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(continued on inside back cover)

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**Studies on Monstereae (Araceae)
of Peninsular Malaysia IV:
The enigmatic *Rhaphidophora corneri* refound
after 75 years**

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ABSTRACT. *Rhaphidophora corneri* P.C.Boyce, a highly distinctive but hitherto poorly known species described from fragmentary material collected by E.J.H. Corner late in 1935 from Kemaman (Terengganu state in Peninsular Malaysia) has recently been refound in neighbouring Kelantan. A much-expanded species description is provided, along with new information pertaining to its ecology. A reinterpretation of possible relationships with other *Rhaphidophora* species is offered in light of these novel data. Photographs depicting newly observed vegetative morphology are provided.

Keywords. Monstereae, Peninsular Malaysia, *Raphidophora*

Introduction

The taxonomic revision of *Rhaphidophora* for Peninsular Malaysia and Singapore by Boyce (1999) included the description of a highly distinctive new species from Kemaman (Terengganu state) based on somewhat fragmentary material collected by E.J.H. Corner in November 1935. Despite the paucity of material (Fig. 1) Boyce noted at the time that “*Rhaphidophora corneri* is a remarkable species, unique in the genus by the manner of inflorescence production, small leaves with dense reticulate veins, and large perforations...”, although the nature of the single specimen left many questions open.

During a preliminary survey of the aroids of Taman Negara Kuala Koh, Kelantan, in June 2010, a small population of *R. corneri* was located. A second more detailed survey by the second author in the following July revealed the population to be larger. These plants represent only the second ever collection, and enable expansion of the species description presented by Boyce, resolving several aspects of the plant's morphology. Furthermore, these additional data permit insight into possible relationships of *R. corneri* with other *Rhaphidophora* species.

Rhaphidophora corneri P.C.Boyce, Gard. Bull. Singapore 51 (1999) 183–256. TYPE: Malaysia, Kemaman, Terengganu, Ulu Kajang, 13 Nov 1935, *E.J.H. Corner SFN 30441* (holo SING!). (Fig. 1–3)

Small, rather slender, homeophyllous, leptocaul, liane up to 2.7 m height, with shoots extending along the ground for up to 2.4 m; seedling stage and pre-adult plants unknown; **adult shoot** architecture comprised of a much elongated, free or weakly clinging, physiognomically monopodial, leafy stem; **stems** smooth, without prophyll, cataphyll and petiolar sheath fibre, the internodes 1–14 \times 0.5–0.7 cm long, with up to 31 internodes per module; branches arising almost perpendicular to main axis, up to 44 cm long, junction with main axis with a prominent corky leaf scar; roots one per node, adherent, stout, corky; **leaves** glossy medium green, erect or spreading on adult shoots, cataphylls and prophylls membranaceous, soon drying and falling; **petiole** narrowly canaliculate, pulvinate, 5–14 \times 0.5–1.6 cm, smooth, apical and basal pulvini prominent; **petiolar sheath** obscure except for basal-most portion, extending to the apical pulvinus, sheath of newest leaf degrading into a very few feeble fibres, sheath soon falling to leave a proportionally wide, corky scar basally on the petiole; **blade** oblong-lanceolate, slightly oblique, 15–27 \times 8–14 cm, sub-coriaceous, entire or with 1–4 perforations on the wider side, these large, ovate to rhomboid or trapezoid, often extending almost to the margin, base obtuse to weakly cordate, apex acute to acuminate with a slightly prominent apiculate tubule; mid-rib prominently raised abaxially, slightly raised adaxially; primary venation pinnate but distal-most veins becoming weakly reticulate and not reaching leaf margin, raised abaxially, raised (but weakly so) adaxially, 3–4 per side, alternate; interprimaries weakly reticulate to sometimes sub-parallel to primaries, slightly raised abaxially, weakly raised adaxially, often forming a weak reticulum; secondary venation reticulate, slightly raised abaxially, weakly raised adaxially; tertiary venation prominently reticulate. **Inflorescence** solitary, terminating a much-abbreviated specialised axis arising from the axil of a foliage leaf, with several inflorescences arising from sequential or semi-sequential leaf axils; **peduncle** terete, 1–1.3 \times 0.2–0.25 cm; **spathe** canoe-shaped, thick, stout-beaked, c. 2.7–2.9 \times 0.7–0.8 cm, soon caducous; **spadix** cylindrical, sessile, inserted slightly obliquely on peduncle, c. 2 \times 0.4 cm; **stylar region** well developed, rounded-rhombohexagonal, c. 3 \times 2 mm, convex to truncate, smoothly rounded; stigma impressed, irregularly elliptic, longitudinally oriented, c. 1 \times 0.5 mm; **stamens** elongating at anthesis; **filaments** lorate, c. 2.5 \times 1 mm; **anthers** ellipsoid, bluntly rostrate terminally, c. 1.5 \times 0.6 mm; mature **infructescence** not observed.

Distribution. Peninsular Malaysia: Terengganu (Kemaman) and Kelantan (Kuala Koh).

Habitat. Perhumid lowland mixed dipterocarp forest on ridgetops and flat open areas, 80–100 m asl.



Fig. 1. *Rhaphidophora corneri* P.C.Boyce. Holotype: E.J.H.Corner SFN 30441 (SING).



Fig. 2. *Rhaphidophora corneri* P.C.Boyce. A. Terrestrial population. B. Climbing axis. C. Adult leaf blade, adaxial view. (Photos: Zulhazman H.)



Fig. 3. *Rhaphidophora corneri* P.C. Boyce. **A.** Adult shoot, leaves in adaxial view; note the single root arising from each node. **B.** Adult shoot, abaxial view. The lateral branches arise almost perpendicularly to the main axis. **C.** Adult leaf blade, abaxial view. (Photos: Zulhazman H.)

Other specimen examined: Malaysia, Kelantan, Kuala Koh National Park, 4°52'5.37"N 102°26'31.2"E, 1 June 2010, *Zulhazman H.UMK00031* (Herbarium Universiti Malaysia Kelantan, Faculty of Earth Science, UMK).

Notes. Boyce (1999) speculated that the manner of inflorescence production in *R. corneri*, as then understood—several inflorescences together, each subtended by a cataphyll—indicated a close relationship with the New Guinean *R. ledermannii* Engl. & K.Krause and *R. versteegii* Engl. & K.Krause (Spathacea Group: see Boyce 2000, 2001a, b). However, re-examination of the single flowering shoot on the holotype of *R. corneri* (SING), coupled with insights provided by the hitherto unknown vegetative morphologies presented here, suggest that *R. corneri* is markedly more similar to Peninsular Malaysian *R. tetrasperma* Hook.f., and through this probably related to morphologically congruent taxa such as *R. pertusa* (Ridl.) Schott and *R. nicolsonii* P.C.Boyce. The taxa together form a distinctive and hitherto unrecognised morphotaxon—the Pertusa Group.

The holotype collection of *R. corneri* is, as remarked, somewhat fragmentary. The single flowering shoot bears four inflorescences; three post-anthesis and one in bud, and the entire inflorescence-bearing portion is leafless, with the last foliage leaf on the shoot situated some distance behind the first inflorescence, and that with a somewhat reduced blade. Along the inflorescence-bearing portion there are numerous conspicuous scars, with one scar associated with each of the post-anthesis inflorescences. Initial interpretation of the inflorescence-bearing shoot was that each inflorescence had been subtended by a prophyll/cataphyll, the scars being the result of this being shed, and that the inflorescence in bud marked the tip of a still-extending flowering axis. Such shoot morphology, albeit with the axis between each inflorescence considerably reduced, is found in the *Rhaphidophora* Spathacea Group (Boyce 2001b), while remarkably similar inflorescence architecture (but there certainly independently derived) occurs in *Pothos* L. (Araceae: Potheae), notably in *P. insignis* Engl. (Boyce & Poulsen 1994; Boyce & Hay 1997, 2001).

At the time of the first examination (late 1997), the age and fragility of the holotype material, its unique nature, and nomenclatural importance, precluded further (destructive) examination. More detailed examination has now been enabled, aided by digital enhancement, and we are now of the belief that the probable origin of the scars subtending each of the inflorescences is result of the loss of *foliage* leaves rather than prophylls or cataphylls and that the flowering shoot is better interpreted as having originally comprised solitary inflorescences, each terminating a much-abbreviated specialised axis arising from the axil of a foliage leaf. This is exactly the manner in which *R. tetrasperma* produces inflorescences (see Fig. 4).

Vegetative characteristics revealed by this rediscovery support the new interpretation presented here. *Rhaphidophora corneri*, together with all species in the Pertusa Group, has green, smooth stems, and bears foliage leaves at all except the first few congested nodes of a new module. Virtually every node produces one or occasionally two roots that may either remain short and function as climbing



Fig. 4. *Rhaphidophora tetrasperma* Hook. f. Holotype: Fr B. Scortechini 169b (K).

roots, or extend to the ground as feeder roots. Leaf blades in the group are always irregularly perforated and/or irregularly pinnate. All species have one or more primary axes which remain sterile and produce lateral shoots, along which are fertile nodes (Stone's Model—see Hallé & Oldeman 1970; Hallé, Oldeman & Tomlinson 1978). Inflorescences are born on very short lateral shoots arising from the axils of foliage leaves towards the ends of moderately elongated, lateral shoots.

ACKNOWLEDGEMENTS. The authors would like to acknowledge the Department of Wildlife and National Parks, Peninsular Malaysia (PERHILITAN) for allowing them to conduct the study in the Kuala Koh National Park. Special thanks to Mr. Nik Yuszrin Yusof, Ms. Naziah Zaid and Ms. Norzielawati Salleh for their kind assistance in our work. The first author's fieldwork was supported by USM Grant No: 1001/ JNC/ AUPRM001. The second author's project is funded by Universiti Malaysia Kelantan through short-term research grant R/SGJP/A03.00/00279A/001/2009/000021 via the Faculty of Agro Industry & Natural Resources.

References

- Boyce, P.C. (1999) The genus *Rhaphidophora* Hassk. (Araceae-Monsteroideae-Monstereae) in Peninsular Malaysia and Singapore. *Gard. Bull. Singapore* 51: 183–256.
- Boyce, P.C. (2000) The genus *Rhaphidophora* Hassk. (Araceae-Monsteroideae-Monstereae) in the southern and western Indonesian archipelago. *Gard. Bull. Singapore* 52: 101–183.
- Boyce, P.C. (2001a) The genus *Rhaphidophora* Hassk. (Araceae-Monsteroideae-Monstereae) in Borneo. *Gard. Bull. Singapore* 53: 19–74.
- Boyce, P.C. (2001b) The genus *Rhaphidophora* Hassk. (Araceae-Monsteroideae-Monstereae) in New Guinea, Australia and the tropical western Pacific. *Gard. Bull. Singapore* 53: 75–183.
- Boyce, P.C. & Hay, A. (1997) Diversity in shoot architecture in *Pothos* (Araceae: Pothoideae): Observations towards a new infrageneric classification. In: J. Dransfield et al. (eds) *Plant Diversity in Malesia III*, pp. 51–58.
- Boyce, P.C. & Hay, A. (2001) A taxonomic revision of Araceae tribe Potheae (*Pothos*, *Pothoidium* and *Pedicellarum*) for Malesia, Australia and the tropical Western Pacific. *Telopea* 9(3): 449–571.
- Boyce, P.C. & Poulsen, A.D. (1994) Notes on *Pothos insignis* (Araceae: Pothoideae). *Kew Bull.* 49(3): 523–538.
- Hallé, F. & Oldeman, R.A.A. (1970) *Essai sur l'Architecture et la Croissance des Arbres Tropicaux*. 178 pp. Paris: Masson et Cie.
- Hallé, F., Oldeman, R.A.A. & Tomlinson, P.B. (1978) *Tropical Trees and Forests; An Architectural Analysis*. 441 pp. Heidelberg: Springer-Verlag.

***Coelachne madayensis* (Poaceae: Pooideae: Isachneae), a new species from Kerala, India**

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ABSTRACT. A new species of *Coelachne* (Poaceae: Pooideae: Isachneae) from Madayippara in the Kannur District of Northern Kerala, India is described and illustrated. A key for the identification of the Indian congeners is provided.

Keywords. *Coelachne*, India, Kerala, Poaceae

Introduction

The genus *Coelachne* R.Br. (Poaceae: Pooideae: Isachneae) is represented by 10 species distributed in the tropics and subtropics of the Old World (Mabberley, 2008; Clayton et al. 2006+). In India the genus is represented by 3 species, of which one species and one variety are endemic (Prakash & Jain 1984). In Kerala there are 2 species, viz. *Coelachne infirma* Buse [syn. *C. simpliciuscula* (Wight & Arn. ex Steud.) Munro ex Benth.] and *C. perpusilla* (Arn. ex Steud.) Thwaites, which usually occur in wet places (Sreekumar & Nair 1991).

During a floristic survey in July 2011 of the lateritic plateau habitats of Northern Kerala, India, the first two authors noticed a population of a very small species of *Coelachne* in the shallow seasonal pools and nearby wet areas. The specimens turned out not to belong to any described species of *Coelachne*, though they showed some similarity with the Indian species *C. minuta* Bor in their general habit, size, and organization of the spikelets. However, they differed in their non-tufted habit, absence of a ligule, ovate leafblades, flagleaves without a blade, racemes with up to 15 spikelets, lower florets with 0-nerved glumes and paleas, and 3 stamens. Therefore they are here described as a new species.

***Coelachne madayensis* Pramod & Pradeep, sp. nov.**

Coelachnae minutae similis in habitu generali magnitudineque spicularum structura, sed habitu non caespitoso, foliorum laminis ovatis sine ligula, ultimis lamina carentibus, racemis paucispiculatis, glumis paleisque avenis, staminibus 3 differt. TYPE: India, South India, Kannur District, Madayippara, alt. 36 m, 12°1.792'N 75°15.246'E, 25 July 2011, Pramod & Pradeep CU126681 (holo K; iso BRIT, CALI, SING). (Fig. 1)

Erect aquatic herb, 3–8 cm high, rooting at the lower nodes. **Culm** canaliculate, internodes 3–5 mm long, glabrous, nodes glabrous. **Sheaths** up to 6 mm long, as long as or shorter than the internodes, laxly clasping the culm, distinctly striate, sparsely hispid (especially on the midrib); **ligule** absent; **blades** ovate, 0.8–1.2 × 0.5–0.6 mm, 7–15-nerved, glabrous above, puberulous below, base cordate, margin at base ciliate, apex acute; **flagleaf** sheaths 1–3 cm long, glabrous, margins hyaline, apex pointed, blade absent. **Panicles** 3–6 cm long; branches up to 8 mm long, with gland-like swellings at base. **Spikelets** up to 15, 1–3 per branch, elliptic, 1–1.5 × 0.5–0.7 mm; purplish. **Glumes** ovate, purplish, margins hyaline; lower glume c. 0.75 × 0.5 mm, purplish; upper glume, 0.9 × 0.5 mm. **Lower** lemma lanceolate, 1.5 × 0.5 mm, 0-nerved, purplish, margins hyaline, margins and upper surface pilose. Palea boat-shaped, c. 1.25 × 0.8 mm × c. 0.5 mm, deep purplish, margins hyaline, 0-nerved, upper surface pilose. **Stamens** 3; anthers 1.25 × 0.5 mm, greenish white. **Style** forked, hyaline, stigma plumose. **Upper floret** tufted cottony hairy at base, c. 1.5 × 0.5 mm, purplish. Lemma boat-shaped, c. 1.2 × 0.5 mm, 0-nerved, pilose, purplish, margins hyaline. Palea slightly shorter than lemma, boat-shaped, c. 1 × 0.5 mm, purplish, margins hyaline. **Caryopses** ellipsoid, c. 1 × 0.5 mm, deep purplish, glabrous, shiny.

Ecology: The species is found growing in shallow seasonal pools and nearby wet areas along with, e.g., *Eriocaulon* spp., *Fimbristylis* sp., *Geissaspis cristata* Wight & Arn. var. *tenella* (Benth.) M.R.Almeida, *Isachne veldkampii* K.G.Bhatt & Nagendran, *Rhamphicarpa longiflora* Benth., *Rotala malabarica* Pradeep, K.T.Joseph & Sivar., *R. malampuzhensis* R.V.Nair ex C.D.K.Cook, and *Utricularia* spp. Usually the panicle alone is seen emerging from the water.

Etymology: The new species is named after its type locality, Madayippara in the Kannur District of Kerala, India.

Key to the Indian taxa of *Coelachne*
(Prakash & Jain, 1984, modified)

- 1a. Culms erect. Spikelets 1–1.5 mm long 2
b. Culms ascending. Spikelets over 1.5 mm long 3

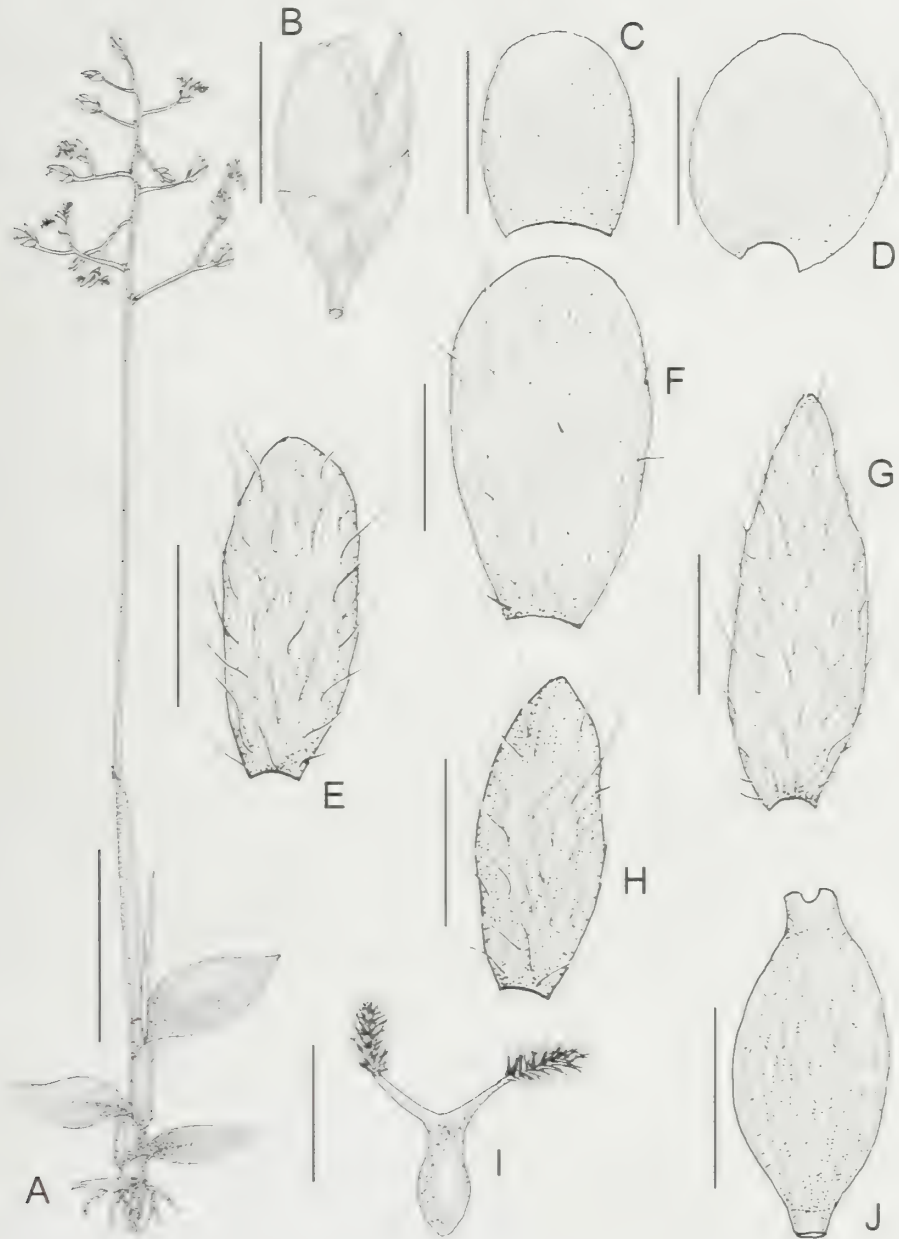


Fig. 1. *Coelachne madayensis* Pramod & Pradeep. **A.** Habit. **B.** Spikelet. **C.** Lower glume. **D.** Upper glume. **E.** Lower lemma. **F.** Lower palea. **G.** Upper lemma. **H.** Upper palea. **I.** Pistil. **J.** Caryopsis. Scale bars: A = 1 cm; B = 1 mm; C–J = 0.5 mm. (Drawn by C. Pramod)

- 2a. Culms not tufted. Sheaths laxly clasping the culm. Ligule absent. Blades ovate. Flagleaf bladeless. Panicle usually with less than 15 spikelets. Lower glume c. 0.75 mm long; upper glume c. 0.9 mm long, 0-nerved. Palea 0-nerved. Stamens 3
..... *C. madayensis*
- b. Culms tufted. Sheaths firmly clasping the culm. Ligule present, silky hairy. Blades lanceolate. Flagleaf with a blade. Panicle with more than 15 spikelets. Lower glume c. 0.25 mm long; upper glume c. 0.5 mm long, 2-nerved. Palea 2-nerved. Stamens 2 *C. minuta*
- 3a. Panicles few-flowered, very lax. Spikelets 2.5–4 mm long. Lemmas densely bearded at base 4
- b. Panicles many-flowered, mostly contracted and spiciform. Spikelets 1.5–2.5 mm long. Lemmas glabrous at base *C. infirma*
- 4a. Culms slender. Blades flat, linear-lanceolate. Spikelets 3.5–4.0 mm long. Lower glume 1.7–2.0 mm long, 1–3-nerved; upper glume 2.3–2.5 mm long. Upper lemma and palea not keeled, 0- (or 1-)nerved, glabrous or sparsely hairy in the lower half. Anthers 1.5–1.7 mm long *C. perpusilla* var. *nilagirica*
- b. Culms capillary. Blades involute, filiform. Spikelets 2.5–3.0 mm long. Lower glume 1–1.5 mm long, 3–7-nerved; upper glume 1.5–2.0 mm long. Upper lemma and palea 2-keeled, 2-nerved, hairy along the keels and all over the dorsal surface. Anthers 0.8–1(–1.5) mm long *C. perpusilla* var. *perpusilla*

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References

- Clayton, W.D., Vorontsova, M.S., Harman, K.T. & Williamson, H. (2006+) GrassBase - The online world grass flora. <http://www.kew.org/data/grasses-db.html> accessed 8 March 2012.
- Mabberley, D.J. (2008) *The Plant-Book: A Portable Dictionary of Vascular Plants*. Cambridge: Cambridge University Press.
- Prakash, V. & Jain, S.K. (1984) Poaceae: tribe Isachneae. *Fascicles of Flora of India* 14: 3–7, t. 1–13. Howrah: Botanical Survey of India.
- Sreekumar P.V. & Nair, V.J. (1991) *Flora of Kerala - Grasses*. Pp. 414–416. Calcutta: Botanical Survey of India.

The rediscovery of *Dischidia hirsuta* (Apocynaceae, Asclepiadoideae) in Singapore

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ABSTRACT. This paper seeks to document the rediscovery of *Dischidia hirsuta* (Bl.) Decne. in Singapore. The taxon was last collected from Singapore in 1903 and later considered nationally extinct. Botanical investigation of Nee Soon Swamp Forest in May 2011 resulted in the rediscovery of a single specimen of *D. hirsuta*, now considered critically endangered.

Keywords. *Dischidia*, IUCN Red Lists, Nee Soon Swamp Forest, Singapore

Introduction

The genus *Dischidia* R.Br. occurs from India, across SE Asia, to the east Pacific region and Australia. The genus has not been recently revised but it has been the subject of modern floristic treatments (Rintz 1980; Li et al. 1995; Forster et al. 1996; Jagtap & Singh 1999; Livshultz et al. 2005). *Dischidia* species are epiphytic and lithophytic climbers with long and slender stems rooting at the nodes and along internodes. The leaves are usually opposite, entire, ovate to elliptic but can alternatively develop into three distinct types: shell-like leaves, usually tightly appressed to the host plant bark, pitchers, and terete leaves (observed in *Dischidia bengalensis* Colebr. only). Shell-like leaves and pitcher leaves accommodate ants that establish a symbiotic interaction with the plant (Janzen 1974).

Inflorescences are spirally-elongating racemes producing flowers more-or-less regularly over a variable amount of time, sometimes up to years. The flowers are pentamerous, with a small calyx and a typically urceolate corolla more-or-less pubescent internally. All species have a staminal corona composed of five hyaline anchor-shaped appendages alternating with the stamens. In some species, a corolline corona also occurs together with the staminal corona and is formed by five lobes attached to the inner surface of the corolla. The pollen is carried in pollinia lacking sterile edges, attached to a central retinaculum by two often broad and cristate caudicles. Fruit follicles are variable, from terete to reniform or triangular in cross section (Rintz 1980). The phylogenetic position of *Dischidia* with respect to *Hoya* is unresolved (Wanntorp et al. 2006a, b; Wanntorp et al. 2011) but they are considered to be separate on a morphological basis (Wanntorp & Kunze 2009).

In Singapore, Ridley (1900) recognised seven species at first, but later eight (Ridley 1923). Rintz (1980) made a critical revision of *Dischidia* for the Malay Peninsula (now including Peninsular Malaysia and Singapore) and recognised seven species occurring in Singapore. Currently nine species are listed as native in the Checklist of Singapore Flora (Chong et al. 2009) but five of these are considered nationally extinct. Among these, *D. singaporensis* Ridl., is considered a globally extinct species.

Distribution and variability of *D. hirsuta*

Dischidia hirsuta derived its specific epithet from the characteristic pubescence of the young leaves and stems. It was first described as *Leptostemma hirsuta* Bl. (1826) and transferred to the genus *Dischidia* by Decaisne (1844). It is a rather common species occurring continuously from Burma across to New Guinea (Rintz 1980). It occupies a narrow altitudinal range and can be found growing from lowland to hill forests below 100 m asl. (Rintz 1980). It is usually found on small branches high in the tree canopy where it is exposed to nearly full sun. For this reason, despite its showy flowers, it is difficult to notice unless it is found on recently fallen branches, for example, after storms.

The species is very variable in vegetative and flower morphology depending on the provenance and on the growing condition. Flower colour can range from pale yellow with white corolla lobes to burgundy red, and corolla shape can be from broadly urceolate with a nearly flat base to narrowly ovoid (Fig. 1). Leaf shape can vary from lanceolate to orbicular, flat with visible veins or thick, succulent, with an obscure venation, and leaf size ranges from 0.5×0.5 cm to 2.5×1.5 cm. Leaf colour varies from dark green to light green-yellow with red or maroon spots (Fig. 1). Lighter-coloured, thicker leaves are typical of specimens growing in direct sunlight but even this may vary from one locality to another (Rodda, pers. obs.). In mature parts of the plant the pubescence typical of juvenile leaves is less conspicuous and often completely absent. While different collections have been described under different names over the years, *D. hirsuta* is currently considered a single species with a large intraspecific variation. Such a high morphological variation has not yet been studied in detail and future studies could lead to resurrection of some of the six species names that are currently considered to be synonymous with *D. hirsuta* (Rintz 1980).

***Dischidia hirsuta* in Singapore**

From herbarium records it appears that *D. hirsuta* was rather widespread in Singapore at the end of the 19th century. It was recorded from natural areas such as Kranji and Seletar, but also along the more populated Nassim Road. The last collection (in Woodlands) dates back to 1903 and therefore the species had been considered presumably extinct (Tan et al. 2008; Davison 2008) until a recent botanical survey of Nee Soon Swamp Forest we conducted in May 2011. It was found growing on

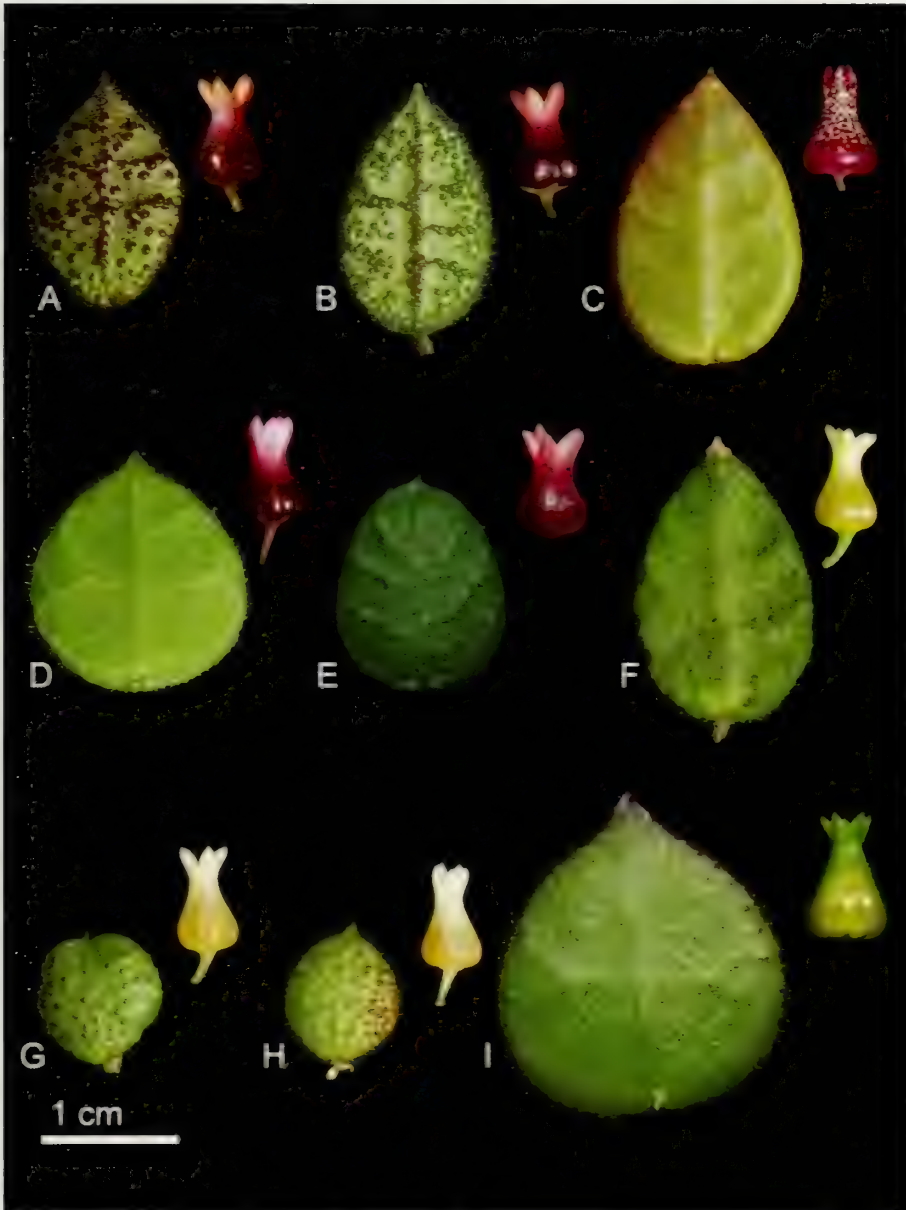


Fig. 1. Morphological variation of *Dischidia hirsuta* across its distribution area. For each accession a leaf (adaxial surface) and a flower (side view) is presented. **A.** Borneo, Sabah, 1989, *Ridsdale s.n.* (Hortus Botanicus Leiden number 910235). **B.** Thailand, 24 Aug 2000, *de Wilde* 143909 (20031259). **C.** Indonesia, Irian Jaya, Feb 1998, *Yumte s.n.* (981096). **D.** s. loc. s. coll., (970839). **E.** Singapore, Upper Seletar track, 3 May 2011, *Rodda, Leong-Škorničková, Tran, Liew & Chew* MR11-008 (SING). **F.** Philippines, 21 Jan 1993, *Ridsdale & Pancho s.n.* (930049). **G.** Borneo, Sarawak, 1998, *Vogel, Schuiteman & Roelfsema s.n.* (980056). **H.** s. loc, 21 Jan 1993, *Ridsdale s.n.* (930045). **I.** Indonesia, Sulawesi, *Tauecchio* ETS94031 (20000247). All pictures from living specimens cultivated in the Hortus Botanicus Leiden unless otherwise stated. (Photos: M. Rodda)

fallen branches on the forest floor in deep shade in secondary forest, but the branches had grown in the canopy where they were exposed to nearly full sun. We could not locate any additional specimen on neighbouring trees. The species can be observed in similar habitats in Johore, Malaysia, where *D. hirsuta* is a common epiphyte in lowland freshwater swamps (Rodda, pers. obs.).

Conservation considerations

Since the discovery of a single specimen of *D. hirsuta* and its precarious state, the species is more suitably considered Critically Endangered in Singapore, according to guidelines given in *The Singapore Red Data Book* (Davison 2008). It is plausible that further specimens of *D. hirsuta* and other nationally extinct epiphytic species could still persist in the canopy of suitable trees in the relatively under-collected Nee Soon Swamp Forest. This habitat should therefore be further explored and preserved. Cuttings for propagation were taken from the specimen of *D. hirsuta* in Nee Soon Swamp Forest. Currently about 50 plants have been raised at the Singapore Botanic Gardens (SBG Acc. No. 20111110) to create enough stock for conservation work, including possible re-introduction trial planting.

Further collections and detailed studies both at the population level and across the distribution range are needed to verify the extent of morphological as well as genetic variation in order to understand whether *D. hirsuta* is a species complex, which may then require to be recognised as different taxonomic units. From a conservation perspective, the geographic and genetic origin of propagation materials to be potentially used for reintroduction is therefore of essential importance to understand together with its taxonomy. This then helps to avoid genetic contamination of the natural populations of the taxon, in particular in Singapore, where natural populations could be highly restricted and ecological repercussions potentially impactful.

Description of the Singapore taxon

The following morphological description is based on specimens collected in Singapore (Fig. 2):

Plants succulent, herbaceous; epiphytic vines growing tightly appressed to the host tree stems, clinging by adventitious roots, rarely pendulous, usually preferring to colonise small canopy branches up to 5 cm diameter. Latex white. **Roots** on mature plants adventitious, produced just below each node and along the internodes. **Leafy stems** terete, up to 2.5 mm diameter, dark green, hirsute when young; internodes 1–2 cm long. **Leaves** opposite, petiolate; petiole cylindrical, 1.5–2.5 mm long, c. 1 mm in diameter, sparsely pubescent; lamina dark green, underneath lighter green with darker spots, coriaceous, fleshy, (orbicular) broadly ovate (lanceolate), 1–2.5 × 0.6–1.5 cm, hirsute on both surfaces when young; apex acute-apiculate, base round-truncate (shortly attenuate), margin entire, main vein evident on adaxial surface, marked by a dark green line on abaxial surface, secondary veins 3–4 pairs, branching at 60–80(–90)° from main vein. **Inflorescences** usually bearing a single open flower at a time; peduncle extra-axillary, perennial, bearing scars of previous flowerings 2–5 mm long, c. 1 mm in diameter, pubescent; pedicels 2–3 mm long, c. 0.7 mm in diameter, glabrous



Fig. 2. *Dischidia hirsuta* in Singapore. **A.** Flowering branches bearing single-flowered inflorescences. **B.** Single-flowered inflorescence. **C.** Dissected flower. The double ring of hairs lining the corolla tube, the hyaline appendages surrounding the staminal corona and the central anther appendages can be observed. Based on Rodda, Leong-Škorničková, Tran, Liew & Chew MR11-008 (SING). (Photos: M. Rodda (A, C) and J. Leong-Škorničková (B)).

(sparsely hirsute). **Calyx** c. 3 mm in diameter, red-purple, lobes ovate 1–1.5 × 0.6–1 mm, apex acute to round, glabrous. **Corolla** succulent, urceolate, c. 7 × 4 mm, basally dark red, progressively fading into light pink at the lobe apices, externally glabrous.

corolla throat with two rings of hairs, the first just below the corolla lobe sinus, the second at the same high as the anther appendages; lobes nearly entirely fused, glabrous, with free ovate tips up to 2 mm long. *Corolline corona* absent. *Staminal corona* 3 mm high, 3 mm in diameter, basally pubescent, composed of five hyaline appendages with a truncate apex and two downcurved lobes. *Stigma* head prominent, convex, hidden by the anther appendages. *Pollinarium* erect (measuring c.) $1000 \times 600 \mu\text{m}$ with two oblong pollinia, $600 \times 200 \mu\text{m}$, apex and base rounded to obtuse, retinaculum $420 \times 120 \mu\text{m}$, caudicles broad, laterally crested, 400 μm long. *Ovary* bi-carpellate, bottle shaped, 1.5 mm long, each carpel c. 0.7 mm in basal diameter. Fruits and seeds not seen.

Singapore specimens examined. Tanglin, Nassim Road, 1901, *H.N. Ridley 14165* (SING, barcode SING0003915); Seletar, Nov? 1889, *H.N. Ridley 2730* (SING, barcode SING0003916); Kranji, 26 Feb 1889, *H.N. Ridley s.n.* (SING barcode SING0003914); Seletar, 10 Mar 1890, *J.S. Goodenough s.n.* (SING barcode SING0003919); Woodlands, Jun 1903, *H.N. Ridley s.n.* (SING barcode SING0003917); Upper Seletar track, 3 May 2011, *Rodda, Leong-Škorničková, Tran, Liew & Chew MR11-008* (SING, spirit barcode SING0126958).

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References

- Blume, C. (1826) Asclepiadeae. *Bijdr. Fl. Ned. Ind.* 16: 1048–1066.
- Chong, K.Y., Tan, H.T.W. & Corlett, R.T. (2009) A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised and Cultivated Species. Raffles Museum of Biodiversity Research, National University of Singapore, Singapore. 273 pp. Uploaded 12 November 2009. http://rmbr.nus.edu.sg/raffles_museum_pub/flora_of_singapore_tc.pdf.
- Decaisne, J. (1844). *Dischidia*. In: De Candolle, A. P., *Prodr.* 8: 631–633.
- Davison, G.W.H. (2008) The Red List categories. In: Davison, G.W.H., Ng, P.K.L. & Ho, H.C. (eds) *The Singapore Red Data Book: Threatened Plants and Animals of Singapore*. 2nd ed. Singapore: Nature Society (Singapore). Pp. 1–4.
- Forster, P.I., Liddle, D.J. & Nicholas, A. (1996) Asclepiadaceae. In: Robertson, R. et al. (eds) *Flora of Australia* 28. *Gentianales*: 197–283. Melbourne: CSIRO.
- Jagtap, A.P. & Singh, N.P. (1999) Asclepiadaceae. *Fascicles of Flora of India*. Fascicle 24. Calcutta: Botanical Survey of India.
- Janzen, D.H. (1974) Epiphytic myrmecophytes in Sarawak: mutualism through the feeding of plants by ants. *Biotropica* 6: 237–259.
- Li, P.T., Gilbert, M.G. & Stevens, W.D. (1995) Asclepiadaceae. In: Wu, Z. & Raven, P.H. (eds) *Flora of China* 16. *Gentianaceae through Boraginaceae*: 189–270. St. Louis: Missouri Botanic Garden.

- Livshultz, T., Tran, T.B., Bounphanmy, S & Schott, D. (2005) *Dischidia* (Apocynaceae, Asclepiadoideae) in Laos and Vietnam. *Blumea* 50: 113–134.
- Ridley, H.N. (1900) Flora of Singapore. *J. Straits Branch Roy. Asiat. Soc.* 33: 27–196.
- Ridley, H.N. (1923) *Hoya*. *Flora of the Malay Peninsula*. 2: 402–410. London: Reeve & Co.
- Rintz, R.E. (1980) The Peninsular Malayan species of *Dischidia* (Asclepiadaceae). *Blumea* 26: 81–126.
- Tan, H.T.W., Tan, K., Ali Ibrahim, Chew, P.T., Chua, K.S., Duistermaat, H., Ganesan, S.K., Goh, M.W.K., Gwee, A.T., Kiew, R., Lee, S.M.L., Leong, P., Lim, J., Lok, A.F.S.L., Loo, A.H.B., Lum, S.K.Y., Morgany, T., Saifuddin Suran, Sim, S., Samsuri Ahmad, Wee, Y.C., Yap, K.F., Yeo, C.K. & Yong, J.W.H. (2008) Checklists of Threatened Species—Seed Plants. In: Davison, G.W.H., Ng, P.K.L. & Ho H.C. (eds) *The Singapore Red Data Book*. 2nd ed. Singapore: The Nature Society (Singapore). Pp. 213–244.
- Wanntorp, L., Kocyan, A., van Donkelaar, R. & Renner, S.S. (2006a) Towards a monophyletic *Hoya* (Marsdenieae, Apocynaceae): Inferences from the chloroplast *trnL* region and the *rbcL-atpB* spacer. *Syst. Bot.* 31(3): 586–596.
- Wanntorp, L., Kocyan, A. & Renner, S.S. (2006b). Wax plants disentangled: A phylogeny of *Hoya* (Marsdenieae, Apocynaceae) inferred from nuclear and chloroplast DNA sequences. *Molec. Phylogen. Evol.* 39: 722–733.
- Wanntorp, L. & Kunze, H. (2009) Identifying synapomorphies in the flowers of *Hoya* and *Dischidia*—towards phylogenetic understanding. *Int. J. Pl. Sci.* 170(3): 331–342.
- Wanntorp, L., Gotthardt, K. & Muellner, A.N. (2011) Revisiting the Wax Plants (*Hoya*, Marsdenieae, Apocynaceae) phylogenetic tree using the chloroplast markers *matK* gene and *psbA-trnH* intergenic spacer. *Taxon* 60(1):4–14.

Studies in Malesian Gentianaceae I: *Fagraea sensu lato*—complex genus or several genera? A molecular phylogenetic study

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ABSTRACT. Phylogenetic studies of *Fagraea* s.l. based on maximum parsimony and Bayesian analyses of gene sequences for the nuclear ITS region and a number of chloroplast regions (*trnL* intron, *trnL*–*F* spacer and two partial sequence regions of *ndhF*) were carried out. Separate experiments with an ingroup of 29 taxa of *Fagraea* s.l. (8 from section *Cyrtophyllum*, 16 from section *Fagraea* and 5 from section *Racemosae*; all new sequences) were made with individual gene-region and combined data sets; and with 43 taxa using only an ITS data set that included published gene sequences of other recently revised, well-established genera of the same tribe (Potalieae). Reasonably consistent clade composition was obtained with all analyses: two clades could be equated to sections *Fagraea* and *Racemosae*, another two (Elliptica and Gigantea clades) are different portions of the section *Cyrtophyllum*, and the solitary *F. crenulata* resolved basal to the *Fagraea* clade in the chloroplast gene analyses but was a distinct lineage in a polytomy with the *Fagraea*, *Racemosa* and *Gigantea* clades in the ITS analyses. The equivalence of these clades and the *F. crenulata* lineage to other monophyletic groups represented by established genera in the expanded-ITS analysis, as well as considerations of potential morphological synapomorphies for these individual entities, suggest that *Fagraea* s.l. is too morphologically and phylogenetically divergent to be considered a single genus.

Keywords. *Cyrtophyllum*, *Fagraea*, generic circumscription, Gentianaceae, Malesia, molecular phylogenetic analyses, morphology, Potalieae, *Racemosae*, synapomorphic characters

Introduction

Fagraea Thunb. and s.l. are paleotropical, with a distribution from Sri Lanka and India, through tropical South East Asia, reaching east to Polynesia (Struwe et al. 2002). The genus (or group) is centred in Malesia, where over 70 species are present (Struwe et al. 2002), and around 50 species are distributed within the Malay Peninsula and Borneo (Leenhouts 1962; Wong & Sugau 1996). Species of *Fagraea* s.l. represent a variety of life forms. They are tall canopy trees, smaller understory trees reaching only a few meters in height, shrubs, or are epiphytes and hemi-epiphytes. They occur from sea level to about 3000 m in very moist montane conditions, mostly in forest gaps, forest edges, rocky outcrops, along stream beds in wet tropical forests, and less commonly in

mesic forests, mangrove swamps and savannas (Motley 2004).

With a large diversity in habit and form, *Fagraea* s.l. includes species that are both conspicuous and ecologically important in natural landscapes. The widespread *F. fragrans* Roxb. is a common pioneer on sandy sites, a frequent secondary forest species in the lowlands, and can persist in mature forest. In the Malay Peninsula, *F. racemosa* Jack ex Wall. is also a common secondary forest species and the large-leaved *F. auriculata* Jack with long-tubed flowers is often conspicuous in coastal sandy sites and on quartz ridges in the lowlands. Throughout the lowland and lower montane forests of the Malay Peninsula and Borneo, the frequent presence of *Fagraea* epiphytes or hemi-epiphytes is detected by fallen corollas on the ground at different times during the year. Burkill (1936), Macmillan (1991), Motley (2004), Perry (1980), Quisumbing (1978) and Watson (1935) describe how a number of species are used mainly for wood, medicinal purposes and horticulture.

