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Series II: Seed Plants, Volume 5

Flora of Peninsular Malaysia

Edited by
R. Kiew
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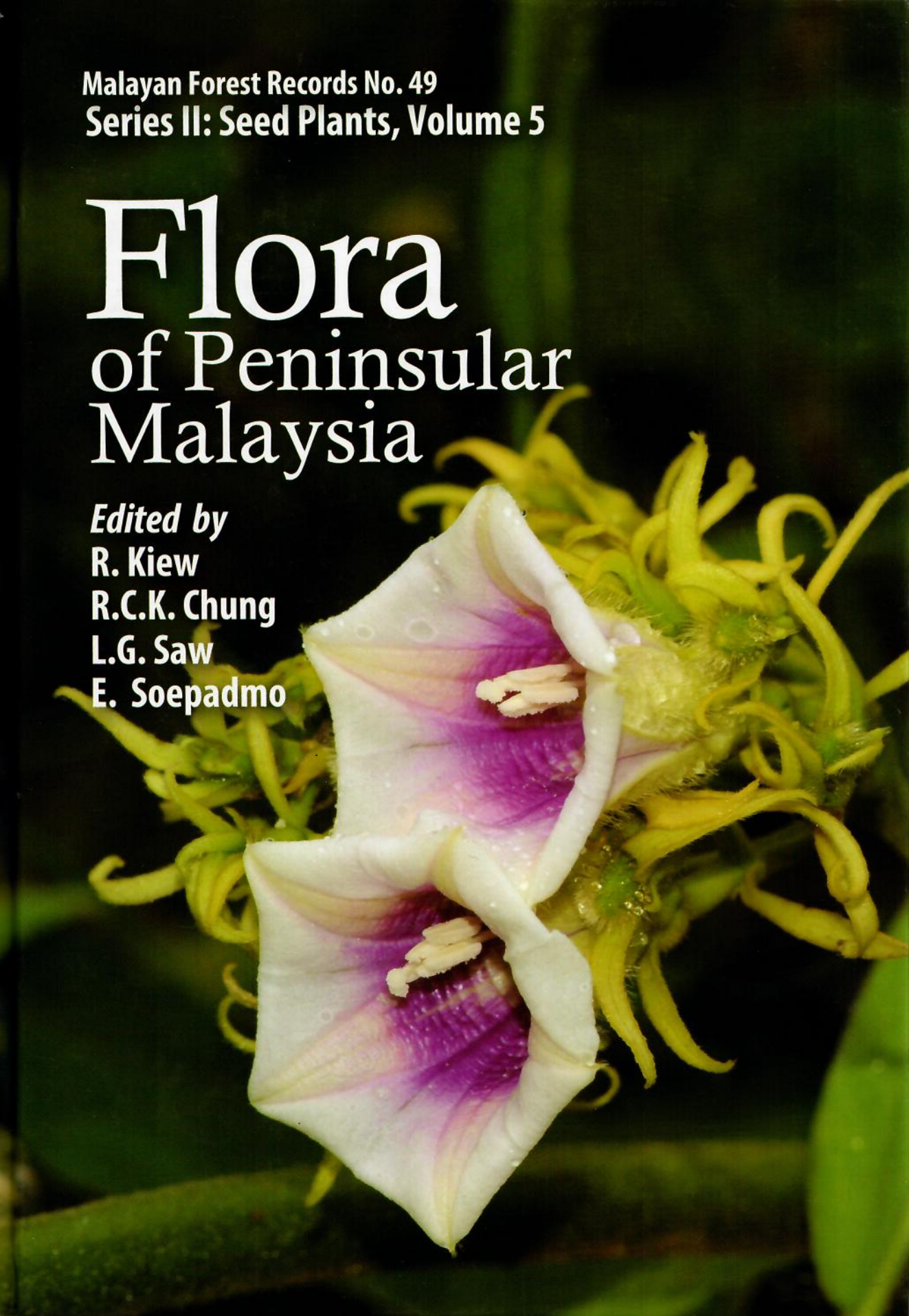

FLORA
OF
PENINSULAR MALAYSIA

Series II: Seed Plants

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ARISTOLOCHIACEAE

T.L. Yao

Forest Research Institute Malaysia,
Kepong, Malaysia

Juss., Gen. Pl. (1789) 72; Bentham & Hooker *f*., Gen. Pl. 3 (1880) 121; Hooker *f*., Fl. Brit. India 5 (1886) 72; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 23; Ridley, Fl. Malay Pen. 3 (1924) 14; Hutchinson, Fam. Flow. Pl. 1 (1959) 414; Backer & Bakhuizen *f*., Fl. Java 1 (1964) 161; Henderson, Malay. Wild Flowers, Dicot. (1974) 420; Hou, Fl. Malesiana 1, 10 (1984) 53; Huber, Fam. Gen. Vasc. Pl. 2 (1993) 129; Brummitt *in* Heywood *et al*., Flow. Pl. Fam. World (2007) 44; Mabberley, Pl. Book, 3rd ed. (2008) 67.

Climbing undershrubs or shrubs, sometimes high lianas, or erect or scrambling herbs. Rhizome sometimes tuberous. **Stem** often *slightly swollen at nodes*. Hairs simple, *short ones often hooked*. **Stipules** *absent*. **Leaves** simple, alternate, petiolate, *marcescent*; lamina entire or lobed; venation often palmate or pinnate. **Inflorescences** cymose, racemose, rarely corymbose or flowers solitary, produced from terminal, axillary, or various parts of stem; bracts present, often persistent. **Flowers** bisexual, radially or bilaterally symmetrical; *demarcation of pedicel and ovary not distinct*; perianth petaloid, 3- (or elsewhere 6-) lobed and 1(–2)-lipped, lobes valvate; stamens 6 (in *Aristolochia*, fewer or greater elsewhere) in one whorl or 6–30(–42) (in *Thottea*) in 1–2 whorls, with filaments or sessile; anthers free (in *Thottea*) or dorsally united with style column (in *Aristolochia*), each with 2 thecae with 4 pollen sacs, extrorse, longitudinally dehiscing; ovary inferior, 4- (in *Thottea*) or 6- (in *Aristolochia*) locular, *carpels free joined by styles*, placentation parietal, ovules numerous, stigmatic lobes usually 6 (in *Aristolochia*) or 3 to many (in *Thottea*). **Fruits** capsular or siliquiform, 4- or 6-valved, dehiscing from apex to base (in *Thottea*) or base to apex (in *Aristolochia*). **Seeds** many in each valve, horizontal or pendulous; ovoid, deltoid or flat, surface wrinkled (in *Thottea*) or margin winged (in *Aristolochia*); endosperm copious, oily, embryo small.

Distribution. Worldwide in tropical and northern temperate regions. There is a discrepancy in the number of genera and species accepted for the family: Brummitt (2007) estimates 600 species in 7–12 genera, whereas Stevens (APG Website, 15 August 2014) estimated 490 species in 11 genera. In Peninsular Malaysia it is represented by two genera and 22 species: *Aristolochia* (6) and *Thottea* (16).

Ecology. Occurs in rain forests, temperate woodlands, open grassy places and dry Mediterranean-type vegetation. In Peninsular Malaysia, they are often found in lowland rain forest. Species of both *Aristolochia* and *Thottea* are food plants for larvae of birdwing butterflies (family Papilionidae, subfamily Papilioninae, tribe *Troidini*, *e.g*. Rajah Brooke's birdwing). Leaves of aristolochiaceous plants are often perforated and the margins nibbled. The butterflies are attracted to lay their eggs and the larvae feed exclusively on aristolochiaceous plants (Nishida *et al*., J. Chem. Ecol. 19 (1993) 1587). By sequestration of aristolochic acids the larvae have chemical defence against predators and hence maintain the host fidelity (Weintraub, *in* Scriber, Tsubaki & Lederhouse (eds.), Swallowtail Butterflies:

Their Ecology & Evolutionary Biology (1995) 307). The flowers are generally adapted to fly pollination (see under genus) and smell unpleasant. Pollination and dispersal ecology of aristolochiaceous plants are scarcely studied in the Malesian region. Elsewhere, Berjano *et al*. (Pl. Biol. 11 (2009) 6–16), Burgess *et al*. (Ann. Miss. Bot. Gard. 91 (2004) 346–356), Disney & Sakai (Eur. J. Entomol. 98 (2001) 367–373), Hipolito *et al*. (Botany 90 (2012) 815–829), Murugan *et al*. (Current Science 91 (2006) 795–798), Nakonechnaya *et al*. (Biol. Bull. 35 (2008) 459–465), Oelschlägel *et al*. (New Phytologist 184 (2009) 988–1002, *ibid*. 206 (2015) 342–351), Valdivia & Niemeyer (Biol. J. Linn. Soc. (2007) 239–245) and Wolda *et al*. (Biotropica 18 (1986) 295–299) have provided accounts in pollination ecology aspects of several *Aristolochia* species.

Uses. Some *Aristolochia* species (chiefly American species) with large showy flowers are planted as ornamentals (see under *Aristolochia*). Several species in *Aristolochia* and *Thottea*, mainly the common ones, were regarded as traditional medicines for various illnesses (Burkill, Econ. Prod. Malay Pen. (1966) 189, 240, 2195). More recent studies have confirmed that some chemical compounds, such as aristolochic acids or their derivatives and sesquiterpenes, are found in species of *Aristolochia* and *Thottea* (Kiew, PROSEA 12, 1 (1999) 135; Ong, *ibid*. 12, 2 (2001) 547). Aristolochic acids or their derivatives display a range of pharmacological activity including antimicrobial, antitumor and immunomodulatory. Conversely, aristolochic acids are nephrotoxic to humans and several animal species, and their strong mutagenic and carcinogenic activities are known from both *in vitro* and *in vivo* studies (Ong, PROSEA 12, 2 (2001) 547). Hence, restrictions are imposed on laboratory preparations containing aristolochic acids and a ban on aristolochic acids in traditional herbal preparations is also enforced in several countries. Michl *et al*. (Nat. Prod. Rep. 31 (2014) 676–693) provide an update on aristolochic acids and their analogues, aristolactams and 4, 5-dixoxaporphines derived from Aristolochiaceae taxa reported between 2003 and 2013, and their biological activities. Common species, such as *A. acuminata* and *T. tomentosa*, are planted in the Penang Butterfly Farm as food plants for Papilionidae (birdwing) butterfly larvae.

Taxonomy. This family belongs in Piperales. Its division into two subfamilies, Asaroideae and Aristolochioideae, is widely accepted (Brummitt, 2007), and Stevens (APG Website, 15 August 2014) included a third, Hydnoroideae. Both Malaysian genera fall within subfamily Aristolochioideae with *Aristolochia* placed in tribe Aristolochieae and *Thottea* in tribe Bragantieae (Huber, 1993).

Key to genera

1. Slender climbing shrubs, sometimes high lianas. Flowers bilaterally symmetrical; stamens 6, always in 1 whorl. Capsules 6-valved, oblong or sometimes sub-globose. ..... **1. Aristolochia**

2. Shrubs or undershrubs, erect or scrambling. Flowers radially symmetrical; stamens 6–42 in 1 or 2 whorls. Capsules 4-valved, slender. ..... **2. Thottea**

1. **ARISTOLOCHIA** L.

(Greek, *aristos* = best, *lochia* = childbirth; medicinal use in helping childbirth)

Birthwort, Dutchman's Pipe, Pipevine, *Akar ketola* (Malay)

Sp. Pl. (1753) 960; Duchartre *in* DC. Prod. 15, 1 (1864) 432; Bentham & Hooker *f*., Gen. Pl. 3 (1880) 123; Hooker *f*., Fl. Brit. India 5 (1886) 74; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 29; Ridley, Fl. Malay Pen. 3 (1924) 17; Hou, Fl. Malesiana 1, 10 (1984) 83; Phuphathanaphong, Fl. Thailand 5 (1987) 1; Huber, Fam. Gen. Vasc. Pl. 2 (1993) 137.

Slender climbing shrubs, sometimes high lianas. Old stem bark corky, deeply fissured. **Leaves:** lamina entire or lobed, lower surface pubescent or glabrous. **Inflorescence** usually a few-flowered raceme or elsewhere flowers solitary, produced in axils of foliage leaves and/or on bare stem, i.e. after leaves have fallen, sometimes close to base; bracts present. **Flowers** *bilaterally symmetrical*; perianth shape variable, usually curved (S-shaped), sometimes with a stipe between ovary and utricle, utricle globose or oblong or urn-shaped, narrowed into a slender cylindric tube topped with oblique funnel-shaped or disc-shaped limb, often lobed; inside utricle with patches of glandular hairs; *stamens 6* (rarely more elsewhere) *in 1 whorl*, adnate to and merged with style column to form gynostemium; ovary 6-grooved, 6-loculed, stigmatic lobes 6. **Capsules** *6-valved*, *oblong or sometimes sub-globose*, septicidally dehiscing from base to apex. **Seeds** horizontally arranged, flat, 3-angular in outline.

Distribution. About 400 species, largely New World, widely distributed throughout the tropics and subtropics and some in warm temperate regions, throughout Malesia; six species in Peninsular Malaysia.

Ecology. Its habitat ranges from dense primary forest, forest fringes, secondary forest to thickets. Most Peninsular Malaysian taxa are lowland species. The flowers are generally adapted for fly pollination and often smell of carrion, or rotten fruit (*FRI 57891*, *A. foveolata*). Insects, mainly flies, are attracted to the smell and then further down into the utricle by the translucent window at the bottom. They get trapped within the utricle by stiff downward pointing hairs inside the tube wall. The flowers are protogynous and the ripe stigmas are pollinated by incoming insects carrying pollen. Secretory hairs, which form glandular bodies on the inner surface of the utricle, provide food to keep the trapped insects alive until the anthers mature and shed pollen. The hairs then wither allowing the insect to leave and, if it visits another flower, effect cross-pollination. This long-proposed pollination mechanism is supported by recent studies on the structure and biomechanics of *Aristolochia* trapping flower trichomes (Oelschlägel *et al*., 2009). The seeds are dispersed by wind. Some *Aristolochia* species are the food plants of Papilionidae butterflies (Igarashi & Fukuda, The Life Histories of Asian Butterflies 1 (1997) *t*. 305, figs. 2 & 4). Exotic species are poisonous to native butterflies (see http://www.butterflygardeningandconservation.com/plant/host/pipevine.php and http://www.butterfly-insect.com/yellow-birdwings/yellow-birdwing-host-plant.html). So although the adults might lay eggs on their leaves, the caterpillars will eventually die. Hence, if the introduced taxa naturalise and become widespread they might result in devastation of local butterfly populations.

Uses. The major chemical constituents of *Aristolochia* species are generally divided into aristolochic acids (derivatives), alkaloids and sesquiterpenes. In SE Asia, the medicinal use of a decoction of the roots as a stomachic, emmenagogue and febrifuge is most common and a poultice of the leaves is sometimes used to treat skin diseases (Kiew, PROSEA 12, 1 (1999) 133). Heinrich *et al*. (J. Ethnopharmacol. 125 (2009) 108–144) assessed the worldwide local medicinal uses of *Aristolochia* species as a response to concern for the nephrotoxicity of aristolochic acids.

Several ornamental species are cultivated in gardens in Peninsular Malaysia. Commonly encountered species include tropical American species, *A. gigantea* Mart. & Zucc., *A. grandiflora* Sw., *A. littoralis* Parodi, *A. ringens* Vahl and *A. odoratissima* L. They are readily distinguished from native species by their large showy flowers and, in many cases, their sub-orbicular, kidney-shaped or broadly ovate laminas.

Taxonomy. Two infrageneric groups, namely the *Aristolochia* and *Isotrema* groups, were proposed based on molecular phylogenetic studies (Ohi-Toma *et al*., Syst. Bot. 31 (2006) 490). The *Aristolochia* group is characterised by a gynostemium with more than 3 lobes, a single anther arranged equidistant on each gynostemium lobe, perianth with 1–3 lobes and a dehiscent capsule or fleshy indehiscent fruit (Huber, 1993). On the other hand, the *Isotrema* group (sometimes referred as subgenus *Siphisia*) is characterised by a 3-lobed gynostemium, anthers paired on each gynostemium lobe, perianth 3-lobed or peltate, valvate in bud and an apically dehiscent capsule. In Peninsular Malaysia, the *Isotrema* group is represented solely by *A. vallisicola*; all the other species belong to the *Aristolochia* group.

Key to Aristolochia species

1. Lamina deeply 3-lobed, lobes widely spreading, 'W'-shaped in outline. 2
   Lamina not lobed, ovate, lanceolate, or oblanceolate. 3

2. Lamina base cuneate, intercostal veins faint. Inflorescence peduncle straight; bracts crowded, base clasping. ..... **2. A. curtisii**
   Lamina base cordate or truncate, intercostal veins distinct. Inflorescence peduncle zig-zag; bracts lax, base rounded. ..... **4. A. jackii**

3. Stem puberulent. Lamina pinnately veined, veins in 6–7 spaced pairs, lanceolate or oblanceolate, base shallowly cordate, sinus 2–3 mm deep. Perianth limb disc-shaped. ..... **6. A. vallisicola**
   Stem glabrous. Lamina palmately veined or palmate-pinnate, pinnate veins sometimes lacking or 1–2 pairs; narrowly to broadly ovate, base cordate, often deeply so or truncate, sinus 10–25(–35) mm deep. Perianth limb an oblique funnel, front lobe obscure, rear lobe tongue-like or linear. 4

4. Lamina leathery, lower surface minutely pitted, sparsely to densely puberulent. ..... **3. A. foveolata**
   Lamina membranous to papery, lower surface pustulate, glabrous or sparsely pubescent. 5

5. Lamina palmate-pinnately veined with 2 pairs of pinnate veins. Perianth 4–4.5 cm long, with a stipe between ovary and utricle. Capsule surface smooth. ..... **1. A. acuminata**
Lamina palmately veined without pinnate vein or sometimes with 1 obscure pinnate pair. Perianth 1.5–1.7 cm long, without a stipe between ovary and utricle. Capsule surface transversely wrinkled. ..... **5. A. minutiflora**

1. **Aristolochia acuminata** Lam. Fig. 1A–B, Map 1, Plate 1A–B

(Latin, *acuminatus* = tapered towards a narrow point; referring to the lamina apex)

Encycl. Méth. 1 (1783) 254; Klotzsch, Monatsb. Berl. Akad. (1859) 596; Bosser, Adansonia 3, 19 (1997) 170. **Type:** *Commerson s.n.*, Mauritius [*Inde*, *Isle de France*], *cultivé au Jardin de Mr Poivre*, (holotype P-LA; isotypes P, P-JU 3908). **Synonyms:** *Aristolochia tagala* Cham., Linnaea 7 (1832) 207, *t*. 5, fig. 3; Duchartre *in* DC. Prod. 15, 1 (1864) 480; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 30; Ridley, Fl. Malay Pen. 3 (1924) 18, excl. fig. 136 (= *A. indica*); Backer & Bakhuizen *f*., Fl. Java 1 (1964) 163; Henderson, Malay. Wild Flowers, Dicot. (1974) 421, fig. 381A & B; Hou, Blumea 29 (1983) 232, Fl. Malesiana 1, 10 (1984) 94; Phuphathanaphong, Fl. Thailand 5 (1987) 15, fig. 10; Kiew, PROSEA 12, 1 (1999) 138, fig. 1–3. **Type:** *Chamisso s.n.*, Philippines, Luzon, Cavite Province, Romanzoff Expedition (MPU, barcode 18735). *Aristolochia roxburghiana* Klotzsch, Monatsb. Berl. Akad. (1859) 596; Hooker *f*., Fl. Brit. India 5 (1886) 75. **Type:** *Wallich 2705* Myanmar, Irawaddi (K, barcodes 978959, 978960, 978961, 978962).

Climbing shrub, sometimes climbing 20 m high to top of trees. **Stem** 2–4(–6) mm thick, surface furrowed, *glabrous*. **Leaves:** petiole twisted, 1.5–5.5 cm long, 1–2 mm thick, glabrous; lamina *ovate*, *not lobed*, (8–)11.5–20.5 × 5.5–8(–10) cm; base *deeply cordate*, auricles rounded or sometimes overlapping, sinus *10–25(–35) mm deep*, 5–22 mm wide, margin entire, apex acute; *papery or sometimes membranous*; lamina surface above smooth, glabrous, below *pustulate*, often with a scattering of black gland dots, *glabrous*; midrib above flat, below prominent; venation *palmate-pinnate*, lateral veins faint above, below distinct, palmate pairs 3, pinnate pairs *2*; intercostal veins reticulate. **Inflorescences** in leaf axils or on bare stem, solitary; peduncle once-branched; 1–4.5(–6) cm long, 1–1.5 mm thick, glabrous; bracts broadly ovate, 2–4 × 1–3 mm, puberulent or densely ciliate, base rounded, apex acute, venation distinct. **Flowers:** pedicel and ovary 15–17 mm long, ovary *c*. 1 mm thick, puberulent or pubescent, trichomes hooked; perianth dark purple-red, *4–4.5 cm long*, straight or curved, outer surface pubescent, *with a stipe between ovary and utricle*, 2–3 mm long, utricle globose, 3–7 mm diameter, inner surface with 2 ellipsoid patches of woolly trichomes, tube 8–10 mm long, limb an *oblique funnel*, 2-lobed, front lobe *obscure*, scarcely emarginate, rear lobe *tongue-like*, curved and sheltering the tube opening, 22–30 mm long, 5–7 mm wide, apex mucronate, venation distinct; gynostemium top view circular; stamens 6; anthers oblong, *c*. 1.2 mm long, *c*. 0.7 mm wide; stigmatic lobes 6, long conical, *c*. 2 mm long, apex blunt. **Fruits** ripening brown, stalk 2–4 cm long, globose or oblong in outline, 2–3 cm long, 2–3 cm wide, surface *smooth*. **Seeds** obovate in outline, winged, 7–8 × 9–10 mm; upper surface warty, lower surface smooth.

