothai [Khiri Mat, Ram Kham Haeng National Park, Khao Luang, 990 m, 24 Oct. 2014, Middleton et al. 5838 (BK); 1181 m, 24 Oct. 2014, ibid., Middleton et al. 5833 (BK, SING); ibid., 1040 m, 24 Oct. 2014, Middleton et al. 5835 (BK, SING); ibid., 2 May 1922, Kerr 5921 (BM); ibid., 10 Sept. 2010, La-ongsri & Norsaengsri 1159 (QBG); NORTHEASTERN: Phetchabun [Nam Nao, Nam Nao National Park, 400 m, 1 Aug. 2015, Middleton et al. 5851 (BK, SING)]; Loei [Na Hao, ca 900 m, 29 July 1995, Nanakorn et al. 4011 (E, QBG)]; Bueng Khan [Bueng Khla, Phu Wua Wildlife Sanctuary, 300 m, 30 July 2008, Poom et al. 1321 (BK)]; ibid., 348 m, 15 June 2010, Suddee et al. 4184 (BK); ibid., 325 m, 5 Aug. 2015, Middleton et al. 5915 (BK, SING)]; EASTERN: Si Sa Ket [Kantaratul, Khao Phra Wihan National Park, Pha Mo I Daeng, 17 Sept. 2004, Poom et al. 4773.
(BKf, E); ibid., 560 m, 26 Aug. 2012, Middleton et al. 5658 (BKf, E, SING); Kantaraluk, Dongrak Range, Chong Bat Lak, 600 m, 19 Aug. 1976, Maxwell 76-575 (AAU, BK?, L).

Distribution.—Cambodia.

Ecology.—On limestone or sandstone rocks on exposed summits or in mixed or dipterocarp deciduous forest with bamboo.

Proposed IUCN conservation assessment.—Least Concern (LC). This is the most widespread species of Dorcoceras in Thailand. Although it is not known from many localities, these are widely distributed and many are in protected areas.

Note.—The key characters of this species are that the leaves are often elliptic (not elongate), both leaf surfaces are densely tomentose with an indumentum of colourless eglandular hairs, and the leaf margin is serrulate to entire.

3. Dorcoceras glabrum C.Puglisi, sp. nov.

Most similar to Dorcoceras brunneum but differing in the structure of the inflorescence and in

Figure 2. Dorcoceras geo/tayi (Pellegr.) C.Puglisi. A. Habit; B. Habit; C. Flower, front view; D. Fruit; E. Flower, side view. Photos of Middleton et al. 5658 (A), Middleton et al. 5835 (B) and Middleton et al. 5833 (C–E). All photos by Preecha Karaket.
Figure 3. *Dorcoceras geoffreyi* (Pellegr.) C. Puglisi. A. Habit; B. Flower, side view; C. Calyx opened out; D. Corolla opened out; E. Pistil, dorsal and side views; F. Fruit.

Rosulate herb. Leaves sessile or petiolate; lamina 3–8.6 × 1–2.5 cm, 2.5–5 times as long as wide, oblancoate, apex acute to obtuse, base attenuate, margin more or less crenulate and undulate; abaxial surface glabrous, abaxial surface densely pubescent with an indumentum of eglandular multicellular hairs; 3–4 pairs of secondary veins, depressed on the adaxial surface and raised on the abaxial, tertiary venation inconspicuous. Inflorescence with an elongated axis with paired flowers along its length and, distally, cymes, 3–6–flowered, pubescent; peduncles 5–15 cm long; bracts 2–4 mm long, to 1 mm wide, apex acute, glabrous on the adaxial surface, pubescent on the abaxial; pedicels 0.4–2 cm long, delicate, with sparse eglandular hairs. Calyx slightly bilabiata with sepals almost completely free, narrowly lanceolate, 2–3 × ca 0.5 mm, apex acute, tomentose on the outer side, glabrous on the inside. Corolla purple, shortly campanulate, bilabiata and glabrous; tube ca 3 mm long; upper two lobes elliptic, ca 4.5 × 3.5 mm, lower central lobe rounded, ca 6 × 6.5 mm, lateral lobes ca 3.5 × 4 mm. Stamens with filaments attached ca 0.5 mm above the corolla base, ca 1 mm long; anthers ca 2 mm wide; staminodes 3, much reduced, less than 0.5 mm long. Utrary glabrous, ca 2 mm long; style ca 2.5 mm long, glabrous; stigma bilabiata. Capsule ca 1.5 cm long, twisted at least dehiscent (only 1 dehisced fruit seen). Seeds elliptic, ca 0.3 × 0.1 mm.

Thailand.—SOUTH-WESTERN: Kanchanaburi [Ban Kao, Pattawee [Khao Patthawi]], 90 m, 18 Nov. 1961, Larsen 8311 (BK); Phetchaburi [Nongyaplong, 10 Sept. 2002, Puudjaä 1117 (BK)].

Distribution.—Endemic to Thailand.

Ecology.—Dry evergreen forest.

Proposed IUCN conservation assessment.—Endangered ENB1lab(iii). Currently only known from two localities, both of which are subject to human disturbance.

Note.—The collection Larsen 8311, here included in D. glabrum, was listed by Xu et al. (2008) as Paraboea ferruginea. By removing this collection, the distribution of Paraboea ferruginea becomes restricted to the Langkawi Islands (Kedah, Malaysia).


Rosulate herbs. Leaves sessile or petiolate; petiole to 1.5 cm long, often merging into blade, reduced or absent, covered in long eglandular hairs; lamina 1.4–6 × 0.6–2.2 cm, 1.8–6 times as long as wide, spathulate or oblanceolate to elliptic, apex acute, eglandular pubescent on the abaxial, tertiary venation inconspicuous. Inflorescence with an elongated axis with paired flowers along its length and, distally, cymes, 3–6–flowered, pubescent; peduncles 0.4–2 cm long, delicate, with sparse eglandular hairs. Calyx slightly bilabiata with sepals almost completely free, narrowly lanceolate, 2–3 × ca 0.5 mm, apex acute, tomentose on the outer side, glabrous on the inside. Corolla purple, shortly campanulate, bilabiata and glabrous; tube ca 3 mm long; upper two lobes elliptic, ca 4.5 × 3.5 mm, lower central lobe rounded, ca 6 × 6.5 mm, lateral lobes ca 3.5 × 4 mm. Stamens with filaments attached ca 0.5 mm above the corolla base, ca 1 mm long; anthers ca 2 mm wide; staminodes 3, much reduced, less than 0.5 mm long. Utrary glabrous, ca 2 mm long; style ca 2.5 mm long, glabrous; stigma bilabiata. Capsule ca 1.5 cm long, twisted at least dehiscent (only 1 dehisced fruit seen). Seeds elliptic, ca 0.3 × 0.1 mm.
as part of a PhD studentship and the National Parks
plants, yellow-orange in herbarium specimens) and
as the type in 1984 but did not distinguish between
the two specimens (one in the general collection,
K-W). A second step lectotypification is
needed, A. von (1833). Enumeratio plantarum quas
in China boreali collegit Dr. Al. Bunge.
Burtt, B.L. (1984). Studies in the Gesneriaceae of
the Old World: XLVII. Revised generic concepts
for Boea and its allies. Notes from the Royal
Botanic Garden Edinburgh 41: 401–452.
Burtt, B.L. (2001). Kaisupeea: a new genus of
Gesneriaceae centred in Thailand. Nordic
Journal of Botany 21: 115–120.
Clarke, C.B. (1883). Cyrtandreae. In: De Candolle, A.
& DeCandolle, C., MonographiaePhanerogamarum
5: 1–303.
genera of Gesneriaceae from limestone of
Peninsular Malaysia. Beitrage zur Biologie der
Pflanzen 70: 383–403.
Pellegrin, F. (1926). Les Gesneracées-Cyrtandrées
d’Indo-Chine. Bulletin de la Société Botanique
Puglisi, C., Middleton, D.J., Triboun, P. & Möller,
M. (2011). New insights into the relationships
between Paraboëa, Trisepalum and Phylloboëa
(Gesneriaceae) and their taxonomic conse-
Puglisi, C., Yao, T.L., Milne, R., Möller, M.,
& Middleton, D.J. (2016). Generic recircumscrip-
tion in the Loxocarpinae (Gesneriaceae), as
inferred by phylogenetic and morphological
Botanische Jahrbücher für Systematik 58:
255–379.
Thiers, B. [continuously updated]. Index Herbariorum:
A global directory of public herbaria and associated
staff. New York Botanical Garden’s Virtual
Xu, Z., Burtt, B.L., Skog, L.E. & Middleton, D.J.

Distribution.— India (Mizoram), Myanmar.
Ecology.— Deciduous forest, in shaded areas
on granite.

Proposed IUCN conservation assessment.—
Least Concern (LC). This species is widespread and,
in Thailand, found in several protected areas.

Notes.— The key characters of this species are
the leaves spirally arranged and sessile; the lamina
elliptic to oblanceolate or spathulate, more than twice
as long as wide in mature leaves; eglandular hairs
in adaxial surface, sessile glands (colourless in fresh
plants, yellow-orange in herbarium specimens) and
e glandular hairs on the abaxial; and margin entire
to crenulate. Burtt (1984) designated a K specimen
as the type in 1984 but did not distinguish between
the two specimens (one in the general collection,
one in K-W). A second step lectotypification is
designated here.

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of the cited herbaria for providing access to the
material.

REFERENCES

Bachman, S., Moat, J., Hill, A.W., de la Torre, J.
assessments with GeoCAT: geospatial conservation
e-Infrastructures for data publishing in biodiversity
science. ZooKeys 150: 117–126. (Version BETA)*

from J.J. Bennett & R. Brown, R. Plantae
Javanicae Rariores, part 1 incl. t. 24, mostly
reprint from part 2: 105–122 and t. 25].


Burtt, B.L. (1984). Studies in the Gesneriaceae of
the Old World: XLVII. Revised generic concepts
for Boea and its allies. Notes from the Royal
Botanic Garden Edinburgh 41: 401–452.

Burtt, B.L. (2001). Kaisupeea: a new genus of
Gesneriaceae centred in Thailand. Nordic
Journal of Botany 21: 115–120.

Clarke, C.B. (1883). Cyrtandreae. In: De Candolle, A.
& DeCandolle, C., MonographiaePhanerogamarum
5: 1–303.

genera of Gesneriaceae from limestone of
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Pflanzen 70: 383–403.

Pellegrin, F. (1926). Les Gesneracées-Cyrtandrées
d’Indo-Chine. Bulletin de la Société Botanique

Puglisi, C., Middleton, D.J., Triboun, P. & Möller,
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Botanische Jahrbücher für Systematik 58:
255–379.

Thiers, B. [continuously updated]. Index Herbariorum:
A global directory of public herbaria and associated
staff. New York Botanical Garden’s Virtual

Xu, Z., Burtt, B.L., Skog, L.E. & Middleton, D.J.

[Thoen, Mae Wa National Park, Mae Wa waterfalls,
350 m, 29 May 2011, Pooma & Phattarahirantricin
7731 (BKF, E); ibid., 28 Aug. 2011, Pooma &
Phattarahirantricin 7760 (BKF)]; Tak [Larn Sang
National Park, 350 m, 29 May 1973, Geesink et al.
5518 (BKF); ibid., 350 m, 29 May 1973, Geesink
et al. 5510 (AAU, BKF, C, L); Sam Ngao, Bhumibol
Dam, 23 Aug. 2010, Norsaensgri 7151 (QBG)];
SOUTH-WESTERN: Kanchanaburi [Si Sawat, Erawan,
2 July 1974, Larsen & Larsen 34018 (AAU)].

Distribution.— India (Mizoram), Myanmar.
‘Habenaria limprichtii’ (Orchidaceae) in Thailand, encompassing two distinct species

HUBERT KURZWEIL

ABSTRACT

A Habenaria species in northern Thailand is widely known as H. limprichtii Schltr., but most specimens are in fact referable to H. yuana Tang & F.T.Wang. This incorrect identification was first pointed out in one Thai specimen by Ormerod & Sathish Kumar (2008) in a study of Myanmar orchids, and is confirmed in re-examinations of a large number of Thai specimens in the present study. However, the study revealed that true H. limprichtii also occurs in Thailand, although it is very rare. The two species are superficially similar but are distinct in details of their flower morphology. Descriptions, a key to the species, and illustrations are provided.

KEYWORDS: Habenaria yuana, H. limprichtii, misapplied name, northern Thailand.

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INTRODUCTION

A large-flowered and rather attractive Habenaria species in northern Thailand is widely known as H. limprichtii Schltr. However, it was recently shown that this name is incorrectly applied to the species as the plant is actually referable to H. yuana Tang & F.T.Wang (as originally pointed out by Ormerod & Sathish Kumar, 2008: 78). The incorrect name H. limprichtii is the result of a mis-identification that was made by G. Seidenfaden (Seidenfaden & Smitinand, 1965; Seidenfaden, 1977), and this name was subsequently adopted by all authors working on the group (including the treatment of Habenaria for Flora of Thailand). In addition, the name H. limprichtii has sometimes also been incorrectly applied to specimens of H. yuana from China, Myanmar and Vietnam. All available specimens of Thai ‘Habenaria limprichtii’ were here re-examined and almost all of them were identified as H. yuana. But this examination revealed that true H. limprichtii also occurs in Thailand (although it is very rare in the country), thus indicating that ‘H. limprichtii’ in the sense of Seidenfaden (1977) encompassed two different species, i.e. is a mixture of two species.

As the incorrect name is still widely applied to this plant, I am publishing this article to clarify the identity of the Thai specimens of ‘Habenaria limprichtii’. All cited specimens have been seen by the author (except for the type specimen of H. oligochista Schltr.).

KEY TO THE SPECIES

Petals with prominent basal anterior lobe; flowers green, yellow-green or greenish white, rarely petals and lip partly or entirely white; lobules of lip side lobes 6−10

1. H. yuana

Petals obliquely oblong, basally not dilated; sepals green or greenish white, petals and lip white; lobules of lip side lobes 6−10

2. H. limprichtii

DESCRIPTIONS


— Habenaria limprichtii auct., non Schltr.: Seidenf. & Smitinand, Orchids Thailand: 727. 1965; Seidenf., Dansk Bot. Ark. 31(3): 82, fig. 46. 1977; Seidenf., Opera Bot. 114: 57. 1992; Nanakorn & Watthana,

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Figure 1. Habenaria yuana Tang & F.T.Wang in its natural habitat in Chiang Rai Province, Thailand. Photos by Peter O’Byrne.


Terrestrial herb, deciduous, erect, (15–)17–60 (–74) cm tall, entirely glabrous except for sometimes the tips of the leaves and some of the floral parts as indicated below. Tuber oblong, fleshy. Cataphylls 3, tubular, enveloping the stem up to 70 mm high. Leaves (3–)5–7, ovate, ovate-elliptic or lanceolate-elliptic, acute or acuminate, mucronate, with three pronounced veins, 6–14(–20) × 1.5–4 cm, spreading, cauleine, scattered along the stem, basally amplexicaul, margins entire or papillose, surface usually glabrous but rarely sparsely hairy near the tip. Sterile bracts of inflorescence axis not present. Inflorescences lax to semi-dense, with (2–)4–10 flowers; rachis (3–)5–17 cm long; floral bracts lanceolate, apex acuminate, longer than the pedicel plus the ovary, 22–45 × 6–12(–19) mm, margins papillose. Flowers large, 34–43(–55) mm in diameter, green, yellow-green or greenish-white, rarely petals and lip partly or entirely white. Ovary plus pedicel cylindric-fusiform, 19–33 mm long, with papillose or shortly hairy keels. Sepals subacute to acuminate, glabrous. Median sepal erect, elliptic or oblong-elliptic, 5-veined, concave, 19–28 × 8–15(–20) mm; lateral sepals spreading and distal parts slightly recurved, obliquely elliptic-lanceolate to obliquely oblong, 3–5-veined, 19–27 × 6–7.5(–9) mm. Petals erect, forming a hood with the median sepal, obliquely subovate-falcate and basally strongly dilated with a broadly rounded lobe on the anterior side, 5–6-veined, 20–23 × 8–11 mm, lamina glabrous but anterior margin slightly ciliate. Lip 22–35 × 15–20 mm, deeply 3-lobed, with an undivided stalk 9–12 mm long, spurred, lobes more or less ciliate; midlobe oblong or linear, spreading or somewhat deflexed, 15–18(–25) × 1.3–2 mm; side lobes linear or oblong, 17–22 × 1–1.9 mm, outer margin with 10 or more filiform side branches 3–7 mm long, side branches sometimes branched further; spur cylindrical and apically clavate, shorter than the ovary, 14–25 mm long, glabrous. Column 3–5 mm tall; anther thecae positioned on the far corners of an elongate horseshoe-shaped connective to 15 mm wide, anther locules small, about 3 mm long, anther canals 3–4 mm long, slender, sharply bent upwards; stigmatic processes linear, clavate, to 7 mm long, sharply bent upwards. Capsule not seen.

Thailand [22 collections examined].—NORTHERN: Chiang Mai [Doi Suthep, 1325 m, 20 July 1921, Kerr 92 (K); idem., 1650 m, 5 Aug. 1958, Sørensen et al. 4557 / (BKF, C); idem., 1550 m, 9 Sept. 1958, Sørensen et al. 4855 (C); idem., 1500 m, 19 Aug. 1963, Smitinand & Sleumer 8300 (BKF); idem., 1450 m, 25 July 1988, Måkweil 88-91 / (L); idem., 1200–1400 m, 19 Sept. 1995, Larsen et al. 46681 (AAU); idem., without date, Seidenfaden & Smitinand 2705 (C [spirit]); Doi Pui, 1400 m, 14 July 1989, Songkakul 67 (BKF [spirit]); Mae Rim, 30 Aug. 1996, Nanakorn et al. 6981 (QBQ); idem., 1400 m, 2 Aug. 2007, Watthana 2418 (QBQ [spirit]); Doi Phenom Pok, 1885 m, 25 Aug. 2006, Dhamapong 78 (BKF [spirit]); idem., 1657 m, 30 Sept. 2006, Dhamapong 97 / (QBQ, BKF); Doi Pa Kao, ca 1800 m, 2 Sept. 1931, Garrett 715 (AMES, BK, K, P); Ang Khang, 1780 m, 23 Sept. 2007, Tritarsarsii et al. 319 (BKF [spirit]); Hot District, 1100 m, 8 July 1995, Pooma 1034 (BKF); idem., 8 Sept. 1995, Pooma s.n. (BKF [spirit]); Doi Inthanon National Park, 2200 m, 6 Sept. 1998, Sukasathan 1199 (QBQ [spirit]); idem., 2300 m, 22 Sept. 2001, Sukasathan 3085 (QBQ); idem., 2000 m, 7 Sept. 2010, Watthana 3550 (QBQ [spirit])); Chiang Rai [Wiang Kaen District, 1485 m, 23 Oct. 2012, La-onsri et al. 2489 (QBQ); idem., 1440 m, Aug. 2015, O’ByrneCHR001, photographic record]; Phitsanulok [Phu Soi Dao National Park, 1600 m, 14 Aug. 2000, Sukasathan 2707 (QBQ)].

Distribution.— Myanmar (Chin and Shan States, Mandalay Region), SW China (S Yunnan, W Sichuan), Vietnam.

Ecology and phenology.— In Thailand the species is found in open areas in pine and broad-leaved forest as well as in grassland at an elevation of 1100–2300 m, and is in flower during the rainy season from July to September (once recorded in October).

Conservation.— The species is known from at least 22 collections made in northern Thailand in Chiang Mai, Chiang Rai and Phitsanulok Provinces,
with several of them situated inside conservation areas. It is here assumed that several of the Thai ‘Habenaria limprichtii’ which were not available for the present re-examination in fact also belong to H. yuana. The species also does not fall into the threatened category in neighbouring Myanmar, where several localities are also situated inside conservation areas (Natma Taung National Park in Chin State, Popa Mountain Park in Mandalay Region). Therefore the conservation status Least Concern (LC) is proposed here.

Previously, the conservation status of the species has been assessed as Vulnerable A2c (http://www.iucnredlist.org/search; accessed 16 Sept. 2016) although a note ‘needs updating’ suggests that this status needs to be reviewed.

Etymology. Named in honour of the collector, T.T. Yu.

Notes. This plant was originally referred to Habenaria oligoschista (Seidenfaden & Smitinand, 1959: 44), based on an identification at Kew by V.S. Summerhayes. Following the advice given by Prof. Tang it was later re-identified as H. limprichtii Schltr. (Seidenfaden & Smitinand, 1965: 727). In the latter publication it was also stated that the two species hardly differ. Interestingly, at one time H. oligoschista had indeed merely been considered a variety of H. limprichtii (Soó von Bere, 1929: 372). Currently H. oligoschista and H. limprichtii are considered conspecific (Chen & Cribb, 2009: 153; Govaerts et al., 2016). The name H. limprichtii, which had been introduced for this plant by Seidenfaden & Smitinand (1965), was adopted by several students of the Thai orchid flora, such as Seidenfaden (1977), Nanakorn & Watthana (2008) and Kurzweil (2009, 2011).

However, both Habenaria limprichtii and H. oligoschista differ markedly from the Thai plants in the shape of their petals, which are obliquely oblong in H. limprichtii and H. oligoschista, whereas almost all Thai plants have basally strongly dilated petals with a prominent anterior lobe. One of the Thai collections (Garret 715) was therefore identified as H. yuana Tang & F.I. Wang in a publication on Myanmar orchids (Ormerod & Sathish Kumar, 2008: 78). Unfortunately this publication was apparently overlooked by most botanists working on the orchids of Thailand. A re-examination of all of the available herbarium and spirit material in the present study confirmed this identification also for a number of other Thai specimens. No significant variation in the petal shapes of H. yuana and H. limprichtii could be found, and it is therefore concluded that the two species are distinct, and that the commonly used name H. limprichtii is incorrectly applied to this species. Interestingly, the study also revealed the occurrence of true H. limprichtii in Thailand (see below).

Additional distinguishing features between H. yuana and H. limprichtii are the flower colour (green, yellow-green or greenish white, petals and lip rarely partly or entirely white in H. yuana; sepals green or greenish white, petals and lip apparently consistently white in H. limprichtii) and the number of filiform lobes of the lip side lobes (10 or more in H. yuana; 6–10 in H. limprichtii). There are also several differences between the two species in other sets of characters but these are tentative and overlap. A comparison of some diagnostic features of the two species is given in Table 1.

In Thailand, Habenaria yuana is far more common than H. limprichtii. Twenty-two out of 24 specimens of H. limprichtii-lookalikes examined here were identified as belonging to the former species. In contrast, only one out of these 24 specimens was correctly identified as H. limprichtii while the identification of a second specimen is uncertain.

Among the other Habenaria species with basally dilated petals and a 3-lobed lip with laciniate side lobes, the widespread Himalayan H. aretiina Hook.f. differs by its adaxially pubescent petals. H. intermedia D.Don, another widespread Himalayan species, also shares the basally dilated petals but differs by few-flowered inflorescences, long lip spur (7–8.5 cm) and anther with a narrow connective.


<table>
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<tr>
<td>leaf size</td>
<td>6–14(–20) × 1.5–4 cm</td>
<td>4–10 × 1.5–3 cm</td>
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<tr>
<td>flower number</td>
<td>(2–)4–10</td>
<td>(1–3)–20</td>
</tr>
<tr>
<td>floral bracts</td>
<td>lanceolate, 22–45 × 6–12(–19) mm</td>
<td>ovate-lanceolate or elliptic, 30–40 × ca 10 mm</td>
</tr>
<tr>
<td>flower colour</td>
<td>flowers green, yellow-green or greenish white, petals and lip rarely partly or entirely white</td>
<td>sepals green or greenish white, petals and lip white</td>
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<tr>
<td>length of ovary plus pedicel</td>
<td>19–33 mm</td>
<td>18–25 mm</td>
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<tr>
<td>sepal length</td>
<td>19–28 mm</td>
<td>18–21 mm</td>
</tr>
<tr>
<td>petal shape</td>
<td>obliquely subovate-falcate, with prominent basal anterior lobe</td>
<td>obliquely oblong</td>
</tr>
<tr>
<td>petal size</td>
<td>20–23 × 8–11 mm</td>
<td>18–22 × 4–5.5 mm</td>
</tr>
<tr>
<td>length lip midlobe</td>
<td>15–18(–25) mm</td>
<td>14–15 mm</td>
</tr>
<tr>
<td>lobules of lip side lobes</td>
<td>10 or more</td>
<td>6–10</td>
</tr>
<tr>
<td>lip spur length</td>
<td>14–25 mm</td>
<td>18–30 mm</td>
</tr>
<tr>
<td>anther connective width</td>
<td>to 15 mm</td>
<td>8–12 mm</td>
</tr>
<tr>
<td>known distribution</td>
<td>Thailand, Myanmar, SW China, Vietnam</td>
<td>SW China, Thailand</td>
</tr>
<tr>
<td>flowering time in Thailand</td>
<td>beginning of July to end of September; once recorded in October</td>
<td>first half of July</td>
</tr>
</tbody>
</table>

Very similar to Habenaria yuana but differing in its flower structure and colour. The most distinctive difference between the two species are the petals which are obliquely oblong and 4–5.5 mm wide in H. limprichtii, but subovate-falcate and basally strongly dilated to 8–11 mm in H. yuana. While the sepals are green or whitish green in both species, petals and lip are apparently consistently white in H. limprichtii, and greenish or rarely partly or entirely white in H. yuana. The lip side lobes differ somewhat in the two species, having 6–10 filiform lobules in H. limprichtii as opposed to 10 or more in H. yuana. Many specimens of H. limprichtii also differ from H. yuana by smaller but more numerous flowers, by longer lip spurs and a narrower anther connective.

Thailand—[2 collections examined].—NORTHERN: Chiang Mai [Doi Chiang Dao, 2100 m, 9 July 1998, Pongamornkul 393 (QBG)]; Nan [Doi Phu Kha National Park, 1800 m, 4 July 1999, Srisanga et al. 871 (QBG), identification uncertain].

Distribution. SW China (Yunnan, Sichuan, Hubei, Guizhou).

Ecology and phenology.— In Thailand occurring in evergreen montane forest at 1800–2100 m, the two collections known so far were found in flower in July.

Conservation.— Apparently rare in Thailand as seen by the very small number of collections. As only two collections are available (only one of them reliably identified), a conservation assessment using IUCN categories is not attempted here.

Etymology. The species is named after its collector, Dr W. Limpricht.

Notes. The identification of the species is based on spur length, petal shape and hairiness, and connective width (after Chen & Cribb, 2009; Pearce & Cribb, 2002; as well as the protologues and type specimens of this and the similar species).

Only the collection Pongamornkul 393 is here reliably identified. The single plant in the second collection, Srisanga et al. 871, is a depauperate, small specimen with a single flower. Although it shares the flower size, the obliquely oblong petals and the lip spur length with Habenaria limprichtii, the column was not examined in order not to dissect the single flower, and the identification is therefore uncertain.
A FEW NOTES ON THE HABENARIA PECTINATA GROUP

Habenaria yuana and H. limprichtii belong to a group of about eight or nine species related to H. pectinata D.Don, which are concentrated in the Himalayas and their foothills in northern Myanmar and south-western China. The species belong to H. sect. M multipartitae Kraenzl., characterised by entire petals and 3-lobed lip with laciniate side lobes. The delimitation of the species and their relationships are poorly understood as yet, and a thorough study based on morphometric and molecular data is much needed. It is possible that such a study may eventually show that some of the species should be considered merely forms of H. pectinata (see also Seidenfaden, 1977: 82), which was in some species already proposed by Kraenzlin (1898: 405), Finet (1901: 531), Soó von Bere (1929: 373–374) and Pradhan (1976: 72).

Two subgroups within the Habenaria pectinata group, a long-spurred and a short-spurred group, were distinguished by Seidenfaden (1977: 84). Spurs longer than 40 mm characterise the long-spurred group which comprises H. intermedia D.Don, H. leucopecten Schltr. (now considered a synonym of H. davidii Franch.; Govaerts et al., 2016; Chen & Cribb, 2009), H. chloropecten Schltr. (now also considered a synonym of H. davidii; Govaerts et al., 2016; Chen & Cribb, 2009) and H. arietina Hook.f. On the other hand, spurs of up to 26 mm characterise the short-spurred group comprising H. triquetrà Rolfe, H. limprichtii, H. ensifolia Lindl. (accepted by Govaerts et al., 2016; considered a synonym of H. pectinata by Chen & Cribb, 2009, and Pearce & Cribb, 2002), H. yuana, H. oligoschista (now considered a synonym of H. limprichtii; Govaerts et al., 2016; Chen & Cribb, 2009), H. pectinata and H. mairei Schltr.

On the basis of their examination of a large number of specimens in the Himalayan region, Pearce & Cribb (2002: 152) distinguished three groups within the region: (a) the H. pectinata group with glabrous petals and a short, clawed lip base; (b) the H. arietina group with linear-lanceolate leaves, basally gibbous pubescent petals and upturned linear stigmatic processes; and (c) the H. intermedia group with ovate-elliptic leaves, basally flat pubescent petals and longer, hastate, projecting stigmatic processes. Pearce & Cribb (2002) did not list the species belonging to these groups.
As pointed out by Ormerod (Ormerod & Sathish Kumar, 2008; Ormerod, pers. comm.), the basal anterior petal lobes are critical in the systematics of the Habenaria pectinata group; therefore a future taxonomic treatment of the group will also need to consider this character.

Molecular studies of the group with complete sampling are not available as yet. As could be expected, in the only study which includes a species of the Habenaria pectinata group, the Asian alpine H. intermedia is resolved as sister to the African montane H. praestans Rendle (Jin et al., 2014) (both species belong to H. sect. Multiflora).

ACKNOWLEDGEMENTS

I express my sincere gratitude to Paul Ormerod for various advice. The following herbaria were consulted during the preparation of the manuscript: AAU, BKF, C, K, P, QBG, WU, and I would like to thank their curators for providing access to their collections and for sending material on loan. In particular, help and assistance during recent personal visits were provided by Dr Prachaya Srisanga (QBG), Drs Rachun Pooma, Nannapat Pattharakitinrintranic and Somran Suddee (all three at BKF) and Dr Walter Till (WU). Peter O’Byrne is thanked for giving me permission to use his photographs. I am furthermore indebted to Mag. Susanne Sontag and Serena Lee for help with literature and photo plates, respectively.