In the past, *Fagraea* s.l. was placed within the Loganiaceae (e.g., Leeuwenberg & Leenhouts 1980; Leenhouts 1962) but this classification is now controversial. Subsequent analyses of morphological data (Struwe et al. 1994; Struwe & Albert 1997) and molecular characteristics (Struwe et al. 2002; Downie & Palmer 1992; Olmstead et al. 1993) have demonstrated that *Fagraea* s.l. and its tribe Potalieae are better placed in the Gentianaceae. There is also support for this from some phytochemical evidence (Jensen 1992; Jensen & Schripsema 2002). Potalieae members have diverse flower merosity (e.g., 3-merous in the genus *Pycnosphaera* Gilg, up to 16-merous in the genus *Anthocleista* Afzel. ex R.Br.) and habit (trees, lianas, shrubs, scramblers and herbs) compared to most other tribes within Gentianaceae. The distribution of Potalieae is strictly tropical, mostly found around the equatorial regions (Struwe et al. 2002).

Molecular analyses have consistently shown that *Anthocleista*, *Fagraea* and *Potalia* Aublet form a monophyletic group that justifies inclusion in the same subtribe (Potaliinae) within Gentianaceae (Struwe et al. 2002; Molina & Struwe 2009). Whereas *Fagraea* s.l. is a large Indo-Pacific group, *Potalia* is found in the Central and South American region with nine recorded species and *Anthocleista* is only found in tropical Africa and Madagascar with 14 known species (Struwe et al. 2002). The only two clear morphological (non-synapomorphic) characters that make the subtribe Potaliinae aberrant in Gentianaceae are the occurrence of fleshy berries and occasional large tree habit in some taxa (Molina & Struwe 2009). Other members of the Gentianaceae have dry and capsular fruits and relatively smaller size; and there are trees in other gentian genera, but typically much less than 10 m high (Struwe et al. 2002).

Within *Fagraea*, three subgeneric groups have been recognised, considered as the sections *Cyrtophyllum* (Reinw.) Blume, *Fagraea* and *Racemosae* Benth. (Leenhouts 1962). This classification was adopted by Wong & Sugau (1996), who delimited the sections by inflorescence form and branching, seed form, the nature of fruit epidermis, axillary scale characters and stigma form.

In their review for Borneo, Wong & Sugau (1996) enumerated 42 species, including 20 that they newly described. This was a big contrast to the previous work by Leenhouts (1962, 1984) for Malesia, where he only enumerated 15 species for Borneo.

The species concepts of Leenhouts were considered too broad by Conn & Brown (1993) and Wong & Sugau (1996). An example stated by Wong & Sugau (1996) is that Leenhouts (1962) had only one species accepted in the whole section *Racemosae* for Malesia, having reduced many previously described species to synonymy. Wong & Sugau (1996) found many of such taxa morphologically distinct and possible to key out using both vegetative and flower and fruit characters, and resurrected many corresponding names from synonymy.

Scope of the present study

The bizarre contrast between the results obtained by Leenhouts (1962) and Wong & Sugau (1996), the demonstration of what appears to be likely impractical species concepts in Leenhouts (1962) by both Conn & Brown (1993) and Wong & Sugau (1996), and the lack of any recent detailed reviews for Malesia other than Borneo, precipitated the present inquiry. Just as species concepts were apparently too broad, so the inclusion of morphologically very different sections in the same genus was perhaps also questionable.

At the fundamental level, the distinctness of the subgeneric groups recognised as *Fagraea* sections *Cyrtophyllum*, *Fagraea* and *Racemosae* require further consideration. This is in view of somewhat conspicuous characters distinguishing them, as summarised by Wong & Sugau (1996), and very preliminary possibilities for generic distinction suggested by limited molecular evidence discussed by Struwe & Albert (1997). This problem is investigated using a molecular analysis of as many taxa as possible from the Malay Peninsula and Borneo, and augmented by molecular results for other taxa in the same subtribe and tribe from other geographical regions. The extents of morphological distinction among the so-called sections are also re-examined.

Finally, the merits and intricacies of classifying the several morphologically distinct groups of species within *Fagraea* s.l. as either sections or distinct genera will be discussed. From this, recommendations would be made for an appropriate classification of the group.

Sectional classification of *Fagraea* s.l.

The recognition of infrageneric groups within *Fagraea* has a convoluted history. Blume (1838) erected *Fagraea* section *Cyrtophyllum*, which included the two species *Cyrtophyllum peregrinum* Reinw. (this is in fact a synonym of the earlier published and better known *F. fragrans*) and *C. speciosum* Blume (synonymous with *Picrophloeus javanensis* Blume, to which also some authors have applied the name *F. elliptica* Roxb.). Blume had evidently done this because the many-branched cymes with much smaller flowers in these taxa were rather different from the sparsely branched cymes with larger flowers of *F. ceilanica* Thunb., the type species of the genus.

Later, Blume (1850) included two of his species, *F. kimangu* Blume and *F. picrophloea* Blume (both synonyms of his *P. javanensis*) in his *Fagraea* section *Eufagraea*, with a number of other species that had a very different inflorescence form, where cyme-like clusters of flowers were borne along an elongate main inflorescence axis that superficially resembled a complex raceme (described by Blume as “*cymis in racemum terminalem longissimum*”). In the same paper, Blume (1850) placed *F. ceilanica* (spelled as *F. zeylanica*) and associated species in “section *Fagraea verae*”.

Bentham (1856) appears to be the first person who clearly differentiated three groups within *Fagraea*, as section *Parviflorae* Benth. (= Blume's section *Cyrtophyllum*), section *Racemosae* (which is that group with raceme-like inflorescences in Blume's section *Eufagraea*), and section *Corymbosae* Benth. (= Blume's section *Fagraea verae*). Subsequent authors also provided infrageneric names. Miquel (1857) employed subgenus *Cyrtophyllum* and subgenus *Eufagraea*, in place of Blume's sections *Cyrtophyllum* and *Fagraea verae*, respectively. Solereder (1892), on the other hand, named section *Pseudoracemosae* and section *Pseudocorymbosae* for Bentham's *Racemosae* and *Corymbosae*, respectively.

In his revision for the Flora Malesiana, Leenhouts (1962) recognised three infrageneric groupings that he called sections *Fagraea* (containing the type and by far the largest number of species), *Cyrtophyllum* (as designated by Blume) and *Racemosae* (as proposed by Bentham). Leenhouts (1962) gave very few characters for sectional distinction, some of which were somewhat inconsistent (see Table 1).

Wong & Sugau (1996) also used these sections as circumscribed by Leenhouts (1962) for their account of *Fagraea* in Borneo, but added more distinguishing characters and provided a key to sections. They used such characters as fruit size, ease of epidermis detachment on drying, seed form, inflorescence branching, characters of the petiole base (including whether scale-like structures develop at the leaf axils), stigma form and the extent of stamen and style exsertness in open flowers.

Alternative taxonomic interpretations

Several species placed in *Fagraea* s.l. by Leenhouts (1962) and other authors have been the basis of other generic names. Although Cammerloher (1923) considered *Cyrtophyllum* a synonym of *Fagraea*, Ridley (1923) had distinguished the two genera, using the former name for *C. lanceolatum* (Wall.) DC., *C. peregrinum* and *C. giganteum* (Ridl.) Ridl. The equivalents for these names in *Fagraea* are *F. lanceolata* Wall. (a synonym of *F. wallichiana* Benth.), *F. peregrina* Blume (a synonym of *F. fragrans*), and *F. gigantea* Ridl., respectively.

Leenhouts (1962) suggested that *Cyrtophyllum* and *Picrophloeus* Blume are synonyms of *Fagraea* section *Cyrtophyllum*. He also placed the names *Utania* G. Don, *Kuhlia* Reinw. and *Kentia* Steud. (the latter two illegitimate as a later homonym and a name lacking a description, respectively) as synonyms of *Fagraea* section *Racemosae*.

Table 1. Diagnostic characteristics of three sections in *Fagraea* s.l. according to Leenhouts (1962).

Character	Section	sect. <i>Fagraea</i>	sect. <i>Cyrtophyllum</i>	sect. <i>Racemosae</i>
leaves		auriculate or not	not auriculate	not auriculate
stipules		(not explicitly stated)	(not explicitly stated)	connate in an ochrea
inflorescence form		corymbose, dichasial, glomerulous or with solitary flowers; "usually with a pair of strong branches in the upper leaf axils, therefore the inflorescence as a whole mostly sessile"	corymbose	racemiform, with a number of decussate pairs of small cymes
inflorescence position		always terminal	(not explicitly stated, but including terminal and axillary types in different taxa)	always terminal
flower size		(not explicitly stated)	small	(not explicitly stated)
corolla form		(not explicitly stated)	tubular	(not explicitly stated)
stamens, style		hardly or not exerted	far exerted (except in <i>F. umbelliflora</i>)	not or only slightly exerted
fruit shape, size		(not explicitly stated)	globular, small	(not explicitly stated)

Materials and methods

Herbarium materials and studies. Study specimens were loaned from, or examined at, the following herbaria: Royal Botanic Gardens, Kew (K), Forest Research Institute Malaysia, Kepong (KEP), Nationaal Herbarium Nederland (L), Forest Research Centre, Sabah (SAN), Singapore Botanic Gardens (SING) and the University of Malaya (KLU). A hand lens ($\times 20$ magnification) and binocular microscope ($\times 40$ magnification) were used to examine material.

Field collections and processing. Additional material collected yielded specimens that were oven-dried at 55°C for 2–4 weeks; and flowers, fruits and leafy branches preserved in AWG solution (70% alcohol + 28% distilled water + 2% glycerol) for

study. Leaf material of 30 taxa of *Fagraea* collected from various locations were preserved in silica gel for subsequent DNA extraction (Table 2).

DNA extraction, gene regions and primers. Total DNA extraction from silica-dried or fresh leaf tissue samples followed the CTAB (cetyltrimethylammonium bromide) method of Doyle & Doyle (1987), or made use of *DNeasy* plant kits (Qiagen) following the manufacturer's protocol (Qiagen 2003–2009). Gene regions chosen for the phylogenetic analyses were: ITS (Internal Transcribed Spacer) (nuclear) and the *trnL* intron, *trnL*–F spacer and *ndhF* region (chloroplast). These regions have been widely used to study phylogenetic relationships at the family level and lower (Chassot et al. 2001; Davis et al. 2001; Gielly & Taberlet 1996; Ranker et al. 2003; Struwe et al. 2002; Thiv et al. 1999; Hagen & Kadereit 2001; Yuan & Küpfer 1995, 1997; Yuan et al. 1996, 2003). The whole ITS region (ITS1, 5.8S rDNA & ITS2) was amplified with universal primers: ITS 1 (forward) and ITS 4 (reverse), following White et al. (1990). For the *trnL* intron and *trnL*–F regions, universal primer sets (C & D and E & F, respectively) given by Taberlet et al. (1991) were used. Two new primer sets for the *ndhF* gene sequences were constructed at conserved regions following alignment of *ndhF* sequences for three taxa obtained from the GenBank: *Fagraea* sp. (AJ 235830), *Anthocleista grandiflora* (AJ 235829) and *Potalia resinifera* (AJ 235831). Each of these two sets of primers (GB1 Fwd & GB1 Rev and GB2 Fwd & GB2 Rev) was estimated to amplify about 900–1000 bp of the *ndhF* gene. Sequences of all primers used in this study are listed in Appendix A.

Polymerase Chain Reaction (PCR). PCR for all the regions were performed in a Whatman Biometra T Gradient or Perkin Elmer GeneAmp PCR System 9600 thermocycler. A total reaction mix of 50 μ l was used, containing 25 μ l of PCR master mix (2x Go Taq[®] Green Master Mix), 2 μ l (50 mM) each of forward and reverse primer, 1–3 μ l of DNA template and RNase free water topped up to a final volume of 50 μ l. Parameters for PCR amplification were: 1 cycle of 3 min at 94 °C, linked to 30 cycles of 10 s at 94°C, 20 s at 55°C, 90 s at 72°C, followed by 4 min at 72°C to complete primer extension. PCR-amplified samples were electrophoresed on agarose gel and samples that had a clear single desired band were selected for sequencing. Purification of PCR products used the QIAquick PCR purification kit (Qiagen) following the manufacturer's protocol. When multiple bands of different sizes were observed in some cases, a gradient PCR (with different annealing temperatures) was carried out to find the optimal temperature that amplified a single desired band. The sample with such band was then selected for purification and sequencing. Occasionally, samples still produced multiple bands after PCR despite optimising the annealing temperature. For these, the PCR product was electrophoresed on agarose gel (1.2–1.5 %) for about 60 to 90 min. The target band was then excised and purified using a Qiaquick Gel extraction Kit (Qiagen) following the manufacture's protocol. This product was then sequenced.

Table 2. Voucher specimens and GenBank accession numbers of sequences for *Fagraea* s.l. taxa representing the different “sections” collected for the present study.

Fagraea sp. A, *F.* sp. B and *F.* sp. C are new Malay Peninsula taxa diagnosed in the present study, whereas two other unidentified Bornean taxa were labeled as *F.* sp 1 and *F.* sp 2. *Fagraea elliptica* is represented by two accessions from Peninsular Malaysia and Borneo. Sections: C (*Cyrtophyllum*), F (*Fagraea*), R (*Racemosae*). Vouchers with ‘SAN’ numbers were deposited in the Forest Research Centre Sandakan, Sabah (SAN); all other vouchers were deposited in the University of Malaya herbarium (KLU). The two partial non-overlapping *ndhF* sequences are represented with two GenBank accession numbers.

Taxon	Section	Voucher specimen	GenBank accessions for (ITS) – (<i>trnL-F</i>) – (<i>ndhF</i> : 2 partial sequences)
<i>F. belukar</i>	C	Postar & Ahmad SAN 147987	JX283355–JX217749–JX283385 & JX283414
<i>F. caudata</i>	C	Low LYW 213	JX283356–JX217750–JX283386 & JX283415
<i>F. collina</i>	C	Low LYW 260	JX283357–JX217751–JX283387 & JX283416
<i>F. elliptica</i> 1	C	Low LYW 358	JX283358–JX217752–JX283388 & JX283417
<i>F. elliptica</i> 2	C	Postar et al. SAN 147993	JX283359–JX217753–JX283389 & JX283418
<i>F. fragrans</i>	C	Sugumaran SM 212	JX283360–JX217754–JX283390 & JX283419
<i>F. gigantea</i>	C	Sugumaran SM 193	JX283361–JX217755–JX283391 & JX283420
<i>F. wallichiana</i>	C	Low LYW 206	JX283362–JX217756–JX283392 & JX283421
<i>F. auriculata</i>	F	Sugumaran SM 240	JX283363–JX217757–JX283393 & JX283422
<i>F. carnosa</i>	F	Lee DLKP 30	JX283364–JX217758–JX283394 & JX283423
<i>F. crassifolia</i>	F	Low LYW 244	JX283365–JX217759–JX283395 & JX283424
<i>F. crenulata</i>	F	Sugumaran SM 246	JX283366–JX217760–JX283396 & JX283425
<i>F. curtisii</i>	F	Low LYW243	JX283367–JX217761–JX283397 & JX283426
<i>F. gardenioides</i>	F	Sugumaran SM 170	JX283368–JX217762–JX283398 & JX283427
<i>F. imperialis</i>	F	Sugumaran SM 238	JX283369–JX217763–JX283399 & JX283428
<i>F. oblonga</i>	F	Sugumaran SM 165	JX283370–JX217764–JX283400 & JX283429
<i>F. renae</i>	F	Sugumaran SM 177	JX283371–JX217765–JX283401 & JX283430
<i>F. resinosa</i>	F	Postar et al. SAN 147998	JX283372–JX217766–JX283402 & JX283431
<i>F. ridleyi</i>	F	Low LYW 227	JX283373–JX217767–JX283403 & JX283432
<i>F. splendens</i>	F	Zahid ZMS 42	JX283374–JX217768–JX283404 & JX283433
<i>F. stonei</i>	F	Wong et al. SAN 147989	JX283375–JX217769–JX283405 & JX283434
<i>F.</i> sp. A	F	Low LYW 138	JX283376–JX217770–JX283406 & JX283435
<i>F.</i> sp. B	F	Sugumaran SM164	JX283377–JX217771–JX283407 & JX283436
<i>F.</i> sp. 1	F	Postar et al. SAN 149702	JX283378–JX217772–JX283408 & JX283437
<i>F. cuspidata</i>	R	Seligi & Lingkong SAN 145303	JX283379–JX217773–JX283409 & JX283438
<i>F. racemosa</i>	R	Sugumaran SM 248	JX283380–JX217774–JX283410 & JX283439
<i>F. spicata</i>	R	Postar & Ahmad SAN 147985	JX283381–JX217775–JX283411 & JX283440
<i>F. volubilis</i>	R	Sugumaran SM 206	JX283382
<i>F.</i> sp. C	R	Sugumaran SM 201	JX283383–JX217777–JX283412 & JX283441
<i>F.</i> sp. 2	R	Postar SAN 149705	JX283384–JX217778–JX283413 & JX283442

Sequencing PCR products and data authentication. PCR products were sequenced on an Applied Biosystems 3730xl DNA Analyser with BigDye[®] Terminator ver. 3.1 Sequencing Kit with: 25 cycles of 96°C for 10 s, 50°C for 5 s and 60°C for 4 min, at rapid thermal ramp for 1°C/s. Sequencing in both directions used the same primers as for PCR. All sequence data were manually checked by eye with the corresponding electrophoregrams. Ambiguous base pairs (those with multiple peaks) were cross-checked with the complementary sequence data (i.e., forward sequence was cross-checked with reverse sequence and vice versa). This could be done because forward and reverse strands that were sequenced had an approximate overlap of about 80%. Samples that had very noisy sequence data were not used in the analyses.

Sequence alignment. Sequence data were initially aligned using ClustalX 2.0.10 (Larkin et al. 2007). Aligned sequences were then manually adjusted using the software Bioedit (Hall 1999). The boundaries of the ITS, *trnL* intron, *trnL*-F spacer and *ndhF* were determined by comparison with the published outgroup sequence, *Anthocleista grandiflora*, that was also used in the analyses (Table 3). The *trnL* intron and *trnL*-F spacer sequences were aligned and combined into a single data matrix (hereafter referred to as the “*trnL*-F data set”). Numerous single and multibase insertions or deletions (indels) were introduced for the ITS and *trnL*-F data sets but no indels were needed for aligning the *ndhF* data set. The aligned data was then saved in a Nexus file format and phylogenetic analyses were performed using PAUP* version 4.0b4a for Macintosh (Swofford 2001) and MrBayes v.3.1 (Huelsenbeck & Ronquist 2001).

Phylogenetic assessments: scope and experimental design. Two phylogenetic assessments were conducted. The first assessment included analyses with individual data sets (ITS, *trnL*-F or *ndhF*) and a combined data set (ITS + *trnL*-F + *ndhF*). This assessment aims to evaluate if (a) reasonable support can be found for any monophyletic groups forming within the ingroup; (b) if such clades correspond to the sections of *Fagraea* s.l. circumscribed by existing classification; and (c) if these clades are consistent (or congruent) among the topologies representing the different gene regions. The combined data analysis was performed to evaluate whether clades were better resolved in comparison with single-gene analyses. This assessment was performed with 29 taxa of *Fagraea* s.l. (8 from section *Cyrtophyllum*, 16 from section *Fagraea* and 5 from section *Racemosae*) and one taxon as outgroup (*A. grandiflora*). The 29 DNA sequences of *Fagraea* s.l. from all four gene regions included in these analyses are new (details in Table 2). The sequences for *A. grandiflora* were obtained from GenBank (Table 3).

The second assessment was done with only the ITS data set where sampling was expanded to 45 taxa. This assessment was done to evaluate whether clades formed among so-called *Fagraea* species within the ingroup can be reasonably circumscribed as distinct genera. The selected ingroup taxa are all from Potalieae and include the well recognised genera *Anthocleista* and *Potalia* (in the same subtribe, Potaliinae, as *Fagraea*) as well as *Lisianthus* (subtribe Lisianthiinae) (Weaver 1972; Sytsma 1988). The two outgroup taxa belong to two other distantly related tribes within the

Table 3. List of species for which GenBank accessions were included for this study, including tribal and subtribal classification in Gentianaceae (Struwe et al. 2002) and voucher information. Herbarium acronyms: *E* – Royal Botanic Garden Edinburgh, Edinburgh, Scotland, UK; *HNWP* – Northwest Plateau Institute of Biology, Xining, Qinghai, China; *F* – Field Museum of Natural History, Chicago, Illinois, USA; *NEU* – Université de Neuchâtel, Neuchâtel, Switzerland; *NY* – New York Botanic Garden, Bronx, New York, USA; *UPS* – Uppsala University, Uppsala, Sweden; *US* – Smithsonian Institution, Washington, District of Columbia, USA.

Taxa	Current tribe–subtribe	Voucher (<i>Herbarium</i>)	GenBank accession (and gene region)
<i>Anthocleista amplexicaulis</i>	Potalia–Potaliinae	Woulhauser PBZT (<i>NEU</i>)	AJ489863 (ITS)
<i>Anthocleista grandiflora</i>	Potalia–Potaliinae	Callmander s.n. (<i>NEU</i>)	AJ489864 (ITS)
		Callmander s.n. (<i>NEU</i>)	AJ490190 (<i>trnL</i> (UAA) intron)
		Callmander s.n. (<i>NEU</i>)	AY251777 (<i>trnL</i> -F spacer)
		Bremer 3098 (<i>UPS</i>)	AJ235829 (<i>ndhF</i>)
<i>Exacum affine</i>	Exaceae	Miller et al. 6201 (<i>E</i>)	AJ489879 (ITS)
<i>Fagraea berteroa</i>	Potalia–Potaliinae	L. Struwe 1219 (<i>NY</i>)	DQ449918 (ITS)
<i>F. ceilanica</i>	Potalia–Potaliinae	L. Struwe 1300 (<i>NY</i>)	FJ23257 (ITS)
<i>F. elliptica</i>	Potalia–Potaliinae	Takeuchi 7122 (<i>NY</i>)	FJ232579 (ITS)
<i>F. macroscypha</i>	Potalia–Potaliinae	Beaman et al. 8867 (<i>US</i>)	FJ232573 (ITS)
<i>F. salticola</i>	Potalia–Potaliinae	Pullen 326 (<i>US</i>)	FJ232571 (ITS)
<i>Gentiana algida</i>	Gentianeae–Gentianinae	Liu 1257 (<i>HNWP</i>)	DQ398659 (ITS)
<i>Lisianthus brevidentatus</i>	Potalia–Lisianthiinae	Ortiz 1664 (<i>F</i>)	FJ32569 (ITS)
<i>Lisianthus cuspidatus</i>	Potalia–Lisianthiinae	Lewis 895 (<i>F</i>)	FJ32567 (ITS)
<i>Lisianthus laxiflorus</i>	Potalia–Lisianthiinae	Struwe & Specht 1153 (<i>NY</i>)	FJ232552 (ITS)
<i>Potalia amara</i>	Potalia–Potaliinae	S. Mori 24123 (<i>NY</i>)	DQ449919 (ITS)
<i>Potalia elegans</i>	Potalia–Potaliinae	P. Berry 7434 (<i>NY</i>)	DQ449920 (ITS)
<i>Potalia resinifera</i>	Potalia–Potaliinae	B. Stahl 1872 (<i>NY</i>)	DQ449921 (ITS)

Gentianaceae, namely, Exaceae (*Exacum affine*) and Gentianeae (*Gentiana algida*) (Struwe et al. 2002). The ITS region was chosen because it was relatively more informative than the other two data sets; moreover, many more ITS sequences were available in GenBank compared to *trnL*-F (intron + spacer) and *ndhF* sequences. The ingroup included 35 *Fagraea* taxa, two *Anthocleista* taxa, three *Lisianthus* taxa and three *Potalia* taxa. Of the *Fagraea* sequences used in this assessment, 30 are new

sequences, including *F. volubilis* (which was excluded from the first assessment as sequencing results for the *ndhF* region was very poor) (Table 2). All other sequences, including five sequences of *Fagraea* and the outgroup sequences, were obtained from GenBank (Table 3).

Parsimony analyses in PAUP* were performed with heuristic searches where all characters were unordered and unweighted ('Fitch parsimony'; Fitch 1971). All gaps in the sequence were treated as missing data. Starting trees were obtained using simple stepwise addition sequences, with one tree held at each step with tree bisection–reconnection (TBR) branch swapping algorithm, MULTREES option in effect, accelerated transformation (ACCTRAN), branches with zero length collapsed and topological constraints not enforced. Separate and combined analyses of the three data sets (ITS, *trnL–F* and *ndhF*) were performed and strict consensus trees were generated. The bootstrap method (Felsenstein 1985) was used to estimate robustness of the various clades revealed in the consensus tree. Bootstrap values were estimated from 1000 replicates of full-heuristic searches using simple addition sequence and TBR branch swapping with a set 'MAXTREES' limit of 10000 trees per bootstrap replicate. Branches less than 50% value were collapsed. The consistency index (CI) (Kluge & Farris 1969), the retention index (RI) and rescaled consistency index (RC) (Farris 1989) were also calculated using PAUP* as measures of character fit to the phylogenetic trees.

For Bayesian inference analyses, an appropriate evolutionary model was selected using MrModeltest 2.2 (Nylander 2004) together with PAUP* (Swofford 2001). The programme (MrModeltest 2.2) specifically tests the 24 models available common to PAUP* and MrBayes (Huelsenbeck & Ronquist 2001) with a given data set. The Akaike Information Criterion tests selected the General Time Reversible model with gamma distribution of rates for all individual data sets (ITS, *trnL–F*, *ndhF* and ITS-expanded). Two independent runs of 1.5 million generations were performed each with four MCMC (Markov Chain Monte Carlo) chains. One tree was sampled every 500 generations and the first 750 trees (burn-in=750) were excluded from the analyses which amounts to 25% of trees sampled. A 95% credible set of trees was generated by including all trees with the highest posterior probabilities until the cumulative posterior probabilities (PP) was 95% (Huelsenbeck et al. 2001). A 50% majority rule consensus of these generated trees was used to estimate the PP of each clade. PP values above $p=0.95$ were considered to be statistically significant (Huelsenbeck & Ronquist 2001; Larget & Simon 1999; Lewis 2001; Rannala & Yang 1996; Kauff & Lutzoni 2002).

The incongruence length difference test (ILD; Farris et al. 1994, 1995) as the partition homogeneity test (PHT) implemented in PAUP* was employed to test the null hypothesis that the three data sets (ITS, *trnL–F* and *ndhF*) were homogeneous with respect to phylogenetic information. PHT was performed with 100 replicates of heuristic searches, Maxtree=1000 and TBR branch swapping. It has been suggested that PHT p values more than 0.01 indicate that the data sets are congruent and if combined will either improve or will not affect the accuracy of the phylogenetic information (Cunningham et al. 1998).

Results

Sequence variation

The aligned data matrix of the ITS data set with 30 taxa had 639 characters. Out of these, 89 characters were variable but parsimoniously uninformative whereas 64 characters (10% of total characters) were phylogenetically informative. The unaligned length of ITS sequences among the 30 taxa of *Fagraea* (Table 2) used in this study varied from 622 to 631 bp. These data resulted in uncorrected pairwise sequence divergences ranging from 0 (*F. sp. 1* vs. *F. gardenioides*, *F. curtisii* vs. *F. crassifolia*) to 13.9% (*F. oblonga* vs. *F. sp. 2*).

The individual *trnL*-F sequences (*trnL* intron + *trnL*-F spacer) in *Fagraea* used in this study ranged from 652 to 836 bp. The length varied mainly at several A-T rich regions where alignment could not be readily done due to repeated motifs. These highly variable regions which accounted for 156 bp were excluded from the analyses. The final aligned *trnL*-F data matrix had a total of 811 characters where 60 characters were variable and parsimoniously uninformative, and 49 characters (6% of total characters) were phylogenetically informative. These data resulted in uncorrected pairwise sequence divergences ranging from 0 (*F. auriculata* vs. *F. imperialis*, *F. gigantea* vs. *F. caudata*, *F. wallichiana* vs. *F. caudata*, *F. wallichiana* vs. *F. gigantea*, *F. spicata* vs. *F. cuspidata*, *F. sp. C* vs. *F. cuspidata* and *F. spicata* vs. *F. sp. C*) to 3.5% (*F. stonei* vs. *F. fragrans*).

The two new primer pairs that were used to amplify two partial sequence regions of *ndhF* produced 1832 bp in total. The primer pair "GB1" produced 899 bp whereas the "GB2" pair produced 933 bp. Based on the *ndhF* sequence of *A. grandiflora* (GenBank Acc. AJ235829), the 899 bp sequence data corresponds with positions 161 to 1059 whereas the 933 bp sequence data corresponds with positions 1182 to 2114. The *ndhF* sequences were easily aligned and the total 1832 characters had 114 characters that were variable and parsimoniously uninformative whereas 81 characters (4.4% of total characters) were informative. These data resulted in uncorrected pairwise sequence divergences ranging from 0 (*F. racemosa* vs. *F. sp. C*, *F. cuspidata* vs. *F. sp. C*, *F. sp. 2* vs. *F. sp. C*, *F. splendens* and *F. sp. B* and *F. imperialis* vs. *F. auriculata*) to 2% (*F. resinosa* vs. *F. sp. C*, *F. resinosa* vs. *F. racemosa*, *F. resinosa* vs. *F. spicata*, *F. resinosa* vs. *F. sp. 2*).

The combined data set of ITS, *trnL*-F and *ndhF* resulted in 3282 characters. The data matrix had 263 variable and parsimoniously uninformative characters whereas 194 characters (5.9% of total characters) were informative.

The aligned matrix of the expanded ITS data set (45 taxa) had 697 characters where 131 characters were variable and parsimoniously uninformative, and 185 characters (26.5% of total characters) were phylogenetically informative. These data resulted in uncorrected pairwise sequence divergences ranging from 0 (*F. ridleyi* vs. *F. gardenioides*, *F. sp. 1* vs. *F. gardenioides*, *F. sp. 1* vs. *F. ridleyi*, *F. curtisii* vs. *F. crassifolia* and *F. macroscypha* vs. *F. auriculata*) to 14% (*F. sp. 2* vs. *F. imperialis*).

Phylogenetic analyses

Data set characteristics are presented in Table 4. In all the analyses, parsimony and Bayesian tree topologies were generally congruent and bootstrap (BS)-supported nodes mostly also had high support of posterior probabilities (PP). The trees presented were obtained from maximum parsimony analyses and congruent branch support values obtained from the Bayesian analyses (PP) are stated.

Analyses of the ITS data set

Parsimony analyses of the 30-taxon ITS data set resulted in 3520 trees with a tree length of 211 (strict consensus shown in Fig. 1), CI (Consistency Index) of 0.8152 and RI (Retention Index) of 0.8691. Four monophyletic groups can be recognised, referred to as the *Fagraea*, *Racemosa*, *Gigantea* and *Elliptica* clades. In these analyses, all included taxa representing *Fagraea* section *Fagraea* were represented on the *Fagraea* clade except *F. crenulata*, which is placed in a tetrachotomy with three other clades. Within the *Fagraea* clade, two monophyletic sister groups are formed where one group is smaller, consisting of three taxa, and the rest form a bigger group with 12 taxa. The 3-taxon group is well-supported (BS = 100%; PP = 1.00) with *F. resinosa* sister to the branch with *F. auriculata* and *F. imperialis*. Within the 12-taxon group, there are two smaller well-supported subgroups (*F. crassifolia* and *F. curtisii*; *F. splendens* and *F. sp. B*) as well as other species whose relationships are unresolved.

Species included in the study representing section *Racemosae* (*Racemosa* clade) form a strongly supported monophyletic group (BS = 100%; PP = 1.00). Within the *Racemosa* clade, *F. sp. 2* is sister to an equivocal clade of only moderate support (BS = 69%) with four unresolved taxa. Section *Cyrtophyllum* is paraphyletic with the eight representative taxa split into two distinct monophyletic groups. The groups comprising four taxa each are referred to as the *Elliptica* and *Gigantea* clades. The *Elliptica* clade is sister to the rest of *Fagraea* s.l. and well-supported with BS (91%) and moderately supported with PP (0.82) values. Within the *Elliptica* clade, *F. belukar* is sister to a clade with moderate BS (65%) but strong PP (0.99) support containing the three other taxa. The *Gigantea* clade is well supported (BS = 81%; PP = 1.00) and also well resolved where *F. fragrans* is the most basal taxon. The branches within this clade received moderate BS and good PP support.

Analyses of the *trnL-F* data set

The resulting 7224 most parsimonious trees with the *trnL-F* data set were 135 steps long (strict consensus shown in Fig. 2) with a CI of 0.8519 and RI of 0.9206. The clades formed are similar to those observed for the ITS tree; however, the interspecific relationships within each clade were less resolved with the *trnL-F* data set. Again, as in the ITS tree, *F. crenulata* was outside of the *Fagraea* clade. *Fagraea crenulata* is basal to both the *Elliptica* and *Fagraea* clades together and the relationship is well supported (BS = 82%; PP = 1.00). The rest of the species representing *F.* section *Fagraea* (the *Fagraea* clade) form a strongly supported clade (BS = 99%; PP = 1.00). Within the *Fagraea* clade, *F. sp. A* and *F. gardenioides* were unresolved, *F. crassifolia* and *F. curtisii* form a strongly supported group (BS = 100%; PP = 1.00) and the rest also form

Table 4. Characteristics of the parsimony-based analyses with individual and combined data sets.

Characteristics	ITS	<i>trnL</i> - <i>F</i> (<i>trnL</i> intron + <i>trnL</i> - <i>F</i> spacer)	<i>ndhF</i> (2 combined partial regions)	ITS + <i>trnL</i> - <i>F</i> + <i>ndhF</i>	ITS (expanded data set)
Number of taxa	30	30	30	30	45
Total characters	639	811	1832	3282	697
Constant characters	486	702	1637	2825	381
Parsimony informative characters	64	49	81	194	185
Variable characters	89	60	114	263	131
Most parsimonious trees	3520	7224	1	4	2145
Tree length	211	135	242	591	582
Consistency Index, CI (values excluding uninformative sites in parentheses)	0.82 (0.66)	0.85 (0.73)	0.83 (0.68)	0.83 (0.68)	0.73 (0.65)
Retention Index, RI	0.87	0.92	0.91	0.90	0.81
Rescaled Consistency Index, RC	0.71	0.78	0.76	0.74	0.59

a well-supported group (BS = 84%; PP = 1.00). In this latter group, *F. ridleyi* is placed in a trichotomy with two well-supported subclades. These subclades have three and seven taxa, respectively. The 3-taxon subclade comprising of *F. resinosa*, *F. imperialis* and *F. auriculata* were well resolved where *F. resinosa* was sister to the other two. In the 7-taxon subclade, *F. sp. B* and *F. splendens* formed a strongly supported group while the rest were unresolved.

Section *Cyrtophyllum* is paraphyletic, with four out of eight species represented forming the Elliptica clade and three other species forming the Gigantea clade. The Elliptica clade was basal to the *Fagraea* clade and the relationship was only moderately supported with BS (60%) but well supported with PP (0.99) values. The Elliptica clade itself was only weakly supported with 51% BS and a moderate PP support (0.93). The relationship within the Elliptica clade was unresolved.

The Gigantea and Racemosa clades plus *F. fragrans* formed a well-supported group (BS = 97%; PP = 1.00). The Gigantea clade received strong branch support (BS = 97%; PP = 1.00) but was internally unresolved. The remaining taxon, *F. fragrans*, was placed in a trichotomy with the Racemosa and Gigantea clades. The Racemosa clade included all the five representative taxa of section *Racemosae* and was monophyletic with moderate BS (67%) and good PP (0.96) support. The *F. cuspidata* and *F. spicata* subgroup within the Racemosa clade received moderate BS (66%) and good PP (0.99) support; the other three taxa were not resolved.

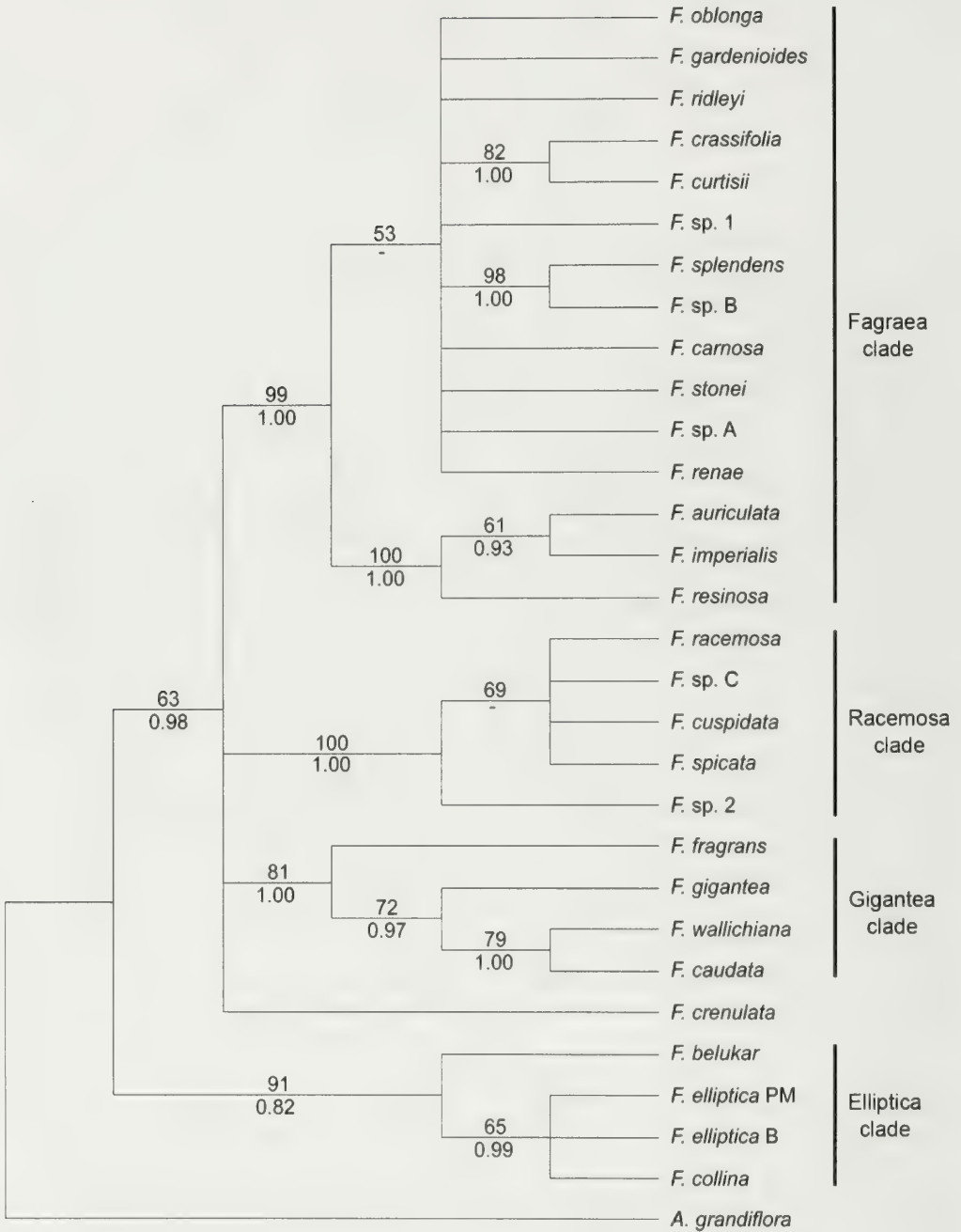


Fig. 1. Strict consensus of 3520 equally parsimonious trees based on the ITS sequence data. The numbers above and below the branches denote Bootstrap and Bayesian Posterior Probability values, respectively. Length (L) = 211; consistency index (CI) = 0.8152; retention index (RI) = 0.8691. *A.* = *Anthocleista*; *F.* = *Fagraea*. Different accessions of *F. elliptica* are indicated (PM = Peninsular Malaysia, B = Borneo).

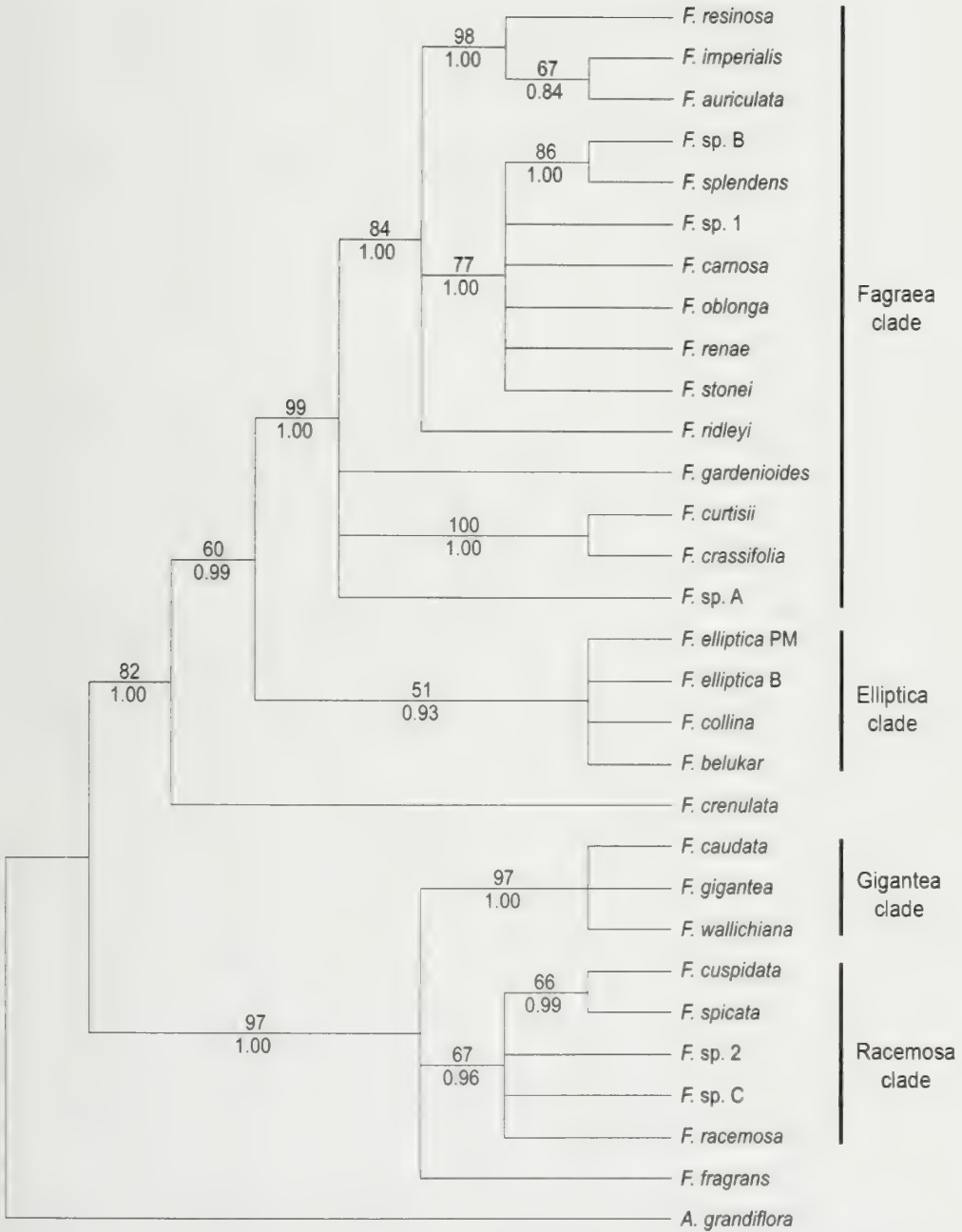


Fig. 2. Strict consensus of 7224 equally parsimonious trees based on the *trnL-F* sequence data. The numbers above and below the branches denote Bootstrap and Bayesian Posterior Probability values, respectively. Length (L) = 135; consistency index (CI) = 0.8519; retention index (RI) = 0.9206. *A.* = *Anthocleista*; *F.* = *Fagraea*. Different accessions of *F. elliptica* are indicated (PM = Peninsular Malaysia, B = Borneo).

Analyses of the *ndhF* data set

Parsimony analysis of the *ndhF* data set produced a single most parsimonious tree with tree length of 242 (Fig. 3), a CI of 0.8347 and RI of 0.9109. The four major clades common to the previous two analyses were also observed here and all had good BS and PP support. The *F.* section *Fagraea* (*Fagraea* clade + *F. crenulata*), was a well-supported monophyletic group, with *F. crenulata* basal within the clade. There were two well-supported sister groups, with four and eleven taxa, respectively. The 4-taxon group was well resolved with good branch support where *F. gardenioides* was basal. The 11-taxon group has two well supported subgroups: *F. sp. B* plus *F. splendens*; and a subgroup with *F. resinosa*, *F. imperialis* and *F. auriculata*. These groups were also observed in the analyses with the ITS and *trnL-F* data sets. The relationships among the other taxa in this clade were unresolved.