Vernacular names. *Akar ketola hutan* (preferred name), *pohon timbang dacing* (Malay).

Distribution. Widely distributed in Mauritius, India, Sri Lanka, Indo-China, China, throughout Malesia to tropical Australia (Queensland). Throughout Peninsular Malaysia except for Kedah and Melaka.

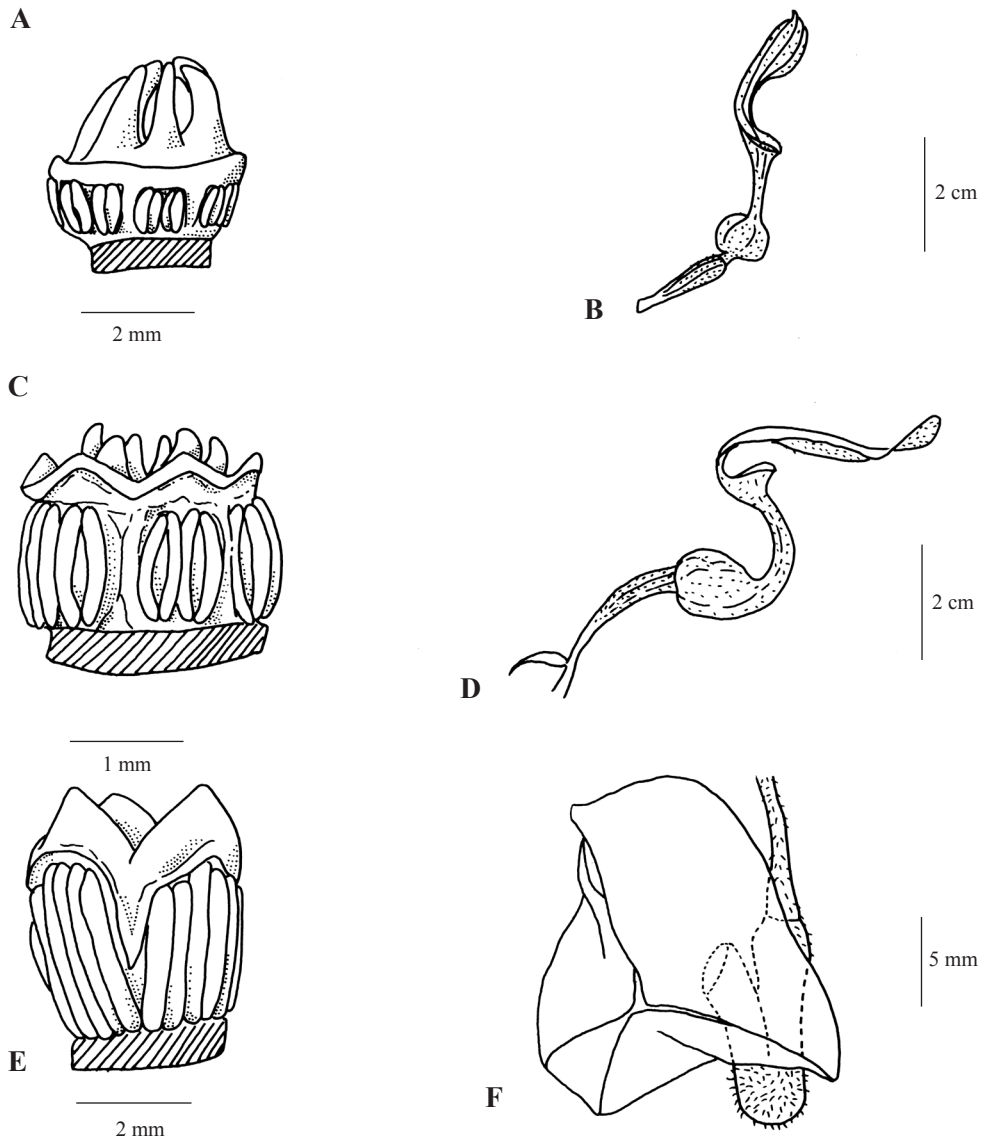
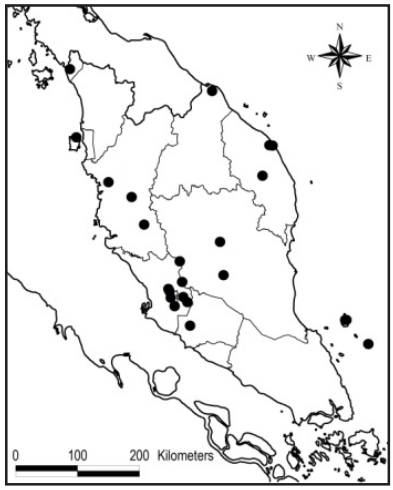


Figure 1. Gynostemia and flowers of *Aristolochia*. *Aristolochia acuminata*. A, gynostemium; B, flower. *Aristolochia foveolata*. C, gynostemium; D, flower. *Aristolochia vallisicola*. E, gynostemium; F, flower bud. (A–B from *FRI 65588*; C–D from *FRI 57891*; E–F from *Kiew RK 4879*.)



Map 1. Distribution of *Aristolochia acuminata*.

Conservation status. Least Concern. This species is widespread and common.

Ecology. In forest fringes or thickets, lowlands to 250 m altitude. It is the food plant of the Yellow Birdwing, *Troides helena* (Papilionidae).

Uses. The leaves were pounded and applied to the head to treat fever (Burkill, Econ. Prod. Malay Pen. 1 (1966) 241). It is planted to attract and breed the Yellow Birdwing.

2. **Aristolochia curtisii** King Map 2

(Charles Curtis, 1852–1928; a British botanist, superintendent of Gardens and Forests, Penang, 1884–1903)

Ann. Bot. Gard. Calc. 5 (1896) 161, *t*. 195; Gamble, Bull. Misc. Info. Kew (1910) 78; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 32; Ridley, Fl. Malay Pen. 3 (1924) 18; Hou, Blumea 29 (1983) 227, Fl. Malesiana 1, 10 (1984) 89; Phuphathanaphong, Fl. Thailand 5 (1987) 8, fig. 6. **Type:** *Curtis 330*, Peninsular Malaysia, Penang, Government Hill (lectotype K, barcode 674010, here designated; isolectotypes BM barcode 950682, SING, barcode 59536).

Small creeper, 3–4.5 m long. Stem 2–3 mm thick, surface smooth, glabrous. **Leaves:** petiole twisted, 5.5–8.5 cm long, 1–2 mm thick, glabrous; lamina *deeply 3-lobed*, *lobes widely spreading*, '*W*'*-shaped in outline*,12.5–17 × 13–18 cm; base *cuneate*; mid-lobe 11–15 cm long, 3–4 cm wide, apex acuminate, side lobes 8–11 cm long, 2–3(–5) cm wide, apex rounded; membranous; upper surface smooth, glabrous, lower surface minutely pitted, with a scattering of black gland dots, glabrous; midrib distinct above and below; lateral veins palmate, distinct above and below, palmate pairs 3, pinnate pairs lacking; intercostal veins *faint*, a mix of scalariform and reticulate, scalariform veinlets more pronounced. **Inflorescences** axillary, solitary or sometimes 2 per leaf axil; peduncle *straight*, not branched, 5–6 cm long, *c*. 0.5 mm thick, glabrous. Bracts narrowly ovate, *c*. 8 × 4 mm, *crowded*, glabrous, base *clasping*, apex blunt or acute, venation distinct. **Flowers:** pedicel and ovary 5–10 mm long, ovary *c*. 1 mm thick, glabrous; perianth velvety dark blue and pink, 3.5–5 cm long, straight, outer surface

puberulent, without a stipe between ovary and utricle, utricle ovoid, 15–20 mm long, 5–7 mm wide, tube 5–10 mm long, limb an oblique funnel, 2-lobed, front lobe rounded, *c*. 3 mm long, rear lobe tongue-like, curved and sheltering the tube opening, 10–15 mm long, *c*. 4 mm wide, apex blunt, venation faint; gynostemium top view faintly hexagonal; stamens 6, anthers oblong; stigmatic lobes 6, conical, apex blunt. **Fruits:** stalk *c*. 4 cm long, capsule oblong in outline, *c*. 3 cm long, *c*. 1.5 cm wide, surface smooth. **Seeds** broadly ovate in outline, not winged, *c*. 5 × 4 mm; upper and lower surfaces warty.

Vernacular name. *Sayap kelawar* (Malay).

Distribution. Islands off Peninsular Thailand (Phuket) and in northern Peninsular Malaysia (Penang and Langkawi Is., Kedah).

Map 2. Distribution of *Aristolochia curtisii* (●), *A. foveolata* (▲) and *A. jackii* (■).

Conservation status. Data Deficient. The species was last collected in Peninsular Malaysia more than 50 years ago. It needs to be searched for in all recorded localities before any conclusive assessment can be made.

Ecology. Primary lowland and hill forests to 500 m altitude.

Note. The description of the flower is based on Gamble's drawing on the herbarium sheet of *King's Coll. 1453* (CAL) and partly adapted from his account.

3. **Aristolochia foveolata** Merr. Fig. 1C–D, Map 2, Plates 1C–D, 2A–D

(Latin, *foveolatus* = minutely pitted; referring to the lamina lower surface)

Philip. J. Sc. Bot. 13 (1918) 280; Hou, Blumea 29 (1983) 227, Fl. Malesiana 1, 10 (1984) 91. **Type:** *Ramos BS 30370*, Philippines, Catanduanes (BM, BO, acc. no. 108745, K, barcodes 820368, 820369, L, barcode 38884, NY, 285567, US, barcode 105833).

Climbing shrub to 10(–40) m high. **Stem** *c*. 2 cm thick, *glabrous*, surface smooth, old stem with a thick corky bark. **Leaves:** petiole twisted, 5.5–7 cm long, 2–2.5 mm thick, glabrous; lamina *not lobed*, *narrowly ovate or ovate or broadly ovate*, 14–19.5 × 6–11 cm; base *cordate or deeply cordate*, auricles rounded, sinus (*10–*)*20–25 mm deep*, 14–30 mm wide, margin entire, apex acute; *leathery*; lamina surface above smooth, glabrous, trichomes club-shaped, below *minutely pitted*, sometimes with a scattering of black gland dots, *sparsely to densely puberulent*; midrib above sunken, below prominent; venation *palmate*, lateral veins above sunken, below prominent, palmate pairs 3–4, *pinnate pairs lacking*; intercostal veins *prominent*, reticulate. **Inflorescences** axillary or on bare stem, solitary; peduncle not branched, 2.6–3 cm long, *c*. 0.5 mm thick, glabrous. Bracts narrowly ovate, 5–15 × 2–4 mm, puberulent, base rounded, apex acute, venation distinct. **Flowers:** pedicel and ovary 14–30 mm long, ovary 2 mm thick, densely puberulent; perianth greyish purple, tube inner surface cream, mouth and lip beneath dark purple-red, 4–10.6 cm long, curved, outer surface puberulent, *without a stipe between ovary and utricle*, utricle sub-globose, 5–8 mm diameter, inner surface glabrous, with 2 or 6 ovoid patches of densely woolly trichomes, tube 10–12 mm long, inner surface sparsely pubescent, limb an *oblique funnel*, 2-lobed, front lobe *obscure*, rounded, rear lobe *tongue-like*, curved and sheltering tube opening, lower surface densely pubescent, 25–70 mm long, 6–8 mm wide, apex blunt, venation faint; gynostemium top view faintly hexagonal; stamens 6, anthers oblong, *c*. 0.8 mm long, *c*. 0.5 mm wide; stigmatic lobes 6, conical, *c*. 0.6 mm long, apex blunt. **Fruits:** stalk *c*. 5 cm long, capsule oblong in outline, *c*. 3.5 cm long, *c*. 1.3 cm wide, surface smooth. **Seeds** triangular, 4.5–5 × 3–4 mm; upper surface warty, lower surface slightly ridged at the centre.

Distribution. NE Sumatra, Peninsular Malaysia, Borneo, the Philippines and China (Taiwan). In Peninsular Malaysia known from Pahang, Terengganu and Johor.

Conservation status. Near Threatened. It is an uncommon species with a scattered distribution.

Ecology. Primary lowland and hill forests to 500 m altitude. It is a food plant of Rajah Brooke Birdwing, *Trogonoptera brookiana*, Papilionidae, (*KEP76347*).

Note. According to Hou (1984), the number of glandular bodies in the perianth utricle is 6 (or 2). Whether this correlates with other character(s) or with geography is not known. Specimens with 6 or 2 glandular bodies are both represented in Peninsular Malaysia. The number of glandular bodies in type specimens (*Ramos BS 30370*) is not known because they are in fruit.

4. **Aristolochia jackii** Steud. Map 2

(William Jack, 1795–1822; a British surgeon and botanist with the British East India Company)

Nom. Bot. ed. 2, 1 (1840) 132; Hou, Blumea 29 (1983) 230, Fl. Malesiana 1, 10 (1984) 88. **Homotypic synonym:** *Aristolochia hastata* Jack, Malay Misc. 2, 7 (1822) 6, *nom. illeg.*, *non* Kunth (1817), *nec* Nuttall (1818). **Type:** *Jack s.n.*, Sumatra, West Coast, Natal (specimen probably lost). **Heterotypic synonym:** *A. ungulifolia* Mast., J. Linn. Soc. Bot. 14 (1875) 494; Gard. Chron. 14 (1880) 116, fig. 28; Hooker *f. in* Curtis' Bot. Mag. 121 (1895) *t.* 7424; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 30; Ridley, J. Str. Br. Roy. Asiat. Soc. 33 (1900) 126, Fl. Malay Pen. 3 (1924) 18; Henderson, Malay. Wild Flowers, Dicot. (1974) 421, fig. 381C. **Type:** *Motley 233*, Borneo, Labuan Is. (lectotype K, barcode 820376, here designated).

Climbing or scandent shrub. Stem 3–4 mm thick, surface shallowly furrowed, glabrous. **Leaves:** petiole twisted, 4–5 cm long, 1–1.5 mm thick, glabrous; lamina *deeply 3-lobed*, *lobes widely spreading*, '*W*'*-shaped in outline*, *c*. 14.5 × *c*. 19.5 cm; base *truncate or cordate*, sinus 5–10 mm deep, *c*. 35 mm wide; mid-lobe *c*. 10.5 cm long, *c*. 7 cm wide, apex acute, side lobes *c*. 7 cm long, *c*. 4.5 cm wide, apex rounded; membranous; lamina surface above smooth, below pustulate, glabrous; midrib above distinct, below prominent; venation palmate-pinnate, lateral veins above faint, below distinct, palmate pairs 3, pinnate pair 1; intercostal veins *distinct*, a mix of scalariform and reticulate, scalariform veinlets more pronounced. **Inflorescences** axillary, solitary; peduncle not branched, *zig-zag*, *c*. 9.5 cm long, *c*. 1.5 mm thick, glabrous. Bracts broadly ovate, *c*. 1 × *c*. 1 mm, *lax*, apex densely ciliate, base *rounded*, apex blunt or truncate, venation obscure. **Flowers:** pedicel and ovary *c*. 15 mm long, ovary *c*. 1 mm thick, glabrous; perianth violet, *c*. 4.2 cm long, curved, outer surface glabrous, with a stipe between ovary and utricle, *c*. 2 mm long, utricle broadly oblong in outline, *c*. 15 mm long, *c*. 10 mm wide, tube *c*. 14 mm long, limb an oblique funnel, 2-lobed, front lobe rounded, rear lobe oblong, *c*. 15 mm long, *c*. 7 mm wide, at centre longitudinally grooved, venation obscure; stamens 6, anthers oblong; stigmatic lobes 6, conical, apex blunt. **Fruits:** stalk *c*. 4 cm long, capsule oblong in outline, *c*. 2.5 cm long, *c*. 2 cm wide, surface smooth. **Seeds** triangular-orbicular, 4–5 × 5–7 mm, lower surface smooth except for a few warts, upper surface slightly ridged at the centre.

Distribution. N Sumatra, Peninsular Malaysia, Singapore, Java, Borneo, the Philippines (Palawan) and probably Papua New Guinea. In Peninsular Malaysia from Perak (Pulau Jarak) and Pahang.

Conservation status. Data Deficient. This species has not been collected in Peninsular Malaysia for more than 50 years. Habitat status of recorded localities is not known.

Ecology. In lowland forest, sometimes in swamp forest.

Note. The description of the flower is partly adapted from Ridley (1924), the description of seeds is adapted from Hou (1984).

5. **Aristolochia minutiflora** Ridl. *ex* Gamble Map 3

(Latin, *minutus* = small, *flora* = flower)

Bull. Misc. Inform. Kew (1910) 79, J. Asiat. Soc. Bengal 75, 1 (1912) 31; Ridley, Fl. Malay Pen. 3 (1924) 18; Hou, Fl. Malesiana 1, 10 (1984) 93. **Type:** *Ridley 8022*, Peninsular Malaysia, Perak, Dindings, Lumut (lectotype K, barcode 674005, here designated; isolectotypes BM, barcode 950684, SING, barcode 59493). **Synonym:** *Aristolochia minutiflora* Ridl. *ex* Gamble var. *dolabrata* Gamble, Bull. Misc. Inform. Kew (1910) 79, J. Asiat. Soc. Bengal 75, 1 (1912) 32; Ridley, Fl. Malay Pen. 3 (1924) 18. **Type:** *Wray 2997*, Peninsular Malaysia, Perak, Bt. Larut [Maxwell Hill] (lectotype K, barcode 674001, here designated; isolectotype SING, barcode 116680).

Slender creeper or climber to 10 m high. Stem *c*. 2 cm thick, surface shallowly furrowed, old stem with thick corky bark, *glabrous*. **Leaves:** petiole twisted, 2.5–5 cm long, 1–1.5 mm thick, glabrous; lamina *narrowly ovate or ovate*, *not lobed*, 11.5–16.5 × 4.5–8 cm; base *deeply cordate*, auricles rounded, sinus *15–25 mm deep*, 10–25 mm wide, margin entire, apex acute or acuminate; *membranous or papery*; lamina surface above smooth, *glabrous*, below *pustulate*,

with a scattering of black gland dots, *sparsely puberulent* or sometimes only on veins; midrib above flat, below prominent; venation *palmate*, *pinnate vein lacking or sometimes with an obscure pair*, lateral veins above distinct, below prominent, palmate pairs 3, *pinnate pair when present 1*; intercostal veins reticulate, faint to distinct. **Inflorescences** axillary or on bare stem, solitary; peduncle not branched; 0.5–1.5 cm long, *c*. 1 mm thick, puberulent. Bracts broadly ovate, 1(–3) × 1–1.5 mm, puberulent, base cordate, apex blunt, venation obscure. **Flowers:** pedicel and ovary 3–7 mm long, ovary *c*. 1 mm thick, puberulent, trichomes hooked; perianth red and light grey, *1.5–1.7 cm long*, curved, outer surface puberulent, *without a stipe between ovary and utricle*, utricle sub-globose, *c*. 3 mm diameter, tube 3–4 mm long, limb *an oblique funnel*, 2-lobed, front lobe *obscure*, scarcely rounded or cleft, sometimes to 3 mm long, rear lobe *linear*, twisted, puberulent, 8–9 mm long, apex blunt, venation faint; gynostemium top view faintly hexagonal; stamens 6, anthers oblong; stigmatic lobes 6, conical, apex blunt. **Capsules** ripening brown, stalk 1.5–2.5 cm long, capsule oblong in outline, *c*. 3 cm long, *c*. 1.5 cm wide, surface *transversely wrinkled*. **Seeds** pear-shaped, not winged, *c*. 10 mm long; upper and lower surfaces warty-wrinkled.

Vernacular name. *Ketola hutan* (Temuan).

Distribution. Peninsular Malaysia and N Borneo. In Peninsular Malaysia from Perak, Selangor, Melaka and Johor.

Map 3. Distribution of *Aristolochia minutiflora* (●) and *A. vallisicola* (▲).

Conservation status. Least Concern. This species is quite widespread and persists in secondary forest.

Ecology. Forest fringes, sometimes in old secondary forest. Lowland to lower montane forest to 1100 m altitude.

Taxonomy. *Aristolochia minutiflora* var. *dolobrata* was described based on a single, subtle character, *viz*, perianth with an upper lip about 3 mm long and broadened (Gamble, 1910). Hence, I follow Hou (1984) in not recognising var. *dolobrata*.

6. **Aristolochia vallisicola** T.L.Yao Figs. 1E–F, Map 3

(Latin, *vallisicola* = dweller in valleys; denoting its habitat preference)

PhytoKeys (2012) 16. **Type:** *Kiew RK 4879*, Peninsular Malaysia, Pahang, Genting Highlands, Awana Waterfall, 26 November 1999 (holotype SING, barcode 78162).