REFERENCES


The correct name of *Croton roxburghii* N.P.Balakr., nom. illeg. (Euphorbiaceae)

HANS-JOACHIM ESSER

ABSTRACT

The complicated nomenclatural situation surrounding the names of the widespread species currently known as *Croton roxburghii* N.P.Balakr. is discussed, and its earlier homonym *C. mangelong* Y. I. Chang is established as the valid name to be used. The confusion with other, superficially similar species is discussed and important differences listed. A lectotype for *C. roxburghii* is designated.

KEYWORDS: Baliospermum, Chrozophora, nomenclature, taxonomy, typification.

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INTRODUCTION

One of the most widespread species of *Croton* L. (Euphorbiaceae) in South-East Asia, including Thailand, is currently known as *Croton roxburghii* N.P.Balakr. Unfortunately this name, although widely used recently, is illegitimate.

The species is distributed from India through Indochina (including Thailand) to southern China. It had been originally described as *C. oblongifolius* Roxb. However, this name from 1832 was recognized as illegitimate by Balakrishnan (1962), being a later homonym of *C. oblongifolius* Delile from 1814. Although this latter name is now classified under the genus *Chrozophora* A. Juss., it nonetheless has nomenclatural priority. Consequently, Balakrishnan replaced Roxburgh’s name with *C. roxburghii* N.P.Balakr. This latter name has been used in several recent publications, including the Flora of Thailand (Esser, 2005) and Forest Herbarium (2001).

It was recently recognized that *C. roxburghii* is illegitimate too as it is predated by *Croton roxburghii* Wall. This latter name was validly published in an obscure publication by Wallich (1840), a letter that had been printed and distributed in several copies and must therefore be considered a valid publication, but had long been overlooked. This earlier homonym is a replacement name for the likewise illegitimate *C. polyandrus* Roxb. (non Spreng.), but is actually a synonym of *Baliospermum solanifolium* (Burm.) Suresh. Because of this unfortunate and complicated nomenclatural situation, the name *C. roxburghii* was not used in the Flora of China (Li & Esser, 2008), but left unsolved. A replacement name for this widespread species, namely *C. virbalae* M.R. Almeida, had been published in 2003, but it was widely overlooked. This name was validly published in two publications, in the Flora of Maharasthra and in the Journal of the Bombay Natural History Society (Almeida, 2003; Almeida et al., 2003). The exact publication date of this volume of the Flora of Maharasthra is not currently known (K. Gandhi, pers. comm.), and the journal paper (which is a summary of distribution patterns and nomenclatural changes in the Flora of Maharasthra) is dated August–December 2003.

In the Flora of China (Li & Esser, 2008), it was mentioned that *C. mangelong* Y. I. Chang might be identical to *C. roxburghii* N.P.Balakr. After studying the protologue and holotype image of *C. mangelong* this can now be confirmed. *Croton mangelong* had been proposed as a new species characterized by scattered, flat and lepidote trichomes and compared with *C. cascarilloides* Raesusch. and *C. roxburghii* (Chang, 1983). From the former the species is clearly distinct in several characters, such as serrate leaves that are much larger and abaxially not silvery-whitish. To distinguish it from *C. roxburghii* only a

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A single difference was cited, namely ciliate trichomes, referring to their apically slightly free radii. This falls within the range of variation of *C. roxburghii*, and the names are indeed synonymous.

The situation of *C. roxburghii* N.P.Balakr. was complicated further in that the species had been synonymized with two older names, i.e. with *C. persimilis* Müll.Arg. (by, e.g., Pooma & Suddee, 2014) and with *C. laevigatus* Vahl (by, e.g., Govaerts et al., 2000). This might have happened because the unpublished herbarium name *C. laevigatus* Wall. is indeed referable to this species, and while *C. persimilis* Müll.Arg. was based on a mixed concept that included several species, the name was later restricted to plants from Sri Lanka by lectotypification (Philcox, 1997).

The three species are, although superficially similar, distinct taxa (see also Li & Esser, 2008). Differences are summarized in Table 1.

**TAXONOMY**


**ACKNOWLEDGMENTS**

My due thanks are to Liu Ende and Xu Zhoufeng of KUN for providing the type image and permission to publish it, and to Paul Berry (MICH) and an unknown reviewer who helped to improve the manuscript.

Table 1. Comparison of *C. mangelong, C. laevigatus* and *C. persimilis*

<table>
<thead>
<tr>
<th></th>
<th><strong>Croton mangelong</strong></th>
<th><strong>Croton laevigatus</strong></th>
<th><strong>Croton persimilis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distribution</strong></td>
<td>widespread (India to China)</td>
<td>endemic to Hainan (China)</td>
<td>endemic to S India and Sri Lanka</td>
</tr>
<tr>
<td><strong>Trichome type</strong></td>
<td>peltate with mostly fused radii</td>
<td>stellate with free radii</td>
<td>peltate with mostly fused radii</td>
</tr>
<tr>
<td><strong>Leaf margin</strong></td>
<td>distinctly serrate</td>
<td>subentire</td>
<td>distinctly serrate</td>
</tr>
<tr>
<td><strong>Inflorescence</strong></td>
<td>scattered, trichomes pale-hyaline (not yellowish)</td>
<td>dense and persistent, trichomes pale yellowish</td>
<td>dense and persistent, trichomes pale yellowish</td>
</tr>
</tbody>
</table>
Figure 1. Holotype of Croton mangelong
REFERENCES
Asplenium minutifolium (Aspleniaceae), a new species from Thailand

HIRONOBU KANEMITSU1*, SHUICHIRO TAGANE1, SOMRAN SUDDEE2, SUKID RUEANGRUEA & TETSUKAZU YAHARA1

ABSTRACT
A new species of Asplenium (Aspleniaceae), A. minutifolium Kanem. & Tagane, from Phu Kradueng National Park, Loei Province, Northeast Thailand and Khao Yai National Park, Nakhon Nayok Province, Central Thailand, is described and illustrated. This species can be distinguished from all similar species in East and South-East Asia by its simple and small lamina (1–5 × 0.3–0.7 cm), small and entire pinnae (1–4 × 0.8–2.5 mm), reflexed pinna arrangement (>90° from the midrib) in the lower 2/3 of the lamina and a sori arrangement that is almost always arranged in a single row on the basiscopic vein.

KEYWORDS: Asplenium, Aspleniaceae, Pteridophyte, Fern, new species, Phu Kradueng National Park, Khao Yai National Park, Thailand.
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INTRODUCTION
The genus Asplenium L. (Aspleniaceae) is one of the largest genera of the Pteridophyta, comprising about 700 species. The species are widely distributed, from temperate to tropical regions (Boonkerd & Sukasathan, 2009; Chang et al., 2013), are adapted to various environments, and are often epiphytic or epipetric (de Winter & Amoroso, 2003). In Thailand, 38 Asplenium species have been recorded (Boonkerd & Pollawatn, 2000; Boonkerd, 2009; Lindsay & Middleton, 2012 onwards; Lindsay et al., 2013).

During a botanical survey in Phu Kradueng National Park in June 2015, we discovered an unknown species of Asplenium in a rock crevice at the top of the mountain. The plant is characterized by very small pinnae, obscure venation and asymmetrically arranged sori. In these characters, it differs from all the known Asplenium species in Thailand and the surrounding regions, including Cambodia, China, Japan, Korea, Laos and Vietnam. In addition, when we examined material of Asplenium at the Kyoto University Museum (KYO), we also found specimens of the same species collected from Khao Yai National Park, Nakon Nayok Province, Central Thailand.

Here we describe and illustrate it as a new species, Asplenium minutifolium Kanem. & Tagane, based on our newly collected materials as well as the herbarium specimens at KYO. In addition to morphological examination, DNA sequences can be extremely helpful for delimiting species (Hebert & Gregory, 2005; Dick & Webb, 2012). We sequenced the plastid region rbcL following the recommendation of the CBOL Plant Working Group (2009).

MATERIALS AND METHODS
Morphological observations
We compared the specimen collected from Phu Kradueng National Park with dried specimens in the herbaria BK, BKF, KYO and TNS and with digitized specimen images available on the web pages of JSTOR Global Plants (http://plants.jstor.org/). We compared the morphology of Asplenium minutifolium with that of all similar species in the region using taxonomic literature (Iwatsuki, 1995; Lin & Viane, 2013) and the website of Ferns of Thailand, Laos and Cambodia (Lindsay & Middleton, 2012 onwards; http://rbg-web2.rbge.org.uk/thaiferns/index.htm).

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DNA barcoding

DNA amplification and sequencing were performed according to published protocol (Kress et al., 2009).

DESCRIPTION

Asplenium minutifolium Kanem. & Tagawa, sp. nov.

Similar to Asplenium kiangsuense Ching & Y.X.Jing of southern China in size and shape of lamina, but differs in having a narrower lamina (ca 0.7 cm wide in A. minutifolium vs. ca 1 cm wide in A. kiangsuense), wingless rachis (vs. 2 slightly raised lateral wings), smaller pinnae (1–4 × 0.8–2.5 mm vs. 4–5 × 4–5 mm), generally fewer sorī per pinna (1–3(–4) vs. 3–5), and in the sorī arrangement (usually arranged in a row vs. arranged oppositely). Also similar to Asplenium siamense Tagawa & K.Iwats. of North-East Thailand, but can be distinguished by its simple pinnae at the tip of lamina (vs. lamina forked several times at the tip), thicker pinnae (thickly papery vs. thinly papery), reflexed pinna arrangement in lower part (vs. divaricate around lamina), and pinnae with entire or slightly undulate margins (vs. shallowly lobed (lobes to ca 1 mm long)), (Table 1). — Type: Thailand. Loei Province, Phu Kradueng National Park, Lom Sak Cliff, alt. 1292 m, 16°51′37.44″N, 101°43′40.1″E, 12 June 2015, Kanemitsu et al. 143/36 (holotype BKF!, isotype TNS!). Figs. 1–2.

Epipetric. Rhizome short, ascending, bearing fronds in a tuft, densely scaly at apex; scales linear, up to 2 mm long, 0.2 mm wide, blackish, clathrate, more or less membranous at margin. Stipe 0.4–2 cm long, dark purple, polished, flat adaxially, rounded abaxially, glabrous but scaly at base; rachis dark purple, polished, flat adaxially, rounded abaxially, wingless throughout, almost glabrous except for a few small fibrous scales near base. Lamina simply pinnate, oblong to oblong-lanceolate, 1–5 × 0.3–0.7 cm. Pinnae thickly papery, glabrous, 7–20 pairs, sub-sessile to shortly stalked (stalks ca 0.3 mm long), lower 2/3 pinnae reflexed against rachis (at an angle of (90°–)110–120° (~140°) from the midrib), subopposite or alternate up to 1.7 mm distant, sub-flabellate to trapeziform-oblong, 1–4 × 0.8–2.5 mm, base asymmetrical, truncate to cuneate on acroscopic side, cuneate to acute on basiscopic side, margin entire but slightly undulate on the upper edge; veins all free, simple or forked, not reaching the margin, obscure on both surfaces but the ends of the veins can be visible on the upper surface of pinnae (possibly as hydathodes). Sorī 1–3(–4) per pinna, usually 1–3 sorī on the acroscopic veins only (arranged in a row with their indusia opening towards the pinna apex), rarely with 1 additional sorus on the basal basiscopic vein (its indusium opening towards the upper edge of the pinna) indusia ca 1 × 0.3 mm, membranous, (sub)entire, glabrous, persistent; sporangia glabrous.


Ecology.— In Phu Kradueng National Park, Asplenium minutifolium occurs in a semi-shaded and damp rock crevice that is ca 50 cm wide and 10 cm deep, on the plateau at an altitude of ca 1300 m. Associated fern and lycophyte species include Aglaomorpha rigida (Sw.) Hovenkamp & S.Linds., Goniophlebus subauriculatum (Blume) C.Presl, Oleandra undulata (Wild.) Ching, Pyrosia lingua (Thunb.) Farw. var. heteractis (Mett. ex Kuhn) Hovenkamp, and Selaginella siamensis Hieron. Other than the elevation, nothing is known about the ecology of this species at Khao Yai National Park.

Etymology.— The species epithet “minutifolium” refers to the very small lamina and pinnae of this species.

Preliminary conservation assessment.— Critically Endangered (CR D) (IUCN 2012). Only five individuals in a single population occupying < 1 m² were found on the plateau of Phu Kradueng, despite an extensive search for more plants at the same site and other sites in the summit area of Phu Kradueng National Park. Moreover, in view of the fact that the plateau of Phu Kradueng has been well botanized and that there are no other specimens of this species in BK and BKF, A. minutifolium is likely very rare. Because of the plateau of Phu Kradueng is very popular for tourists, specific conservation
efforts are desirable to protect the population and habitat of this species. At Khao Yai National Park only a single collection is known from about 40 years ago but the lack of collections from an area otherwise well collected would also suggest very few individuals are present there.

We estimate that there are fewer than 50 individuals of this species and hence apply category D of CR for the species.

**DNA Barcode.**— GenBank accession No. LC147386 (rbCL). We sequenced material from Kanemitsu et al. T4736.

**Table 1. Comparison of Asplenium minutifolium with the two most similar Asian species.**

<table>
<thead>
<tr>
<th>Characters</th>
<th>A. minutifolium</th>
<th>A. kiangsuense*1</th>
<th>A. siamense*2, 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridges on rachis</td>
<td>Absent (flat adaxially)</td>
<td>Absent or with 2 slightly raised lateral ridges</td>
<td>Absent (flat adaxially)</td>
</tr>
<tr>
<td>Lamina size</td>
<td>1–5 × 0.3–0.7 cm</td>
<td>3–10 × ca 1 cm</td>
<td>3–8 × 1.2 cm</td>
</tr>
<tr>
<td>Lamina at tip</td>
<td>Simple</td>
<td>Simple</td>
<td>Forked several times</td>
</tr>
<tr>
<td>Pinna</td>
<td>Thickly papery</td>
<td>Papery</td>
<td>Thinly papery</td>
</tr>
<tr>
<td>Pinnac size</td>
<td>1–4 × 0.8–2.5 mm</td>
<td>4–5 × 4–5 mm</td>
<td>3–7 × 2–4 mm</td>
</tr>
<tr>
<td>Pinna arrangement in lower 2/3 part of frond</td>
<td>Reflexed (at an angle of (90°–)110–120°–140° from midrib)</td>
<td>Divaricate (at an angle of ca 90° from midrib)</td>
<td>Divaricate *(at an angle of ca 60–90°–100° from midrib)</td>
</tr>
<tr>
<td>Pinna shape</td>
<td>Sub-lobate to sub-elliptic</td>
<td>Elliptic to trapeziform-oblong</td>
<td>Ovate-elliptic to sub-triangular</td>
</tr>
<tr>
<td>Acrosscopic edge of pinna</td>
<td>Entire but slightly undulate</td>
<td>Entire to sinuate</td>
<td>Shallowly lobed</td>
</tr>
<tr>
<td>Sori per pinna</td>
<td>1–3 on acrosopic veins, rarely 1 on basal basiscoic vein</td>
<td>2 or 3 on both basiscoic and acrosopic veins</td>
<td>3–5 per pinna, 2–3 on acrosopic veins, 2 on basiscoic veins.</td>
</tr>
<tr>
<td>Distribution</td>
<td>Thailand (Phu Kradueng National Park and Khao Yai National Park)</td>
<td>China (Anhui, Fujian, Hunan, Jiangsu, Jiangxi, Yunnan, Zhejiang)</td>
<td>Thailand (North-Eastern: Loei)</td>
</tr>
</tbody>
</table>

*1 from Lin & Viane (2013).


*3 from the specimen Shimizu et al. T2757 (Phu Kradueng National Park, alt. 1250–1280 m, KYO!)

**ACKNOWLEDGEMENTS**

We are grateful to the manager and staff of Phu Kradueng National Park for providing us with a permit and the opportunity to conduct a field survey in the protected area. We thank the director and staff of the Forest Herbarium (BKF) for their support on our field trip and for their help in the herbarium. We thank the herbaria BK, KYO and TNS for giving us the opportunity to check their specimens. We also thank Keiko Mase (Kyushu University) for DNA sequence data, Hidetoshi Nagamasu (KYO) for his helpful comments on the manuscript, and two anonymous reviewers for their corrections and suggestions. This study was supported by the Environment Research and Technology Development Fund (S9 & 4-1601) of the Ministry of the Environment, Japan and partially supported by MEXT/JSPS KAKENHI Grant Number JP15H02640.

**REFERENCES**


Figure 1. Asplenium minutifolium Kanem. & Tagane, sp. nov. A. whole plant (hydathodes are visible at the margin of pinnae on upper surface); B. a scale from rhizome; C. undersurface of pinna with four sori (three sori on acroscopic veins with their indusia opening towards the pinna apex and one sorus on the basal basiscopic vein with its indusium opening towards the upper edge of the pinna). Most pinnae have fewer sori and lack the one on the basal basiscopic vein; D. a schematic diagram of the same pinna revealing the position of the obscure veins. Drawn by H. Kanemitsu. All from Kanemitsu et al. 14/36 (1NS!)}
Figure 2. Asplenium minutifolium Kanem. & Tagane, sp. nov. A. habit; B. portion of lamina (undersurface) showing sori; C. rhizome with scales; D. habitat.


A revision of *Middletonia* (Gesneriaceae) in Thailand

CARMEN PUGLISI¹ & DAVID J. MIDDLETON²

ABSTRACT

The genus *Middletonia* in Thailand is revised. We recognise four species, including the newly described *Middletonia glebosa* C. Puglisi and the resurrected *M. reticulata* (Barnett) C. Puglisi. A key to the species, full descriptions and proposed conservation assessments are provided.

KEYWORDS: taxonomy, new species, Flora of Thailand.

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INTRODUCTION

*Middletonia* C. Puglisi belongs to subtribe Loxocarpinae, tribe Trichosporeae (Weber et al., 2013) of the family Gesneriaceae. Subtribe Loxocarpinae includes all species of Southeast Asian Gesneriaceae with twisted fruits (plus many species with straight fruits). The genus was segregated from *Paraboea* (C. B. Clarke) Ridl. by Puglisi et al. (2016) as a result of a study of the Loxocarpinae which showed that the species now in *Middletonia* did not form a monophyletic group with the rest of *Paraboea*. The segregation from *Paraboea* is supported by both molecular data and the morphological characters discussed below. This group of species had already been noted by Xu et al. (2008) as being distinctive although no formal infrageneric classification was proposed.

Like *Paraboea*, *Middletonia* presents a matted, interwoven indumentum of long and fine hairs on the abaxial side of the leaf, a flat-faced corolla and a capsular fruit. The characters that separate *Middletonia* from *Paraboea* are the erect anthers (borne at a right angle in *Paraboea*) and the minutely glandular indumentum on the anthers and ovary. Other characters that can aid in the distinction of *Middletonia* from *Paraboea* are the reticulate tertiary venation, which is visible at least by the leaf margin, and the considerably smaller corolla and shorter fruit compared to most species of *Paraboea*.

MATERIALS AND METHODS

The investigation is based on an examination of specimens from the herbaria A, AAU, ABD, BK, BKF, BM, E, K, L, MO, P, SING (herbarium codes from Thiers, continuously updated), and on the living and spirit collections of the Royal Botanic Garden Edinburgh and Singapore Botanic Gardens. All the specimens cited have been seen unless otherwise stated. Measurements of the fruit and the vegetative parts were taken from dry specimens, while flowers were measured from fresh, rehydrated or preserved samples. Accuracy of the fine measurements should be estimated at 0.05 mm.

*MIDDLETONIA*


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Lithophytic herbs with short stems. Leaves petiolate, opposite, rarely alternate or subopposite at the base of the stem and then becoming opposite apically. Lamina elliptic to obovate, often with unequal base, abaxial surface with a matted eglandular indumentum and visible tertiary venation. Inflorescence axillary and cymose; bracts inconspicuous; flowers 5-merous. Calyx with sepals divided to base. Corolla with short tube and spreading limb, slightly bilabiate, with 2 lobes on the upper lip and three on the lower. Stamens 2; filaments straight; anthers erect, dorsifixed, with a minute glandular indumentum; staminodes 2, often reduced. Ovary ovoid, minutely glandular; ovules many; stigma capitate. Fruit a straight or twisted capsule, bivalved, orthocarpic and longitudinally dehiscing. Seeds minute and elliptic.

Five species, found in India, Bangladesh, Bhutan, Myanmar, China, Thailand, Laos, Cambodia, Vietnam and Malaysia. Four in Thailand.

**Key to the Thai Species**

1. Inflorescence longer than the subtending leaf; fruit strongly twisted
2. Leaves pubescent above (hispid and glandular)
3. Fruit slightly twisted, valves smooth; habit distinctly caulescent

1. **M. evrardii**
2. **M. reticulata**
3. **M. regularis**
4. **M. glebosa**


Shorty caulescent herb. Stem 3–7 cm long, woody, densely covered in a thick layer of matted long, brown hairs. Leaves congested or with internodes to 0.5 cm long, opposite or subopposite; petioles 0.5–4 cm long, tomentose as on stem, the indumentum slightly less appressed; lamina 2.5–8 × 1.2–4 cm, 2–2.6 times as long as wide, elliptic; apex acute; base shortly attenuate; margin serrulate to crenulate; adaxial surface hispid with scattered uniseriate multicellular hairs, abaxial surface tomentose with brown hairs, appressed along the venation, looser over the rest of the lamina; 8–9 pairs of secondary veins, tertiary venation seldom visible on the adaxial surface, evident on the abaxial. Inflorescence an axillary, compound cyme, tomentose and glandular, longer than the subtending leaf, many-flowered; peduncles 1–1.3 cm long; bracts 4.5–5 × 0.7–0.8 mm, ligulate, tomentose outside, glandular inside; pedicels 3–7 mm long, delicated. Calyx divided to base; lobes triangular, ca 1.4 × 0.4 mm, apex broadly acute, densely glandular and sparsely tomentose outside, sparsely glandular inside. Corolla almost flat-faced, white and densely glandular inside; otherwise poorly known (see note below). Stamens exerted, inserted ca 1 mm from corolla base; filaments ca 0.8 mm long, straight; anthers free, ca 1.5 × 0.8 mm, thecae parallel, glabrous and dehiscing longitudinally; staminodes not seen. Ovary ca 2 mm long, ca 0.7 mm diameter, markedly distinct from style and covered in glands; style 3.5–4 mm long, ca 0.1 mm diameter, glabrous, straight; stigma capitate, ca 0.2 mm long. Capsule to 16 mm long, densely covered in glands, twisted. Seeds not seen.

Thailand. — **EASTERN**: Nakhon Ratchasima [Khao Yai National Park, along River Huyta Kon, 600-800 m, 19 July 1973, Murata et al. T-16373 (BKF)]; **CENTRAL**: Nakhon Nayok [Nang Rong Waterfall, ca 100 m, 29 July 1959, Smiñnand & F loto 6106 (BKF, E)].


Ecology. — Evergreen forest.

Proposed IUCN conservation assessment. — Endangered (EN B2ab(iii)). In Thailand this species is only known from two collections in the Khao Yai area, of which the most recent was made in 1973 despite Khao Yai being frequently explored. It is also known from a few collections in Lao PDR and Vietnam over a wide distribution. Although its EOO is large the few and localised collections give it an AOO in the Endangered range. It also has a fragmented distribution, not all populations are in...
protected areas and those that are may be subject to pressure from tourists.

Note.— The material from Thailand differs slightly from the Vietnamese material, especially in the leaf shape which is more elongated and with an acute apex in the Thai specimens. As there are rather few specimens from throughout the distribution range, with no floral material from Thailand available for dissection, further collections are necessary to assess whether the Thai and Vietnamese plants belong to one or more species.

2. Middletonia glebosa C.Puglisi, sp. nov.

Similar to Middletonia regularis in having the inflorescences shorter than the leaves and to Middletonia reticulata in the shortly caulescent habit. Differs from both in having a dense indumentum on the adaxial side of the leaf, with glands and eglandular hispid hairs (upper leaf surface glabrescent or minutely glandular in Middletonia regularis, glabrescent in M. reticulata), and in the short, non-twisted, lumpy and irregular fruit (longer, weakly to strongly twisted, smooth and regular in M. regularis and M. reticulata). Type: Thailand, Sukhothai, Khiri Mat, Ram Kham Haeng National Park, Khao Luang, alt. 520 m, 11 Oct. 2012, fr., Middleton, Karaket, Suddee & Triboun 5559 (holotype E [E00547434]; isotypes BK, BKF [SN201922]). Fig. 1A–B.

Stoloniferous, very shortly caulescent herb. Stem to 2 cm long, densely covered in a thick layer of matted long, brownish hairs. Leaves congested, opposite; petioles 1–4.5 cm long, tomentose as on stem; lamina 5–11 × 2–4.5 cm, 2–3 times as long as wide, elliptic, with a rugose surface; apex broadly acute to obtuse; base seemingly attenuate in herbarium specimens, rounded to subcordate in living plants; margin more or less crenate and undulate, sometimes appearing irregularly denticulate; adaxial surface mid-green and hispid with scattered unicellular hairs and glands; abaxial surface pale green, with glands throughout and long, thin hairs which entirely cover the surface but become restricted to the veins in mature leaves; 6–7 pairs of secondary veins; tertiary venation seldom visible on the adaxial surface, more evident on the abaxial. Inflorescence an axillary, compound cyme, tomentose, shorter than the leaf subtending it, many-flowered; peduncles 3–6 cm long; bracts to ca 3 mm long, narrow; hirsute on the abaxial surface, glabrous or glandular on the adaxial; pedicels white, 1–7 mm long, delicate and slightly pendulous, glandular and less tomentose than the lower axes. Calyx divided to base; lobes white, becoming green towards the apex, narrowly ovate, 1–2 mm long, apex obtuse, glabrous or with a scattered glandular and eglandular indumentum. Corolla almost flat-faced, slightly bilabiate, white and densely glandular outside; tube ca 1 mm long; lip lengths not measured; upper lobes elliptic, ca 4 × 2.5 mm; lower lobes broader, ca 4 × 3 mm. Stamens inserted ca 0.5 mm from corolla base; filaments ca 2 mm long, geniculate in the middle and with a small hump below the attachment point of the anther; anthers pale yellow and free, ca 1 × 2 mm, thecae subparallel and reniform, glandular towards the middle line and dehiscing longitudinally; staminodes absent. Ovary ca 1 mm long, markedly distinct from style and covered in minute glands conferring it a pale yellow-green colour; style ca 3 mm long, glabrous, more or less straight; stigma inconspicuous, slightly bilabiate, with lower lip slightly bifid and a little longer than the upper. Capsule green, to 6 mm long, densely covered in glands and with a lumpy, uneven surface, not twisted, sometimes curved. Seeds elliptic, ca 0.2 × 0.1 mm.


Distribution.— Cambodia [Stung Treng, 1866–1868, Thorel 2268 (P×2)].

Ecology.— Mixed deciduous forest with bamboo on granite bedrock.

Etymology.— The specific epithet is the Latin adjective glebosus, -a, -um, which means “lumpy” and refers to the peculiar surface of the capsule.

Proposed IUCN conservation assessment.— Endangered (EN B2ab(iii)). This species is only known from two localities, Ram Kham Haeng National Park in Thailand and Stung Treng in Cambodia. There have been no collections from the Cambodian site since the nineteenth century and the area is poorly collected overall. Although the potential EOO is large, given the wide separation of the two known localities, the AOO is less than 500 km², even considering the possibility of a much more
widespread distribution in the National Park than has been collected. Although the status of the Cambodian population(s) needs to be verified, in Ram Kham Haeng National Park this plant has been observed growing in areas subject to considerable tourist pressure.

Notes.—In Ram Kham Haeng National Park this species grows in a mixed population with Middletonia reticulata. The two are readily told apart in the field by Middletonia glebosa having softer, paler leaves, a shorter inflorescence, generally slightly smaller flowers, and the curious short, straight, lumpy fruit. The species is known only from Ram Kham Haeng National Park and a single collection made around 150 years ago in Cambodia. The Cambodian collection, placed in Paraboea regularis by Xu et al. (2008), is only in fruit so the identification will need to be verified with flowering material. However, the fruit of this species is rather distinctive.


Rhizomatous, caulescent herb. Stem 10–40 cm tall. Leaves alternate along the stem, becoming opposite and sometimes tightly congested apically; petioles 0.5–7 cm long, densely tomentose; lamina 2.9–10.5 × 1.5–5.5 cm, 1.6–3.2 times as long as wide, ovate, obovate or elliptic; apex acute; base often unequal, acute or shortly so; margin irregularly serrate to crenulate; adaxial surface dark green and minutely glandular or glabrescent; abaxial surface brownish green, densely tomentose with fine and long hairs which are rusty brown, woolly and caducous along the veins and pale brown and sparse over the rest of the lamina; 5–10 pairs of secondary veins; tertiary venation prominent on both sides, on dry specimens seldom visible on the adaxial surface, reticulate and clearly visible on the abaxial. Inflorescence an axillary, compound cyme, with the same loose indumentum of the stems and lower leaf surface (sometimes reduced in mature plants or missing in old specimens), as long as or shorter than the subtending leaf, 4 to many-flowered; peduncles 1–4.5 cm long; bracts reduced, 1–3.5 × 0.2–1.5 mm, ligulate to lanceolate, tomentose outside, sparsely so or glabrescent inside; pedicels 10–15 mm long, tomentose. Calyx greenish brown; tube 0.2–0.5 mm long; lobes ligulate to lanceolate, 1–2 mm long, apex broadly acute to obtuse, tomentose outside, sparsely glandular inside. Corolla almost flat-faced, slightly bilabiate, white and glabrous outside and inside; tube 1.5–1.8 mm; upper lip 2.2–2.7 mm long, lower lip 3.2–3.3 mm long; lobes spreading, upper lobes elliptic, ca 3 × 3.1 mm, lateral lobes ca 2.8 × 2.4 mm, lower lobe ca 2.7 × 3.3 mm. Stamens inserted on 0.7 mm from corolla base; filaments white, 2–2.5 mm long, straight or geniculate, with minute glands towards the apex; anthers pale orange and free, ca 2 × 1.6–2 mm, glandular dorsally and dehiscing longitudinally; staminodes 2, 1.5–6 mm long, arising ca 0.4 mm from corolla base. Ovary pale yellow to light green, 1.3–2.1 long, 0.6–0.7 mm diameter, distinct from the style and covered in anthers; style 2.5–3.8 mm long, white, glabrous, straight; stigma green at tip, capitate. Capsule pale green, 5–10 mm long, densely covered in glands, straight or slightly twisted. Seeds elliptic, ca 0.2 × 0.1 mm.
Phangnga, 25 Sept. 2006, Triboun 3662 (BK, E); Pulau Panji (Koh Paneyee), 2 Dec. 1928, Haniff & Nur 4013 (K, SING); Thap Put, Khaoh Tao, 10 m, 21 June 2006, Williams et al. 2036 (A, BKF, E)); SOUTH-WESTERN: Kanchanaburi [Kwae Noi Basin, near Wangka, 150 m, 13 June 1946, Den Hooed 946 (L)].