Section *Cyrtophyllum* was paraphyletic where four out of eight taxa formed the Elliptica clade, while a further three taxa grouped to form the Gigantea clade. The Elliptica clade was sister to the *Fagraea* clade, both forming a group with good branch support (BS = 75%; PP 0.99). The Elliptica clade itself was well supported (BS = 97%; PP = 1.00) and the interspecies relationships within the clade were well resolved with moderate branch support.

The Gigantea clade was well supported and was sister to the Racemosa clade. However, the interspecies relationships within the Gigantea clade were not resolved. The Racemosa clade was monophyletic and received good branch support (BS = 100%; PP = 1.00). Within the Racemosa clade, *F. sp. C*, *F. racemosa* and *F. sp. 2* formed a group with moderate BS (66%) but good PP (0.98) support. The remaining two species were unresolved. *Fagraea fragrans* resolved as a basal taxon for the Gigantea + Racemosa clades.

Analyses of the combined ITS, *trnL-F* and *ndhF* data sets

The result of the ILD test was not significant ($p=0.03$), indicating that the null hypothesis of data set homogeneity could not be rejected. The three data sets were thus combined into a single matrix and parsimony and Bayesian analyses were performed. Parsimony searches on the combined data set produced four trees having a tree length of 591 (strict consensus shown in Fig. 4) with a CI of 0.8274 and RI of 0.8979. The combined data set tree was most congruent to the tree resulting from the *ndhF* data set. *Fagraea* section *Fagraea* (*Fagraea* clade + *F. crenulata*) was monophyletic and strongly supported (BS = 96%; PP = 1.00) with *F. crenulata* as the basal taxon for the clade. *Fagraea crenulata* is then sister to two well-supported groups, one smaller comprising of four taxa and another bigger with eleven taxa. These groups were also observed in the *ndhF* tree but the internal resolutions were slightly better in this tree. The 4-taxon group was well resolved and received good branch support. The 11-taxon group was divided into two subclades with one unresolved taxon (*F. ridleyi*). The *F. resinosa*, *F. imperialis* and *F. auriculata* clade was well resolved with good branch support. *Fagraea resinosa* was sister to the latter two and this clade was also observed in all the individual data set analyses. The interspecies relationships among the taxa in the remaining group were not resolved except for two taxa, *F. splendens* and *F. sp. B*.

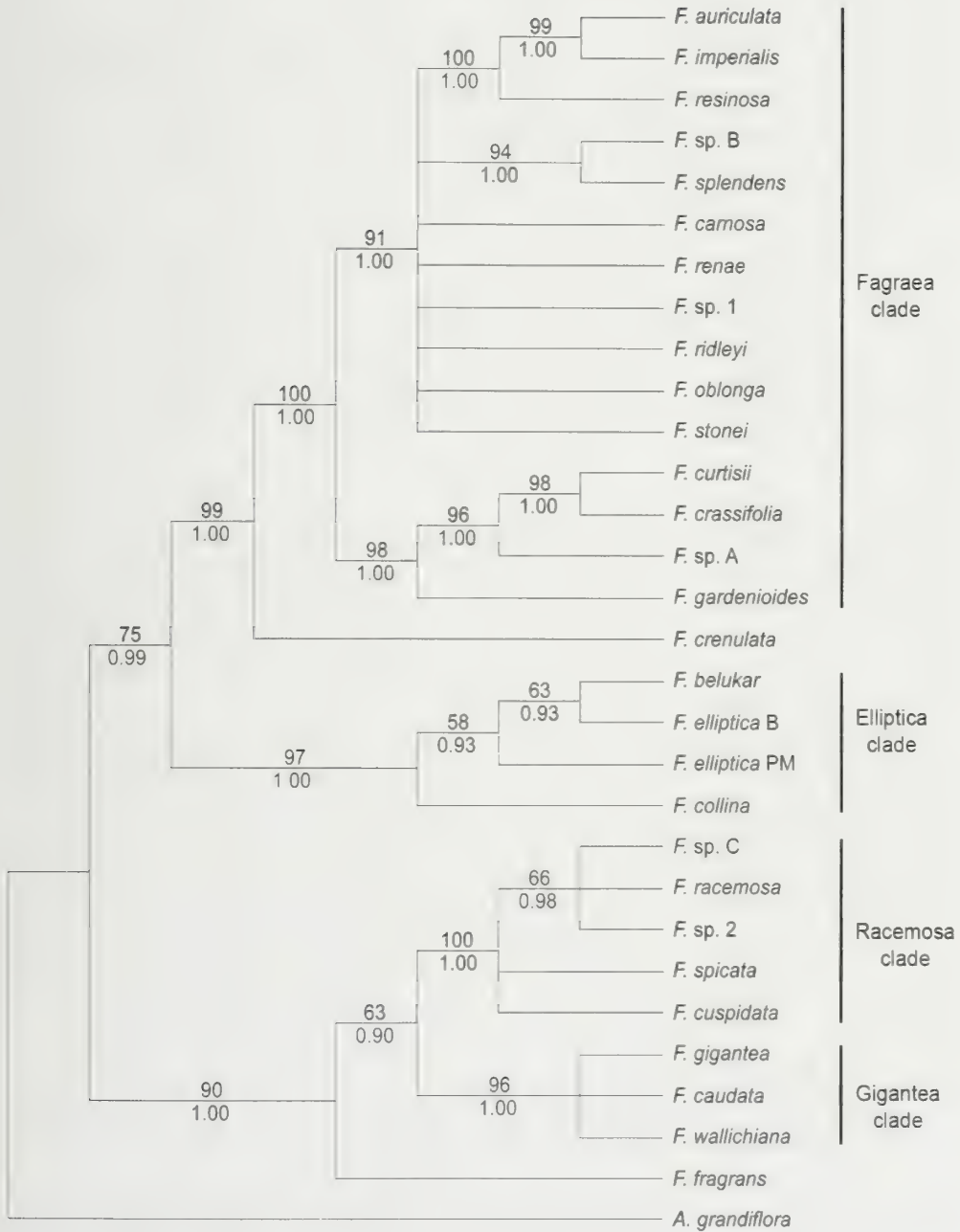


Fig. 3. Single most parsimonious tree based on the *ndhF* sequence data. The numbers above and below the branches denote Bootstrap and Bayesian Posterior Probability values, respectively. Length (L) = 242; consistency index (CI) = 0.8347; retention index (RI) = 0.9109. *A.* = *Anthocleista*; *F.* = *Fagraea*. Different accessions of *F. elliptica* are indicated (PM = Peninsular Malaysia, B = Borneo).

that formed a well-supported subclade. This subclade was also found in the all the individual data set analyses.

The section *Cyrtophyllum* was paraphyletic and resolved into two distinct clades (Elliptica and Gigantea) as also observed in all individual data set analyses. The Elliptica clade was sister to the Fagraea clade with good support (BS = 82%; PP = 0.95). The Elliptica clade was itself strongly supported (BS = 100%; PP = 1.00), wherein *F. collina* was sister to a clade with weak support (BS = 59%; PP = 0.69) that contained the remaining three taxa.

The Gigantea and Racemosa clades were sisters to each other with good branch support (BS = 99%; PP = 1.00). The Gigantea clade was internally well resolved, with *F. fragrans* basal to the remaining three taxa. This relationship received moderate BS support (65%) but good PP support (0.96). The Racemosa clade was well supported (BS = 100%; PP = 1.00), with *F. sp 2* sister to a weakly formed clade (BS = 58%). Within this clade, *F. cuspidata* and *F. spicata* formed a moderately supported subclade (BS = 64%; PP = 0.94).

Analyses of the expanded ITS data set

Parsimony analyses of the expanded ITS data set produced a total of 2145 most parsimonious trees having tree length of 582 with a CI of 0.7337 and RI of 0.8089 (strict consensus shown in Fig. 5). As seen in the individual and combined data set results, *Fagraea* s.l. was divided into four major clades. *Fagraea crenulata* was placed in a tetrachotomy with the Fagraea, Racemosa and Gigantea clades. A similar pattern was also seen in the 30-taxon ITS tree (Fig. 1).

Within the Fagraea clade, *F. berteriana* and *F. salticola* form a well-supported subclade (BS = 92%; PP = 0.99). These two taxa are sister to a subclade with two other monophyletic groups, where one is larger with 13 taxa and the other is a smaller 4-taxon clade. The 13-taxon clade is moderately supported with BS = 67% but well supported in the Bayesian analyses (PP = 0.98). Within this 13-taxon clade there are two smaller subclades (*F. splendens* and *F. sp. B*; *F. crassifolia* and *F. curtisii*) with good BS and PP support, as well as several other species whose relationships are unresolved. The 4-taxon clade is well supported with both BS and PP values. Within this clade, *F. resinosa* is sister to a moderately supported (BS = 62%; PP = 0.91) subclade.

The Racemosa clade which represents all the taxa selected from section *Racemosae*, is monophyletic and received good support (BS = 100%; PP = 1.00). Within this clade, *F. sp 2* was sister to the rest of the taxa in a weakly formed clade (BS = 71%).

As with all other individual data set analyses, section *Cyrtophyllum* is paraphyletic and was split into two distinct monophyletic groups, viz., the Elliptica and Gigantea clades. The Gigantea clade was moderately supported with BS = 78% but well-supported in the Bayesian analyses (PP = 1.00). The clade was internally well resolved with moderate BS and strong PP support. The widespread *F. fragrans* was placed as the basal taxon in the Gigantea clade.

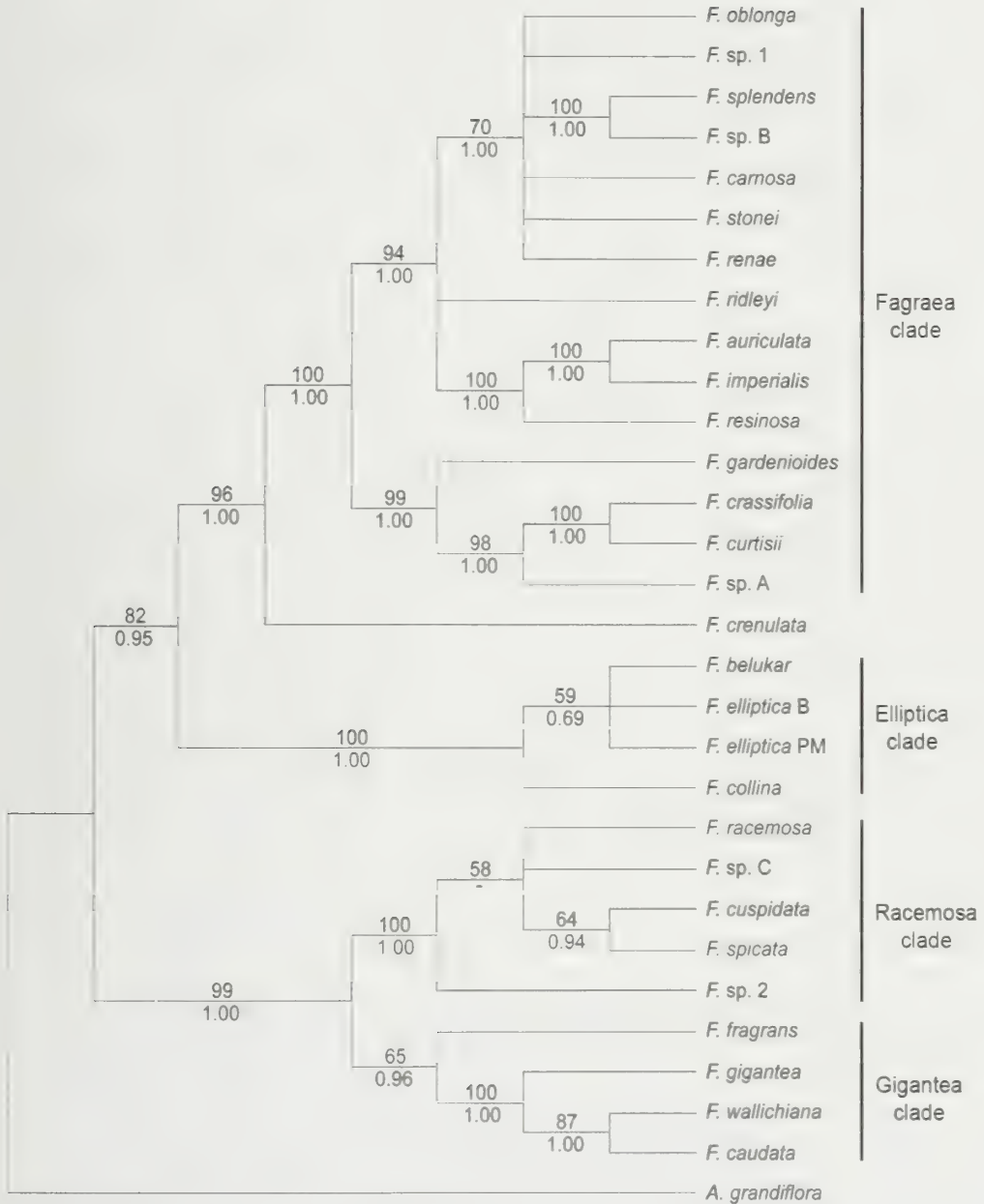


Fig. 4. Strict consensus of four equally parsimonious trees based on the combined ITS, *trnL-F* and *ndhF* sequence data. The numbers above and below the branches denote Bootstrap and Bayesian Posterior Probability values, respectively. Length (L) = 591; consistency index (CI) = 0.8274; retention index (RI) = 0.8979. *A.* = *Anthocleista*; *F.* = *Fagraea*. Different accessions of *F. elliptica* are indicated (PM = Peninsular Malaysia, B = Borneo).

The position of the Elliptica clade, sister to the rest of *Fagraea* s.l., was well supported (BS = 98%; PP = 0.99). The Elliptica clade itself received moderate branch support (BS = 77%; PP = 0.81) and within this clade, *F. belukar* was sister to the rest. The three accessions of *F. elliptica* from Peninsular Malaysia, Borneo and New Guinea along with *F. collina* were clustered together, receiving moderate supported with BS (72%) but good support with PP (0.99).

The other three genera represented in the ingroup, *Anthocleista*, *Potalia* and *Lisianthus*, were each monophyletic. *Anthocleista* and *Potalia* both formed a group sister to *Fagraea* s.l. with good support (BS = 97%; PP = 1.00), whereas *Lisianthus* was sister to *Anthocleista*, *Potalia* and *Fagraea* s.l. in turn, also with good support (BS = 90%; PP = 0.96).

Implications of the molecular phylogenetic analyses

Clade correspondence to named taxonomic sections

Regardless of which gene regions were employed in the study, including the individual and combined data set analyses, as well as the different methods used (MP and Bayesian), the results show *Fagraea* s.l. segregating into four reasonably well-supported monophyletic groups. Among these, the *Fagraea* clade and the *Racemosa* clade closely correspond to the sectional classification, i.e., *Fagraea* section *Fagraea* and *F.* section *Racemosae*, respectively.

The position of the bizarre *F. crenulata* is interesting. It was unresolved in a polytomy in both the ITS and the ITS-expanded data sets. It also failed to resolve with the *Fagraea* clade in the analyses of the *trnL*-F data set. Only the analyses with the *ndhF* and the combined data set supported the placement of *F. crenulata* as a basal taxon to the *Fagraea* clade.

Taxa sampled as *Fagraea* section *Racemosae* were shown to be monophyletic in all the analyses. The clade received strong BS and PP support in analyses with all the data sets except in the *trnL*-F data set where it received moderate support for BS (67%).

Fagraea section *Cyrtophyllum* as defined by Leenhouts (1962) was paraphyletic and resolved as two distinct clades, i.e., the Elliptica and Gigantea clades, in all the analysed data sets. The inclusion of *F. fragrans* within the Gigantea clade was shown in the analyses with the ITS, ITS-expanded and combined data sets. In the *trnL*-F data set analyses, the position of *F. fragrans* was unclear and in the *ndhF* data set analysis, *F. fragrans* was sister to the Gigantea + *Racemosa* clades.

Thus, there was large but incomplete correspondence between well-formed monophyletic groups in the series of analyses conducted with the various molecular data sets and the existing taxonomic "sections" of *Fagraea* s.l. Whereas sections *Fagraea* and *Racemosae* appear well-defined, the section *Cyrtophyllum* appears to be an artificial grouping of two natural groups, and *F. crenulata* appears to be somewhat isolated within *Fagraea* s.l.

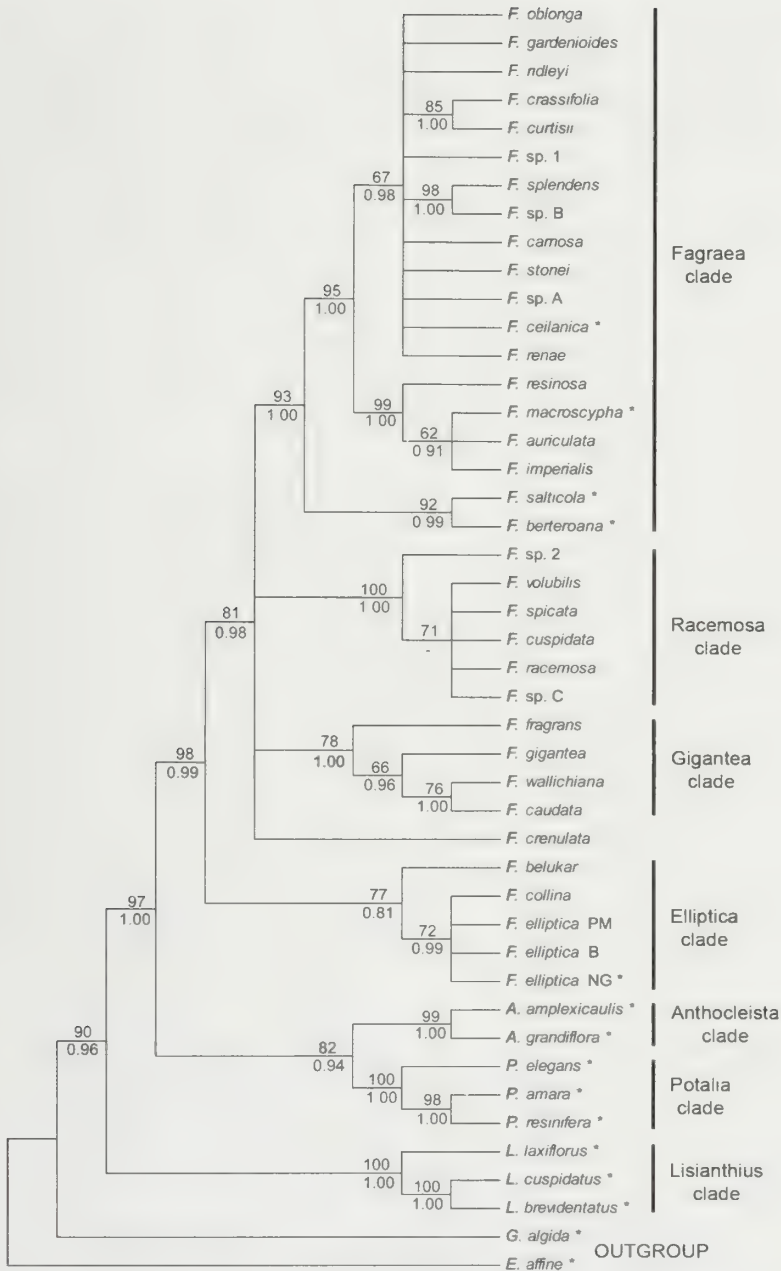


Fig. 5. Strict consensus of 2145 equally parsimonious trees based on the expanded ITS sequence data. The numbers above and below the branches denote Bootstrap and Bayesian Posterior Probability values, respectively. Length (L) = 582; consistency index (CI) = 0.7337; retention index (RI) = 0.8089. *A.* = *Anthocleista*; *E.* = *Exacum*; *F.* = *Fagraea*; *G.* = *Gentiana*; *L.* = *Lisianthus*; *P.* = *Potalia*. Different accessions of *F. elliptica* are indicated (PM = Peninsular Malaysia, B = Borneo, NG = New Guinea). An asterisk after a name indicates the taxon's sequence data obtained from GenBank (see Methods and Materials).

Potentially synapomorphic morphological characters for clades

An attempt to identify unique, non-molecular characters defining monophyletic groups (likely synapomorphies in cladistic terms) was made. This is shown in summary form in Table 5. This attempt might also be viewed against the pre-existing notion that *Fagraea* s.l. was not particularly well distinguished as a natural group with a large defining character suite. Prevost (1978), surveying modularity in growth architecture among tropical woody plants, remarked that *Fagraea* s.l. was quite polymorphic in the sense that it included many examples of architectural models. The examples she provided included *F. crenulata*, *F. fragrans* and *F. racemosa* s.l. (she cited an Australian-New Guinea provenance for this), with the models of Fagerlind, Aubréville and Roux, respectively. We have surveyed multiple species for the tree architectural character and find distinct forms representing each of the identified lineages or clades in our phylogenetic study.

From the present survey, it can be appreciated that the section *Racemosae* appears to have the most number of unique character-states among the sections compared within *Fagraea* s.l. It is thus highly distinct by morphological characteristics from the other two sections and from *F. crenulata*. *Fagraea crenulata* appears to diverge from all other *Fagraea* s.l. in a number of characteristics, including Fagerlind's architectural model with modular branch construction (as mentioned by Hallé et al. 1978 and Prevost 1978), and the presence of stem/branch prickles and a serrulate leaf margin. Likewise, two groups appear morphologically well distinguished within the section *Cyrtophyllum*—one with Scarrone's architectural model, with orthotropic branch complexes and terminal flowering; the other with Aubréville's architectural model, with branches that extend plagiotropically by apposition and axillary flowering. Likely synapomorphies were identifiable for the *Fagraea* clade, the *Racemosa* clade and the *Gigantea* clade, but not for the *Elliptica* clade, which resolved most basally in the ITS analyses (Fig. 1 & 5).

THE FAGRAEA CLADE (*Fagraea* s.s., excluding *F. crenulata*) — The growth habits of members in this group are erect, scrambling, climbing or scandent shrubs or smallish trees, which are also facultatively hemi-epiphytes. All the other distinguished groups as well as *F. crenulata* are free-standing trees and do not have scrambling, climbing or hemi-epiphytic habit. *Anthocleista* and *Potalia* are free-standing trees, with a few climbers found in the former genus (Struwe et al. 2001; Struwe & Albert 2004). Members of *Fagraea* s.s. produce copious amounts of creamy-pale to yellowish latex in the fruit pericarp (visible especially when fresh fruits are cut or bruised). The other groups as well as *F. crenulata* either have small amounts of translucent gummy latex or (like the *Racemosae* clade, *Anthocleista* and *Potalia*) do not produce latex at all. The seed shape in *Fagraea* s.s. is ellipsoid-rounded (similar to the condition in *Anthocleistus* and *Potalia*: Struwe et al. 2001; Struwe & Albert 2004), compared to polygonal in all the other three groups of *Fagraea* s.l. as well as *F. crenulata*.

FAGRAEA CRENULATA — The Fagerlind's tree architectural model is found only in *F. crenulata* within *Fagraea* s.l. The model applies to trees that have a monopodial trunk

with episodic growth as well as branching tiers. The branch modules are terminated by an inflorescence. The other groups have Scarrone's, Aubréville's or Roux's models. Perhaps the character that makes this species bizarre among *Fagraea* s.l. is the presence of prickles on the stems and branches. Prickles are completely absent in all other species within *Fagraea* s.l. and the Potaliinae. Another aberrant character which unmistakably distinguishes this species is the serrulate leaf margin. All other species in *Fagraea* s.l., *Anthocleista* and *Potalia* (Struwe et al. 2001; Struwe & Albert 2004) have entire leaf margins. In terms of morphology, *F. crenulata* is arguably the most enigmatic species in *Fagraea* s.l.

Notwithstanding, *Fagraea* s.s. and *F. crenulata* do share a number of characters (Table 5), although most of these are not exclusive to them and can be found in other groups or genera. A possible link is that the petiolar sheaths of a leaf pair in both *Fagraea* s.s. and *F. crenulata* do not fully fuse. The slight fusion at the extreme edges of the pairing sheaths do not form a consistent cup-like structure (ochrea) around the stem as in *Anthocleista* and *Potalia* (Struwe et al. 2001; Struwe & Albert 2004; Struwe, pers. comm.) and other taxa of *Fagraea* s.l.

THE RACEMOSA CLADE — Roux's architectural model applies to all members of the Racemosa clade. Species with this growth model have a monopodial orthotropic stem / trunk with continuous growth. In comparison, all other taxa in *Fagraea* s.l. have episodic stem / trunk growth. The branches on the stem/trunk in the Racemosa clade are opposite and decussate but leaf arrangement on the branches is secondarily distichous; in all the other groups of *Fagraea* s.l., the leaves are opposite-decussate in arrangement. The branches in the Racemosa clade are plagiotropic, ending with a terminal inflorescence, whereas the branches in other groups are orthotropic complexes or plagiotropic by apposition. The terminal buds of vegetative shoots in the Racemosa clade are not conspicuously covered with any resinous substances whereas all the others (including *Anthocleista* and *Potalia*: Struwe, pers. comm.) have creamy to yellowish resin covering the shoot apices.

Among Racemosa clade members, the inflorescence is generally a pendulous elongate panicle with cymose branching where the branching pairs are condensed and distinctly shorter than the rachis. In comparison, the inflorescences in the other groups bear only a solitary flower or are branched cymes in which the longest basal branches are nearly as long as the rachis. The mature fruit colour in the Racemosa clade are generally pale to dark brown, whereas in the other groups they are yellow-orange to red-scarlet or creamy pale grey-green to white. The fruits in the Racemosa clade (and also *Anthocleista* and *Potalia*) do not exude any conspicuous latex, whereas fruits in all the other *Fagraea* s.l. groups produce a gummy latex. Also, fruits in the Racemosa clade (and also in *Anthocleista* and *Potalia*: Struwe, pers. comm.) in both fresh and dried specimens, have a rather intact fruitwall epidermis that does not easily come off; on the other hand, in all the other *Fagraea* s.l. groups, the epidermis separates easily as a thin, tough and translucent peel. The mature fruit wall in dried herbarium samples is firm and retains its rounded structure (as in *Anthocleista* and *Potalia*: Struwe, pers. comm.), whereas in other groups the fruit wall breaks down and crumples as it dries.

Table 5. A comparison of various habit, plant-architectural and morphological characters found in distinct groups of *Fagraea* s.l. resolving as monophyletic groups and an isolated lineage in molecular phylogenetic analyses in the present study. Specially diagnostic character-states which are potentially synapomorphic for the identified clades (in the context of *Fagraea* s.l.) are given in bold italics. Other states which are unusual for (absent in) other (non-Malesian) members of the subtribe, are marked with an asterisk. Thus, traits marked by both an asterisk and bold italics are likely clade / generic synapomorphies in the context of the subtribe in general. A few characters placed in brackets (column 1) appear not to be of special taxonomic utility at this level of classification.

	Elliptica clade	Gigantea clade	Fagraea clade	F. crenulata	Racemosa clade
Monophyletic groups in molecular analyses (present work)					
Sectional name fide Leenhouts (1962)	<i>Cyrtophyllum</i>	<i>Cyrtophyllum</i>	<i>Fagraea</i>	<i>Fagraea</i>	<i>Racemosae</i>
Growth habit	free-standing trees, never scrambling or climbing or hemi-epiphytic	free-standing trees, never scrambling or climbing or hemi-epiphytic	erect, *scrambling, *climbing or *scandent shrubs or small trees but these also *facultative hemi-epiphytes	free-standing trees, never scrambling or climbing or hemi-epiphytic	free-standing trees, never scrambling or climbing or hemi-epiphytic
General architecture	Scarrone's model	*Aubréville's model	Scarrone's model	*Fagerlund's model	*Roux's model
Trunk / stem growth	episodic	episodic	episodic	episodic	*continuous
Trunk / stem bark	becoming fissured in older trees or smooth to scaly-dipped; lacking prickles	becoming fissured in older trees; lacking prickles	smooth to lightly scaly-dipped; lacking prickles	becoming fissured and *densely set with prickles	becoming fissured in older trees; lacking prickles
Branches on stem / trunk	orthotropic complexes	*plagiotropic by apposition	orthotropic complexes	*plagiotropic by substitution and modular	*plagiotropic
Vegetative terminal buds	yellowish resinous	yellowish resinous	creamy yellowish resinous	creamy yellowish resinous	*non-resinous
Leaf arrangement on branches	decussate	decussate	decussate	decussate	*secondarily distichous
Leaf margin	entire	entire	entire	*serrulate-crenulate	entire
Petiole sheaths	fused at node into a cuplike ochrea	fused at node into a cuplike ochrea	*not fused to slightly fused at extreme edges, not forming a cuplike ochrea	*not fused to slightly fused at extreme edges, not forming a cuplike ochrea	fused at node into a cuplike ochrea

**elongate panicle with cymose branching (branches several pairs, condensed, distinctly shorter than rachis)*

Inflorescence, general form	branched cymes (basal branches longest, nearly as long as rachis, mostly rebranched)	solitary flowers / 1–few-flowered cymes / branched cymes (basal branches longest, nearly as long as rachis, mostly rebranched)	branched cymes (basal branches longest, nearly as long as rachis, mostly rebranched)	<i>*elongate panicle with cymose branching (branches several pairs, condensed, distinctly shorter than rachis)</i>
Inflorescence, position	terminal	terminal	terminal	terminal
(Number of flowers per inflorescence)	several to many	several to many; *single flowers	many	several to many
(Corolla size)	very small (up to 10 mm wide at mouth)	very small to *large (over 40–50 mm wide at mouth)	medium	very small to medium (up to 25 mm wide at mouth)
Stamen exsertness	*long-exsert (typically > 70% exsert)	slightly to medium-exsert	medium exsert	not to medium-exsert
Style exsertness	*medium- to long-exsert (typically > 40% exsert)	not to slightly exsert	not to slightly exsert	not to slightly exsert
Stigma structure & form	knoblike; stigma base not expanding conspicuously; stigmatic surface with 2 very slightly distinct lobes resembling twin mounds	*stigma base expanding into a circular plate-like rim that is often undulating; stigmatic surface weakly to distinctly 2-lobed	*stigma base expanding into a circular plate-like rim that is often undulating; stigmatic surface weakly to distinctly 2-lobed	*stigma base expanding into a circular plate-like rim; stigmatic surface moundlike or weakly to distinctly 2-lobed
(Fruit size)	very small (< 10 mm diameter)	very small to *big (> 40 mm diameter)	medium (10–15 mm across or more)	very small to medium (< 15 mm diameter)
Fruit colour at maturity	yellow-orange to red-scarlet	creamy pale grey-green to white	pale grey-green	<i>pale to dark brown</i>
Latex in fruit epidermis / fruitwall	*translucent gummy latex	<i>*copious creamy pale yellowish latex</i>	small amounts of *translucent gummy latex	<i>no latex</i>
Fruit epidermis	*separating easily as a thin, tough, translucent 'peel'	*separating easily as a thin, tough, translucent 'peel'	*separating easily as a thin, tough, translucent 'peel'	<i>not separating from the fruit wall easily</i>
Fruitwall at maturity	*soft	*soft	*soft	<i>firm</i>
Seed shape	*polygonal	<i>ellipsoid-rounded</i>	*polygonal	*polygonal

THE GIGANTEA CLADE — The general architecture of members of the Gigantea clade follows Aubréville's model in which the monopodial main trunk shows episodic growth with opposite-decussate phyllotaxis, and the branches extend plagiotropically by apposition (this is sometimes referred to as Terminalian branching) (Hallé et al. 1978; Prevost 1978). The other Malesian groups in *Fagraea* s.l. follow Scarrone's, Fagerlind's or Roux's models. The position of the inflorescence in the Gigantea clade is axillary, whereas in all other groups of *Fagraea* s.l. and its subtribe (including *Anthocleista* and *Potalia*: Struwe et al. 2001; Struwe & Albert 2004), the inflorescence is terminal.

THE ELLIPTICA CLADE — The Gigantea and Elliptica clades have several morphological similarities that distinguish them from other taxa in *Fagraea* s.l. The exertness of the filament from the corolla tube is very prominent within these two clades, typically more than 70% of the total length of the filament, whereas in the others, the filament is not exerted at all or only slightly to moderately so. Also, style exertness in these two clades is typically more than 40% of the total length of the pistil, whereas in the other groups it is either not or only slightly exerted (refer to Appendix B for a detailed comparison of filament and style exertness among the taxa). The structure of the stigma in these two clades is knoblike or capitate and the base of the stigma does not expand conspicuously, as in *Anthocleista* and *Potalia* (Struwe, pers. comm.). In *Fagraea* s.s., *F. crenulata* and the Racemosa clade, the stigma structure is peltate due to the base of the stigma expanding conspicuously into a circular plate-like rim. Further, the fruits in the Gigantea and Elliptica clades turn yellow-orange to red-scarlet upon maturity whereas in the other two clades as well as *F. crenulata*, the fruits ripen creamy grey-green to white or dark brown. The fruits are also generally smaller in these two clades compared to the others. Given the distinctness of the Gigantea and Elliptica clades as expressed in the topologies resulting from the molecular analyses (Fig. 1–5), any apparently shared character-states they have must be considered homoplasious in nature (i.e., similarity not due to common ancestry). Furthermore, inflorescence position is consistently terminal in the Elliptica clade, and axillary in the Gigantea clade.

***Fagraea*: complex genus or several genera?**

The analysis with the expanded ITS data set (Fig. 5) shows that the monophyletic groups are comparable in distinctness to several recently reviewed or revised ingroup genera, i.e., *Anthocleista*, *Potalia* and *Lisianthus* (Struwe et al. 2002; Struwe & Albert 2004; Weaver 1972; Sytsma 1988), which are well-established genera of the same tribe. From the systematic and taxonomic points of view, therefore, the respective clades are best recognised as separate genera because of their phylogenetic resolution as monophyletic groups or isolated lineages, and their equivalence to other well-established genera of the same tribe.

A survey of possible morphological markers also suggests that *Fagraea* s.l.

contains morphologically well-distinguished groups of taxa with clear-cut boundaries. It was possible to ascribe potential morphological synapomorphies for the four monophyletic groups in *Fagraea* s.l. and for *F. crenulata*.

In summary, *Fagraea* s.l. is morphologically too divergent to be considered as a single genus and even the sectional classification available (Leenhouts 1962) appears to be incompletely circumscribed. The proposed concepts here for recognising the main lineages as genera are clearly applicable to Sundaland species, which represent the major geographical core of the complex, as these were well-represented in the present analyses. Notwithstanding an increased clarity now available for sorting out *Fagraea* s.l., various remarks on remaining problems and suggestions for future work may be made. The two species, *F. berteriana* and *F. salticola* (New Guinea and the south-west Pacific islands) included in the expanded ITS analysis, were resolved within the *Fagraea* clade (= *Fagraea* s.s.). These species are among several from east Malesia that form a group morphologically distinguished from others in *Fagraea* s.s. by a fleshy ring on the inside of the corolla tube, at the insertion level of the stamens (Leenhouts 1962; Struwe et al. 2002). Better taxon sampling that includes more species from other parts of Malesia and the south-west Pacific islands in future phylogenetic analyses may give better resolution and confidence about clade relationships for this group. The potential inclusion of taxa from beyond the so-called boundaries of Malesia, such as *F. schlechteri* Gilg & Gilg-Ben. from New Caledonia, which Prevost (1978) has observed to have the modular growth model of Koriba (so far not encountered within the Malesian *Fagraea* complex), also promises greater insight. Also, the exploration of further gene regions in similar studies should be interesting.

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References

- Bentham, G. (1856) Notes on Loganiaceae. *J. Proc. Linn. Soc., Bot.* 1: 52–115.
- Blume, C.L. (1838) *Rumphia*. Vol. 2. Leiden.
- Blume, C.L. (1850) *Stirpium exoticarium novarum vel minus cognitarium ex vivis aut siccis brevis exposito et descriptio*. Pp. 163–173. Lugduni-Batavorum.
- Burkill I.H. (1936) *A Dictionary of the Economic Products of the Malay Peninsula*. Fourth print (2002). Kuala Lumpur: Ministry of Agriculture and Co-Operatives. Vol. 1: 1009–1013.
- Cammerloher, H. (1923) Die Loganiaceen und Buddleiaceen Niederländisch-Indiens. *Bull. Jard. Bot. Buitenzorg Ser. III*, 5 (4): 295–338.
- Chassot, P., Nemomissa, S., Yuan, Y.-M., K pfer, P. (2001) High parphyly of *Swertia* L. (Gentianaceae) in the *Gentianella*-lineage as revealed by nuclear and chloroplast DNA sequence variation. *Pl. Syst. Evol.* 229: 1–21.
- Conn, B.J. & Brown, E.A. (1993) Review of *Fagraea gracilipes* complex (Loganiaceae). *Telopea* 5 (2): 363–374.
- Cunningham, C.W., Omland, K.E. & Oakley, T.H. (1998) Reconstructing ancestral character states: a critical reappraisal. *Trends Ecol. Evol.* 13: 361–366.
- Davis, C.C., Anderson, W.R. & Donogue, M.J. (2001) Phylogeny of Malphiaceae: Evidence from chloroplast *ndhF* and *trnL-F* nucleotide sequence. *Amer. J. Bot.* 88: 1830–1846.
- Downie, S.R. & Palmer, J.D. (1992) Restriction site mapping of the chloroplast inverted repeat: a molecular phylogeny of the Asteridae. *Ann. Missouri Bot. Gard.* 79: 266–283.
- Doyle, J.J. & Doyle, J.L. (1987) A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochem. Bull.* 19: 11–15.
- Farris, J.S. (1989) The retention index and the rescaled consistency index. *Cladistics* 5: 417–419.
- Farris, J.S., K llersj , M., Kluge, A.G. & Bult, C. (1994) Testing significance of incongruence. *Cladistics* 10: 315–319.
- Farris, J.S., K llersj , M., Kluge, A.G. & Bult, C. (1995) Constructing a significant test of incongruence. *Syst. Biol.* 44: 570–572.
- Felsenstein, J. (1985) Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783–791.
- Fitch, W.M. (1971) Toward defining the course of evolution: minimal change for a specific tree topology. *Syst. Zool.* 20: 406–416.
- Gielly, L. & Taberlet, P. (1996) A phylogeny of the European gentians inferred from chloroplast *trnL* (UAA) intron sequences. *Bot. J. Linn. Soc.* 120: 57–75.
- Hagen, K.B. von & Kadereit, J.W. (2001) The phylogeny of *Gentianella* (Gentianaceae) and its colonization of the Southern hemisphere as revealed by nuclear and chloroplast DNA sequence variation. *Org. Divers. Evol.* 1: 61–79.
- Hall, T.A. (1999) Bioedit: a user-friendly biological sequence alignment editor and analyses program for Windows 95/98/NT. *Nucl. Acids. Symp. Ser.* 41: 95–98.
- Hall , F., Oldeman, R.A.A. & Tomlinson, P.B. (1978) *Tropical trees and forests. An architectural analysis*. Berlin: Springer-Verlag.

- Huelsenback, J.P. & Ronquist, F. (2001) MrBayes: bayesian inference of phylogenetic trees. *Biometrics* 17: 754–755.
- Huelsenback, J.P., Ronquist, F. & Hall, B. (2001) MrBayes: A program for the Bayesian of phylogeny (Instruction Manual). <http://golab.unl.edu/teaching/SBseminar/manual.pdf> (accessed September 25, 2009).
- Jensen, S.R. (1992) Systematic implications of the distribution of iridoids and other chemical compounds in the Loganiaceae and other families of the Asteridae. *Ann. Missouri Bot. Gard.* 79: 284–302.
- Jensen, S.R. & Schripsema, J. (2002) Chemotaxonomy and pharmacology of Gentianaceae. In: Struwe, L. & Albert, V.A. (eds.), *Gentianaceae—systematics and natural history*. Pp. 573–631. U.K., Cambridge: Cambridge University Press.
- Kauff, F. & Lutzoni, F. (2002) Phylogeny of the Gyalectales and Ostropales (Ascomycota, Fungi): among and within other order relationships based on nuclear ribosomal RNA small and large subunits. *Molec. Phylogenet. Evol.* 25: 138–156.
- Kluge, A.G. & Farris, J.S. (1969) Quantitative phyletics and the evolution of anurans. *Syst. Zool.* 18: 1–32.
- Larget, B. & Simon, L. (1999) Markov chain Monte Carlo algorithms in the Bayesian analyses of phylogenetic trees. *Molec. Biol. Evol.* 16: 750–759.
- Larkin, M.A., Blackshields, G., Brown, N.P., Chenna, R., McGettigan, P.A., McWilliam, H., Valentin, F., Wallace, I.M., Wilm, A., Lopez, R., Thompson, J.D., Gibson, T.J. & Higgins, D.G. (2007) Clustal W and Clustal X version 2.0. *Bioinformatics* 23: 2947–2948.
- Leenhouts, P.W. (1962) Loganiaceae. In: Steenis, C.G.G.J. van (ed.), *Flora Malesiana*. Series 1 Vol. 6. Pp. 293–336. Groningen: Wolters-Noordhoff Publishing.
- Leenhouts, P.W. (1984) A new *Fagraea* from Borneo (Loganiaceae). *Blumea* 29: 423–424.
- Leeuwenberg, A.J.M. & Leenhouts, P.W. (1980) Taxonomy. In: Leeuwenberg, A.J.M. (ed.), *Engler and Prantl's Die natürlichen Pflanzenfamilien, Angiospermae. Ordnung Gentianales, Fam. Loganiaceae*. Vol. 28b (1). Pp. 8–96. Berlin: Duncker & Humblot.
- Lewis, P.O. (2001) Phylogenetic systematics turns over a new leaf. *Trends Ecol. Evol.* 16: 30–37.
- Macmillan H. F. (1991) *Tropical Planting and Gardening*. Sixth edition. Pp. 115 & 265. Malayan Nature Society, Kuala Lumpur.
- Miquel, F.A.W. (1857) *Flora van Nederlandsch-Indië*. Vol. 2. Amsterdam.
- Molina, J. & Struwe, L. (2009) Utility of secondary structure in phylogenetic reconstruction using *nrDNA* ITS sequences – an example from *Potalieae* (Gentianaceae: Asteridae). *Syst. Bot.* 34 (2): 414–428.
- Motley T.J. (2004) The ethnobotany of *Fagraea* Thunb. (Gentianaceae): The Timber of Malesia and the scent of Polynesia. *Econ. Bot.* 58 (3): 396–409.
- Nylander, J.A.A. (2004) MrModeltest 2.2. Evolutionary Biology Centre, Uppsala University. Software programme distributed by the author.
- Olmstead, R.G., Bremer, B., Scott, K.M. & Palmer, J.D. (1993) A parsimony analysis of the Asteridae sensu lato based on *rbcl* sequences. *Ann. Missouri Bot. Gard.* 80: 700–722.
- Perry, L.M. (1980) *Medicinal plants of East and Southeast Asia*. Cambridge: The MIT Press.
- Prevost, M.-F. (1978) Modular construction and its distribution in tropical woody plants. In: Tomlinson, P.B. & Zimmermann, M.H. (eds) *Tropical Trees as Living Systems*. Pp. 223–231. New York: Cambridge Univ. Press.
- Qiagen Sample & Assay Technologies (2003–2009) Handbook for DNA extraction. <http://www1.qiagen.com/>.