Slender climber. **Stem** *c*. 2.5 mm thick, surface shallowly furrowed, sometimes smooth, *puberulent*, trichomes hooked. **Leaves:** petiole twisted, 5.5–7 cm long, *c*. 2.5 mm thick, puberulent, trichomes a mix of hooked and straight stubby ones; lamina *lanceolate or narrowly oblanceolate or oblanceolate*, *not lobed*, 20.5 × 8.5–10.5 cm; base *shallowly cordate*, sinus *2–3 mm deep*, 8–12 mm wide, margin entire, apex acute or acuminate; leathery; lamina surface above with a scattering of black gland dots, glabrescent, lamina surface below pustulate, puberulent, indumentum a mix of longer straight and shorter hooked hairs; midrib above sunken, below prominent; venation *pinnate*, faint above, prominent below, basal pair 1, *spaced pairs 6–7*; intercostal veins reticulate. **Inflorescences** on bare stem, solitary; peduncle branched once; *c*. 15.5–17 cm long, *c*. 2 mm thick, puberulent, trichomes hooked, scattered among long spreading ones. Bracts pubescent. **Flowers:** perianth glossy greyish pale orange with purple tinge, purple beneath, *c*. 6.5 cm long, outer surface sparsely villose with shorter hooked trichomes, tube geniculately curved, utricle cylindric, c. 30 by 8 mm, inner surface with a glistening white patch (stellate trichomes or glands?), perianth tube c. 35 by 8 mm, *limb disc-shaped*, *5.8–6.5 cm diam*., 3-lobed, venation faint, mouth annulate, villous; gynostemium in transverse section faintly trigonal; anthers 9, congregated in 3 per group, narrowly oblong, *c*. 3 by 0.6 mm; stigmatic lobes 3, conical, *c*. 0.8 mm long, apex blunt. **Fruit** and **seed** unknown.

Distribution. Endemic in Peninsular Malaysia, Pahang (Genting Highlands and Raub).

Conservation status. Endangered. Two of its known localities are on private land.

Ecology. Hill and lower montane forests, stream side in valley to 1100 m altitude. Observations by H. Barlow and S.K.L. Hok (*pers*. *comm*.) in nearby Genting Tea Estate, Pahang, show the larvae of the White Head Batwing, *Atrophaneura sycorax egertoni*, Papilionidae, (*kepala putih* in Malay) feed on the leaves of this species. The larvae can defoliate a young plant and, just before it develops into a pupa, it bites and girdles the stem base. The plant re-sprouts later.

2. **THOTTEA** Rottb.

(T.O. Thott, 1703–1785, a Danish nobleman, patron of the University of Copenhagen)

Hempedu beruang (Malay)

Nye Saml. Kongel. Danske Vidensk. Selsk. Skr. 2 (1783) 529; Miquel, Fl. Ind. Bat. 1, 1 (1858) 1068; Duchartre *in* DC., Prod. 15, 1 (1864) 428; Bentham & Hooker *f*., Gen. Pl. 3 (1880) 123; Hooker *f*., Fl. Brit. India 5 (1886) 74; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 26; Ridley, Fl. Malay Pen. 3 (1924) 15; Henderson, Malay. Wild Flower Dicot. (1974) 424; Hou, Blumea 27 (1981) 303, Fl. Malesiana 1, 10 (1984) 65; Phuphathanaphong, Fl. Thailand 5 (1987) 22; Huber, Fam. Gen. Vasc. Pl. 2 (1993) 135. **Synonyms:** *Apama* Lam., Encycl. Méth., Bot. 1 (1783) 91; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 24; Ridley, Fl. Malay Pen. 3 (1924) 14; Henderson, Malay. Wild Flower Dicot. (1974) 422. *Bragantia* Lour.,

Fl. Cochinch. (1790) 528, ed. Willd. (1793) 645, *non* Vandelli 1771 (= *Gomphrena* L., Amaranthaceae); Griffith, Trans. Linn. Soc. 19 (1845) 335; Miquel, Fl. Ind. Bat. 1, 1 (1858) 1067; Klotzsch, Monatsb. Akad. Berlin (1859) 589; Duchartre *in* DC., Prod. 15, 1 (1864) 429; Bentham & Hooker *f*., Gen. Pl. 3 (1880) 122; Hooker *f*., Fl. Brit. India 5 (1886) 72. *Asiphonia* Griff., Trans. Linn. Soc. 19 (1845) 333; Huber, Fam. Gen. Vasc. Pl. 2 (1993) 134. *Lobbia* Planch. *in* Hook., Lond. J. Bot. 6 (1847) 144; Miquel, Fl. Ind. Bat. 1, 1 (1858) 1068. *Strakaea* C. Presl, Epimel. Bot. (1851) 221.

Shrubs or undershrubs, *erect or scrambling*, stem usually tufted with rhizome. **Stem** not branched or in some sparsely branched, usually erect and the top drooping (Troll's model), rarely much branched and scrambling. Plants generally pubescent or glabrous; indumentum usually a mix of straight and hooked hairs, the latter often shorter. **Leaves** on lower part of stem reduced to bract-like structures, foliage leaves petiolate; petiole grooved above; lamina glabrous above, beneath puberulent, pubescent or tomentose, venation palmate-pinnate or acrodromous-pinnate. **Inflorescence** a few-flowered raceme, cyme, or corymb, flowers rarely solitary, produced at stem base close to ground level or on lower part of stem at the nodes of fallen bract-like leaves, or axillary, rarely terminal; bracts usually opposite a flower, rarely in pairs. **Flowers** *radially symmetrical*, in bud usually triangular in top view; perianth bell-shaped or urn-shaped, 3-lobed, the base contracted into a cup or flat, lobes valvate, rarely perianth spherical with top axis perforated; stamens *6–30(–42) in 1 or 2 whorls*, sometimes with a few inserted between the whorls, free or adnate to the style column; ovary 4-grooved, 4-locular, stigmatic lobes 3–15; ovules numerous. **Fruits** capsulate, *4-valved*, *slender*, 5–22(–35) cm long, 3–10 mm thick, usually loculicidally dehiscing from apex to base. **Seeds** pendulous, ovoid or ellipsoid, in cross-section triangular, testa surface pimply or wrinkled.

Distribution. About 45 species widespread in Asia (Sri Lanka, India, Bangladesh, Myanmar, Thailand, Vietnam, China (Hainan), Sumatra, Peninsular Malaysia, Singapore, Java, Borneo, the Philippines and Sulawesi) with 16 species in Peninsular Malaysia.

Ecology. In lowland to hill forests, rarely above 1000 m altitude, sometimes persisting in gaps and disturbed sites, e.g. rubber estates. Growing as scattered individuals, occasionally locally abundant. The carrion-coloured flowers without apparent scent or white flowers which smell like rotten fish (*pers*. *obs*.), are possibly pollinated by flies or beetles. The flowers are protogynous and cross-pollination might occur between the female to male stage, though self-pollination is also possible because more than one flower is open at a time. The fully ripe capsule splits from top to bottom exposing the central pith, which separates from the fruit wall (*pers*. *obs*.). The seeds, which are embedded in the central pith, might attract ground foraging birds or fall off by chance. It is the food plant for a few species of Papilionidae butterflies (Igarashi & Fukuda, The Life Histories of Asian Butterflies 1 (1997) *t*. 305, fig. 7–9, 2 (2000) *t*. 400, fig. 1).

Uses. *Thottea* species contain an essential oil that is specific at the species level (Ong, PROSEA 12, 2 (2001) 547), mostly a mixture of monoterpenes with sesquiterpenes and/or phenylpropanoids. Saponins, triterpenes and steroids are found in *T. grandiflora*. Some common species are widely used by indigenous communities as traditional medicines (Burkill, Econ. Prod. Malay Pen. 2 (1966) 2195). *Thottea tomentosa* is planted as a food plant for butterfly breeding.

Taxonomy. Huber (1993) reinstated *Asiphonia*, a monotypic genus with *A*. *piperiformis*, based on seed anatomy and plastids structurally different from those of *Thottea*. However,

genetic molecular research (Oelschlägel *et al*., Gard. Bull. Sing. 63 (2011) 267) found that the number of base pair substitutions in the species is not higher compared with other *Thottea* species. Thus, I follow Hou (1981, 1984) in recognising *Thottea* which includes *Asiphonia* as a synonym. See Hou (1984) for a fuller list of synonyms.

Note. *Thottea* leaves are extremely variable. Lamina length to width ratio ranges from 1.7–3.1 in *T. dependens*, 1.4–2.8 in *T. grandiflora*, 2.0–4.3 in *T. piperiformis* and 1.7–4.1 in *T. tricornis*. It is important to record the plant habit, inflorescence position and preserve flowers in spirit when collecting. Leins *et al*. (Blumea 33 (1988) 357) observed that four placentae is a constant character for the genus and the variable androecial pattern might be a derived feature within the family. The stigmatic lobe number does not correspond with placentae in number and position suggesting that they are a phylogenetically secondary organ, which may function in pollen capture.

Key to Thottea species

1. Inflorescences terminal. Stem much-branched, scrambling. ..... **8. T. piperiformis**
   Inflorescences axillary, on lower part of stem at the nodes of fallen bract-like leaves, or at ground level. Stem scarcely branched, decumbent or erect. 2

2. Inflorescence peduncle *c*. 28 cm long. ..... **5. T. longipedunculata**
   Inflorescence peduncle up to 25 cm long. 3

3. Stems decumbent. Lamina beneath tomentose (at least when young), sometimes sparsely so. ..... **15. T. tomentosa**
   Stems erect. Lamina beneath pubescent or puberulent or glabrous, never tomentose. 4

4. Lamina beneath pubescent, hairs conspicuous to the naked eye. 5
   Lamina beneath glabrous or puberulent, hairs hardly visible to the naked eye. 9

5. Inflorescences at stem base close to ground level. 6
   Inflorescences axillary, or well above ground level on the lower part of stem at the nodes of fallen bract-like leaves. 8

6. Inflorescence peduncle length *c*. 2.5 cm. ..... **12. T. ruthiae**
   Inflorescence peduncle length at least 6 cm. 7

7. Flowers erect or held horizontally; perianth dark purple-red on outer surface, cream with dark purple-red rim (or entirely dark purple-red) on inner surface, diameter 3.5–5 cm; perianth lobes spreading, slightly laterally reflexed; stamens 24–29 in 2 whorls. ..... **14. T. terengganuensis**
   Flowers pendent; perianth creamy white, diameter *c*. 1 cm; lobes completely reflexed and blanketing perianth base; stamens 9–10 in 1 whorl. ..... **11. T. reflexa**

8. Perianth bell-shaped, lobes less than half of perianth length, base not contracted. Capsule dull yellow villose. ..... **3. T. grandiflora**

Perianth lobes dissected almost to the base of perianth, base contracted into a shallow cup. Capsule ferruginous villose. ..... **4. T. kamarudiniana**

9. Lamina narrowly lanceolate, beneath drying distinctly glaucous. Perianth creamy white. ..... **9. T. piscodora**
Lamina ovate, lanceolate, oblong, obovate or oblanceolate but not narrowly lanceolate; drying brown (if slightly glaucous or glaucous beneath then perianth dark purple-red, not creamy white: *T. dependens*). 10

10. Inflorescence axillary. 11
Inflorescence produced at stem base close to ground level or on lower part of the stem at the nodes of fallen bract-like leaves well above ground level. 13

11. Lamina base rounded. Stamens consistently 6 arranged in 1 whorl. ..... **13. T. sumatrana**
Lamina base cuneate. Stamens 15—26 arranged in 2 whorls. 12

12. Inflorescence peduncle 3–6 cm long. Flowers pendent; perianth funnel-shaped, stamens at least 23, stigmatic lobes at least 8. ..... **16. T. tricornis**
Inflorescence peduncle 1.3–2.4 cm long. Flowers erect; perianth ovoid to spherical, stamens not more than 20, stigmatic lobes not more than 5. ..... **1. T. anthonysamyi**

13. Inflorescence on lower part of stem at the nodes of fallen bract-like leaves well above ground level. 14
Inflorescence at stem base close to ground level (or sometimes, also with a few younger inflorescences on stem well above ground level in *T. praetermissa*). 15

14. Leaves papery, petiole to 5 mm long. Capsule *c*. 5 cm long. Perianth outer surface white, inner surface pale pink, 4–6 mm long, 3–5 mm diameter; stamens to 18, loosely arranged in two whorls. ..... **7. T. parviflora**
Leaves thinly leathery, petiole at least 10 mm long. Capsule 13–17 cm long. Perianth dark purple-red throughout, (8–)15–20 mm long, (10–)20 cm diameter; stamens at least 20, strictly arranged in 2 whorls..... **2. T. dependens**

15. Lamina oblanceolate (widest at upper half). Perianth dark purple-red with a creamy white patch on each lobe. ..... **6. T. papilionis**
Lamina oblong or lanceolate (widest at the middle or lower half). Perianth dull purple-red. ..... **10. T. praetermissa**

1. **Thottea anthonysamyi** T.L.Yao Fig. 2, Map 4

(Anthonysamy Savarimuthu, 1943–; herbarium assistant and avid plant collector in the Biology Department, Universiti Pertanian Malaysia [now Universiti Putra Malaysia], Serdang, Malaysia)

Blumea 58 (2013) 246, fig. 1, 10a. **Type:** *Anthonysamy s.n*., Peninsular Malaysia, Perak, Tapah, 13 October 1987, disturbed forest in [a] rubber estate, (holotype SING, barcode 15182; isotypes SING, barcodes 15183, 15178, 15179). **Synonym:** *Thottea tricornis auct. non*. Maingay *ex* Hook.*f. p.p.*: Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 29; Ridley, Fl. Malay Pen. 3 (1924) 16; Hou, Fl. Malesiana 1, 10 (1984) 74.

Shrub, 1.5–1.8 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, 4–5 mm diameter, surface shallowly furrowed, puberulent; nodes swollen. **Leaves:** petiole slender, 7–13 mm long, 2.5–3 mm thick, densely puberulent; lamina pale green beneath, *drying brown*, *lanceolate or oblanceolate*, 21–25 × 7.5–10.5 cm; papery to thinly leathery, beneath sparsely *puberulent*; *base cuneate*, margin entire, apex blunt or acute; midrib above distinct, below prominent, venation palmate-pinnate, above distinct, below prominent, basal pairs 2, upper basal pair less than, or sometimes more than half of the lamina length, pinnate pairs 5–6; intercostal veins a mix of scalariform and reticulate, scalariform ones more pronounced. **Inflorescences** *axillary*, congregated or solitary; peduncle sometimes once branched, *1.3–2.4 cm long, c.* 2 mm thick, pubescent; bracts lanceolate, *c.* 3 × 1.5 mm, densely pubescent, apex blunt, venation obscure.

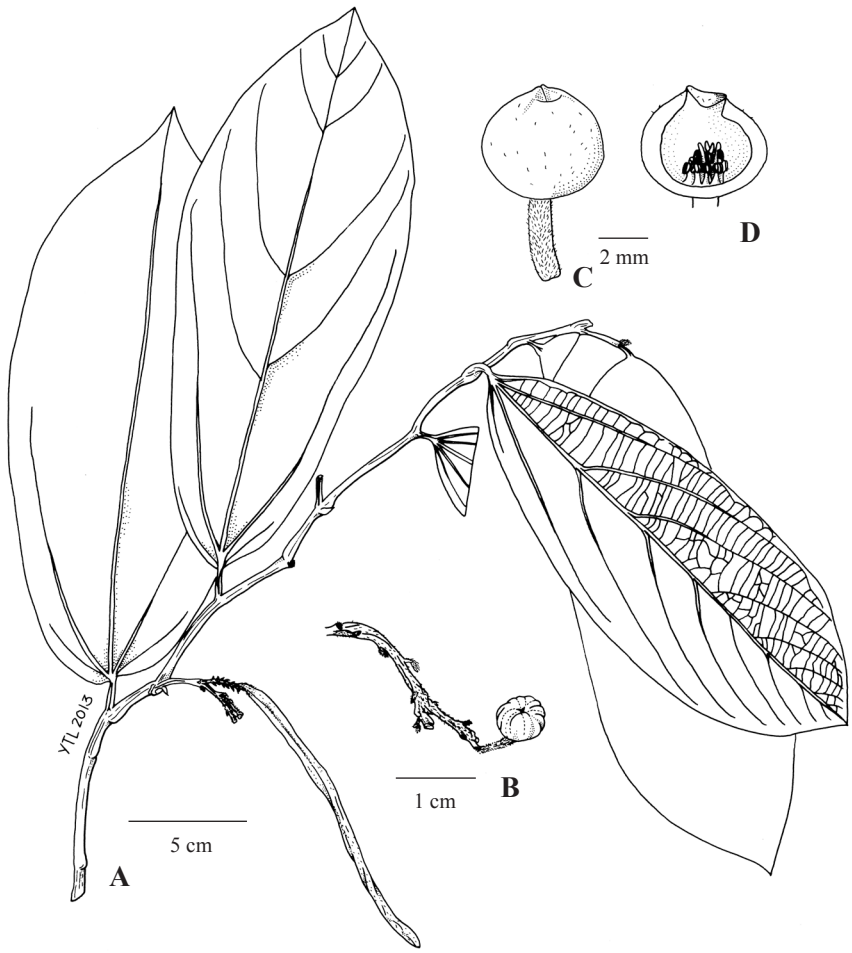
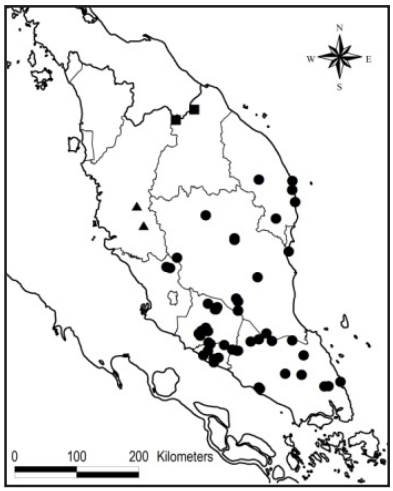


Figure 2. *Thottea anthonysamyi*. A, habit and a fruiting branch; B, inflorescence with a flower at apex; C, flower bud; D, flower bud with perianth partly removed showing gynostemium. (A from *Anthonysamy s.n.*, barcode 15178; B from *Anthonysamy s.n.*, barcode 15182; C–D from *Anthonysamy s.n.*, barcode 15179.)

Flowers *erect*; pedicel and ovary *c*. 0.6 cm long, ovary *c*. 1 mm thick, densely pubescent; perianth creamy white, *ovoid to spherical*, obscurely 3-lobed, top axis perforate, *c*. 0.4 cm long, *c*. 0.7 cm diameter, venation faint, outer surface puberulent, glabrescent, inner surface puberulent; stamens *15–20 in 2 whorls*, upper whorl with 5–6 stamens, lower whorl 10–14; filaments *c*. 0.5 mm long, glabrous, anthers positioned at the swollen connective apex, oblong, *c*. 0.5 mm long, *c*. 0.2 mm wide; style column cylindric, *c*. 1 mm long, glabrous; *stigmatic lobes 4–5*, positioned higher than stamens, *c*. 1 mm long, glabrous. **Capsules** pendent, ripening brown, twisted, 4-angled, 12.5–14.5 cm long, 3–6 mm thick, densely puberulent. **Seeds** ellipsoid, 3-angled, slightly ridged, margin corrugated, testa surface wrinkled, *c*. 4 × 2 mm, apex and base acute.

Distribution. Endemic in Peninsular Malaysia, known only from Perak (*King's Coll. 705* (SING); *Scortechini 1952* (SING); *Anthonysamy s.n*., barcodes 15178, 15179, 15182, 15183 (SING).



Map 4. Distribution of *Thottea anthonysamyi* (▲), *T. grandiflora* (●) and *T. longipedunculata* (■).

Conservation status. Endangered B2ab(iii). No population occurs within the network of Totally Protected Areas. The type locality in Tapah is now a residential area while no locality details are available for the Gopeng collections.

Ecology. Lowland, collected from old rubber estate.

Note. The largest flower available for this study might not be fully developed.

2. **Thottea dependens** (Planch.) Klotzsch — Map 5, Plate 3A–B

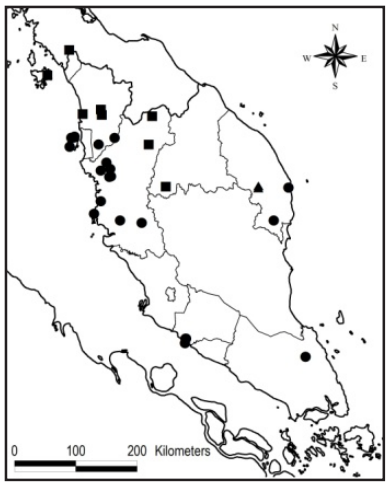
(Latin, *dependeo* = to hang down; referring to the inflorescence)

Monatsb. Akad. Berl. (1859) 589; Duchartre *in* DC. Prod. 15, 1 (1864) 428; Hook. *f*., Fl. Brit. India 5 (1886) 74; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 28; Ridley, Fl. Malay Pen. 3 (1924) 16; Hou, Blumea 27 (1981) 311, fig. 5–7, Fl. Malesiana 1, 10 (1984) 75, fig. 1b; Yao, Blumea 58 (2013) 259. **Basionym:** *Lobbia dependens* Planch. *in* Hooker, London J. Bot. 6 (1847) 145, *t*. 3; Miquel, Fl. Ind. Bat. 1, 1 (1858) 1068. **Type:** *Lobb 289*, 'Singapore' (see notes) (holotype K, barcode 575923; isotypes K, barcodes 575922, 575924, BM, barcode 950665, E, barcodes 317719, 317720). **Synonym:** *Piper arborescens*, Roxb. *ex* Wall. Cat. 6648 B. **Type:** *Wallich 6648B*, Penang (holotype K-W, barcode 575918).