Distribution.—Malaysia.

Ecology.—Lowland evergreen forest on limestone soils.

Proposed IUCN conservation assessment.—Least Concern (LC). This species is relatively widespread with an EOO of around 40,000 km², well beyond the threshold for a threat category. Its status should, however, be monitored as not all of the limestone localities where it is found are in protected areas.

Note.—The protologue of Paraboëa monticola suggests the flowers to be much larger: “lobes ... 6–9 x c. 6.5 mm”. However, none of the material available for this study had lobes longer than 3.3 mm.


Rhizomatous, very shortly caulescent herb. Stem to 1.5 cm. Leaves tightly congested, seemingly opposite; petioles 0.3–0.9 cm long, densely tomentose; lamina 2–9 × 1.9–5 cm, 1.2–2.3 times as long as wide, ovate, obovate or elliptic, often irregular; apex obtuse to rounded; base unequal, slightly attenuate and forming small auricles at the insertion on the upper surface; margin irregularly crenate to crenulate; adaxial surface dark green and glabrescent, abaxial surface brown, densely tomentose with hairs that are somewhat woolly, dark brown along the veins, pale brown over the rest of the lamina and which can be removed very easily (the base of the hair is very fine); 5–9 pairs of secondary veins, secondary venation deeply sunk on the upper surface of the leaf, slightly raised beneath; tertiary venation sometimes visible on the adaxial surface on dry specimens, clearly visible and reticulate on the abaxial. Inflorescence an axillary, compound cyme, with a loose reddish brown tomentum that becomes patchy on dry specimens, longer than the subtending leaf, dense and many-flowered; peduncles 4.5–17 cm long; bracts 1.6–3 × 0.2–0.5 mm, ligulate, tomentose; pedicels 1–12 mm long, tomentose. Calyx brown, tube 0.2–0.7 mm long; lobes triangular, 1–2.5 mm long, apex broadly acute, tomentose outside, sparsely glandular inside. Corolla almost flat-faced, slightly bilabiate, white and glabrous outside and inside; tube 1–1.8 mm; upper lip 0.1–4.5 mm, lower lip 3.2–6.9 mm; upper lobes elliptic, 3–5 × 2.5–4.7 mm, lateral lobes 2.8–4.7 × 2.4–5.2 mm, lower lobe 2.7–4.5 × 3–4.7 mm. Stamens inserted at 0.3–0.7 mm from corolla base; filaments white, 1.5–3 mm long, straight, with minute glands towards the apex; anthers pale orange, free, 1.3–2 × 1.6–1.8 mm wide, apically confluent, glandular dorsally and dehiscing longitudinally; staminodes absent or ca 2.6 mm long, arising ca 0.4 mm from corolla base. Uvar sticky pale yellow, 2–2.5 mm long, 0.6–1 mm diameter, markedly distinct from style and covered in minute glands; style 2.5–3.8 mm long, glabrous, straight; stigma capitate and densely papillose. Capsule pale green, 7–14 mm long, densely covered in glands, twisted. Seeds elliptic, 0.2–0.3 × 0.1–0.2 mm.

Thailand.—NORTHERN: Mae Hong Son [Payap, West of Muang Hot, 350 m, 23 Sept. 1958, Sørensen et al. 5201 (BKF)]; Chiang Mai [Mae Wang, ca 400 m, 19 July 1922, Kerr 6356 (ABD, BM, K)]; Chom Thong, Doi Inthanon National Park, Mae Ya Falls, 550 m, 11 Sept. 1994, Païee 257/A (A, BKF); Doi Inthanon, Mae Klang waterfall, 310–400 m, 18 July 1988, Tamura T-60094 (BKF); ibid., Takahashi T-62973 (BKF); ibid., 400 m, 19 Sept. 2008, Middleton et al. 4516 (BKF, E); ibid., 10 Nov. 1965, Sangkachand 25 (BK); ibid., 25 Nov. 1965, Phusomsaeng 5 (BKF); ibid., 430 m, 3 Nov. 1967, P Sitt 212 (E); Doi Inthanon National Park, 7 km below Wachiratan Waterfall, 400 m, 19 Aug. 2004, Nielsen et al. 1783 (BKF); Doi Inthanon, along Mae Klang river, 450 m, 31 July 1988, Fukuoka T-62387 (BKF, L); Hot, Op Luang Nature Park, Doi Op Luang, Mae Jam river, 550 m, 23 Oct. 1987, Maxwell 8/1281 (BKF); Hot, Op Luang Gorge, 325 m, 24 Sept. 1989, Maxwell 89-1134 (A, MO); Hot, Ob Luang National Park, 9 Aug. 2014, Prommanut et al. P528 (BK)]; Lamphun [Li, Mae Ping, Ko Luang waterfall, 300–400 m, 27 Sept. 2006, Dongkumfu 2 (E); Pa Sang, Erawan Cave, 575 m, 5 Dec. 2004,
Figure 1. *Middletonia gebosa* C. Puglisi: A. Habit, showing young fruit; B. Flowers; *M. reticulata* (Barnett) C. Puglisi: C. Habitat with fruiting plants; D. Habit; E. Flowers; F. Fruit. Photographs by Preecha Karaket (A, C–E) and David Middleton (B, F).

Ecology.— Mixed deciduous forest on granite bedrock.

Distribution.— Currently endemic to Thailand but possibly also occurring in Lao PDR and Myanmar.

Proposed IUCN conservation assessment.— Near Threatened (NT). This species has an EOO of more than 20,000 km² but occurs in many areas subject to tourist pressure and microclimate changes due to surrounding agricultural practices.

Note.— This species is resurrected from synonymy of Middletonia multiflora (R.Br.) C. Puglisi from which it differs in the distinctively reticulate venation pattern covered in loose brown indumentum on the lower surface of the leaves, and in the auriculate leaf base. Middletonia multiflora has a denser indumentum on the leaf and the tertiary venation is less densely reticulate and less visible altogether. Middletonia multiflora is widespread along the northern distribution of the genus (from India to Vietnam), but none of the material from Thailand studied can be attributed to M. multiflora.

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REFERENCES


A new species of *Alphonsea* (Annonaceae)

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**ABSTRACT**

*Alphonsea isthmicola* I.M.Turner & Utteridge is described. It is a species of tree currently known from two limestone outcrops in Peninsular Thailand and one limestone hill near the Thai border in Peninsular Malaysia. A key to the *Alphonsea* species of Peninsular Malaysia and Southern Thailand is included.

**KEYWORDS:** limestone, South-East Asia, taxonomy.

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**INTRODUCTION**

In working on the genus *Alphonsea* for the Flora of Peninsular Malaysia, the first author noted a fruiting collection from Kaki Bukit, Perlis, which did not fit any of the 11 known species from Peninsular Malaysia (Sinclair, 1955; Kessler, 1996; Turner & Utteridge, 2015; Turner, 2016). As the collection site is close to the border with Thailand, material collected north of the border was investigated. A matching fruiting specimen from Surat Thani and a flowering specimen from Nakhon Si Thammarat in Peninsular Thailand were found. All the collections were made on limestone outcrops and have similar foliage. We therefore consider them to represent a single undescribed species and present a description here. A key to the *Alphonsea* species of Peninsular Malaysia and Southern Thailand is also included.

Photographs and a description of the flowering plant, from which the flowering specimen (and type) was gathered, appear in Gardner et al. (2015) as *Alphonsea* sp. B. In the description of sp. B, the number of carpels per flower is given as 1. The herbarium material definitely has more than one carpel per flower. It may be that the carpels are tightly pressed together in the living state and therefore appear as a single entity. The fruiting specimens certainly have more than one monocarp per infructescence.

**DESCRIPTION**

*Alphonsea isthmicola* I.M.Turner & Utteridge, sp. nov.

Similar in vegetative and floral morphology to *Alphonsea boniana* but differs in having more than one carpel per flower, monocarps smooth rather than verrucose and not distinctly nipple-tipped. Differs from *Alphonsea siamensis* in having leaf bases generally cuneate rather than rounded and not having irregular latitudinal constrictions in the monocarps when dry. Type: Thailand, Nakhon Si Thammarat, Tha Sala District, Khao Luang National Park, Krung Ching Waterfall, alt. 270 m, nature trail east of camp, canopy of slightly disturbed lowland evergreen forest on narrow ridge at edge of limestone doline, 8°43'1"N, 99°40'E, 28 Feb. 2006, Gardner ST2393 (holotype BK, isotype K). Figs. 1–2.

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Tree to 24 m tall, 43 cm dbh. Twigs dark grey or dark brown, longitudinally striate, becoming brown or grey-brown with age; youngest parts with adpressed brown or pale hairs, soon lost. Leaves chartaceous to subcoriaceous, slightly shiny, drying grey or brown above, pale brown beneath with the midrib generally a darker and redder brown, lamina margin also frequently a redder brown; generally glabrous though some long adpressed hairs may be present on the midrib below and pale hairs on the midrib above near leaf base, midrib above flush to slightly sunken in dry leaves, prominent below; lamina elliptic, 3.5–9 × 1.5–3.5 cm, base cuneate, apex acute to acuminate, lateral nerves 10–12 pairs though difficult to distinguish from intercostal veins; tertiary venation more or less reticulate, obvious from below, more obscure from above; petiole 2–3 mm long, 1 mm diameter, drying dark brown or blackish, wrinkled, wrinkled, sometimes with scattered hairs. Inflorescences extra-axillary, axis ca 3 mm long bearing flowers in distichous arrangement. Flowers with pedicel (3–)5–10 mm long, ca 0.5 mm wide, with dense short brown hairs; tiny mediar bract ca 1 mm long, 0.8 mm wide, brown hairy; sepals ovate, ca 1 × 1 mm; outer petals ovate, ca 6 mm long, 4 mm wide, thin, drying dark brown with short pale hairs outside and inside; inner petals ovate-lanceolate, ca 7 mm long, 3 mm wide, apex prolonged and reflexing at anthesis, drying dark brown, densely pale hairy outside, more or less glabrous within; stamens many, ca 1 mm long; carpels 3–5, ca 1.5 mm long, densely covered with ascending pale hairs. Fruits with pedicel 8–15 mm long, ca 3 mm thick, longitudinally wrinkled, covered with short brown hairs; monocarps 3–5, ellipsoidal to 3 cm long, 2.5 cm wide, drying brown, surface minutely pimpled, covered in very dense, very short brown hairs, monocarp wall to 3 mm thick; stipe to 7 mm long, 3 mm wide. Seeds ca 6.

Thailand.— PENINSULAR: Nakhon Si Thammarat, Tha Sala District, Khao Luang National Park, Krung Ching Waterfall, alt. 270 m, nature trail east of camp, canopy of slightly disturbed lowland evergreen forest on narrow ridge at edge of limestone doline, 8°43′1″N, 99°40′E, 28 Feb. 2006, Gardner ST2393 (BKF, K); Surat [Thani], Ban Nasan [Ban Na San District], 13 Aug. 1927, Kerr 13366 (K, BM).

Malaysia.— Perlis, Kaki Bukit, ca 300 ft, 11 Apr. 1938, Kiah SF N 35235 (K ×2, L).

Field notes.— Bark mid grey-brown with vertical lines of raised lenticels, inner bark dense, yellow-brown with a few pale vertical streaks and a fine network of dark lines (ST2393). Flower petals pale yellow (ST2393). Fruit pale green (SF N 35235).

Distribution.— Known from three collections from Peninsular Thailand and the Peninsular Malaysia near the border with Thailand. All lie in the relatively narrow isthmus region of the Malay Peninsula (Fig. 2).

Phenology.— Reported as evergreen. No clear pattern of reproductive phenology is discernible from the limited collections.

Ecology.— All collections are from limestone outcrops.

Conservation status.— Alphonsea isthmicola is known only from three collections and has an Extent of Occurrence (EOO) of only 3,027 km²; in addition, the Area of Occupancy (AOO) is 12 km² (when using a user-defined cell width of 2 km) – both of these fall within the Endangered category of the IUCN Red List Categories (IUCN, 2012). The species has been collected at the extreme ends of the Nakhon Si Thammarat Range: at the southern end in the Malaysian state of Perlis, and at the northern end in Thailand. The mountain range runs north from Perlis along the centre of the Isthmus of Kra through to the northern tip of Nakhon Si Thammarat/border of Surat Thani, and has a total area of ca 9560 km². The species is only collected from limestone areas which are relatively small outcrops in the Nakhon Si Thammarat Range, especially in the northern part, and thus the AOO is a good estimate of the occurrence of A. isthmicola. Large areas of granite dominate the Range, and using detailed geological maps (Suensilpong et al., 1984), we have estimated the granite to have an area of ca 3915 km² – thus reducing the species potential EOO to ca 5645 km². That would further reduce with refinement of field observations, as we have had to include various conglomerate classes etc which may not be suitable habitat, and also does not take into account destruction of
Figure 1. Alphonsea isthmicola I.M. Turner & Uteridge, sp. nov. A. Habit, B. Mature leaf, adaxial surface, C. Flower (one outer petal missing), D. Flower in vivo drawn from photograph (hairs omitted), E. Reproductive structures from C, F. Infructescence, G. Indumentum on surface of monocarp. Scale bars: A and F = 5 cm, B = 1 cm, C = 5 mm, D = 5 mm, E = 1 mm, G = 500 μm. Material used Gardner ST2393 (A–C, E); Kiah SFN 35235 (F–G); Photograph Gardner et al. (2016: 98, Alphonsea sp. B) (D)
limestone habitats, especially in the heavily urbanised region around Don Sak at the northern end of the Range. In addition, whilst the Malaysian collection is within the Perlis State Park and one of the Thai collections is from Khao Luang NP, outside protected areas much of the range, especially the lowland plains right up to the edge of the hills, has been converted to agriculture, mainly oil palm and rubber plantations. The species is only known from three collections from three locations, with two of the collections from 1927 and 1938. We assign a provisional conservation assessment of Endangered EN B1ab(i, ii, iii)+2ab(i, ii, iii) following, IUCN (2012).

Vernacular.— Kerr reported the Thai name sang yu [สังยู], which is used for a number of Annonaceae species in Thailand, more often written as สังหยู (R. Pooma pers. comm.).

Etymology.— from the Latin, isthmus and –cola (dweller); living on an isthmus.

Figure 2. Map showing the known distribution of Alphonsea isthmicola I.M.Turner & Utteridge, sp. nov.

KEY TO ALPHONSEA SPECIES OF PENINSULAR MALAYSIAN AND SOUTHERN THAILAND

The species covered include those from Peninsular Malaysia (Sinclair, 1955; Kessler, 1996; Turner & Utteridge, 2015; Turner, 2016) and the ones listed by Gardner et al. (2015) for Southern Thailand, including a still unnamed species. Three species (A. keithii, A. siamensis and A. sp. A) are not recorded from Peninsular Malaysia. The key is based largely on fruit characters as fruiting material is collected more often than flowering material (carpel number can be inferred from monocarp number), though the fruits of Alphonsea keithii remain unknown.

1. Carpels 1–2
2. Young twigs densely red-brown hairy; petals to 5 mm long
3. Monocarps ellipsoidal, apex acute
4. Monocarps globose, apex rounded
5. Monocarps cylindrical, apex rounded

A. keithii Ridl.

2. Young twigs glabrous or glabrescent; petals more than 5 mm long
3. Monocarps globose or cylindrical, apex rounded
4. Monocarps globose, apex rounded
5. Monocarps cylindrical, apex rounded

A. boniana Finet & Gagnep.

A. malayana Kessler

A. sp. A of Gardner et al.

A. cylindrica King

1. Carpels 3–6 or carpels more than 6
2. Carpels 3–6
3. Young twigs with dense tomentum
4. Young twigs glabrous or sparsely hairy
5. Monocarps verrucose
8. Secondary venation very distinct; monocarps ellipsoidal, warts closely packed, densely covered with short brown tomentum
   A. lucida King
8. Secondary venation relatively obscure; monocarps ± cylindrical, warts not closely packed, appearing glabrous
   A. kingii J.Sinclair
7. Monocarps smooth or rugose, but not verrucose
9. Leaves generally lanceolate; monocarps subsessile
10. Monocarps with surface rugose, glabrous
11. Leaves generally more than 4 cm wide; stipe of monocarp to 20 mm long
12. Leaf base generally rounded; monocarps ± cylindrical, drying with irregular latitudinal constrictions
   A. siamensis Kessler

5. Carpels more than 6
13. Young twigs with dense tomentum
14. Leaves generally less than 4 cm wide, secondary venation indistinct; monocarps verrucose, to 1.5 cm in diameter
   A. johorensis J.Sinclair
14. Leaves generally more than 4 cm wide, secondary venation distinct; monocarps not verrucose, mostly more than 3 cm in diameter
   A. javanica Schelff.

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REFERENCES


Seed morphology of nineteen *Crotalaria* L. (Fabaceae) species in Thailand

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ABSTRACT
Seed morphology of 19 *Crotalaria* species in Thailand was studied using stereoscopic microscopy and scanning electron microscopy. Five different morphological types are described based on differences in shape, aril, fracture lines, size and seed coat surface. Each type is morphologically described, compared, illustrated, and the taxonomic implications are discussed. A key to identify the different types or some species is presented.

KEYWORDS: *Crotalaria*, Leguminosae, Papilionoideae, micromorphology, Thailand.
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INTRODUCTION
Seed morphology often provides useful characters for generic and species identifications, and can also help understand taxonomic relationships, such as in the following families: Acanthaceae (Rueangsawang *et al.*, 2012), Asteraceae (Chehregani & Mahanfar, 2007; Inceer *et al.*, 2012), Iridaceae (Erol *et al.*, 2006), Orobanchaceae (Plaza *et al.*, 2004) and Scrophulariaceae (Kaplan *et al.*, 2007).

Various seed morphological characters in Fabaceae have been studied several times and some seed characters are very useful for faboid generic identifications (Kirkbride *et al.*, 2003). Studies based on various genera in the Fabaceae indicated that seed morphology provides valuable taxonomic characters for distinguishing some taxa in the tribe Genisteae (López *et al.*, 2004) and the genera *Colutea* L. (Mirzaei *et al.*, 2015), *Entada* Adans. (Rodrigues, 2015), *Lathyrus* L. (Günes & Ali, 2011; Günes, 2013), *Indigofera* L. (Al-Ghamdi, 2011), *Trigonella* L. (Turki *et al.*, 2014), and *Vigna* Savi (Nath & Dasgupta, 2015).

Seed morphology of nine Indian *Crotalaria* L. species was studied by Gandhi *et al.* (2011) using light and scanning electron microscopy. The seeds varied significantly in size, colour, surface, and hilum characters. Seeds of *Crotalaria* were typically kidney-shaped. Seed colour appeared to be of less diagnostic and systematic value. All species of *Crotalaria* had a smooth surface, except *C. albida* Heyne ex Roth and *C. spectabilis* Roth. The study showed that seed coat ornamentation pattern can be helpful for species identification. Moreover, the shape of Thai *Crotalaria* seed has been described by Niyomdham (1978). However, he overlooked seed coat sculpturing.

Because previous data on seed morphology of Thai *Crotalaria* species is insufficient, the current study evaluates the taxonomic significance of seed morphology of the *Crotalaria* species in Thailand for application in classification and identification of the species.

MATERIALS AND METHODS
Mature seeds of 19 *Crotalaria* species from five sections of Le Roux *et al.* (2013) were obtained from living specimens, vouchers are stored in the KKU herbarium (Table 1). The seed were examined with microscopes and measurements were based on a sample size of 10 grains. Seeds were cleaned by ultrasonic cleaner for 2–5 minutes and dehydrated

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with an alcohol series (70%, 95%, 100%), and subsequently studied by stereoscopic microscope (SM) and scanning electron microscopy (SEM). The seed measurements were investigated under SM. For SEM, the seed was adhered onto an aluminum stub with double-sided cellophane tape and air-dried at room temperature. Finally, the samples were sputter-coated with a gold-palladium mixture under vacuum and examined with Leo 1450 VP SEM. The terminology of seed morphology mainly follows Kirkbride et al. (2003) and Bojňanský & Fargašová (2007). The measurement of length and width are represented in Figure 1.

Table 1. List of specimens examined of Crotalaria for seed morphology

<table>
<thead>
<tr>
<th>Species</th>
<th>Voucher Collector</th>
<th>Locality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. C. acicularis</td>
<td>S. Ninkaew 259 (KKU)</td>
<td>Phetchabun</td>
</tr>
<tr>
<td>2. C. alata</td>
<td>S. Ninkaew 263 (KKU)</td>
<td>Phetchabun</td>
</tr>
<tr>
<td>3. C. albida</td>
<td>S. Ninkaew 305 (KKU)</td>
<td>Chiang Mai</td>
</tr>
<tr>
<td>4. C. assamica</td>
<td>S. Ninkaew 312 (KKU)</td>
<td>Nan</td>
</tr>
<tr>
<td>5. C. bracteata</td>
<td>S. Ninkaew 253 (KKU)</td>
<td>Nan</td>
</tr>
<tr>
<td>6. C. calycina</td>
<td>S. Ninkaew 325 (KKU)</td>
<td>Phetchabun</td>
</tr>
<tr>
<td>7. C. chinensis</td>
<td>S. Ninkaew 261 (KKU)</td>
<td>Phetchabun</td>
</tr>
<tr>
<td>8. C. dubia</td>
<td>S. Ninkaew 25I (KKU)</td>
<td>Chiang Mai</td>
</tr>
<tr>
<td>9. C. filiformis</td>
<td>S. Ninkaew 306 (KKU)</td>
<td>Chiang Mai</td>
</tr>
<tr>
<td>10. C. gorrensis</td>
<td>S. Ninkaew 28I (KKU)</td>
<td>Sakon Nakhon</td>
</tr>
<tr>
<td>11. C. juncea</td>
<td>S. Ninkaew 280 (KKU)</td>
<td>Nakhon Ratchasima</td>
</tr>
<tr>
<td>12. C. lejoloba</td>
<td>S. Ninkaew 318 (KKU)</td>
<td>Phetchabun</td>
</tr>
<tr>
<td>13. C. medicaginea</td>
<td>S. Ninkaew 281 (KKU)</td>
<td>Khon Kaen</td>
</tr>
<tr>
<td>14. C. montana</td>
<td>S. Ninkaew 329 (KKU)</td>
<td>Khon Kaen</td>
</tr>
<tr>
<td>15. C. neriifolia</td>
<td>S. Ninkaew 180 (KKU)</td>
<td>Sakon Nakhon</td>
</tr>
<tr>
<td>16. C. pallida</td>
<td>S. Ninkaew 273 (KKU)</td>
<td>Bueng Kan</td>
</tr>
<tr>
<td>17. C. sessiliflora</td>
<td>S. Ninkaew 291 (KKU)</td>
<td>Sakon Nakhon</td>
</tr>
<tr>
<td>18. C. spectabilis</td>
<td>S. Ninkaew 271 (KKU)</td>
<td>Sa Kaeo</td>
</tr>
<tr>
<td>19. C. verrucosa</td>
<td>S. Ninkaew 298 (KKU)</td>
<td>Loei</td>
</tr>
</tbody>
</table>

Figure 1. The measurement of length and width in each shape of Crotalaria seeds: A) reniform; B) harp-shaped (L = Length; W = Width).
RESULTS

The micromorphological characters of Crotalaria seeds in Thailand including shape, colour, size, seed coat surface, fracture lines, hilum shape and aril features, were studied and summarized in Table 2. Among the taxa examined, two basic morphological seed shape types can be distinguished, which are reniform and harp-shaped. Both show a wide range of variation in the characters of shape, aril, fracture lines, size and seed coat surface. Based on our SM and SEM studies we distinguish five different seed morphological types. However, the seed morphological features of each type cannot be used for species identification except in Type IV. The types are keyed out and described here, for type IV identification to species level is provided:

KEY TO SPECIES

1. Seeds reniform, 1.8–3.5 × 1–3 mm, brown-black, with aril; seed coat surface smooth with or without fracture lines; hilum oval, ruminate. This type occurs in C. alatâ Buch.-Ham. ex D. Don (seeds slightly larger, 3–3.5 × 2.5–3 mm) and C. lejoloba Bartl. (seeds slightly smaller, 1.8–3 × 1–2 mm) (Figs. 2 & 3). The aril was already reported by Niyomdham (1978).

2. Seeds reniform, 1.3–2.8 × 1–2.2 mm, brown, without aril; seed coat surface smooth with fracture lines; hilum circular or oval, ruminate. This type occurs in C. acicularis Buch.-Ham. ex Benth., C. chinensis L. and C. montana Heyne ex Roth (Figs. 2, 3 & 4), of which the seeds are similar in colour, size and seed coat surface. The hilum is different, circular in C. acicularis and C. chinensis and oval in C. montana.

3. Seeds reniform, 3–5 × 2.8–5 mm, brown, yellow

1. Type I
2. Type II
3. Type III
4. Type IV
5. Type V

KEY TO SPECIES

1. Seeds smooth and irregularly wrinkled
2. Seeds orange-brown, 2.5–2.8 mm wide; hilum oval
3. Seeds brown-black, 3.5–4 mm wide; hilum circular
1. C. goreensis
2. C. spectabilis
3. C. juncea
4. C. pallida
Table 2. A comparison of seed characters studied for *Crotalaria* species

<table>
<thead>
<tr>
<th>Seed types</th>
<th>Species</th>
<th>Shape</th>
<th>Colour</th>
<th>Size (Length (mm) Width (mm))</th>
<th>Seed coat surface</th>
<th>Fracture lines</th>
<th>Hilum shape</th>
<th>Aril</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td><em>C. alata</em></td>
<td>reniform</td>
<td>brown-black</td>
<td>3−3.5 (3.23±0.19) 2.5−3 (2.68±0.14)</td>
<td>smooth</td>
<td>oval</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>C. lejoloba</td>
<td>reniform</td>
<td>brown-black</td>
<td>brown-black</td>
<td>1.8−3 (2.29±0.53) 1−2 (1.60±0.46)</td>
<td>smooth</td>
<td>+ oval</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td><em>C. acicularis</em></td>
<td>reniform</td>
<td>brown</td>
<td>1.3−1.5 (1.39±0.09) 1−1.2 (1.10±0.08)</td>
<td>smooth</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. chinensis</td>
<td>reniform</td>
<td>brown</td>
<td>brown</td>
<td>2−2.3 (2.13±0.14) 1.5−1.7 (1.58±0.09)</td>
<td>smooth</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. montana</td>
<td>reniform</td>
<td>brown</td>
<td>brown</td>
<td>2−2.8 (2.43±0.35) 1.5−2.2 (1.88±0.30)</td>
<td>smooth</td>
<td>+ oval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td><em>C. assamica</em></td>
<td>reniform</td>
<td>brown-black</td>
<td>3−5 (4±0.94) 3−5 (4.2±0.79)</td>
<td>smooth &amp; irregularly wrinkled</td>
<td>+ oval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. bracteata</td>
<td>reniform</td>
<td>yellow-brown</td>
<td>brown-black</td>
<td>3−3.2 (3.11±0.10) 2.8−3 (2.91±0.10)</td>
<td>smooth &amp; colliculate</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. nerifolia</td>
<td>reniform</td>
<td>brown-black</td>
<td>brown-black</td>
<td>3.5−3.8 (3.66±0.14) 2.8−3 (2.9±0.09)</td>
<td>smooth &amp; irregularly wrinkled</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. verrucosa</td>
<td>reniform</td>
<td>brown</td>
<td>brown</td>
<td>3.5−4.3 (3.95±0.30) 3−3.5 (3.25±0.21)</td>
<td>smooth &amp; colliculate</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td><em>C. gorrensis</em></td>
<td>reniform</td>
<td>orange-brown</td>
<td>4−5 (4.55±0.44) 2.5−2.8 (2.67±0.13)</td>
<td>smooth &amp; irregularly wrinkled</td>
<td>oval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. juncea</td>
<td>reniform</td>
<td>brown-green</td>
<td>brown-green</td>
<td>4.5−5 (4.74±0.24) 4−4.5 (4.26±0.24)</td>
<td>smooth &amp; tuberculate</td>
<td>− oval</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. pallida</td>
<td>reniform</td>
<td>brown</td>
<td>brown</td>
<td>3−4 (3.5±0.47) 2−2.5 (2.26±0.24)</td>
<td>smooth &amp; colliculate</td>
<td>circular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. spectabilis</td>
<td>reniform</td>
<td>brown-black</td>
<td>brown-black</td>
<td>4.5−5 (4.77±0.22) 3.5−4 (3.76±0.23)</td>
<td>smooth &amp; irregularly wrinkled</td>
<td>circular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td><em>C. albida</em></td>
<td>harp-shaped</td>
<td>brown</td>
<td>1−1.5 (1.28±0.22) 1.3−2 (1.63±0.29)</td>
<td>smooth</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. calycina</td>
<td>harp-shaped</td>
<td>brown</td>
<td>brown</td>
<td>1.5−2 (1.76±0.21) 2.5−3 (2.76±0.21)</td>
<td>smooth</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. dubia</td>
<td>harp-shaped</td>
<td>yellow-brown</td>
<td>brown</td>
<td>1−1.5 (1.27±0.19) 1.6−1.8 (1.49±0.26)</td>
<td>smooth</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. filiformis</td>
<td>harp-shaped</td>
<td>brown</td>
<td>brown</td>
<td>0.8−1 (0.94±0.08) 1−1.3 (1.22±0.12)</td>
<td>smooth</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. medicaginea</td>
<td>harp-shaped</td>
<td>brown-black</td>
<td>brown-black</td>
<td>1.5−1.7 (1.61±0.09) 1.7−2 (1.90±0.12)</td>
<td>smooth</td>
<td>+ circular</td>
<td>−</td>
<td></td>
</tr>
<tr>
<td>C. sessiliflora</td>
<td>harp-shaped</td>
<td>brown</td>
<td>brown</td>
<td>1.3−1.5 (1.38±0.08) 1.5−1.7 (1.57±0.08)</td>
<td>smooth</td>
<td>+ circular</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: + = present; − = absent
Figure 2. LM micrographs of Crotalaria seeds: Type I: A) C. alata, B) C. lejoloba; Type II: C) C. acicularis, D) C. chinensis, E) C. montana; Type III: F) C. assamica, G) C. bracteata, H) C. verrucosa; Type IV: I) C. goreensis, J) C. juncea, K) C. pallida, L) C. spectabilis and Type V: M) C. albida, N) C. calycina, O) C. medicaginea, P) C. sessiliflora. Scale 1 mm.
5. Type V

Seeds harp-shaped, 0.8–2 × 1–3 mm, yellow-brown, brown, brown-black, without aril; seed coat surface smooth with fracture lines; hilum circular, ruminate. This type is found in C. albida, C. calycina Schrank, C. dubia Graham ex Benth., C. filiformis Wall. ex Benth., C. medicaginea Lam. and C. sessiliflora L. (Figs. 2 & 6). The seed of C. filiformis is smallest (0.8–1 × 1–1.3 mm) and of C. calycina largest (1.5–2 × 2.5–3 mm). The smooth seed coat surface of C. albida is in contrast with the undulating lines reported by Gandhi et al. (2011). The taxa cannot be keyed out with seed characters alone.