- Quisumbing, E. (1978) *Medicinal plants of the Phillipines*. Philippines: Katha Publishing Co., Inc.
- Ranker, T.A., Geiger, J.M.O., Kennedy, S.C., Smith, A.R., Hauffler, C.H. & Parris, B.S. (2003) Molecular phylogenetics and evolution of the endemic Hawaiian genus *Adenophorus* (Grammitidaceae). *Molec. Phylogenet. Evol.* 26: 337–347.
- Rannala, B. & Yang, Z. (1996) Probability distribution of molecular evolutionary trees: a new method of phylogenetic inference. *J. Molec. Evol.* 43: 304–311.
- Ridley, H.N. (1923) *The Flora of the Malay Peninsula*. Vol. 2. Pp. 415–422. London: L. Reeve & Co.
- Solereder, H. (1892) Loganiaceae. In: Engler, A. & Prantl, K. (eds.), *Die natürlichen Pflanzenfamilien* 4(2): 1–50. Germany, Leipzig: Engelmann.
- Struwe, L., Albert, V.A. & Bremer, B. (1994) Cladistics and family level classification of Gentianales. *Cladistics* 10: 175–206.
- Struwe, L. & Albert, V.A. (1997) Floristics, cladistics and classification: three case studies in Gentianales. In: Dransfield, J., Coode, M.J.E. & Simpson, D.A. (eds.), *Plant Diversity in Malesia, III*. Pp. 321–352. Royal Botanic Gardens, Kew.
- Struwe, L., Kadereit, J., Klackenberg, J., Nilsson, S., Thiv, M., von Hagen, K.B. & Albert, V.A. (2002) Systematics, character evolution and biogeography of Gentianaceae, including a new tribal and subtribal classification. In: Struwe, L. & Albert, V.A. (eds.), *Gentianaceae—Systematics and Natural History*. Pp. 21–309. U.K., Cambridge: Cambridge University Press.
- Struwe, L. & Albert, V.A. (2004) A monograph of neotropical *Potalia* (Gentianaceae: Potalieae). *Syst. Bot.* 29: 670–701.
- Swofford, D.L. (2001) *PAUP*: Phylogenetic analyses using parsimony and other methods, version 4.0*. Sunderland, Massachusetts: Sinauer Associates.
- Sytsma, K.J. (1988) Taxonomic revision of the Central American *Lisianthus skinneri* species complex (Gentianaceae). *Ann. Missouri Bot. Gard.* 75: 1587–1602.
- Taberlet, P., Gielly, L., Pautou, G. & Bouvet, J. (1991) Universal primers for amplification of the three non-coding regions of chloroplast DNA. *Pl. Molec. Biol.* 17: 1105–1109.
- Thiv, M., Struwe, L. & Kaderiet, J.W. (1999) The phylogenetic relationships and evolution on the Canarian laurel forest endemic *Ixanthus viscosus* (Aiton) Griseb. (Gentianaceae): evidence from *matK* and ITS sequences, and floral morphology and anatomy. *Pl. Syst. Evol.* 218: 299–317.
- Watson, J.G. (1935) Tembusu. *Malayan Forester* 4: 136–137.
- Weaver, R.E. (1972) A revision of a neotropical genus *Lisianthus* (Gentianaceae). *J. Arnold Arb.* 53: 76–100.
- White, T.J., Burns, T., Lee, S. & Taylor, J. (1990) Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis, M.A., Gelfand, D.H., Sninsky, J.J. & White, T.J. (eds.), *PCR Protocols: A Guide to Methods and Applications*. Pp. 315–322. San Diego: Academic Press.
- Wong, K.M. & Sugau, J.B. (1996) A revision of *Fagraea* (Loganiaceae) in Borneo, with notes on related Malaysian species and 21 new species. *Sandakania* 8: 1–93.
- Yuan, Y.-M. & Küpfer, P. (1995) Molecular phylogenetics of the subtribe Gentianinae (Gentianaceae) inferred from the sequences of the internal transcribed spacer (ITS) of nuclear ribosomal DNA. *Pl. Syst. Evol.* 196: 206–226.
- Yuan, Y.-M. & Küpfer, P. (1997) The monophyly and rapid evolution of *Gentiana* sect. *Chondrophyllae* Bunge s.l. (Gentianaceae): evidence from the nucleotide sequences of the internal transcribed spacer of nuclear ribosomal DNA. *Bot. J. Linn. Soc.* 123: 25–43.

- Yuan, Y.-M., Küpfer, P. & Doyle, J.J. (1996) Infrageneric phylogeny of the genus *Gentiana* (Gentianaceae) inferred from nucleotide sequences of the internal transcribed spacer (ITS) of nuclear ribosomal DNA. *Amer. J. Bot.* 83: 641–652.
- Yuan, Y.-M., Wolhauer, S., Möller, M., Chassot, P., Mansion, G., Grant, J., Küpfer, P. & Klackenberg, J. (2003) Monophyly and relationships of the tribe Exaceae (Gentianaceae) inferred from nuclear ribosomal and chloroplast DNA sequences. *Molec. Phylogenet. Evol.* 28: 500–517.

Appendix A. Sequences of primers used in PCR for amplifying the ITS, *trnL* intron, *trnL*-F spacer and *ndhF* regions.

PCR amplified regions	Primer names	Sequences (5' — 3')	Approximate size of amplification in PCR	Source
ITS	ITS 1	TCC GTA GGT GAA CCT GCG G	700–750 bp	White et al. 1990
	ITS 4	TCC TCC GCT TAT TGA TAT GC		
<i>trnL</i> intron	'C'	CGA AAT CGG TAG ACG CTA CG	300–400 bp	Taberlet et al. 1991
	'D'	GGG GAT AGA GGG ACT TGA AC		
<i>trnL</i> -F spacer	'E'	GGT TCA AGT CCC TCT ATC CC	300–400 bp	Taberlet et al. 1991
	'F'	ATT TGA ACT GGT GAC ACG AG		
<i>ndhF</i>	GB 1 Fwd	CTT TCA TTC CAC TTC CAG TTC CT	900–1000 bp	This study
	GB 1 Rev	TAT AGG GTG AAT AGC CAA GAA GCC		
	GB 2 Fwd	AAA GCC AAA ATA TGG TTC TTA TGG G	900–1000 bp	This study
	GB 2 Rev	AAA TAA ATA GAA GAA AAT ATA AGA AGA AAT GCG		

Appendix B. Style and filament exertness from the corolla tube in selected species of *Fagraea* s.l., representing sections *Cyrtophyllum*, *Fagraea*, and *Racemosae*.

The three blocks of species from top to bottom in the Table, correspond to *Fagraea* sections *Cyrtophyllum*, *Fagraea* and *Racemosae*, respectively. *CA* = *Cyrtophyllum* (Axillary Inflorescence), *CT* = *Cyrtophyllum* (Terminal Inflorescence), *F.* = *Fagraea*, *R.* = *Racemosae*.

Species and section in <i>Fagraea</i> s.l.	Corolla tube length (mm)	Style length (mm)	Style protrusion (mm)	Style protrusion (%)	Filament length (mm)	Filament protrusion (mm)	Filament protrusion (%)
<i>F. fragrans</i> - CA	(4-)6-8	(14-)18-22	(8-)10-12(-14)	57-64	(10-)12-16(-17)	(8-)10-12(-13)	76-80
<i>F. gigantea</i> - CA	7-8	(12-)18-22	(5-)12-14	42-64	13-15	12-13	87-92
<i>F. wallichiana</i> - CA	(12-)20-25	(34-)42-45(-55)	22-25(-30)	55-65	(27-)30-38	20-23(-28)	73-74
<i>F. elliptica</i> - CT	3-5	(6)-7-9	3-4	44-50	(4-)7-8	(4-)7-8	100
<i>F. auriculata</i> - F	60-82	70-90	8-10	11-12	45-60	15-23	33-38
<i>F. carnosa</i> - F	106-140	123-126	0-17	0-13	12-15	5	33-41
<i>F. crassifolia</i> - F	26-30	28-30	0-2	0-7	-	-	-
<i>F. crenulata</i> - F	15-18	15-20(-23)	0-5	0-22	12-14	7-8	57-58
<i>F. curtisii</i> - F	35-55	c. 60	c. 5	c. 8.3	32-40	c. 10	c. 25
<i>F. gardenioides</i> - F	40-53	50-55	2-10	4-18	20-27	12-17	60-63
<i>F. imperialis</i> - F	90-160	90-115	0-5	0-4	(55-)80-90	(5-)27-40	9-44
<i>F. littoralis</i> - F	25-32	32-35	3-7	9-20	23-25	12-13	c. 52
<i>F. oblonga</i> - F	21-36	22-30	1-6	5-20	18-22	c. 8	36-44
<i>F. renae</i> - F	23-34	28-32	0-5	0-16	20-26	10-14	50-54
<i>F. ridleyi</i> - F	32-37	40-45	c. 8	18-20	25-28	c. 10	36-40
<i>F. splendens</i> - F	25-37	40-45	8-15	20-33	20-25	7-8	32-35
<i>F. tubulosa</i> - F	75-93	85-88	5-10	6-12	15-18	c. 10	56-67
<i>F. sp. B</i> - F	26-36	35-42	6-9	14-26	20-24	6-10	30-42
<i>F. sp. D</i> - F	43-60	65-70	10-22	15-31	40-50	17-20	40-43
<i>F. sp. E</i> - F	22-30	-	-	-	16-20	5-6	30-31
<i>F. maingayi</i> - R	16-25	12-23	0	0	19-23	2-6	11-26
<i>F. peninsularis</i> - R	c. 14	17-19	3-5	18-26	6-7	1-2	17-28
<i>F. racemosa</i> - R	10-22	15-20(-25)	3-5	20	11-17(-20)	6-8	40-55
<i>F. volubilis</i> - R	15-25	17-20	0-2	0-10	11-13	0-3	0-23
<i>F. sp. C</i> - R	21-26	22-25	0-1	0-4	10-15	0	0
<i>F. sp. G</i> - R	20-25	20-28	0-3	0-11	15-16	4-5	27-31

Twenty new species of *Paraboea* (Gesneriaceae) from Thailand

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ABSTRACT. Twenty new species of *Paraboea* are described from Thailand: *Paraboea arachnoidea* Triboun, *Paraboea axillaris* Triboun, *Paraboea bhumboliana* Triboun & Chuchan, *Paraboea doitungensis* Triboun & D.J.Middleton, *Paraboea eburnea* Triboun, *Paraboea insularis* Triboun, *Paraboea lavandulodora* Triboun, *Paraboea monticola* Triboun & D.J.Middleton, *Paraboea nana* Triboun & Dongkumfu, *Paraboea nobilis* Triboun & D.J.Middleton, *Paraboea peninsularis* Triboun & D.J.Middleton, *Paraboea phanomensis* Triboun & D.J.Middleton, *Paraboea quercifolia* Triboun, *Paraboea rosea* Triboun, *Paraboea sangwaniae* Triboun, *Paraboea siamensis* Triboun, *Paraboea takensis* Triboun, *Paraboea tenuicalyx* Triboun, *Paraboea vachareea* Triboun & Sonsupab and *Paraboea xylocaulis* Triboun. Full descriptions and conservation assessments are provided for all taxa.

Keywords. Gesneriaceae, IUCN conservation assessments, *Paraboea*, Thailand.

Introduction

Paraboea (C.B.Clarke) Ridl. is one of the larger genera in the Gesneriaceae (Weber, 2004) and has recently been revised by Xu et al. (2008) who recognised 89 species and five varieties. Since the publication of the revision three more species have been described (Chen et al., 2008; Kiew, 2010). In addition the genera *Phylloboea* Benth. and *Trisepalum* C.B.Clarke have been synonymised into *Paraboea* (Puglisi et al., 2011), following the conservation of *Paraboea* against these other two names (Middleton et al., 2010). This broader genus concept has resulted in about 107 currently accepted species.

The Gesneriaceae are currently under revision for the *Flora of Thailand*. This project has involved intensive field work all over Thailand and has already resulted in a number of new discoveries (Middleton & Triboun, 2010; Triboun & Middleton, 2010). It has also yielded many collections that were not available to Burt (1984), for his synopsis of *Trisepalum*, nor to Xu et al. (2008), for their revision of *Paraboea*. In the revision by Xu et al. (2008) very many taxa were shown to be very locally endemic and consequently more recent collections of previously unexplored or underexplored limestone areas has revealed many taxa that are new to science. All of these are described in *Paraboea* but of these the following have the characters that would previously have qualified them as belonging to *Trisepalum*: *Paraboea axillaris*, *P. bhumboliana*, *P. lavandulodora*, *P. nana*, *P. nobilis*, *P. peninsularis*, *P. phanomensis*, *P. sangwaniae*,

P. siamensis, *P. takensis* and *P. xylocaulis*. These make up a large proportion of the newly described species partly because *Trisepalum* has received considerably less research attention than *Paraboea* in recent years. Limestone areas in Thailand still require considerably more exploration. We estimate that about 60% of karst limestone in Thailand has been unexplored and of the remaining 40% about half has had only the minimum of collecting possible at the site.

Xu et al. (2008) noted the desirability of providing IUCN conservation assessments for all species of *Paraboea* under IUCN criteria (IUCN, 2001), especially given the prevalence of *Paraboea* species in karst limestone habitats, a habitat that is under pressure throughout Southeast Asia, particularly due to exploitation for cement (see Clements et al., 2006). Since the publication of Xu et al. (2008) the more intensive field work in limestone areas of Thailand has indeed confirmed that most of the species thought to be rather locally endemic are indeed so. We, therefore, make some assumptions in order to provide these provisional IUCN conservation assessments: 1. we assume that species known only from the type or very few geographically restricted specimens really are confined to the area in which they were collected; 2. we assume that when the plant is known only from the type collection or from very few collections which were all collected from the same site its extent of occurrence (see IUCN, 2001 for definitions) is < 100 km² and area of occupancy is less than 10 km².

The Thai names adopted below have been coined by Pramote Triboun. The flowering and fruiting periods listed below are mostly estimated by comparing them to the phenology of similar and better known species and extrapolating from the fertile condition of the specimens when collected.

***Paraboea arachnoidea* Triboun, sp. nov. (Fig. 1A)**

Paraboeae roseo Triboun magnitudine ubique magna, foliis rosulatis, planta pro parte maxima pilis arachnoideis dense obtecta et floribus densis similis, sed pilis arachnoideis in foliis magis densis, foliis ellipticis, pedunculis longioribus, corollis violaceis et capsulis brevioribus differt. TYPUS: *P. Triboun*, B. Sonsupab & P. Yothakaew 4325, 2 September 2009, Thailand, Krabi, Mu Koh Lanta, Koh Lapu Le (holo BK; iso E).

Lithophytic perennial herb to subshrub. Stem erect, 15–40 cm high, c. 1.3 cm in diam., hard, woody, cracked and rough, the upper parts covered with white arachnoid hairs, the remains of old petioles and scars remaining in the lower parts, woody root stock stout. Leaves 11–25, arranged in a dense rosette at the top of the stem; petiole 2–6 cm long, c. 7 mm in diam., densely covered with white arachnoid hairs; blade subcoriaceous, elliptic, 8.5–20 × 3–5.5 cm, apex obtuse, base cuneate or slightly attenuate, margin crenate, secondary veins 9–11 on each side of midrib, tertiary veins reticulate, densely covered with short multicellular glandular hairs but these somewhat obscured by dense white arachnoid hairs on both sides. Inflorescences 6–10, subterminal, compound pleiochasia, loosely congested 4–5 branches at each node, 4–8 orders of branching in each branch, 1–5 terminal orders mostly compound dichasia; peduncle

18–26 cm long, c. 4 mm in diam., densely covered with white arachnoid hairs; bracts elliptic or lanceolate, $1.2\text{--}1.8 \times 0.3\text{--}0.7$ cm, the upper ones strongly reduced, densely covered with white arachnoid hairs, flowers paired; pedicels 3–4 mm, covered with white woolly hairs. Calyx green, fused for less than 0.5 mm at base, 5-lobed; lobes lanceolate, c. 1.2×0.6 mm, apex acute, slightly covered with white hairs. Corolla violet-blue, with a short tube and spreading lobes; tube 1.5–2.5 mm long; 2 posterior lobes obovate or orbicular, $3\text{--}3.8 \times 2.5$ mm, apex obtuse, inner margins overlapping each other, 3 anterior lobes ovate, $2.5\text{--}3.5 \times 2$ mm, the 2 lateral ones asymmetrical, the middle one smaller than the lateral ones, apex rounded. Stamens 2, inserted near base of corolla tube; filament creamy white, c. 2 mm long, geniculate; anthers yellow, c. 1.5×2.5 mm; staminodes strongly reduced. Ovary ovoid, c. 2 mm long; style white or light mauve, 3–4 mm long; stigma capitate, white or light mauve. Capsules cylindric, 0.8–1 cm long, c. 1.5 mm in diam., twisted, glabrous.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. Open sun or in shade of dry evergreen forest on steep limestone cliff, alt. 10–200 m.

Phenology. Flowering and fruiting in July to October.

Vernacular. Cha Rue Si Yai Mang Mum (ชาฤๅษีไฮแมงมุม).

Etymology. The specific epithet refers to the dense arachnoid hair covering.

Proposed IUCN conservation assessment. Endangered (EN D). This species is only known from the type locality which is in a legally protected area. Although the exact size of the population is uncertain we estimate that it is between 50 and 250 individuals.

Notes. *Paraboea arachnoidea* is most similar to another new species *Paraboea rosea* Triboun in its large overall size, the leaves in a rosette, the dense covering of arachnoid hairs on most parts and the dense flowers, but it differs in the denser covering of arachnoid hairs on the leaves, elliptic leaves, longer peduncles (18–26 cm long in *P. arachnoidea*, 10–15 cm in *P. rosea*), violet corollas and shorter capsules (0.8–1 cm in *P. arachnoidea*, 1–1.9 cm in *P. rosea*).

***Paraboea axillaris* Triboun, sp. nov.** (Fig. 1B)

Paraboeae glandulosae (B.L.Burt) C.Puglisi *bracteis globosis, calyce distincte spectabili et floribus albis similis sed foliorum pubescentia, floribus paucioribus et capsulis longis tenuibus cylindricis differt.* TYPUS: *P. Triboun* 3608, 14 July 2006, Thailand, Tak, Umphang, Palata (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 20–70 cm high, rarely branched, densely covered with brown arachnoid hairs, woody root stock short and finely striped. Leaves

8–12, the lower ones immediately above the root stock congested, opposite decussate, the upper ones on upright stems loosely opposite; petiole 1–6 cm long, the upper ones short, sulcate near base, densely covered with brown arachnoid hairs; blade papery, ovate, elliptic or orbicular, 5–16 × 5–8.5 cm, apex obtuse, base cuneate, margin crenate, covered with multicellular glandular hairs above, densely covered with brown woolly hairs beneath, secondary veins 8–9 on each side of midrib, tertiary veins reticulate, venation prominent on both sides. Inflorescences 3–8, axillary, compound monochasia, the lower ones sometimes subtended by reduced leaves; peduncle 3–5.5 cm long, 1–1.5 mm in diam., glabrous or lightly covered with brown woolly hairs; bracts shiny green, globose, c. 1 cm, apex rounded or obtuse, glabrous; flowers paired, 2–5; pedicels 0.3–1 cm long, unequal, glabrous. Calyx cotyliform, light green, c. 1 cm long, 5-lobed, imbricate at base, upper 3 lobes fused at base; each lobe ovate or globose, c. 3 × c. 2 mm, apex rounded, glabrous, 2 lower lobes free, ovate, c. 2.5 × c. 2 mm, apex rounded, glabrous. Corolla white, campanulate; tube 0.8–1 cm long, slightly pale green at base; lobes globose or widely ovate, 4–6.5 × 6.5–8.5 mm, apex rounded. Stamens 2; filaments white, c. 3 mm long, geniculate; anthers brownish yellow, c. 2 × c. 4 mm; staminodes 3, narrowly linear, c. 1.5 mm long. Ovary ovoid, c. 3 mm long, glabrous; style white, c. 5 mm long; stigma linguiform, 5–7 mm long, grooved on the dorsal side. Capsules cylindrical, 1.8–2.2 × c. 0.25 cm, twisted, glabrous.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On limestone rocks in dry evergreen or mixed bamboo deciduous forest, alt. 600–900 m, in the same habitat as *Paraboea takensis* and *P. vachareeae*.

Phenology. Flowering and fruiting in June to October.

Vernacular. Khao Tok Rue Si (ข้าวตอกฤๅษี).

Etymology. The specific epithet refers to the distinct axillary inflorescences.

Proposed IUCN conservation assessment. Critically Endangered (CR B1ab(ii,iii,v)). This species is known only from the type locality. It is in a legally protected area but is subject to burning from adjacent agricultural practices. The extent of occurrence is < 100 km².

Notes. *Paraboea axillaris* is similar to *Paraboea glandulosa* (B.L.Burtt) C.Puglisi in its globose bracts, distinctly showy calyx and white flowers, but it differs in the pubescence on the leaves, the fewer flowers (2–5 in *P. axillaris*, 6–12 in *P. glandulosa*) and the long slender cylindrical capsules (1.8–2.2 cm in *P. axillaris*, 2–2.7 cm in *P. glandulosa*).

***Paraboea bhumiboliana* Triboun & Chuchan, sp. nov.** (Fig. 1C–D)

Paraboeae takensi Triboun magnitudine ubique modesta, ramis tenuibus, floris magnitudine et calycibus gemmis juvenibusque cum pilis albis arachnoideis tectis similis, sed ramis multis, inflorescentiis brevibus, pedunculo brevi, bracteis minoribus et corolla pallide purpurea ad pallide malvina ad basin lobi inferiore cum macula flava orbiculari notata recedit. TYPUS: P. Triboun, T. Chuchan, S. Pintasean, C. Intasan & J. Sittikan 3980, 1 September 2007, Thailand, Lamphun, Li, Bhumibol dam, Mae Ping Rapid (holo BK; iso BKF, E).

Lithophytic perennial herb to undershrub. Stem erect or pendulous, 20–60 cm high, with 10–30(–50) branches, 10–40 cm long, slender, 2–5 mm in diam., all parts covered with dense white to pale brown hairs, lower part woody, straight or bent, 15–20 cm long, 1.2–1.7 cm in diam., bark brownish, root stock cracked and corky with parallel grooves. Leaves 5–14, opposite decussate, crowded towards the apex of each branchlet when in flower; petiole 3–7 mm long, winged, base amplexicaul and connected to the one opposite; blade coriaceous, elliptic, oblong, or ovate, 2.5–6 × 1.5–2.5 cm, apex obtuse, base cuneate or obtuse (the young ones attenuate), margin slightly crenate, secondary veins 6–8 on each side of midrib, prominent on both sides, densely covered with multicellular glandular hairs above, densely covered with white woolly hairs beneath, these extending beyond margin. Inflorescences 9–20, with a solitary flower or a short cyme of 2–5 flowers, terminal or subterminal, 1–2 flowers opening at a time, young bud densely covered with white arachnoid hairs; peduncle very short, less than 5 mm long; bracts leaf-like, lanceolate, 9–12 × 3–4 mm wide, apex obtuse or mucronate, appressed and close to the lateral sepals; pedicel very short. Calyx cotyliform, 6–8 mm long, 5-lobed, base slightly imbricate, upper 3 lobes fused at base; each lobe triangular, 1–1.5 mm long, apex reflexed and hooded, acute, 2 lower lobes free, elliptic or oblong, 3–6 × 3–3.5 mm, apex acute to acuminate, all 5 lobes green and covered with white arachnoid hairs. Corolla campanulate, c. 2 cm across; tube 1.4–1.8 cm long, limb bilabiate, lower lobe 3-lobed, upper lobe 2-lobed, not symmetrical, base of lobes slightly imbricate; lobes suborbicular, 0.8–1 cm long, 1–1.3 cm wide, apex rounded, pale purple to pale mauve with yellow circular patch at base of lower lobe. Stamens 2; filament white, flattened, somewhat parallel, upper part wider than lower part, 5.5–7 × c. 1.5 mm, fused to corolla tube near base; anthers 1.5–2.5 × 4–5 mm, creamy white or pale brown, mauve at juncture with filament; staminodes 3, narrowly linear, 1.8–2 mm long. Ovary 3–5 mm long, pubescent; style 6–7 mm long, sparsely hairy; stigma linguiform, 4–5 mm long, apex split into 2 lobes. Capsules ellipsoid, 1–1.5 × 0.3–0.5 cm, twisted, covered with dense arachnoid hairs, calyx persistent.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On limestone cliffs and slopes above the river in dry evergreen to mixed deciduous forests.

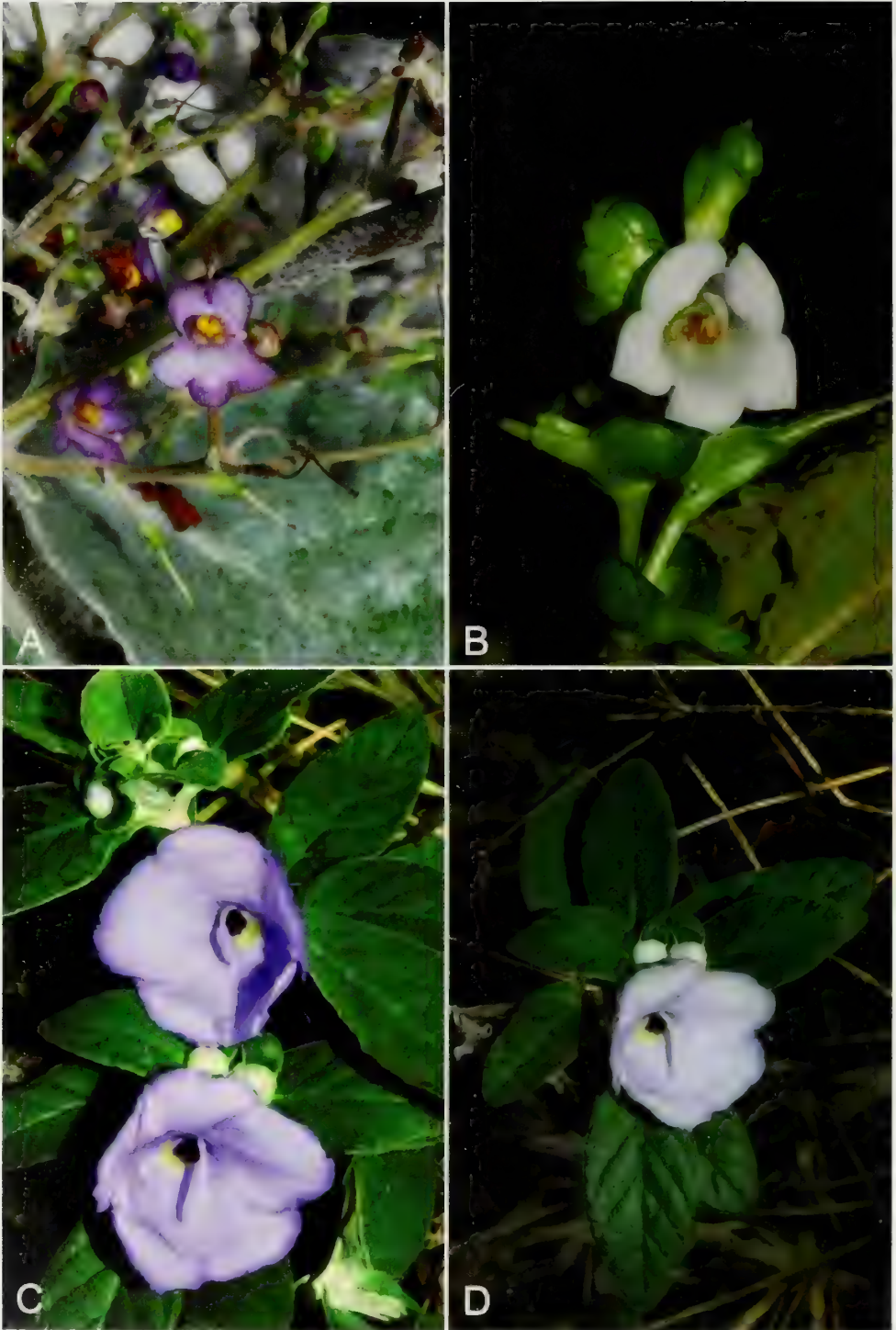


Fig. 1. A. *Paraboea arachnoidea* Triboun. B. *Paraboea axillaris* Triboun. C–D. *Paraboea bhumiboliana* Triboun & Chuchan. (Photos: P. Triboun)

Phenology. Flowering and fruiting in July to December.

Vernacular. Bhumibolin (ภูมิพลินทร์), name given by His Majesty King Bhumibol of Thailand.

Etymology. The specific epithet refers to the collection locality in the Bhumibol Dam area in Lamphun and Tak Provinces in Thailand. The name also honours His Majesty King Bhumibol of Thailand who has taken a keen interest in the conservation of forests and the relationship between people and the environment. This species is dedicated to him on the occasion of his 84th Birthday.

Proposed IUCN conservation assessment. Least Concern. Although this species is only known from the type locality it is on both sides of the boundary of two well legally protected areas and there are a few subpopulations.

Notes. *Paraboea bhumiboliana* is similar to the new species *Paraboea takensis* Triboun in its globose bracts, distinctly showy calyx and white flowers, but it differs in the pubescence on the leaves and often fewer flowers (2–5 in *P. bhumiboliana*, 2–8 in *P. takensis*).

***Paraboea doitungensis* Triboun & D.J.Middleton, sp. nov.** (Fig. 2, Fig. 3A–B)

Paraboeae paramartinii Z.R.Xu & B.L.Burt in *dichasio amplissimo composito terminali vel subterminali et capsulis longis cylindricis similis, sed calycibus spectabilibus, pedicellis brevioribus et bracteis floralibus majoribus obovatis recedit.* TYPUS: *P. Triboun & B. Sonsupab 4041*, 26 July 2008, Thailand, Chiang Rai, Mae Fah Luang District, Doi Tung (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 10–30 cm high, more rarely up to 70 cm, woody root stock stout. Leaves 4–10, opposite decussate and congested at the apex of the stem; petiole narrowly winged, 6–12 cm long; blade papery, ovate, obovate or elliptic, 27–40 × 10.5–12.5 cm, apex acute, base narrowly attenuate onto petiole, margin indistinctly crenate, secondary veins 13–15 on each side of midrib, tertiary veins reticulate, venation obscure above and prominent beneath, mid green and glabrous above, lightly covered with brownish woolly hairs underneath. Inflorescences 1–2, terminal or subterminal compound dichasia, 3–4(–5) orders of branching in each compound dichasium, some congested with 3–4 branches; peduncle dark red or green, 8–35 cm long, 1.5–2 mm in diam., the upper order branching with axes (1.5–)10(–15) cm long; bracts cordiform or linear, the upper ones strongly reduced; flowers paired; pedicels 0.6–1.5 cm long. Calyx green, brown at tips, fused at base for c. 1 mm, 5-lobed; lobes narrowly cylindric, (4.5–)7–7.5 × 0.5–1 mm, apex round, glabrous. Corolla pink, campanulate; tube 7–9 mm long, very pale pink, tinted yellow at base; lobes orbicular or widely ovate, c. 5 × 6–7 mm, apex rounded. Stamens 2, inserted near base of corolla tube; filament creamy white, geniculate, 7–10 mm long, c. 1.5 mm

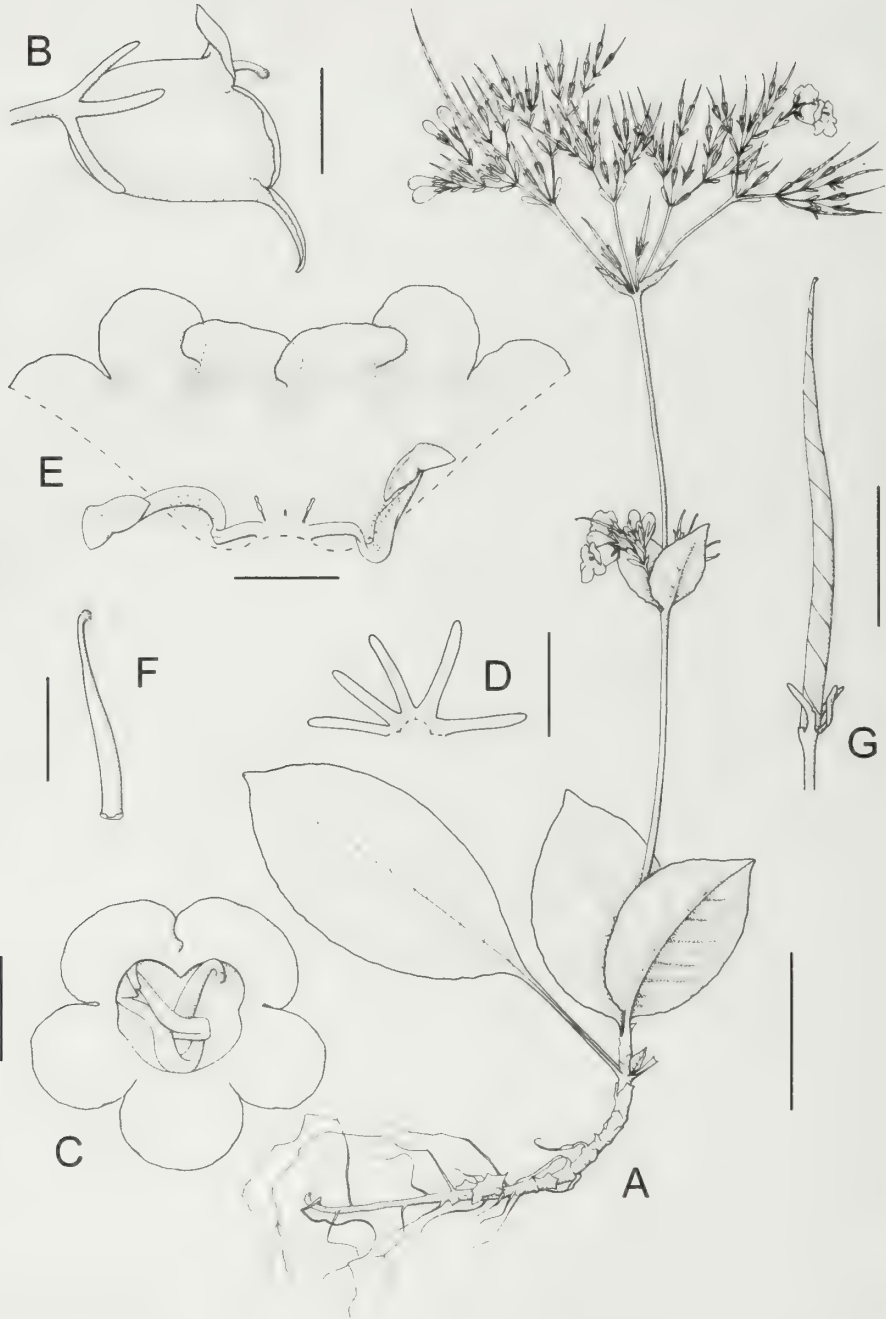


Fig. 2. *Paraboea doitungensis* Triboun & D.J.Middleton. **A.** Habit. **B.** Flower, lateral view. **C.** flower, front view showing enantiostyly. **D.** Calyx opened out. **E.** Corolla opened out. **F.** Ovary and style. **G.** Twisted fruit. Scale bars: A = 5 cm; B–F = 0.5 cm; G = 1.5 cm. (Drawn by Claire Banks)

wide; anthers creamy yellow, c. 2 × c. 4 mm. Staminodes 2–3, white or tinted pink at tip, cylindric, c. 2 mm long, medial staminode not apparent. Disc annular. Ovary ellipsoid, 4–6 mm long, c. 1 mm wide, green; style enantiostylous, white or pale green, 3–4 mm long; stigma capitate with glandular hairs. Capsules narrowly cylindric, 5–6.8 cm long, c. 1.8 mm wide, twisted, glabrous.

Additional specimens examined: THAILAND. **Chiang Rai:** Doi Tam Tu Pu, c. 520 m, 5 October 1924, *H.B.G. Garrett* 204 (K-2 sheets); Mae Fa Luang District, Doi Tung, 1365 m alt., 20°19.6'N 99°50.0'E, 23 September 2008, *D.J. Middleton, P. Karaket, P. Triboun, U. Kawatkul & R. Meeboonya* 4555 (BK, BKF, E); Mae Fa Luang District, summit of Doi Tung, 1510 m altitude, 20°19.6'N 99°50.0'E, 23 September 2008, *D.J. Middleton, P. Karaket, P. Triboun, U. Kawatkul & R. Meeboonya* 4576 (BK, BKF, E).

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. Montane forest on summit of limestone hill, alt. 1100–1450 m.

Phenology. Flowering and fruiting in July to November.

Vernacular. Cha Rue Si Doi Tung (ชาฤๅษีดอยตุง).

Etymology. The specific epithet refers to the collection locality in Doi Tung, Chiang Rai Province in Thailand.

Proposed IUCN conservation assessment. Endangered (EN B1ab(iii,v)). This species is only known from Doi Tung and has an Extent of Occurrence of < 100 km² but is known from two distinct populations. The area is not protected and there has been a reduction in the quality of the habitat through large scale tourism and a reduction in the number of mature individuals.

Notes. Xu et al. (2008) included the specimen *Garrett 204* in *Paraboea paramartinii* Z.R.Xu & B.L.Burt but also suggested that further collecting could reveal that this is an undescribed species. New collections have indeed confirmed that this is a distinct and undescribed species. It is most similar to *Paraboea paramartinii*, with which it shares the characters of a large terminal or subterminal and glabrous inflorescence, papery leaves and long cylindrical capsules, and to *P. martinii* (H.Lév.) B.L.Burt and *P. glutinosa* (Hand.-Mazz.) K.Y.Pan, with which it shares the characters of a terminal or subterminal compound dichasium and long slender cylindrical twisted capsules. However it can be distinguished from these by the showy calyx.

***Paraboea eburnea* Triboun, sp. nov.** (Fig. 3C)

Paraboeae variopilae Z.R.Xu & B.L.Burt inflorescentiis, floribus et fructibus cum pilis glandulis multicellularibus omnino obtectis similis, sed ramis inflorescentiae

compositis monochasialibus, foliis et floribus majoribus differt. TYPUS: *P. Triboun*, *B. Sonstupab* & *P. Yothakaew* 3835, 12 September 2007, Thailand, Ranong, Kraburi, Thum Pra Khayang (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 50–80 cm high, 7–8 mm in diam., greyish brown, woody, 4–6(–10) branches, hanging, young parts covered with rusty brown hairs, woody root stock stout. Leaves 10–20, loosely opposite decussate; sessile; blade papery, oblong, obovate or oblanceolate, 18–23 × 6–7.8 cm, apex obtuse, base attenuate, margin crenate or serrate, secondary veins 8–10 on each side of midrib, tertiary veins reticulate, venation prominent on both sides, sparsely covered in short glandular hairs above, densely covered with brownish woolly hairs beneath. Inflorescences 3–10 (2–4 on each branch), subterminal dichasia with 1(–2) orders of branching, each branch a compound monochasium (rarely dichasial), whole inflorescence densely covered with whitish multicellular glandular hairs; peduncle c. 4 cm long, c. 1.5 mm in diam.; bracts strongly reduced or absent; flowers paired; pedicels 7–9 mm long, covered by whitish multicellular glandular hairs. Calyx green, fused at base for less than 1 mm, 5-lobed; lobes lanceolate, c. 3 × 1 mm, apex obtuse, covered by whitish multicellular glandular hairs. Corolla white, with a short tube and spreading lobes; 2 posterior lobes ovate, c. 7 × c. 5 mm, apex obtuse, 3 anterior lobes oblong to obovate, 9–10 × 6–7 mm, apex obtuse or truncate, the middle lobe longer than the laterals. Stamens 2, inserted near the base of corolla tube; filament white, c. 3 mm long, geniculate; anthers yellow, c. 2.5 × 3.5–4 mm; staminodes 3, white, c. 2.5 mm. Ovary white, ellipsoid, c. 3.5 mm long, covered with short whitish multicellular glandular hairs; style white, c. 4.5 mm long, glabrous; stigma capitate, white. Capsules narrowly cylindrical, 2.2–2.9 × c. 0.2 cm wide, twisted, covered with whitish multicellular glandular hairs.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On rock in shade in evergreen forest on an isolated limestone hill, surrounded by mangrove forest dominated by *Nypa fruticans*, alt. 50–100 m.

Phenology. Flowering and fruiting in late July to November.

Vernacular. Cha Rue Si Pra Kha Yang (ชาถ้ำพระขยงค์).

Etymology. The specific epithet refers to the white flowers.

Proposed IUCN conservation assessment. Critically Endangered (CR D). This species is only known from one small population at the type locality. The population is estimated to contain fewer than 50 individuals and the locality currently has no protected status.

Notes: *Paraboea eburnea* is similar to *Paraboea variopila* Z.R.Xu & B.L.Burt in the complete covering of multicellular glandular hairs on the inflorescences, flowers and



Fig. 3. A–B. *Paraboea doitungensis* Triboun & D.J. Middleton. C. *Paraboea eburnea* Triboun. D. *Paraboea insularis* Triboun. (Photos: P. Triboun)

fruits, but it differs in the compound inflorescence branches being monochasial, the larger leaves (18–23 cm long in *P. eburnea*, 5–17 cm long in *P. variopila*) and larger flowers (upper lobes c. 7 mm long in *P. eburnea*, c. 3.5 mm long in *P. variopila*).

***Paraboea insularis* Triboun, sp. nov.** (Fig. 3D)

Paraboeae suffruticosae (Ridl.) B.L. Burt in habitu et statura, foliis ellipticis usque lanceolatis, et florum fructuumque magnitudinum similis, sed partibus inflorescentiarum ultimis dense congestis et corollis violascenti-caeruleis differt. TYPUS: *P. Triboun*, B. Sonsupab & P. Yothakaew 4587, 25 September 2010, Thailand, Phangnga, limestone island border of Phang-gna-Krabi bay (holo BK; iso E).

Lithophytic perennial herb to subshrub. Stem erect, 7–20 cm high, solitary or with 2–4 twigs, 3–6 mm in diam., grey, deeply grooved and corky, root stock stout and rough. Leaves 8–16, arranged in a whorl or slightly opposite decussate, densely congested at the apex; petiole yellowish brown, 0.5–2 cm long, sulcate, densely covered with short brown woolly hairs; blade coriaceous, elliptic to lanceolate, 5–8 × 1.4–2.6 cm, apex acute, base cuneate, margin slightly crenate, glaucous, densely covered with multicellular glandular hairs above, densely covered with light brown woolly hairs beneath, secondary veins 14–17 on each side of midrib, prominent beneath, tertiary veins reticulate, obscure on both sides. Inflorescences 1–3, subterminal, mostly compound dichasium, rarely pleiochasial at first node, 3–4 orders of branching; peduncle green or brown, 5–9 cm long, c. 1.5 mm in diam., densely covered with short light brown hairs; bracts leafy, elliptic, 1–2.5 × 0.3–0.7 cm, apex obtuse, densely covered with light brown arachnoid hairs; the first order branch axis long and slender, 3–6 cm long, c. 0.5 mm in diam., densely covered with short light brown hairs, subtended by leafy bracts and without a flower at the branching point, the upper orders densely congested, less than 1 cm long; flowers paired; pedicels 0.3–1 cm long, densely covered with light brown hairs. Calyx light brown, fused at base for c. 1 mm, 5-lobed; lobes narrowly linear, 2–3.5 × c. 0.5 mm, apex obtuse, densely covered with light brown woolly hairs. Corolla violet-blue, with a short tube and 2-lipped spreading limb, tube 3–5 mm long, the lower lip much longer; 2 posterior lobes orbicular, c. 3 × c. 3 mm, apex rounded, 3 anterior lobes unequal, 2 lateral ones obovate, 3–3.5 × c. 3.5 mm, the middle one orbicular, c. 3.5 × c. 3 mm, apex rounded. Stamens 2; inserted near base of corolla tube; filament white, c. 3 mm long, geniculate; anthers yellow, c. 2 × c. 3.5 mm; staminodes 2, c. 1.5 mm long. Ovary creamy white, ellipsoid, c. 3 mm long, glabrous; style white, c. 3 mm long; stigma capitate, white. Capsules ellipsoid, 6–8 × 1.5–2 mm, twisted, glabrous.

Additional specimens examined: THAILAND. **Krabi:** Koh Hin Bai, 31 October 2006, *P. Triboun* 3673 (BK, E).

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. In open sun on limestone cliffs, alt. 10–150 m.

Phenology. Flowering and fruiting in July to November.

Vernacular. Sud Sa Khon (สุดสาคร).

Etymology. The specific epithet refers to the collection locality on limestone islands in Phangnga-Krabi Bay in Thailand.

Proposed IUCN conservation assessment. VU D1. Although this species is only known from the type locality this is in a legally protected area. It is difficult to estimate the population size as the plants are on inaccessible cliffs but is likely to be between 250 and 1000 mature individuals.

Notes. *Paraboea insularis* is similar to *Paraboea suffruticosa* (Ridl.) B.L.Burtt in its habit and overall size, elliptic to lanceolate leaves, flower and fruit sizes, but it differs in the densely congested ultimate parts of the inflorescences and the violet-blue corollas.

***Paraboea lavandulodora* Triboun, sp. nov. (Fig. 4A)**

Paraboeae glabrescenti (Barnett) C.Puglisi *floribus binatis in monochasiis compositis densis aggregatis, bracteis globosis et corollis dilute caeruleis similis, sed foliis sessilibus, inflorescentiis brevibus et partibus plurimis cum trichomatibus glandulis viscidis tectis differt.* TYPUS: *P. Triboun* 4433, vouchered from material flowering at BK on 11 April 2010, originally collected in the wild, Thailand, Bung Kan, Phu Tok (holo BK).