Shrub 0.5–2 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, diameter 4–8 mm, surface smooth, sparsely puberulent; nodes swollen, above nodes constricted, nodes thickened with repeated flowering. **Leaves:** bract-like reduced leaves *c*. 4, foliage leaves 6–10 on one stem; petiole stout, *10–18 mm long*, 2–3 mm thick, puberulent; *lamina* pale green beneath, sometimes *slightly glaucous or glaucous or drying brown*, *ovate*, *obovate*, *oblong or oblanceolate*, (17–)19.5–28.5(–31) × (5.5–)8.5–13(–16) cm; first foliage lamina distinctly smaller, narrowly ovate, *c*. 4.5 × 1.5 cm; *thinly leathery*, indumentum *beneath puberulent*; base cuneate or rounded, margin entire, apex acute, acuminate, shortly mucronate or mucronate; midrib above slightly raised, below prominent; venation palmate-pinnate, above obscure, below distinct, basal pairs 2, upper basal pair less than, or sometimes more than half of the lamina length, pinnate pairs 6–8(–10); intercostal veins a mix of scalariform and reticulate veinlets, reticulate ones obscure. **Inflorescences** *on lower part of stem at the nodes of fallen bract-like leaves*, *well above ground level*, solitary; peduncle branched 1–2 time(s), *2.8–4.5*(*–6*) cm long, 1–2 mm thick, puberulent or pubescent; bracts green, narrowly oblanceolate or narrowly ovate, (3–)6–10 × (1–)2–4 mm, pubescent, apex acute, venation obscure or sometimes distinct. **Flowers** pendent; pedicel and ovary 1–2.4 cm long, ovary 0.5–1 mm thick, pubescent; *perianth dark purple-red throughout*, 3-lobed, (*0.8–*)*1.5–2 cm long*, (*1–*)*2 cm diameter*, venation faint, outer surface puberulent or pubescent, inner surface puberulent; base contracted into a bowl-shaped cup, (0.4–)0.7–1 cm deep, (0.8–)0.9–1.5 cm diameter, inner surface sparsely puberulent; perianth lobes broadly ovate, flared, (4–)6–10 × 9–13 mm, apex acute; *stamens 23–30 in 2 whorls*, upper whorl with (8–)11–12 stamens, lower whorl (13–)17–18; filament *c*. 2 mm long, glabrous; anthers positioned at the swollen connective apex, oblong, *c*. 1.8 mm long, *c*. 0.4 mm wide; style column cylindric, *c*. 2 mm long, glabrous; stigmatic lobes 5–8, positioned higher than stamens, *c*. 2 mm long, glabrous. **Capsules** pendent, ripening brown, straight to slightly twisted, 4-angled, *13–17 cm long*, 3–10 mm thick, puberulent. **Seeds** ellipsoid, 3-angled, slightly ridged, margin corrugated, testa surface transversely strongly wrinkled, 4–5 × 1.5–2 mm, apex and base acute.

Vernacular name. *Telinga beruang* (Malay).

Distribution. Endemic in Peninsular Malaysia, known from Kedah, Penang, Perak, Negeri Sembilan, Terengganu and Johor.



Map 5. Distribution of *Thottea dependens* (●), *T. kamarudiniana* (▲) and *T. parviflora* (■).

Conservation status. Least Concern. This species is widespread and locally common.

Ecology. Lowland and coastal hill forests, on ridges or slopes, sometimes on sandy soil with a thin humus layer. The fully ripe capsule splits from top to bottom exposing a string of seeds covered in white glistening starchy pulp hanging by their funicles. The starchy pulp rapidly turns sour, indicating a high carbohydrate content. The white worm-like string of seeds may attract ground-foraging birds to consume the seeds.

Note. The east coast specimens, *Corner s.n.* (SING, barcodes 97372, 97360; Kemaman, Terengganu), *Imin 74657* (Mersing, Johor) and *Poore 5063* (Dungun, Terengganu), represent a disjunct distribution from the main population (Map 5). *Imin 74657* possesses smaller flowers (0.8 cm long, 1 cm diameter), fewer stamens (upper whorl 8, lower whorl 13) and stigmatic lobes (5) but in other characters matches *T. dependens*. *Corner s.n.* is a sterile specimen with an oblanceolate lamina and long mucronate apex. Based on the looped ornamentation (microscopic) on the lower lamina surface of these specimens, I identify them as *T. dependens*.

3. **Thottea grandiflora** Rottb. Map 4, Plates 3C–D, 4A–B

(Latin, *grandis* = large, *flora* = flower)

Nye Saml. Kongel. Danske Vidensk. Selsk. Skr. 2 (1783) 529, *t.* 2; Griffith, Trans. Linn. Soc. 19 (1845) 325, *t.* 36, Icon. Pl. Asiat. 4 (1854) *t.* 530 & 531; Miquel, Fl. Ind. Bat. 1, 1 (1858) 1068; Klotzsch, Monatsb. Akad. Berl. (1859) 589, *t.* 1. fig. 3; Duchartre *in* DC. Prod. 15, 1 (1864) 428; Hooker *f.*, Fl. Brit. India 5 (1886) 74; Ridley, J. Str. Br. Roy. Asiat. Soc. 33 (1900) 127; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 27; Ridley, Fl. Malay Pen. 3 (1924) 16; Henderson, Malay. Wild Flowers, Dicot. (1974) 424, fig. 383; Hou, Blumea 27 (1981) 308, fig. 8–10, 317, fig. 62, Fl. Malesiana 1, 10 (1984) 69, fig. 3; Phuphathanaphong, Fl. Thailand 5 (1987) 26, fig. 16; Ong, PROSEA 12, 2 (2001) 549. **Type:** *Koenig s.n.*, Peninsular Malaysia, Melaka (holotype C; isotypes C, 2 sheets, BM, barcode 950666).

Shrub, 1–2 m tall. **Stem** stout, *erect*, *scarcely branched*, drooping at top, dark dirty green, 5.5–9 mm diameter, surface shallowly furrowed, densely pubescent; nodes swollen. **Leaves:** bract-like reduced leaves 3–5, foliage leaves 4–8 on one stem; petiole stout, 9–12 mm long, 3–5 mm thick, densely pubescent; lamina dark green above, green beneath, drying brown, ovate, oblong, broadly lanceolate or oblanceolate, (16–)21.5–26(–43.5) × (6.5–)10.5–24(–26.5) cm; first foliage lamina distinctly smaller, narrowly ovate, 5.5–10 × 1.5–3.5 cm; leathery, indumentum *beneath* densely *pubescent*; base truncate, rounded or cordate, margin entire, apex blunt or acute; midrib above distinct, below prominent; venation palmate-pinnate, above obscure, below prominent, basal pairs 2, upper basal pair up to half of the lamina length, pinnate pairs (5–)6–8(–10); intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *axillary or on lower part of stem at the nodes of fallen bract-like leaves well above ground level*, solitary; peduncle branched, 1(–2) time(s), *3.5–6 cm long*, 2.5–5 mm thick, pubescent or villose; bracts green, lanceolate, narrowly oblanceolate or narrowly ovate, 10–30(–35) × 4–12 mm, densely pubescent or villose, apex acute, venation distinct. **Flowers** pendent; pedicel and ovary 2–2.5 cm long, ovary *c.* 2.5 mm thick, villous; perianth dark purple-red, venation distinct, veins white on outer surface, *bell-shaped*, *base not contracted*, 3-lobed, (3–)6–14 cm long, 6–10 cm diameter, outer surface pubescent, inner surface puberulent; perianth lobes *less than half of perianth length*, oblong, sometimes deltoid, 30–50(–65) × 25–30(–45) mm, apex rounded, blunt or acute; stamens 28–42 in 2 whorls, upper whorl with 12–18 stamens, lower whorl 16–24; filament *c.* 0.5 mm long, glabrous; anthers

almost cover the whole connective, oblong, *c*. 2.2 mm long, *c*. 0.4 mm wide; style column cylindric, *c*. 4 mm long, glabrous; stigmatic lobes 10–15, positioned higher than stamens, 1.5–2 mm long, glabrous. **Capsules** usually pendent, sometimes erect, ripening brown, straight or sometimes curved, 4-angled, 7–17 cm long, 5–8 mm thick, dull yellow villose. **Seeds** ovoid, 3-angled, slightly ridged, margin corrugated, testa surface pimply, 4–4.5 × 2–2.5 mm, apex truncate, base rounded.

Vernacular names. *Hempedu beruang* (preferred name)*, pokok kurubut*, *seburut* and *sentondok gajah* (Malay); *sel-wohl* (Semelai).

Distribution. Myanmar (Moulmein), Peninsular Thailand, Peninsular Malaysia and Singapore. In Peninsular Malaysia known from Selangor, Negeri Sembilan, Melaka, Terengganu, Pahang and Johor.

Conservation status. Least Concern.

Ecology. Often locally common and widely scattered, in lowland to hill dipterocarp forests to 610 m altitude, often on lateritic soil with a thin humus layer, occasionally in coastal hill dipterocarp forest and seasonal freshwater swamp. Populations persist in logged secondary forest.

Uses. The root is an excellent tonic; a decoction is given for fever and ague, and to women after confinement; it is also used for dysentery (Burkill, Econ. Prod. Malay Pen. 2 (1966) 2195).

Note. Flower size is variable, for example on a single plant, *KEP 98185*, the perianth of the largest open flower measured 10.5 cm long, the medium-sized ones about 4.5 cm long, while the smallest measured 2.5 cm long.

4. **Thottea kamarudiniana** T.L.Yao Fig. 3, Map 5

(Kamarudin Mat Salleh, 1959–2009; affectionately known as Pak Din, Malaysian botanist and Professor in Universiti Kebangsaan Malaysia, best known for his research on and conservation of *Rafflesia* (Rafflesiaceae).)

Blumea 58 (2013) 247, fig. 2, 10b. **Type:** *Sani et al. SM 449*, Peninsular Malaysia, Terengganu, Pasir Raja FR [Kampung Pasir Raja], Track to big Chengal, 6 June 2004, (holotype UKMB; 2 sheets of sterile specimens with a colour photograph of inflorescence and flowers in full bloom, collected during G. Mandi Angin Expedition organised by Forestry Department of Peninsular Malaysia).

Shrub, 1.3–2.5 m tall. **Stem** stout, *erect*, *scarcely branched*, drooping at top, dark dirty green, diameter 8–10 mm, surface shallowly furrowed, densely pubescent; nodes indistinct. **Leaves:** bract-like reduced leaves 11–19, foliage leaves *c*. 7 on one stem; petiole stout, 12–14 mm long, 4–5 mm thick, densely pubescent; lamina dark green above, green beneath, drying brown, broadly lanceolate, 43–44 × 26–27 cm; first foliage lamina distinctly smaller; papery to thinly leathery, indumentum *beneath densely pubescent*; base rounded or cordate, margin entire, apex acute; midrib above distinct, below prominent; venation palmate-pinnate, above distinct, below prominent, basal pairs 2, upper basal pair less than half the leaf length, pinnate pairs 8–12; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *on lower part of stem at the nodes of fallen bract-like leaves well*

Figure 3. *Thottea kamarudiniana*. A, habit; B, the largest leaf; C, inflorescence with an opened flower and three flower buds. (A from *FRI 65595*; B from *Sani et al*. *SM 449*; C adapted from a photograph taken by S. Kamarudin, http://m.flickr.com/photos/kmatsalleh/2320556359/lightbox/, last accessed 1 August 2013.)

above ground level, solitary; peduncle sometimes once branched, *c*. *4.5 cm long*, *c*. 4 mm thick, densely pubescent; bracts light green, lanceolate, 10–12 × 4–6 mm, pubescent, apex acute, venation distinct. **Flowers** pendent; perianth creamy-white on outer surface, venation distinct, dark purple-red, creamy white on inner surface, 3-lobed, lobes *deeply dissected almost to the base*, base *contracted into a shallow cup*; perianth lobes broadly ovate, flared, apex acute. **Capsules** pendent, ripening brown, twisted, 4-angled, *c*. 13 cm long, ferruginous villose. **Seed** unknown.

Distribution. Endemic in Peninsular Malaysia, known only from Pasir Raja, Terengganu.

Conservation status. Critically Endangered B2ab(iii). Ground truthing shows that the population lies outside Taman Negara. Not more than ten living plants were observed.

Ecology. Lowland forest gap at 160 m altitude, known from trailside by an abandoned logging camp and beside a wallow.

Note. Flowers of this species are currently known only from colour photographs, which are available at http://www.flickr.com/photos/kmatsalleh/2320556359/.

5. **Thottea longipedunculata** T.L.Yao Fig. 4, Map 4

(Latin, *longus* = long, *pedunculus* = peduncle)

Blumea 58 (2013) 249, fig. 3, 10c. **Type:** *Motan KEP 94538*, Peninsular Malaysia, Kelantan, Tanah Merah, Kemahang FR, Compartment 65, 13 July 1960 (holotype KEP, barcode 78121).

Shrub *c*. 1.8 m tall. **Stem** slender, *erect*, *scarcely branched*, *drooping at top*, dark dirty green, *c*. 7.5 mm diameter, surface smooth, pubescent; nodes indistinct, above nodes constricted. **Leaves:** petiole rather stout, 8–10 mm long, 2–4 mm thick, pubescent; lamina drying brown, narrowly ovate or oblong, 24.5–30 × 9.5–10 cm, papery, indumentum beneath pubescent, base cuneate or rounded, margin entire, apex acute or shortly mucronate; midrib above flat or sometimes sunken, below prominent; venation palmate-pinnate, above distinct, below prominent, basal pairs 2, upper basal pair less than half the leaf length, pinnate pairs 7–8; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescence** (position unknown) solitary; peduncle twice branched, *c*. *28 cm long*, *c*. 3 mm thick, pubescent; bracts ovate, *c*. 11 × 5 mm, pubescent, apex blunt or acute, venation obscure or sometimes distinct. **Flower:** ovary densely pubescent; perianth white and red, 3-lobed, *c*. 1.5 cm long, *c*. 1.6 cm diameter, outer surface pubescent, inner surface sparsely pubescent; perianth lobes shallowly deltoid, *c*. 5 × 10 mm, apex blunt; stamens *c*. 20 in 2 whorls, upper whorl with *c*. 8 stamens, lower whorl *c*. 12; filament *c*. 1 mm long, glabrous; anthers positioned at the swollen connective apex, oblong, *c*. 0.5 mm long, *c*. 0.2 mm wide; style column cylindric, *c*. 1.5 mm long, glabrous; stigmatic lobes *c*. 6, positioned higher than stamens, *c*. 2.5 mm long, glabrous. **Capsule** and **seed** unknown.

Vernacular name. *Hempedu beruang* (Malay).

Distribution. Endemic in Peninsular Malaysia, known only from Kelantan.

Conservation status. Critically Endangered B1ab(iii). No population occurs within the network of Totally Protected Areas. The habitat status of the two sites requires checking. One recent survey was unsuccessful in relocating the species.

Ecology. Forest undergrowth.

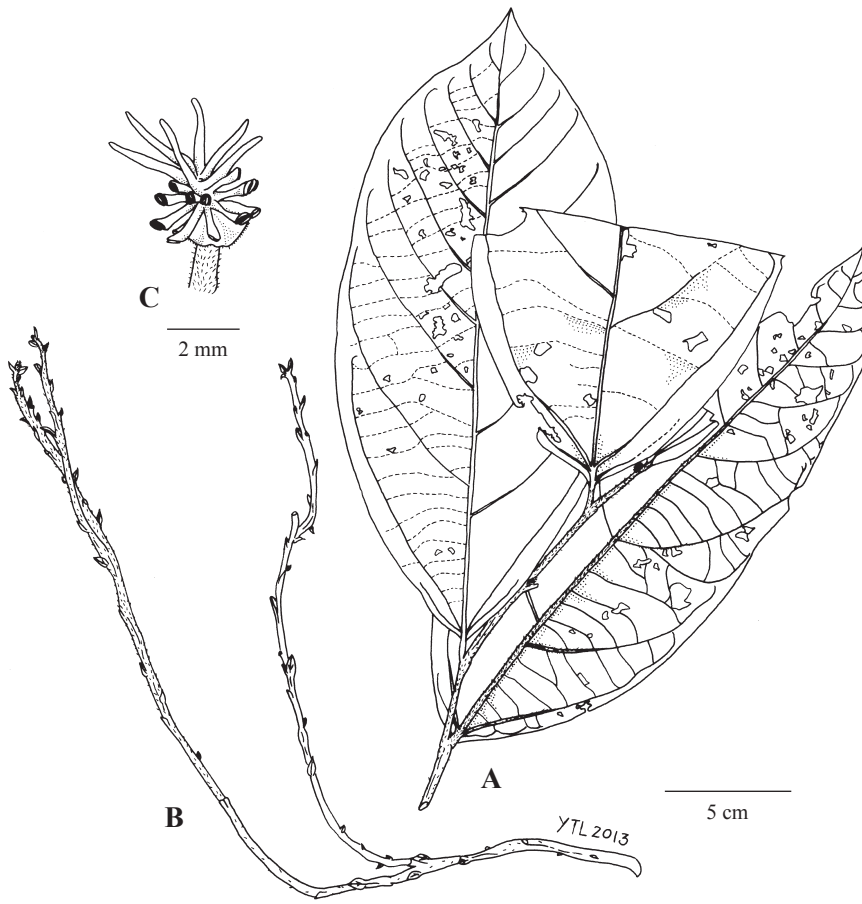


Figure 4. *Thottea longipedunculata*. A, leafy twig; B, inflorescence; C, gynostemium. (All from *KEP 94538*.)

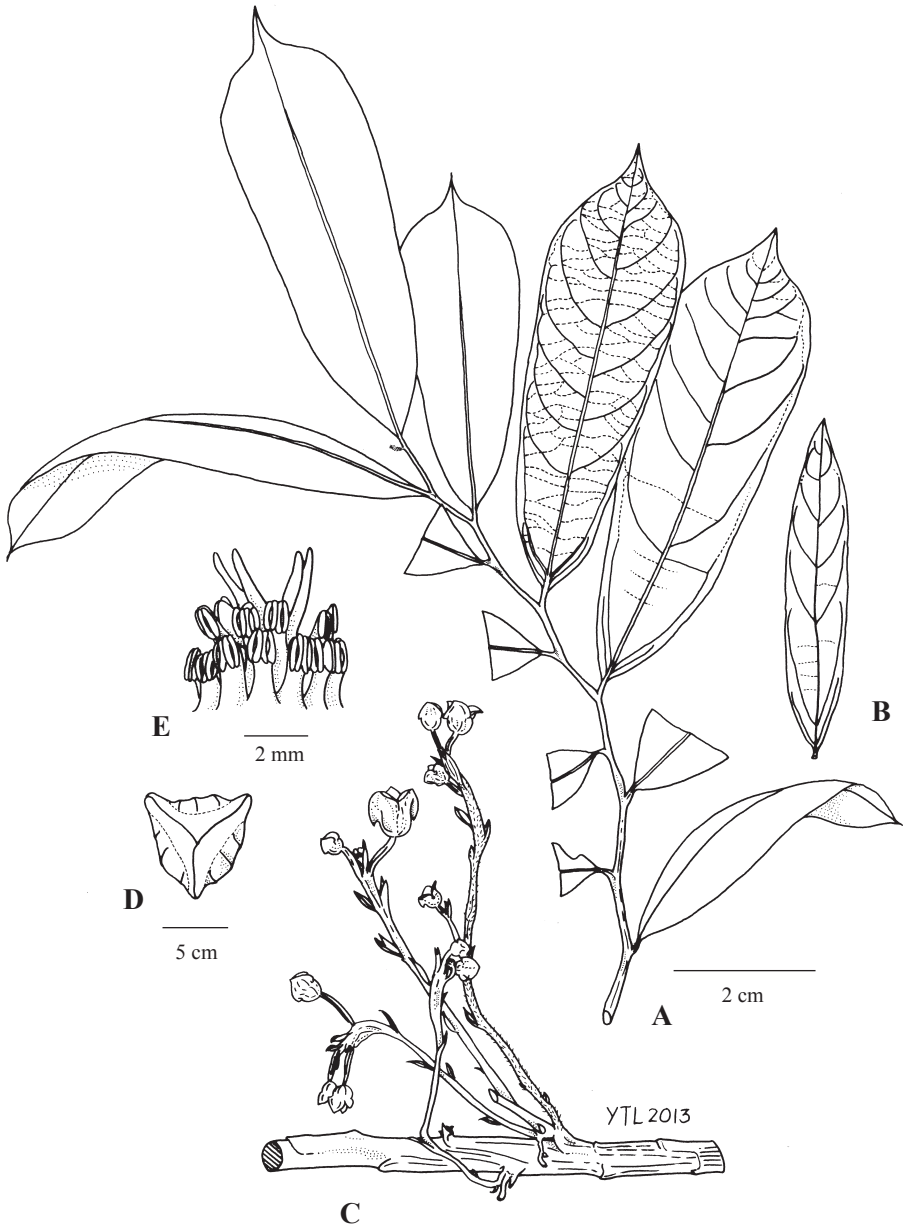


Figure 5. *Thottea papilionis*. A, habit; B, first foliage leaf; C, congregated inflorescences issuing from procumbent stem base; D, flower bud top view; E, gynostemium. (All from *FRI 65421*.)

6. **Thottea papilionis** T.L.Yao — Fig. 5, Map 7, Plate 4C

(Latin, *papilio* = butterfly; of butterfly because it is a food plant for caterpillars)

Blumea 58 (2013) 250, fig. 4, 10d. **Type:** *Yao et al. FRI 65421*, Malaysia, Perak, Tapah, orchard on Sg. Batang Padang north bank, 31 March 2009 (holotype KEP, barcode 192442; isotypes K, L).