DISCUSSION AND CONCLUSION

Based on external morphology, two groups of species were traditionally distinguished, reniform or harp-shaped, which agrees well with Niyomdham (1978). The seed colour varies from yellow-brown, orange-brown, brown, brown-green to brown-black. Seed sizes vary between 0.8–5 mm in both length and width. The seed of C. filiformis is the smallest (0.8–1 × 1–1.3 mm), while that of C. juncea is the largest (4.5–5 × 4–4.5 mm).

Gandhi et al. (2011) reported that seed colour is not diagnostic, but in contrast, we found it to be an important character for identification of the species with Type IV.

Seed morphology has proven to provide useful characters for the identification and delimitation of species or species groups within Crotalária as the seeds of Crotalária can be divided into five types.

The seeds shape, colour and seed coat surface are quite similar in each species while seeds size is slightly variable based on standard deviation (SD; Table 2). The three species with the highest variation in seed sizes are: C. assamica (3–5 (4±0.94) × 3–5 (4.2±0.79)), C. legoloba (1.8–3 (2.29±0.53) × 1–2 (1.60±0.46)) and C. montana (2–2.8 (2.43±0.35) × 1.5–2.2 (1.88±0.30)), respectively. However, this study is based on few specimens per species. It can be that the variability appears to greater than described here if more specimens from other areas were collected too. However, we are confident that especially the qualitative characters used in the key are stable.

The seed types do not agree with the division of Crotalária into sections that are based on morphological characters of Polhill (1982) and molecular evidence of Le Roux et al. (2013) and Rockinger et al. (2017). Seed morphological characters alone are insufficient for a full taxonomic resolution of Crotalária species as the variability in morphology is too great. Nevertheless, in combination with other characters seed morphology can help to resolve taxonomic problems. Therefore, as in other Leguminosae, pollen morphology (Ridder-Numan & Van der Ham, 1997), anatomy (Ninkaew & Chantaranothai, 2015) and molecular characters (The Legume Phylogeny Working Group, 2017) should be combined to clarify the taxonomy of Crotalária in Thailand.

ACKNOWLEDGEMENTS

The first author would like to thank the Science Achievement Scholarship of Thailand, the Carlsberg Foundation, the Graduate School for Science and Technology, Aarhus University and the Higher Education Research Promotion and National Research University Project of Thailand, Office of the Higher Education Commission for financial supports. We thank Nualanon Nakkong, Pasakorn Bunchalee, Ponprom Pisuttimarn and Natthawut Triyutthachai for their help in the LM and SEM photographs. Finally, we also thank Peter van Welzen and two anonymous reviewers for their critical comments and suggestions.

REFERENCES


Figure 3. SEM micrographs of Crotalaria seeds: Type I: A & B) C. alata, C & D) C. lejoloba; Type II: E & F) C. acicularis. Scale bars: 1 mm (A, C, E), 200 μm (B, D, F); Ar = Aril; white arrows = fracture lines.

SEED MORPHOLOGY OF NINETEEN CROTALARIA L. (FABACEAE) SPECIES IN THAILAND (S. NINKAEW, P. PORNPONGRUNGRUENG, H. BALSLEV & P. CHANTARANOTHAI)

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Figure 4. SEM micrographs of *Crotalaria* seeds: Type II: A & B) *C. montana*; Type III: C & D) *C. assamica*, E & F) *C. bracteata*. Scale bars: 1 mm (A, C, E); 200 μm (B, D, F); Hi = hilum; Co = colliculate; Ir = irregularly wrinkled; white arrows = fracture lines.
Figure 5. SEM micrographs of *Crotalaria* seeds: Type IV: A & B) *C. goreensis*, C & D) *C. juncea*, E & F) *C. pallida*. Scale bars: 1 mm (A, C, E); 200 μm (B, D, F); Co = colliculate; Ir = irregularly wrinkled; Tu = tuberculate.
Figure 6. SEM micrographs of *Crotalaria* seeds, Type V: A & B) *C. albida*, C & D) *C. calycina*, E & F) *C. sessiliiflora*. Scale bars: 1 mm (A, C, E); 200 μm (B, D, F); white arrows = fracture lines.


Stories from the Mekong, part 2. The Cryptocoryne (Araceae) of Chiang Khan District, Loei Province, Thailand

TAKASHIGE IDEI*, JAN D. BASTMEIJER2 & NIELS JACOBSEN3

ABSTRACT
Between March 2006 and February 2015, the occurrence and habitats of the aroid genus Cryptocoryne were investigated in Chiang Khan District, Loei Province, Thailand. In addition to the well-known Cryptocoryne crispatula Engl. var. crispatula and C. crispatula var. yunnanensis (H.Li) H.Li & N.Jacobsen, a recently described species was found: C. loeiensis Bastmeijer et al., as well as a number of plants considered to be hybrids. Although Cryptocoryne is presently abundant, decimation or extinction could occur in the future because of the dam constructions in the Mekong River.

KEYWORDS: Cryptocoryne, Araceae, habitats, hybrids, floodplain, hydro-power dam.

Published online: 26 September 2017

INTRODUCTION
The Mekong River (Mae Nam Khong) is the longest river in Southeast Asia, running through six countries with a length of around 4,800 km and emptying into the South China Sea. Its catchments area is about 795,000 km², approximately about 1½ times as large as Thailand or France. The biodiversity of the Mekong River basin is only exceeded by that of the Amazon River basin, and it is one of the most productive inland fisheries in the world, with over 1300 fish species (WWF, 2008). The present study area Chiang Khan is located about 1,700 km from the estuary, at an altitude of about 200 m a.s.l. Observations were made during March–April 2006, March 2007, March 2008, January 2010, August 2010, January 2011, and February 2015.

The first part of ‘Stories from the Mekong’, was published by Idei et al. (2010) with the description of two new taxa of Cryptocoryne: C. mekongensis Idei et al. and C. crispatula var. decus-mekongensis Idei et al., with pictures of their habitats in southern Lao P.D.R. as well as of the plants. An overview of the genus Cryptocoryne as well as other species mentioned in this article may be found in Jacobsen (1980), Bastmeijer (2017) and in Jacobsen et al. (2012) regarding their occurrence in Thailand.

Maxwell (2009), presented a survey of the vegetation and flora of the Mekong between Kratie and Stung Treng, in central Cambodia, where Cryptocoryne crispatula var. crispatula was recorded. Puff & Chayamarit (2011) presented a study of the rheophytes of the Mekong at the Pha Taem N.P., some 800 km further down the Mekong from Chiang Khan together with data from the Mekong River basin, but did not report any Cryptocoryne.

CLIMATE
Chiang Khan has a tropical savanna climate with an average annual temperature of about 26°C. The dry season is from November to April with an average monthly precipitation of around 16 mm, and the driest period (December and January) having total average rainfall of merely 8 mm. The rainy season is from May until September with an average precipitation of around 1100 mm per month (Climate-data, 2017).

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There is a period of relative low temperatures from December to February with a daily mean low of 15°C (frequently down to 9°C), and a daily mean high of 29°C (up to 34°C). A higher temperature period from March and April has a daily high of 34°C (frequently rising to 41°C), and a daily low of 22°C (occasionally as low as 19°C). The daily temperature range from May to September is narrower with a daily low of around 23°C (for a month mean) to daily high of around 32°C (Accuweather, 2017; Climate-data, 2017; Tempstat, 2017).

The rainfall in the upper parts of the Mekong catchments region influences the water level fluctuations more than does the local rainfall, and thus has an influence on the Cryptocoryne ecology in the shallow water places during the dry season. In the smaller tributaries to the Mekong the local rainfall is of more importance as regards the situation in the local habitat.

INVESTIGATION AREA

The study site is on sedimentary rock in the meandering riverbed about 35 km downstream from Chiang Khan, focused on the five areas of Chiang Khan western part, Chiang Khan eastern part, Kaeng Khut Khu (Kaeng Kood Koo), Ban Pah Baen and Ban Hat Bia; all with abundant Cryptocoryne populations. The width of the river varies from about 0.3 km to 1.2 km, and at Chiang Khan town, it is approximately 0.6 km wide. The open laterite soil in the steep riverbanks (Fig. 1A) and the boundary of the secondary forests clearly reveals the extent of the highest water levels (Fig. 1B), where the soft soils are often collapsing owing to river erosion during high water, and also owing to the deforestation along and around the riverbanks. The three segments in the river profile are the steeply inclined riverbank, the seasonal floodplain, which is to some extent undulated, and the channel of the perennial river. The channel of the perennial river is not braided between Chiang Khan and Pak Chom. The floodplain may amount to about 60–90% of the width of the river in the latter half of the dry season, when it has a prominent detritus cover. Local residents perform seasonal agriculture on the exposed floodplain during the dry season (Fig. 2). The sedimentary rock riverbed is overall comparatively flat, although moderately steep places do occur. Characteristics of various sedimentary rocks, such as mud rock with the slaking, slate, clastic dike, granite-cobble conglomerate, and convolute bedding, are seen frequently. Heaps of exposed large boulders, and high rocky shelves that are found elsewhere in the Mekong flood plain do not occur in the investigated area.

RIVER PROFILE

Water level: Figure 3A shows the annual water level fluctuation for selected years. The absolute water depth, is based on a zero gauge of 194 m above MSL by an official water gauge in Chiang Khan. The minimum water level is defined as 1.9 m, and floodwater level is defined as 17.4 m (Mekong River Commission, 2017; for additional data see also Puff & Chayamarit, 2011). Figure 3B–C shows the water level measurement scale at Chiang Khan on 1 January 2010.

The water level fluctuation at Chiang Khan originates from the rainfall in the upriver districts (especially in northern part of the Lao P.D.R.) rather than the local weather, and a temporary rise in water level occurs frequently even during the dry season. Furthermore, the actual water level is always fluctuating owing to ripples or small waves, and these are not reflected in daily water gauge data. When standing on the river bank one can frequently see fluctuations of more than 15 cm within a minute and this is especially notable at water levels below 4.0 m. Hydropower dams operating in the upstream of China’s Yunnan Province have continuously been affecting water level fluctuations in recent years.

During the rainy season the muddy water contains soil particles and various types of driftwood and other floating fragments. Water visibility is always the less than 10 cm in August. The clearest water flow is found from the middle of March to the beginning of April, with visibility increasing to a depth of about 80 cm in the clearest parts. The seasonal surface water temperature in the mainstream varies from January (ca 22°C) to March–April (ca 29°C).

FLOODPLAIN

The floodplain is generally below the water level at 6.5 m (see Fig. 3). The soil surface emerges gradually after the middle of November with numerous ephemeral shallow rapid streams occurring on the
Figure 1. Seasonal water level fluctuation in front of Chiang Khan town; A. 5 April 2006, with a water level of ca 3.5 m. The bare laterite soil of the steep riverbank and the boundary of the secondary forests shows the extent of the highest water levels; B. 15 August 2010, water level ca 10.5 m. Photographs by T. Idei unless otherwise stated.
floodplain. Creeks and stagnant pools are then formed in openings on the sedimentary rock that emerges during the latter half of the dry season (Fig. 4A).

The floodplain consists of a sediment layer and a surface accumulation layer (Fig. 4B). The sediment layer is composed of an assortment of deposited detritus with stones of various sizes due to the undertow. The mixture and the vertical range varies spatially (Fig. 5). The accumulation layer consists mainly of detritus with stones; the vertical accumulation range varies from the thin accumulation immediately above the sedimentary rock, to an accumulation of more than 5 m and forming gentle undulating sandbars, which vary every year. The habitat of Cryptocoryne shows a considerable accumulation of plastics on the surface and down to a depth of 50 cm.

**VEGETATION**

The seasonal vegetation layer appears during the latter half of the dry season. The sluggish flow section is inhabited by the aquatic *Hydrilla verticillata* (L.f.) Royle, *Najas indica* (Willd.) Cham., *Potamogeton crispus* L., and *Vallisneria gigantea* Graebn. As the eastern part of Chiang Khan, located about 1 km downstream from the water gauge, an amphibious vegetation layer is situated immediately above the aquatic layer in the floodplains with a water level up to 5.5 m. Here *Cryptocoryne* is distributed in the range from water level 3.2 to 5.5 m (see Fig. 3A), and dense populations of *Cryptocoryne* are situated from water level 3.4 m to 4.0 m. In the positions higher than this, they are only found in somewhat protected habitats.

Rheophytic shrubs were not studied during our investigation, and the only species that we with some certainty can say that was found in abundance is the very widespread *Homoioa riparia* Lour. Besides shrubs, there are a number of herbaceous plants in the generally annual habitats. Puff & Chayamarit (2011) described a large number of rheophytes from the Mekong further downstream from Chiang Khan, and Maxwell (2009) described the comparable
Figure 3. A. Water level at Chiang Khan for selected years. The average value is based on data from 1980 to 2013. Redrawn from the Mekong River Commission (2017); B. Water level scales by Chiang Khan on 1 January 2010 measured in relation to the zero gauge at Chiang Khan town (194 m above MSL); C. The water level of 3.6 m as shown in B.
Figure 4. A. general view downstream at Ban Pah Baen, 21 January 2011, showing wetlands with creeks and stagnant pools among
the shrubs; B. The edge of the flood plain near to the perennial channel looking downstream, 13 January 2010. Between the emerging
rocks, sandbars and moving detritus accumulate.
Figure 5. Change in the river bed structure at the eastern part of Chiang Khan: A. The river bed characterized by a green carpet on the low lying areas with many stones (arrow) and the water surface noticeable to the left, 21 January 2011; B. The same place as A, but the water has just receded, with mud flats left bare to the right and the stones visible in A can barely be seen on 15 February 2015.
Mekong vegetation between Kratie and Stung Treng, Cambodia. Scrub thicket is found in various places associated with Cryptocoryne habitats at Chiang Khan. The vertical distribution range of the rheophytes is wider than for Cryptocoryne.

**CRYPTOCORYNE IN CHIANG KHAN**

Cryptocoryne crispatula var. crispatula (short tube – including C. crispatula cf. var. yunnanensis) accounts for about 60% of the observed Cryptocoryne populations, C. loeiensis about 30%, while C. crispatula var. crispatula (long tube) amounts to about 10%. A minority of natural hybrid types were also observed. Cryptocoryne loeiensis coexists with C. crispatula var. crispatula (short tube) in many places. Cryptocoryne crispatula var. crispatula (short tube and long tube) are situated across the whole vertical distribution. Cryptocoryne crispatula var. crispatula (short tube) is found from above the 3.5 m water level to around a water level of 5.0 m. Cryptocoryne crispatula var. crispatula (long tube) is sparsely situated in the highest part around water level 5.5 m including the “slope part” adjoined to the riverbank, from about water level 4.0 m and may be found in large patches. The C. crispatula morph with the long, white spathe is only seen a few places between the immobile stones or sedimentary rock in the deepest part of the river. Cryptocoryne loeiensis is almost exclusively situated also with natural hybrid types in the 3.6 m to 4.0 m water level.

**HABITAT**

**Bedrock bottom:** Although the midstream and lower stream region of the Mekong comprises sandy riverbed, some bedrock sections are seen around Chiang Khan (Figs. 6 & 7). The bedrock zone is an important requirement for Cryptocoryne distribution in the Mekong as it is a stabilizing factor for the rheophyte shrubs and the retention of soil forming a suitable soil environment. The sedimentary rock of the places in which Cryptocoryne is found is rather brittle with conspicuous rock fissures and cracks. Cryptocoryne is found sheltered between relatively large stones, and the plants are not affected by the bottom flow during high water. Although the riverbed is firm owing to intermingled immobile stones in the sedimentary layer, surface accumulation and a certain amount of the substrate is constantly replaced by the undertow. The sedimentary rock, which is the basis for the establishment of the habitat, is full of fractures providing a good situation for the roots of rheophytes that develop in the cracks of the bedrock (Figs. 6 & 7). Cryptocoryne is a pioneer species here, with the majority of individuals found in open spaces or in gaps between the rheophytes.

**Niches:** Cryptocoryne crispatula var. crispatula (short and long tube), C. loeiensis, and the natural hybrids are usually seen as separate patches but may occur mixed. The Cryptocoryne are the inhabitants of the relatively open zone at the margin of the rheophytic scrub thicket or the vegetation-gaps, but do not inhabit the interior scrub thicket which is a shaded area covered by woodland canopy, nor between the roots of the scrub rheophytes that develop laterally and cover the substrate forming an impenetrable mesh.

**Substrate:** The substrate varies, but no difference in the habitat niche conditions has been observed. Total substrate accumulation above the upper part of the rhizome is generally up to 20 cm. The depth of the accumulated substrate layer varies from 10 cm in the usual habitat to a depth of more than 50 cm. The substrate pH is around 6.3–6.8.

**Riverbed temperature:** In April 2010 the air temperature of the habitat at 08.00 was 23–26°C in clear weather, and the surface temperature of the riverbed 25–27°C. In the same spot, the highest temperature in the daytime reaches 35–40°C under direct sunlight. The surface temperature of the heated bare riverbed rises up to 40–55°C. Temperature in the soil at a depth of 20 cm at the time was ca 28–35°C. Thus the difference of the vertical temperature frequently varies more than 20°C for the individual plants. Although such a high temperature is unusual in Cryptocoryne habitats in general, it occurs very often during the dry season in the Mekong.

**LIFE CYCLE SUMMARY**

**Beginning growth:** The Cryptocoryne of Chiang Khan are dormant with short, dark brown terete bristle like leaves during the high water period (Figs. 7C & 8). The vertical position of a habitat and its relation to a “seasonal water level decline” greatly influences the ecology and habit of the plants. The
shallow water level at each vertical position causes repeated submergence and emergence of plants owing to water level fluctuation over small time scales, e.g. hours and minutes as the mean level lowers over the course of the dry season. Under such a progression, the terete leaves are followed by narrow hard, reddish brown leaves that are undulated, with the new leaves producing larger and larger blades (Fig. 8B).

Noticeable plant activity starts when the water depth declines continuously and becomes shallower than 20 cm. Therefore, re-growth starts in early to mid-December when the water level is 5.5 m. Water level in mid-December is generally less than 5.5 m with swift, muddy streams still flowing over the floodplain.

**Middle growth:** The middle growth period occurs when the plants become completely emergent. The

Figure 6. A. *Cryptocoryne* plants situated in cracks of the sedimentary rock in late growing season, with weeds, 17 March 2007, east of Chiang Khan; B. Patches of *Cryptocoryne* situated between the rocks near the edge of the flood plain, 18 January 2010, east of Chiang Khan.
Figure 7. *Cryptocoryne* situated in cracks in the bedrock in the eastern part of Chiang Khan. A. An emergent situation with a luxuriant growth with plants tightly tucked into the cracks, 13 March 2007; B. The same situation as in A but in a submerged state, where some characteristic rock features (arrows) can be seen, 10 January 2010; C. Excavated *Cryptocoryne* rhizomes with narrow terete leaf blades of the submerged plants from B (as seen in A) showing the characteristic modules.
Figure 8. A. *Cryptocoryne* beginning to grow in shallow water, with terete leaves followed by narrow, stiff, reddish brown leaves with an undulating margin; Chiang Khan eastern part, 11 January 2010; B. *Cryptocoryne* already emergent, at the start of the middle growth season, leaf blades are still rather stiff, reddish brown with an undulating margin; Chiang Khan eastern part, 11 January 2010.
transition period to the long narrow green or brown leaves that are typical adult leaves requires more than three weeks of growth. Simultaneously, as growth continues, the markedly undulating margin gradually disappears, and the leaf blade width increases (Fig. 8B). Each patch has various leaf colours, from dark-brown to green, depending on the exact location or habitat of the plants. The maximum active leaf number of individual plants is ca 25.

End growth: The habitat is in its driest and warmest state during the middle of March to the middle of April just before the rainy season starts (Fig. 9). All the patches are emergent, and most Cryptocoryne are developing new leaves. The moisture of the surface soil varies with the stone or rock arrangement, vicinity of rheophytes, etc. When the dry state further progresses, the dead Cryptocoryne leaves remain in patches.

Dormancy: Water level begins to rise after the middle of April with the muddy water usually containing many soil particles. From June, all Cryptocoryne patches are under water. When the leaves become submerged they begin to melt and disintegrate, and Cryptocoryne will soon become dormant. Each plant develops less than ten dark brown terete leaves with a length less than 3 cm, and a width less than 2 mm. This occurs during the highest hydraulic pressure situations in all the Cryptocoryne habitats during the rainy seasons.

Supplementary notes: The Mekong has, in recent years, changed from a situation of natural water level fluctuations arising from seasonal precipitation to artificial water level fluctuations due to up-stream dam operations. This results in long-term drying or long-term submergence according to riverbed level. In addition, the water level can suddenly rise by up to 1 m in a day, and if that water level continues, the riverbed emergent period necessary for normal Cryptocoryne growth is obstructed.

The start date of re-growth is variable, corresponding to the water level, which varies from year to year (Fig. 3). In a period of growth with a water level below 4 m, the longest period can be more than four months from the beginning of January to the middle of May in dry year, as in 1992. However, 2014, which was an exceptional high water situation, Cryptocoryne were completely inactive due to constant high water level. In 2015, patches that were already in the transition stage to an emergent condition in February, had only sparse re-growth owing to a surface accumulation of more than 20 cm of mobile detritus. Then, water level below 4 m lasted for only 17 days (21 February–9 March); the large majority of plants had not undergone their usual growth activity for two years.

The spathe: During the flowering period from the middle to end of December to the middle of February, up to four simultaneously open spathes on one plant have been observed. Flowering becomes possible when the water level becomes lower than the riverbed surface and the flowering period is less than three weeks duration. The opening period of a spathe is three days and pollination is performed by various small fly species. The keel part of the spathe is situated deep in the riverbed, and the syncarp matures in that position. Although the upper part of immature, exposed syncarps have been seen above the riverbed soil in several instances, opened syncarps have not observed. If the pattern is similar to that of C. crispatula from Peninsular Thailand, syncarps would mature about a year later at a time of low water, and later in the year than the observation period of the present study.

Rhizome and root system: The rhizome is usually situated deeper than 10 cm in the substrate, with several contractile roots further anchoring them deeply and helping stabilize them under unstable situations in a riverbed with a swift bottom flow during high water. Several upright, finely branching roots reaching above the soil surface may form a carpet-like growth. The creeping rhizome (Fig. 10 & 7C) shows an activity period during the dry season and a dormancy period during the rainy season, i.e., the swelling and constriction of one section, one “module” (Hallé & Oldeman, 1970, or one “article” sensu Engler, 1877). Rhizomes with up to ten years of modules have been observed in C. loeiensis and C. crispatula var. crispatula – long tubed spathe, which resemble pearls on a string. Subterranean stolon propagation is usually seen and may enter into a patch of a different species or variety that is close by. A lateral sprout of the rhizome, thereby forming “rhizome agglomeration”, often occurs. The quantity of agglomerations and stolons show the minimum semi-stable period of the riverbed at each place. The rhizome of C. loeiensis has been found
Figure 9. A. Stagnant pools with clear water at the peak of the dry season near Ban Hat Bia, 1 April 2006; B. River bank west of Kaeng Kood Koo towards the end of the growing season for plants situated near water level 5 m, 15 March 2010. Weeds are prominent on higher ground at this time.
Figure 10. Excavated Cryptocoryne crispatula var. crispatula rhizome of more than eight years of age showing the characteristic enlarged modules of the rhizome. Chiang Khan, January 2010.

with a diameter up to 1.5 cm, and a total length of more than 10 cm. The rhizome of C. crispatula var. crispatula has been found with a diameter up to 2.2 cm, and a length longer than 14 cm. The maximum length of contractile roots is over 50 cm.

**TAXONOMY**

The taxonomy of the species of Cryptocoryne has been dealt with in the volume of the 'Flora of Thailand': Araceae (Jacobsen et al., 2012), so this will not be dealt with here in detail, but some of the characteristics are below described.

Cryptocoryne crispatula Engl. var. crispatula – long spathe tube (Fig. 11A).

This species is based on material from the Mekong at Se Lam Phao; the type specimen is a plant with a long tube to the spathe (Hármand 65, holotype P!, isotypes B!, BM!, K!, P!).

Leaves 10–30 cm long, blade linear to lanceolate 0.5–1.5 cm wide, green to brownish (markings in open sun), smooth to undulate at margin; margin mostly entire, blades usually more or less upright, often rather stiff (lax in shaded places). Spathe 10–25 cm long, limb slender, 2–8 cm long, more or less spirally twisted, yellowish to greyish to greenish, with short to long, usually purple (sometimes black purple) markings (sometimes almost completely covering the inner surface or completely missing).

Cryptocoryne crispatula Engl. var. crispatula – long spathe tube – entirely white (Fig. 11B).

Leaves 20–30 cm long, blade 0.2–0.4 cm wide, flaccid, green to brownish, smooth to somewhat denticulate at the margin. Spathe 12–20 cm long, limb slender, 2–4 cm long, spirally twisted and entirely white, sometimes slightly purple on the outside. The spathe has a distinct sweet honey-like smell (most Cryptocoryne species smell like a rotting meat).

Plants with a similar appearance but with browner leaves and spathe which is purplish have also been found, and it is unknown if this plant is more related to the plant with the white spathe or the “normal” var. crispatula.

Cryptocoryne crispatula Engl. var. crispatula – short spathe tube (Fig. 12A, C, H).

Leaves 10–30 cm long, blade linear to lanceolate, 0.5–1.5(–2.5) cm wide, green to brownish to red brownish (markings in open sun), smooth to undulate at the margin, margin entire to finely or distinctly irregularly denticulate, usually upright to
Figure 11. *Cryptocoryne* spathes from the Chiang Khan region. A. Typical *C. crispatula* var. *crispatula* with a long tube and a spirally coiled spathe limb (Chiang Khan eastern part, 15 March 2007); B. *C. crispatula* var. *crispatula* with a long tube and an entirely white and spirally coiled spathe limb (Chiang Khan western part, 14 March 2007); C. *C. crispatula* var. *crispatula* hybrid with a somewhat short tube and a rather short spathe limb (Ban Pah Baen, 17 January 2010); D. *C. crispatula* var. *crispatula* hybrid, with a short tube and a rather short, and open spathe limb (Ban Pah Baen, 17 January 2010). Scale 2 cm.
STORIES FROM THE MEKONG, PART 2. THE CRYPTOCORYNE (ARACEAE) OF CHIANG KHAN DISTRICT, LOEI PROVINCE, THAILAND

T. IDEI, J.D. BASTMEIJER & N. JACOBSEN

Figure 12. Cryptocoryne spathes sampled from the Chiang Khan region, with short tubes and varying degrees of coiling and colouring of the spathe limb, indicating a hybrid origin. A. C. crispatula var. crispatula, short tube, with a just-opening spathe limb still showing a rather long spiral (Chiang Khan eastern part, 17 January 2010); B. C. crispatula var. yunnanensis, short tube, a spathe with a short spiral with black-purple markings on the inner surface (Chiang Khan eastern part, 17 January 2010); C. C. crispatula var. crispatula, short tube, with dark markings on the inner surface of a backwards-bent spathe limb (Chiang Khan eastern part, 18 January 2010); D. Hybrid with a short tube, a long, somewhat spirally coiled, yellowish spathe limb with few markings on the inner surface (Chiang Khan eastern part, 21 January 2011); E. Hybrid with a yellowish, recurred spathe limb with spotted dense patterning (Chiang Khan eastern part, 15 January 2010); F. Hybrid with a reddish, recurred spathe limb with elongate dense patterning (Chiang Khan eastern part, 21 January 2011); G. Hybrid with markings in the tube opening, but spathe limb recurred with the markings fading distally (Ban Pah Baen, 17 January 2010); H. Brownish, recurred spathe limb with a dense colour on inner surface and spotting in the tube opening; note also the irregular denticulations of the leaf margins (Chiang Khan eastern part, 10 January 2010). Scale 2 cm.
flat on the soil, rather stiff. Spathe robust, 6–12(–14) cm long, limb robust, 2–4 cm long, shortly spirally twisted, greyish with short to long, usually distinct strong black-purple markings of various shapes, sizes and intensities, sometimes almost wholly black-purple.