Lithophytic perennial herb. Stem erect, 16–45 cm high, 2–4 mm in diam., brown. Leaves 8–15, shortly opposite decussate; sessile; blade coriaceous, elliptic, lanceolate or obovate, 5–7 × 2–4 cm, apex acute, base broadly attenuate, margin serrate, covered with short multicellular glandular hairs on both sides, sticky, also covered with light brown arachnoid hairs, secondary veins 6–8(–10), prominent on both sides, tertiary veins reticulate. Inflorescences 2–3, subterminal or axillary; compound monochasia, rather dense; peduncle c. 9 cm long, 2–2.3 mm in diam., covered with multicellular glandular hairs, bracts green, globose, 0.8–1.1 × c. 1 cm, apex rounded or shallowly lobed, base slightly plicate, covered with multicellular glandular hairs; paired flowers 3–5; pedicels c. 7 mm long, unequal, green, covered with multicellular hairs. Calyx cotyliform, 5-lobed, upper 3 lobes fused at base; each lobe linear to elliptic, 7–7.5 × c. 3.5 mm, apex obtuse, 2 lower lobes fused together at the base, free from the upper ones, lobes lanceolate to elliptic, c. 8.5 × c. 3.5 mm, apex obtuse, covered by short glandular hairs. Corolla light blue, campanulate; tube 8–9 mm long; lobes widely ovate, 5.5–6 × 9–9.5 mm, apex rounded. Stamens 2, inserted near base of corolla tube; filament white, c. 4.5 × c. 1 mm, flattened, geniculate; anthers creamy yellow, c. 2 ×

c. 4.5 mm; staminodes 3, white, linear, c. 1.5 mm long. Disc annular, c. 0.3 mm high. Ovary light green, ellipsoid, c. $3 \times c. 1.8$ mm, glabrous; style 5–5.5 mm long; stigma white, linguiform, c. $3 \times c. 1$ mm, apex bilobed. Capsule not seen.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On sandstone cliffs in shade of mixed deciduous forest.

Phenology. Flowering in May to July (data only from cultivation).

Vernacular. Cha Rue Si Bai Hom (ชาฤๅษีใบหอม).

Etymology. The specific epithet refers to the mild lavender-like scent, particularly noticeable in the leaves of fresh plants.

Proposed IUCN conservation assessment. Near Threatened. This species is only known from the type locality which is in the grounds of a temple. This means that it has no formal protected status but is unlikely to be under any immediate threat. However, we are unsure of the population size and the total distribution of the species is restricted. It requires regular monitoring of its status to see if it requires a higher threat status.

Notes. *Paraboea lavandulodora* is similar to *Paraboea glabrescens* (Barnett) C. Puglisi in its paired flowers in dense compound monochasia, globose bracts and the light blue corollas, but it differs in the sessile leaves, short inflorescences (peduncle c. 9 cm long in *P. lavandulodora*, 10–15 cm in *P. glabrescens*) and having most parts covered with sticky glandular trichomes.

***Paraboea monticola* Triboun & D.J. Middleton, sp. nov.** (Fig. 4B–C)

Paraboeae regulari (Ridl.) Ridl. *magnitudine ubique parva et fructibus rectis similis, sed foliis tenuibus chartaceisque, petiolis multo longioribus et tenuibus, floribus fructibusque multis differt.* TYPUS: *P. Triboun* 3662, 25 September 2006, Thailand, Phangnga, Tai Toy (holo BK; iso E).

Lithophytic perennial herb or subshrub. Stem erect, 10–35 cm high, solitary or in clumps of 2–6 shoots, c. 4 mm in diam., light brown or grey, woody root stock slender and striped. Leaves 6–15, arranged densely in whorls or alternate and congested at the apex; petiole slender, (1.5–)4(–7) cm long, the ones lower on the plant longer, sulcate, densely covered with short brown hairs; blade papery, obovate, oblanceolate, ovate or elliptic, 4–10.5 \times 2.5–5.5 cm, apex acute, base oblique, cuneate or rounded, margin serrate or cuneate, glabrous above, densely covered with short hairs and furfuraceous beneath; secondary veins 7–10 on each side of midrib, tertiary veins finely reticulate, prominent on both sides. Inflorescences 5–15, axillary or subterminal, compound

dichasia, 2–4 orders of branching; peduncle thin and slender, 1–4 cm long, c. 0.5 mm in diam., furfuraceous; bracts reduced, linear, 1–3.5 × c. 0.3 mm, the upper ones strongly reduced, apex acute; flowers paired, pedicels thin and slender, 0.5–1.5 cm, furfuraceous. Calyx greenish brown; fused at base for c. 0.5 mm long, 5-lobed; lobes linear, c. 2 mm long, apex obtuse, furfuraceous. Corolla white, with a short tube and spreading lobes; tube c. 1.5 mm long; lobes ovate to obovate, 6–9 × c. 6.5 mm, apex rounded. Stamens 2, inserted near base of corolla tube; filament white, c. 2.5 mm, geniculate; anthers yellow, c. 2 × 2 mm; staminodes strongly reduced, c. 1.5 mm, white. Ovary light green, ellipsoid, c. 1.3 × 0.7 mm; style white, c. 2.5 mm; stigma capitate, white with green at tip. Capsules cylindric, 0.8–1 × c. 1.5 mm, straight, glabrous or furfuraceous.

Additional specimens examined: THAILAND. **Surat Thani:** Phanom District, Khlong Phanom National Park, trail from Park headquarters, 200 m altitude, 8°52'4"N 98°40'6"E, 7 September 2008, *D.J. Middleton, P. Triboun, V. Chamchumroon, S. Saengrit & R. Simma* 4363 (E); Phanom District, Khao Sok National Park, 100–200 m altitude, 12 December 1979, *T. Shimizu, H. Toyokuni, H. Koyama, T. Yahara & C. Niyomdham* T-27069 (L). **Phangnga:** Muang Phangnga, 25 September 2006, *P. Triboun* 3662 (E); Pulau Panji, 2 December 1928, *Haniff & Nur* 4013 (K).

Distribution. Endemic to Thailand. Known only from Phangnga and Surat Thani Provinces.

Ecology. On shaded limestone rocks in evergreen forest, alt. 20–200 m.

Phenology. Flowering and fruiting in late June to October.

Vernacular. Cha Pho Ta Rue Si (ชาพ้อตาฤๅษี).

Etymology. The specific epithet refers to its collection localities in low but rugged hilly areas in Phangnga and Surat Thani Provinces in Thailand.

Proposed IUCN conservation assessment. Vulnerable (VU B1ab(iii,v)). This species is relatively widespread over two provinces and known from several populations, some of which are in legally protected areas and others which are not. The Extent of Occurrence is < 20,000 km² and those populations not in protected areas are in decline due to habitat disturbance.

Notes. *Haniff & Nur* 4013 (K) was included in *Paraboea regularis* (Ridl.) Ridl. by Xu et al. (2008). Although *Paraboea monticola* is similar to *Paraboea regularis* in its small stature and straight fruits it differs in having thin papery leaves, much longer and slender petioles and many flowers and fruits. With the removal of *Haniff & Nur* 4013 from *Paraboea regularis* this species is now not known from Thailand.

***Paraboea nana* Triboun & Dongkumfu, sp. nov.** (Fig. 4D)

Paraboeae birmanicae (Craib) C. Puglisi magnitudine ubique parva, petiolis oppositis conjungentibus trans nodum auriculam formantibusque et floribus parvis similis, sed floribus in inflorescentia paucioribus, pedicellis robustis et corollis dilute caeruleis recedit. TYPUS: *P. Triboun & W. Dongkumfu* 4035, 18 July 2008, Thailand, Lamphun, Li District, Mae Ping National Park, Kor Noi Falls (holo BK; iso BKF, E).

Lithophytic perennial herb or subshrub. Stem erect, 10–25 cm high, few branches with many shoots, glaucous, woody root stock slender. Leaves 8–14, loosely opposite decussate; petiole brown, 1–1.3 cm long, forming an auricle with the opposite petiole at the node, sparsely covered with glandular hairs; blade coriaceous, ovate or elliptic, 3.2–5.3 × 1.4–2.4 cm, apex acute or obtuse, base cuneate, margin slightly crenate, densely covered with multicellular glandular hairs above, densely covered with brown wooly hairs beneath, secondary veins 3–5 on each side of midrib, prominent beneath. Inflorescence 1–2 flowers only, monochasia, subterminal and axillary; bract linear, c. 1 cm × 1.5–2 mm, light brown covered with white arachnoid hairs; pedicel robust, 2.2–3 cm long (up to 4 cm when fruiting), unequal, light brown covered with white arachnoid hairs. Calyx cotyliform, 5–6 mm long, 5-lobed, slightly imbricate at base, upper 3 lobes fused at base; each lobe ovate to obovate, c. 5 × 5–5.5 mm, apex obtuse, 2 lower lobes free, ovate to oblong, c. 4 × c. 5 mm, apex obtuse, covered with light brown arachnoid hairs. Corolla light blue, campanulate; tube light blue to nearly white, 8–9 mm long; lobes broadly ovate, c. 5 × 4.5–7 mm, apex rounded or obtuse. Stamens 2, filament white, c. 3 mm long, geniculate; anthers creamy yellow, c. 3 × c. 2 mm; staminodes 2, 0.5–0.6 mm long. Ovary subglobose, 1.5–2 mm long; style white, c. 3.5 mm long, covered with glandular hairs; stigma linguiform, c. 1.5 mm, white. Capsules ovoid, 1–1.4 cm long, twisted, covered with white arachnoid hairs, surrounded by persistent calyx.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On limestone cliffs in dry evergreen to mixed dipterocarp forests, alt. 600–900 m.

Phenology. Flowering and fruiting in late June to October.

Vernacular. Cha Rue Si Noi (ชาภูเขีน้อย).

Etymology. The specific epithet refers to the very small stature of the plant and the particularly small flowers amongst those plants previously referred to *Trisepalum*.

Proposed IUCN conservation assessment. Least Concern. Although this species is only known from the type locality it is on both sides of the boundary of two legally protected areas and there are a few subpopulations.

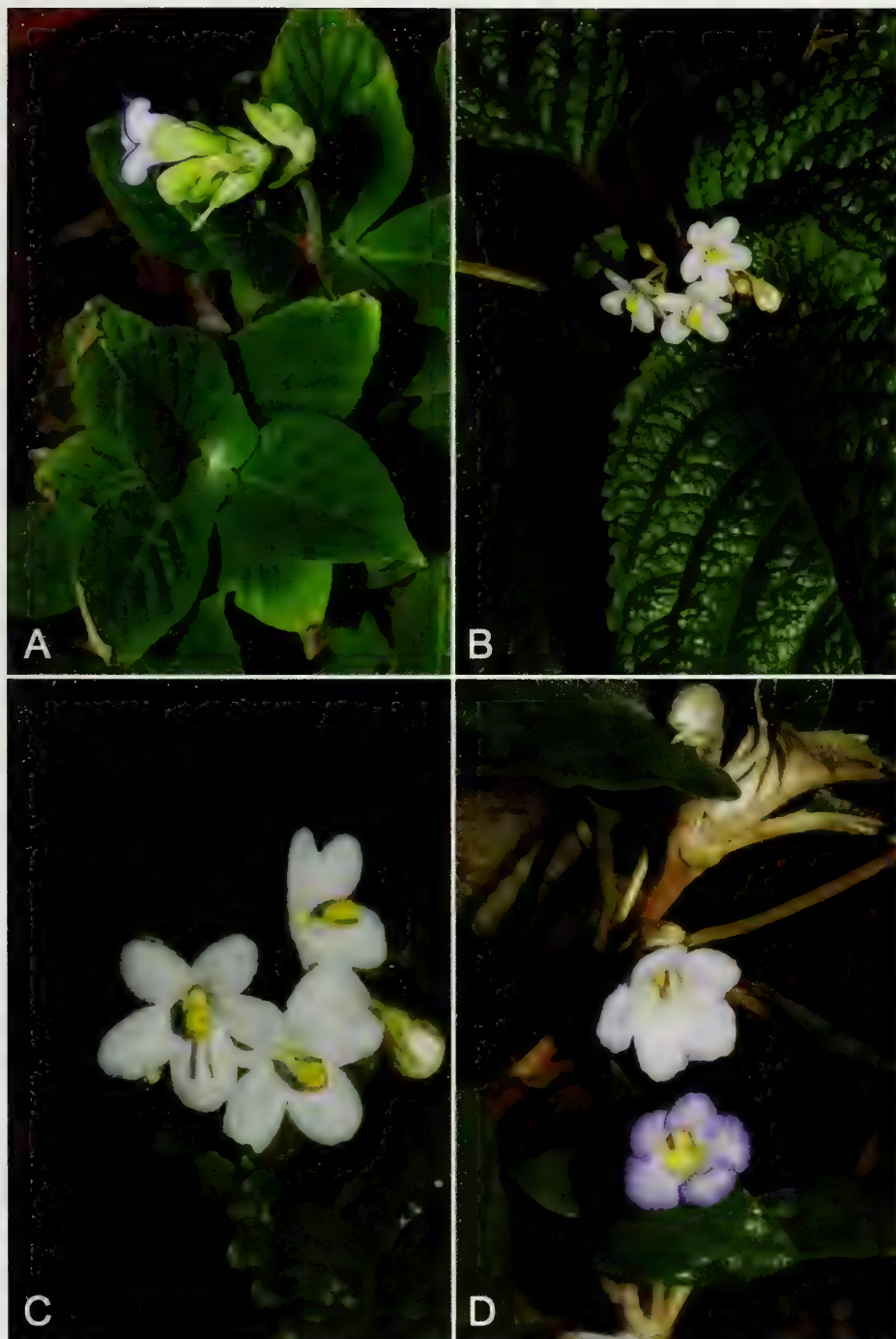


Fig. 4. A. *Paraboea lavandulodora* Triboun. B–C. *Paraboea monticola* Triboun & D.J. Middleton. D. *Paraboea nana* Triboun & Dongkumfu. (Photos: P. Triboun)

Notes. *Paraboea nana* is similar to *Paraboea birmanica* (Craib) C. Puglisi in its small overall size, the opposite petioles joining and forming an auricle across the node and the small flowers, but it differs in the fewer flowers in an inflorescence (1–2 in *P. nana*, 4–10 in *P. birmanica*), the robust pedicels and the light blue corollas.

***Paraboea nobilis* Triboun & D.J. Middleton, sp. nov.** (Fig. 5A)

Paraboeae phanomensi Triboun & D.J. Middleton pedunculo pedicelloque tenui, foliis lanceolatis et magnitudine ubique similis sed pedicellis longioribus, floribus paucioribus et majoribus, lobis corollae atriore caeruleis recedit. TYPUS: D.J. Middleton, P. Triboun, V. Chamchumroon, S. Saengrit & R. Simma 4312, 6 September 2008, Thailand, Surat Thani, Ban Thakhun subdistrict, Khao Sok National Park (holo BK; iso BKF, E, K, KEP).

Lithophytic perennial herb or small shrub. Stem erect, 25–50 cm high, branches many, c. 20 cm long, c. 6.5 mm in diam., woody root stock robust and rough. Leaves many, 10–15 on each shoot, arranged rather densely opposite decussate; petiole 1.5–2 cm long, sulcate, covered with light brown wooly hairs; blade coriaceous, lanceolate or oblong, 6–9 × 1.4–2.6 cm, apex obtuse or acute, base cuneate, margin indistinctly crenate, loosely covered with white arachnoid hairs above, glaucous and densely covered with light brown wooly hairs beneath, secondary veins 10–13 on each side of midrib, tertiary venation not visible, prominent on both sides. Inflorescences 4–5, subterminal or axillary, mostly a single flower or rarely 1 pair of monochasia; bracts brown, coriaceous, globose, 1.3–1.5 cm, hooded, lightly rugose, apex rounded or acute, a protruding bulge present around the middle to base on the outside, outside light brown and densely covered with wooly hairs, inside green and glabrous; pedicel and peduncle 3–5.5 cm long, c. 1.3 mm in diam., densely covered with wooly hairs. Calyx cotyliform, tube 5–6 mm long, 3-lobed; lobes obovate, dorsal lobe c. 1.2 × c. 0.9 cm, lateral lobes c. 1 × c. 0.6 cm, apex acute, margin fimbriate, densely covered with light brown wooly hairs. Corolla campanulate; tube white, c. 1.5 cm long; lobes violet-blue, widely globose or widely ovate, 1.2–1.5 × 1.3–1.5 cm, apex rounded, margin plicate and fringed. Stamens 2; filaments white, c. 5 mm long, geniculate; anthers yellowish brown, c. 4 × c. 6 mm; staminodes 3, linear, 2–2.5 mm long. Ovary ovoid, c. 5 × c. 3 mm, covered with white arachnoid hairs; style white, c. 7 mm long; stigma linguiform, c. 8 mm long, white. Capsules woody, ellipsoid, c. 2.7 × c. 0.7 cm, twisted, glaucous and loosely covered with white arachnoid hairs, surrounded by persistent calyx.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On limestone rocks in evergreen forest, alt. 100–300 m.

Phenology. Flowering and fruiting in May to October.

Vernacular. Sri Ra Cha Pra Pha (ศรีรัชประภา).

Etymology. The specific epithet refers to its large and spectacular flowers, coupled with an attractive leaf shape, all in pleasant proportion to the size of the plant.

Proposed IUCN conservation assessment. Endangered (EN D). This species is only known from the type locality which is in a legally protected area. Although, the exact size of the population is uncertain we estimate that it is between 50 and 250 individuals.

Notes. *Paraboea nobilis* is most similar to another new species, *Paraboea phanomensis* Triboun & D.J. Middleton, in its slender peduncle and pedicel, lanceolate leaves and overall size, but it differs in longer pedicels (3–5.5 cm in *P. nobilis*, 2–6 mm in *P. phanomensis*), fewer (1–2 in *P. nobilis*, 2–5 in *P. phanomensis*) and larger flowers (corolla tube 1.5 cm in *P. nobilis*, 1–1.3 cm in *P. phanomensis*) and darker blue corolla lobes.

Paraboea peninsularis Triboun & D.J. Middleton, **sp. nov.** (Fig. 5B–C)

Paraboeaeae barnettiae C. Puglisi in habitu et statura, foliis lanceolatis, inflorescentiis longis et capsulis tortis cylindricis similis sed foliorum apicibus acutis, bractearum apicibus rotundis et corollis albis differt. TYPUS: *P. Triboun* & *P. Yothakaew* 4300, 31 July 2009, Thailand, Krabi, Hat Nop Parat Thara (holo BK; iso E).

Lithophytic perennial herb to small shrub. Stem erect, 20–65 cm high, 10–20 branches, 10–20 cm long, c. 2 mm in diam., woody root stock thick and rough. Leaves many (10–20 on each shoot), loosely opposite decussate; petiole 0.6–1.5 cm long, sulcate, densely covered with short brown hairs; blade coriaceous, lanceolate, 6.5–10 × 2.3–3 cm, apex acute, base cuneate, margin indistinctly crenate, secondary veins 7–10 on each side of midrib, prominent beneath, above shiny green and glabrous, densely covered with brownish woolly hairs beneath. Inflorescences 1–2, subterminal, compound monochasia, c. 6 cm long; peduncle 5–7 cm long, c. 2 mm in diam., square in cross-section, densely covered with light brown woolly hairs; bracts globose, 1.4–1.7 cm, apex rounded, hooded, outside densely covered with light brown woolly hairs, inside green and glabrous; flowers paired c. 6; pedicels 2–8 mm long, unequal, densely covered with light brown woolly hairs. Calyx cotyliform c. 1 cm long, 3-lobed, almost free; lobes globose, c. 1.3 cm, apex rounded or obtuse and fimbriate, densely covered with light brown woolly hairs. Corolla white, campanulate; tube c. 1 cm long; lobes orbicular, c. 0.6 × 0.9–1.1 cm, apex rounded. Stamens 2; filament creamy white, 4–5 mm long, geniculate; anthers yellow, c. 2 × c. 4 mm; staminodes 2, linear, c. 2.5 mm long. Ovary ovoid, c. 4.5 × c. 2 mm, densely covered with woolly hairs; style white, c. 6.5 mm long; stigma linguiform, 3.5–4 mm long, white. Capsules cylindrical, c. 2 × c. 0.5 cm, twisted, densely covered with light brown woolly hairs.

Additional specimens examined: THAILAND. **Krabi:** Muang Krabi District, Ko Phi Phi National Park, small limestone island on Nop Parat Thara Beach, alt. 5 m, *D.J. Middleton, P. Triboun, V. Chamchumroon, S. Saengrit & R. Simma 4449* (BK, BKF, E).

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On rocks in dry evergreen forest on limestone island near shore, alt. 20–100 m.

Phenology. Flowering and fruiting in June to October.

Vernacular. Sin Sa Mut (สินสมุทร).

Etymology. The specific epithet refers to Peninsular Thailand in which Krabi Province is to be found.

Proposed IUCN conservation assessment. Endangered (EN D). This species is only known from the type locality which is in a legally protected area. Although, the exact size of the population is uncertain we estimate that it is between 50 and 250 individuals.

Notes. *Paraboea peninsularis* is similar to *Paraboea barnettiae* C.Puglisi in its habit and overall size, lanceolate leaves, long inflorescences and twisted cylindrical capsules, but it differs in having acute leaf apices, rounded bract apices and white corollas.

This species was referred to as *Trisepalum* sp. nov. 2 in Puglisi et al. (2011).

Paraboea phanomensis Triboun & D.J. Middleton, **sp. nov.** (Fig. 5D, Fig. 6)

Paraboeae albidae (Barnett) C.Puglisi *magnitudine ubique magna, bracteis globosis et foliorum forma similis, sed foliorum pagina superiore glabra, bracteis cum apice acuto, inflorescentiis cum axibus ultimis dense fasciculatis et capsulis minoribus differt.* TYPUS: *D.J. Middleton, P. Triboun, V. Chamchumroon, S. Saengrit & R. Simma 4365*, 7 September 2008, Thailand, Phanom District, Khlong Phanom National Park, Trail from Park headquarters (holo BK; iso BKF, E, K, KEP, L).

Lithophytic perennial herb to small shrub. Stem erect, 25–60 cm high, branches many, 20–40 cm long, 3–3.5 mm in diam., woody root stock robust and finely striate. Leaves many, 10–16 on each shoot, arranged densely opposite decussate; petiole 1.4–2 cm long, sulcate, covered with light brown woolly hairs; blade coriaceous, lanceolate, 4.5–8(–12) × 2–2.8(–3.7) cm, apex acute or subacute, base cuneate, margin crenate, glabrous or loosely covered with white arachnoid hairs above, glaucous and densely covered with light brown woolly hairs beneath, secondary veins 10–13 on each side of midrib, prominent beneath. Inflorescences 4–8, subterminal or axillary, compound monochasia, axis 1.5–3 cm long, 1–2 flowers at each node; peduncle slender, 3–6 cm long, 0.8–1 mm in diam., glaucous, hairs

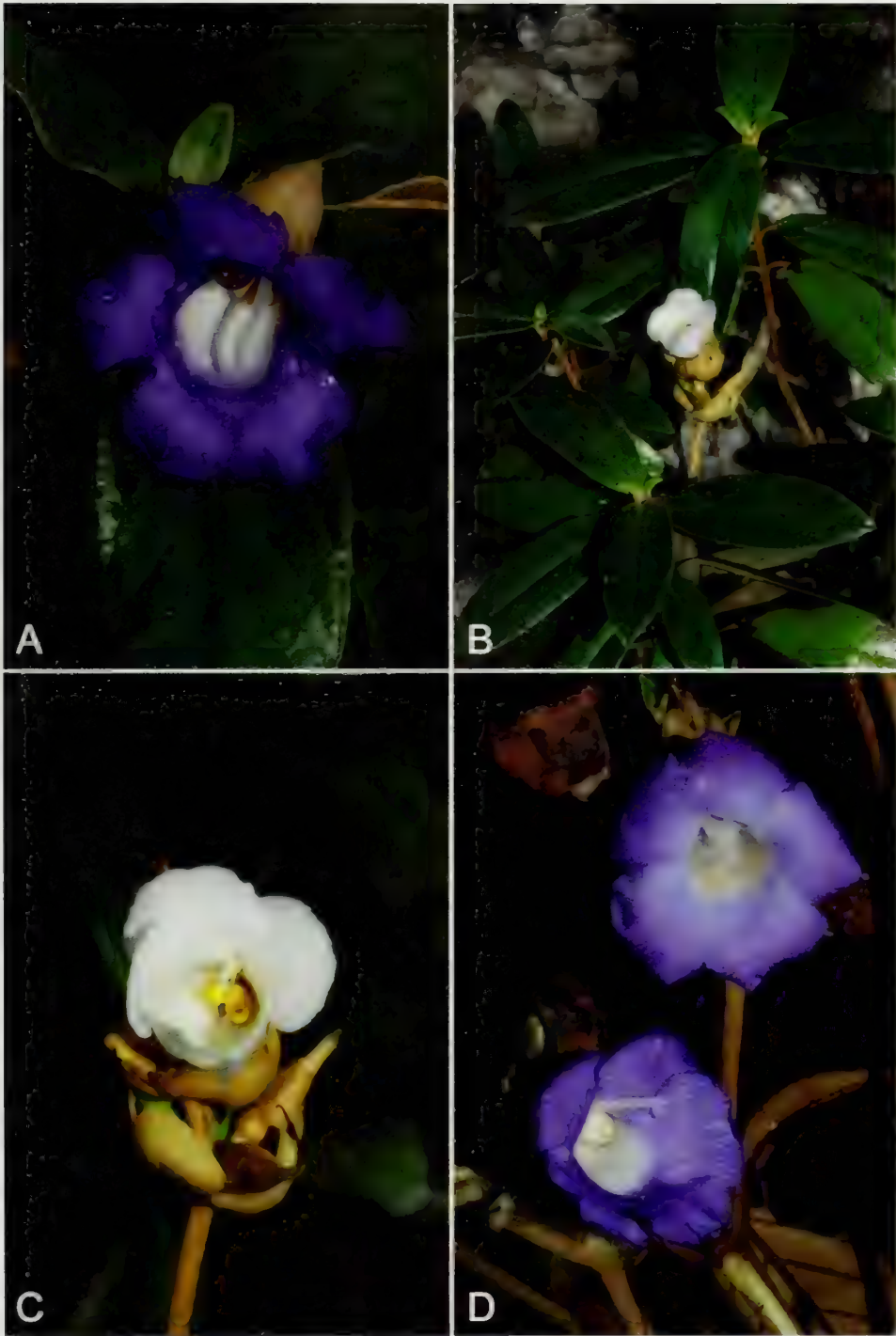


Fig. 5. **A.** *Paraboea nobilis* Triboun & D.J. Middleton. **B–C.** *Paraboea peninsularis* Triboun & D.J. Middleton. **D.** *Paraboea phanomensis* Triboun & D.J. Middleton. (Photos: P. Triboun)

sparse; bracts globose, 0.8–1 × c. 0.8 cm, hooded, apex sharply acute, outside light brown and densely covered with white woolly hairs, inside green and glabrous; pedicels 2–6 mm, unequal, densely covered with white or light brown woolly hairs. Calyx cotyliform, 3-lobed, almost free; posterior lobe oblong to elliptic, 6–8.5 × 3–4.5 mm, apex sharply acute, margin fimbriate, 2 interior lobes linear to lanceolate, c. 7 × c. 2 mm, apex acute, margin fimbriate. Corolla campanulate; tube white or pale pink, (7–)1–1.3 cm long; lobes light blue, pink or pale blue, broadly globose or broadly ovate, (0.6–)0.8–0.9 × 0.9–1.3 cm, apex rounded, margin fringed. Stamens 2; filaments creamy white, c. 5.5 × c. 2 mm, geniculate, flattened; anthers c. 2.5 × c. 4 mm, yellow; staminodes 2–3, linear, c. 1 mm long, white, medial staminode not apparent. Ovary ovoid, c. 5 mm, densely covered with brown woolly hairs; style white, 6–8 mm long; stigma linguiform, 4–6 mm long, white. Capsules woody, cylindrical to ellipsoid, 2–2.7 × 0.3–0.45 cm, twisted, glaucous and densely covered with brown woolly hairs, surrounded by persistent calyx.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On limestone rocks at edge of evergreen forest, alt. 100–300 m.

Phenology. Flowering and fruiting in May to October.

Vernacular. Sri Su Rat (ศรีสุราษฎร์).

Etymology. The specific epithet refers to the collection locality in Khlong Phanom National Park, Surat Thani province in Thailand.

Proposed IUCN conservation assessment. Least Concern. This species is known from several populations over a wide area. Some of these populations are not in protected areas and monitoring is necessary to assess whether this species may qualify for a threat category in the future.

Notes. *Paraboea phanomensis* is similar to *Paraboea albida* (Barnett) C. Puglisi in its large overall size, globose bracts and leaf shape, but it differs in the glabrous upper leaf surface, the acute apex to the bracts, inflorescences with densely clustered ultimate axes and smaller capsules (2–2.7 cm long in *P. phanomensis*, 2.3–3 cm long in *P. albida*).

Several new species from a range of families have been described from Khlong Phanom National Park in recent years (e.g. Lindsay & Middleton, 2004; Phupathanapong, 2006; Lindsay et al., 2008; Inthachub et al., 2009) even though this is a relatively small National Park. It is fairly accessible and many of these species may eventually also be found in the more difficult terrain of the neighbouring Khao Sok National Park.

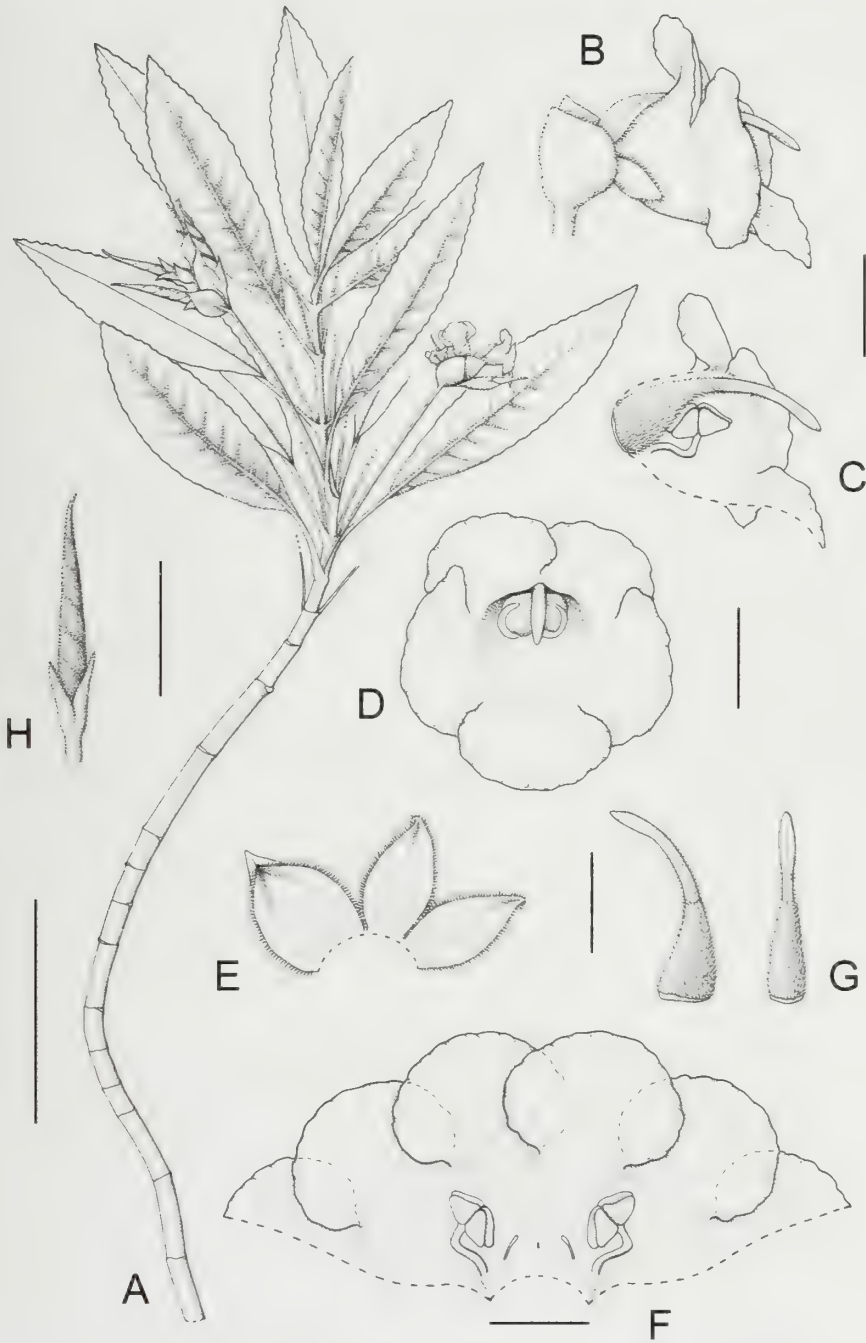


Fig. 6. *Paraboea phanomensis* Triboun & D.J.Middleton. **A.** Habit. **B.** Flower, lateral view. **C.** Flower, lateral view cross section. **D.** Corolla opening. **E.** Calyx opened out. **F.** Corolla opened out. **G.** Ovary and style front and lateral views. **H.** Twisted fruit. Scale bars: A = 5 cm; B–G = 0.5 cm; H = 1.5 cm. (Drawn by Claire Banks)

***Paraboea quercifolia* Triboun, sp. nov. (Fig. 7A)**

Ab aliis speciebus generis combinatione characterum sequentium: caulis brevis tenuisque lignosus ad apicem cum foliis congestis, inflorescentiae pilis glandulis minutis viscidis dense obiectae, calyx 5-partitus cum lobis anguste ovatis et corollae violaceo-caeruleae. TYPUS: *P. Triboun* & *P. Yothakaew* 4296, 18 June 2009, Thailand, Lopburi, Sri Samrong-Chibadan, Khao Tumbol, Wat Tham Wiweg Sri Sawat (holo BK; iso E).

Lithophytic perennial herb, solitary or in clumps, stem 5–10 cm high with 2–3 shoots, woody rootstock cracked and rough. Leaves 10–20, arranged in a dense rosette at the top of the stem; sessile; blade lanceolate, elliptic or oblong, 3–6.5 cm × 2.5–3.5 cm, the lower ones larger than the upper ones, apex acute or obtuse, margin crenate but entire near the base, green above, light brown beneath, secondary veins 4–5 on each side of midrib, obscure above, prominent beneath, both sides with dense glandular hairs and a sparse covering of arachnoid hairs. Inflorescences 1–4, subterminal, 2–4 times branched in each compound dichasium; peduncle red, 6–15 cm long, 2–3 mm in diam., covered with dense red multicellular glandular hairs, tips of hairs with yellow sticky substance; bracts linear, the upper ones strongly reduced; bracteoles reduced or absence; flowers paired; pedicels up to 3 cm long, those of a pair unequal in length. Calyx greenish brown, c. 5 mm long, fused at base for c. 1 mm, 5-lobed; lobes narrowly ovate, covered with dense tiny glandular hairs. Corolla violet-blue, with a short tube and spreading lobes; tube c. 4.5 mm long; 2 posterior lobes ovate or obovate, c. 5 × c. 5.5 mm, apex rounded; 3 anterior lobes orbicular to ovate, c. 7 × c. 6 mm, apex rounded, the middle one hooded at apex. Stamens 2, inserted near base of corolla tube; filament mauve, geniculate, c. 3 mm long, c. 0.8 mm wide; anthers yellow, c. 3 × c. 3 mm. Staminodes 2, white, ± triangular, 1–2 mm long, medial staminode not apparent. Disc annular. Ovary ovate, c. 2 mm long, green, covered with tiny glandular hairs. Style mauve, 3–4 mm long. Stigma capitate, yellowish brown. Capsules narrowly cylindrical, 0.8–1 × c. 0.1 cm, twisted.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. Mixed deciduous forest on summit of limestone hill, alt. 100–300 m.

Phenology. Flowering and fruiting in late May to August.

Vernacular. Cha Rue Si Bai Ko (ชาฤๅษีใบก้อ).

Etymology. The specific epithet refers to the oak-like, deeply crenate leaf margin.

Proposed IUCN conservation assessment. Critically Endangered (CR B1ab(iii,v)). This species is only known from the type locality which is in the grounds of a temple surrounded by farmland and prone to fire damage.

Notes. *Paraboea quercifolia* differs from all other species in the genus by the combination of a short and slender woody stem with congested leaves at top of stem, the inflorescences densely covered in minute sticky glandular hairs, the calyx 5-partite with narrowly ovate lobes and violet-blue corollas.

***Paraboea rosea* Triboun, sp. nov.** (Fig. 7B)

Paraboeae arachnoideae Triboun *magnitudine ubique magna, foliis rosulatis, partibus plantae plurimis pilis arachnoideis dense obtectis et floribus densis similis, sed in foliis cum pilis arachnoideis minus densis, foliis lanceolatis, pedunculis brevioribus, corollis rubescentibus et capsulis longioribus recedit.* TYPUS: *P. Triboun, P. Blenchitra & B. Sonsupab* 3844, 14 September 2007, Thailand, Krabi, Mu Koh Lanta, Koh Talabeng (holo BK; iso E).

Lithophytic perennial herb to subshrub. Stem erect, 10–40 cm high, 1–1.8 cm in diam., hard and woody, robust, grooved, cracked and rough, densely covered with petiole scars, covered with light whitish brown arachnoid hairs, woody root stock stout. Leaves 10–15, arranged in a dense rosette at the top of the stem; petiole 3–5.5 cm long, 5–7 mm in diam., densely covered with very light whitish brown arachnoid hairs; blade sub-coriaceous, lanceolate, 8–16 × 3–6.5 cm, apex acute or obtuse, base crenate or slightly attenuate, margin crenate, secondary veins 7–9 on each side of midrib, tertiary veins reticulate, densely covered with short multicellular glandular hairs but somewhat obscured by white arachnoid hairs above, densely covered with whitish brown arachnoid hairs beneath. Inflorescences 1–3, subterminal, compound pleiochasia, loosely congested 4–6 branches at each node, 3–6 orders of branching in each branch, 1–2 terminal orders mostly compound dichasia; peduncle 10–15 cm long, c. 2.5 mm in diam, sulcate, covered with white arachnoid hairs; bracts lanceolate, c. 1 × c. 0.2 cm, covered with white arachnoid hairs, flowers paired; pedicels 3–9 mm, covered with brown woolly hairs. Calyx green, red tinged at tips of lobes, fused for less than 0.5 mm at base, 5-lobed; lobes lanceolate, 1.5–1.8 × c. 0.7 mm, apex acute, sparsely covered with white hairs. Corolla pinkish red, with a short tube and spreading lobes; tube c. 2.5 mm; 2 posterior lobes ovate or orbicular, c. 3.5 × c. 2.5 mm, apex rounded, 3 anterior lobes obovate, c. 3 × c. 2 mm, the 2 lateral ones asymmetrical, apex rounded or obtuse. Stamens 2, inserted near base of corolla tube, surrounded by red markings; filament white, c. 2.5 mm, geniculate; anthers yellow, c. 2.5 × c. 2 mm; staminodes 2, strongly reduced. Ovary ovoid, c. 2 mm; style white to light green, c. 3 mm; stigma capitate, white or light brown. Capsules cylindric, 1–1.9 cm, 2–2.5 mm in diam., twisted.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. Open sun or in shade on steep limestone cliffs, alt. 10–200 m.

Phenology. Flowering and fruiting in July to October.

Vernacular. Dao Pra Dab Pha (ดาวประดับผา).

Etymology. The specific epithet refers to the pinkish red colour of the corollas.

Proposed IUCN conservation assessment. Vulnerable (VU D1). This species is only known from the type locality which is in a legally protected area. Although, the exact size of the population is uncertain we estimate that it is < 1000 individuals.

Notes. *Paraboea rosea* is most similar to another new species, *Paraboea arachnoidea* Triboun, in its large overall size, the leaves in a rosette, the dense covering of arachnoid hairs on most parts and the dense flowers, but it differs in a less dense covering of arachnoid hairs on the leaves, lanceolate leaves, shorter peduncles (10–15 cm in *P. rosea*, 18–26 cm long in *P. arachnoidea*), pinkish red corollas and longer capsules (1–1.9 cm in *P. rosea*, 0.8–1 cm in *P. arachnoidea*).

***Paraboea sangwaniae* Triboun, sp. nov. (Fig. 7C–D)**

Paraboeae axillari Triboun habitu haud frutescenti, foliorum in superficiebus ambabus cum venis secundariis tertiariisque prominentibus, inflorescentiis axillaribus et subterminalibus et capsula glabra similis, sed pedunculis robustis, corollis purpureis usque malvinis cum tubo albo ad pallide marronino et in tubo venis pallide viridibus, et capsulis majoribus differt. TYPUS: *P. Triboun, P. Blenchitra & B. Sonsupab 4039*, 26 July 2008, Thailand, Chiang Rai, Mae Fa Luang, Doi Tung (holo BK; iso E).

Lithophytic perennial herb. Stem erect or trailing, 20–60 high, lower part 6–8 mm in diam, with old and dry persistent leaves, bark densely covered with brown woolly hairs giving a felt-like appearance. Leaves 8–12, opposite decussate, sometimes congested towards the apex; petiole 1.5–5 cm long, base amplexicaul, covered with woolly hairs; blade subcoriaceous, ovate or obovate, 7.5–12 × 4.7–5.5 cm, apex acute, base attenuate or oblique, margin crenate, secondary veins 8–10 on each side of midrib, tertiary veins reticulate, venation prominent on both sides; green with some red tinges, covered with multicellular glandular hairs above, covered with white woolly hairs beneath. Inflorescences 1–6, compound monochasia, subterminal or axillary; peduncle 4–8 cm long, c. 2.2 mm in diam., densely covered with white arachnoid hairs; second order branching c. 4 cm long, flowers 2–6, paired; bracts orbicular, c. 1.9 × c. 2.5 cm, apex acute, green and maroon, shiny above, glabrous; pedicel 1.2–1.7 cm long, c. 3.5 mm in diam., covered with brown woolly hairs. Calyx appressed to corolla tube, fused at base for 6–9 mm long, and then divided into lobes, the upper three lobes further fused and then divided, base of lobes slightly imbricate; lobes lanceolate, apex acute, upper 3 lobes c. 5 mm long, 4–5 mm wide; lower 2 lobes free, c. 1.2 × c. 0.4 cm; all 5 lobes green with maroon patches, glabrous. Corolla campanulate, c. 2.3 cm long; tube 2.6–

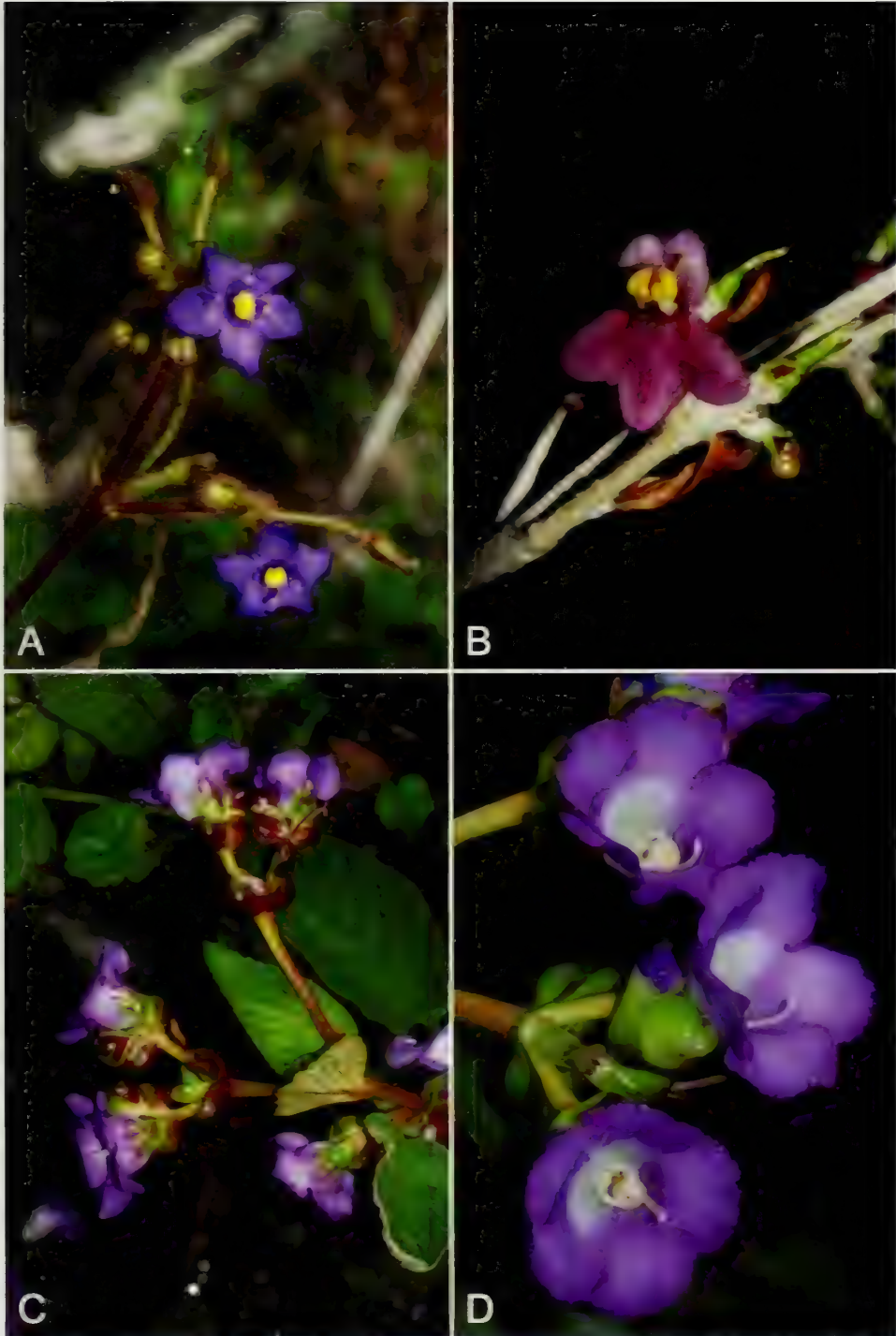


Fig. 7. A. *Paraboea quercifolia* Triboun. B. *Paraboea rosea* Triboun. C–D. *Paraboea sangwaniae* Triboun. (Photos: P. Triboun)

2.9 cm long, white to pale maroon with pale green veins, limb bilabiate, lower lobe 3-lobed, upper lobe 2-lobed, not symmetrical and not equal; lobes circular to widely ovate, 1–1.2 × 1.2–2 cm, apex rounded to obtuse, pale purple to mauve. Stamens 2; filaments creamy white, flattened, somewhat parallel, 5–6 mm long, c. 1 mm in diam., fused to corolla tube near base; anthers semicircular in shape, c. 5 mm, creamy yellow and turning brown when very mature; staminodes 3, inserted at base of corolla tube, spatulate, 3.5–4 × c. 0.5 mm, white with yellow tip. Ovary ovoid to ellipsoid, 4–5 × 2.3–2.7 mm; style 4–10 × 1–1.5 mm, pale green, glabrous; stigma linguiform, 4.5–6.5 × 1.5–1.8 mm wide, white, apex split into 2 lobes. Capsules ellipsoid, 2.5–3.5 × c. 0.4 cm, twisted, glabrous, calyx persistent.