Shrub *c*. 1 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, *c*. 6.5 mm diameter, surface smooth, puberulent; nodes swollen, constricted above nodes. **Leaves** 12–19 on one stem; petiole slender, 7–8 mm long, 1.5–2 mm thick, densely puberulent; lamina green above, pale green beneath, *drying brown*, *oblanceolate*, 15.5–17.5 × 4–5 cm; first foliage lamina distinctly smaller, narrowly lanceolate, *c*. 11.3 × 2 cm; papery, indumentum *beneath sparsely puberulent*; base cuneate, margin entire, apex acute or mucronate; midrib above distinct or sometimes sunken, below prominent; venation palmate-pinnate, above faint, below distinct, basal pairs 2, inner basal pair less than half the leaf length, pinnate pairs 5–7; intercostal veins a mix of scalariform and reticulate, scalariform ones more pronounced. **Inflorescences** *at stem base close to ground level*, congregated; peduncle not branched, *7.5–9 cm long*, *c*. 1 mm thick, densely puberulent; bracts narrowly ovate, 6–7 × 2–3 mm, pubescent, apex acute, venation distinct. **Flowers** erect; pedicel and ovary 1–1.2 cm long, ovary *c*. 1 mm thick, densely pubescent; perianth *dark purple-red with a creamy white patch on each perianth lobe*, 3-lobed, 1.3–1.6 cm long, 1.3–2 cm diameter, venation distinct, outer surface sparsely pubescent, inner surface puberulent; base contracted into a bowl-shaped cup, 0.5–0.7 cm deep, *c*. 0.7 cm diameter, inner surface pubescent; perianth lobes broadly ovate, flared, 8–10 × 13 mm, apex blunt or acute; stigmatic lobes positioned higher than stamens; stamens 20–24 in 2 whorls, upper whorl with 7–9 stamens, lower whorl 13–15; filament *c*. 1 mm long, glabrous; anthers positioned on swollen connective apex, oblong, *c*. 1.2 mm long, *c*. 0.6 mm wide; style column disc-shaped, *c*. 2.6 mm long, glabrous; stigmatic lobes 4–6, *c*. 1.8 mm long, glabrous. **Capsule** and **seed** unknown.

Distribution. Endemic in Peninsular Malaysia, known only from Tapah, Perak.

Conservation status. Critically Endangered B2ab(iii). No population occurs within the network of Totally Protected Areas. The species is represented only by the type specimen. It is used in breeding butterflies and the plants were collected from the wild and replanted in an orchard. They are monitored regularly by the pupae collectors, who trade with commercial collectors.

Ecology. Lowland forest. Its natural habitat is unknown, collected from a transplanted population in an orchard.

Note. Known only from the type and a photograph of a plant from this population as *Thottea* sp. in Polunin (Plants and Flowers of Malaysia (2004) 88, fig. 44).

7. **Thottea parviflora** Ridl. — Map 5, Plates 4D, 5A–B

(Latin, *parva* = small, *flora* = flower)

J. Str. Br. Roy. Asiat. Soc. 57 (1910) 89, Fl. Malay Pen. 3 (1924) 17; Hou, Blumea 27 (1981) 305, fig. 38–40, 70D, Fl. Malesiana 1, 10 (1984) 67, fig. 7n–p.; Phuphathanaphong, Fl. Thailand 5 (1987) 28, fig. 18; Ong, PROSEA 12, 2 (2001) 549; Yao, Blumea 58 (2013) 260. **Type:** *Ridley 14580*, Peninsular Malaysia, Perak, Temenggor [Temango] (lectotype SING, barcode 97415; isolectotypes BM, barcode 950667, K, barcode 634535).

Shrub, 1–1.8 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, diameter 4–6.5 mm, surface smooth, puberulent; nodes indistinct, above nodes constricted, side branching common. **Leaves:** bract-like reduced leaves 4–5, foliage leaves 8–9 on one stem; petiole slender, *4–5 mm long*, *c*. 1 mm thick, sparsely puberulent; lamina green above, pale green beneath, *drying brown*, *ovate or lanceolate*, 14–23 × 5.5–8.5 cm; first foliage lamina distinctly smaller, narrowly ovate, 7.5–8 × 2–2.5 cm; *papery*, indumentum *beneath puberulent*; base cuneate or rounded, margin entire, apex acute or acuminate; midrib above flat, below distinct; venation palmate-pinnate, above obscure, below distinct, basal pairs 2, upper basal pair up to half the lamina length, pinnate pairs (6–)8–10; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *on lower part of stem at the nodes of fallen bract-like leaves well above ground level*, congregated or rarely solitary, usually a few inflorescences produced at nodes thickened due to repeated flowering; peduncle sometimes once branched, *1–2.5 cm long*, *c*. 0.5 mm thick, pubescent; bracts green, narrowly lanceolate, 1.5–2 × 0.5 mm, densely pubescent, apex acute, venation obscure. **Flowers** erect; pedicel and ovary 3–7 mm long, ovary *c*. 0.5 mm thick, densely pubescent; perianth *outer surface creamy white*, *inner surface pale pink*, 3-lobed, lobes dissected to about half the perianth length, base almost flat, *0.4–0.6 cm long*, *0.3–0.5 cm diameter*, venation faint, outer surface sparsely puberulent, inner surface sparsely pubescent; perianth lobes broadly ovate, spreading, 3–4 × 3–4 mm, apex acute; stamens *13–18 loosely arranged in 2 whorls*, upper whorl 5–7, lower whorl 8–11; filament *c*. 0.5 mm long, puberulent; anthers positioned on the swollen connective apex, oblong, *c*. 1 mm long, *c*. 0.2 mm wide; style column disc-shaped, *c*. 1.6 mm long, glabrous; stigmatic lobes 4–5, positioned higher than stamens, *c*. 1.5 mm long, glabrous. **Capsules** pendent, ripening brown, straight to slightly twisted, 4-angled, *c*. *5 cm long*, *c*. 3 mm thick, puberulent. **Seeds** ovoid, 3-angled, slightly ridged, margin corrugated, testa surface wrinkled, *c*. 2.5 × 1.5 mm, apex acute, base rounded.

Vernacular name. *Kemed kawit* (Jahai).

Distribution. Peninsular Thailand and northern Peninsular Malaysia. In Peninsular Malaysia known from Perlis, Kedah (including Langkawi), N Perak and Kelantan.

Conservation status. Near Threatened. A few populations occur within the network of Totally Protected Areas.

Ecology. Primary evergreen lowland to hill forests to 550 m altitude, persisting in disturbed areas in primary forest or in shade in secondary forest. In Thailand to 725 m altitude, occasionally in riparian vegetation and freshwater swamps, often on sandy soil on ridges or steep earth banks and in Peninsular Thailand also known from sandy soils over limestone bedrock.

Note. The capsule description is based on a Thai specimen since no Peninsular Malaysian fruiting material is available.

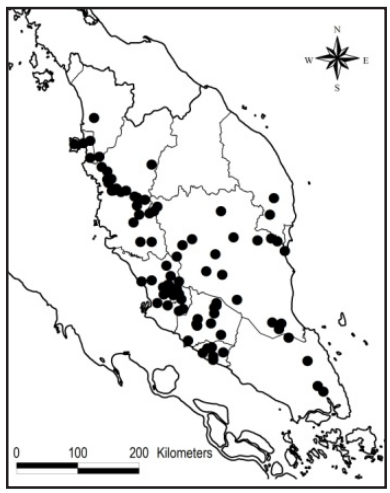
8. **Thottea piperiformis** (Griff.) Mabb. Map 6, Plates 5C–D, 6A

(Latin, *piper* = pepper, *forma* = form; with pepper-like appearance)

Blumea 44 (1999) 350. **Basionym:** *Asiphonia piperiformis* Griff., Proc. Linn. Soc. Lond. 1 (1844) 218, Trans. Linn. Soc. Lond. 19 (1845) 333, *t*. 37, Icon. Pl. Asiat. 4 (1854) *t*. 528. **Homotypic synonyms:** *Bragantia corymbosa* Griff. *nom*. *superfl*., *illegit*., Trans. Linn. Soc. 19 (1845) 335; Miquel, Fl. Ind. Bat. 1, 1 (1858) 1068; Klotzsch, Monatsb. Akad. Berl. (1859) 591, *t*. 1, fig. 4; Duchartre in DC. Prod. 15, 1

(1864) 429; Hooker *f*., Fl. Brit. India 5 (1886) 73. *Apama corymbosa* (Griff.) Willd. *ex* Soler., Naturl. Pflanzenfam. 3, 1 (1889) 272; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 25; Ridley, Fl. Malay Pen. 3 (1924) 15; Henderson, Malay. Wild Flowers, Dicot. (1974) 422, fig. 382A–D. *Thottea corymbosa* (Griff.) Ding Hou, Blumea 27 (1981) 320, fig. 4, Fl. Malesiana 1, 10 (1984) 78, fig. 1a, 8d. **Type:** *Griffith s.n*., Peninsular Malaysia, Melaka, Ayer Panas [Ayer Punnus] (holotype K, barcode 634532; isotypes K, barcode 634533, BM, barcode 950672). **Heterotypic synonyms:** *Strakaea melastomaefolia* C.Presl, Epimel. Bot. (1851) 222. *Bragantia melastomaefolia* (C.Presl) Duchartre *in* DC., Prod. 15, 1 (1864) 429. **Type:** *Cuming 2333*, Peninsular Malaysia, Melaka (lectotype K, barcode 634530, here designated; isolectotypes BM, K, barcodes 634529, 634531, L, barcode 38895).

Shrub 2–6 m tall. **Stem** slender to stout, at base erect, *much branched*, branches *scrambling* and drooping, dark green, young stem tinged purplish, 5–12 mm diameter, surface smooth, densely puberulent; nodes swollen, scrambling stem distinctly articulated and slightly zig-zagging. **Leaves** many; petiole slender, 4–7 mm long, 1–2 mm thick, densely puberulent, trichomes straight; lamina dark green above, bluish green beneath or slightly glaucous, drying dark brown, ovate or lanceolate, 9–20(–26.5) × (2.5–)4–7(–8) cm; papery to thinly leathery, indumentum beneath puberulent; base cuneate or rounded, margin entire, apex long acuminate or apiculate; midrib above distinct, below prominent; venation acrodromous-pinnate, above distinct, below prominent, basal pairs 2, upper basal pair more than half of the lamina length, pinnate pairs 1(–2); intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *terminal*, solitary; peduncle branched, 2–3 times, *2–8.5 cm long*, *c*. 1 mm thick, densely puberulent; bracts cream, in pairs subtending every flower, narrowly lanceolate or lanceolate, *c*. 5 × 1–1.5 mm, densely pubescent, apex acute, venation obscure. **Flowers** erect; pedicel and ovary 0.5–1.7(–2.1) cm long, ovary 0.6–0.8 mm thick, densely puberulent; perianth cream tinged pale green, turning darker to almost dark brown with age, 3-lobed, lobes deeply dissected to the base, base almost flat, 1.5–2(–3) mm long, 6–7 mm diameter, venation obscure, outer surface densely puberulent, inner surface glabrous, smooth or minutely pitted; perianth lobes broadly ovate, spreading to reflexed, 2–5 × 0.5 mm, apex acute; stamens 7–10 in 1 whorl, sessile; anthers oblong, *c*. 0.8 mm long, *c*. 0.2 mm wide; style column disc-shaped, *c*. 1 mm long, glabrous; stigma scarcely lobed, positioned higher than stamens, glabrous. **Capsules** pendent, ripening brown, twisted, 4-angled, 22–35 cm long, 5–7 mm thick, puberulent. **Seeds** ellipsoid, 3-angled, margin strongly corrugated, testa surface transversely strongly wrinkled, *c*. 3 × 2 mm, apex truncate, base rounded.



Map 6. Distribution of *Thottea piperiformis*.

Vernacular names. *Pokok akar melada* (preferred name), *akar julong bukit*, *akar surai*, *cambai ular*, *ekor pelandok*, *jangat*, *mahjan pahit*, *tinjau binti*, *upas* (Malay); *kumar bayen*, *lepas* (Orang Ulu); *lerkor* (Jahai).

Distribution. Sri Lanka, Sumatra, Peninsular Malaysia and Borneo (Kalimantan). In Peninsular Malaysia known from all states except Perlis and Kelantan.

Conservation status. Least Concern. This species is common and widespread.

Ecology. Lowland to hill forests to 780 m altitude, often in forest fringes and riverside.

Uses. Used medicinally throughout Peninsular Malaysia. The leaves are pounded and placed against the gums for toothache in Perak and Pahang; in Negeri Sembilan, the pith of the roots is chewed together with betel-nut as a diuretic during confinement. It was stocked by Chinese herbalists under the name '*long tam yap*' (lóng dǎn yè) (Burkill, Econ. Prod. Malay Pen. 1 (1966) 189).

9. **Thottea piscodora** T.L.Yao Fig. 6, Map 7, Plate 6B–D

(Latin, *piscis* = fish, *odor* = smell; denoting the flowers that smell of rotten fish)

Blumea 58 (2013) 251, fig. 5, 10e. **Type:** *Yao et al. FRI 65443*, Peninsular Malaysia, Terengganu, Kemaman, Rasau Kerteh FR, 8 April 2009 (holotype KEP, barcode 192446; isotypes K, L, SING).

Shrub, *c*. 2 m tall. **Stem** stout, erect, *scarcely branched*, drooping at top, dark dirty green, diameter 4–6 mm; nodes swollen. **Leaves:** petiole rather stout, *c*. 7 mm long, *c*. 4.5 mm thick; lamina dark green above, *distinctly glaucous beneath*, *narrowly lanceolate*, 25–28.5 × 7.5–9.5 cm; first foliage lamina distinctly smaller, narrowly ovate, 11–15.5 × 1–2.5 cm; thinly leathery, *beneath glabrous*, base cuneate, margin entire, apex acute; midrib above distinct or slightly raised, below prominent; venation palmate-pinnate, distinct above and below, basal pairs 2, upper basal pair less than half of the leaf length, pinnate pairs 5–8; intercostal veins a mix of scalariform and reticulate veinlets, reticulate ones obscure. **Inflorescences** *on lower part of stem at the nodes of fallen bract-like leaves well above ground level*, congregated, a few inflorescences issuing from the same node that thickens due to repeated flowering; peduncle sometimes once branched, *0.4–0.8 cm long*, *c*. 1.6 mm thick, glabrescent; bracts oblanceolate or ovate, *c*. 2 × 1 mm, glabrescent, apex acute or sometimes notched or bifid, venation obscure. **Flowers:** ovary ascending, perianth held horizontally; pedicel and ovary *c*. 2 cm long, ovary *c*. 1.5 mm thick, pubescent; perianth *creamy white*, towards centre tinged pale greenish grey, 3-lobed, *c*. 12 mm long, *c*. 9 mm diameter, venation distinct, outer surface puberulent, inner surface sparsely puberulent; base contracted into an urn-shaped cup, *c*. 5 mm deep, *c*. 7 mm diameter, inner surface pubescent; perianth lobes broadly ovate, flared, *c*. 7 × 5 mm, apex acute; stamens 14–15 in 2 whorls, upper whorl with 5–6 stamens, lower whorl *c*. 9; filament *c*. 1 mm long, puberulent; anthers positioned on the swollen connective apex, oblong, *c*. 1.2 mm long, *c*. 0.4 mm wide; style column cylindric, *c*. 2 mm long, glabrous; stigmatic lobes 4–5, positioned higher than stamens, *c*. 1.5 mm long, glabrous. **Capsule** and **seed** unknown.

Distribution. Endemic in Peninsular Malaysia, known only from Rasau Kerteh FR, Terengganu.

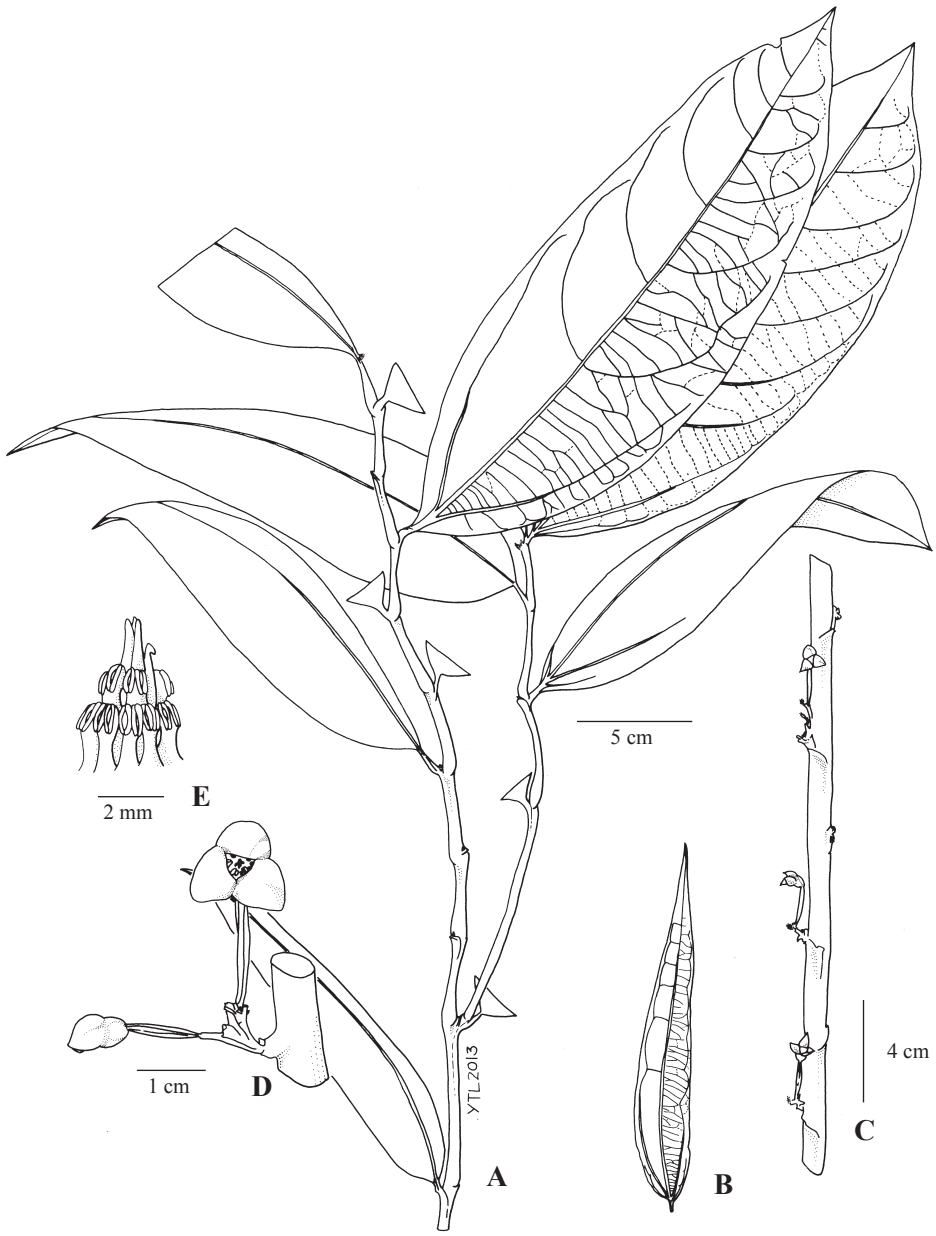


Figure 6. *Thottea piscodora*. A, habit; B, first foliage leaf; C, inflorescences from nodes thickened due to repeated flowering on lower part of stem; D, inflorescence with an opened flower and a flower bud; E, gynostemium. (All from *FRI 65443*.)

Map 7. Distribution of *Thottea papilionis* (▲), *T. piscodora* (■) and *T. praetermissa* (●).

Conservation status. Critically Endangered B2ab(iii). Known only from the type. Its population does not occur within the network of Totally Protected Areas.

Ecology. Lowland forest fragment close to freshwater swamp, below 100 m altitude.

10. **Thottea praetermissa** T.L.Yao Fig. 7, Map 7, Plate 7A–B

(Latin, *praetermissus* = overlooked; it was not previously recognised as a distinct species)

Blumea 58 (2013) 252, fig. 6, 10f. **Typus:** *Anthonysamy SA 917*, Peninsular Malaysia, Melaka, Asahan (holotype KEP, barcode 192448; isotype SING, barcode 15180). **Synonyms:** *Thottea dependens auct. non*. (Planch.) Klotzsch: Ridley, J. Str. Br. Roy. Asiat. Soc. 33 (1900) 127, *p.p.*: Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 28; Ridley, Fl. Malay Pen. 3 (1924) 16; Hou, Fl. Malesiana 1, 10 (1984) 75. *Thottea tricornis auct. non*. Maingay *ex* Hook. *f*.: Hou, Fl. Malesiana 1, 10 (1984) 74, *p.p.*

Shrub, 0.5–1.3 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, diameter 4–5 mm, surface smooth, densely puberulent; nodes swollen. **Leaves:** bract-like reduced leaves 4–5, foliage leaves (4–)7–9 on one stem; petiole slender, 5–10 mm long, 1–3 mm thick, puberulent; lamina green above, pale green beneath, *drying brown*, *oblong or lanceolate*, 15–22 × 5–7.5 cm; first foliage lamina sometimes distinctly smaller, narrowly lanceolate, *c*. 11 × 2 cm; thinly leathery, indumentum *beneath sparsely puberulent*, base cuneate, margin entire, apex acute or shortly mucronate; midrib above distinct or sometimes sunken, below prominent; venation palmate-pinnate, distinct above and below, basal pairs 2, upper basal pair less than, or sometimes more than half of the lamina length, pinnate pairs 5–6; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *at stem base close to ground level*, *or sometimes also with a few younger inflorescences on stem well above ground level*, solitary; peduncle not branched, *4–8 cm long*, 1–1.5 mm thick, densely pubescent; bracts narrowly ovate, *c*. 4 × 2 mm, densely pubescent, apex blunt or acute, venation obscure. **Flowers** erect; pedicel and ovary *c*. 2.2 cm long, ovary *c*. 1.8 mm thick, densely pubescent; perianth *dull purple-red* on outer surface, paler on inner surface, 3-lobed, *c*. 7 mm long, *c*. 25 mm diameter, venation distinct, outer surface sparsely pubescent, inner surface sparsely puberulent; base contracted

Figure 7. *Thottea praetermissa*. A, habit; B, inflorescences from procumbent stem with a few younger ones on stem well above ground level; C, flower bud side view; D, flower side view; E, gynostemium. (A–B from *Anthonysamy SA 917*; C–E from *Gwee et al*. *SING-MS 20*.)

into a shallow cup, *c*. 5 mm deep, *c*. 8 mm diameter, inner surface pubescent; perianth lobes deltoid, spreading to reflexed, *c*. 10 × 17.5 mm, apex blunt or acute; stamens 24–30 in 2 whorls, upper whorl with 9–14 stamens, lower whorl 15–16; filament *c*. 1.5 mm long, glabrous; anthers positioned at the swollen connective apex, oblong, *c*. 1 mm long, *c*. 0.3 mm wide; style column disc-shaped, *c*. 2.3 mm long, glabrous; stigmatic lobes 11–13, some lobes bifurcate, positioned higher than stamens, *c*. 2.6 mm long, glabrous. **Capsules** pendent, ripening brown, twisted, 4-angled, *c*. 15 cm long, *c*. 4 mm thick, densely puberulent. **Seeds** ovoid, 3-angled, slightly ridged, margin corrugated, testa surface pimply, 2.3–2.6 × 4–4.3 mm, apex acute, base acute or rounded.