*Cryptocoryne crispatula* Engl. cf. var. *yunnanensis* (H.Li) H.Li & N.Jacobsen (Fig. 12B).

Leaves 10–30 cm long, blade 0.5–1.5 cm wide, usually, green to brownish with markings, smooth to somewhat undulate, margin entire to finely or distinctly irregularly denticulate, spathe with a rather short tube, 8–12 cm long, limb with a rather short, thick spiral with a yellowish base colour and purple-reddish spots.

The plants from Chiang Khan referred to var. *yunnanensis* differ a little from the plants from the more northern sites at Chiang Khong and in Yunnan (Li & Jacobsen, 2010), and the Lao P.D.R. by having a darker spathe and spots, and the margins of the spathe are darker. Plants are not numerous at Chiang Khan. It could be that the Chiang Khan plants referred to var. *yunnanensis* also belong to the extensive hybrid complex discussed below.

*Cryptocoryne crispatula* Engl. – deviating plants or hybrids?

There are a number of plants at Chiang Khan that deviate from the ones mentioned above in spathe morphology. All have rather short spathes of about 10 cm in length. The leaf blades of these plants fall within what is known from the populations in general: green in shaded positions, brownish to dark brown in open positions, and blades with an undulate margin, which often has distinct irregular denticulations especially in sun-exposed situations.

Different types of spathe limbs may be characterized as follows:

a. Short, upright, coiled or open spathe limb with spots and lines (Fig. 11C–D).

b. Narrow yellow upright limb without any markings on the inner surface (Fig. 13A).

c. Broad yellow recurved limb with or without markings on the inner surface (Fig. 12E).

d. Yellowish upright or recurved limb with stripes or markings on the inner surface (Figs. 12D; 13B).

e. Brownish upright to recurved limb with a more or less brown inner surface (Fig. 12C & H).

f. Brownish to almost reddish somewhat rough inner limb surface (Fig. 12F).

g. Markings in the tube opening but fading distally on the recurved limb (Fig. 12G).

A common feature for almost all of these types is that the inner surface if the spathe tube below the limb is spotted or striped reddish to purplish. The above-mentioned types are not discrete entities, with almost all intermediate forms to be found.

Although a recurved spathe limb not seen so often in *C. crispatula*, there are reports from Lao P.D.R. where forms regarded as belonging to *C. crispatula* s.l. have a yellowish-whitish, spotted recurved limb of the spathe: Tam Leuk (Linke, 1997; as *C. albida* Parker) and Nam Chim (as var. *crispatula*), as well as var. *yunnanensis* (as var. *sinensis* (Merr.) N. Jacobsen) has been found at Nam Lik (Andersen et al., 2006).

Molecular analysis of plants similar to these from Tam Leuk, Lao P.D.R. resembling *C. albida*, have been shown to fall outside the *C. albida* types from southern peninsular Thailand and Myanmar, but are more related to northern Thai and Lao populations of *C. crispatula* (Jacobsen et al., 2015).

*Cryptocoryne loeiensis* Bastmeijer et al. (Fig. 14A–D).

This species is based on material from Chiang Khan and has until now only been found there (Bastmeijer et al., 2010; Bastmeijer 1145a, holotype BKF!; isotypes CI!, L!).

The leaves resemble some of the forms of *C. crispatula* found in the area: Leaves up to 30 cm long, blade to 1.5 cm wide, margin somewhat undulate, irregularly denticulate, green to brownish and with brownish markings. Spathe ca 4–6 cm long, limb evenly purple to brown to black brown purple, obliquely forward twisted, with inner surface evenly rough throughout, and lacking a collar.

There are also plants which have a brownish, open spathe limb like *C. loeiensis* but with markings in the throat of the tube resembling those found in *C. crispatula*. These may be hybrids (Fig. 14E–F).
Figure 13. Plants of Cryptocoryne sampled from the Chiang Khan region, with short tubes and a rather open yellow spathe limb, indicating that they are of hybrid origin. A. Showing an all yellow upright spathe limb (Chiang Khan eastern part, 11 January 2010); B. Showing a slightly twisted spathe limb with purplish shading towards the tube opening; notice the irregular denticulations on the leaf blade margins (Chiang Khan eastern part, 15 January 2010). Scale 2 cm.
DISCUSSION

The number of Cryptocoryne at Chiang Khan is overwhelming. From this and other studies (Li & Jacobsen, 2010; Idei et al., 2010; Jacobsen et al., 2012) it can be concluded that Cryptocoryne are a prominent element in the Mekong, both in the main course and probably in most of the Mekong catchments area, not least in its tributaries. An observer must be there at the time of flowering, as the narrow grass-like leaves may not be recognized, or they may be totally dried out. From the documented material available (Jacobsen et al., 2012 & 2016, and unpublished) it is also likely that Cryptocoryne also occurs in the rivers and streams in the adjacent regions.

From the studied areas around Chiang Khan, it is obvious that Cryptocoryne does not occur as continuous carpets along the Mekong, but in more or less scattered places along the main river course.

Puff & Chayamarit (2011) did not record Cryptocoryne in the Pha Taem N.P. area, but this could be owing to the difficulty in finding them:
Cryptocoryne mekongensis has been found on two adjacent islands just at the Mekong–Mun River confluence as well as a little upstream in the Mekong. Cryptocoryne mekongensis was described from Don Khon, Champasak Province, Lao P.D.R, and has also been found in Kratie Province in Cambodia and Khong Chiam District in Thailand (Idei et al., 2010; Jacobsen et al., 2012).

The Cryptocoryne crispatula complex and other narrow-leaved Thai Cryptocoryne seem to be found in areas with limestone components rather than regions with a highly acid bedrock, such as granite. These soils are naturally mixed in many rivers and streams, but usually resulting in not very acidic soil and water conditions.

From our experiences in Thailand we would say that the C. crispatula types with long tubed spathes are found in habitats where there is or may be some water at the time of flowering, i.e., with a higher or maybe fluctuating higher water level during flowering, while the short tubed types are found along larger rivers or streams with a great water seasonal fluctuation and a water bearing that is always low during the dry season, such as the Mekong, where the success of flowering depends on complete emergence. We interpret the presence of long tubed C. crispatula at Chiang Khan as plants or seeds that have been washed downstream from smaller tributaries into the Mekong and have landed in suitable places where they are able to reproduce and perhaps also hybridize with other flower types present (Jacobsen et al., 2015 & 2016).

Many Cryptocoryne have a proliferous mode of vegetative propagation via long subterranean stolons, which may easily attain a length of 20–30 cm. In a number of instances as seen in Chiang Khan, not all plants show this vegetative propagation. It may be that mature plants under stable growth conditions do not produce many stolons but rely on production of new modules on their rhizome each year. Nevertheless, under more unstable conditions, such as newly established habitats, stolons tend to proliferate.

Apparently much introgression can be found between the different forms; the situation at Chiang Khan – and the Mekong and tributaries – deserves a much more thorough investigation.

THE FUTURE

Cryptocoryne habitats in the Mekong may be threatened. The ecological niches are dependent on natural seasonal water level fluctuations. Dam construction created a large upstream water reservoir over Cryptocoryne habitats. As of 2017 six major hydroelectric dams are already operating in Yunnan Province, China, in the northern part of the Mekong. A further 14 more dams are under construction or being planned in Yunnan and Tibet.

In addition a total of 11 dam projects are advancing in the Mekong midstream region and lower stream region. About 55% of this river course will be dam reservoirs, almost all bedrock sections which Cryptocoryne inhabit will be submerged by the reservoirs. In the future, the whole habitat area described here will be completely submerged on the “step” between these two dams. This may mean the extinction of C. loeensis together with other Cryptocoryne in the area.

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REFERENCES


A revision of Damrongia (Gesneriaceae) in Thailand

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ABSTRACT
The genus Damrongia Kerr ex Craib was revised. We recognise eight species in Thailand, including one newly described. This account includes an identification key, species descriptions, photographs of several species, and IUCN conservation assessments.

KEYWORDS: New species, taxonomy, revision, limestone, Loxocarpaceae.
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INTRODUCTION
The genus Damrongia Kerr ex Craib was first proposed by Kerr, to accommodate a plant (Kerr 2196) he collected in Thailand and defined as somewhat close to Didymocarpus. It was named after H.H. Prince Disakumara Krom Phraya Damrong Rachanuphap (1862–1943) of Thailand (Triboun & Middleton, 2010). It was, however, only formally published by Craib (1918) with the type species Damrongia purpureolineata Kerr ex Craib. Damrongia was later synonymised into Chirità Buch.-Ham. (Wood, 1972, 1974) due to the affinity of D. purpureolineata to Chirità lacunos (Hook.f.) B.L.Burt. At that time Chirità was a large genus which included a broad range of morphological variation. Its unifying feature was the “chiritoid” stigma, i.e. a bilabiate stigma with one lip reduced and the other well-developed and usually bilobed. The status of Chirità as a natural group was questioned by Burtt (2001) on morphological grounds and subsequently by Möller et al. (2009, 2011) and Wang et al. (2011) using molecular data. This led to the resurrection of Damrongia (Triboun & Middleton, 2010) and the dismemberment of Chirità into several other genera, including the synonymisation of the type species of Chirità, and hence the genus, into Henckelía Spreng. (Weber et al., 2011). The newly defined Damrongia included a number of the species formerly placed in Chirità sect. Chirità.

Further studies on the phylogeny of the group (Puglisi et al., 2016) led to the inclusion in Damrongia of the three Asian species of Streptocarpus Lindl. and of the Chinese species Boea clarkeana Hemsl. This introduced new morphological features into Damrongia, such as a caulescent habit and a twisted capsule, making the genus difficult to succinctly distinguish from several other genera of Asian Gesneriaceae. Characters that are common to all species of Damrongia are the chiritoid stigma and the tubular to funnel-shaped corolla, which can be white to purple or blue.

The Thai species Petrocosmea kerrii Craib also has a combination in Damrongia as D. kerrii (Craib) Pellegrin (Pellegrin, 1930) but this is a good species of Petrocosmea Oliv. (Wang, 1985; Burtt, 2001).

MATERIALS AND METHODS
This revision is based on a study of the specimens from the herbaria A, AAU, ABD, BK, BKF, CMU, CMUB, E, K, L, P, PH, QBG, SING (Thiers et al., continuously updated). All specimens have been seen unless otherwise noted. In addition to the herbarium material, a few species were studied in the wild in Thailand, from the living collection at the Royal Botanic Garden Edinburgh, and from pickled flowers. The vast majority of the floral

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2 Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh EH3 5LR, Scotland, UK.
measurements were taken from rehydrated herbarium material. When available, measurements of fresh or pickled flowers were added to the descriptions. Fruits and vegetative parts were only measured from dry specimens. The fine measurements were taken with a micrometer and should be considered accurate to 0.05 mm.

TAXONOMIC TREATMENT


Caulescent or acaulescent herbs. Leaves petiolate, phyllotaxis opposite in plants with internodes, obscure in acaulescent species. Inflorescence cymose, axillary or scapose. Calyx 5-partite, lobes highly variable in size and shape, free or partly fused into a tube. Corolla white to purple or blue, sometimes with lateral and ventral longitudinal stripes, with an extended tube, campanulate to funnel-shaped; upper lip with two lobes, lower lip with three. Stamens 2, ventral, anthers coherent and glabrous; staminodes 3. Disk annular and 5-lobed. Ovary narrow, ovoid to cylindrical, unilocular with parietal placenta; stigma chiritoide. Fruit ortho- or plagiocarpic, bivalved, valves straight or twisted. Seeds small, many.

Damrongia includes 11 species distributed from China to Sumatra. Of the eight species recognised in Thailand, seven are endemic.

Key to Thai species of Damrongia

1. Caulescent herb; flowers pendulous; fruit twisted
   2. Corolla 10–15(–22) mm long, predominantly whitish or yellowish, sometimes with purplish patches or with a very pale blue or purplish hue
   3. Calyx bilabiata and fused into a tube for 6–10 mm of length
   4. Calyx divided almost to base
   5. Calyx lobes < 3 times as long as wide, apex acute to acuminate
   6. Petioles with villous brown indumentum; leaf blade with short and fine hairs above and long and brown hairs beneath
   7. Leaf margin entire or subentire; bract 4–6 mm long; plant drying green
   8. D. trisepala


   Acaulescent lithophytic herb to ca 20 cm tall. Leaf arrangement obscure; petiole 0.8–8 cm long, 1.5–2 mm diameter, with long, orange-brown eglandular hairs; blade thinly papery when dry, green above, paler beneath, lanceolate, elliptic or oblanceolate, 1.8–18.5 × 1–6.5 cm, 1.8–3.1 times as long as wide, apex broadly acute to obtuse, base more or less shortly attenuate, sometimes unequal, margin serrate, indumentum above of eglandular hairs of different lengths, beneath of sparser eglandular hairs, abundant only along the veins, margin ciliate, secondary veins flat above and beneath, 4–8 pairs. Inflorescences scapose, 1–many-flowered, short to over 20 cm long and often compound; peduncles 1.9–2.5 cm long, ca 0.5 mm diameter, with patent eglandular hairs; bracts green, ligulate, 5–8 × ca 0.6 mm, apex acute, sessile, margin subentire, with a dense eglandular indumentum on both sides; pedicles 15–30 mm long, with long and short eglandular hairs. Calyx actinomorphic, green, with long eglandular hairs outside, inside glabrous basally and hairy apically; sepals divided to base, narrowly triangular, 7–10.5 × 0.6–1 mm wide, apex caudate, margin entire. Corolla 27–40 mm long, purple to blue; tube ca 25 mm long; upper lip ca 2.5 mm long,
lower lip ca 10.5 mm long; lobes white to purple or blue, glandular hairy outside, glabrescent inside, elliptic, very slightly spreading, upper lobes ca 4.5 \times 7 mm, lateral lobes ca 5.5 \times 7.5 mm, lower lobe ca 3 \times 8.5 mm. Stamens included in tube, inserted ca 11 mm from corolla base; filaments 10–10.5 mm long, 0.3–0.7 mm diameter, straight, slightly swollen in the middle, pale green-yellow, glabrous; anthers white, 1.5–2 \times 0.6–1 mm, thecae divergent; staminodes 3, the lateral two ca 4 mm long, arising ca 9 mm above the corolla base, the central ca 1 mm long, arising ca 10.5 mm above the corolla base. Disk ca 1 mm high, 5-lobed, lobes deeply divided but forming a continuous ring. Petiolule ca 23.5 mm long; ovary ca 9.5 \times 1 mm, densely glandular hairy; style ca 11 \times 0.4 mm, sparsely glandular hairy; stigma lower lip ca 2.5 mm long, bilobed. Capsule 2.5–4.2 cm long, ca 3 mm wide, covered in fine glandular hairs, orthocarpic, valves straight. Seeds maroon, elliptic, ca 0.4 \times 0.2–0.3 mm.

Thailand.——Unknown origin: Unknown collector s.n., with a letter from Raffill to Hemsley dated 17/10/1907 (K); Curtis s.n., probably cultivated (K); Peninsular: Phangnga [Kasoom [Kasum]], Nov. 1896, cultivated in Penang BG and collected between June and Sept. 1897, Curtis s.n. (SING 5 specimens); Surat Thani [Khirirat, Khao Phra Rahoo [Khao Phra Rahu], ca 200 m, 20 Sept. 1963, Smitinand & Sleumer 1151 (BK, E, K, L, SING)); Krabi [Mueang Krabi, near Khao Penom Bench [Khao Phanom Bench] National Park, Ban Huay To, 60 m, 17 June 2006, Williams et al. 1807 (A, BKF, E); Khao Phanom Bench, Khao Look Chang [Khao Luk Chang] Area, 13 Oct. 2002, Pallee 562 (CMUB)].

Distribution.——Endemic to Thailand.

Habitat and Ecology.——On limestone cliffs in shade of surrounding vegetation.

Proposed IUCN Conservation Assessment.——Endangered (EN B1ab(iii), B2ab(iii)). From the known localities in southern Thailand the Extent of Occurrence (EOO) is less than 5000 km² and Area of Occurrence (AOO) is calculated to be 12 km² at three localities (although note that no plants have been recently collected in Phangnga). Not all of these localities are in protected areas, the distribution is fragmented, and many limestone areas in the region are subject to human disturbance, possible mining for cement, and changes in the microclimate due to conversion of surrounding forest to agricultural land.

Notes.——The original publication only cites a Curtis specimen collected “in the Siamese territory at Kasum”. Burtt (1965: 267) cites “Curtis (holo)”. Wood (1974) suggested the type specimen is in Kew but noted that he had not seen it and we were unable to trace any material there. The only original material traced is in SING, one specimen of which has been lectotypified.

Burtt described the fruit of the Unknown collector s.n. (K), a specimen also annotated “Bot Mag 8204”, as “slightly but distinctly twisted”. The very little fruiting material examined has inconsistent and almost imperceptible twisting of the valves as was also observed in other straight-valved species and is not, therefore, a useful character to distinguish this species.

This species is most easily recognised by the long corolla, the brownish indumentum on young leaves and petioles, and the calyx lobes long and very narrow.


Acaulescent herb to ca 15 cm tall. Leaf arrangement obscure; petioles 0.6–2.5 cm long, 1–1.5 mm wide, densely covered in long, brownish, eglandular hairs; blade papery when dry, pale to mid-green above, paler beneath, lanceolate, elliptic or oblanceolate, 3–14.7 \times 1.9–6.3 cm, 1.8–2.7 times as long as wide, apex acute, base acuminate, margin crenulate to serrulate, indumentum of eglandular hairs above and beneath, hairs predominantly short above, longer and denser along the veins beneath, secondary veins slightly raised beneath, 4–6 pairs. Inflorescences scapo, 1–6-flowered; peduncles 0.5–1 cm long, indumentum as on petioles; bracts linear, 4–6 \times 0.5–1 mm, apex acute, sessile, margin entire to crenate, tomentose; pedicels 9–15 mm long, indumentum as on petioles. Calyx pale green, divided almost to base, outside densely eglandular tomentose, inside hairy; tube 0.3–0.7 mm long; lobes narrowly
lanceolate to triangular, unequal, 5–11 mm long, 0.8–1.3 mm wide, apex narrowly acute to acuminate, margin entire. Corolla 10–15(–22) mm long, pale green outside, white inside, outside with a glandular indumentum; tube 11–12 mm long; upper and lower lip lengths not measurable in available material; lobes round to elliptic, upper lobes ca 2 × 2 mm, lateral lobes ca 3 × 2.5 mm, lower lobe 3.3–3.5 × 2.3–3.5 mm. Stamens probably slightly exerted from tube, inserted at ca 4.5 mm from corolla base; filaments ca 5 × 0.1–0.2 mm, apically bent, glabrous; anthers ca 2 × 0.5–1 mm, thecae strongly divergent; staminodes 3, the lateral ca 1 mm long, arising ca 6 mm above the corolla base, the central not measured, arising ca 6.5 mm above the corolla base. Disk 0.1–0.4 mm high, annular, irregularly lobed, lobes divided to base. Pistil 10–14 mm long; ovary 2.8–4 × ca 1.5 mm, densely covered in fine glandular hairs; style 7–10 mm long, ca 0.3 mm diameter, with the same indumentum as the ovary, but becoming glabrescent apically; stigma with an expanded 1 mm long lower lip, bilobed. Capsule ca 0.85 cm long, ca 2 mm wide, plagiocarpic, valves straight. Seeds not seen.

Thailand.—Peninsular: Surat Thani [Koh Samui, Khao Ma Ngan [Khao Ma Ngaen], 26 June 1966, Sakol 1119 (BK); Nisan, Ban Kawp Kep [Ban Kop Kaep], ca 50 m, 5 Aug. 1927, Kerr 13171 (K)]; Nakhon Si Thammarat [Lan Sak, ca 100 m, 25 Apr. 1928, Kerr 15390 (K)]; Thung Song, Kao Chem [Khao Chaem], 21 July 1929, Rabil 139 (BKF, K); Thung Song, Khao Tham Long, 50 m, 31 Aug. 1982, Shimizu et al. T-28990 (BKF); Thung Song, Ban Klong Yai, 11 Sept. 2010, Middleton et al. 5393 (BKF, E)].

Distribution.—Endemic to Thailand.

Habitat and Ecology.—On limestone.

Proposed IUCN Conservation Assessment.—Endangered (EN B1ab(iii), B2ab(iii)) (Middleton, 2012a). The EOO is < 4700 km² and the AOO is about 24 km². The populations are fragmented and mostly do not occur in protected areas. Many limestone areas in the region are subject to human disturbance, possible mining for cement, and changes in the microclimate due to conversion of surrounding forest to agricultural land.

Notes.—This species is recognizable by the short corolla and fruit, the mostly crenulate leaf margin and the orange indumentum of the petioles.


Acaulescent herb to 30 cm tall. Leaf arrangement obscure; petiole 1–17 cm long, delicate, with an indumentum of long, brownish multicellular hairs; blade thick papery, ovate to rounded, 4–17 × 3–7.7 cm, 1.3–2.3 times as long as wide, apex acuminate to acute, base rounded or to 1 cm peltate, often unequal, margin entire to subentire (very finely serrate), with sparse long, white hairs above, beneath with the same indumentum found on the petioles, abundant
only along the venation, secondary veins flat on both surfaces in dry material, 2–6 pairs. Inflorescences scapose, 2–4 flowered; peduncles 10–13.5 cm long, ca 1 mm diameter, with the same indumentum present on the petioles; bracts extremely reduced to absent, if present ca 1 × 0.2 mm; pedicels 3–10 mm long, with long brownish eglandular hairs. Receptacle slightly plagirotropic. Calyx bilabiate, green, densely eglandular hairy outside, glandular inside; tube 5–8 mm long, lobes lanceolate to triangular, the upper ca 5 × 2.5 mm, the lower 7.5–8 × 2.8–3 mm, apex broadly acute to obtuse, margin entire. Corolla 33.5–42.5 mm long, purple outside, lobes white inside, throat with purple and white stripes and a yellow patch, eglandular hairy outside, with sessile glands inside; tube ca 27.5 mm long; upper lip ca 6 mm, lower lip ca 11 mm; lobes elliptic to ovate, upper lobes ca 7.5 × 10 mm, lateral lobes ca 8 × 7.5 mm, ventral lobe ca 9.5 × 8 mm. Stamens included, inserted ca 10 mm from corolla base; filaments 7.5–10 mm long, ca 1 mm diameter, straight, glabrous; anthers ca 2.6 × 1.8 mm, thecae slightly subparallel and apically confluent; staminodes 3, the lateral well developed, ca 8 mm long, arising ca 11 mm above the corolla base, with globaral antheroids, apically coherent, the central ca 1.5 mm long, arising ca 12 mm above the corolla base. Disk 0.2–1 mm high, annular, deeply 5-lobed or irregular. Pistil ca 25 mm long; ovary 6.5–8 mm long, ca 2 mm diameter, densely eglandular and glandular hairy, less so at the base, and with sessile glands; style paler green, ca 15 mm long, ca 1 mm diameter, decreasingly glandular hairy from base to top; stigma not measured. Capsule shorter than the persistent calyx, ca 1 cm long, plagio-carpic, valves straight. Seeds not seen.

Thailand. — Peninsular: Krabi [Panom Bench & Phanom Bench], 27 Mar. 1930, Kerr [16884 (ABD) (2 specimens), BKF, K (2 specimens)]; ibid., trail from Ban Penom to top of Khao Penom Bench [Phanom Bench], 1000 m, 20 June 2006, Williams et al. 1995 (BKF, E)].

Distribution. — Endemic to Thailand.

Habitat and Ecology. — Lower montane forest.

Proposed IUCN Conservation Assessment. — Critically Endangered (CR B1ab(iii)). This species is only known from Khao Phanom Bencha National Park which is around 50 km² in total. Although it is in a National Park the area is subject to considerable tourist pressure. It was previously listed as Data Deficient by Middleton (2012b).

Notes. — This species can be recognised by the combination of entire or subentire leaf margin, peltate or rounded leaf base, and sub-umbellate inflorescence.


Acaulescent herb to 20 cm tall. Leaf arrangement obscure; petiole 1–11 cm long, robust, ca 2.5 mm diameter, densely eglandular hairy; blade thin when dry, green above, pale green beneath, lanceolate, elliptic or ovate, 2.5–13.5 × 2–8 cm, 1.2–2(–3.8) times as long as wide, apex broadly acute, base shortly attenuate, obtuse or slightly auriculate, sometimes unequal, margin serrate, indumentum above of short and fine eglandular hairs, beneath of longer and brown eglandular hairs, especially abundant along the veins beneath, veins sunken above, raised beneath, 5–8 pairs of secondary veins. Inflorescences scapose, can be wide and with a well-developed compound cyme, 2–10-flowered; peduncles 6–15+ cm long, 1–2 mm diameter, densely eglandular hairy; bracts lanceolate to narrowly so, ca 6 × 1.5–2 mm, apex acute, base sessile, margin entire, covered in the same indumentum as the peduncles; pedicels 4–9 mm long, with the same indumentum as the peduncles. Calyx bilabiate, with sparse, long eglandular hairs outside, glabrous inside; tube 3–3.5 mm dorsally, 3 mm laterally and ventrally, lobes triangular or lanceolate, upper lobe ca 8 mm long, lateral lobes ca 7 mm, ventral lobes ca 5.5 mm, 0.7–1.4 mm wide, apex acuminate, margin entire. Corolla (20–)34.5–37.5 mm long, blue or purplish, tube narrow at base, then broadening, slightly pouched ventrally, finely glandular hairy outside, glabrous inside; tube (18–)31.5 mm long; upper lip ca 1.5 mm, lower lip ca 8.5 mm; lobes elliptic, upper lobes (1.7–)3 × (3.6–)6.5 mm, lateral lobes (3.1–)5.5 × (2.8–)5 mm, lower
lobe (3.4–)6 × (3.9–)7 mm. Stamens included, inserted (9.7–)17 mm from corolla base; filaments 9–11 mm long, 0.7–1.3 mm diameter, straight for \(\frac{3}{4}\) of their length, swollen in the middle, then sharply bent, with a 1–1.2 mm long projection at the anther insertion, glabrous; anthers ca 2.3 × 1 mm, thecae divergent; staminodes 3, the lateral 3–6 mm long, arising (8–)14 mm above the corolla base, the central ca 4.5 mm long, arising (8–)14 mm above the corolla base. Utrica ca 0.5 mm high, annular, deeply 5-lobed. Pistil 25–30 mm long; ovary 10–14 mm long, 0.6–1.2 mm diameter, densely glandular hairy; style 10–12 mm long, ca 0.5 mm diameter, glandular hairy; stigma ca 3.5 mm long, linguiform, shallowly bilobed. Capsule 2.7–6 cm long. Seeds not seen.

Thailand.—Unknown origin [but probably Tarutao]: Cultivated in Penang, flowered on 30 July 1891, fruited on 25 Sept. 1891, Unknown collector s.n. (K); Peninsular: Satun [Tarutao Island, Apr. 1892, Curtis 1655 (K, SING (2 specimens)); ibid., Aug. 1888, Curtis 1655 (K); ibid., Curtis s.n. (SING)].

Distribution.—Peninsular Malaysia.

Habitat and Ecology.—On limestone rocks, in shade or semi-shade

Proposed IUCN Conservation Assessment.—Least Concern (LC). The distribution of this species in Thailand is restricted to Ko Tarutao. However, it is fairly widespread in Peninsular Malaysia, where it is recorded from Kelantan, Terengganu, Pahang, Perak and Kedah.

Notes.—The flower measurements in brackets in the description above are estimates based on a smaller flower which was observed but could not be measured beyond its overall length.

The only Thai collections are the various Curtis 1655 specimens from Tarutao. There are three distinct sets of material which have been associated with the type:

1. Curtis 1655, collected in Aug. 1888. There are three duplicates, one in Kew, two in Singapore. The Kew specimen has been chosen as the lectotype.

2. Curtis 1655, collected in Apr. 1892. This collection postdates the protologue and is therefore to be excluded from the original material. Specimens: K[K000438735], SING[SING0117723, SING0117724, SING017725].

3. K000438737 with label information: “Type of Bot. Mag. T. 7236!, Penang – Curtis, From J. Veitch & Sons, Flower July 30, Fruit Sept. 25. 1891”. This specimen includes the same line drawings that are in the protologue. It would not make a suitable lectotype due to the provisions of Art. 8.2 of the ICN (McNeill et al., 2012).