Additional specimen examined: THAILAND. **Chiang Rai:** Mae Fa Luang District, Summit of Doi Tung, 20°19.6'N 99°50.0'E, alt. 1510 m, 23 September 2008, *D.J. Middleton, P. Karaket, P. Triboun, U. Kawatkul & R. Meeboonya 4572* (BK, BKF, E).

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On open limestone summit, alt. 1000–1500 m.

Phenology. Flowering and fruiting in July to December.

Vernacular. Nagarinthra (นกรินทร์รา), name given by His Majesty King Bhumibol of Thailand.

Etymology. The specific epithet honours Princess Sangwan (1900–1995), the late Princess Mother of King Ananda Mahidol (Rama VIII) and King Bhumibol Adulyadej (Rama IX), under whose initiative the conservation and reforestation of the collection locality at Doi Tung in Chiang Rai in Thailand was established.

Proposed IUCN conservation assessment. Critically Endangered (CR B1ab(iii,v)). This species is only known from Doi Tung, has an Extent of Occurrence of < 100 km² and is known from only one population. The area is not protected and there has been a reduction in the quality of the habitat through large scale tourism which has also led to a reduction in the number of mature individuals.

Notes: *Paraboea sangwaniae* is most similar to the new species *Paraboea axillaris* Triboun in its non shrubby habit, the secondary and tertiary veins prominent both abaxially and adaxially, the axillary and subterminal inflorescences and the glabrous capsule, but it differs in having robust peduncles, purple to mauve corollas with a white to pale maroon tube and pale green veins in the tube, and larger capsules (2.5–3.5 cm in *P. sangwaniae*, 1.8–2.2 cm in *P. axillaris*).

This species was referred to as *Trisepalum* sp. nov. 1 in Puglisi et al. (2011).

***Paraboea siamensis* Triboun, sp. nov.** (Fig. 8A–B)

Paraboeae acauli (Barnett) C. Puglisi habitus perenni suffruticoso, phyllotaxe ad instar rosulae, foliorum laminis ellipticis, pilis arachnoideis densis et flore magno similis sed foliis minoribus, bracteis calycibusque majoribus ac magis spectabilibus et corolla caerulea differt. TYPUS: *P. Triboun*, B. Sonsupab & P. Yothakaew 4565, 7 September 2010, Thailand, Tak, Umphang, Doi Hua Mot (holo BK; iso BKF, E).

Lithophytic perennial herb to subshrub; each plant with 1–5 branches, lower part of each branch with persistent old and decayed leaves; rootstock long, rough. Leaves 10–25, arranged in a dense rosette at the top of the stem; sessile or petiole very short; blade lanceolate to elliptic, 5–12 cm × 1.5–3.5 cm, the lower ones larger than the upper ones, apex acute, base attenuate and winged, amplexicaul to petiole and node, margin slightly crenate, both sides covered with white arachnoid hairs, more densely so beneath, secondary veins 5–8 on each side of midrib. Inflorescences 1–4, subterminal or axillary near shoot apex, a compound dichasium with 1 order of branching; peduncle 5–9 cm long, 2–2.5 mm in diam., covered with white arachnoid hairs; axis 1.2–1.5 cm long, covered by white arachnoid hairs; bracts reddish mauve in the upper half, broadly ovate, c. 2.5 cm long, apex rounded, margin erose, sparsely covered with white arachnoid hairs, uppermost bracts 1.8–2 cm long, c. 1.7 cm wide; flowers paired; pedicels c. 4 mm, covered with white arachnoid hairs. Calyx green, tube 4–5 mm long, c. 5 mm in diam., 3-lobed; lobes obovate, ovate or oblong, 1–1.4 × 0.7–1 cm, margin erose, sparsely covered with white hairs, each lobe closed and slightly imbricated. Corolla blue, campanulate; tube 1.2–1.8 cm long; posterior and anterior lobes nearly same shape and size, broadly ovate, orbicular or obovate, 6–8 × 0.9–1.1 cm, apex rounded or obtuse. Stamens 2, inserted near base of corolla tube; filaments white, geniculate, c. 5 mm long; anthers yellow, reniforme, c. 3 × c. 6 mm; staminodes 2, 2–3 mm long, medial staminode not apparent. Disc annular, c. 2 mm high. Ovary ovoid, c. 3.5 mm long, green, glabrous; style 1.3–1.5 cm long, white to light green; stigma minute, obcordately bilobed, yellowish brown. Capsules narrowly ovate, c. 1 cm long, slightly twisted, calyx persistent.

Additional specimens examined: Thailand, **Tak**, Um Phang, Doi Hua Mot, alt. 900 m, 23 April 2004, R. Pooma, K. Phattarahirankanok, S. Sirimongkul & M. Poopath 4606 (BKF, E, L).

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. Among rock on open limestone hill.

Phenology. Flowering and fruiting in July to November.

Vernacular. Sri Siam (ศรีสยาม).

Etymology. The specific epithet refers to the collection locality in Thailand, Siam being the former name for Thailand.

Proposed IUCN conservation assessment. Critically Endangered (CR B1ab(iii,v), D). This species is only known from a very small population of < 50 individuals. It is in a legally protected area but the site is prone to fire and is impacted by tourism.

Notes. *Paraboea siamensis* is unusual because although it is quite clearly part of the *Trisepalum* group it has a minutely capitate stigma rather than the linguiform stigma usually found in species traditionally placed in *Trisepalum*. It is most similar to *Paraboea acaulis* (Barnett) C.Puglisi in its perennial suffruticose habit, rosette-like phyllotaxy, elliptic leaf blades, the dense covering of arachnoid hairs and the large flower, but it differs in the smaller leaves (5–12 cm long in *P. siamensis*, 6–14 in *P. acaulis*), more showy and larger bracts (1.8–2 cm in *P. siamensis*, c.1.2 cm in *P. xylocaulis*) and calyces (1.4–1.9 cm long in *P. siamensis*, 1–1.2 cm long in *P. xylocaulis*), and the blue corolla.

***Paraboea takensis* Triboun, sp. nov.** (Fig. 8C–D)

Paraboeae strobilaceo (Barnett) C.Puglisi *magnitudine modica, foliis chartaceis, venatione prominenti et floribus albis similis sed foliis haud scabridis, bracteis ovatis vel naviculiformibus et floribus paucioribus recedit.* TYPUS: *P. Triboun 3606*, 14 July 2006, Thailand, Tak, Umphang, Doi Hua Mot (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 20–50 cm high, c. 2.5 mm in diam., brownish grey, with 1–2 young shoots at the base of stem; woody root stock slender and finely striped. Leaves 8–15, loosely opposite decussate; upper pairs sessile, lower ones with petiole 1–2.5 cm long, glaucous, densely covered with white hairs; blade papery, lanceolate, elliptic or ovate, 3–10 × 1.4–3.3 cm, apex acute, base cuneate or attenuate, margin slightly crenate, slightly glaucous, covered with short glandular trichomes above, covered with brown woolly hairs beneath, secondary veins (6–)10–12 on each side of midrib, tertiary veins reticulate, venation prominent beneath. Inflorescences 2–5, subterminal, a single flower or in compound monochasia, with 1–2 orders of branching; peduncle 2.5–2.8 cm long, densely covered with white arachnoid hairs, bracts ovate or naviculiform, 1.2–1.5 × 8–1.1 cm, apex obtuse or acute, outside glaucous and sparsely covered with arachnoid hairs, inside green; pedicels to c. 1.2 cm, unequal, some nearly sessile, densely covered with white hairs. Calyx cotyliform, 3-lobed; lobes ovate or lanceolate, upper 3 lobes fused at base, c. 1.2 × 0.4–0.5 cm, the 2 lateral lobes covering the middle lobe, 2 lower lobes c. 1.2 × c. 0.6 cm, free. Corolla white, campanulate, tube c. 1.8 cm long, lobes broadly obovate or broadly ovate, 0.8–1.1 × 1.3–1.5 cm, apex rounded. Stamens 2; filaments creamy white, c. 3.5 mm long, geniculate; anthers light brown, c. 4.5 × c. 4.8 mm; staminodes 3, linear, c. 2.5 mm. Ovary ovoid, c. 3 mm, glabrous; style white, c. 7 mm long; stigma linguiform, c. 1.2 cm long, white. Capsules not seen.

Distribution. Endemic to Thailand. So far known only from the type locality.



Fig. 8. A–B. *Paraboea siamensis* Triboun. C–D. *Paraboea takensis* Triboun. (Photos: P. Triboun)

Ecology. On open limestone rock in mixed deciduous oak forest, alt. 600–1000 m.

Phenology. Flowering and fruiting in late June to October.

Vernacular. Khao Tog Yai (ข้าวตอกใหญ่).

Etymology. The specific epithet refers to the locality in Tak province in Thailand.

Proposed IUCN conservation assessment. Critically Endangered (CR B1ab(iii,v), D). This species is only known from a very small population of < 50 individuals. It is in a legally protected area but the site is prone to fire and is impacted by tourism.

Notes. *Paraboea takensis* is similar to *Paraboea strobilaceum* (Barnett) C. Puglisi in its moderate size, papery leaves, prominent venation and white flowers, but it differs in its non scabrid leaves, ovate or naviculiform bracts and fewer flowers (2–8 in *P. takensis*, 4–10 in *P. strobilaceum*).

***Paraboea tenuicalyx* Triboun, sp. nov.** (Fig. 9A)

Paraboeae harrovianae (Craib) Z.R.Xu in inflorescentiis pleiochasiis compositis, lobis calycis minimis linearibusque et corollis dilute malvinis similis sed apicibus foliorum acutis, pedunculis longioribus, inflorescentiis (pedunculi, bracteae, pedicelli et calyces) sine pilis albis arachnoideis, et inflorescentiis magis laxis recedit. TYPUS: *P. Triboun* 3837, 28 August 2007, Thailand, Kanchanaburi, Tung Yai Naresuan Wildlife Reserve, Lai Wo Subdistrict, Ban Saneh Pawng area (Karen village) (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 8–18 cm high, solitary, 4–6 mm in diam, densely covered with greyish brown woolly hairs, root stock short and robust, sometimes young shoots sprouting from root stock. Leaves 4–8, opposite decussate, slightly congested at the apex of the stem; petiole (2–)4–8(–12) cm long, 1.5–2.5 mm in diam., densely covered with brown woolly hairs; blade coriaceous, lanceolate or ovate, 8–17 × 3.5–6.5 cm, apex acute, base cuneate or obtuse, margin indistinctly crenate, glaucous beneath, secondary veins 8–11 on each side of midrib, obscure above, prominent beneath; glabrous above, densely covered with short light brown woolly hairs beneath. Inflorescences 1–2, subterminal, compound pleiochasia, 4–6 branches at each node, each branch with 4–5 orders of branching; peduncle 30–60 cm long, 3–4.5 mm in diam., densely covered with light brown woolly hairs; bracts linear, 1–2.5 × 0.1–0.5 cm, apex acute, the upper ones strongly reduced; flowers paired; pedicels slender, 3–7 mm long, glabrous. Calyx very small, fused at base for 1–1.5 mm, 5-lobed; lobes narrowly linear, 1–1.5 × 0.2–0.3 mm, apex obtuse, glabrous. Corolla light mauve, with a short tube and spreading lobes; lobes widely ovate, orbicular or obovate, 2–4 × 2.5–4 mm, apex rounded or obtuse. Stamens 2; filament light green, slightly geniculate, c. 2 mm long; anthers yellow, reniforme, c. 1.8 × c. 2 mm; staminodes 2, c. 0.8 mm long, median staminode not apparent. Ovary ovoid, c. 2.5 mm long, light green, glabrous;

style c. 2.5 mm long, white; stigma capitate, white. Capsules slender, narrowly cylindrical, 2–2.5 × c. 0.1 cm, twisted, glabrous.

Additional specimens examined: THAILAND. **Kanchanaburi:** Kin Sayok, about 120 km NW of Kanchanaburi, alt. 100–150 m, 4 August 1946, *A. Kostermans 1451* (US); Thong Pha Poom, 4 July 1973, *J.F. Maxwell 73-103* (AAU); Sangklaburi, Toong Yai Naresuan Wildlife Reserve, Lai Wo subdistrict, Ban Saneh Pawng area (Karen village), 300 m, 11 October 1993, *J.F. Maxwell 93-1223* (L); between Huay ban kao and Kritee, alt. 500 m, 4 July 1973, *R. Geesink & C. Phengkhlai 6084* (AAU); near Neeckey, near Wangka, alt. 150 m., *G. den Hoed 580* (K).

Distribution. Endemic to Thailand. So far known only from Kanchanaburi Province.

Ecology. On limestone rocks in dry evergreen to mixed deciduous forest, alt. 300–500 m.

Phenology. Flowering and fruiting in late June to November.

Vernacular. Khao Tok Phra Nares (ข้าวตอกพระนเรศ).

Etymology. The specific epithet refers to the minute calyces.

Proposed IUCN conservation assessment. Vulnerable (VU B1ab(iii,v)). This species is quite widespread within Kanchanaburi and most populations are in legally protected areas. However, there are fewer than 10 populations and some of these populations are prone to fire damage from neighbouring farming practices leading to a nett erosion in the quality of the habitat and the number of mature individuals.

Notes. Several of the paratypes listed above were included in *Paraboea harroviana* (Craib) Z.R.Xu var. *harroviana* by Xu et al. (2008) although they did note that the material from Kanchanaburi was morphologically distinct. With additional material and field observations we conclude that these populations form a distinct species differing from *Paraboea harroviana* in leaf apex shape, longer peduncles (30–60 cm in *P. tenuicalyx*, 10–20 cm in *P. harroviana*), laxer inflorescences, and the lack of white arachnoid hairs on all inflorescence parts.

***Paraboea vachareea* Triboun & Sonsupab, sp. nov. (Fig. 9B)**

Paraboeae harrovianae (Craib) Z.R.Xu *magnitudine ubique modica, dichasio composito congesto et corollis dilute caeruleis similis, sed foliis lanceolatis cum apicibus acutis et inflorescentiis minoribus differt.* TYPUS: *P. Triboun, B. Sonsupab & P. Yothakaew 4566*, 8 September 2010, Thailand, Tak, Umphang, Palata (holo BK; iso E).

Lithophytic perennial herb. Stem erect, 10–25 cm high, 3–4 mm in diam., with a few twigs and branches 2–5 cm long, 2–5 mm in diam., woody root stock slender and

finely striped. Leaves 9–18, densely opposite decussate; petiole brown, 3–8 cm long, covered with woolly brown hairs; blade coriaceous, lanceolate, 5–11 cm × 3–5.5 cm, apex acute, base cordate or cuneate, margin crenate, shiny green above, covered by short dark woolly brown hairs beneath, secondary veins 5–7 on each side of midrib. Inflorescences 1–5, subterminal, c. 3 orders of branching in each compound pleiochasia, some congested with 4–8 branches on each order; peduncle (1.5–)10–25 cm long, covered by woolly brown hairs; bracts linear, 0.6–1.5 cm long, the upper ones strongly reduced; flowers paired; pedicels 6–7 mm, glabrous. Calyx brownish green, fused less than 1 mm at base, 5-lobed; lobes narrowly linear, c. 2.5 mm long, glabrous. Corolla light blue, campanulate; tube 0.5–1 cm long; 2 posterior lobes obovate, 4–5 × c. 2.5 mm, apex rounded; 3 anterior lobes obovate, c. 5–5.5 × 3 mm, apex rounded, the middle one largest. Stamens 2, inserted near base of corolla tube; filament light green, c. 2 mm long, geniculate; anthers white, c. 2 × c. 3.5 mm. Staminodes 3, narrowly linear, 1–2 mm long. Ovary ovoid, c. 3 × c. 1.5 mm long; style white, c. 3 mm long; stigma capitate, white. Capsules narrowly cylindrical, twisted.

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On limestone rock in dry evergreen to mixed bamboo deciduous forest, alt. 600–900 m.

Phenology. Flowering and fruiting in August to November.

Vernacular. Va Cha Ree Phun (วัชรพิพรรณ).

Etymology. The specific epithet honours Mrs. Vacharee Prachasaisoradej, a senior botanist at the Bangkok Herbarium (BK), who encouraged the first author in the field of plant taxonomy.

Proposed IUCN conservation assessment. Critically Endangered (CR B1ab(iii,v), D). This species is known from only one small population of fewer than 50 individuals. Although it is in a legally protected area the population is prone to fire damage from neighbouring farming practices.

Notes. The type of inflorescence in this species is found in many species of *Paraboea*, particularly in Thailand. It is most similar to *Paraboea harroviana* (Craib) Z.R.Xu in its size and the light blue corollas. It can be distinguished by its lanceolate leaves with an acute apex and its dense inflorescences.

***Paraboea xylocaulis* Triboun, sp. nov.** (Fig. 9C–D)

Paraboeae siamensi Triboun *planta magna robusta, foliis lanceolatis, calyce spectabili et corollis pallide purpureis similis sed calycibus bracteisque minoribus et foliis, pedunculis pedicellisque cum pilis albis arachnoideis obtectis differt.* TYPUS: *P.*

Triboun, B. *Sonsupab* & P. *Yothakaew* 4585, 25 September 2010, Thailand, Border of Krabi-Phangnga bay, Pa Koh (holo BK; iso BKF, E).

Lithophytic perennial herb or small shrub. Stem woody, up to 70 cm high, with many twigs and branches, 15–20 cm long, 5–1.5 cm in diam., hanging from cliff but then with upright shoots, bark greyish brown, cracked and rough, lower part of each branch with persistent old and decayed leaves; root stock woody, robust, cracked and rough. Leaves 8–15, densely opposite decussate or 3-whorled, congested at the apex; appearing sessile but actually a winged petiole 1.2–5 × 0.25–0.5 cm, covered with light brown arachnoid hairs and brownish orange hairs along the midrib; blade coriaceous, lanceolate, 2.7–7.5 × 1.4–2.5 cm, apex acute, base attenuate, margin indistinctly crenate, densely covered with multicellular glandular hairs above, densely covered with brown woolly hairs beneath, secondary veins 8–10 on each side of midrib. Inflorescences 6–20 (2–6 on each branch), subterminal, in 1 pair of monochasia, rarely compound monochasia; peduncle c. 1 cm long, covered with brownish orange woolly hairs; bracts brownish green, globose, c. 1.2 × c. 1 cm, hooded, apex rounded, glabrous; flowers paired; pedicels 3–9 mm long, unequal, glabrous. Calyx shiny green with red margin, 3-lobed, almost free; lobes elliptic to oblong, 1–1.2 cm long, the posterior lobe 7–8 mm wide, apex obtuse or shallowly 2–3-lobed, the inferior lobes 5–5.5 mm wide, apex obtuse, glabrous. Corolla campanulate; tube light purple, c. 1.2 cm long; lobes purple, orbicular or broadly ovate, 0.8–0.9 × 0.9–1.2 cm, apex rounded. Stamens 2, inserted near the base of corolla tube; filament white, c. 6 mm long geniculate; anthers white or creamy white, c. 3 × c. 3 mm; staminodes 3, white, linear, 0.5–2 mm, the middle one smaller than the lateral ones. Ovary creamy yellow, oblong to ovoid, c. 3 mm long; style white, c. 1 cm long, covered with glandular hairs; stigma linguiform, c. 5 mm, white. Capsule ovoid, c. 1.5 × c. 0.85 cm, green tinged red, glabrous, surrounded by persistent calyx.

Additional specimens examined: THAILAND. **Krabi**: Koh Hin Bai, 31 October 2006, P. *Triboun* 3674 (BK, E).

Distribution. Endemic to Thailand. So far known only from the type locality.

Ecology. On steep cliffs on limestone islands, alt. 30–150 m.

Phenology. Flowering and fruiting in August to November.

Vernacular. Cha Ha Nu Man (ชาหนุแมน).

Etymology. The specific epithet refers to the distinct woody stem of this plant; *xylo* (Gk.) = woody, *caulis* = stem.

Proposed IUCN conservation assessment. Critically Endangered (CR D). Although this species is only known from the type locality this is in a legally protected area. However, the population contains fewer than 50 individuals.

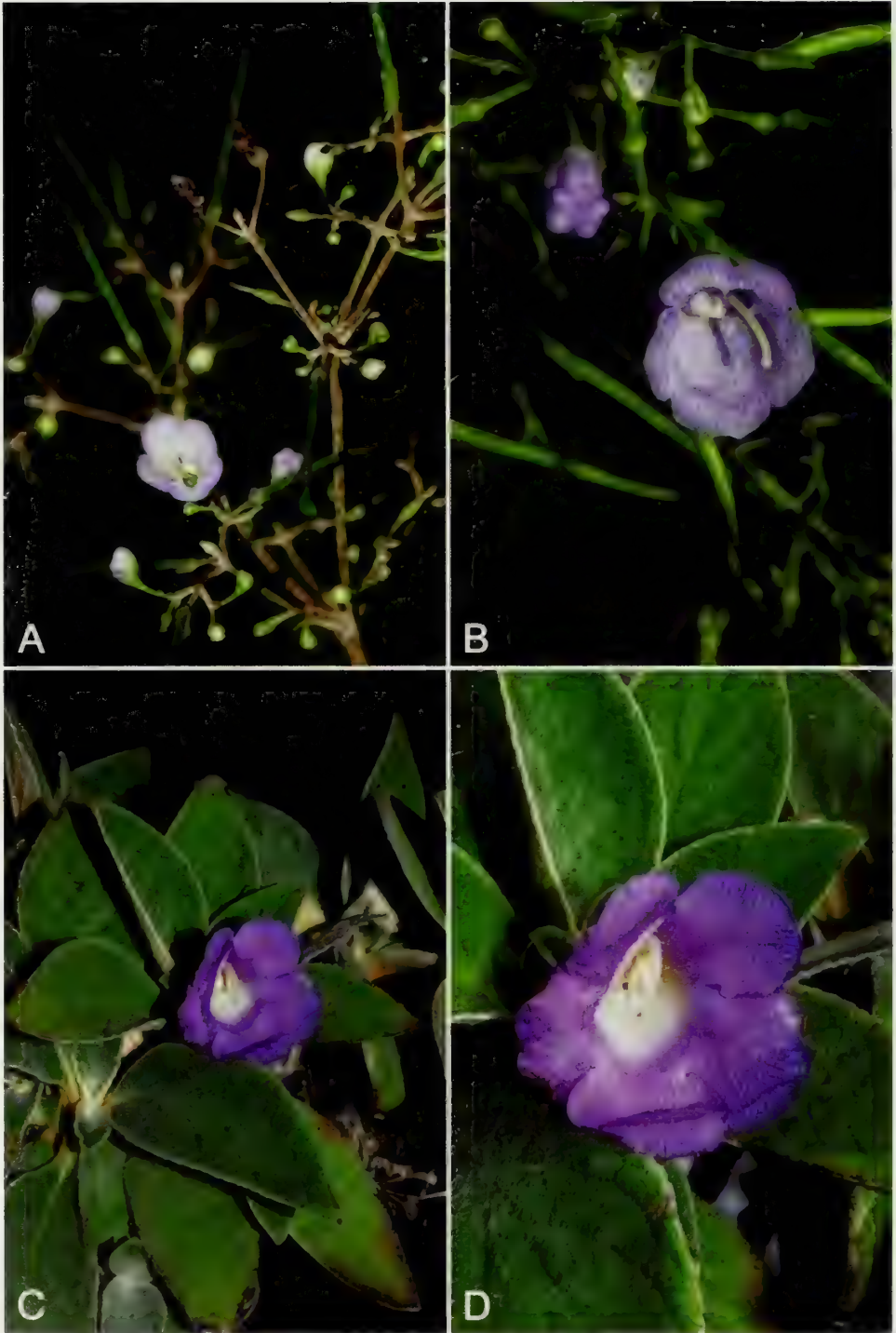


Fig. 9. A. *Paraboea temicalyx* Triboun. B. *Paraboea vachareea* Triboun & Sonsupab. C–D. *Paraboea xylocaulis* Triboun. (Photos: P. Triboun)

Notes. *Paraboea xylocaulis* is most similar to the new species *Paraboea siamensis* Triboun in being a large and robust plant, the lanceolate leaves, showy calyx and blue corollas, but it differs in the smaller calyces (1–1.2 cm long in *P. xylocaulis*, 1.4–1.9 cm long in *P. siamensis*) and bracts (c. 1.2 cm in *P. xylocaulis*, 1.8–2 cm in *P. siamensis*) and the covering of white arachnoid hairs on the leaves, peduncles and pedicels.

This species was referred to as *Trisepalum* sp. nov. 3 in Puglisi et al. (2011).

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References

- Burtt, B.L. (1984) Studies in the Gesneriaceae of the Old World: XLVII. Revised generic concepts for *Boea* and its allies. *Notes Roy. Bot. Gard. Edinburgh* 41: 401–452.
- Chen, W.H., Möller, M., Shui, Y.M. & Zhang, M.D. (2008) A new species of *Paraboea* (Gesneriaceae) from a karst cave in Guangxi, China, and observations on variations in flower and inflorescence architecture. *Bot. J. Linn. Soc.* 158: 681–688.
- Clements, R., Sodhi, N.S., Schilthuizen, M. & Ng, P.K.L. (2006) Limestone karsts of Southeast Asia: imperiled arks of biodiversity. *BioScience* 56: 733–742.
- Inthachub, P., Vajrodaya, S. & Duyfjes, B.E.E. (2009) Review of the genus *Stichoneuron* (Stemonaceae). *Edinburgh J. Bot.* 66: 213–228.
- IUCN (2001) *IUCN Red List Categories and Criteria, Version 3.1*. Gland and Cambridge: IUCN Species Survival Commission.
- Kiew, R. (2010) Two new species of *Paraboea* (Gesneriaceae) from Peninsular Malaysia and Thailand. *Edinburgh J. Bot.* 67: 209–217.
- Lindsay, S. & Middleton, D.J. (2004) *Adiantum phanomensis* (Adiantaceae), a new fern species from Peninsular Thailand. *Harvard Pap. Bot.* 8: 137–140.
- Lindsay, S., Middleton, D.J. & Suddee, S. (2008) Two new species of ferns from Thailand. *Thai Forest Bull., Bot.* 36: 46–51.
- Middleton, D.J., Puglisi, C., Triboun, P. & Möller, M. (2010) Proposal to conserve *Paraboea* against *Phylloboea* and *Trisepalum* (Gesneriaceae). *Taxon* 59: 1603.
- Middleton, D.J. & Triboun, P. (2010) Two new species of *Petrocosmea* (Gesneriaceae) from Thailand. *Thai Forest Bull., Bot.* 38: 42–47.

- Phuphathanapong, L. (2006) New taxa of *Aristolochia* (Aristolochiaceae) from Thailand. *Thai Forest Bull., Bot.* 34: 179–194.
- Puglisi, C., Middleton, D.J., Triboun, P. & Möller, M. (2011) New insights into the relationships between *Paraboea*, *Trisepalum* and *Phylloboea* (Gesneriaceae) and taxonomic consequences. *Taxon* 60: 1693–1702.
- Triboun, P. & Middleton, D.J. (2010) A new species of *Damrongia* (Gesneriaceae) from Thailand. *Thai Forest Bull., Bot.* 38: 108–110.
- Weber, A. (2004) Gesneriaceae. In: Kubitzki K. & Kadereit, J.W. (eds.) *The families and genera of vascular plants*, volume 7. *Flowering plants: Dicotyledons: Lamiales (except Acanthaceae including Avicenniaceae)*. Pp. 63–158. Berlin & Heidelberg: Springer.
- Xu, Z., Burt, B.L., Skog, L.E. & Middleton, D.J. (2008) A revision of *Paraboea* (Gesneriaceae). *Edinburgh J. Bot.* 65: 161–347.

Annonaceae of Borneo: a review of the climbing species

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ABSTRACT. The climbing species of the Annonaceae native to Borneo are reviewed. Eight genera of lianas are represented: *Artabotrys* (17 spp.), *Desmos* (4 spp.), *Fissistigma* (15 spp.), *Friesodielsia* (9 spp.), *Mitrella* (3 spp.), *Pyramidanthe* (1 sp.), *Sphaerocoryne* (1 sp.) and *Uvaria* (19 spp.). The species are described. Synonymy, typifications and keys for identification are included. No nomenclatural novelties are presented in this account.

Keywords. Brunei Darussalam, Indonesia, Malaysia, Malesia, lianas, systematics, taxonomy

Introduction

The Annonaceae are essentially a pantropical family and an important element in the flora of the lowland tropical forest. The family is well represented in Borneo, which is hardly surprising given that it is a large equatorial island with a warm and wet climate and was, until recently, covered in vast tracts of tropical rain forest. Most species of Annonaceae are free-standing trees, treelets or shrubs, but a substantial minority are woody climbers (lianas) or scandent shrubs. It is this element of the family as represented in Borneo that is the subject of the present paper.

The annonaceous climbers of Borneo merit attention for several reasons. Firstly, there has been relatively little work on them by taxonomists in recent decades. Secondly, they are particularly important in terms of representation amongst the liana flora. While the Annonaceae are pantropical, climbing species are almost confined to the Old World. Gentry (1991) reports only six species from two genera in the Neotropics, compared to a rich diversity in the Palaeotropics e.g. 41 species in West Africa (Jongkind & Hawthorne 2005), 49 species recognised here for Borneo. While published inventories of lianas in the forests of Borneo are rare and none is extensive, the data suggest that the Annonaceae are typically among the top three families in terms of representation by species or numbers of individuals (Putz & Chai 1987; Appanah et al. 1993; DeWalt et al. 2006), contesting top spot with the Leguminosae and Palmae.

The climbing Annonaceae of Borneo

The present revision is greatly facilitated by the strong tendency of life form to be shared across all members of a genus within the Annonaceae. Sinclair (1955) emphasised the

taxonomic value of knowing if a plant is a climber or not in the Annonaceae of the Malay Peninsula. Among the species in Borneo, the split of genera in to lianas or trees/treelets appears completely sound. The only possible doubt concerns *Desmos* and *Sphaerocoryne*. In cultivation, members of both genera will grow as shrubs if given no support. A number of *Sphaerocoryne* collections I have seen from Borneo are reportedly from trees, but this also happens for other genera of strict climbers such as *Uvaria*, so confusion between climber and mechanical host may be the explanation. Alternatively some species may be found as both climbers and free-standing plants in nature. In Borneo, the species of *Dasymaschalon* are treelets, but there is at least one climbing species in Thailand (Wang et al. 2009).

I recognise eight genera in the current revision. This is fewer than the 11 Sinclair (1955) recognised in his revision for the Malay Peninsula. This difference is explained by the reduction of genera into *Uvaria*. *Cyathostemma*, *Ellipeia* and others have been considered untenable after molecular phylogenies became available (Zhou et al. 2009). Notably, the only Asia-Pacific genus of climbing Annonaceae not recorded from Borneo is the poorly known New Guinea endemic *Schefferomitra*.

Molecular phylogenies make it clear that the climbing habit has arisen independently several times in the Annonaceae. Among the Bornean representatives, two lines are present. All the genera, except *Artabotrys*, are members of tribe *Uvariae* of subfamily Annonoideae (Chatrou et al. 2012), which consists mostly of lianas and represents a majority of the Old World climbing Annonaceae species. *Artabotrys* is a member of the same subfamily, but forms tribe *Xylopieae* with the non-climbing *Xylopia*. *Artabotrys* differs from the other Bornean climber genera in having specialised structures to assist climbing. Recurved hooks are formed from the inflorescence axes. These act as grapples, securing attachment to the supporting plants. Members of the other genera climb by means of twining and coiling stems, a response apparently elicited by the presence of a support, as growth appears relatively straight otherwise. Phyllotaxy also differs between the two climber clades; *Artabotrys* typically has spirally arranged leaves whereas the other genera show a distichous leaf arrangement (Johnson 2003).

Identification

Climbing Annonaceae material from Borneo is relatively easily identified as such. Even sterile material should be identifiable to family given the fairly clear characters of twig and leaf available.

Annonaceae (description applies to the climbing genera of Borneo)

Large woody climbers never truly herbaceous, unarmed except for *Artabotrys*. **Twigs** with fibrous bark, often striate or latticed, medullary rays broadening outwards generally obvious to the naked-eye as a star-shaped pattern in cross-section, pith

often septate. **Indumentum** hairs simple; stellate or caespitose in *Uvaria*. **Leaves** simple, entire, generally alternate and distichous, rarely spiral, membranous to coriaceous, often glaucous, pinnately nerved, with lateral veins looping within the lamina margin, though often obscurely, stipules absent. **Inflorescences** axillary or terminal, sometimes appearing leaf-opposed or supra-axillary through growth of the uppermost axillary vegetative shoot or the inflorescence axis being partly adnate to the vegetative shoot. **Flowers** bisexual, trimerous, rarely dimerous, solitary, paired or in few-many-flowered fascicles, regular and actinomorphic, sessile or stalked, often nodding or pendulous, fleshy and often rather brittle, typically bracteate, often fragrant; development often open without an obvious bud stage (not so in some *Uvaria* spp.). Sepals (2-)3(-4), hypogynous, valvate or imbricate, free to entirely connate. Petals mostly green, white or yellow, sometimes red or purple, hypogynous, usually 2 whorls of (2-)3(-4), valvate or imbricate, free or connate at the base, often apically coherent, usually alternating with the sepals. Stamens hypogynous, numerous, spirally arranged, closely packed on the torus, sometimes staminodes present, filaments absent or short, anthers linear, generally opening by longitudinal slits, connective mostly with a truncate dilated apex, but sometimes produced to a cone, point or tongue-like projection, filaments short and free. Carpels several to many, free or slightly connate at the base, ovules 1-many, basal or lateral; styles free or united, mostly short and terete, stigma capitate, oblong or variously folded. **Fruits** several to many fleshy or somewhat woody indehiscent, sessile or stipitate monocarps, monocarps cylindrical (moniliform in *Desmos*), ellipsoidal, globose or irregular, with 1-many seeds in 1-2 rows, with seeds transverse or longitudinal to long axis of monocarp. **Seeds** sometimes with a circumferential groove, sometimes pitted, endosperm abundant, ruminant, hard, oily, often divided almost to the axis into a series of horizontal plates; embryo straight, minute.

Key to genera of climbing Annonaceae in Borneo

- 1a. Stellate hairs present *Uvaria*
- b. Stellate hairs absent 2

- 2a. Inflorescence axis hooked *Artabotrys*
- b. Inflorescence axis not hooked..... 3

- 3a. Petal whorls of similar shape and size with petals at least 2 cm long, monocarps moniliform *Desmos*
- b. Petals whorls of dissimilar shape and size, or if similar then less than 2 cm long, monocarps not moniliform 4

- 4a. Petal whorls of similar shape and size *Sphaerocoryne*
- b. Petal whorls dissimilar in shape and/or size 5

- 5a. Leaves with a pair of glands in the margin of the lamina base, one on each side of the petiole, apex of anther connective more or less flat
.....*Friesodielsia*
- b. Leaves without glands, apex of anther connective obtuse, apiculate 6
- 6a. Leaves with lateral nerves distinct, interlateral veins absent, tertiary venation scalariform, inflorescences generally branched and multi-flowered, though some species have 1- or 2-flowered inflorescences, calyx connate near the base only*Fissistigma*
- b. Leaves with lateral nerves indistinct, or if distinct with clear interlateral nerves, tertiary venation not scalariform, inflorescences usually 1- or 2-flowered, calyx mostly or entirely connate.....7
- 7a. Calyx united into a shallow circular or weakly three-pointed cup.....
.....*Pyramidanthe*
- b. Calyx united into a distinctly three-pointed cup..... *Mitrella*

An index to the specimens identified in this study is given in the Appendix.

ARTABOTRYS R.Br.

(Greek, *artane*, *artao* = that by which something is hung up,
botrys = cluster, bunch of grapes; the hooked inflorescences)

Bot. Reg. 5 (1820) t. 423. Sinclair, Gard. Bull. Singapore 14 (1955) 246. Nurainas, Floribunda 2(5) (2004) 117–127. Turner, Folia Malaysiana 10 (2009) 59. TYPE: *Artabotrys odoratissimus* R.Br., *nom. illegit.* (≡ *Annona hexapetala* L.f., ≡ *Artabotrys hexapetalus* (L.f.) Bhandari)

Ropalopetalum Griff., Not. Pl. Asiat. 4 (1854) 716. TYPE: *Ropalopetalum uniflorum* Griff.

Woody climbers. Twigs glabrous or hairy. Leaves chartaceous to coriaceous, midrib sometimes raised above, lamina often decurrent to petiole. Inflorescences extra-axillary, borne on thick woody peduncles that form reflexed, often laterally compressed, hooks that assist with climbing, fascicled or single-flowered. Flowers bisexual, white or yellow, often fragrant, sepals 3 valvate, free or united at the base, petals 6, valvate in two whorls, subequal, clawed with concave bases connivent, closely adpressed over reproductive organs, inner whorl often remaining attached by their bases when it falls, torus flat or concave, stamens many, truncate, apex dilated, carpels numerous, ovules 2, basal. Monocarps few to many, cylindrical or ellipsoidal, often sessile. Seeds 2, erect, collateral.

Distribution and diversity: 100 or more species in the Old World tropics from Africa to Australia. 17 species recorded from Borneo.

Notes. The persistent inflorescence hooks make *Artabotrys* a relatively easy genus to recognise.

Key to *Artabotrys* species

- 1a. Petal blades of both whorls less than 2 mm wide, monocarps per pedicel typically 3 or fewer (monocarps of *A. sarawakensis* are unknown but carpel number indicates this to be true) 2
- b. Petals blades of one or both whorls at least 2 mm wide, more than three monocarps per pedicel 5
- 2a. Pedicel of flower longer than 16 mm *A. sarawakensis*
- b. Pedicel of flower up to 16 mm long 3
- 3a. Petals drying black with sparse pale hairs, monocarps more than 2 cm wide *A. veldkampii*
- b. Petals drying brown often with dense pale tomentum, monocarps drying less than 2 cm wide 4
- 4a. Pedicel longer than flower, outer petals with relatively little distinction between claw and blade when viewed abaxially, blade relatively flat, monocarps 10 mm or more in diameter, longitudinally ridged and beaked
..... *A. gracilis*
- b. Pedicel shorter than flower, outer petals with clear distinction between claw and filiform blade, monocarps less than 10 mm in diameter, smooth with rounded apex *A. suaveolens*
- 5a. Blades of inner petals 2 mm wide or less 6
- b. Blades of inner petals more than 2 mm wide 8
- 6a. Flower pedicel less than 5 mm long, petals covered with red-brown hairs
..... *A. sumatranus*
- b. Flower pedicels more than 5 mm long, petals densely covered with pale hairs 7
- 7a. Pedicel shorter than flower, monocarps with apex rounded
..... *A. roseus*
- b. Pedicel longer than flower, monocarps with apex beaked *A. costatus*

- 8a. Pedicel villose, monocarps flat-topped, generally angular 9
 b. Pedicel glabrous or tomentose but not villose, monocarps ellipsoidal and beaked (flat-topped in *A. pandanicarpus*) 11
- 9a. Leaves typically coriaceous, sepals broader than long, monocarps glabrous *A. lanuginosus*
 b. Leaves typically chartaceous, sepals longer than broad, monocarps shortly tomentose, at least near base 10
- 10a. Outer petals lanceolate, more than 2 cm long, monocarps with angled sides extending over the whole length *A. hirtipes*
 b. Outer petals ovate, less than 2 cm long, monocarps with angled sides near the base only *A. kinabahuensis*
- 11a. Blades of at least one petal whorl more than 10 mm wide 12
 b. Blades of both petal whorls less than 10 mm wide 14
- 12a. Petal blades ovate, monocarps flat-topped and angled *A. pandanicarpus*
 b. Petal blades of at least one whorl lanceolate, monocarps ellipsoidal, markedly beaked, not angled 13
- 13a. Flower pedicel less than 10 mm long, monocarps to 2.5 cm long, 1 cm diameter, beak very hard and sharp *A. polygynus*
 b. Flower pedicel more than 20 mm long, monocarps to 4 cm long, 2 cm diameter, beak not hard and sharp *A. macropodus*
- 14a. Foliage, flowers and fruits often with yellow powdery spots, monocarps fusiform *A. atractocarpus*
 b. Foliage, flowers and fruits not yellow spotted, monocarps sessile 15
- 15a. Petals densely red-brown tomentose, monocarps drying dull brown *A. venustus*
 b. Petals densely to sparsely pale or brown tomentose, monocarps drying shiny smooth brown 16
- 16a. Petals relatively thick and fleshy, little difference in shape of blades between whorls, monocarps longer than broad *A. maingayi*
 b. Petals relatively thin, blades of inner whorl narrower than outer whorl, monocarps broader than long *A. ochropetalus*

1. *Artabotrys attractocarpus* I.M. Turner
(Greek, *atractos* = spindle-shaped, *karpos* = fruit)

Folia Malaysiana 10 (2009) 79. TYPE: Borneo, Sarawak, Miri Division, Sungai Tutoh, Melana Protection Forest, Bukit Pelamau, 20 April 1997, *R.M.A.P. Haegens* & *N. Klazenga* 438 (holotype: L[12] (barcode nos. L 0196939, L0196940); isotypes: K, SAR).

Large woody climber. Foliage, flowers and fruits in dry specimens often with yellow powdery spots and splashes (a feature of several Borneo Annonaceae species including *Polyalthia rumphii* (Blume ex Hensch.) Merr. and *Artabotrys gracilis*). Twigs drying brown, sometimes quite dark, smooth and shiny but tending to become longitudinally wrinkled or latticed, glabrous or with a few scattered erect short pale hairs, sometimes with small pale lenticels. Leaves chartaceous, drying brown or grey-brown above, brown beneath typically with the midrib and lateral nerves contrasting a darker brown, midrib more or less flesh above in dry leaves, prominent beneath, lateral nerves very slightly raised above, prominent beneath, glabrous except for scattered pale adpressed hairs along midrib and laterals below, often with abundant irregular minutely pimply pustules on lower lamina, lamina ovate to elliptic, more rarely obovate, 6–17 × 2.5–7 cm, base rounded, truncate or obtuse, ultimately narrowly decurrent to petiole with lamina edge continuing in to the raised edge of a groove along the top of the petiole, apex acuminate, acumen rather narrow and sharp, lateral veins 10–13 pairs, looping very distinctly within the margin, tertiary venation reticulate; petiole 4–7 mm long, 0.5–2 mm thick. Inflorescence hooks variably adpressed pale hairy, single-flowered. Flowering pedicel 8–22 mm long, c. 1 mm thick, widening distally, drying brown or blackish, shiny, longitudinally wrinkled, sometimes bumpy, sepals thick, triangular, c. 3 × 4 mm, apex acute, reflexing, base slightly connate, scattered pale hairs outside, glabrous within, petals green, coriaceous, with clear distinction between claw and blade, blade of outer petals lanceolate, c. 26 × 6–7 mm, more or less flat, though sometimes with a faintly raised central ridge adaxially, drying red-brown, dense short pale tomentum soon lost except near base of petal, often pustulated, inside of claw drying dark brown, shiny, glabrous, inner petals coherent at margins of claw, with linear blade c. 26 × 3 mm, incurving with tips crossing, flat or slightly grooved with transition to claw pentagonal in cross section, drying red-brown, often pustulate, short pale tomentose near base, stamens many, c. 2 mm long, connective flat-topped, minutely erect hairy, carpels c. 8, c. 1.5 mm long, glabrous. Fruiting pedicel 15 mm long, 2 mm thick, monocarps c. 6, fusiform, to 30 mm long including 10-mm beak, 13 mm across, drying black and shiny with a series of laterally flattened ridges or flanges running longitudinally from base to apex, the two most pronounced on opposite sides extending to form the laterally compressed beak of the fruit, between these there are several less-pronounced longitudinal ridges, some reduced to a series of raised warts, stipe to 15 mm long. Seeds 2.