Distribution. Peninsular Malaysia and Singapore. In Peninsular Malaysia known from Melaka and Johor.

Conservation status. Rare, known from two localities in Johor, G. Ledang and Endau-Rompin State Parks. The populations occur in the network of Totally Protected Areas but are nowhere common.

Ecology. Lowland forest in heavily shaded undergrowth, on damp soil close to a freshwater swamp.

11. **Thottea reflexa** T.L.Yao Fig. 8, Map 8, Plates 7C–D, 8A–B

(Latin, *reflexus* = bend backwards by more than 90˚; referring to the perianth lobes)

Blumea 58 (2013) 254, fig. 7, 10g. **Type:** *Yao et al. FRI 65597*, Peninsular Malaysia, Terengganu, Lata Tembakah Recreational Forest, 29 June 2011 (holotype KEP, barcode 192444; isotypes K, L).

Shrub, *c*. 0.4 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, *c*. 6 mm diameter, surface shallowly furrowed, sometimes smooth, sparsely pubescent; nodes swollen. **Leaves:** bract-like reduced leaves 4–8, foliage leaves 5–8 on one stem; petiole slender, sometimes rather stout, 8–9 mm long, *c*. 2 mm thick, pubescent; lamina green above, pale green beneath, drying brown, ovate or obovate or broadly lanceolate, 23.5–24.5 × 11–11.5 cm; first foliage lamina sometimes distinctly smaller, narrowly ovate, *c*. 17 × 6 cm; leathery, indumentum *beneath pubescent*, base cuneate or rounded, margin entire, apex acute; midrib above flat or sometimes sunken, below prominent; venation palmate-pinnate, above distinct, below prominent, basal pairs 2, upper basal pair less than half the leaf length, pinnate pairs 6–7; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *at stem base close to ground level*, solitary or rarely congregate; peduncle sometimes once branched, *6–12 cm long*, *c*. 1 mm thick, densely pubescent; bracts green, ovate, *c*. 4 × 2 mm, densely pubescent, apex blunt or acute, venation obscure. **Flowers** *pendent*; pedicel and ovary *c*. 1.4 cm long, ovary *c*. 1.3 mm thick, pubescent; *perianth creamy white*, 3-lobed, *c*. 8 mm long, *c. 10 mm diameter*, venation obscure, outer surface pubescent, inner surface puberulent; base contracted into a bowl-shaped cup, *c*. 5 mm deep, *c*. 4 mm diameter, inner surface pubescent; perianth lobes broadly ovate, *completely reflexed and blanketing perianth base*, *c*. 6 × 9 mm, apex retuse; stamens *9–10 in 1 whorl*; filament *c*. 0.5 mm long, glabrous; anthers positioned on the swollen connective apex, oblong, *c*. 1 mm long, *c*. 0.3 mm wide; style column cylindric, *c*. 1 mm long, glabrous; stigmatic lobes 5–7, positioned higher than stamens, *c*. 1.2 mm long, glabrous. **Capsules** pendent, ripening dark purple, straight, 4-angled, *c*. 5.5 cm long, *c*. 4 mm thick, sparsely puberulent. **Seeds** ovoid,

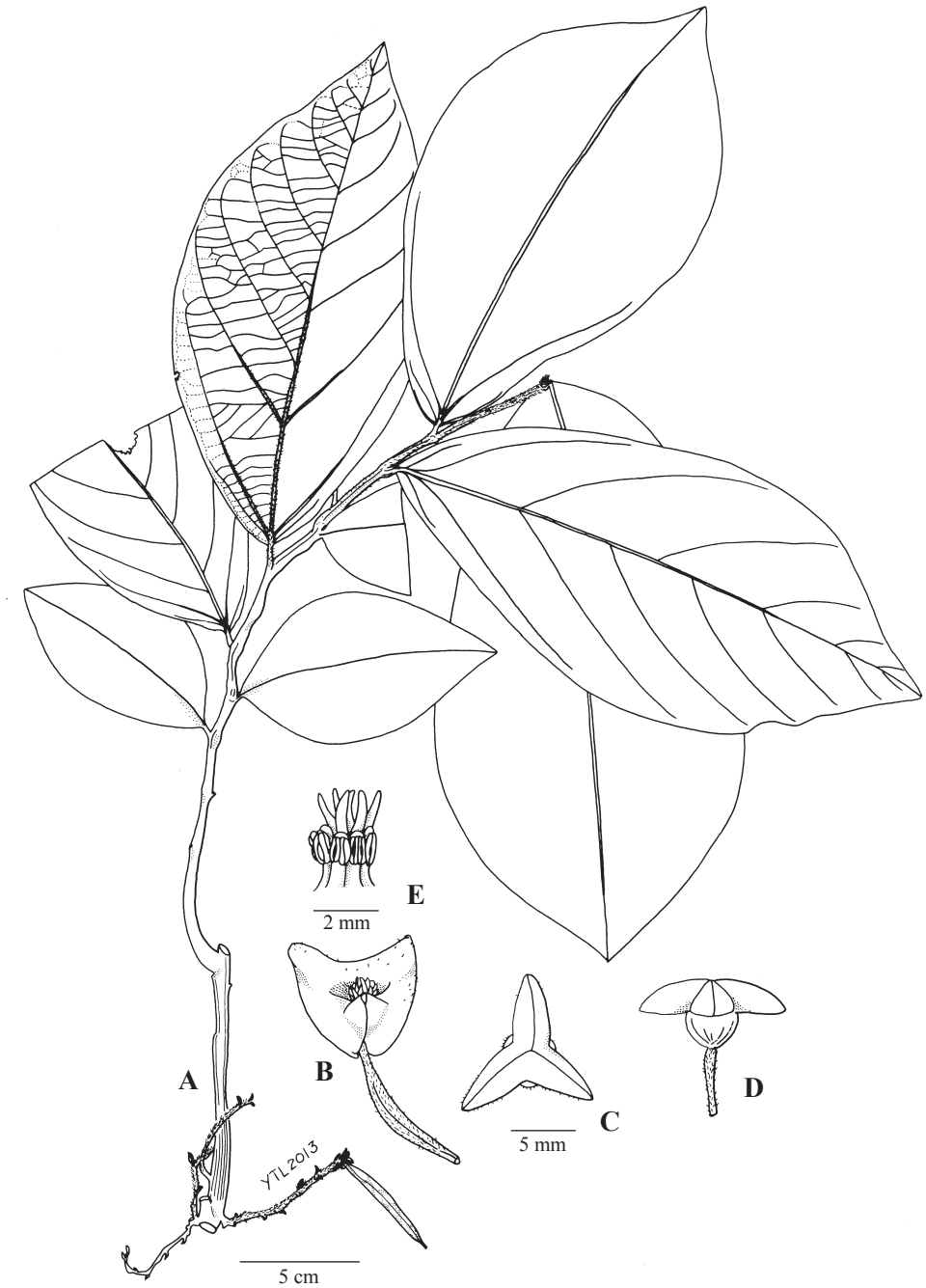
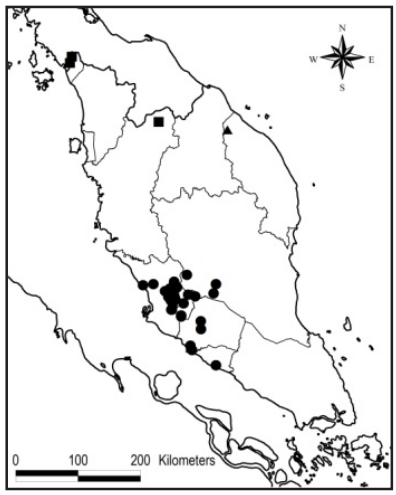


Figure 8. *Thottea reflexa*. A, habit and a fruiting branch; B, flower; C & D, flower bud: top view (C), side view (D); E, gynostemium. (All from *FRI 65597*.)

3-angled, slightly ridged, margin corrugated, testa surface pimply, 3–3.6 × 2.2–2.4 mm, apex truncate, base rounded.

Distribution. Endemic in Peninsular Malaysia, known only from Lata Tembakah, Terengganu.



Map 8. Distribution of *Thottea reflexa* (▲), *T. sumatrana* (■) and *T. tricornis* (●).

Conservation status. Rare. The population occurs in a recreational forest that is vulnerable to disturbance by visitors.

Ecology. Lowland forest undergrowth, on slopes or flat areas, persisting in forest gaps. In the field, I observed that only the plants in forest gaps produced flowers.

12. **Thottea ruthiae** T.L.Yao Fig. 9, Map 9

(Ruth Kiew, 1946–; a Malaysian botanist, best known for her research on *Begonia* (Begoniaceae), herbaceous and limestone floras)

Blumea 58 (2013) 256, fig. 8, 10h. **Type:** *Kiew RK 2703*, Peninsular Malaysia, Terengganu, Jertih, hydro-intake across river from Kampung La, 9 May 1988 (holotype KEP, barcode 192449, a rehydrated flower preserved in spirit).

Shrub *c*. 0.3 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, diameter *c*. 4 mm, surface smooth, puberulent; nodes indistinct. **Leaves:** foliage leaves *c*. 6 on one stem; petiole slender, *c*. 10 mm long, *c*. 3 mm thick, densely pubescent; lamina green above, pale green beneath, *drying brown*, lanceolate, *c*. 20.5 × 8 cm; first foliage lamina distinctly smaller, narrowly lanceolate, *c*. 9.5 × 4 cm; thinly leathery, indumentum *beneath pubescent*, base cuneate or rounded, margin entire, apex blunt or acute; midrib above flat, below prominent; venation palmate-pinnate, above obscure, below prominent, basal pairs 2, upper basal pair less than, or sometimes more than half the lamina length, pinnate pairs 5–7; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *at stem base close to ground level*, solitary; peduncle not branched, *c*. *2.5 cm long*, *c*. 1 mm thick, pubescent; bracts oblanceolate, *c*. 1.5 × 1 mm, pubescent, apex blunt, venation obscure. **Flowers** erect; pedicel and ovary *c*. 7 mm long, ovary *c*. 1 mm thick, pubescent; perianth

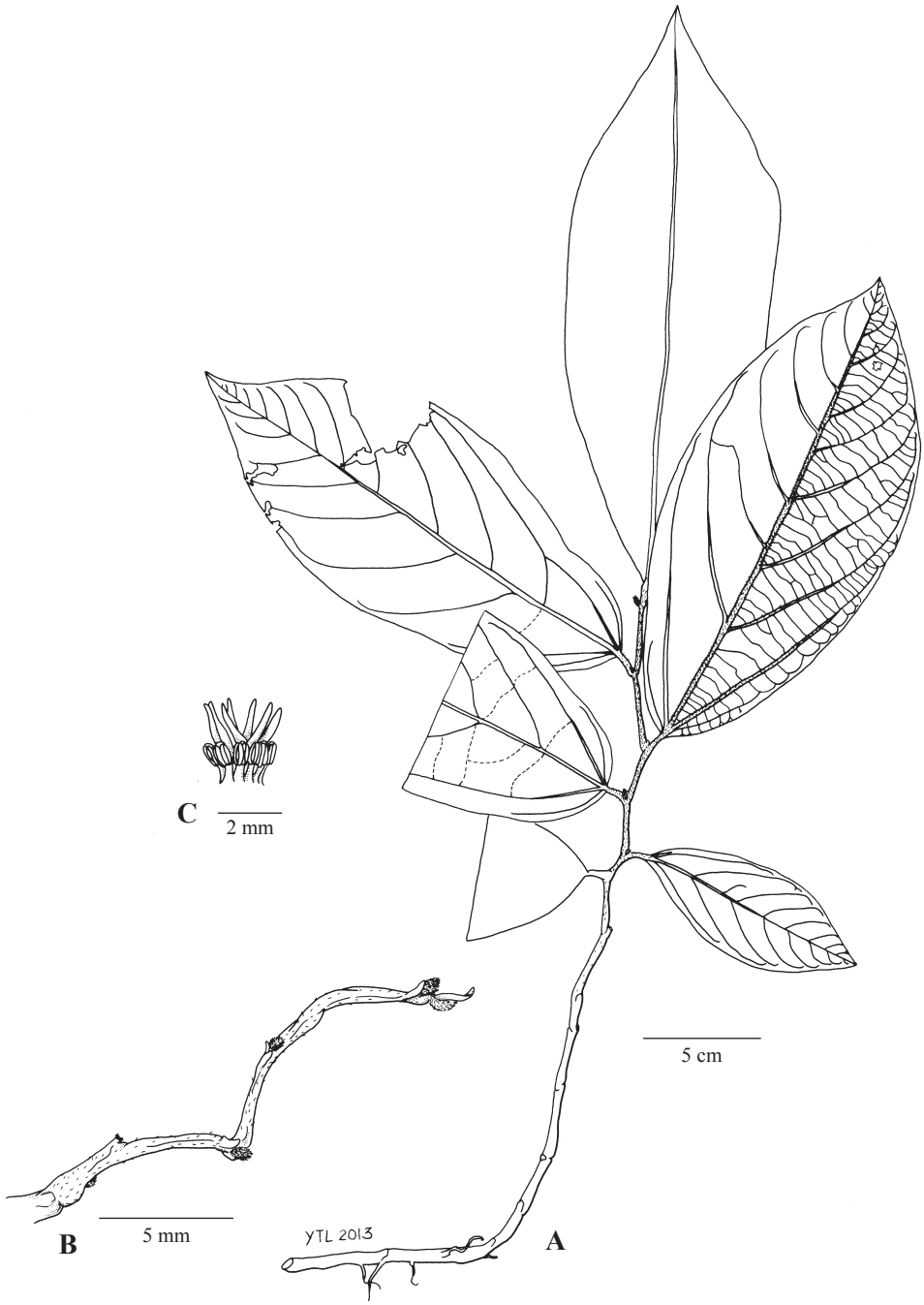


Figure 9. *Thottea ruthiae*. A, habit; B, inflorescence; C, gynostemium. (All from *Kiew RK 2703*.)

white with purple veins, 3-lobed, *c*. 5 mm long, *c*. 7 mm diameter, outer surface pubescent, inner surface sparsely puberulent; perianth lobes shallowly deltoid, *c*. 2 × 7 mm, apex blunt, sparsely puberulent but thinning out towards centre; stamens *c*. 10 in 1 whorl; filament *c*. 0.3 mm long, glabrous; anthers positioned on the swollen connective apex, narrowly oblong, *c*. 0.7 mm long, *c*. 0.2 mm wide; style column cylindric, *c*. 0.7 mm long, glabrous; stigmatic lobes *c*. 7, positioned higher than stamens, *c*. 0.7 mm long, glabrous. **Capsule** and **seed** unknown.

Distribution. Endemic in Peninsular Malaysia, known only from Kampung La, Jertih, Terengganu.

Map 9. Distribution of *Thottea ruthiae* (▲) and *T. terengganuensis* (●).

Conservation status. Critically Endangered B2ab(iii). No population occurs within the network of Totally Protected Areas. Further ground truthing is required.

Ecology. Riverine forest, locally common in undergrowth in an area disturbed by the construction of a pump house for a hydro-intake point.

13. **Thottea sumatrana** (Merr.) Ding Hou Map 8, Plates 8C–D, 9A–B

(of Sumatra)

Blumea 27 (1981) 328, fig. 70C, Fl. Malesiana 1, 10 (1984) 81, fig. 7j–m; Phuphathanaphong, Fl. Thailand 5 (1987) 28, fig. 19. **Basionym:** *Apama sumatrana* Merr., Pap. Michigan Acad. Sci. 23 (1938) 178. **Type:** *Rahmat si Boeea* (not si Toroes) *5259*, Indonesia, Sumatra (holotype NY, barcode 285523; isotypes MICH, barcode 1000100A, 1000100B, MIN, barcode 1002810, UC, barcode 530356, US, barcode 105817).

Shrub, 0.5–0.7 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, diameter 4–5.5 mm, surface shallowly furrowed, sometimes smooth, puberulent; nodes swollen. **Leaves:** bract-like reduced leaves 1–2, foliage leaves 5–8 on one stem; petiole rather stout, 3–10 mm long, 2–3 mm thick, sparsely puberulent; lamina green above, pale green beneath, *drying brown*, *narrowly ovate or lanceolate*, 20–21.5 × 7–9.5 cm; first foliage lamina distinctly smaller, narrowly ovate, 2.5–3 × 1 cm; papery to thinly leathery, indumentum *beneath puberulent*, base *rounded*, margin entire, apex blunt or acute; midrib above distinct, below

prominent; venation palmate-pinnate, above distinct, below distinct, basal pairs 2, upper basal pair up to half the lamina length, pinnate pairs 4–6(–8); intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *axillary*, solitary; peduncle not branched, *7.5–10.5 cm long*, 2–3 mm thick, puberulent; bracts green, crowded, ovate, *c*. 7 × 3 mm, densely pubescent, apex blunt or acute, venation distinct. **Flowers** erect; pedicel and ovary *c*. 1.8 cm long, ovary *c*. 1.1 mm thick, pubescent; perianth cream on outer surface, a shade of dull crimson on inner surface, 3-lobed, lobes deeply dissected to the base, base not distinctly contracted, *c*. 3.5 cm long, *c*. 3.5 cm diameter, venation obscure, outer surface puberulent, inner surface glabrous; perianth lobes oblong, flared, *c*. 17 × 7 mm, apex acute; stamens *consistently 6 in 1 whorl*, length exceeding stigmatic lobes; filament *c*. 1 mm long, glabrous; anthers positioned in the middle of connective, narrowly oblong, *c*. 3 mm long, *c*. 0.4 mm wide; style column cylindric, *c*. 2.6 mm long, glabrous; stigmatic lobes consistently 3, *c*. 1.7 mm long, glabrous. **Capsules** pendent, ripening brown, straight, 4-angled, 10–12(–16) cm long, 4–5 mm thick, pubescent. **Seeds** ovoid, 3-angled, margin corrugated, testa surface wrinkled, 4.5 × 2.5–3 mm, apex acute, base truncate.

Distribution. Peninsular Myanmar, Peninsular Thailand, Sumatra and Peninsular Malaysia. In Peninsular Malaysia known from Perlis and the Royal Belum State Park, N Perak.

Conservation status. Near Threatened. Populations occur within the network of Totally Protected Areas.

Ecology. Lowland primary forest to 250 m altitude, locally common, often on earth banks by riverside.

14. **Thottea terengganuensis** T.L.Yao (of Terengganu)

Fig. 10, Map 9, Plates 9C–D, 10A–B

Blumea 58 (2013) 257, fig. 9, 10i. **Type:** *Sam & Mohd Aidil FRI 68960*, Peninsular Malaysia, Terengganu, Dungun, Jengai FR, 21 April 2009 (holotype KEP, barcode 192450; isotypes K, L). **Synonym:** *Thottea tomentosa auct. non*. (Blume) Ding Hou, *p.p.*: Hou, Fl. Malesiana 1, 10 (1984) 79.