Caulescent herb to 1 m tall. Leaves opposite; petiole 0.5–8 cm long, with an indumentum of mixed short glandular and long eglandular hairs; blade softly herbaceous, mid to dark green above, paler beneath, ovate to truncate or round, 3–14 × 1.3–10 cm, 0.8–2.3 times as long as wide, apex broadly acute to rounded, base broadly acute to rounded, often unequal, margin crenate to serrate or dentate, indumentum of eglandular hairs above and, more sparsely, beneath, secondary veins only slightly raised beneath and often inconspicuous above, 3–5 pairs. Inflorescences subterminal, often elongated, cymose or sometimes with a thyrsse of reduced cymes, few to many-flowered; peduncles 5–18 cm long, with an indumentum of mixed glandular and eglandular hairs; bracts green, oblanceolate, 5–9 × 1.7–3.5 mm, apex broadly acute, base sessile to attenuate, margin entire, with an indumentum of mixed glandular and eglandular hairs on both sides; pedicels 6–40 mm long, with the same indumentum observed on the peduncles. Calyx actinomorphic, green, densely glandular hairy on both sides, the upper three lobes joined at base for ca 0.4 mm; lobes narrowly lanceolate or triangular, 4–7.5 × 0.4–1.3 mm, apex acute, margin entire. Corolla (18–)23–36 mm long, purple-violet with dark purple fine stripes on throat and lobes, pendulous, trumpet-shaped and slightly reflexed upwards, with the lower lip longer than the upper, inside with two ridges of tissue arising between the upper lobes and surrounding the style, each ca 5 mm long and ca 1 mm wide, outside glandular hairy, inside minutely glandular hairy; tube
Figure 2. *Damrongia orientalis* (Craib) C.Puglisi. A. Habit; B. Inflorescence; C. Flower; D. Fruit. Photos by Preecha Karaket (A, B) and Pramote Triboun (C, D).
17.5–29 mm long; upper lip 2–6 mm, lower lip 6.5–9.5 mm; lobes elliptic, upper lobes 2.5–5 × 3.5–5.5 mm, lateral lobes 3.5–4.5 × 2.8–4.9 mm, lower lobe 2–4 × 2–4.5 mm. Stamens included, inserted 16–18.5 mm from corolla base; filaments 6–10 mm long, 0.3–1 mm diameter, slightly geniculate in the middle, with sparse glandular hairs or glabrescent; anthers 2–2.5 × ca 0.7 mm, thecae divergent; staminodes 3, sparsely glandular hairy, the lateral 3.5–6 mm long, arising 14–17 mm above the corolla base, the central ca 5 mm long, arising ca 20.5 mm above the corolla base. Disk 0.9–1.5 mm high, annular, shallowly 5-lobed. Pistil ca 28 mm long (probably still immature); ovary 13–20 mm long, 1–1.3 mm diameter, densely glandular hairy; style 8–14 mm long, 0.5–0.7 mm diameter, densely glandular hairy; stigma 2–2.5 mm long, lobed for half length, lobes ca 1 × 0.7 mm, triangular. Capsule 2–6 cm long, 0.8–1.2 mm diameter, orthocarpic, valves twisted, glandular hairy. Seeds maroon, elliptic, acuminate, 0.3–0.4 × 0.1–0.2 mm.

Thailand.—NORTHERN: Chiang Mai [Cult. Hort. Kew from seeds received from A.F.G. Kerr from the type locality, 30 vii 1913 (K)]; “type of Bot. Mag. T. 8526”, 31 Mar. 1913 (K (2 specimens)); Chom Tong [Chom Thong], Mae Soi Valley, above Du Bo cave, 475 m, 30 Sept. 1991, Maxwell 91-803 (E, L, P); Hot, Op Luang Nature Park, Doi Op Luang, Mae Jam [Mae Chaem] River, 550 m, 23 Oct. 1987, Maxwell 87-1272 (L); Hot, Ob Luang [Op Luang] National Park, 23 Nov. 2005, Poorna et al. 5816 (BK); Doi Sutep, 1800 ft, 29 Aug. 1909, Kerr 769 (ABD, K (3 specimens), PH); Mueang Chiang Mai, Doi Sutep, East side, 950 m, 17 Sept. 1988, Maxwell 88-1098 (L); Mae Rim, Pong Yaeng, Pong Taa Hoen [Pong Ta Hoen], 8 Sept. 1995, Nanakorn et al. 4181 (E, QBG); Mae Rim, Pong Yaeng, Mon Long, 25 Aug. 1998, Serm 104 (QBG); Mae Rim, Queen Sirikit Botanic Garden, 15 Aug. 1994, Nanakorn et al. 1339 (E, QBG); Mae Rim, Pong Yai Sai, 10 Sept. 1997, Nanakorn et al. 9612 (QBG); Namtok Mae Klang, 10 Nov. 1965, Sangkhachand 26 (BK); Lampang [Hang Chat, Doi Kuhn Dahn [Doi Khun Tan] National Park, Waw Cayo, Mar Pry Station area, 550 m, 30 July 1994, Maxwell 94-833 (L)]; Tak [Lan Sang National Park, ca 400 m, 23 Nov. 1965, Hennipman 311 (E, L); Lan Sang National Park, ca 200 m, 12 Jan. 1970, Smitin and 10775 (E); Mae Sot, Khao Phra War [Khao Phra Wo], 700–850 m, 12 Oct. 1979, Shimizu et al. T-18504 (L); Ban Tak, Nam Tok Kaeng Khua Forest Park, 255 m, 7 Nov. 2010, Poorna et al. 7616 (E); Sam Ngoa, Bhumibol Dam, 23 Aug. 2010, Norsaensgri 7149 (QBG)]; Phetchabun [Nam Nao National Park, Tham Pha Hong, 4 Sept. 2014, Maknoi 7190 (QBG)]; Phitsanulok [Thung Salaeng Luang National Park, Kaeng Sopa Waterfall, 22 Oct. 1984, Murata et al. T-38620 (QBG)]; Sukhothai [Khiri Mat, Ram Kham Haeng National Park, Khao Luang, 10 Sept. 2010, La-onsri & Norsaensgri 1153 (QBG); ibid., 462 m, 24 Oct. 2014, Middleton et al. 5841 (BK, SING); ibid., 960 m, 24 Oct. 2014, Middleton et al. 5839 (BK, SING); ibid., 760 m, 11 Aug. 2012, Middleton et al. 5561 (BK, BKF, E); Muang Gw, 4 Nov. 1971, Maxwell 71-665 (AAU, BK)]; NORTH-EASTERN: Loei [Phu Kradueng, 1300 m, 5 Sept. 1969, Pinnin et al. 30 (E, K, L, P); Phu Kradung [Phu Kradung], ca 1300 m, 4 Sept. 1948, Deel 23 (E); Phu Kradung, 1 Sept. 1969, Phusomsaeng & Nimanong 16 (BK); Phu Kradung, 29 Aug. 1969, Sangkhachand 2025 (BK); Naa Haew [Na Haeo], ca 700 m, 3 Sept. 1995, Nanakorn et al. 4134 (E, QBG); Na Hao, Hua Hom, Phu Suan Sai National Park, 8 July 2008, Maknoi 2474 (QBG); ibid., 1 Sept. 2008, Maknoi 2678 (QBG)].

Distribution.—Currently endemic to Thailand but likely to occur in Myanmar and Laos.

Habitat and Ecology.—Deciduous forest.

Proposed IUCN Conservation Assessment.—Least Concern (LC). The species is common and widespread in the Northern and Northeastern provinces of Thailand. Although the thresholds for EOO and AOO are not met to fall into one of the threat categories, and several collections sites fall within protected areas, there is an overall risk of habitat loss in the region and the situation should continue to be monitored.

Notes.—This species can be distinguished by the combination of its caulescent habit, long and pendulous corolla, and pendulous and strongly twisted fruit.

Thailand, gorge below Ban Kaw [Ban Ko], ca 195 m, 24 Oct. 1911, Kerr 2196 (lectotype E [E00627731], designated by Wood (1974: 152); isolecotype K [K000545607]). Fig. 3.

Aculeaceous herb to 15 cm tall. Leaf arrangement obscure; petiole 0.5–9 cm long, slender, covered in stiff rusty brown, eglandular hairs; blade papery when dry, mid green above, paler beneath, 1.3–13 × 0.8–7 cm, 1.3–2.3 times as long as wide, apex more or less broadly acute, base acute to shortly attenuate, often unequal, margin serrate to dentate, indumentum above of hispid, white, eglandular hairs, beneath of similar but rusty brown hairs, secondary veins raised beneath, 4–5 pairs. Inflorescences scapose, dense, 2–15-flowered; peduncles 4–11 cm long, slender, covered in rusty brown eglandular hairs; bracts green, lanceolate, peduncles 4–11 mm long, slender, covered in rusty brown eglandular hairs; blade papery, mid green above, paler beneath, elliptic, attenuate, often unequal, margin serrate to dentate, indumentum above of hispid, white, eglandular hairs, beneath of similar but rusty brown hairs, secondary veins raised beneath, 4–5 pairs. Inflorescences scapose, dense, 2–15-flowered; peduncles 4–11 cm long, slender, covered in rusty brown eglandular hairs; bracts green, lanceolate, peduncles 4–11 mm long, slender, covered in rusty brown eglandular hairs; blade papery, mid green above, paler beneath, elliptic, attenuate, often unequal, margin serrate to dentate, indumentum above of hispid, white, eglandular hairs, beneath of similar but rusty brown hairs, secondary veins raised beneath, 4–5 pairs. Inflorescences scapose, dense, 2–15-flowered; peduncles 4–11 cm long, slender, covered in rusty brown eglandular hairs; bracts green, lanceolate, peduncles 4–11 mm long, slender, covered in rusty brown eglandular hairs; blade papery, mid green above, paler beneath, elliptic, attenuate, often unequal, margin serrate to dentate, indumentum above of hispid, white, eglandular hairs, beneath of similar but rusty brown hairs, secondary veins raised beneath, 4–5 pairs. Inflorescences scapose, dense, 2–15-flowered; peduncles 4–11 cm long, slender, covered in rusty brown eglandular hairs; bracts green, lanceolate, peduncles 4–11 mm long, slender, covered in rusty brown eglandular hairs; blade papery, mid green above, paler beneath, elliptic, attenuate, often unequal, margin serrate to dentate, indumentum above of hispid, white, eglandular hairs, beneath of similar but rusty brown hairs, secondary veins raised beneath, 4–5 pairs. Inflorescences scapose, dense, 2–15-flowered; peduncles 4–11 cm long, slender, covered in rusty brown eglandular hairs; bracts green, lanceolate, peduncles 4–11 mm long, slender, covered in rusty brown eglandular hairs; blade papery, mid green above, paler beneath, elliptic, attenuate, often unequal, margin serrate to dentate, indumentum above of hispid, white, eglandular hairs, beneath of similar but rusty brown hairs, secondary veins raised beneath, 4–5 pairs.

Capsule 0.4–1 cm long, ca 1.5 mm wide, orthocarpic, valves straight. Seeds light brown, elliptic, 0.2–0.4 × 0.1–0.2 mm.

Thailand.—Northern: Lamphun/Tak boundary [gorge below Ban Kaw [Ban Ko], Kerr 2196 (E, K)]; Lamphun [Li, Mae Ping National Park, gorge in Mae Ping River, 300 m, 9 Sept. 2009, Middleton & Triboun 4812 (BFK, E (2 specimens), SING)]; Tak [Bhumibol Dam, near Ping River, 4 Oct. 2007, Sukhampa s.n. (BFK)].

Distribution.—Endemic to Thailand.

Habitat and Ecology.—On limestone in deciduous forest.

Proposed IUCN Conservation Assessment.—Near Threatened (NT) (Middleton, 2012c). This species is only known from gorges in the Mae Ping on the border between Lamphun and Tak. It was once speculated to be extinct due to the construction of the Bhumibol Dam and the submergence of the type locality (Smitinand, 1969). Although this did undoubtedly cause loss of this and possibly other populations the current known populations are isolated and in protected areas and not under immediate threat of extinction. However, the range is very small and should be monitored.

Notes.—This species is distinguishable by the combination of slender petioles, large bracts, and a mostly white and short corolla.

7. Damrongia tribounii C.Puglisi sp. nov.

Most similar to Damrongia lacunosa and D. trisepala in habit, corolla shape and corolla colour. Differs from D. trisepala in the shorter calyx tube and the narrower and more pubescent calyx lobes, and from D. lacunosa in the indumentum of the petioles (villous in D. lacunosa, pubescent in D. tribounii) and leaf blades (leaf with short and fine hairs above and long and brown hairs beneath in D. lacunosa and leaf with a white indumentum, hispid above in D. tribounii) and in the longer calyx lobes.—Type: Thailand, Surat Thani, Khao Sok, coll. in 2013, cultivated at TISTR, vouchered in 2014 as Triboun 6601 (holotype BFK). Fig. 4.
Figure 3. *Damrongia purpureolineata* Kerr ex Craib. A. Habit; B. Flower from front. Photos by David Middleton.
paler beneath, becoming almost blue-green when dry, lanceolate to broadly elliptic to almost rounded, 1–15 × 0.7–8.5 cm, 1–2.1 times as long as wide, apex broadly acute to acute, base acute, shortly attenuate to obtuse, sometimes unequal, margin minutely crenate or serrate, indumentum above of white, stiff eglandular hairs, uniformly dense, beneath dense only along veins, secondary veins strongly raised beneath, 4–8 pairs. Inflorescences scapose, more or less congested, 3–7-flowered; peduncles 5–25 cm long, densely eglandular hairy; bracts green, ensiform to narrowly lanceolate, 5.5–16 × 1.2–2 mm, apex acute, base sessile, margin crenulate to entire, eglandular hairy outside, glabrous inside or hairy towards the apex; pedicels 0.1–6 mm long, densely eglandular hairy on both sides; tube 2.5–3.2 mm laterally and
ventrally, 3.2–4 mm dorsally, lobes triangular to lanceolate, the dorsal 13.5–14 mm long, the lateral 6–12.5 mm, the ventral 5–11 mm, all 1–2.1 mm wide, apex acute to acuminate, margin entire with sporadic denticulations. Corolla 30–45 mm long, purple, densely glandular hairy outside, glabrous inside the tube, with sessile glands on the limb, particularly dense on the upper lip and the lower lobe; tube 38–31 mm long; upper lip ca 4 mm long, lower lip 7–9 mm; lobes elliptic, upper lobes ca 4 × 6 mm, lateral lobes ca 5 × 6 mm, lower lobe size not available. Stamens included, inserted ca 18 mm from corolla base; filaments 10 mm long, 0.3–1 mm diameter, arched but not bent, swollen in the middle, with a ca 0.3 mm long projection by the anther insertion, brown, glabrous; anthers yellow, ca 2 × 0.5 mm, thecae fully divergent; staminodes 3, the lateral ca 5 mm long, arising ca 14 mm above the corolla base, the central ca 2 mm long, arising ca 11 mm above the corolla base. Disk 0.8–1 mm high, annular, more or less lobed. Pistil developing much later than the stamens, ca 25 mm long; ovary green, ca 16 mm long, ca 0.8 mm diameter, glandular hairy; style pale green, ca 7 mm long, ca 0.5 mm diameter, glandular hairy; stigma lower lip ca 1.5 mm long and shallowly bilobed. Capsule not seen. Seeds not seen.

Thailand.—Peninsular: Surat Thani [Phanom, Khao Sok National Park, Khao Phan Thurat, 80–100 m, 28 Aug. 1982, Shimizu et al. T-28888 (KBF); Khao Sok, coll. in 2013, cult. at TISTR, vouched in 2014, Triboun 6601 (KBF)].

Distribution.—Endemic to Thailand.

Habitat and Ecology.—On limestone, in shade.

Proposed IUCN Conservation Assessment.—Data Deficient (DD). This species has only been collected in the wild twice and its distribution and population size are unknown. Khao Sok National Park has extensive limestone, much of which is difficult to explore.


Acaulescent herb to 40 cm tall. Leaf arrangement obscure; petiole 2.5–18 cm, fleshy, green, densely eglandular strigose; blade papery when dry, dark green and shiny above, paler green beneath, characteristically acquiring a blue-green colouration when dry, elliptic, 4–20.4 × 1.5–10 cm, 1.5–2.9 times as long as wide, apex acute to acuminate, base acute, sometimes unequal, margin irregularly crenate-serrate, eglandular hirsute to glabrescent above, more densely hirsute beneath, especially along the veins, veins slightly raised beneath, 4–9 pairs, tertiary venation visible. Inflorescences capitate, sub-umbellate, 3–7–flowered; peduncles pink to brown, 0.5–31 cm long, sparsely hairy; bracts green, paired, lanceolate to cordate, 6.5–19 × 4–14 mm, sparsely hairy to glabrescent, apex broadly acute, base sessile, each pair joined at the base, margin slightly serrate-crenate; pedicels 1–25 mm long, sparsely hispid. Calyx tripartite, the upper three sepals partially or fully fused, dark green, eglandular hairy to glabrescent outside, glabrous inside; tube 7–13 mm; lobes lanceolate, the upper 3 larger than the 2 lower, 5–10 mm long, 4–7.5 mm wide, apex acute, margin irregularly and shallowly serrate. Corolla purple with darker markings ventrally, 25–52 mm long, outside and inside with sessile and stalked glands, sometimes glabrescent, inside with small glands at the base of the lobes, particularly abundant on the ventral lobe; tube 31–39 mm; upper lip 8–13 mm, lower lip 15–19 mm; lobes elliptic, upper lobes ca 9 × 11–12 mm, lateral lobes ca 10 × 10–12 mm, lower lobe 8–10 × 9–14 mm. Stamens included, inserted 16–19 mm from corolla base; filaments 11–13 mm long, 0.3–0.7 mm diameter, straight, swollen in the upper half, glabrous; anthers 2.5–3 × 0.5–1.5 mm, thecae completely divergent; staminodes 3, the lateral 2.3–3.5 mm long, arising 8–14 mm above the corolla base, the central 1.1–1.3 mm long, arising 11–12 mm above the corolla base. Disk pale yellow, 0.9–2.4 mm high, annular, shallowly 5-lobed. Pistil 33–37 mm long; ovary green, 6–13 mm long, 1–1.5 mm diameter, densely covered in sessile and shortly stalked glands; style purple, 20–27 mm long, ca 0.7 mm diameter, densely glandular hairy; stigma pale purple, lip shallowly bilobed, 1.2–2 mm long. Capsule 1.3–2 cm long, ca
3 mm wide, more or less plagiocarpic, valves straight. Seeds brown, elliptic, ca 0.3 × 0.1 mm.


Figure 5. Damrongia trisepala (Barnett) D.J.Middleton & A.Weber. A. Habit; B. Flower from front; C. Flower from side; D. Fruit. Photos by Preecha Karaket (A, D) and Pramote Triboun (B, C).
[Mueang Nakhon Nayok, Nang Rong Falls, 150 m, 18 July 1975, M. Maxwell 75-704 (BK, L); ibid., 13 Aug. 1968, Larsen et al. 3355 (BK, K, L, P, SING)]; Prachinburi [Na Di, Khao Yai National Park, trail to Heo Narok waterfall, 400 m, 20 Aug. 2012, Middleton et al. 5626 (BK, E (2 specimens))]; SOUTH-WESTERN: Prachuap Khiri Khan [Kaeng Krachan NP, Pa La-u, 220 m, 14 Sept. 2006, Phonsona et al. 5232 (BK)]; PENINSULAR: Phangnga [Si Phangnga National Park, Namtok Tamnang, 8 July 2007, Maknoi 1613 (QBG); Takua Pha, Ban Kukkak, Pi Sairoong Fall, ca 100 m, 27 Aug. 2007, Wongprasert 078-45 (BK)]; Trang [Huai Yot, Khao Phu-Khao Ya [Khao Pu-Khao Ya] National Park, Nam Tok Ton Khran, 100 m, 14 June 2006, Williams et al. 1732 (A, BK)]; Phatthalung [See Bahn Pot [Si Ban Pot], Kao Boo-Kao Yai [Khao Pu-Khao Ya] National Park, Riang Tong Falls, 300 m, 25 Sept. 1986, M. Maxwell 80-73/1 (BK, CMU, L)].

Distribution.— Endemic to Thailand.

Proposed IUCN Conservation Assessment.— Least Concern (LC). The species is widespread across much of Thailand and, although there is an overall risk of habitat loss, several collections sites fall within protected areas.

Notes.— This species is characterised by the dark blue-green colour of the dry specimens, the rough leaves, the long corolla tube and the large calyx lobes.

EXCLUDED SPECIES


ACKNOWLEDGEMENTS

The authors wish to thank the curators and staff of the herbaria which sent their specimens on loan, the staff of the Bangkok Forest Herbarium for their support in the field and Herbarium, Dr Pramote Triboun for field support, information and photographs, and Mr Preecha Karaket for additional photographs. This study was funded from various sources including the Royal Botanic Garden Edinburgh (Scotland), the National Parks Board (Singapore), the BBSRC (UK), the Garden City Foundation (Singapore), the Carlsberg Foundation (Denmark), and the Davis Expedition Fund (Scotland).

REFERENCES


**Hopea macrocarpa** (Dipterocarpaceae), a new species from Peninsular Thailand

**MANOP POOPATH**, **DUANGCHAI Sookchaloem***, **SUTEE DUANGJAI** & **RACHUN POOMA**

**ABSTRACT**
A new species of the important timber tree family Dipterocarpaceae, *Hopea macrocarpa* Poopath & Sookch., from Hala-Bala forest, Narathiwat, Thailand is described and illustrated. *Hopea macrocarpa* is morphologically similar to *Hopea mengarawan* Miq. from Peninsular Malaysia, Sumatra and Borneo in its leaf shape, leaf size, leaf blade texture and number of secondary nerves. The new species differs from *Hopea mengarawan*, however, by having bigger flower buds, bigger fruits and longer fruit stalks.

KEYWORDS: Conservation assessment, Hala-Bala forest complex, *Hopea*, taxonomy.
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**INTRODUCTION**
Finding a new species of Dipterocarpaceae in South-East Asia is unexpected, as the family has probably been more closely examined than any other tree family in Asia. Approximately one-fifth (28 species) of the total number of Dipterocarp species found in Peninsular Malaysia are endemic (Ashton, 1982). Some species are restricted to areas of only approximately 100 square kilometres, for instance, *Hopea sublanceolata* Symington and *Vatica lowii* King, and this appears to be the case with the new species described here; *Hopea macrocarpa* in the Hala-Bala forest complex in Peninsular Thailand.

The Hala-Bala forest complex is mostly tropical rain forest with vegetation similar to that of northern Malaysia, which it adjoins. The Dipterocarps of the Hala-Bala forest complex were surveyed extensively from 2004–2006 by the first author (Poopath et al., 2012). Ten species and one subspecies of Dipterocarps were newly recorded for Thailand, and one new species was discovered - *Hopea macrocarpa*.

*Hopea* contains over 100 species, distributed from Sri Lanka, India, Bangladesh, Burma, southern China, Hainan, Indochina and Malesia; in Thailand, 18 *Hopea* species are recognized (Poopath et al., 2012; Pooma et al., 2017). The genus *Hopea* was placed in the tribe Shoreae together with *Dryobalanops*, *Neobalanocarpus*, *Parashorea*, and *Shorea* (Ashton, 1982).

The current infrageneric classification of *Hopea* includes two sections and four subsections delimited by Ashton (1982), based on leaf venation, the degree of constriction between the ovary and stylodium, the density of the flowers on the racemes, and the persistence of the bracteoles. Species in section *Dryobalanoides* are characterized by dryobalanoid or subdryobalanoid venation of leaves whereas scalariform leaf venation is confined to section *Dryobalanoides* (Ashton, 1982; Choong et al., 2008). *Hopea* section *Hopea* was further split into two subsections *Hopea* and *Pierrea*, while section *Dryobalanoides* was subdivided into two subsections *Dryobalanoides* and *Sphaerocarpus* (Ashton, 1982). Ashton (1982) reported 26 species of *Hopea* subsection *Dryobalanoides* throughout Malesia. In Thailand, seven described species and one undescribed species of *Hopea* subsection *Dryobalanoides* have been reported (Pooma & Newman, 2001; Poopath et al., 2012; Pooma et al., 2017). According to classification of Ashton (1982), *Hopea macrocarpa* belongs to subsection *Dryobalanoides* in its dryobalanoid or subdryobalanoid venation, fugacious bracteole, ovary without distinct stylodium, and white to pale yellow petals.

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DESCRIPTION

Hopea macrocarpa Poopath & Sookch., sp. nov.  

This species is similar to Hopea mengarawan Miq. from Peninsular Malaysia, Sumatra and Borneo in shape, size of leaves and coriaceous leaf but differs by smooth to rough bark (vs fissured bark); young twigs and petiolo without peltate scales (vs with peltate scales); flower buds ca 6 by 3 mm (vs 2.5–3 by 1.8–2 mm); three short fruiting calyx lobes accrescent wing-like, 15–23 mm long, completely enclosing the nut (vs not accrescent wing-like, 3–6 mm long, not completely enclosing the nut) and fruit stalks 2–3 mm long (vs 1–2 mm long) (See Table 1). Type: Thailand, Narathiwat, Sukhirin, Ban Phu Khao Thong, alt. 250 m, 15 May 2005, fl., Poopath B105 (holotype BKF! [BKF193891], isotype BKF! [BKF 193892]). Figs. 1–2.

Tree 20–30 m tall, buttresses more or less acute, frequently with stilt roots, bark smooth to rough, inner bark dark pink to dark red, resin exudations translucent, white. Young twigs sparsely pubescent, becoming glabrous, without peltate scales, lenticellate. Stipules ovate to oblong, 2–3 by 1.5–2 mm, apex obtuse, pubescent outside. Leaves elliptic, elliptic-ovate to broadly ovate, 6–11 by 3–6 cm, coriaceous to thickly coriaceous, glabrous or white waxy on both surfaces; base cuneate to obtuse, symmetrical; margin slightly revolute; apex subacute, to ca 1 cm long; secondary nerves dryobalanoid to subdryobalanoid, (10–)14–18 on each side, base pair continuing as intramarginal nerves, reaching to one-third of marginal leaf length on each side; tertiary nerves reticulate to scalariform-reticulate; midrib raised on both side; petioles 0.7–1.2 cm long, glabrous; domatia absent. Inflorescence 1.5–4 cm long, lax, erect, sparsely puberulent with brown peltate scales; bracteole fugacious. Flower buds ovoid, ca 6 by 3 mm; pedicels ca 2 mm long. Calyx lobes broadly ovate, subequal, sparsely pubescent, brown peltate scale outside, ciliate at tip; 2 outer with acute apex, ca 3 by 2.2 mm; 3 inner with obtuse apex, 3.2 by 2.7 mm. Petal falcate-oblong, ca 8 by 2–3 mm, apex acuminate and undulate, white to pale yellow. Stamens 15, in 2 whorls; filaments 0.5–0.8 mm long; anthers subglobose, ca 0.2 mm diam.; connective-appendages 1–3 times as long as the anthers, scattered glandular papillose. Ovary ovoid, ca 1 by 0.8 mm, glabrous; stylodium absent, attenuate to style; style slender, ca.1.3 mm long, glabrous. Fruiting calyx lobes glabrous, saccate at base, deeply thickened, oblong or oblong-ovate, 7–8 by 5–7 mm, both side margins wing-like, to 2 mm wide; 2 large fruiting calyx lobes wing-like, spathulate to oblanceolate, 3.5–6.5 by 1–2 cm, light green when young, veins 7–9; 3 short fruiting calyx lobes, ovate-lanceolate, 1.5–2.3 by 0.4–0.5 cm, apex accrescent shortly winged to 2 cm long, completely enclosing the nut. Nut ovoid, 1–1.2 by 0.7–0.8 cm, glabrous; style remnant, filiform; cone-like at fruit base, tapering from longer lobes to fruit pedicel, swollen and thickened receptacle, 3–4 mm tall; fruit stalks 2–3 mm long.

Thailand. Peninsular: Narathiwat [Sukhirin, Ban Phu Khao Thong, alt. 250 m, 15 May 2005, Poopath B105 (BKF)]; ibid, alt. 250 m, 11 July 2005, Poopath B118 (BKF); Waeng, Hala-Bala Wildlife Sanctuary, alt. 220 m, 8 June 2004, Poopath B24 (BKF); ibid, alt. 300 m, 22 July 2004, Poopath B39 (BKF); ibid, alt. 200 m, 10 July 2005, Poopath B110 (BKF); ibid, alt. 50 m, 10 July 2005, Poopath B113 (BKF)).

Distribution.—Endemic to Thailand, known only from Narathiwat Province.

Ecology.—Tropical rain forest, foot hills to ridges, 50–300 m alt., rather rare, associated with lowland Dipterocarps species, i.e. Dipterocarpus grandiflorus (Blanco) Blanco, Shorea parvifolia Dyer, S. singkawang (Miq.) Miq., Hopea pedicellata (Brandis) Symington, H. latifolia Symington, H. bracteata Burck and Vatica bella Slooten.

Phenology.—Flowering: March–May; fruiting: June–August.

Vernacular.—Chan hom (ช่วงหอ).

Etymology.—The specific epithet ‘macrocarpa’ refers to the large fruit.

IUCN Conservation Status.—Vulnerable (VU B2ab(iii)) (IUCN, 2001). The species is known only from the type locality, a rather scattered population in eastern Hala-Bala forest. The species has a restricted distribution near Narathiwat Thailand-Kelantan Malaysia border, and all individuals were found within a 50 km radius.
Table 1. Morphological differences between Hopea macrocarpa and H. mengarawan

<table>
<thead>
<tr>
<th>Characters</th>
<th>H. macrocarpa</th>
<th>H. mengarawan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bark</td>
<td>smooth</td>
<td>fissured(^1)</td>
</tr>
<tr>
<td>Indumentum</td>
<td>young twigs, petiole and leaves beneath without peltate scales</td>
<td>young twigs, petiole and leaves beneath with peltate scales(^2, 3)</td>
</tr>
<tr>
<td>Flower buds</td>
<td>ca 6 by 3 mm</td>
<td>2.5–3 by 1.8–2 mm(^4)</td>
</tr>
<tr>
<td>Style</td>
<td>glabrous</td>
<td>villose near base(^2, 3)</td>
</tr>
<tr>
<td>Two large fruiting calyx lobes</td>
<td>spatulate to oblanceolate, 3.5–6.5 by 1–2 cm</td>
<td>narrowly spatulate, 3–4(–7) by 0.8–1 (–1.2) cm(^5)</td>
</tr>
<tr>
<td>Three short fruiting calyx lobes</td>
<td>ovate-lanceolate, apex accrescent wing-like to 2 cm long, 15–23 by 4–5 mm, completely enclosing the nut</td>
<td>ovate, apex acute (not accrescent wing-like), 3–6 by 3–5 mm, not completely enclosing the nut(^5)</td>
</tr>
<tr>
<td>Size of three short fruiting calyx lobes</td>
<td>15–23 by 4–5 mm</td>
<td>3–6 by 3–5 mm(^3)</td>
</tr>
<tr>
<td>Nuts</td>
<td>1.1–1.2 by 0.7–0.8 cm</td>
<td>0.7–1 by 0.3–0.5 cm(^3, 7)</td>
</tr>
<tr>
<td>Fruit stalks</td>
<td>2–3 mm long</td>
<td>1–2 mm long(^2, 3)</td>
</tr>
<tr>
<td>Ecology</td>
<td>tropical rain forest, foot hills to ridges, 50–300 m. alt.</td>
<td>swamp forest or tropical rain forest. It favours low-lying often swampy land, river bank, or land subject to inundation, but it has also been found on low hills(^2, 3)</td>
</tr>
<tr>
<td>Distribution</td>
<td>Thailand (Narathiwat)</td>
<td>Sumatra, Borneo, Peninsular Malaysia (Kelantan, Trengganu, Pahang, Selangor, Negeri Sembilan, Johor), and Singapore(^4)</td>
</tr>
</tbody>
</table>

\(^1\) Symington et al. (2004)
\(^2\) Ashton (1982)

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REFERENCES

Figure 1. *Hopea macrocarpa* Poopath & Sookch.: A. habit & inflorescences; B. tertiary nerves scalariform-reticulate on lower surface of leaf; C. flower buds; D. ovary & stamens; E. stamens; F. fruit. Drawn by Manop Poopath.
Figure 2. *Hopea macrocarpa* Poopath & Sookch.: A. stilt roots & bark; B. resin; C. inner bark; D. inflorescences; E. flowers; F. fruit. Photographed by Manop Poopath.
**Heteropanax thaiensis**, a new species and *Schefflera wrayi* (Araliaceae), a new record to Thailand

SHUICHIRO TAGANE1*, SUKID RUEANGRUEA2, SOMRAN SUDDEE2, HIDETOSHI NAGAMASU3, AKIYO NAIK1 & HIRONORI TOYAMA1

**ABSTRACT**

Two species of Araliaceae, *Heteropanax thaiensis* Tagane, Suddee & Rueangr., a new species from Phu Kradueng National Park, Loei Province, and *Schefflera wrayi* (King) R.Vig., from Khao Luang National Park, Nakhon Si Thammarat, formerly known only from Malaysia, are added to the flora of Thailand. Descriptions and illustrations, as well as DNA barcodes of *rubC* and *matK* are provided based on our newly collected specimens.