Distribution. Endemic to Borneo. Collected from eastern Sarawak and East Kalimantan.

Ecology. Lowland forest.

Notes. When I published this as a new species, the diagnosis was based on the stipitate monocarps in comparison to the sessile monocarps of other Malesian *Artabotrys* species. I have subsequently seen *Nengah Wirawan 439* collected from Java that has stipitate monocarps and appears to be *A. sumatranus*. *Forbes 3242* from Sumatra also has stipitate monocarps. The monocarps from these specimens have a rounded apex and not the pronounced beak of *A. atractocarpus*.

Vegetatively the frequent yellow powdering leads to confusion with *Artabotrys gracilis* King but the flowers of *A. atractocarpus* are far larger.

2. *Artabotrys costatus* King

(Latin, *costatus* = ribbed, the distinct lateral veins)

J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61(2) (1892) 37. Ridley, Sarawak Mus. J. 1(3) (1913) 78. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Masamune, Enum. Phan. Born. (1942) 280. Sinclair, Gard. Bull. Singapore 14 (1955) 255. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 81. TYPE: Peninsular Malaysia, Perak, Ulu Bubong 500-800', *King's Collector* [H.H. Kunstler] 4291 (lectotype, designated by Turner (2009a), K (barcode no. K000381022); isolectotypes: BM, BO, CAL, K, SING[×2]).

Large woody climber. Twigs dark brown, smooth, some red-brown hairs on youngest parts. Leaves chartaceous, drying (pale) brown, midrib flush to slightly raised above, prominent below, secondary veins faintly raised above, but lamina often a little bullate giving impression of sunken veins above, sparse scattered hairs on lamina and along midrib in youngish leaves, leaves oblong elliptic, 9–26 × 3–9 cm, base obtuse, slightly decurrent, apex acuminate, lateral veins distinct, 11–13 pairs, petiole to 8 mm long, 2 mm thick. Inflorescence hooks recurved bearing many flowers. Pedicel to 3 cm long, very slender, c. 0.5 mm wide when dry, more or less glabrous, sepals broadly triangular 2 mm long, 3 mm across, petals yellow, densely covered with pale tomentum, outer petals clawed but with little distinction between claw and blade visible from outside, blade ovate oblong, 7 × 3 mm, inner petals clawed, blade concave, 6 × 2 mm, stamens many, carpels 3–8. Fruiting pedicel to 3 cm long, 3 mm thick, monocarps to 7 or more, ripening red, cylindrical, 3 × 1.5 cm, drying black, strongly wrinkled, sessile, often beaked. Seeds 1 or 2, 20 × 10 × 6 mm, pale brown, longitudinally grooved.

Distribution. Malay Peninsula, Borneo. Recorded from Brunei, Sabah and Sarawak.

Ecology. Lowland and montane forest to 1500 m.

3. *Artabotrys gracilis* King

(Latin, thin, slender)

J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61(2) (1892) 35. Ridley, Sarawak Mus. J. 1(3) (1913) 77. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Masamune, Enum. Phan. Born. (1942) 280. Sinclair, Gard. Bull. Singapore 14 (1955) 258. Kessler & van Heusden, Rheedeia 3 (1993) 54. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 12 as 'cf. *gracilis*'. TYPE: Peninsular Malaysia, Perak, *King's Collector* [H.H. Kunstler] 4987 (lectotype, designated by Nurainas (2004), BO; isoelectotypes: BM, CAL, K, L, SING).

Woody climber to at least 25 m long. Twigs smooth, sometimes faintly latticed, drying brown, glabrous. Leaves chartaceous, drying brown, generally darker above, often with powdery splashes of white or yellow reminiscent of *Polyalthia rumphii*, ovate-elliptic, 5–15 × 2–6 cm, base obtuse, slightly decurrent, apex acuminate, almost caudate, midrib slightly sunken above, prominent below, lateral veins c. 8 pairs, arching forwards and looping within the margin. Petioles 4–7 mm long, 0.5–1 mm thick. Inflorescences hooks recurved and laterally compressed. Flowers pedicels 10–16 mm long, c. 0.5 mm thick, thickening distally, glabrous, sepals free, broadly ovate, 2 × 3 mm, petals pink when young, yellow when older, when dry densely covered in pale adpressed hairs, often with powdery white or yellow spots, outer whorl clawed, blade triangular, 5 × 1.5 mm, a broad-based triangle in cross section with the flat face inwards, claw broadly ovate, c. 2 × 3 mm, adpressed pale hairy externally, glabrous and concave within with a distinct raised upper rim, inner whorl clawed, blade terete, triquetrous or flattened, 2–3 mm long by 1 mm wide, claw c. 3 × 3 mm, glabrous except for a narrow central inverted triangle externally, glabrous within, stamens many, c. 1 mm long, apex truncate, carpels 3. Fruits pedicels 10–16 mm long, c. 1 mm thick, monocarps 1 or 2, ellipsoidal, 15–22 × 10–15 mm, glabrous, drying black or brown sometimes with many pale brown pustules, drying slightly ridged longitudinally, shortly beaked, stipe to c. 3 mm long. Seeds 1–2, 10 × 8 × 4 mm.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo collected from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest to 800 m.

4. *Artabotrys hirtipes* Ridl.

(Latin, *hirti* = hairy, *pes* = foot, the hairy pedicel)

Bull. Misc. Inform. Kew (1912) 383. Sarawak Mus. J. 1 (1913) 77. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Masamune, Enum. Phan. Born.

(1942) 280. TYPE: Borneo, Sarawak, Rejang Kapit, *G.D. Haviland 2326* (lectotype designated by Turner (2009a), K (barcode no. K000691269)).

Artabotrys trichopetalus Merr., J. Straits Branch Roy. Asiat. Soc. 85 (1922) 176. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 71. Masamune, Enum. Phan. Born. (1942) 281. TYPE: Borneo, Sabah, Sandakan, September-December 1920, *M. Ramos 1465* (lectotype, designated by Turner (2009a), K (barcode no. K000691311)); isolectotypes: A[×2], BM, L, US).

Artabotrys cinnamomeus Diels, Notizbl. Bot. Gart. Berlin-Dahlem 11 (1931) 84. TYPE: Borneo, Sarawak, September 1865, *O. Beccari P.B. 531* (holotype: FI-B; isotype: B(fragment)).

Artabotrys sp. 1, Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 13.

Large woody climber. Twigs pale when older, latticed or longitudinally wrinkled, bark rather papery, brown tomentum on the youngest twigs. Leaves chartaceous to subcoriaceous, drying brown, generally darker above, glabrous above, scattered long adpressed hairs along midrib beneath, midrib flush above, prominent beneath, narrowly elliptic-obovate to oblanceolate, 10–32 × 3.5–6 cm, lateral veins c. 8 pairs, arching well forward, petiole drying black, 6–10 mm long, 2–3 mm thick. Inflorescence hooks recurved, bearing many flowers. Pedicel 12–15 mm long, densely rusty or pale brown villose, sepals triangular, c. 10 mm long, 5 mm across, apex acute, villose outside, glabrous inside, to 2.5 cm long, basal bract foliose to 3 cm long, medial bract to 2 cm long, petals relatively thin, densely covered with pale hairs, outer petals blade lanceolate, 25 mm long, 9 mm wide, inner petals similar length, slightly narrower c. 6 mm wide, stamens many, c. 2 mm long, carpels many, c. 1.5 mm long, densely pale hairy. Monocarps many in large groups to 6 cm diameter, pyriform, to 4 × 2.5 cm, drying brown, angled, flat-topped, central apiculus, covered with very short, pale tomentum. Seeds 2, 22 × 15 × 7 mm, pale brown, smooth.

Distribution. Endemic to Borneo. Collected from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forests.

Notes. *Artabotrys hirtipes* is close to two other species from Borneo, *A. lanuginosus* and *A. kinabaluensis*. Vegetatively *A. hirtipes* is closer to *A. kinabaluensis* which tends to have less coriaceous leaves and less hairy foliage than *A. lanuginosus*. The three species are most easily separated on the size and shape of the sepals and outer petals. *Artabotrys lanuginosus* has particularly broad sepals, which unlike the other two species are broader than long. In *A. hirtipes* the outer petals are lanceolate and longer than the more ovate outer petals of *A. kinabaluensis*. In fruit the species can also be distinguished. The monocarps of *A. lanuginosus* are glabrous whereas the other

two species are at least partially shortly pale tomentose. *Artabotrys hirtipes* and *A. lanuginosus* typically have angled sides running up the length of the sessile fruitlets. In *A. kinabaluensis* the base of the monocarp may have angled faces but the angles do not extend up the length of the fruitlet which remains more or less a flattened circle in cross section in the distal portions.

See notes under *A. pandanicarpus* for differences from that species.

5. *Artabotrys kinabaluensis* I.M. Turner
(of Mt Kinabalu)

Malayan Nat. J. 62: (2010) 360. TYPE: Borneo, Sabah, Mt Kinabalu, Tenompok, 7 March 1932, *J. Clemens & M.S. Clemens 28697* (holotype: BM (barcode no. BM000895993); isotypes: A, K, SING).

Artabotrys aff. *hirtipes*. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 81.

Large woody climber. Twigs drying pale brown to pale grey brown, latticed with raised pale lenticels, youngest twigs brown with adpressed long straight pale hairs, sometimes quite dense. Leaves chartaceous, drying brown, generally darker above, midrib sometimes a paler yellow-brown below, glabrous above, adpressed hairs along lamina below, sometimes scattered on lower lamina, midrib in dry leaves flush above, prominent beneath, lateral veins slightly raised above, raised below, lamina elliptic to obovate, 7–15.5 × 3–6 cm, apex shortly acuminate, base obtuse, lateral veins 9–11 pairs, arching forward and looping distinctly within the margin; petiole 4–6 mm long, 1–2 mm thick, often drying blackish with adpressed hairs. Inflorescence axes bearing several flowers. Flower pedicels 10–15 mm long, c. 1.5 mm thick, densely brown hairy, sepals ovate-lanceolate, c. 9 × 6 mm, densely covered with long and straight brown hairs, inside drying black, glabrous except near margins where hairs are finer and sparser than externally, outer petals broadly ovate 16 × 11 mm, densely covered in straight brown hairs except for near the base inside which is glabrous and surrounded by a raised rim, inner petals clawed, blade broadly ovate 11 × 10 mm, densely brown hairy, stamens many c. 2 mm long. Fruiting pedicel 12–15 mm long, c. 5 mm thick, monocarps to 15 or more, sessile to 4 × 3 cm, ellipsoidal, slightly compressed laterally, drying slight sunken between the seeds, apex often quite flat-topped and ultimately apiculate, base obtuse, sometimes slightly angled with flat faces, drying black or very dark brown, minutely warty, with scattered short brown hairs densest near the base, much denser when young. Seeds 2, c. 3 × 1 cm.

Distribution. Endemic to Borneo where it is only known from the Mount Kinabalu area of Sabah.

Ecology. Montane forest from 1500 to 2100 m.

Notes. See notes under *A. hirtipes* for distinction of *A. kinabaluensis* from *A. hirtipes* and *A. lanuginosus*.

6. *Artabotrys lanuginosus* Boerl.

(Latin, woolly, downy)

Cat. Pl. Phan. (1899) 23. Boerlage, Icon. Bogor. 1 (1899) 121, t. 52 (p. 159), as '*lanuginosa*'. Ridley, Sarawak Mus. J. 1(3) (1913) 78. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Masamune, Enum. Phan. Born. (1942) 280. TYPE: Borneo, Penigin, 1896-1897, *Jaheri* 320 (lectotype, designated by Turner (2009a), BO (sheet no. BO-1339062)).

Artabotrys macranthus Holth., Blumea 5 (1942) 180. Kessler & van Heusden, Rheedea 3 (1993) 54, as '*macrantha*'. TYPE: Sulawesi, Sangi and Talaud Islands, Karakelang, Pasir Malap, E. of Lobo, 14 May 1926, *H.J. Lam* 3003 (holotype: L (barcode no. L 0037895); isotypes: BO, L[×2], K).

Artabotrys sp. 2, Bygrave in Coode et al., Checkl. Fl. Pl. Gymnos. Brunei (1996) 13.

Large woody climber. Twigs covered with dense red-brown tomentum, becoming glabrous with age when brown, latticed, often with raised, dark lenticels giving a rough feel. Leaves coriaceous to chartaceous, drying chestnut brown, sometimes slightly paler beneath, midrib slightly raised to slightly sunken above in dry leaves, prominent beneath, lateral veins flush to slightly sunken above, prominent beneath, lamina glabrous above, hairy below, hairs long (to 2 mm), more or less straight, red-brown becoming pale with age, scattered over lower lamina, denser and more clearly adpressed on midrib below, lamina elliptic or ovate-elliptic, 16–21 × 7–10 cm, apex shortly acuminate, base obtuse, lateral nerves 11–14 pairs, angled forward and arching, looping obscurely within margin, clearly visible from both surfaces, tertiary venation rather lax, only visible from below. Petiole drying brown, horizontally wrinkled, c. 3 × 7–10 mm, tomentose. Inflorescence hooks recurved, bearing many flowers. Flowering pedicel to 15 mm long, 2 mm thick, densely covered with long pale hairs, sepals drying brown, broader than long, 6 × 10 mm, densely hairy outside, much more sparsely hairy within, petals green becoming yellow, petal whorls similar in shape, ovate, 25 × 15 mm, apex blunt; densely covered on both surfaces with pale brown hairs, outer petals glabrous near base inside which is surrounded by a raised rim, inner petals clawed with a thick, pointed rim over top of claw; stamens many, carpels many. Fruiting pedicel not seen, monocarp ellipsoidal, slightly laterally compressed, c. 3 × 2 × 1.5 cm, sessile or subsessile, apex rather flat-topped, with angles ridges extending the length of the monocarp, drying dark brown with paler patches where in contact with neighbours, glabrous, surface minutely warty and somewhat shiny. Seeds 2.

Distribution. ?Sumatra, Borneo and Sulawesi. In Borneo known from a few scattered

collections from Brunei, Kalimantan and Sabah. *S 60776* from Limbang in Sarawak may also belong here.

Ecology. Lowland forest.

Notes. See notes under *A. hirtipes* for distinction of *A. lanuginosus* from *A. hirtipes* and *A. kinabaluensis*.

7. *Artabotrys macropodus* I.M. Turner

(Greek, *makro* = big, *podus* = footed, based: the large pedicel of the flower)

Folia Malaysiana 10 (2009) 77. TYPE: Borneo, Sabah, Ranau District, about 3 miles NW of Kampung Pinanantai, 9 May 1973, *G. Shea & Aban SAN 76878* (holotype: K (barcode no. K000581385); isotypes: L, SAN, SING).

Large woody climber. Twigs brown, often with tiny raised lenticels, youngest parts dark brown, shiny, more or less glabrous but for a few adpressed hairs around nodes. Leaves chartaceous to coriaceous, drying various shades of brown, main nerves more consistent dark brown above and below, contrasting with lamina when pale, midrib in dry leaf flush to slightly raised above, prominent below, lateral nerves slightly raised above, prominent below, leaves more or less glabrous except sometimes for some sparse pale long adpressed hairs along midrib below, lamina oblong-ovate or oblong-elliptic, more rarely oblong-obovate, 10–31 × 4–13 cm, base acute, obtuse or rounded, apex shortly acuminate, lateral nerves 8–14 pairs, looping distinctly within margin, tertiary venation reticulate, distinct from both surfaces in dry leaves. Petioles 7–12 mm long, 2–5 mm thick. Inflorescence hooked, single-flowered. Flower pedicel 2–3 cm long, 0.5–1.0 mm thick, pale adpressed hairs, sepals triangular 5–8 × 4–5 mm, apex acute, externally with long pale hairs, inside glabrous, outer petals thick, coriaceous, ovate with only slight constriction between claw and blade, 20–22 × 10–13 mm, densely adpressed pale hairy externally, particularly near the base, inside similarly tomentose except for the excavation at the base which is glabrous, inner petals cohering at their margins with gap between, blades thick, flat, ovate-lanceolate, 10–14 × 5–10 mm, densely pale hairy on both surfaces, stamens many, c. 2 mm long, connective apex convex, carpels many. Fruiting pedicel 2.5–3.5 cm long, 2–5 mm thick, monocarps 5–20 or more, ripening red, ellipsoidal c. 4 × 2 cm, drying brown, apparently markedly wrinkled if collected fully ripe, more or less glabrous except for a few short hairs near base, unripe fruit drying smooth with faint longitudinal lines, surface minutely warty under magnification, apex acuminate with a distinct beak, subsessile, stipe c. 3 mm long. Seeds 2, ellipsoidal with one flattened face, c. 26 × 14 × 8 mm, with a longitudinal groove.

Distribution. Endemic to Borneo. In Borneo collected from Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. Among Bornean species *A. macropodus* is not easily confused. *Artabotrys costatus* King has similar long pedicels, but they are more slender and the petals are much narrower and the monocarps are less broad. *Artabotrys polygynus* has broad petals and numerous monocarps but the leaves dry a characteristic very dark brown, the petals are thicker but not so broad as *A. macropodus* and the monocarps are narrower and have a characteristic very hard, sharp point when dry.

8. *Artabotrys maingayi* Hook.f. & Thomson

(Alexander C. Maingay (1836–1869), English doctor and prison administrator in colonial service)

Fl. Brit. India 1 (1872) 55. Sinclair, Gard. Bull. Singapore 14 (1955) 259. Turner, Folia Malaysiana 10 (2009) 62. TYPE: Peninsular Malaysia, Malacca, 1867–1868, *A.C. Maingay 2617* [Kew distrib. no. 34] (holotype: K[×2] (barcode nos. K000381024, K000381029); isotypes: BM, CGE).

Artabotrys havilandii Ridl., Bull. Misc. Inform. Kew 1912 (1912) 382. Ridley, Sarawak Mus. J. 1(3) (1913) 77. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Masamune, Enum. Phan. Born. (1942) 280. Sinclair, Sarawak Mus. J. 5 (1951) 598. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 12. TYPE: Borneo, Sarawak, near Kuching, 9 September 1892, *G.D. Haviland 1629* (lectotype, designated by Turner (2009a), K (barcode no. K000691275); isolectotype: SAR).

Large woody climber. Twigs drying dark and smooth, more or less glabrous. Leaves chartaceous to thinly coriaceous, drying grey-brown, ovate-elliptic to oblong ovate, 7–13 × 3–5 cm, base obtuse to rounded, slightly decurrent, apex acuminate, midrib slightly raised above, prominent beneath. Inflorescence hooks recurved, drying black, glabrous. Pedicel 7–10 mm long, drying black, longitudinal wrinkled, some scattered pale hairs, sepals ovate, 4 × 4 mm, scattering of pale hairs outside, petals relatively thick and fleshy, densely covered with dense, pale adpressed hairs, outer petals ovate lanceolate, 20 × 6–7 mm, blade 15 × 6–7 mm, inner petals clawed, blades shaped like rabbits' ears, 15 × 4–5 mm, stamens many, carpels many. Fruiting pedicel c. 10 × 4 mm, monocarps 2–5, ellipsoidal to 4.5 × 3.5 cm, ripening orange-yellow, drying black, glabrous, thick-walled (to 4 mm), apex beaked, subsessile, stipe c. 3 mm long, 5 mm thick. Seeds 2, plano-convex, c. 2.5 × 1.5 × 1 cm.

Distribution. Malay Peninsula and Borneo. In Borneo from Brunei and Sarawak. Earlier reports of the species from Kalimantan (Turner 2009a), were based on misidentification of *A. veldkampii* specimens.

Ecology. Lowland forest.

Notes. Refer to *A. veldkampii* for notes on confusion of fruiting specimens with that species.

9. *Artabotrys ochropetalus* I.M. Turner

(Greek, *ochros* = pale yellow, *petalon* = petal)

Folia Malaysiana 10 (2009) 63. TYPE: Borneo, Sabah, Tawau Division, Lahad Datu District, Ulu Sungai Segama, Danum Valley Research Centre, 28 February 1985, *Argent et al.* SAN 108284 (holotype: K (barcode no. K000581905); isotypes: K, KEP, L, SAN).

Artabotrys roseus auct. non Boerl., Merrill, Univ. Calif. Publ. Bot. 15 (1929) 71. Kessler & van Heusden, Rheede 3 (1993) 55.

Large woody climber. Twigs drying black or brown, smooth, more or less glabrous, sometimes with sparse pale brown adpressed hairs on youngest parts. Leaves chartaceous, drying brown, generally darker below, midrib flush to slightly raised above, prominent beneath, lamina elliptic to elliptic lanceolate, 7–20 × 2.5–6.5 cm, base acute to obtuse, slightly decurrent, apex acuminate, lateral veins 10–13 pairs, looping clearly within margin; petiole 10 mm long, 2 mm thick. Inflorescence hooks recurved, multi-flowered. Pedicels 6–11 mm long, with pale adpressed hairs, sepals triangular, apex acute, 3 × 3 mm, with sparse pale hairs; petals yellow, drying brown with short pale pubescence, outer petals with slight constriction between claw and blade, blade lanceolate 21–30 × 4–5 mm, pale pubescent to glabrescent on both surfaces, claw c. 2 mm long, 3 mm wide, pubescent externally, excavated, glabrous within; inner petals with blade 3–5 mm wide with a central ridge adaxially, pale pubescent on both surfaces, claw c. 2 × 2 mm, slight ridge externally, pubescent externally, excavated, glabrous within, stamens many, c. 1.5 mm long, apex truncate, carpels c. 6, ovoid, glabrous but with long hairs among carpels. Fruiting pedicel c. 10 mm long, 6 mm thick, monocarps to 6, ripening yellow, ellipsoidal, wider than long, to 3 × 4.5 × 2.5 cm, longitudinal ridges, glabrous, drying brown, beaked. Seeds 2, 14 × 10 × 8 mm, smooth, brown, pale hilum.

Distribution. Endemic to Borneo where it has been collected from Brunei, Kalimantan, Sabah and Sarawak, but is particularly commonly collected in Sabah and East Kalimantan.

Ecology. Lowland forest.

Notes. The name *Artabotrys roseus* was widely misapplied to this species which is one of the more commonly collected taxa.

10. *Artabotrys pandanicarpus* I.M. Turner

(Greek, *carpos* = fruit, the fruits like those of *Pandanus*)

Folia Malaysiana 10 (2009) 83. TYPE: Borneo, Sarawak, near Kuching, 7 October 1892, G. D. Haviland 1775 [Garai leg.] (holotype: K (barcode no. K000581386)).

Artabotrys blumei auct. non. Hook.f. & Thomson, Ridley, Sarawak Mus. J. 1(3) (1913) 78. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 266. Masamune, Enum. Phan. Born. (1942) 279.

Large woody climber. Twigs drying brown with youngest parts almost black, occasional pale hairs soon lost. Leaves thinly coriaceous, drying dark brown and shiny above, brown and dull beneath, midrib flush to slightly raised above, prominent beneath, lateral nerves flush to slightly raised above, raised beneath, leaf glabrous except for a few adpressed pale hairs on midrib below, lamina ovate or elliptic, 9–14.5 × 4–7 cm, base obtuse to rounded, ultimately slightly decurrent to petiole, apex acuminate, lateral veins, 10–12 pairs, looping within margin, tertiary venation areolate; petiole 6–7 mm long, 1–2 mm thick. Inflorescence hooks, recurved, laterally compressed, adpressed pale hairy when young, glabrous with age. Flowering pedicel unknown (no specimens with attached flowers available), sepals relatively thin, triangular, c. 6 × 5 mm, apex acute, base slightly connate, densely adpressed pale hairy externally, glabrous within, petals thick and coriaceous, clawed, outer petals with ovate blade, c. 18 × 13 mm, flat, apex blunt, densely covered with very short pale tomentum, claw c. 4 × 5 mm, excavated, glabrous within with raised rim around excavation, blade of inner petals ovate to almost sagittate, c. 14 × 12 mm, apex rounded, densely short pale tomentose on both surfaces, claw c. 5 × 3 mm, glabrous within (reproductive structures unknown). Monocarps many, at least 10, sessile, ellipsoidal, to 3.5 × 3 cm, angular with generally 4–5 longitudinal ridges, apex with a distinct 4–5-sided flat-bottomed depression, thick-walled (3–5 mm), drying dark brown, smooth, covered with dense pale, very short, tomentum. Seeds, 1, c. 2.5 × 1.5 × 1 cm.

Distribution. Endemic to Borneo, where it is known from two or three collections from Sarawak (type and a Haviland collection with the same number which may or may not be a true duplicate from Kuching, *S* 28025 from Bintulu).

Ecology. Lowland forest.

Notes. The species of the *A. hirtipes* group (see notes under *A. hirtipes*) have sessile, angular, flat-topped monocarps similar to those of *A. pandanicarpus*. However the *A. hirtipes* group members have leaves with much more distinct secondary venation and floral parts covered with long hairs and relatively thin petals, whereas *A. pandanicarpus* has short to very short hairs on the flowers and thick fleshy petals.

11. *Artabotrys polygynus* Miq.

(Greek, *poly* = many, *gyne* = female; the many carpels)

Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 41. Ridley, Sarawak Mus. J. 1(3) (1913) 77. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Masamune, Enum. Phan. Born. (1942) 280 as 'polygonus'. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 12, as 'cf. polygynus'. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 82. TYPE: Borneo, Mt Pamatton, *P.W. Korthals s.n.* (lectotype, designated by Turner 2011, U (barcode no. U0000239)).

Artabotrys borneensis Merr., J. Straits Branch Roy. Asiat. Soc. 85 (1922) 175. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 71. Masamune, Enum. Phan. Born. (1942) 280. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 12. TYPE: Borneo, Sabah, Sandakan, September–December 1920, *M. Ramos 1366* (lectotype, designated by Turner (2009a), BM (barcode no. BM000898081); isolectotypes: A, B, BO, K, L, P, US).

Artabotrys hexagonolobus Priyanti, Floribunda 2(6) (2004) 161. TYPE: Borneo, Kalimantan, East Kalimantan, Berau, 9 October 1997, *P.J.A. Kessler et al. B867* (holotype: BO; isotypes: K, L, WAN).

Large woody climber. Twigs drying dark brown or black sometimes paler brown, often noticeably latticed, rusty adpressed tomentose on young parts, sometimes glabrescent. Leaves chartaceous, drying dark brown often greyish above, midrib flush to slightly raised above, prominent below, sometimes with pale, relatively long adpressed hairs along midrib and lamina beneath, otherwise glabrous, elliptic to obovate, base acute to obtuse, decurrent, apex apiculate to acuminate, 5–16 × 2–6 cm, lateral veins visible from both sides in dry leaves, 8–9 pairs, petiole 3–5 mm long. Inflorescence hooks recurved, single-flowered. Pedicel 7–8 mm long, dilating distally, covered with red-brown hairs, densely brown hairy, sepals triangular 5–8 mm long, 5–6 mm across, apex acute; petals yellowish, drying dark brown with pale adpressed hairs sparser on blades, outer petals thick fleshy, clawed, blade lanceolate 30 mm long, 12–15 mm wide, inner petals, blade ovate lanceolate, 20 mm long, 8–10 mm wide, stamens many, 2–3 mm long, carpels many. Monocarps 8 or more, irregularly cylindrical, spindle-shaped, sessile, apex sharply beaked, 2–2.5 cm long, 1 cm diameter, drying black or brown. Seeds 2, 15 × 7 × 4 mm, brown with longitudinal groove.

Distribution. Endemic to Borneo. In Borneo it has been recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland and hill forest to 1500 m.

12. *Artabotrys roseus* Boerl.

(Latin, rosy, pink)

Icon. Bogor. 1 (1899) 122, t. 53 (p. 161), as '*rosea*'. Ridley, Sarawak Mus. J. 1(3) (1913) 77. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 71. Masamune, Enum. Phan. Born. (1942) 280. Kessler & van Heusden, Rheedeia 3 (1993) 55. TYPE: Borneo, Sarawak, near Kuching, 12 October 1894, *G.D. Haviland s.n.* (holotype: BO (sheet no. BO-1344062).

Artabotrys pleianthus Diels, Notizbl. Bot. Gart. Berlin-Dahlem 11 (1931) 84. TYPE: Sarawak, September 1865, *O. Beccari P.B. 554* (holotype: FI-B; isotypes: B, K, M).

Large woody climber. Twigs drying brown, grey or blackish, latticed, often with raised lenticels giving a very rough feel, short brown tomentum on youngest parts. Leaves chartaceous to coriaceous, often drying grey-green or yellowy brown with yellowish venation, midrib distinctly raised above, prominent beneath, more or less glabrous, ovate elliptic to obovate, 2.5–12 × 1.2–4.5 cm, base obtuse to rounded, lamina slightly decurrent, apex apiculate to acuminate, lateral veins 9–10 pairs, clearly visible from both surfaces in dry leaves. Inflorescence hooks recurved, laterally compressed, sometimes with adpressed brown hairs, many-flowered. Pedicel 8–20 mm long, tomentose; sepals broadly ovate, 4 mm long by 3 mm wide, apex acute, slightly connate at base, outer petals triangular with little external distinction between blade and claw, 15 mm long, 4 mm wide, densely short pale or brown hairy on both surfaces except glabrous basal excavation inside; inner petals clawed, blade linear c. 1 mm wide, densely tomentose on both surfaces; stamens many, carpels c. 15. Fruiting pedicel to 2 cm long, drying 2 mm thick, monocarps to 8 or more, globose to ellipsoidal, to 3.5 × 2 cm, apex rounded not beaked, drying black or brown, smooth, glabrous, not sessile, stipe short but distinct, 2–6 mm long, 3–4 mm thick. Seeds 2, c. 19 × 13 × 8 mm.

Distribution. Endemic to Borneo. In Borneo collected from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest including heath forest.

Notes. Similar to *A. havilandii* but *A. roseus* can be distinguished by its thinner petals, linear inner petals and unconstricted outer ones.

13. *Artabotrys sarawakensis* I.M.Turner

(of Sarawak)

Folia Malaysiana 10 (2009) 70. TYPE: Borneo, Sarawak, Baram District, 26 October 1894, *C. Hose 302* (holotype: K (barcode no. K000581384); isotypes: BM, CGE).

Large woody climber. Twigs brown to dark brown, smooth or with faint longitudinal wrinkling or latticing. Leaves drying brown, often dark brown, rather shiny above, glabrous, midrib and lateral nerves raised on both surfaces in dry leaves, lamina elliptic to oblong elliptic, 6.5–11.5 × 2.5–4.5 cm, base acute to obtuse, decurrent, apex acuminate, venation distinct, particularly from above, lateral nerves 8–9 pairs, looping distinctly within margin. Inflorescences several flowered. Flower pedicel 17–23 mm long, c. 0.5 mm thick, drying black, longitudinally wrinkled, glabrous, sepals triangular 3 × 3 mm, petals yellow, clawed, densely covered in pale straw-coloured hairs on all surfaces including very short tomentum on interior excavations, blades of two whorls similar, triquetrous, sometimes grooved adaxially, 12–15 mm long, 1 mm across, stamens c. 20, c. 1 mm long, carpels c. 3, glabrous. Fruits unknown.

Distribution. Endemic to Borneo where it is known from Brunei and Sarawak.

Ecology. Lowland forest including heath forest.

Notes. Similar in flower form to *Artabotrys suaveolens* in having the blades of both petal whorls relatively narrow and not flat in cross section but the flowers are distinctly larger than *A. suaveolens* and the pedicels are much longer. The ‘*corniculatus*’ form of *A. suaveolens* that occurs in Sabah (described by Merrill as *Artabotrys trigynus*) has larger flowers and longer pedicels than typical *A. suaveolens* but it also has large, thick sepals not found in *A. sarawakensis*. Also the petals of *A. sarawakensis* are more densely and regularly tomentose – in *A. suaveolens* the petal blades are typically glabrescent giving a brown appearance in dried material.

Artabotrys costatus has flowers with long pedicels, but the outer petals have flat blades and the strongly ribbed leaves are unlike those of *A. sarawakensis*.

14. *Artabotrys suaveolens* (Blume) Blume (Latin, fragrant, sweetly smelling)

Fl. Javae Anonaceae (1830) 62, t. 30. Ridley, Sarawak Mus. J. 1(3) (1913) 76. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 173. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 67. Airy Shaw, Bull. Misc. Inform. Kew 1939 (1939) 289. Masamune, Enum. Phan. Born. (1942) 280. Sinclair, Gard. Bull. Singapore 14 (1955) 256. Kessler & van Heusden, Rheedeia 3 (1993) 55. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 12. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 82. *Unona suaveolens* Blume, Bijdr. (1825) 17. TYPE: Java, in sylvis montium Salak, Seribu etc

Unona corniculata Blanco, Fl. Filip. (1837) 469. — *Artabotrys corniculatus* (Blanco) Merr., Sp. Blancoanae (1918) 150 as ‘*corniculata*’. TYPE: Philippines, Luzon, Laguna Province, 15 March 1913, *M. Ramos Species Blancoanae No. 298* (neotype, designated by Turner (2009a), US; isoneotypes: BM, K, L).

Artabotrys parviflorus Miq., Fl. Ned. Ind., Eertse Bijv. (1861) 375. — *Artabotrys suaveolens* var. *parviflorus* (Miq.) Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 43. TYPE: Sumatra, Lampong Prvince, near Kebang, *Anon. s.n.* [Herb. Bogor. no. 4317] (lectotype, designated by Turner (2011b), U (barcode no. U 0000238)).

Artabotrys rolfei S. Vidal, Rev. Pl. Vasc. Filip. (1886) 39. TYPE: Philippines, Luzon, Prov. Albay, 1841, *H. Cuming 1099* (lectotype, designated by Turner (2009a), K (barcode no. K000691330); isolectotypes: BM, CGE, MA, MEL).

Artabotrys monogynus Merr., Philipp. J. Sci., C. 14 (1919) 383. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 173. TYPE: Philippines, Luzon, Zambales Province, Mt Canaynayan, Castillejos, December 1916, *G. Edaño Bur. Sci. 26826* (lectotype, designated by Turner (2009a), K (barcode no. K000691328); isolectotypes: A, US).

Artabotrys trigynus Merr., J. Straits Branch Roy. Asiat. Soc. 85 (1922) 177. TYPE: Borneo, Sabah, Sandakan, September–December 1920, *M. Ramos 1178* (lectotype, designated by Turner (2009a), K; isolectotypes: A, BM, GH, L, P, US).

Woody climber to 25 m long of more. Twigs smooth, drying brown, typically glabrous with a few scattered pale hairs on youngest parts, but some collections have dense brown tomentum on the twigs. Leaves chartaceous to coriaceous, drying light brown, sometimes greenish, ovate-elliptic, 6–12 × 2.5–5 cm, apex acuminate, base obtuse, slightly decurrent; midrib slightly raised above particularly near the base where the broad, flat-topped midrib is just proud of the lamina in the dry leaf, prominent beneath, generally glabrous, sometimes with adpressed hairs on lamina and along midrib below, lateral veins 9–12 pairs, looping well within the margin, easier to see from above. Petioles 3–5 mm long, less than 1 mm thick when dry. Inflorescence hooks recurved, laterally compressed, side branches to 20 mm long. Flowers sweet smelling, pedicels 5–8 mm, widening distally, glabrous or brown tomentose, basal bracts lanceolate to 4 mm long; sepals free, triangular 1–3 mm wide by 1–4 mm long, apex acute; petals pink or red turning pale creamy yellow, clawed, blades filiform (terete, triquetrous or channelled), 8–11 mm long, less than 1 mm wide, claw covered with short dense pale adpressed hairs, blade less densely tomentose, stamens many, truncate, c. 1 mm long; carpels c. 7. Fruits pedicels 5–8 mm long, monocarps 1 or 2, ellipsoidal, 12–15 × 7–9 mm, smooth, drying dark brown or black, unbeaked, sessile. Seeds 1–2, ellipsoidal, 10 × 6 × 5 mm, one face flattened if seeds paired, longitudinally grooved.

Distribution. Indochina to the Philippines. In Borneo widespread and apparently common as indicated by the many collections, particularly from Sabah.

Ecology. Lowland and montane forests up to 1220 m, including heath, peat swamp and limestone forests.

Notes. As is to be expected from a wide-ranging species, *A. suaveolens* shows some

variation in form. A few collections from Sabah were described as *A. trigynus*. They are much the same as *A. corniculatus* (Blanco) Merr. from the Philippines, which in turn may simply represent the upper end of the flower size range for *A. suaveolens*. I have reduced much of this variation to synonymy of *A. suaveolens*, but do recognise a set of distinctive collections from Borneo as *A. sarawakensis*. See this for notes on how it differs from *A. suaveolens*.

15. *Artabotrys sumatranus* Miq.

(of Sumatra)

Fl. Ned. Ind., Eertse Bijv. (1861) 375. Ridley, Sarawak Mus. J. 1(3) (1913) 77. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 267. Masamune, Enum. Phan. Born. (1942) 281. Kessler & van Heusden, Rheedea 3 (1993) 57. TYPE: Sumatra, Lampongs, near Tiga-nennin, s. dat., *J.E. Teijsmann s.n.* [Herb. Bogor. 4382] (holotype: U (barcode no. U 0000242)).

Large woody climbers. Twigs drying brown or dark brown with fine longitudinal wrinkles or latticing, sparse pale or brown hairs. Leaves chartaceous, drying rather pale brown or grey-brown, glabrous except for sparse long adpressed hairs on midrib below, midrib more or less flush above, prominent beneath, lateral nerves very slightly raised on both surfaces, lamina elliptic to obovate, 7.5–9 × 2.5–3.5 cm, apex acuminate, base acute, lateral nerves 10–12 pairs, looping within margin; petiole 4–5 mm long, c. 1 mm thick. Inflorescence hooks bearing several short-branched axes densely packed with many flowers. Flower pedicel 2–4 mm long, c. 0.5 mm thick, drying dark brown with sparse red-brown hairs, sepals ovate, 3 × 2.5 mm, drying dark brown, minutely wrinkled and warty outside, inside smoother, petals yellow, drying brown, outer petals clawed, to 15 mm long, blade linear lanceolate, 11 × 2 mm, red-brown hairy on both surfaces, claw broadly ovate, 2.5–3 × 3.5 mm, red-brown hairy externally, internally with a slightly raised upper rim, more or less glabrous, verrucose, inner petals similar length to outer petals, blade linear, channelled in upper portion, 11–12 mm long, c. 1 mm wide, red-brown hairy, claw c. 3 × 2 mm, hairy outside, glabrous, verrucose within, rather thick in upper portion, blade with peltate attachment to claw, stamens many, c. 1 mm long, apex acute, carpels 5–8, c. 1 mm long. Fruits unknown.

Distribution. Sumatra, Java and Borneo. In Borneo known with certainty only from Kalimantan with three unnumbered collections made by P.W. Korthals and *Kostermans 6820*.

Ecology. Lowland forest.

Notes. As noted under *A. atractocarpus*, it seems that *A. sumatranus* produces stipitate, but not fusiform, monocarps. I refrain from including these in the description as no fruiting specimens are known from Borneo. While the flowering specimens

from Borneo seem a good match to the type of *A. sumatranus* from (not surprisingly) Sumatra, I have not had access to enough specimens to confirm that the fruiting specimens are truly *A. sumatranus*.

16. *Artabotrys veldkampii* I.M. Turner
(J.F. Veldkamp (1941–), Dutch botanist)

Folia Malaysiana 10 (2009) 73. TYPE: Borneo, Central Kalimantan, Bukit Raya, Batu Badinging, KCT 47 km, 7 February 1983, *J.F. Veldkamp 8567* (holotype: L[×2] (barcode nos. L 0180936, L 0180937); isotype: US).

Large woody climber. Twigs drying brown to black, generally smooth with some shallow latticing, more or less glabrous except for a few pale hairs on young twigs near nodes. Leaves chartaceous to pergamentaceous, drying brown or grey-brown with midrib and laterals below a darker shade, midrib and laterals above slightly raised, midrib prominent below, laterals slightly raised, glabrous except for adpressed pale or brown hairs on midrib below, scattered on lateral nerves, lamina elliptic or oblong-elliptic, 9.5–17 × 3.5–6.5 cm, apex acuminate, base obtuse ultimately slightly decurrent, lateral nerves 11–13 pairs, looping distinctly within the margin, tertiary venation reticulate, distinct from both surfaces in dry leaves; petioles 10–12 mm long, 1.5–2 mm thick. Inflorescence hooks with adpressed pale or brown hairs, flowering repeatedly, distichously, from persistent, short straight side branches to 10 mm long. Flower pedicel 5–6 mm, 1 mm thick, widening distally, drying black, shiny, longitudinally wrinkled, with sparse brown hairs, sepals fleshy, ovate c. 2 × 2.5 mm, drying black, wrinkled outside with scattered hairs, inside smoother and glabrous, outer petals clawed, very narrowly ovate-lanceolate, blade 12–21 × 1–1.5 mm, broadly triquetrous, drying black with adpressed pale tomentum, densest towards base, claw c. 2 × 3 mm, excavation glabrous within, outside with adpressed pale tomentum, inner petals more distinctly filiform than outer, blade 13–25 × 1 mm, terete or quadrangular in cross section, drying black with adpressed pale tomentum, claw c. 3 × 2 mm, with two longitudinal ridges externally, dense very short pale tomentum outside, inside centrally glabrous with short pale tomentum marginally, stamens many c. 1 mm long, apex of connective flat-topped, carpels c. 5, c. 1 mm long, glabrous. Fruiting pedicel 8–10 mm long, to 5 mm thick, monocarps 1–2, globose but flattened apically and laterally compressed, to 3 cm from base to apex, to 3.5 cm at greatest width and 2.5 cm perpendicular to that, so wider than long, thick-walled, drying black, glabrous and relatively smooth to the naked eye, sometimes with slight longitudinal ridges, under magnification the surface appears black, shiny and wrinkled. Seeds 2, more or less hemispherical c. 17 mm diameter, 12 mm high, with circumferential groove, drying dull brown.

Distribution. Endemic to Borneo where it has been collected from Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. *Artabotrys veldkampii* has filiform petals like *A. suaveolens* but they are longer and slightly wider. The fruits are, however, much larger than the pea-sized monocarps of *A. suaveolens*. Fruiting *A. veldkampii* is likely to be confused with *A. ochropetalus*, but the monocarps of *A. veldkampii* dry black, shiny and minutely wrinkled and truly sessile whereas *A. ochropetalus* fruits dry brown, not shiny, and smoother and generally not truly sessile. The fruits of *A. maingayi* are also very similar, drying black, but they are typically longer than wide and have a more pronounced apex and stalk than *A. veldkampii*. The slender petals of *A. veldkampii* readily distinguish it from *A. ochropetalus* and *A. maingayi*.

A group of specimens from Sabah may belong here (SAN 41074, SAN 41075, SAN 147972) – they have more distinct lateral veins than *A. veldkampii* generally does, and the petals are broader.

17. *Artabotrys venustus* King
(Latin, beautiful, graceful)

J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61(2) (1892) 32. Sinclair, Gard. Bull. Singapore 14 (1955) 252. TYPE: Peninsular Malaysia, Perak, August 1884, *King's Collector* [H.H. Kunstler] 6499 (lectotype, designated by Nurainas (2004)). BO: isotypes CAL, K, L, SING).

Large woody climber. Twigs dark, longitudinally wrinkled, drying pale yellow-brown when young. Leaves drying grey olivaceous, midrib slightly prominent above, glabrous, elliptic, 9–15.5 × 4–7 cm, base obtuse to acute, apex acuminate, lateral veins c. 10 pairs, petioles 5–7 mm long. Inflorescence hooks tightly coiled, few flowered. Pedicel 10–25 mm long, 1 mm thick, sepals reflexing at anthesis, triangular, 3–5 mm long, 2–3 mm wide, sparse adpressed red-brown hair, petals yellow, coriaceous, dense rusty tomentose, outer petals flat, with no constriction externally at claw, blade ovate c. 20 × 7 mm, inner similar length to outer, slightly narrower, stamens many, carpels c. 10. Monocarps ellipsoidal, 4.5 × 2–3.5 cm, drying brown, prominently and sharply beaked, more or less sessile. Seeds 2, c. 2.5 × 1.3 cm.

Distribution. Malay Peninsula, Sumatra, Borneo. In Borneo only known from a few collections from Sarawak.

Ecology. Lowland forest.

DESMOS Lour.