Shrub, 0.4–0.8 m tall. **Stem** slender, *erect*, *scarcely branched*, drooping at top, dark dirty green, 4–6.5 mm diameter, surface smooth, pubescent; nodes indistinct. **Leaves:** bract-like reduced leaves 2–8, foliage leaves (2–)4–6 on one stem; petiole rather stout, 4–8 mm long, 2–3.5 mm thick, densely pubescent; lamina dark green above, pale green beneath, drying brown, obovate or broadly lanceolate, (11.5–)19.5–30 × (6.5–)12-13.5 cm; first foliage lamina sometimes distinctly smaller, ovate, 11–16 × 5–5.5 cm; thinly leathery, indumentum *beneath densely pubescent*, base cuneate or rounded, margin entire, near base of dried specimens often in-folded, apex blunt or acute; midrib above distinct, below prominent; venation palmate-pinnate, above faint, below prominent, basal pairs 2, inner basal pair less than, or sometimes more than half the lamina length, pinnate pairs 5–8; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *at stem base close to ground level*, solitary; peduncle not branched, *8–16 cm long*, *c*. 2.5 mm thick, pubescent; bracts green, lanceolate or ovate, 7–8 × 4 mm, densely pubescent, apex acute, venation obscure or sometimes distinct. **Flowers** *erect or held horizontally*; pedicel and ovary *c*. 1.5 cm long, ovary *c*. 1.8 mm thick, densely pubescent; perianth *dark purple-red on outer surface*, *cream with dark purple-red rim* (*or entirely dark purple-red*) *on inner surface*, 3-lobed, *c*. 1

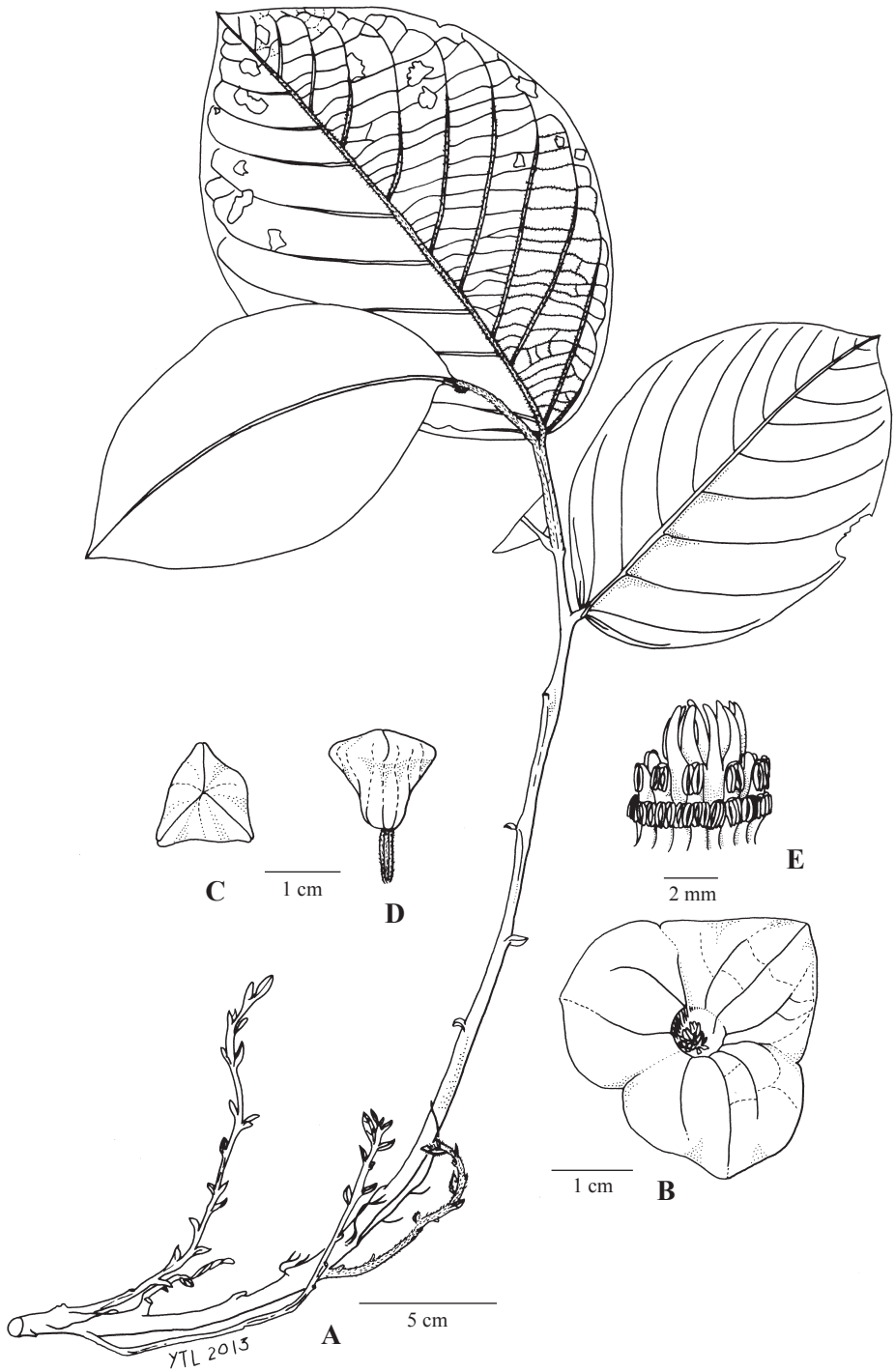


Figure 10. *Thottea terengganuensis*. A, habit and inflorescences from procumbent stem; B, flower top view; C & D, flower bud: top view (C), side view (D); E, gynostemium. (A, C–E from *FRI 68960*; B from *FRI 65444*.)

cm long, *3.5–5 cm diameter*, venation distinct, outer surface sparsely pubescent, inner surface puberulent; base contracted into a bowl-shaped cup, *c*. 0.6 cm deep, *c*. 0.8 cm diameter, inner surface pubescent; perianth lobes shallowly deltoid, *spreading*, *slightly laterally reflexed*, 15 × 20–23 mm, apex blunt; stamens *24–29 in 2 whorls*, upper whorl with 8–10 stamens, lower whorl 16–19; filament *c*. 1 mm long, glabrous; anthers positioned at the swollen connective apex, oblong, *c*. 1.3 mm long, *c*. 0.6 mm wide; style column cylindric, *c*. 2.2 mm long, pubescent; stigmatic lobes 10–11, some lobes bifurcate, positioned higher than stamens, *c*. 2.6 mm long, pubescent. **Capsules** erect, ripening brown, straight, 4-angled, 7.3–7.5 cm long, *c*. 5.5 mm thick, ferruginous pubescent. **Seeds** ovoid, 3-angled, slightly ridged, margin corrugated, testa surface pimply, *c*. 3.5 × 2 mm, apex acute, base rounded.

Vernacular name. *Hempedu beruang* (Malay).

Distribution. Endemic in Peninsular Malaysia, known only from Terengganu.

Conservation status. Vulnerable B1ab(iii). No population occurs within the network of Totally Protected Areas.

Ecology. Lowland forest, on lateritic earth banks, occasionally by riverside, persisting in forest gaps.

Note. On Bkt. Bauk, it grows sympatrically with *Thottea grandiflora*. Both species look similar when not in flower but *Thottea terengganuensis* is distinctive in its more prominent tertiary veins and smaller leaves. I observed a population with perianths entirely dark purple-red on the inner surface in Pasir Raja FR.

15. **Thottea tomentosa** (Blume) Ding Hou Map 10, Plates 10C–D, 11A

(Latin, *tomentum* = densely woolly; referring to the woolly indumentum of lamina undersurface)

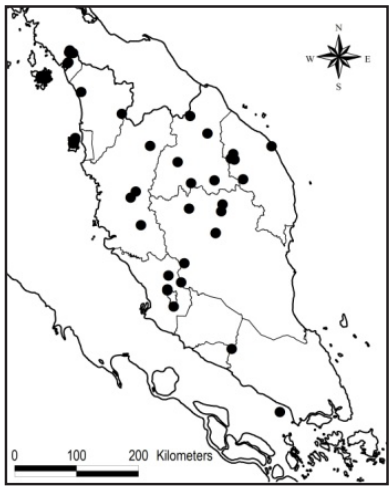
Blumea 27 (1981) 328, fig. 48, 49, Fl. Malesiana 1, 10 (1984) 79; Phuphathanaphong, Fl. Thailand 5 (1987) 26, fig. 17; Ong, PROSEA 12, 2 (2001) 549, fig.1–4. **Basionym:** *Ceramium tomentosum* Blume, Bijdr. Fl. Ned. Ind. (1827) 1135. **Homotypic synonyms:** *Bragantia tomentosa* Blume, En. Fl. Jav. (1827) 82; Bennett, Pl. Jav. Rar. 1 (1838) 43, *t*. 11; Griffith, Trans. Linn. Soc. 19 (1845) 336; Miquel, Fl. Ind. Bat. 1, 1 (1858) 1068; Duchartre *in* DC. Prod. 15, 1 (1864) 431; Hooker *f*., Fl. Brit. India 5 (1886) 73; Clarke, J. Linn. Soc. Bot. 25 (1889) 61; Ridley, J. Str. Br. Roy. Asiat. Soc. 57 (1910) 89, *ibid* 59 (1911) 161. *Apama tomentosa* (Blume) Engl. *ex* Soler., Naturl. Pflanzenfam. 3, 1 (1889) 272; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 25; Ridley, Fl. Malay Pen. 3 (1924) 15; Backer & Bakhuizen *f*., Fl. Java 1 (1964) 162; Henderson, Malay. Wild Fl. (1974) 423, fig. 382E. **Type:** *Herb*. *Blume* '*1690*', Java (lectotype L, barcode 38821; isolectotype L, barcode 38822). **Heterotypic synonyms:** *Bragantia tomentosa* var. *lanuginosa* Hook. *f*., Fl. Brit. India 5 (1886) 74. *Apama tomentosa* var. *lanuginosa* (Hook. *f*.) Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 26. **Type:** *Kurz s.n*., India, South Andaman (holotype K, barcode 634536).

Low shrub, 0.1–0.5 m tall. **Stem** slender, *near base decumbent*, *scarcely branched*, drooping at top, dark green, young stem tinged purplish, diameter 2.5–4 mm, surface shallowly furrowed, pubescent; nodes indistinct. **Leaves:** bract-like reduced leaves (3–)4–6(–8), foliage leaves 2(–4) on one stem; petiole slender, sometimes rather stout, 4–8 mm long, 1.5–3 mm thick, tomentose; lamina dark green or green above, pale green beneath, drying brown, ovate, broadly ovate or oblanceolate, rarely narrowly ovate, (9–)11–16(–19) × 6–12.5(–16) cm; first foliage lamina not distinctly smaller; thinly leathery, indumentum *beneath tomentose* (*at least the young ones*),

sometimes sparsely so, base rounded or cordate, margin entire, apex blunt or acute; midrib above slightly raised, below prominent; venation palmate-pinnate, distinct above and below, basal pairs 2–3, inner basal pair up to half the lamina length, pinnate pairs 4–7; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** at stem base close to ground level, solitary; peduncle not branched, *4–8*(*–25*) *cm long*, *c*. 2 mm thick, pubescent; bracts green or purple, lanceolate or narrowly oblanceolate, 5–8 × 1–2 mm, densely pubescent, apex acute, venation obscure. **Flowers** erect; pedicel and ovary 1–1.5 cm long, ovary *c*. 1 mm thick, tomentose; perianth deep cream or dark purple-red, 3-lobed, 0.7–1.2 cm long, 1.2–2.2 cm diameter, venation obscure, outer surface tomentose, inner surface sparsely pubescent; base contracted into a bowl-shaped cup, 0.5–0.8 cm deep, *c*. 0.7 cm diameter, at the top of cup with a raised annular rim, inner surface glabrous; perianth lobes broadly ovate, spreading, sometimes laterally reflexed, 7–10(–20) × 7–10(–15) mm, apex acute, sparsely pubescent but thinning out towards centre; stigmatic lobes positioned higher than stamens; stamens in 1 whorl, consistently 6; filament *c*. 0.5 mm long, puberulent; anthers positioned near to the connective apex, narrowly oblong, *c*. 2 mm long, *c*. 0.5 mm wide; style column disc-shaped, 1.5–2 mm long, glabrous; stigmatic lobes consistently 3, 1–1.5 mm long, densely pubescent at apex. **Capsules** erect, ripening dark purple, straight, sometimes slightly twisted, 4-angled, 4.5–6.5 cm long, *c*. 5 mm thick, when young sparsely pubescent, glabrescent. **Seeds** ovoid, 3-cornered, margin corrugated, testa surface pimply, *c*. 4 × 2 mm, apex acute, base rounded.

Vernacular names. *Tapak gajah* (Malay); *kemed kaneb* (Jahai).

Distribution. S India (Andaman and Nicobar Is.), Bangladesh, Myanmar, S Vietnam, Peninsular Thailand, Peninsular Malaysia, Java and the Philippines. In Peninsular Malaysia known from all states except Negeri Sembilan and Melaka.



Map 10. Distribution of *Thottea tomentosa*.

Conservation status. Least Concern. Widespread, locally common as scattered populations, sometimes forming colonies.

Ecology. Lowland forest to 315 m altitude, often found on damp sandy soil, rarely at the foot of limestone hills. Populations persist in logged-over and secondary forests. In forest, flowers are

sometimes hidden under leaf litter. The bottom of the perianth base is pale cream, contrasting with the dark purple-red perianth, which to some extent appears translucent in back light and thereby might possibly function as a window for phototropic pollinators to crawl deeper into the base and so come into contact with the pollen. It is the food plant of *Troides amphrysus* (Papilionidae) larvae (Batchelor, Malay. Nat. J. 14 (1959) 3).

Uses. Burkill (Econ. Prod. Malay Pen. 1 (1966) 189) reported it was used for poulticing skin complaints and boils, in the latter case together with *Illigera* (Hernandiaceae); the stem and leaves were pounded and the juice taken for coughs; and the roots and leaves were used as diuretic during confinement. This species is planted as a Papilionidae (birdwing) butterfly food plant in the Penang Butterfly Farm, Malaysia.

Taxonomy. *Bragantia tomentosa* Blume var. *lanuginosa* Hook. *f.* was established based on *Kurz s.n*. (K) from S Andaman. Gamble (1912) listed *Curtis 1681* (Langkawi Is.) and *Yapp 69* (Kuala [Kwala] Aring, Kelantan) under this variety, placing the rest under the type variety. Ridley (1924) mentioned that the Malayan form is 'more tomentose than the Indian and Javan form' and hence belongs to var. *lanuginosa*. Hou (1984) reduced this variety and treated all specimens as *T. tomentosa*. Recently, *T. tomentosa* (Blume) Ding Hou *var*. *lanuginosa* (Blume) Karthik. & Moorthy (Flow. Pl. India (2009) 157) was reinstated. I have found that hairiness of the lamina undersurface is a matter of degree and the hairs are especially dense in young leaves. Hence, I do not recognise var. *lanuginosa*.

16. **Thottea tricornis** Maingay *ex* Hook.*f*. Map 8, Plate 11B–D

(Latin, *tri-* = three, *cornis* = horn-shape; referring to the 3-cornered flower buds)

Fl. Brit. India 5 (1886) 74; Gamble, J. Asiat. Soc. Bengal 75, 1 (1912) 29; Ridley, Fl. Malay Pen. 3 (1924) 16; Hou, Blumea 27 (1981) 318, fig. 2, 17, 18, 43, 44, 61, 70B, Fl. Malesiana 1, 10 (1984) 74, fig. 7f–i; Yao, Blumea 58 (2013) 259. **Type:** *Maingay 1819* (= Kew Distr. No. 1319), Peninsular Malaysia, Melaka (holotype K, barcode 575919; isotypes BM, barcode 950668, K, barcodes 575920, 575921, L, barcode 38825).

Shrub, 0.65–1.8 m tall. **Stem** stout, *erect*, *scarcely branched*, drooping at top, dark dirty green, diameter 4–9 mm, surface smooth, sparsely puberulent or glabrescent; nodes swollen. **Leaves:** bract-like reduced leaves 4–5, foliage leaves 7–15 on one stem; petiole stout, 10–15 mm long, 2.5–4 mm thick, puberulent; lamina green above, pale green beneath, *drying brown*, *broadly ovate*, *narrowly oblanceolate or oblanceolate*, (16.5–)22–36.5 × 8–16.5 cm; first foliage lamina distinctly smaller, oblong, *c*. 6 × 2 cm; papery to thinly leathery, indumentum *beneath puberulent*, base *cuneate*, margin entire, apex acute or acuminate; midrib above distinct, below prominent; venation acrodromous-pinnate, above distinct, below prominent, basal pairs 2, inner basal pair more than half the lamina length, pinnate pairs 4–8; intercostal veins a mix of scalariform and reticulate veinlets, scalariform ones more pronounced. **Inflorescences** *axillary*, solitary; peduncle not branched, *3–6 cm long*, *c*. 1.5 mm thick, densely pubescent or glabrescent; bracts light green, narrowly lanceolate or narrowly oblanceolate, 5–11 × 2–5 mm, densely pubescent, apex acute, venation obscure, sometimes distinct. **Flowers** *pendent*; pedicel and ovary *c*. 2 cm long, ovary *c*. 1 mm thick, pubescent; perianth purple-red on outer surface, creamy white on inner surface, 3-lobed, *funnel-shaped*, base not distinctly contracted, 1.4–1.5 cm long, 1.5–3.5 cm diameter, venation faint, outer surface sparsely pubescent, inner surface pubescent; perianth lobes faintly deltoid, flared, *c*. 20 × 2 mm, apex acute or

mucronate; stamens *23–26 in 2 whorls*, upper whorl with 9–10 stamens, lower whorl 14–16; filament *c*. 0.5 mm long, glabrous; anthers at the swollen apical tip of the filament, oblong, *c*. 1.2 mm long, *c*. 0.4 mm wide; style column disc-shaped, *c*. 2 mm long, glabrous; *stigmatic lobes 8–13*, positioned higher than stamens, 1–2 mm long, glabrous. **Capsules** pendent, ripening brown, straight to slightly twisted, 4-angled, 9.5–14 cm long, 4–7 mm thick, densely puberulent. **Seeds** ovoid, 3-cornered, margin corrugated, testa surface pimply, *c*. 6 × 2.5 mm, acute at both apex and base.

Vernacular names. *Telinga kelawar* (preferred name), *melada* (Malay); *chengrus*, *chudok*, *geram rengkong*, *pokok teringkum*, *tusa lanjut* (Temuan).

Distribution. Endemic in Peninsular Malaysia, known from Selangor, Negeri Sembilan, Melaka and Pahang. Common and widespread in Selangor but scattered in other states.

Conservation status. Least Concern. This species is locally common and persists in old secondary forests.

Ecology. Usually in lowland and hill forests to 760 m altitude, rarely in coastal hill forest. On lateritic earth banks and occasionally by sandy streamsides, persisting in secondary forest and old rubber estates. Kiew (Malay. Nat. J. 38 (1984) 60) reported on the phenology of this species as *T. dependens*. The dehisced capsule splits exposing the central pith that separates from the fruit wall. It is the food plant of *Troides aeacus thomsonii*, Papilionidae (Kiew *et al*., Malay. Nat. 63, 3 (2010) 10).

Uses. Burkill (Econ. Prod. Malay Pen. 2 (1966) 2196) reported that in Pahang, under the name *T. parviflora*, the roots were chewed with betel nut for coughs.

Undetermined Specimen

Littke WL 698 (UKMB) has a 22 cm-long capsule and is similar to *Thottea anthonysamyi* (to 14.5 cm long) and *T. tricornis* (to 14 cm long) in its vegetative characters. However, its occurrence in montane forest at 1900 m altitude (Cameron Highlands, Pahang) is uncommon for Peninsular Malaysian *Thottea*. Until flowering material is available, I am not able to assign the specimen to any species.

PLATES

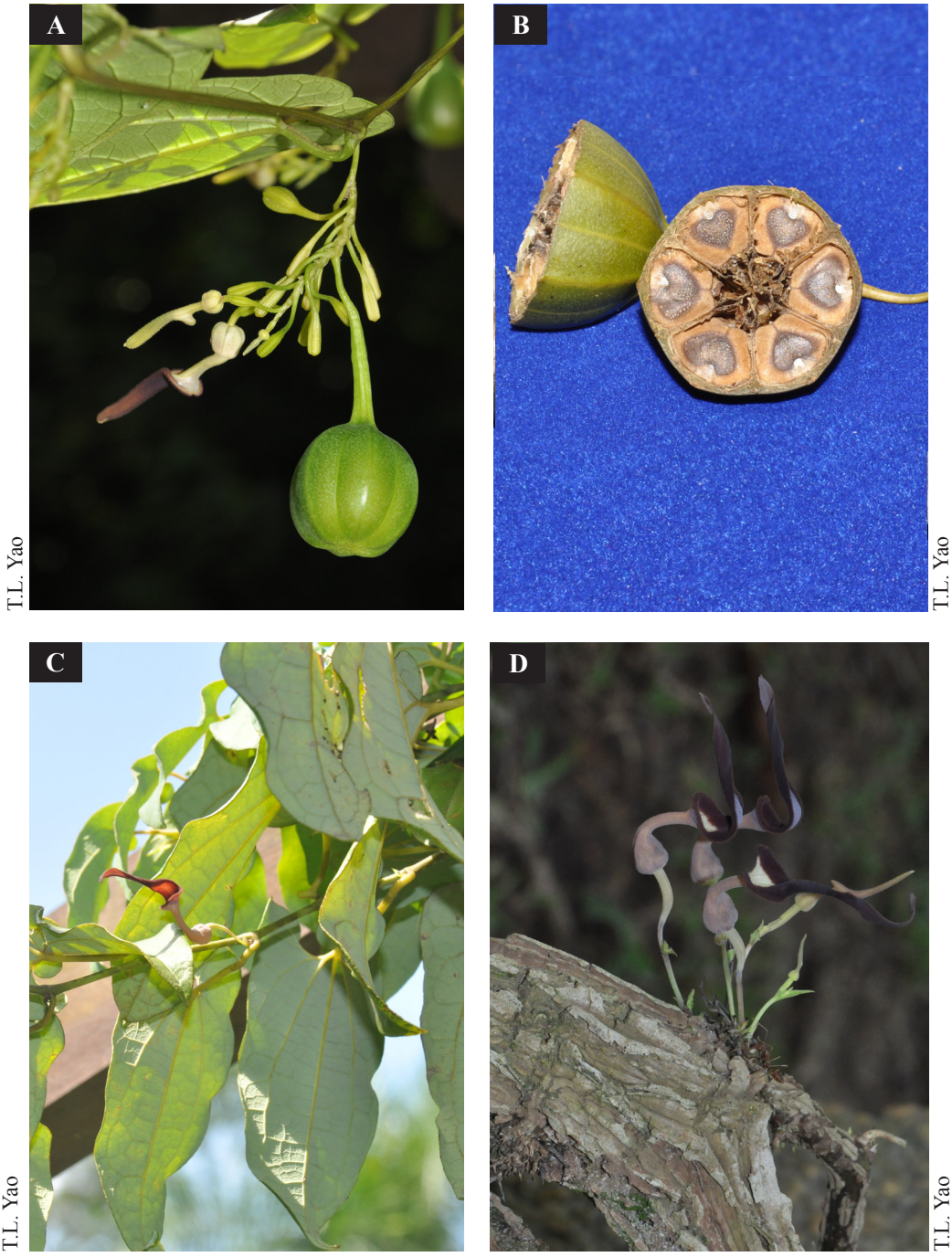


Plate 1. Aristolochiaceae. A–B, *Aristolochia acuminata*; C–D, *A. foveolata*.