KEYWORDS: Araliaceae, DNA barcoding, new species, Khao Luang National Park, Phu Kradueng National Park, taxonomy.

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**INTRODUCTION**


During our botanical surveys in Phu Kradueng National Park, Loei Province, in July 2015 and Khao Luang National Park, Nakhon Si Thammarat Province, in February and December 2015, we found two unrecollected species of Araliaceae in Thailand. After morphological comparison with related species based on the dry specimens of several herbaria (ANDA, BKF, BO, BRUN, FOF, FU, K, KYO, L, P, RUPP, SAR, TNS and VNM) and specimen images on the web (e.g. JSTOR Global Plants, http://plants.jstor.org), as well as study of relevant literature (Li, 1942; Frodin, 1978; Shang, 1997; Ho, 2003; Xiang & Lowry, 2007; Esser & Jebb, 2010; Tagane, 2015), we concluded that one of them was a new taxon of *Heteropanax* and the other one was identified as *Schefflera wrayi* (King) R.Vig. of Peninsular Malaysia.

To contribute to the Flora of Thailand, we here describe a new species, *Heteropanax thaiensis* Tagane, Suddee & Rueangr. and add *Schefflera wrayi* as new record for Thailand based on our newly collected material. We also provide DNA barcodes of *rubC* and *matK* regions (CBOL Plant Working Group, 2009). The methods of DNA barcoding were followed the published protocols (Kress et al., 2009; Dunning & Savolainen, 2010).

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DESCRIPTION

**Heteropanax thaiensis** Tagane, Suddee & Rueangr., sp. nov.

In Thailand, Heteropanax thaiensis is similar to *H. fragrans* (Roxb. ex DC.) Seem. but distinguished by smaller leaflets (2.6–6.7 × 1.0–2.4 cm long in *H. thaiensis* vs (3–)5.5–15.5 × (1.5–)3.5–6 cm long in *H. fragrans*), glaucous below (vs greenish), faintly visible secondary veins abaxially (vs prominent and distinct abaxially), tertiary veins invisible on both surfaces (vs distinct abaxially), longer inflorescences (142 cm vs 81 cm long) and fruits strongly compressed laterally (ca 1 mm thick vs weakly compressed laterally, 2–4 mm thick when mature). From the similar *H. brevipedicellatus* H.L. Li of China and northern Vietnam, the new species differs in having more numerous secondary veins (7–10 pairs vs 5 or 6 pairs), longer inflorescence (vs 30–70 cm), and smaller fruits (ca 3 × 5.5 mm vs 5–6 × 7–8 mm). Type: Thailand, Loei Province, Phu Kradueng National Park, near Tham So Nua Waterfall, 16°52′44.44″N, 101°44′35.35″E, alt. 1223 m, 11 June 2015, fr., Tagane et al. T4678 (holotype BKF!; isotypes FU!, K, KYO, P). Fig. 1.

Trees, 7 m tall, bark greyish brown; young twigs ferruginous stipulate hairy, soon glabrous. Leaves tripinnately compound, 86–119 cm long; petiole 23.5–43 cm long, petiole and rachis glabrous; leaflets elliptic or oblong-elliptic, 2.6–6.7 × 1.0–2.4 cm, upper surface glabrous, lower surface sparsely stipulate pubescent, glaucous, apex acuminate, acute, acuminate 0.6 cm long, base cuneate, margin entire; midrib prominent on both surfaces when dry, secondary veins 7–10 pairs, arising at 60–70° from midrib, obscure adaxially, faintly visible abaxially, tertiary veins invisible on both surfaces. Flowers unknown. Inflorescence consisting of umbel-bearing racemes corymbose arranged on terminal common axis, axes ferruginous stipulate hairy, common axis 142 cm long; racemes 44 per secondary axes, up to 65 cm long, each bearing 24–30 umbels; umbels ca 1.5 cm in diameter, consisting of many flowers; rachis of umbel 1.4–2.0 cm long; bract triangular, 0.5 mm long. Druepe strongly compressed laterally, 3 mm long, 5.5 mm in wide, less than 1 mm thick when dry, very sparsely stipulate hairy; pedicels ca 4.5 mm long, glabrescent; ovary 2-carpellate; styles 2, persistent, ca 0.4 mm long, united near the base.

Thailand.— NORTH-EASTERN: Loei [Phu Kradueng National Park, near Tham Suo Nua Waterfall, 16°52′44.44″N, 101°44′35.35″E, alt. 1223 m, 11 June 2015, with fruits, Tagane et al. T4678 (holotype BKF!; isotypes FU!, K, KYO, P)].

Distribution.— Endemic (so far known only from the type locality).

Vernacular.— Unknown.

Ecology.— On slopes in evergreen forest, ca 20 m apart from a stream; alt. 1223 m.

Etymology.— The specific epithet refers to the country where the type specimen was collected.

DNA barcodes.— GenBank accession No. LC147382 (bcL), LC147383 (matK), based on Tagane et al. T4678.

Note.— The genus *Heteropanax* Seem. is composed of trees, characterized by 2–5-pinnately compound leaves, terminal erect inflorescence, 2-carpellate ovaries, and laterally compressed fruits and seeds. The genus comprises about 11 species distributed in the Old World. While one species, *Heteropanax fragrans* (Roxb. ex DC.) Seem., is widely distributed from India to throughout Southeast Asia including Thailand, the other species have limited distribution areas (Li, 1942; Shang, 1997; Ho, 2003; Xiang & Lowry, 2007; Srivastava et al., 2010; Tagane et al., 2015). *Heteropanax thaiensis* is also considered to have a narrow range of distribution.

Conservation status.— Critically Endangered (CR) (IUCN, 2012). At present, *Heteropanax thaiensis* is known from only a single individual in the southwestern area of the top plateau, at an altitude of 1223 m. Phu Kradueng is a famous mountain in northeastern Thailand and has been intensively surveyed by many botanists (e.g., Koyama, 1986). However, we could not find specimens of this species in the major herbaria (ANDA, BKF, BO, BRUN, FOF, FU, K, KYO, L, P, RUPP, SAR, TNS and VNM), indicating that this is a rare species. Therefore it is suggested that *H. thaiensis* should be placed under the IUCN category ‘Critically Endangered’ because of its small number of individuals estimated to be less than 250 and limited distribution with an area of occupancy estimated to be less than 10 km² (criterion B2a).
Figure 1. *Heteropanax thaiensis* Tagane, Suddee & Rueangr., A. habit; B. leaf; C. bark; D. abaxial surface of leaflets; E. node of petiole, rachis and petiolules; F. dried umbel with only one fruit. All photographed on 11 June 2015.

Trees, 7 m tall, DBH 24 cm; twigs tomentose with flesh colored stellate hairs when young, soon glabrous, with conspicuous lenticels. Leaves alternate, densely stellate hairy when young, soon glabrous, palmately compound, (22–)32–60 cm long; petiole (11–)16–37 cm long; petiolules (1–)1.9–7.3 cm long, leaflets (8–)13–20, oblong-ovate to elliptic-ovate (2.5–)5.2–14.7 × (1.4–)2.1–7.2 cm, thinly coriaceous, apex acuminate, acumen to 1.5 cm long, base cuneate, obtuse, rounded, margin serrulate, glaucous abaxially; midrib slightly prominent adaxially, prominent abaxially, secondary veins 8–12 pairs, prominent on both surfaces, tertiary veins reticulate, slightly prominent on both surfaces. Inflorescences and flowers not seen. Inflorescences a terminal panicle of racemes, almost glabrous except near the base of axes that are sparsely stellate hairy; primary axis 29–37 cm long, secondary axes 2 cm long apically, 20 cm long at base; racemes 2–12.5 cm long, bracts triangular, ca 1 mm long, sparsely stellate hairy to glabrous. Fruits globular, 3.5–4 mm in diameter, prominently 5-ridged when dry, glabrous, crowned by the confluent column of styles, column of style ca 2 mm long, glabrous; pedicels 1–5 mm long, glabrous. Seeds 5 per fruit, strongly laterally compressed otherwise hemispherical, ca 3.5 mm long, 2 mm wide, 0.2 mm thick, yellowish light brown, glabrous.

Thailand.—Peninsular: Nakhon Si Thammarat [Khao Luang National Park, near the summit, in montane evergreen forest, 8°29′39.1″N, 99°44′26.8″E, alt. 1763 m, 11 Feb. 2015, fr., Tagane et al. T3776 (BKF!, FU!, K, KYO, P); on the trail from Khiriwong village to the summit, in lower montane evergreen forest, 8°29′35.7″N, 99°44′33.7″E, alt. 1693 m, 18 Dec. 2015, young fr., Tagane et al. T5229 (BKF!, FU!, K, L)].

Distribution.—Malaysia (Malay Peninsula).

Vernacular.—Unknown.

Ecology.—Locally common in lower montane to montane evergreen forest, at 1690–1770 m alt. Fruiting specimens were collected in December and February.

DNA barcodes.—GenBank accession No. LC147384 (rbcL), LC147385 (matK), based on Tagane et al. T3776.

Note.—Schefflera wrayi occurs very locally in the montane zone of Mt Berembun (as Gunong Brumber in King, 1898), Pahang, Peninsular Malaysia (King, 1898; Frodin, 1978), ca 600 km far from Mt Khao Luang. The population in Khao Luang showed slight differences from that of Mt Berembun [i.e. more numerous leaflets (vs 7–9) and almost glabrous axes of the infructescence (vs densely covered with flesh-colored stellate hairs)] but this variation is considered to be within intraspecific variation. Among the species of Schefflera in Thailand, S. wrayi is distinct in having variable numbers of leaflets from (8–)13–20, serrulate margin on the whole length of leaflets, leaves glaucous beneath, and flowers in panicles of racemes instead of umbels.

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REFERENCES


Figure 2. Schefflera wrayi (King) R. Vig. A. habit; B. top of branch; C. abaxial surface of leaflet; D. leafy twig; E. sapling; F. portion of infructescence; G. fruits. Photographed: A, B & D–G on 11 February 2015, C on 18 December 2015.


Gastrodia albidoide C (Orchidaceae), a new species record for Thailand

SAHUT CHANTANAORRAPINT*, AMONRAT CHANTANAORRAPINT & SOMRAN SUDDEE

ABSTRACT
Gastrodia albidoide C, a rare orchid species previously known only from Yunnan, China, was newly discovered in lowland evergreen forest in peninsular Thailand. A description and photographs are provided.

KEYWORDS: distribution, mycoheterotrophic orchid, peninsular Thailand, rare species

INTRODUCTION
With more than 90 currently accepted species, Gastrodia R.Br. is considered to be the largest genus of mycoheterotrophic orchids (Hsu et al., 2016; Suetsugu, 2016, 2017). The genus is widely distributed throughout the temperate and tropical regions of Asia, Oceania, and Africa. The members of the genus are characterized by mycoheterotrophic habit, a perianth tube formed by united sepals and petals, basally positioned stigma and two pollinia (Pridgeon et al., 2005).

In Thailand, six species have been recorded (Seidenfaden, 1978; Suddee, 2005, 2014; Suddee & Harwood, 2009). During fieldwork carried out to study the orchid flora of Thailand, an interesting collection of the genus Gastrodia was discovered in the southern part of the country. Based on relevant literature, it was identified as G. albidoide Y.H.Tan & T.C.Hsu, which is a new record for the country. The description and photographs below are based on the recent collection in Thailand.

DESCRIPTION

Terrestrial, mycoheterotrophic, achorophyllous herbs. Roots few, filiform, arising from neck at the top of rhizome, 3–10 cm long, ca 0.5–1 mm diam. Rhizome horizontal, fleshy tuberous, irregularly cylindrical to fusiform, gradually narrowed to apex, 25–55 mm long, 4–7 mm diam., grayish brown, finely irregularly verrucose, scaly. Flowering shoot erect, to 8.5 cm tall, creamy white to pale brown, ca 3 mm in diam. at base, unbranched. Inflorescence glabrous; whitish to pale brown, peduncle 1–8-noded; sheath membranous, ovate to broadly ovate, 3–5 mm long, 2–3 mm wide; rachis often less than 5 mm long, 1–3-flowered; floral bracts ovate-triangular to ovate-oblong, apex pointed, 9–11 mm long, 5–7 mm diam., not opening widely, fleshy; pedicel and ovary 3–7 mm long, 1.5–3.5 mm diam. Sepals connate, forming a tube at base, free at apex; dorsal sepal fused with the lateral once about ⅓ their length; lateral sepals fused to ⅔ their length, free for approximately ⅓ their length; free portion 3-lobed, verrucose, acute, hooded, margins subentire; free lobe of dorsal sepal broadly ovate, 1.5–2 mm long, 3–3.5 mm wide at base; free lobes of lateral...
sepals ovate, ca 1.5 mm long, 2 mm wide at base. Petals attached on the sinus between dorsal and lateral sepals, triangular-ovate, 0.8–1 mm long, 0.6–0.8 mm wide. Labellum free, white with tinged yellow at base, narrowly ovate or rhombic-ovate, 3.5–4.5 mm long, 2–2.5 mm wide; apex acute, apical margin irregularly denticulate; base with 2 small subglobose calli, callus ca 1 mm diam.; disc thickened and distinctly 2-ridged in the middle. Column white, straight, 4–5 mm long; with a pair of triangular stelidia at apex, stelidia ca 1.2 mm long; base with short foot; lateral winged towards apex; rostellum well developed; stigma located near base; anther cap hemispherical, 0.6–0.7 mm diam.; pollinia 2. Capsule ellipsoid, 1.5–2 cm long, 0.5–0.8 cm diam.; pedicel elongating to 8–15 cm long in fruit. Seeds fusiform, 1.5–2.1 mm long.

Thailand.—PENINSULAR: Phatthalung [Khao Banthat Wildlife Sanctuary, Khao Sam Phu Mt, ca 650 m altitude, 30 June 2016, Chantanaorrapint 2910 (BKF, spirit)].

Distribution.—China (Yunnan, type).

Ecology.—In Thailand, Gastrodia albidoides was found growing on humus under shade of lower evergreen forest, ca 650 m altitude. During the field survey, only two populations were discovered, which were ca 2 km apart; fewer than 10 individuals were observed at each locality. Flowering and fruiting recorded in June.

Notes.—Gastrodia albidoides was first described by Tan et al. (2012) from Yunnan, China. This is a remarkable new record, not only because the species was considered to be endemic to Yunnan, but also because only one sample had previously been collected. Therefore, this is a significant discovery, being only the second record ever, and a new record for Thailand from the southernmost location for this species.

Figure 1. Gastrodia albidoides Y.H. Tan & T.C. Hsu: A–B. plant in natural habitat, A. plant with flowers, B. plant with immature fruits; C–D. flowers; E. column and labellum. Photographs by S. Chantanaorrapint.
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REFERENCES


**Habenaria iyoensis** (Orchidaceae), a new record for Thailand and Nepal

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**ABSTRACT**

*Habenaria iyoensis* (Ohwi) Ohwi ex Chin S.Chang, H.Kim & K.S.Chang is newly recorded from Thailand and Nepal. A description and illustrations are provided.

**KEYWORDS:** Habenaria iyoensis, Thailand, Nepal, new distribution record.

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**INTRODUCTION**

A specimen of *Habenaria* Willd. was collected in central Nepal in September 2013 that did not match any species currently known from this country. Collections of a very similar plant were later made in two separate localities in northern Thailand, and these could also not be referred to any species previously found in Thailand. After examining literature and herbarium specimens of surrounding countries, the three plants could be identified as *H. iyoensis* (Ohwi) Ohwi ex Chin S.Chang, H.Kim & K.S.Chang from Taiwan, southern Japan and southern Korea, based on morphological characters of habit, inflorescences and flowers. We report on this new distribution record below.

*Habenaria* is the largest genus of the primarily terrestrial orchid subfamily Orchidoideae, comprising about 870 species which are distributed in the subtropical and tropical parts of the world (Pridgeon et al., 2001; Govaerts et al., 2017). Areas of particularly high species richness are sub-saharan Africa and Brazil, but the genus is also well represented in tropical Asia with nearly 200 species (Govaerts et al., 2017). *Habenaria* is characterized by mostly having greenish, whitish or yellowish flowers usually with a 3-lobed, spurred lip and a column with short or long freely projecting stigma lobes.

In Thailand, *Habenaria* is represented by 48 species, which are mainly found in savanna or forested habitats (Kurzweil, 2011, 2017; Makerd et al., 2013). Several studies on the taxonomy of this genus in Thailand have been undertaken (Seidenfaden, 1977; Kurzweil, 2009, 2011, 2017), but occasionally new species or new distribution records are still found in this country. There are currently 21 species of *Habenaria* known from Nepal (Kolanowska et al., 2016; Rokaya et al., 2013).

**TAXONOMIC TREATMENT**


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Slender terrestrial herb, 10.5–33 cm tall, glabrous. Tubers undivided, to 3 × 0.8 cm. Cataphylls 2–3, elliptic-lanceolate, apex subacute to shortly acuminate and recurved, tubular, sheathing, to 2.5 cm long, sometimes partly withered during flowering. Leaves 4–6 in a basal cluster, spreading, sessile, lanceolate, subacute or acute and occasionally mucronate, 8–14 × 1.2–2.4 cm, margins entire but papillose, veins not prominent. Inflorescence: peduncle cylindric, slender, 1–3 mm in diameter; sterile bracts 2–4, broadly lanceolate, long-acuminate, 1.4–2.5 × 0.5–0.8 cm, not sheathing, subfoliaceous or foliaceous, margins entire but papillose; rachis (2.5–)9–14 cm long, with 3 to 20 laxly arranged flowers; lower floral bracts ovate-lanceolate, tapering from a broad base, acute to long-acuminate, 10–13 × up to 5 mm, shorter than the ovary, margins entire and papillose like leaves but papillae more densely arranged. Flowers resupinate, ca 17 mm across, light yellowish-green. Median sepal erect, ovate-elliptic, naviculate, obtuse or shallowly retuse, 6–7 × 4.5–5 mm, 2–3-veined, margins entire and sometimes pale, margins short and irregularly papillose towards the apex; lateral sepals spreading, descending, elliptic to lanceolate-oblong, acute or obtuse, 6.5–7.1 × 2.6–3.2 mm, 3-veined, margins entire and decurved distally, sometimes pale. Petals connivent with the median sepal and forming a hood together with it, lorate with pronounced semi-ovate basal posterior lobe and smaller basal anterior lobe, obtuse, 6.2–7 × 1.2–1.7 mm, 2-veined or veins not significant. Lip 3-lobed from the base, spurred, with an obscure collar in front of the spur mouth; side lobes borne at right angles to the midlobe, transversely divaricate, linear and attenuate with obscure basal posterior lobes to 0.5 × 0.5 mm, acute, 12–13 × 0.8–1.2 mm, semi-terete, longer than the mid-lobes, curved upwards distally; mid-lobe descendent, linear, terete, obtuse, 6.5–8 × 1–1.3 mm; spur descendent and bent forwards, cylindric, obtuse, to 31 mm long and 1.3 mm thick, longer than and close to the ovary. Column 3–3.8 mm long, anther loculi erect, parallel, to 2.5 mm long, narrow basal thecae extensions to 2 mm long, connective short and rather broad, central rostellum lobe wide and half as long as anther loculi, stigma stalks short, rather thick, ca 1.8 × 0.8 mm. Ovary indistinguishable from pedicel, 13–15 mm long and 1.5–2 mm in diameter, curved, with insignificant narrow neck [based on the Nepalese and Thai specimens].

Thailand.— **NORTHEAST**: Mae Hong Son, 2014 (?), *Pingyot* 19 (*QBG, QBG* [spirit]); Tak, Umphang, Doi Hua Mot, ca 1000 m, 30 Aug. 2014, *Watthana* 4211 (*QBQ, QBG* [spirit]).

Nepal.— **EASTERN**: Ilam, Kolbung, Aug. 2013, 1700 m, Raskoti 001399 (*KATH*).

Distribution.— *Habenaria iyoensis* (Ohwi) Ohwi ex Chin S.Chang, H.Kim & K.S.Chang is known from Taiwan, southern Japan and South Korea (Ohwi, 1965: 329; Su, 2000: 915; Chen & Cribb, 2009: 158; Govaerts et al., 2017); it is here newly recorded from Thailand and Nepal which is a considerable range extension. A distribution area encompassing Nepal, south-east Asia and Taiwan is not known in the orchid family. Examples of orchid species with this kind of distribution include *Bulbophyllum affinis* Wall. ex Lindl., *Calanthe tricornata* Lindl., *Cremastria appendiculata* (D.Don) Makino, *Cymbidium lancifolium* Hook., *C. macrorrhizum* Lindl., *Goeuyera foliosa* (Lindl.) Benth. ex C.B.Clarke, *Habenaria dentata* (Sw.) Schltr., *Herminium lancese* (Thunb. ex Sw.) Vuijk, *Liparis bootanensis* Griff., *L. nervosa* (Thunb.) Lindl. and *P haíus flavus* (Blume) Lindl.; most of these are terrestrial species. It is apparent that in a distribution area ranging from the Himalayas eastwards, Taiwan is often at the end point (P. Ormerod, pers. comm.). The disjunct distribution of *H. iyoensis* is particularly interesting. However, the plants of this species are not very conspicuous, and may simply have been overlooked in other regions. It is also possible that plants were misidentified, or mistaken for different species and therefore not collected.
Etymology.—The species is named after the type locality in Iyo Province, a former province of Japan in an area which is today Ehime Prefecture on the island of Shikoku.

Ecology.—In Thailand the plants were found growing terrestrially in open forest on limestone hills. The Nepalese plant was growing at an elevation of 1700 m as a low-level epiphyte on tree trunks in subtropical broadleaf forest. In other parts of the distribution area the plants grow terrestrially on rocky slopes and roadsides in open forest below 700 m (Su, 2000: 916; Lin, 1977: 700 [as Habenaria rupestris(sic)])

Phenology.—Our plants from Thailand and Nepal were flowering at the height of the rainy season in late August. Plants in Taiwan flower in

Figure 1. Habenaria iyoensis (Ohwi) Ohwi ex Chin S.Chang, H.Kim & K.S.Chang: A. Plant habit, from Raskoti 001399 (Nepal); B. Flowers, from Raskoti 001399; C. Plant habit, from Pingyot 19 (Thailand); D. Flower, from Pingyot 19; E. Flowers, from Watthana 4211 (Thailand).

Conservation.—No information regarding the conservation status of the species using IUCN criteria is available as yet (IUCN, 2017). At the single known locality in Nepal, 15 plants were found on the trunks of three trees. Very few plants were observed at the two localities in Thailand. In Japan the species was referred to as ‘very rare’ (Ohwi, 1965: 329).

The species is very widespread, but is currently only known from widely scattered localities in the Himalayas, and in south-eastern and north-eastern Asia. Based on our assumption that its distribution area may be incompletely known we interpret its conservation status currently as ‘data deficient’. However, threat level is probably not high. The flowers are not very attractive and rather small, and plants are therefore not likely to become the target of collectors.

Notes.—From our examination of several descriptions (Ohwi, 1936: 382, 1965: 329; Su, 2000: 915; Lin, 1977: 204; Chen & Cribb, 2009: 158), illustrations (Ohwi, 1936: fig. 3; Lin, 1977: 205; Chen et al., 2010: 210; Nakajima, 2012: 85) and digital copies of herbarium specimens at KPM and TAI, it is apparent that the morphological variation is extensive in this species. Variation is observed mainly in the leaf size; the number, size and orientation of the sterile bracts on the peduncle; the length of the rachis relative to the length of the peduncle; the number of flowers in the inflorescence; as well as the size of the flowers.

In the gynostemium, all three specimens have prominent lobes situated below the stigma stalks which are extensions of the basal portion of the auricles. The pronounced nature of these structures appears unusual in the genus Habenaria, but its distribution in the genus and extent of formation has not been assessed yet. These lobes of the gynostemium of *H. iyoensis* have also been illustrated in Japanese and Taiwanese specimens by Maekawa (1971: fig. 24C) and Lin (1977: 205, figs. 15, 19 & 46) [as *H. rupestri*a(sic)]. Morphologically, these lobes are reminiscent of structures labelled “b?” in some African *Habeneria* species where they have been interpreted as staminodial structures (Kurzweil & Weber, 1992: 51).

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REFERENCES


**Thunbergia lutea** T. Anderson (Acanthaceae), a new record for Thailand

CHALERMPOL SUWANPHAKDEE1,2 & PIYAKASET SUKHSAHAN3

ABSTRACT

Thunbergia lutea T. Anderson, a new record for Thailand is reported. A description, illustrations, and distributional data are provided.

KEYWORDS: Flora of Thailand, IUCN Conservation status, new record, tropical plant.

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INTRODUCTION

Thunbergia Retz. is a large genus in Acanthaceae subfamily Thunbergioideae s.l. (Schonengerber & Endress, 1998; Scotland & Vollensen, 2000; McDade et al., 2008), consisting of about 100 species restricted to tropical and subtropical regions of Africa, Madagascar, Asia, and Australia (Borg et al., 2008; Adhikari et al., 2013). Many Thunbergia species are widely cultivated for ornamental and medicinal purposes. Based on Thai specimens deposited in the following herbaria: AAU, BK, BKF, BM, BO, C, CMU, DMSC, G, G-DC, K, K-W, KEP, KKU, L, PSU, QBG, SING and TCD (herbarium codes from Thiers, continuously updated), and also relevant references, nine Thunbergia species have been recorded as native in Thailand: T. coccinea Wall. ex D. Don, T. colpifera B. Hansen, T. fragrans Roxb., T. grandiflora Roxb., T. hossei C. B. Clarke, T. laurifolia Lindl., T. nivea Craib, T. papilionacea W. W. Sm. and T. similis Craib (Kurz, 1877; Clarke, 1885; Benoist, 1930; Imlay, 1938; Cramer, 1998; Grierson & Long, 2001; Kress et al., 2003; Jiaqi et al., 2011; Norsaengsri & Tatana, 2012; Adhikari et al., 2013; Office of the Forest Herbarium, 2014).

In 2003, the second author visited Thailand’s second highest mountain, Doi Phahompok in Chiang Mai province, and discovered an interesting Thunbergia species growing amidst low disturbed vegetation at the edge of lower montane forest at about 2000 m alt. After taking the specimens back to the herbarium the plant was identified as T. lutea T. Anderson. This information was later passed on to the first author during his preparation of the treatment for the Flora of Thailand. We then decided to revisit Doi Phahompok to gather further information on this species. The plant was then compared to the descriptions in the Flora of China and Flora of Bhutan, and to the type collection (J. D. Hooker s.n., lectotype K 000357692!). We now confirm that T. lutea is indeed a new record for the country.

NEW RECORD


Short perennial herbaceous to slightly woody climber to 5 m long, with cylindrical storage roots. Stems slender, twining or climbing, glabrous except hisrute at node, stem ± 4-angled. Leaves opposite; petiole 1.5–3 cm long, glabrous; lamina ovate to ovate-oblong or elliptic to elliptic-oblong, 10–14 by 4–7 cm, abaxial surface glabrous, adaxial surface...
Figure 1. *Thunbergia lutea* T. Anderson: A. Branch with flowers and fruits; B. Corolla opened to show stamens; C. Stamen; D. Pistil; E. Fruit; F. Storage root. (Drawn from Suwanphakdee et al. 528 (BK, BKF, KKU, QBG) and Suwanphakdee & M. Wongnak 542 (storage root) (BK, BKF, KKU, QBG).
Figure 2. *Thunbergia lutea* T. Anderson: A. Plant habit with flowers; B. & C. Variation in the flowers; D. Didynamous stamens; E. Close-up of stamens; F. Storage root; G. Fruit; H. Seed. (Photos by C. Suwanphakdee & P. Suksathan).
Thunbergia lutea is known only from one mountain (Doi Phahompok, Chiang Mai province) where two small populations (altogether fewer than 100 individuals) were observed. It is considered rare for the country.

Notes.— Thai material of Thunbergia lutea differs somewhat from material from India, Nepal and China in the number of calyx lobes at 12–14 rather than the usual 10 (Clarke, 1884; Jiaqi et al., 2011; Adhikari et al., 2013). This character is, however, known to be variable in other species, e.g., 10–17 toothed in T. fragrans (Imaly, 1938; Jiaqi et al., 2011; Adhikari et al., 2013).

This beautiful high altitude species is characterized by its rigid leaves with pinnate veins (versus palmate in other Thai species), cylindrical storage roots, long pedicel, and anther thecae with dense long apical hairs.

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REFERENCES


Notes on the genus Ormosia (Fabaceae-Sophoreae) in Thailand

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ABSTRACT
Ormosia mekongensis Mattapha, Suddee & Rueangr. is described as a new species and illustrated. Its conservation status is assessed and its distribution is mapped. Three other species, Ormosia grandistipulata Whitmore, O. penangensis Ridl. and O. venosa Baker, are updated for the generic account for the Flora of Thailand: the first could now be fully described, because flowers were found, the latter two are new records for peninsular Thailand.

KEYWORDS: Lectotypifications, Mekong, new species, new record, Peninsular Thailand.
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INTRODUCTION
Ormosia Jacks., a genus in the tribe Sophoreae of the Leguminosae, comprises approximately 90 species distributed in Asia, the Americas and Australia (Queensland) (Lewis et al., 2005). The genus was revised for Thailand by Niyomdham (1980), who accepted eight indigenous species, and here we add three species, which bring the total number of Ormosia species for the Flora of Thailand account to 11. The three species that are new to Thailand are O. mekongensis Mattapha, Suddee & Rueangr., O. penangensis Ridl. and O. venosa Baker. The species newly described here, O. mekongensis, is most similar to O. henryi Prain but differs in having the calyx glabrous on the inner side (densely hairy on both sides in O. henryi), the standard lacking basal callosities (present at the claw on the inner side in O. henryi), and pods that are 1–2-seeded (up to 10 in O. henryi). Ormosia penangensis and O. venosa are from peninsular Thailand. Additionally, we provide the first full description of the flowers of O. grandistipulata Whitmore as the flowers were unknown when first published by Whitmore (1969).

DESCRIPTIONS

Tree 10–15 m tall; young shoots, inflorescences and calyces pubescent. Leaves: rachis 20–25 cm long, apex acute, puberulous; petioles 6–10 cm long; stipules large, ovate, 2–5 by 1–3 cm, puberulous on both sides, persistent; leaflets 9–13, coriaceous, oblong-obovate, 4–18 by 2.5–8 cm, upper surface glabrous, lower surface glabrescent, sparsely hairy along midrib; apex acuminate to cuspidate, base cuneate; secondary veins 8–10 pairs. Inflorescence a terminal panicle, 25–30 cm long, pubescent; secondary axes up to 16 cm long; bracts similar to stipules but much smaller, puberulous; bracteoles similar to bracts, ca 1 by 0.5 mm, inserted at top of pedicels, outside hairy, inside glabrous. Pedicels ca 3 mm long, hairy. Calyx campanulate, 3–3.5 mm long: lobes triangular, apex acute, both sides densely hairy, upper lobes 2, ca 3 by 3–4 mm, lower lobes 3, ca 2 by 3.4–4 mm. Corolla creamy white; standard obovate with basal callosities, 7–8 by 9.5–10 mm, apex retuse, base minutely auriculate, margin entire, both sides glabrous, claw ca 2 mm long; wings oblong, ca 6 by 3 mm, apex obtuse, base minutely auriculate, margin entire, both sides glabrous, claw ca 3 mm long; keels

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falcate, ca 6 by 3–3.5 mm, apex obtuse, base minutely auriculate, margin entire, both sides glabrous, claw 4.5–5 mm long. Stamens 10, all free; filaments glabrous, short ones ca 7 mm long, long ones ca 10 mm long; anthers more or less flattened, ca 0.8 by 0.5 mm. Ovary with 2 ovules, hairy at base and along sutures; stipe ca 2 mm long; style 5–6 mm long, glabrous; stigma small. Pods elliptic-oblong, fleshy, glabrous, 4–5 by 2–3 cm; valves thickened, coriaceous, yellow to yellowish brown when mature, glabrous. Seeds 1(–2), laterally compressed, ca 25 by 15 mm; testa hard, scarlet, papillate, not easily separable from the cotyledons.

Thailand.— PENINSULAR: Songkhla, Yala. Distribution.— Peninsular Malaysia (type).

Ecology.— Evergreen forest, ca 50 m alt. Flowering April–May; fruiting June–July.

Vernacular.— Phai chang ( ListItem is Type: Thailand, Phu Phan National Park, alt. 320 m, 11°1’17” N 103°59’29” E, 29 Apr., 2017, BKF; isotypes BK!, BF!, E!, K!, KKU!, L!, P!, QBG!). Figs. 1–2.

Tree 10–15 m tall, young shoots, rachis, inflorescences and calyces, with short hairs. Leaves imparipinnate; rachis 4–8 cm long, densely hairy; petioles 2–4 cm long; stipules absent; ultrasgual part up to 2 cm long. Leaves 5–7, elliptic, 5–6 by 1.5–2 cm, apex acuminate, base cuneate, coriaceous, margin entire, upper surface glabrous, lower surface hairy with scattered adpressed hairs, glaucous; petiules ca 5 mm long; secondary veins 6–8 pairs. Infl orescence a terminal panicle or sometimes with axillary racemes, 8–10 cm long, densely hairy. Pedicels 5–6 mm long, densely hairy. Calyx campanulate, 2.5–3 mm long, persistent, becoming woody in fruit; lobes triangular, 4–5 by 3.5–4 mm, longer than the tube, apex acute, both sides densely hairy, upper lobes 2, lower lobes 3. Corolla light yellow or light pink, slightly fragrant; standard orbicular with a green patch at the base on the ventral side, 10–12 by 9–10 mm, apex emarginate, base tapering to claw, margin entire, both sides glabrous, claw ca 3 mm long; wings oblong, 9–10 by ca 4 mm, apex obtuse, base slightly auriculate, both sides glabrous with a green path at base on the inner side, claw ca 3 mm long; keels oblong-elliptic, 8–9 by ca 4 mm, apex acute, based slightly auriculate, outside hairy along median vein, inside glabrous, claw ca 5 mm long. Stamens 10, all free; filaments flattened, 10–12 mm long, glabrous; anthers ca 1 by 0.5 mm, glabrous. Ovary densely adpressed hairy; ovules 1–3; style 8–9 mm long, glabrous. Pods flattened, discoid, convex at centre, 2.2–2.4 by 2.8–3.3 cm, woody, brown to grey when dry, hairy, dehiscent, slightly sepalate, margin crested. Seeds 1(–2), orbicular to ellipsoid, 0.8–2 by 1–1.5 mm, bright red.

Thailand.— NORTH-EASTERN: Sakon Nakhon (Phu Phan National Park, alt. 320 m, 11°1’17” N 103°59’29” E, 29 Apr., 2017, M attapha et al. 1164 (holotype BF!; isotypes BK!, BF!, E!, K!, KKU!, L!, P!, QBG!); EASTERN: Ubon Ratcathani, Khong Chiam, Dong Na Tham Forest, Pha Taem National Park, dry evergreen forest on the way to Pha Cha Na Dai, alt. 440 m, 28 Feb. 2007, Suddee et al. 3064 (paratype BF!).

Distribution.— Only known from Thailand, but likely to be found in Laos in areas near the Mekong river (Fig. 3).
Ecology.— Dry deciduous to dry evergreen forests, 320–500 m alt. Flowering April–May; fruiting June–July.

Vernacular.— Ma klam mae khong (มะแอกแม่ข่อง).

Conservation status.— According to the IUCN threatened criteria (IUCN, 2012), we assess it as Data Deficient (DD) because of its small population size with a few individuals for each locality; a further assessment should be carried out when more data is available.

Notes.— *Ormosia mekongensis* is also similar to *O. penangensis* Ridl. in leaf and inflorescence size but differs by having the standard without a hood at the apex (with hood in *O. penangensis*), free of the keel petals (fusion in *O. penangensis*), ovary with 1–3 ovules (2–6 in *O. penangensis*) and much smaller pods (4.5–10 cm long in *O. penangensis*).

Figure 1 *Ormosia mekongensis* Mattapha, Suddee & Rueangr.: A. Habit and inflorescence; B. Pod; C. Flower; D. Ovary with persistent calyx; E. Stamens; F. Dissected flower: standard petal (upper), wing petals (lateral ones), keel petals (lower ones). A & C–F from Mattapha et al. 1164 (BKF); B. from Suddee et al. 3064 (BKF). Drawn by A. Khamkamneod.
Figure 2 Ormosia mekongensis Mattapha, Suddee & Rueangr.: A. Inflorescences; B. Pods. Photos by S. Mattapha (A) & P. Trisarasri (B).


Tree ca 12–25 m tall; young shoots, inflorescences and calyces pubescent. Leaves: rachis 1.6–11 cm long, pubescent to glabrescent; stipules indistinct; petioles 0.8–3.8 cm long; leaflets 3–7, coriaceous, elliptic-oblong, 2.5–9.7 by 1.8–4.5 cm, upper surface glabrous, lower surface glabrescent to sparsely hairy, glaucous, apex acute to acuminate with minutely apiculate, base cuneate to obtuse, margin entire; petiolules 2–5 mm long; secondary veins 7–12 pairs. Inflorescence not seen. Pods subglobose to oblong, septate between seeds, subdiscoid if 1-seeded, 4.5–10 by 2.8–4.5 cm, woody, rugose, densely hairy with brown hairs, margin crested; valves thickened; stipule 0.5–2.3 mm long. Seeds 2–6, ovoid, laterally compressed, 15–28 by 15–25 mm, reddish brown, smooth.

Thailand.— Peninsular: Yala (Than To district, Khao Hin Yok), Narathiwat.

Figure 3. Known distributions of *Ormosia mekongensis* Mattapha, Suddee & Rueangr. The map was created using QGIS version 2.14.1-Essen (QGIS Development team, 2016).
Distribution.—Peninsular Malaysia (type).

Ecology.—Disturbed evergreen forest on thin soil over quartzite and on limestone mountain in evergreen forest, 450–500 m alt. Fruiting December–February.

Vernacular.—Phai penang (年之花).

Specimens examined.—Middleton et al. 2940 (BKF); Puudja & Cholkulchana 736 (BKF).

Notes.—*Ormosia penangensis* was only previously known in Myanmar, Malaysia and Indonesia. The collections, bearing to six seeds per fruits, have recently been collected in peninsular Thailand. The collection of Mohammed Haniff 16338 (BM000958791; Natural History Museum, 2014) is selected as the lectotype for *O. penangensis* because it is in a better condition when we compare to the other syntypes. Koorders 42648B (LO416467) at L is selected here as the lectotype for *O. incerta* (the heterotypic synonym of *O. penangensis*) as it is a well preserved specimen.


Tree ca 28 m tall; young shoots, inflorescences and calyces tomentose. Leaves: rachis 1–2 cm long when flowering, up to 5 cm long when fruiting, densely hairy with velvety brown hairs or tomentose; petioles 1.5–3 cm long; stipules ca 2 by 7 mm, caducous; leaflets 5–7, oblanceolate, 3–4 by 1–2 cm when flowering, larger when fruiting, 8–10 by 4–5 cm, upper surface glabrous, dark green, lower surface densely tomentose with yellow-brown hairs; apex acute to retuse or emarginate, base cuneate; secondary veins 10–12 pairs, raised below, parallel. Inflorescence a terminal panicle, 10–15 cm long, tomentose; bracts 5–8 mm long, ovate, subpersistent; bracteoles similar to bracts, ca 4 by 2 mm, inserted at the top of pedicels, tomentose. Pedicels 5–6 mm long, tomentose. Calyx campanulate, 6–7 mm long; lobes triangular, 3–4 by ca 3 mm, apex acute, both sides densely hairy with short yellow-brown hairs, upper lobes 2, lower lobes 3. Corolla white to yellowish with a green tinge at the middle of standard; standard orbicular, with basal calliostomes, 7–8 by 9.5–10 mm, apex retuse, base inauriculate, margin entire, claw ca 2 mm long; wings 8–9 by 2.5–3 mm, apex obtuse, base inauriculate, margin entire, sculptured, claw ca 2 mm long; keels 8–9 by 2.5–3 mm, base inauriculate, margin entire, claw ca 3 mm long. Stamens 10, all free; filaments glabrous, shorter ones 6–7 mm long, longer ones 9–10 mm long; anthers ca 0.8 by 0.5 mm. Ovary 1–2-ovuled, hairy with brown hairs; style ca 2 mm long; style 8–10 mm long, glabrous; stigma small. Pods ovate to obovate, 4–5 by 2–3 cm, fleshy, woody, yellow when mature, glabrous; valves thickened. Seeds 1(–2), oblong-elliptic, ca 15 by 15 mm, bright orange.

Thailand.—Peninsular: Songkhla, Phangnga.

Distribution.—Peninsular Malaysia (type).

Ecology.—Evergreen forest, ca 280 m alt. Flowering January–March; fruiting April–July.

Vernacular.—Kasae met som (กะแสมเจ้าเมื่อส้ม).

Specimens examined.—Gardner & Sidisunthorn ST1955 (BKF) & ST2245 (BKF).

Notes.—*Ormosia venosa* is characterised by the oblanceolate leaflets, which are densely covered with a brownish tomentum on the lower surface and the brownish-tomentose infl orescences, the standard with basal callosities, and the pods that are 1–2-seeded. The species was originally believed to occur only in India, Malay Peninsula and Indonesia, but two collections with flowers and fruits are now known from peninsular Thailand. The species resembles *O. pachycarpa* Champ. ex Benth. but differs by its glabrous pods with red seeds (tomentose pods with black seeds in the latter species).

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REFERENCES


The genus *Alysicarpus* Neck. ex Desv. (Leguminosae) in Thailand

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ABSTRACT
The three species of *Alysicarpus* known from Thailand are described with notes on their distribution and ecological data, vernacular names and photographs. They are *Alysicarpus bupleurifolius*, *A. rugosus* and *A. vaginalis*. A key for the identification of the three species is provided. A lectotype for *Alysicarpus wallichii* is selected here.

KEYWORDS: Desmodieae, Fabaceae, lectotypification, revision.
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INTRODUCTION

*Alysicarpus* Neck. ex Desv. (Desmodieae, Leguminosae) comprises about 30 species distributed in tropical and subtropical regions in Africa, Asia and Australia, with maximum diversity in India, South Africa and Australia (Pedley, 2001; Adema, 2003; Huang & Ohashi, 2008; Lewis et al., 2005; Pokle, 2017). The genus derives from two Greek words, 'hylýsis' meaning chain and 'carpos' meaning fruit, in reference to the segments of the pods (Lewis et al., 2005). Necker (1793) separated out *Alysicarpus* from *Hedysarum* and was later validly published by Desvaux (1813). The generic name and type of genus, *Alysicarpus bupleurifolius*, proposed for conservation were given in the St. Louise Code (Greuter et al., 2000).

In Thailand, *Alysicarpus* has been listed in two checklists by Craib (1928) and Pooma & Suddee (2014) with four and three species, respectively. However, valid scientific names and comprehensive information on the morphology, distribution and ecology of this genus in Thailand are needed for the forthcoming Flora of Thailand account.

MATERIALS AND METHODS
Fresh field collections in Thailand and specimens from the following herbaria were consulted: AAU, ABD, BCU, BK, BKF, BM, C, CMU, CMUB, E, K, KKU, L, P, PSU, QBG and SING (herbarnium acronyms follow Thiers, 2016). Morphological, ecological and distribution data, vernacular names and illustrations are also provided.

TAXONOMIC TREATMENT

**ALYSICARPUS**


Herbs, annual or perennial. Stems creeping or ascending, simple or branched, glabrous or with hooked hairs and patent straight hairs, rarely with

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appressed hairs. Leaves 1-foliolate, chartaceous or subcoriaceous, alternate, stipulate and stipellate; stipules free or connate; venation reticulate. Inflorescence a pseudoraceme, terminal or axillary, each node on rachides usually with two flowers. Flowers bisexual, zygomorphic, pedicellate; bracts scarious, early caducous; bracteoles usually early caducous. Calyx campanulate, 4-lobed, glumaceous, striate with strong veins proliferated from base of lobes, rigid, persistent; lobes imbricate at base or valvate, dorsal lobes bifid at apex. Corolla 5, papilionaceous, not or slightly longer than calyx; standard broad, obovate or nearly orbiculate, bi-lobed at apex, incurved, clawed; wings oblong-obovate or spathulate, rounded or obtuse at apex, incurved, clawed, slightly shorter than keel; keel adhering to wings, partly connate along lower margin, boat-shaped, slightly incurved, obtuse or rounded at apex, clawed. Stamens 10, diadelphous (9+1); anthers uniform. Pistil 1-carpellate, 1-locular; ovary superior, sub-sessile or shortly stalked, 2- to many-ovuled, glabrous to hairy; style filiform, incurved; stigma capitulate. Pods a legume, indehiscent, swollen, constricted or not between articles; articles 2–8, quadrangular, broadly oblong or rarely ovate to sub-orbicular, surface smooth or with transversely ridged or with reticulate veins, 1 seed per article, glabrous to sparsely straight-b hairy or with hooked hairs. Seeds 2–8, asymmetry, cubic, oblong-ellipsoid, ellipsoid or obloid, light brown to black; hilum circular.

A genus of about 30 species, widely distributed in tropical regions of Africa, Asia and Australia. Three species are native to Thailand.

KEY TO THE SPECIES
1. Calyx lobes imbricate at base; corolla yellow, orangish-yellow, greenish-yellow, pale yellow or white; pod not or slightly constricted between articles
   3. A. vaginalis
1. Calyx lobes valvate; corolla blue, pink, purple, reddish-pink or rarely orangish-yellow; pod not or slightly constricted between articles
2. Pods with transversely ridged veins and hooked hairs; inflorescences with flowers densely arranged; calyx outside with hooked hairs, leaflets oblong, oblong-obovate, oblong-oblanceolate, linear-lanceolate or rarely broadly ovate to orbicular
2. A. rugosus
2. Pods without transversely ridged veins and hooked hairs; inflorescences with flowers laxly arranged; calyx outside without hooked hairs; leaflets linear to linear-lanceolate
1. A. bupleurifolius


acuminate, outside glabrous, except with straight hairs margin, inside glabrous. *Corolla* yellow to orangish-yellow or greenish-yellow, sometimes with red blotch inside at base, glabrous; standard obovate or orbicular, 7–8 by 4.5–5.5 mm, apex emarginate, base attenuate, claw 0.5–2 mm long; wings oblong-obovate, 4–7 by 1–2 mm, apex rounded, base attenuate, sometimes slightly auriculate dorsally, claw 1–2 mm long; keel obovate, 5–8 by 1–1.5 mm, apex rounded, slightly incurved, base attenuate, claw 1–3 mm long. *Stamens* 6–6.5 mm long, staminal tube 5–5.5 mm long, free part of filaments 1–1.2 mm long; *anthers* yellow, oblong, 0.3–0.4 mm long. *Ovary* narrowly oblong, 1–2 mm long, glabrous or with sparse, short appressed hairs; ovules 3–8; style 3–4 mm long, incurving upward ca ⅙ of its length, with sparse long straight hairs at lower part. *Pods* cylindrical, 5–15 by 1.5–2 mm, glabrous to very sparsely hairy at margin, smooth, without transversely ridged vein and hooked hairs, acuminate at apex, light green when young, becoming brown, exserted from persistent calyx, constricted between articles;
articles 3–8, ovate to sub-orbicular or quadrangular, 1.5–2.5 by 1.5–2 mm, smooth or rarely with obscurely reticulate veins; stipe 9.5–12.7 mm long; persistent calyx clearly longer than first article of pod. Seeds cubic to ellipsoid, 0.8–1 by 0.8–1 mm, glossy, brown.


Distribution.—Mauritius, Pakistan, Sri Lanka, India, Nepal, Bangladesh, Myanmar, China, Taiwan, Southeast Asia through Australia.

Ecology.—In mixed deciduous, dry dipterocarp, dipterocarp-oak or scrub forest, especially along roadsides, in grass fields, disturbed, degraded, fire-damaged or edge area, open sandy or rocky places, limestone or granitic bedrock, cultivated grounds and often on heavy soils, in sunny places subject to a pronounced dry season; 0–850 m alt. Flowering and fruiting: September to January.

 Vernacular.—Non plong (น่อนปล้อง) (General).

Note.—Alysicarpus bupleurifolius is characterized by having linear to linear-lanceolate leaflets, calyx outside without hooked hairs, yellow to orangish-yellow or greenish-yellow corolla, persistent calyx which is clearly longer than the first article of fruit and smooth fruit surface.


Perennial herb 0.4–1 m tall. Stems erect, branched, glabrous or with straight hairs. Leaves: petioles 2–10 mm long, glabrous or with straight hairs; stipules triangular, 4–16 by 2–2.5 mm, scarious, striate with parallel-veins, persistent; leaflets oblong, oblong-obovate, oblong-oblanceolate, linear-lanceolate, or rarely broadly ovate to orbicular, subcoriaceous, 1–5 by 0.2–2.5 cm, apex acute, acuminate or obtuse, apiculate, base rounded or cordate, margins entire with appressed straight hairs;
adaxial surface glabrous; abaxial surface covered with pilose or slightly straight hairs especially on veins; lateral veins 6–8 pairs; petiolules 0.5–1 mm long with straight hairs; stipels triangular or rounded 0.5–1.5 mm long. Pseudoaceme terminal or axillary, 2–12 cm long, covered with hooked hairs; peduncle 1–4.7 cm long; flowers 10–24-flowered, densely arranged; bracts ovate to triangular, 1.5–5 by 0.5–1 mm, caducous; pedicels 2–4 mm long with hooked hairs; bracteoles early caducous. Calyx light green, 7–10 mm long; tube 1–2 mm long; lobes imbricate, dorsal lobe lanceolate to ovate, 6–9 mm, apex bifid, other lobes lanceolate to triangular, 7–8 mm, apex acute or acuminate, margins with long straight hairs, ca 1 mm long, outside with sparse hooked hairs, inside glabrous. Corolla white to pale yellow, orangish-yellow or pinkish-white, glabrous; standard obovate 4.5–5 by 2–3 mm long, apex retuse, base attenuate, claw 0.7–1 mm; wings oblong, 4–5 by 0.8–1, apex obtuse, base attenuate, claw 0.5–1 mm long; keel boat-shaped, 4.5–5 by 0.8–1.5 mm, incurved, apex obtuse, base attenuate, claw 1–1.5 mm long. Stamens 4.5–5.5 mm long, staminal tube 4–5 mm long, free part of filaments ca 0.5 mm long, anthers yellow, oblong, 0.3–0.4 mm long. Ovary narrowly oblong, 1–2 mm long, glabrous or with sparsely hooked hairs at upper part; ovules 2–6; style 4 mm long, incurved at right angle. Pods narrowly oblong, 6–9 by 0.2–0.3 cm, covered with hooked hairs, laterally flattened, included or slightly exserted from persistent calyx, constricted between articles; articles 2–6, quadrangular, 2.5–3 by 2–3 mm, surface with prominently and transversely ridged veins; persistent calyx longer than first article of pod. Seeds cubic to ellipsoid, 0.9–1.5 by 1–1.2 mm, brown.

Thailand.—NORTHERN: Chiang Mai [Bo Luang-Bo Kaw, 23 Nov. 2005, Sawai 996 (KKU)]; Chiang Kham, 26 Dec. 1967, Prayad 1152 (BK); Doi Sutep, 13 Nov. 1922, Kerr 6673 (ABD, BK, BM, K); Doi Inthanon, 4 Oct. 1971, Murata et al. T-15772 (BK); Mae Cham, 7 Dec. 1998, Maxwell 98-1432 (BKF, CMUB); Mae Rim, 21 Nov. 1996, BGO. staff/7855 (QBG); Lampang [Chae Son NP, 29 Oct. 1995, Banoc 29 (BKF, CMUB)]; Tak [Doi Din Gi, 9 Nov. 1988, Paisooksantivatana Y2290-88

Figure 2. Alysicarpus rugosus (Willd.) DC.: A. habit (Smitinand 4894); B. dried fruit with persistent calyx (BGO. staff/7855); C. fruit surface showing transversely ridged veins (BGO. staff/7855). Photo by J. Satthaphorn.

Distribution.—Africa to India, Nepal, Myanmar, China, Taiwan, Laos, Vietnam, Malaysia, Indonesia (Java, Bali) and Australia (Queensland).

Ecology.—In open, degraded or disturbed place in mixed deciduous, dry dipterocarp or dry evergreen forest, often occurring along roadsides, grassy or bamboo fields, sunny places, bound to limestone areas, granite bedrock or agricultural areas; 300–1800 m alt. Flowering and fruiting: October to December.

Vernacular.— Non plong wai (ห้วยปล้องวาย) (General).

Note.—Alysicarpus rugosus differs from the other members of this genus in having pods with strongly transversely ridged veins on the surface. Alysicarpus wallychii, a synonym of A. rugosus, there was no designation of the holotype, but six specimens; Wallich Numer. List. 5/111, 5/127, 5763a-c & 5764, at K-W were listed in the protologue. Wallich Numer. List. 5/111 is in good condition and therefore it is chosen here as the lectotype.


Perennial herb, ascending or often prostrate, usually up to 60 cm tall. Stems robust, simple or copiously branched from the base, glabrous or with hooked hairs and patent straight hairs, rarely with appressed straight hairs. Leaves: petioles 2.5–15 mm long, grooved, glabrous or with sparingly straight hairs; stipules lanceolate-triangular, scarious or subcoriaceous, 1.3–15 by 1–4 mm, acuminate, with parallel veins, persistent; leaflets ovate-oblong, oblong-obovate or oblong-lanceolate to lanceolate on upper stem, nearly orbicular or ovate on lower stem, chartaceous to coriaceous, 0.5–6.5 by 0.2–2.5 cm, apex acute or rounded, apiculate, base cordate, subcordate or obtuse, margins entire with appressed straight hairs; adaxial surface glabrous; abaxial surface with appressed straight hairs or hooked hairs, sometimes only on veins; lateral vein 6–15 pairs; venation reticulate; petiolules 0.3–3 mm long with straight hairs; stipules triangular or rounded, 1–2 by ca 0.4 mm, scarious, glabrous or hairy. Pseudoraceme terminal or axillary, 1.5–7 cm long, with sparse or dense hooked hairs; internodes 2–5(–9) mm long; peduncle 1.2–2.3 cm long; flowers 6–13-flowered, laxly to densely arranged; bracts ovate to lanceolate, 2–4 by 0.5–1 mm, acuminate at apex, scarious or subcoriaceous with parallel veins, persistent; pedicels 1–4 mm long with hooked hairs; bracteoles linear-triangular 1.6–1.8 by 0.1–0.2 mm. Calyx green to yellowish-green, sometimes with pink at upper part, 4–6 mm long; tube 1–2.5 mm long; lobes valvate, dorsal lobe triangular to lanceolate, 1.5–4 mm long, apex slightly bifid to long bifid, other lobes triangular or lanceolate, 1.2–1.5 mm long, apex acute or acuminate, outside covered with both straight and hooked hairs, inside glabrous. Corolla blue, pink, purple, mauve to red or rarely orangish-yellow, glabrous; standard obovate, 5–7 by 4–5.5 mm, apex retuse, base attenuate, claw 0.4–1.5 mm long; wings oblong, 4–6.5 by 1–1.6 mm, apex obtuse, slightly incurved towards apex, base attenuate, claw 1.5–2 mm long; keel 5–7 by 0.7–1.8 mm, incurved, apex obtuse, base attenuate with dorsal auricle, claw 1.5–2 mm long. Stamens 5.5–6.5 mm long, staminal tube 4.5–6 mm long, free part of filaments 0.5–1 mm
long; anthers yellow, oblong to ovate, 0.2–0.3 mm long. Ovary oblong, 2–3 mm long, with hooked hairs, stipe 0.4–0.5 mm long; ovules 4–7; style 3.5–4 mm long, incurved at right angle. Pods cylindrical, 1–2.5 by 1.1–3 mm, terete, covered with sparsely to densely hooked hairs, acuminate at apex, green when young, becoming black, exserted from persistent calyx, not or slightly constricted between articles; articles 4–7, quadrangular to broadly oblong, 2.3–3.5 mm long, surface obscurely and coarsely reticulate veins; stipe 2–3 mm long; persistent calyx shorter to slightly longer than first article of pod. Seeds oblong-ellipsoid to suboblong, 1–2 by 0.6–2.5 mm, slightly compressed.

Thailand.—NORTHERN: Mae Hong Son [9 Sept. 1974, Larsen & Larsen 34278 (L, P)]; Chiang Mai [6 Nov. 1910, Kerr 1255 (BM); Doi Sutep, 14 Nov. 1911, Kerr 1536B (ABD, BM, K), 4 Nov. 1958, Sørensen 6046 (C); Chom Thong, 3 Dec. 1991, Maxwell 91-1081 (E); Samoeng, 3 Oct. 1996, BGO staff 7697 (QBG); Fang, 22 Feb. 1958, Sørensen et al. 1517 (C, E); Hot, 23 Sept. 1958, Sørensen et al.

Figure 3. Alysicarpus vaginalis (L.) DC.: A. habit; B. inflorescence showing purplish pink flowers; C. orangish-yellow flowers; D. young fruits; E. dried fruit with persistent calyx (Satthaphorn & Leeratiwong 74); F. fruit surface showing obscurely coarsely reticulate veins (Satthaphorn & Leeratiwong 74). Photos: A–B & D–F by J. Satthaphorn and C by C. Leeratiwong.

Distribution.— Tropics to subtropics of the Old World, introduced in tropical America and Australia.

Ecology.— Weedy on waste grounds, roadsides, agricultural areas, grassy fields, disturbed areas, fire-dominated areas, preferring rather dry soil and appearing in natural forest areas; 0–1000 m alt. Flowering and fruiting: throughout the year.
Vernacular.— Khat saek (หัตท้าเกล้า) (Prachin Buri), thua lisong na (ทุ่ยลิซองนา) (Bangkok), ya klet hoi yai (ยาคัตเล็กใหญ่) (Ang Thong), ya plong wai (ยาปล้องไว้) (Chon Buri).

Note.— **Alysicarpus vaginalis** is easily recognized by its valvate calyx lobes, colour of the corolla which are blue, pink, purple, reddish-pink or rarely orangish-yellow, pods without or with slightly constricted between articles and persistent calyx which is shorter to slightly longer than first article of pod.

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