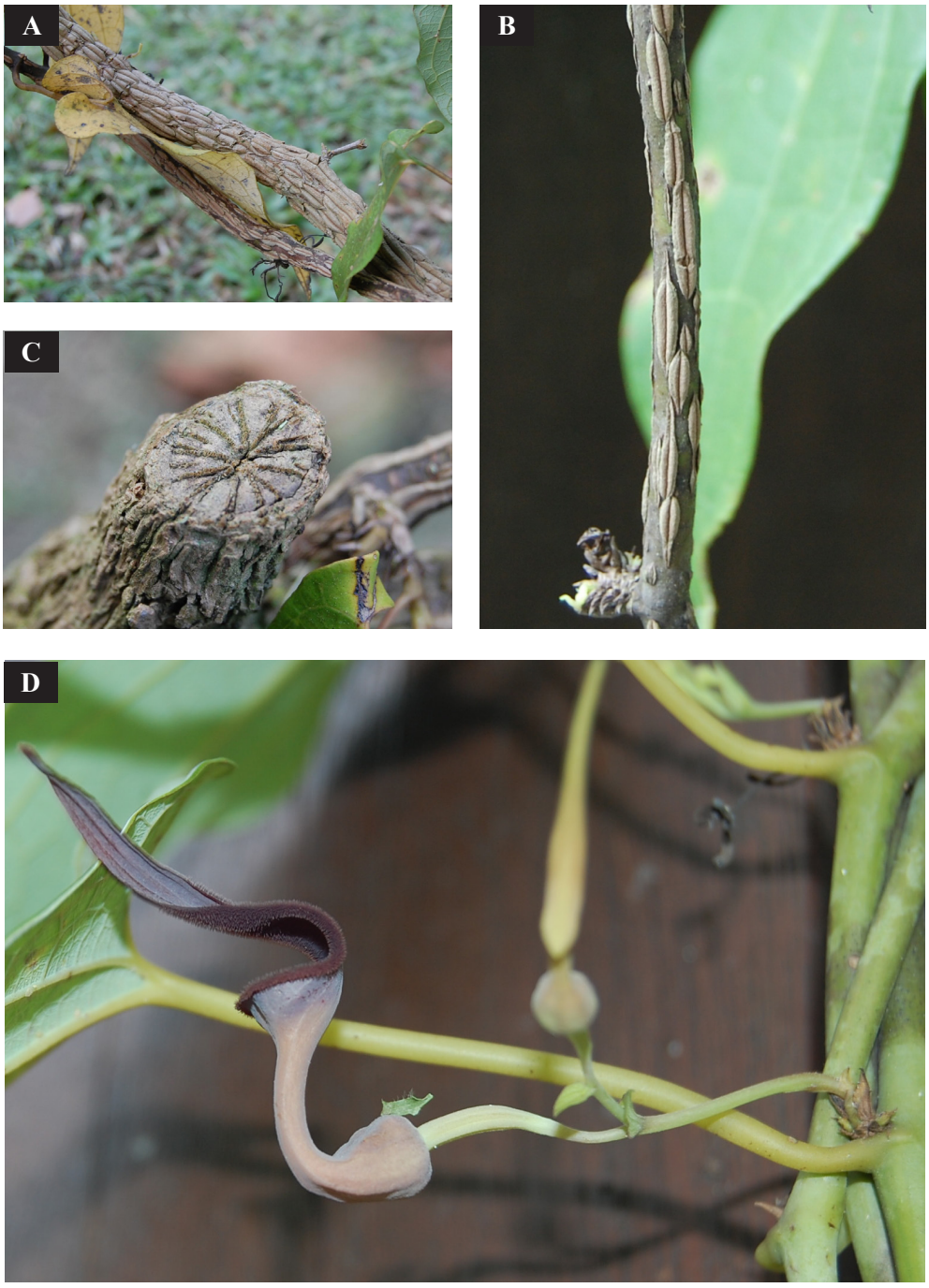


Plate 2. Aristolochiaceae. A–D, *Aristolochia foveolata*.

T.L. Yao

T.L. Yao

H.T. Chan

H.T. Chan

Plate 3. Aristolochiaceae. A–B, *Thottea dependens*; C–D, *T. grandiflora*.

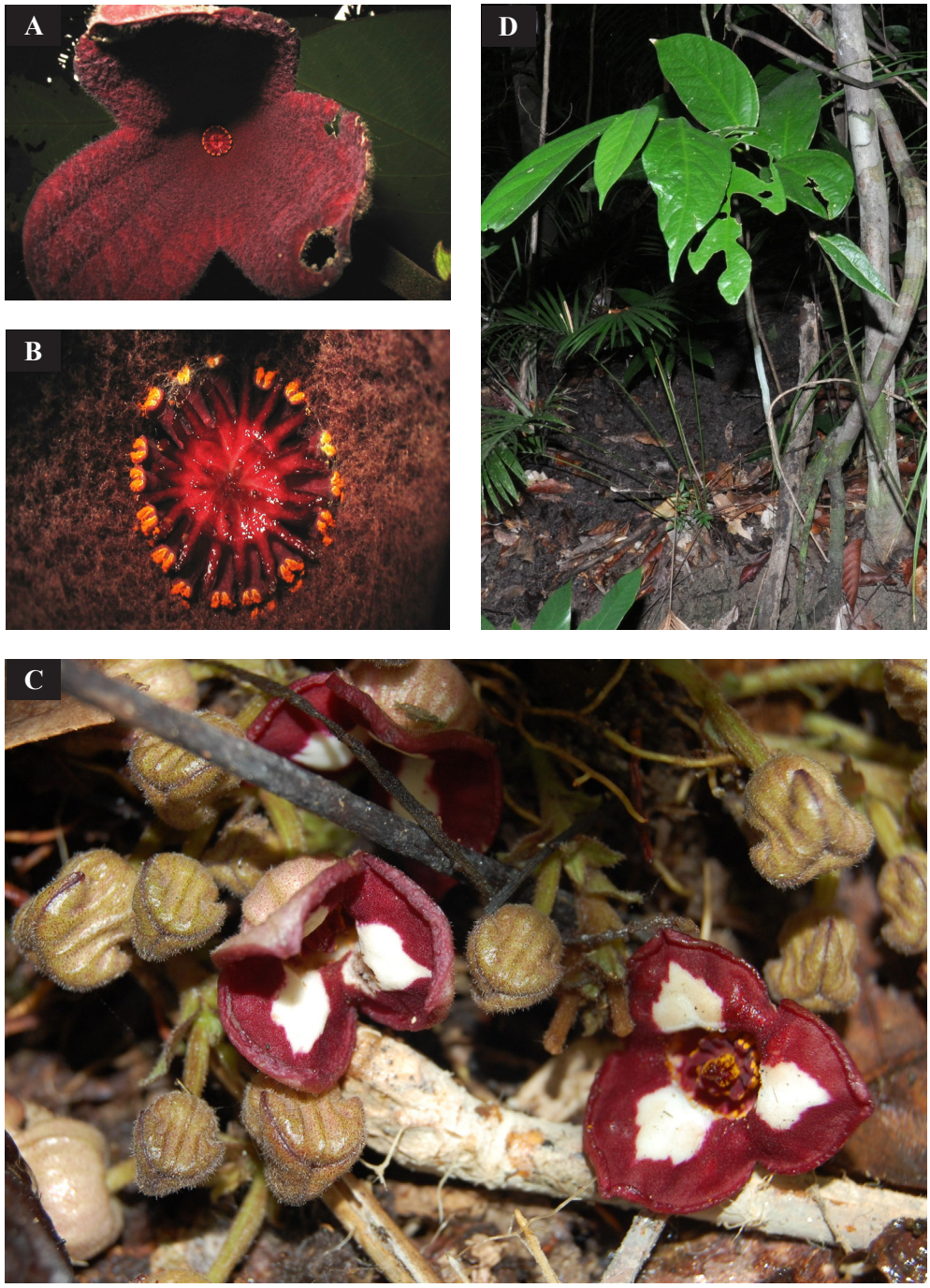


Plate 4. Aristolochiaceae. A–B, *Thottea grandiflora*; C, *T. papilionis*; D, *T. parviflora*.

T.L. Yao

C.L. Lim

C.L. Lim

S. Wanke

Plate 5. Aristolochiaceae. A–B, *Thottea parviflora*; C–D, *T. piperiformis*.

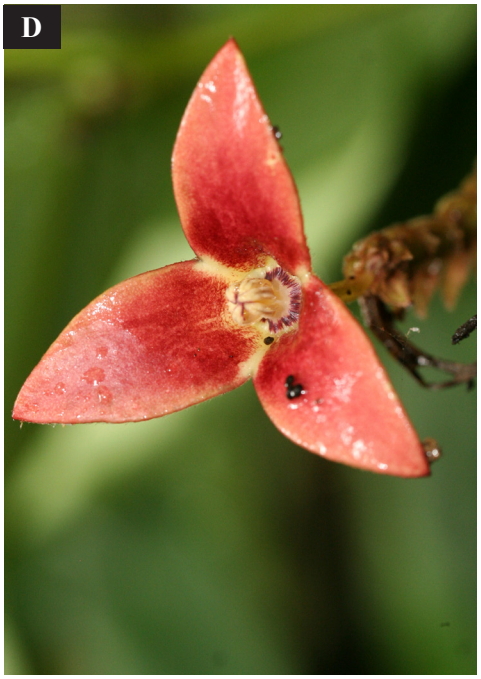
Plate 6. Aristolochiaceae. A, *Thottea piperiformis*; B–D, *T. piscodora*.

Plate 7. Aristolochiaceae. A–B, *Thottea praetermissa*; C–D, *T. reflexa*.

T.L. Yao

T.L. Yao

B. Oelschlaegel



S. Wanke

Plate 8. Aristolochiaceae. A–B, *Thottea reflexa*; C–D, *T. sumatrana*.

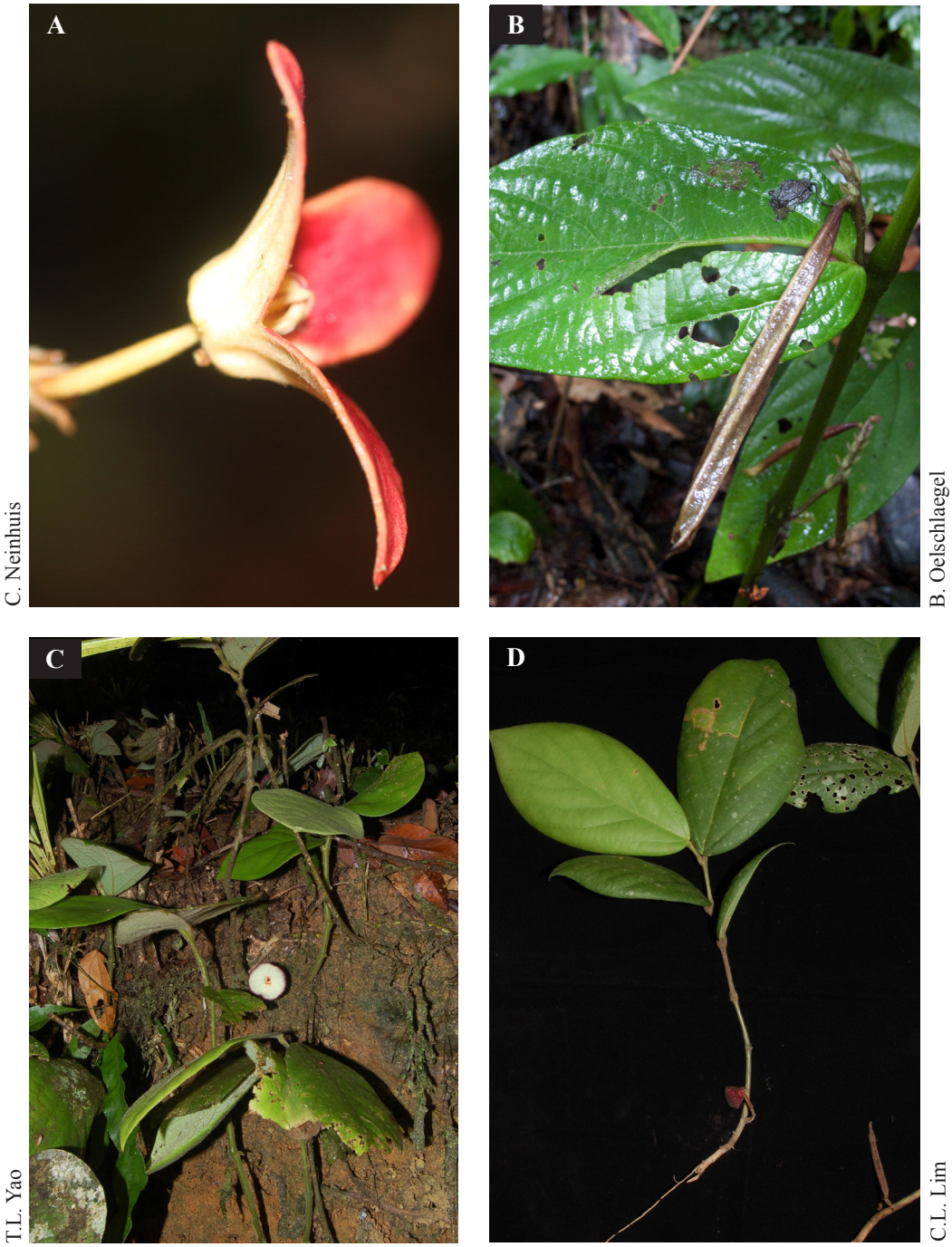


Plate 9. Aristolochiaceae. A–B, *Thottea sumatrana*; C–D, *T. terengganuensis*.

Plate 10. Aristolochiaceae. A–B, *Thottea terengganuensis*; C–D, *T. tomentosa*.

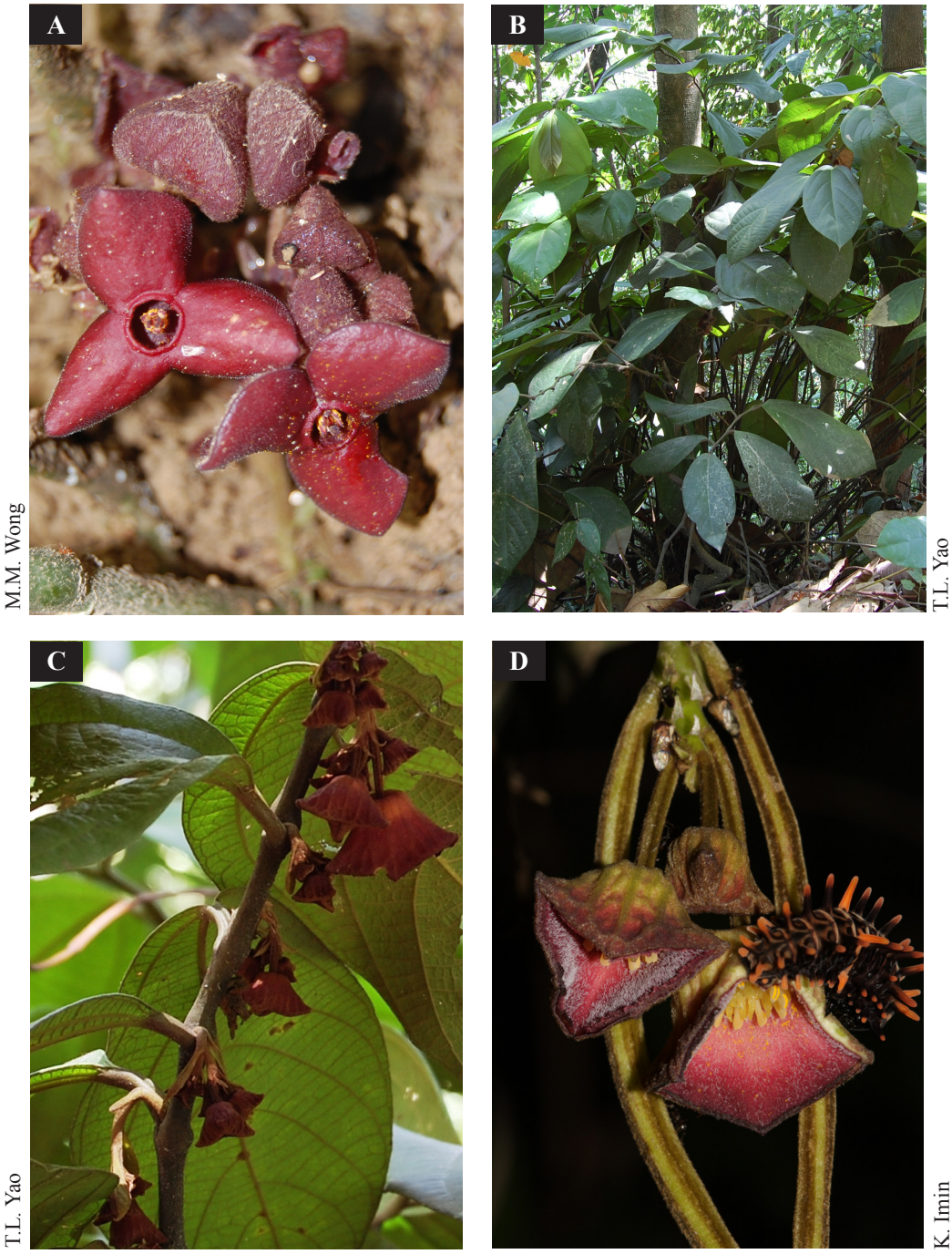
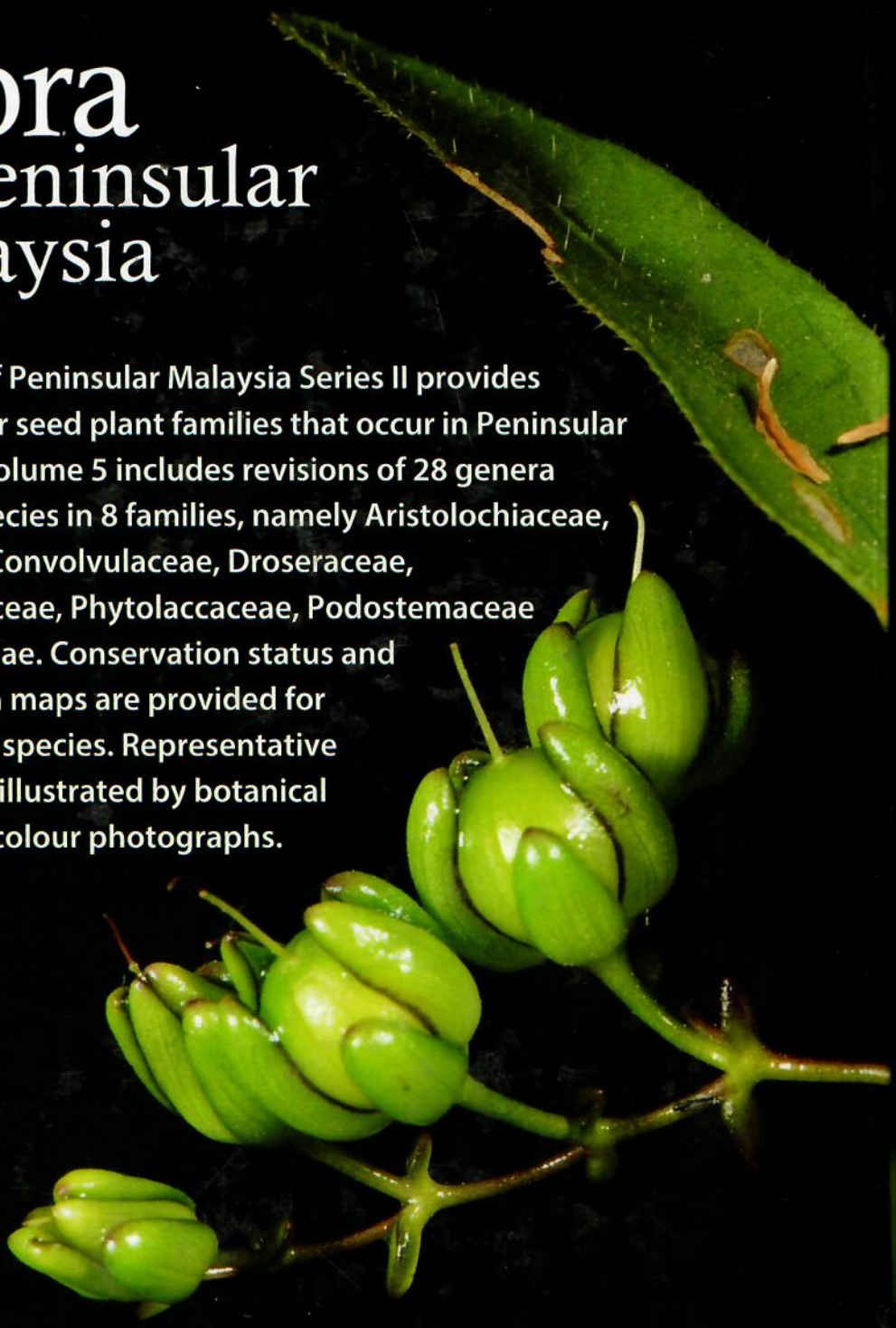


Plate 11. Aristolochiaceae. A, *Thottea tomentosa*; B–D, *T. tricornis*.

Flora of Peninsular Malaysia

The Flora of Peninsular Malaysia Series II provides revisions for seed plant families that occur in Peninsular Malaysia. Volume 5 includes revisions of 28 genera and 123 species in 8 families, namely Aristolochiaceae, Buxaceae, Convolvulaceae, Droseraceae, Nymphaeaceae, Phytolaccaceae, Podostemaceae and Viscaceae. Conservation status and distribution maps are provided for indigenous species. Representative species are illustrated by botanical plates and colour photographs.



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