(Greek, *desmos* = a bond, halter or fetter;
the moniliform monocarps are reminiscent of a chain)

Fl. Cochinch. (1790) 352 as '*Desmis*'. Sinclair, Gard. Bull. Singapore 14 (1955) 261. Bân, Bot. Zhurn. 59 (1974) 1766. Turner, Folia malaysiana 10 (2009) 59. *Unona* [unranked] *Desmos* (Lour.) Dunal, Monogr. Anonac. (1817) 97, 110. *Unona* section *Desmos* (Lour.) DC., Syst. Nat. 1 (1817) 485, 493. LECTOTYPE: *Desmos cochinchinensis* Lour. (designated by Safford 1912).

Woody climbers or scandent shrubs. Twigs glabrous or hairy. Leaves chartaceous to coriaceous, often with paired glands in lamina margin on each side of the petiole. Inflorescences 1- or 2-flowered, leaf-opposed or (supra-)axillary. Flowers bisexual, sepals 3, valvate more-or-less connate at the base, petals valvate in two whorls of 3, subequal, stamens numerous, connective truncate, carpels numerous, ovules several, lateral. Fruits monocarps many, moniliform. Seeds few to many.

Distribution and diversity. 25–30 species from India and Sri Lanka to south China and the Philippines. Four species recorded from Borneo.

Notes. Specimens are quite readily identified as belonging to *Desmos*, particularly if it is considered in the narrow sense with *Dasymaschalon* as a separate genus. The flower form with relatively undifferentiated petal whorls of quite large, free, petals; and the moniliform monocarps, easily distinguish *Desmos* from other genera. Sterile specimens might be confused with *Friesodielsia*, as both have paired glands in the leaves, though these are less distinct in herbarium material in the *Desmos* species compared to most species of *Friesodielsia*.

Key to *Desmos* species

- 1a. Leaves with veins obscure, not glaucous 2
- b. Leaves with veins distinct, often glaucous 3
- 2a. Pedicels more than 3 cm long, opposite leaves *D. acutus*
- b. Pedicels less than 2 cm long, in leaf axils *D. dunalii*
- 3a. Leaves glabrous *D. chinensis*
- b. Leaves tomentose *D. dumosus*

1. *Desmos acutus* (Teijsm. & Binn.) I.M.Turner
(Latin, acute, pointed)

Malayan Nat. J. 62 (2010) 368. — *Uvaria acuta* Teijsm. & Binn., Natuurk. Tijdschr.

Ned.-Indië 4: (1853) 398. — *Unona acuta* (Teijsm. & Binn.) Zoll., *Linnaea* 29 (1858) 320. — *Habzelia acuta* (Teijsm. & Binn.) Miq., *Fl. Ned. Ind.* 1 (1858) 37. TYPE: Java, *Anon. s.n.* (lectotype, designated by Turner (2010a), L (barcode no. L 0186510)).

Desmos teysmannii (Boerl.) Merr., *Philipp. J. Sci., C.* 10 (1915) 235. Merrill, *J. Straits Branch Roy. Asiat. Soc. Spec. No.* (1921) 256. Masamune, *Enum. Phan. Born.* (1942) 282. Sinclair, *Gard. Bull. Singapore* 14 (1955) 264. Bygrave in Coode et al., *Checkl. Fl. Pl. Gymnosp. Brunei* (1996) 14. Beaman et al., *Pl. Mt. Kinabalu* 4 (2001) 83. — *Unona teysmannii* Boerl., *Icon. Bogor.* 1 (1899) 103. Ridley, *Sarawak Mus. J.* 1(3) (1913) 79. TYPE: Borneo, Sungai Landak, *J.E. Teijsmann s.n.* [Bogor distribution no. 185] (holotype: L (barcode no. L 0037925); isotypes: B, K, US).

Scandent shrub or large woody climber to 15 m long at least. Twigs slender, dark, lenticellate, minutely pubescent when young. Leaves membranous, glabrous except for some hairs on midrib beneath, sometimes glaucous beneath, drying pale brown above, ovate or oblong-elliptic to oblong-lanceolate, 5–13 × 2–6 cm, base rounded to acute, apex acute; midrib immersed above, prominent below, lateral veins 11–13 pairs, very fine and faint on both surfaces, tertiary venation reticulate. Petioles 5–7 mm long. Inflorescences opposite leaves, single-flowered. Flowers pendent, fragrant, pedicels long and slender, 3–6 cm, less than 0.5 mm thick; sepals triangular, 5–10 mm long, apex acute, reflexed at anthesis; petals greenish-yellow, thin, puberulous, lanceolate, 4–7 cm long, 10–18 mm wide at widest, apex obtuse; stamens many; carpels many. Fruits pedicels 3–6 cm long, monocarps moniliform, to 20 or more, to 5 cm long, stipe 1–2 cm long. Seeds 2–6, globose or ellipsoidal, c. 7 × 6 mm, drying pale brown, smooth.

Distribution. Malay Peninsula, Java, ?Bali and Borneo. In Borneo from Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. Fruiting material can be confused with that of *Sphaerocoryne affinis*, but the persistent calyx and decurrent veins of the latter identify it as *Sphaerocoryne*.

2. *Desmos chinensis* Lour. (of China)

Fl. Cochinch. (1790) 352. Merrill, *J. Straits Branch Roy. Asiat. Soc. Spec. No.* (1921) 255. Masamune, *Enum. Phan. Born.* (1942) 282. Sinclair, *Gard. Bull. Singapore* 14 (1955) 266. Beaman et al., *Pl. Mt. Kinabalu* 4 (2001) 83. — *Unona chinensis* (Lour.) DC., *Syst. Nat.* 1 (1817) 495. TYPE: China, Canton, s. dat., *Loureiro s.n.* (lectotype, designated by Ban (1974a), BM).

Uvaria monilifera Gaertn., Fruct. Sem. Pl. 2 (1790) 156, t. 114. TYPE: Gaertner's plate (Gaertner 1790: t. 114) (lectotype designated by Turner (2011b)). Java, East Java, Besuki, Nusa Barung Island, between Teluk Tjambak and Teluk Kandangan, 8°30'S, 113°20'E, 11 May 1957, *M. Jacobs 4729* (epitype, designated by Turner (2011b), K; isoepitypes: A, BO, L, LAE, NY, PNH, SING).

Unona discolor Vahl, Symb. Bot. 2 (1791) 63, t. 36. Ridley, Sarawak Mus. J. 1(3) (1913) 79. TYPE: East Indies, *J.G. König s.n.* (holotype: C).

[*Uvaria undulata* Roxb., Hort. Bengal. (1814) 43, *nom. nud.*]

Unona lessertiana Dunal, Monogr. Anonac. (1817) 107, t. 26. TYPE: *Uvaria uncata* Vahl in herb. Delessert.

Unona biglandulosa Blume, Bijdr. (1825) 16. TYPE: Java, Tjikao, s. dat., *J.C.A. van Hasselt s.n.* [Herb. Blume no. 1206] (lectotype, designated by Turner (2011b), L (barcode no. L 0186343)).

Unona discolor var. *bracteata* Blume, Fl. Javae Anonaceae (1830) 37, t. 15. TYPE: Java, in Provincia Krawang.

Unona undulata Wall., Pl. As. Rar. 3 (1832) 42, t. 265, *non Unona undulata* (P. Beauv.) Dunal (1817). — *Uvaria undulata* Walp., Repert. Bot. Syst. 1 (1842) 77. TYPE: India, cultivated in Hort. Bot. Calc., *Anon. s.n.* [EIC 6423B] (lectotype, designated by Turner (2011b), K-W; isolectotypes: CAL, K).

Uvaria cordifolia Roxb., [Hort. Bengal. (1814) 43, *nom. nud.*] Fl. Ind. 2 (1832) 662. TYPE: India, Eastern India, *W. Roxburgh 3663* (lectotype, designated by Turner (2011b), BM).

Unona amherstiana A.DC., Mem. Soc. Phys. Genève. 5 (1832) 204. TYPE: Burma, Amherst, 14 July 1827, *N. Wallich s.n.* [EIC 6424] (lectotype, designated by Turner (2011a), K-W; isolectotype: BM).

[*Unona roxburghiana* Wall., Numer. List (1832) no. 6423, *nom. nud.*]

Unona discolor var. *latifolia* Hook.f. & Thomson, Fl. Ind. (1855) 133. TYPE: Peninsular Malaysia, Malacca, s. dat., *W. Griffith s.n.* (lectotype, designated by Turner (2011b), K).

Unona discolor var. *laevigata* Hook.f. & Thomson, Fl. Ind. (1855) 133. — *Desmos chinensis* var. *laevigatus* (Hook.f. & Thomson) Debika Mitra, Bull. Bot. Survey India 35 (1997) 117, as '*laevigata*'. TYPE: India, cultivated in Hort. Bot. Calc., *Anon. s.n.* [EIC 6423B] (lectotype, designated by Mitra (1997), CAL; isolectotypes: CGE, K, K-W).

Unona discolor var. *pubiflora* Hook.f. & Thomson. Fl. Ind. (1855) 133. TYPE: India.

Unona discolor var. *pubescens* Hook.f. & Thomson. Fl. Ind. (1855) 133. Type: India, Sikkim. s. dat., *Anon.* [J.D. Hooker] 143 (lectotype, designated by Turner (2011b), K (barcode no. K000739190)).

Unona discolor var. *parviflora* Miq., Fl. Ned. Ind., Eerste Bijv. 3 (1861) 376. TYPE: Sumatra, Ins. Pulu Pisang prope Padang, Teijsmann.

Unona discolor var. *angustipetala* Boerl., Cat. Pl. Phan. (1899) 17. TYPE: Java, cult. in Hort. Bot. Bogor sub XI.A.33a. *Anon. s.n.* [Bogor, distrib. no. 168] (lectotype, designated Turner (2011b), L (barcode no. L 0186415); isolectotype: K).

Unona discolor var. *brevifolia* Teijsm. & Binn. ex Boerl., Cat. Pl. Phan. (1899) 17. — *Desmos chinensis* var. *brevifolius* (Teijsm. & Binn. ex Boerl.) Bân. Bot. Zhurn. 59 (1974) 1773. TYPE: Java, cult. in Hort. Bogor., *Anon. s.n.* (Bogor, distrib. no. 170 B) (lectotype, designated by Ban (1974a), US).

Unona discolor var. *macropetala* Teijsm. & Binn. ex Boerl., Cat. Pl. Phan. (1899) 16. — *Desmos chinensis* var. *macropetalus* (Teijsm. & Binn. ex Boerl.) Bân. Bot. Zhurn. 59 (1974) 1774. TYPE: Java, cult. in Hort. Bogor., *Anon. s.n.* [Bogor, distrib. no. 174 A] (lectotype, designated by Ban (1974a), US).

Unona discolor var. *neglecta* Boerl., Cat. Pl. Phan. (1899) 17. TYPE: Java, cultivated in Hort. Bot. Bogor. sub XI.A.17. *Anon. s.n.* [Bogor, distrib. no. 168] (lectotype, designated by Turner (2011b), L (barcode no. L 0181967)).

Unona discolor var. *siamensis* Scheff. ex Boerl., Cat. Pl. Phan. (1899) 17. TYPE: Java, cultivated in Hort. Bot. Bogor. sub XI.A.40a. *Anon. s.n.* [Bogor, distrib. no. 182] (lectotype, designated by Turner (2011b), L (barcode no. L 0181979)).

Artabotrys esquirolii Lév., Fl. Kouy-Tcheou (1914-1915) 29. TYPE: China, Kouy-Tcheou [Gui Zhou], 17 April 1910, *J.H. Esquirol* 2039 (lectotype, designated by Turner (2011b), E (barcode no. E00181425)).

Desmos cochinchinensis auct. non Lour.: Merrill. Enum. Philipp. Fl. Pl. 2 (1923) 158.

Scandent shrub or large climber to 40 m long. Twigs slender, striate, dark, slightly pubescent at the tips. Leaves thinly chartaceous, glabrous, glaucous beneath, oblong, 6–13 × 3–6 cm, base rounded, sometimes emarginate, apex acute to acuminate; midrib immersed above, prominent below, sparsely hairy below; lateral veins 8–10 pairs, feint above, prominent below. Petioles 5 mm long, slender. Inflorescences opposite the leaves, single-flowered. Flowers pendulous, pedicels 3–6 cm long, less than 0.5 mm thick, slender, glabrous or puberulous; sepals ovate-lanceolate, 5–10 mm long, apex

acute, puberulous to glabrous; petals greenish yellow, clawed, narrowly lanceolate, 4–8 cm long, glabrous or sparsely pubescent; stamens numerous, c. 1 mm long, carpels many. Fruits pedicel to 6 cm long, c. 20 moniliform monocarps, 3–4 cm long, glabrous or minutely pubescent, terminal section apiculate, stipes 10–14 mm long. Seeds 2–6, globose or ellipsoidal, c. 6–7 × 5 mm, drying light brown, smooth.

Distribution. Widespread from India to the Philippines. In Borneo, widespread, commonly collected in Sabah, occasional from Sarawak and Kalimantan.

Ecology. Lowland forests. May be cultivated in gardens for its fragrant blooms.

Notes. As a widespread species with a long history of cultivation, it is not surprising that *Desmos chinensis* has a long list of synonyms including many infraspecific taxa. The specimens from the wild in Borneo appear relatively uniform and fall well within the range of morphological variation of *D. chinensis*.

3. *Desmos dumosus* (Roxb.) Saff.

(Latin, bushy)

Bull. Torrey Bot. Club 39 (1912) 506. Sinclair, Sarawak Mus. J. 5 (1951) 599. Sinclair, Gard. Bull. Singapore 14 (1955) 268. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosperm. Brunei (1996) 14. — *Unona dumosa* Roxb., Fl. Ind. 2 (1832) 670. TYPE: Roxburgh Icon. 2294 (lectotype, designated by Turner (2011b), K). India, cult. in Hort. Bot. Calc., s. dat. *Anon. s.n.* [EIC 6429B] (epitype, designated by Turner (2011b), K-W [$\times 2$]); isoepitypes: BM, CGE, K).

Unona subbiglandulosa Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 11. Ridley, Sarawak Mus. J. 1(3) (1913) 78. — *Desmos subbiglandulosus* (Miq.) Merr., Philipp. J. Sci., C. 10 (1915) 235. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 256. Masamune, Enum. Phan. Born. (1942) 282. TYPE: Borneo, Martapoera, P.W. Korthals s.n. (lectotype, designated by Turner (2011b), L (barcode no. L0182002)).

Oxymitra monilifera Merr., Univ. Calif. Publ. Bot. 15 (1929) 73. Masamune, Enum. Phan. Born. (1942) 292. — *Dasymaschalon moniliferum* (Merr.) P.T. Li, Acta Phytotax. Sin. 14(1) (1976) 104. TYPE: Borneo, Sabah, near Tawao, October 1922–March 1923, A.D.E. Elmer 20525 (lectotype, designated by Turner (2011b), MO (barcode no. MO-176168)); isolectotypes: A, BISH, BM, BO, C, CM, DS, K, L, M, MICH, MO, NY, P, PH, S, SING, U).

Scandent shrub. Twigs relatively stout, tomentose when young, striate with numerous lenticels. Leaves membranous, variably pubescent, drying pale brown or grey with midrib and veins dark brown, ovate to oblong-ovate, 6–17 × 4–7 cm, base subcuneate to rounded and emarginate, apex obtuse to acute; midrib sunken above, prominent below,

sparingly pubescent, lateral veins 10–12 pairs, prominent beneath, tertiary venation scalariform. Petioles 7–20 mm long, rusty tomentose. Inflorescences subopposite leaves, single-flowered. Flowers pedicels c. 2 cm long, tomentose, sepals ovate-lanceolate, 5–10 mm long, apex acute, almost glabrous; petals greenish yellow, clawed, narrowly lanceolate, 4–8 cm long, densely pubescent; stamens numerous, c. 1 mm long, carpels many. Fruits pedicels 2–4 cm long, monocarps 30 or more, moniliform, 2–4 cm long, stipes 1–1.5 cm long, minutely pubescent, terminal segment usually beaked. Seeds 2–5, globose or ellipsoidal, c. 6–7 × 5–6 mm, drying light brown, smooth.

Distribution. Widespread from India to Borneo. In Borneo recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

4. *Desmos dunalii* (Wall. ex Hook.f. & Thomson) Saff.

(M.F. Dunal (1789–1856) French botanist who published a monograph of the Annonaceae in 1817)

Bull. Torrey Bot. Club 39 (1912) 506. Sinclair, Gard. Bull. Singapore 14 (1955) 263. — *Unona dunalii* Wall. ex Hook.f. & Thomson, Fl. Ind. 1 (1855) 131. TYPE: Peninsular Malaysia, Penang, *G. Porter s.n.* [EIC 6425] (lectotype, designated by Turner (2011b), K (barcode no. K000691358); isotypes: CAL, CGE, GZU, K, K-W).

Liana to 30 m long. Twigs slender, glabrous with pale lenticels. Leaves subcoriaceous, glabrous except for some hairs on midrib beneath, sometimes glaucous beneath, drying pale brown above, oblong-elliptic to oblong-obovate, 6–13 × 3–6 cm, base rounded to acute, apex acute; midrib flush to slightly sunken above, prominent below, lateral veins 11–13 pairs, fine and faint on both surfaces, tertiary venation reticulate. Petioles 5–7 mm long. Inflorescences axillary or terminal, flowers single or occasionally in pairs. Flowers fragrant, pedicel 8–10 mm long with tiny adpressed hairs, sepals reflexed, broadly ovate, 5–7 mm long, puberulous; petals greenish yellow, drying brown, narrowly oblong-lanceolate, 25–32 mm long, sometimes covered with short adpressed hairs; stamens numerous, carpels many. Fruits pedicel to 15 mm long, monocarps moniliform, numerous, glabrous, 13–35 mm long. Seeds 1–5, globose or ellipsoidal, c. 8 × 5 mm, drying brown, smooth.

Distribution. Malay Peninsula and Borneo. In Borneo collected from Brunei, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. Care must be taken not to include fruiting *Sphaerocoryne affinis* with this or *D. acutus*, though *Sphaerocoryne* does not have moniliform monocarps.

***FISSISTIGMA* Griff.**(Latin, *fissum* = to split, divide, separate, *stigma* = stigma)

Notul. Pl. Asiat. (Posthum. Pap.) 4 (1854) 706. Sinclair, Gard. Bull. Singapore 14 (1955) 349. Irawan, Floribunda 2(7) (2005) 173. Turner, Nord. J. Bot. 27 (2009) 362–369. TYPE: *Fissistigma scandens* Griff.

Woody climbers typically tomentose with simple hairs. Leaves with scalariform tertiary venation. Inflorescences leaf-opposed, or axillary, sometimes appearing terminal, fascicles of few to many flowers. Flowers bisexual, buds conical, sepals 3, valvate, more or less connate at base, petals valvate, coriaceous, two whorls of 3, inner slightly smaller, coriaceous, triquetrous, concave at base, stamens many, connectives with slightly prolonged apex, obtuse or apiculate, carpels many, pubescent, ovules 2 or more, biseriate. Fruits cylindrical, ellipsoidal or globose, thick-walled, stipitate. Seeds several in two rows, smooth and shiny.

Distribution and diversity: Some 60 species or so. India and Sri Lanka, Indochina, China and through Malesia to Australia. 15 species recorded from Borneo.

Notes. Merrill (1919) included *Mitrella* and *Pyramidanthe* in *Fissistigma*. Based on molecular analyses, Bygrave (2000) supported this generic reduction. However other authors (Sinclair 1955; Ban 1974b; Kessler 1993; Jessup 2000; Irawan 2005) have maintained *Fissistigma* in the narrower sense. I follow the latter position because *Fissistigma* is quite readily distinguished from *Mitrella* and *Pyramidanthe* on morphological grounds, at least as far as Borneo material is concerned, and there has been no recent peer-reviewed publication supporting unification.

Key to *Fissistigma* species

- 1a. Midrib of dry leaf with a raised longitudinal ridge on upper surface, monocarps drying rugulose *F. rugosum*
- b. Midrib of leaf without a raised longitudinal ridge, monocarps drying relatively smooth (*F. latifolium* with irregular ridges, *F. longipetalum* verruculose) 2
- 2a. Leaves more than 13 cm wide, petiole 6 mm thick or more, pedicel of flower at least 2.5 cm long, 3 mm thick *F. crassicaule*
- b. Leaves less than 13 cm wide, petiole generally 3 mm or less in diameter (up to 5 mm in *F. kingii*), pedicel of flower generally 2 mm or less in diameter, if thicker then pedicel less than 2.5 cm long 3

- 3a. Lower lamina glabrous (to naked eye or touch) 4
 b. Lower lamina hairy 7
- 4a. Leaves with 18 or more pairs of lateral veins *F. elmeri*
 b. Leaves with 12 or fewer pairs of lateral veins 5
- 5a. Leaf with midrib above glabrous, flowers drying dark brown externally, medial bract absent or very close (3 mm or less) to the base of the pedicel, monocarps more or less glabrous, drying dark brown *F. bygravei*
 b. Leaves with fringe of hairs on midrib above, flowers drying pale or golden brown externally, medial bract more than 3 mm from the base of the pedicel, monocarps covered in short dense tomentum drying pale to mid-brown 6
- 6a. Hairs on midrib above more or less erect, outer petals more than 2 cm long, monocarps verruculose, covered with dense short brown curly hairs
 *F. longipetalum*
 b. Hairs on midrib above prostrate or decumbent, outer petals less than 2 cm long, monocarps smooth, covered with straight adpressed golden brown hairs
 *F. fulgens*
- 7a. Leaf lower lamina when viewed under a lens ($\times 10$) with more or less straight hairs, erect or decumbent 8
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 *F. paniculatum*
 b. Hairs on lower lamina decumbent to adpressed, flowers solitary in leaf axils ..
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..... *F. latifolium*
- b. Leaves drying grey-green above with lateral veins flush, inner petals covered with a short grey tomentum externally and in upper portion of the inner surface, monocarps drying more or less smooth *F. kingie*
- 14a. Tertiary venation of lower lamina obscured by dense brown tomentum, medial bract 4 mm or more long *F. multivenium*
- b. Tertiary venation of lower lamina scarcely visible under magnification, not obscured by tomentum, medial bract absent or to 1 mm long *F. montanum*

1. *Fissistigma brevistipitatum* I.M.Turner

(Latin, *brevi* = short, *stipitatus* = provided with a stalk; the short stipes to the monocarps)

Nordic J. Bot. 27 (2009) 363. TYPE: Borneo, Sabah, Interior Division, Nabawan District, Sungai Millian, 7 November 1986, *Sumbing Jimpin SAN 118571* (holotype: K (barcode no. K000580891); isotypes: A, L, SAN).

Fissistigma sp. 4: Beaman et al., Pl. Mt. Kinabalu 4 (2001) 86.

Large woody climber. Twigs generally drying black with abundant raised pale lenticels, sometimes brown and striate, young parts densely red-brown tomentose. Leaves chartaceous to subcoriaceous, expanding leaves very densely red-brown hairy below and on nerves above, pale hairs on lamina above, mature leaves drying pale brown or grey-brown above with lateral nerves distinctly paler, brown below with midrib and nerves a darker shade, ultimately glabrous above except for hairs on midrib which can be restricted to a few near the petiole attachment, below with red-brown curly hairs, dense on nerves, abundant on lamina, lamina oblong elliptic to oblong obovate, 4–8.5 \times 1.5–4 cm, base obtuse to rounded, apex obtuse to rounded, lateral veins 7–11 pairs, arching forward, looping obscurely, tertiary venation visible from below. Petiole 7–11 mm long, 1–2 mm thick. Inflorescence terminal or leaf-opposed, few-flowered panicle. Pedicel to 15 mm long, 2 mm thick, densely red-brown hairy, medial bract acute, to 2 mm long, densely hairy outside, sepals triangular, c. 3 \times 3 mm, outer petals 15 \times 5 mm, dense red-brown hairs externally, inside covered with very short pale brown wool, inner petals ovate lanceolate c. 11 \times 4 mm, dense very short brown hairs

outside, inside also in upper portion, excavation glabrous, verrucose, stamens many, carpels numerous, densely red-brown hairy. Fruiting pedicel 12–15 mm long, 2–4 mm thick, monocarps to 5 or more, ellipsoidal, 3–3.5 × 2.5 cm, apex broadly nipped, drying densely, very shortly red-brown woolly, stipe, shorter than seed-bearing portion of the monocarp, 1–1.5 cm long, 4 mm thick. Seeds c. 12 in 2 rows, smooth, brown, c. 13 × 9 × 4 mm.

Distribution. Endemic to Borneo where it has been collected quite widely in Sabah and once from Sarawak.

Ecology. Lowland and hill forest to 1200 m.

2. *Fissistigma bygravei* I.M. Turner,

(Paul C. Bygrave (1970–), British Annonaceae taxonomist and nurseryman)

Nordic J. Bot. 27 (2009) 366. TYPE: Borneo, Sabah, West Coast Division, Penampang District, 5th mile path from Kpg. Babgon to Ulu Terian, 15 October 1969, *P.F. Cockburn SAN 65500* (holotype: K (barcode no. K000580483); isotypes: L, SAN, SAR, SING).

Large woody climber. Twigs pale brown, striate, youngest parts brown, sometimes with very short dark brown hairs. Leaves chartaceous, drying dark grey brown above, dark or pale purple brown below, midrib and laterals flush above in dry leaves, midrib prominent below, laterals very slightly raised below, leaves glabrous above, below glabrous to the naked eye but very short adpressed golden brown hairs visible under magnification, leaves elliptic, ovate or oblong obovate, 3.5–15 × 1.5–7 cm, base obtuse to rounded, apex very slightly notched, blunt or shortly acuminate, lateral veins, 9–14 pairs, arching forward and looping obscurely, tertiary venation visible from both surfaces in dry leaves. Petiole 4–12 × 1–2 mm. Inflorescences terminal or leaf-opposed, many-flowered panicle. Pedicel 7–17 mm long, c. 1 mm thick, with red-brown or dark brown short adpressed hairs, medial bract sometimes absent, otherwise within 3 mm of base of pedicel, sepals ovate, c. 1 × 2 mm, somewhat reflexed, drying black with short adpressed brown hairs, outer petals coriaceous, ovate lanceolate, 12–17 × 4 mm, drying blackish or dark brown with short adpressed brown or red-brown hairs outside, inside and on edges with short pale woolly hairs, inner petals ovate lanceolate 8 × 3 mm, base concave, short woolly pale brown externally and on upper portion internally, concavity glabrous, stamens many, c. 1 mm long, carpels many. Fruiting pedicel 16–18 mm long, 3 mm thick, monocarps to 12 or more, ellipsoidal, to 2 cm long, apex with a broad short beak, glabrous, drying black or dark brown, stipe c. 10 mm long, 3 mm thick. Seeds several.

Distribution. Endemic to Borneo where it has been collected from Kalimantan, Sabah and Sarawak.

Ecology. Lowland rain forest to 680 m.

Notes. Among Bornean species, *F. bygravei* is most similar to *F. longipetalum*. *Fissistigma bygravei* differs from *F. longipetalum* in having leaves glabrous above, medial bract absent or very close (3 mm or less) to the base of the flower pedicel, outer petals drying dark brown and monocarps drying dark brown, smooth and more or less glabrous.

3. *Fissistigma carrii* I.M. Turner

(Cedric Erroll Carr (1892–1936), New Zealand-born rubber planter and orchidologist)

Nordic J. Bot. 27 (2009) 367. TYPE: Borneo, Sabah, Mt Kinabalu, path to Ranau, c. 4800 ft, 15 Apr 1933, C.E. Carr SFN 27006 (holotype: SING (barcode no. SING 0108643)).

Fissistigma sp. 2: Beaman et al., Pl. Mt. Kinabalu 4 (2001) 85.

Large woody climber. Twigs drying dark grey with shallow longitudinal wrinkles, youngest parts covered with decumbent golden brown hairs. Leaves chartaceous to subcoriaceous, drying pale to dark brown above, brown to pale brown beneath, midrib immersed to slightly sunken above, prominent beneath, lateral veins immersed above raised beneath, glabrous above except for hairs on midrib, below sparsely to densely tomentose, with more or less straight, decumbent pale brown hairs lying parallel to lateral nerves, lower lamina surface relatively smooth, not granular or wrinkled, elliptic, ovate to ovate-lanceolate, 3.5–10 × 1.5–3 cm, base obtuse to rounded, apex obtuse, acute or acuminate, lateral nerves 12–20 pairs, distinct from both surfaces in dry leaves, tertiary venation sometimes distinct from below. Petiole 6–13 mm long, 1–2 mm thick. Inflorescences axillary, single-flowered. Flower pedicel 6–9 mm long, 1 mm thick, densely golden brown hairy, sepals triangular, c. 2 × 2 mm, brown hairy outside, more or less glabrous within, outer petals ovate-lanceolate c. 11 × 4, outside brown hairy, inside with very short curly brown hairs near margins otherwise more or less glabrous, drying black, minutely papillate, inner petals ovate-lanceolate, c. 9 × 3 mm, drying black, glabrous except for scattering of short brown hairs coinciding with the gaps between the outer petals, drying verrucose inside, stamens many, carpel many, hairy. Fruiting pedicel 7–15 × 3–4 mm, monocarps to 16 or more, globose, c. 2.5 cm diameter, drying dark brown, smooth, sparsely covered with adpressed golden brown hairs, densest near apex, apex rounded sometimes with very short, broad apiculus, stipe 1–2.5 cm long, c. 2 mm thick. Seeds 10–12, flat oblong but with one side more curved, c. 16 × 9 × 3 mm, dark brown, smooth and shiny.

Distribution. Endemic to Borneo. Only known from around Mt Kinabalu in Sabah.

Ecology. Montane forest at 1200–1800 m.

Notes. *Fissistigma carrii* is similar to *F. kinabaluense*, which, as its name suggests, was also described from Mt Kinabalu. *Fissistigma carrii* differs in not having the long slender flower pedicels of *F. kinabaluense*, or the clear central ridge and radiating nerves visible on the outer petals. The monocarps of *F. carrii* are larger (2.5 vs 1.5 cm diameter) than those of *F. kinabaluense*.

4. *Fissistigma crassicaule* I.M. Turner

(Latin, *crassus* = thick, *caulis* = stem)

Nordic J. Bot. 27 (2009) 365. TYPE: Borneo, Sarawak, Kuching Division, Kuching District, Stampin, 5 miles south of Kuching, 6 January 1966. J.A.R. Anderson & P. Chai S 22770 (holotype: K[×2] (barcode nos. K000580484, K000580485); isotypes: L, SAR).

Large woody climber. Twigs densely red-brown hairy, at least when young. Leaves chartaceous to coriaceous, drying dark brown to dark grey-brown above, brown or greeny brown below, glabrous above except for dense fringe on midrib and some laterals, below densely golden brown or pale brown hairy on nerves, sparser on lamina, lamina surface smooth, oblong-elliptic, 22–32 × 13–16 cm, base obtuse, truncate to very slightly cordate, apex rounded to slightly notched, lateral veins 16–17 pairs. Petiole to 3 cm long, 6 mm thick. Inflorescence terminal, many-flowered panicle. Pedicel 2.5–3 cm long, c. 3 mm thick, densely brown hairy, medial bract ovate c. 4 × 3 mm, brown hairy outside, sepals ovate, 5 × 4 mm, brown hairy outside, outer petals ovate lanceolate, 15 × 8–10 mm, densely brown hairy outside, inside glabrous, drying dark brown, except for edges and narrow margin where pale brown adpressed woolly, inner petals ovate acuminate, c. 12 × 8 mm, apex acute, almost glabrous except for pale hairs near apex externally, drying dark brown, pimply outside, verrucose inside, stamens many, red, drying pale, carpels numerous, hairy. Fruiting pedicel c. 4.5 cm long, 6 mm thick, densely brown hairy, monocarps to 20 or more, globose, c. 1.5 cm diameter, densely golden brown hairy, hairs long, straight, more or less erect, stipe to 2 cm long, 3 mm thick.

Distribution. Endemic to Borneo. Known from two collections (type, Beaman 11834) from disturbed lowland kerangas (heath) forest in western Sarawak.

Notes. In its general robustness *Fissistigma crassicaule* is only approached among the Bornean species by *F. rugosum*. However *F. rugosum* is readily distinguished by a characteristic raised longitudinal ridge along the top side of the midrib in dry leaves, its almost glabrous foliage, relatively indistinct tertiary venation and monocarps drying rugose. Otherwise leaves more than 13 cm wide, petioles 6 mm or more thick and flower pedicel 25 mm long and 3 mm thick or more distinguish *F. crassicaule* from all the other species native to Borneo. *Fissistigma crassicaule* is essentially a giant version of *Fissistigma latifolium* (Dunal) Merr. (at least as far as

Borneo material referred to *F. latifolium* is concerned), and the type of *F. crassicaule* has been previously determined as *F. latifolium*. However *F. crassicaule* lacks the ridges on the dry monocarps characteristic of *F. latifolium* and the surface of the lower lamina is smooth in *F. crassicaule* lacking the granular or cobwebbed appearance of *F. latifolium*. One can speculate whether *F. crassicaule* represents a local species derived from *F. latifolium* in the heath forest of Sarawak.

5. *Fissistigma elmeri* Merr.

(A.D.E. Elmer, 1870–1942, American plant collector and botanist)

Univ. Calif. Publ. Bot. 15 (1929) 72. Masamune, Enum. Phan. Born. (1942) 284. TYPE: Borneo, Sabah, Tawao, October 1922–March 1923, A.D.E. Elmer 20881 (lectotype, designated by Turner (2011b), UC (sheet no. 289981); isolectotypes: B[×2], BISH, BM[×2], BO, C, CM, DS, GH, K, L, M, MICH, MO, NY, P[×2], PH, S, SING, US[×2]).

Large woody climber. Twigs drying black or dark chestnut brown with shallow latticing, redder when young, striate, very youngest parts with pale hairs, soon lost. Leaves chartaceous to subcoriaceous, drying pale grey brown to dark brown above, or a mixture of shades, quite shiny, more uniform mid-brown below with darker midrib and laterals, midrib slightly sunken above in dry leaves, prominent beneath, laterals flush above, prominent beneath, short hairs on midrib above, but to the naked eye appearing more or less glabrous, sparse very short adpressed hairs on lamina and nerves beneath, oblong oblanceolate or oblong elliptic, 9–19 × 3.5–9 cm, base broadly cuneate with a round or truncate termination, apex emarginate, obtuse, apiculate or acuminate, acumen rather sharply pointed, lateral veins 18–22 pairs, angled forward, more or less parallel, looping obscurely, short but distinct intersecondary veins present, tertiary venation scalariform, ultimate reticulations areolate giving a characteristic matt appearance to lamina below. Petiole 8–14 mm long, 2 mm thick. Inflorescence terminal or axillary. Pedicels 10–20 mm long, 1 mm thick, drying red-brown, slightly wrinkled, with pale hairs, medial bract ovate, c. 2 × 1 mm, base truncate, sepals coriaceous, triangular, c. 2–3 × 2–3 mm, slightly connate at the base, densely pale brown hairy outside, glabrous inside; outer petals thick, coriaceous, ovate lanceolate, 12–35 × 4–6 mm, outside with central longitudinal ridge, covered in adpressed pale brown hairs, inside very short adpressed pale hairs, sparse on papillate portion near base; inner petals ovate lanceolate, 8–10 × 3 mm, base deeply concave, externally with central ridge, covered with dense, very short adpressed pale hairs, inside sparsely hairy in upper portion, more or less glabrous basally, stamens many, 1–1.5 mm long, connective apex pointed, curved inwards, carpels pale hairy, stigmas drying black with long pale hairs. Fruiting material scarce, monocarps globose, c. 2 cm diameter, stipitate, densely red-brown adpressed tomentose.

Distribution. Endemic to Borneo, where it has been collected quite widely from Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest to 600 m.

6. *Fissistigma fulgens* (Hook.f. & Thomson) Merr.
(Latin, shiny, bright-coloured)

Philipp. J. Sci., C. 15 (1919) 131. Sinclair, Gard. Bull. Singapore 14 (1955) 353. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 15. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 84. Irawan, Floribunda 2(7) (2005) 178. — *Melodorum fulgens* Hook.f. & Thomson, Fl. Ind. (1855) 120. Ridley, Sarawak Mus. J. 1(3) (1913) 90. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 261. Masamune, Enum. Phan. Born. (1942) 287. TYPE: Peninsular Malaysia, Malacca, s. dat., *W. Griffith s.n.* (lectotype, designated by Turner (2011b), K (barcode no. K000574633)).

[*Uvaria fulgens* Wall., Numer. List (1832) no. 6482, *nom. nud.*]

[*Myristica finlaysoniana* Wall., Numer. List (1832) no. 6793), *nom. nud.*]

Magnolia ferruginea P. Parm., Bull. Sci. France Belg. 27 (1896) 203, 263; *non M. ferruginea* Hort. ex W. Wats. (1889). TYPE: India (?wrongly localised), *s.dat.*, *T.S. Ralph s.n.* (holotype: P (barcode no. P01964102)).

Melodorum parviflorum var. *angustifolium* Boerl., Icon. Bogor. 1 (1899) 134. Ridley, Sarawak Mus. J. 1(3) (1913) 90. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. TYPE: Borneo, Sarawak, near Kuching, 17 October 1894, *G.D. Haviland & C. Hose 416L* (holotype: BO (sheet no. BO-1349056); isotype: CGE).

Large woody climber. Twigs drying dark brown or dark grey, young parts with dense red-brown to pale brown adpressed hairs giving a rough feel to finger running proximally down twig. Leaves chartaceous, drying dark brown to almost black above, often with patches or wash of a paler grey-brown, rich brown below with veins and midrib a slightly redder hue, midrib slightly sunken above in dry leaves, prominent beneath, laterals flush above, prominent beneath, tiny golden or red-brown tightly adpressed hairs on lamina and nerves below, hairs on lamina running more or less parallel to the lateral nerves, scarcely visible to naked eye except as a reflective metallic sheen, above pale hairs on nerves, lamina ovate lanceolate, 4.5–18 × 1–5 cm, base obtuse to rounded, apex acute to acuminate, lateral veins 7–11 pairs, arching forward, looping obscurely, tertiary venation obscure to the naked eye; petiole 6–11 mm long, 1–2 mm thick. Inflorescence terminal or axillary. Pedicels 7–9 mm long, c. 1 mm thick, widening distally, densely adpressed straw brown or golden brown hairy, medial bract ovate, 3 × 2 mm, apex acute, sepals triangular, c. 3 × 3 mm, densely hairy outside, glabrous inside except for scattered hairs near the apex; outer petals coriaceous, ovate lanceolate, 10 × 5–6 mm, apex acute, externally densely covered in adpressed straw brown hairs, similar inside except for a glabrous papillate portion near the base; inner

petals ovate lanceolate, 7–8 × 4–5 mm, base deeply concave, drying dark brown except for scattering of adpressed pale hairs near the apex externally, stamens many, 1–2 mm long, connective apex acute, curved inwards, carpels many. Fruiting pedicel c. 15 mm long, 4 mm thick, monocarps to 15 or more, ellipsoidal, c. 2.5 × 2 cm, densely golden brown adpressed hairy, apex rounded, drying relatively smooth, stipe to 20 × 3 mm. Seeds many, drying dark brown, smooth, shiny, 11–14 × 8–9 × 4 mm.

Distribution. Malay Peninsula, Sumatra, Borneo and the Philippines. In Borneo widespread with most collections from Sabah, but also Brunei, Kalimantan and Sarawak.

Ecology. Lowland forest.

7. *Fissistigma kinabaluense* (Stapf) Merr.
(of Mt Kinabalu)

Philipp. J. Sci., C. 15 (1919) 132. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 84. Irawan, Floribunda 2(7) (2005) 180. — *Melodorum kinabaluense* Stapf, Trans. Linn. Soc. Ser. II 4 (1894) 130. Ridley, Sarawak Mus. J. 1(3) (1913) 90. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 261. Masamune, Enum. Phan. Born. (1942) 287. TYPE: Borneo, Sabah, Mt Kinabalu, Penokok alt. 3000 ft, *G.D. Haviland 1310* [e.h.e.] (holotype: K (barcode no. K000574681); isotypes: SAR[×2], SING).

Large woody climber. Twigs drying dark grey or dark brown, striate or latticed, when young with a covering of erect pale hairs, densest on youngest parts. Leaves chartaceous, drying dark brown or grey brown above, or a mixture of shades, more uniform brown below with redder brown midrib and laterals, midrib and lateral more or less flush above, prominent beneath, lower lamina covered with decumbent pale hairs angled in direction of the laterals, giving a slightly rough feel when rubbed in the opposite direction, lamina ovate, ovate lanceolate or ovate oblong, 5–12 × 2–5 cm, base rounded or obtuse, apex obtuse to acuminate, lateral veins 12–15 pairs, angled forward, more or less parallel, looping obscurely, tertiary venation scalariform; petiole 6–8 mm long, 1–2 mm thick. Inflorescence axillary. Pedicels 2–4 cm long, c. 0.5 mm thick, densely pale brown hairy, medial bract c. 2 mm long, sepals triangular, c. 4 × 2 mm, apex acute, hairy outside, glabrous inside, outer petals ovate, 13–14 × 3–11 mm, outside with central longitudinal ridge and radiating nerves, covered in semi-adpressed pale hairs, inside covered with very short pale woolly tomentum; inner petals ovate, c. 8 × 5 mm, externally with central ridge, covered with pale tomentum on both surfaces, stamens many, c. 1 mm long, carpels. Fruiting pedicel 2–3.5 cm × 2 mm, monocarps to 20 or more, irregularly globose, c. 1.5 cm diameter, apex minutely apiculate, drying blackish, scurfy grey, stipe to 4.5 cm long, 1 mm thick. Seeds several, dark brown shiny, c. 10 × 8–9 × 4–5 mm.

Distribution. Endemic to Borneo, where is restricted to Sabah; mostly, but not solely, to Mt Kinabalu.

Ecology. Hill and montane forest to 900 m.

Notes. See notes under *F. carrii* for distinction from that species.

8. *Fissistigma kingii* (Boerl.) Burkill

(Sir George King (1840–1909), British botanist, Superintendent of Royal Botanic Garden, Calcutta, and first director of the Botanical Survey of India)

Bull. Misc. Inform. 1935 (1935) 317. Masamune, Enum. Phan. Born. (1942) 284. Sinclair, Gard. Bull. Singapore 14 (1955) 358. Kessler & van Heusden, Rheedeia 3 (1993) 63. Irawan, Floribunda 2(7) (2005) 180. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 84. — *Melodorum kingii* Boerl., Icon. Bogor. 1 (1899) 134. TYPE: Peninsular Malaysia, Perak, *King's Collector* [H.H. Kunstler] 4070 (lectotype, designated by Irawan (2005), BO (sheet no. BO-1372487); isotypes: CAL, K).

Melodorum parviflorum auct. non Scheff., King, J. As. Soc. Bengal 51 (1892) 107.

Melodorum rubiginosum auct. non (A. DC.) Hook.f. & Thomson. Ridley, Sarawak Mus. J. 1 (1913) 91, *p.p.* Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262, *p.p.* Masamune, Enum. Phan. Born. (1942) 288, *p.p.*

Melodorum fagifolium Ridl., Bull. Misc. Inform. 1912 (1912) 386. Ridley, Sarawak Mus. J. 1(3) (1913) 91. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 261. Masamune, Enum. Phan. Born. (1942) 287. — *Fissistigma fagifolium* (Ridl.) Merr., Philipp. J. Sci., C. 15 (1919) 131. — *Fissistigma kingii* (Boerl.) Burkill var. *fagifolium* (Ridl.) Airy Shaw, Bull. Misc. Inform. Kew 1939 (1939) 238. Masamune, Enum. Phan. Born. (1942) 284. TYPE: Borneo, Sarawak, Entagut River, December 1894, *C. Hose* 397 (lectotype, designated by Turner (2011b), K (barcode no. K000574676); isolectotypes: A, B, BM, CGE, K, L, P).

Fissistigma kingii var. *grandiflorum* Airy Shaw, Bull. Misc. Inform. Kew 1939 (1939) 287. Masamune, Enum. Phan. Born. (1942) 284. TYPE: Borneo, Sarawak, near Kuching, 13 November 1894, *G.D. Haviland* & *C. Hose* 3336K (holotype: K (barcode no. K000574680); isotypes: SAR, SING).

Fissistigma kingii var. *multinerve* Airy Shaw, Bull. Misc. Inform. Kew 1939 (1939) 287. Masamune, Enum. Phan. Born. (1942) 284. TYPE: Borneo, Sarawak, Fourth Division, Mt Dulit (Ulu Tinjar) near Long Kapa, 10 August 1932, *P.W. Richards* 1192 (lectotype, designated by Turner (2011b), K (barcode no. K000574679); isolectotypes: K, SING).

Large woody climber. Twigs drying brown, dark to pale, sometimes with pale lenticels, latticed or striate, youngest parts with short crisped chocolate-brown hairs, almost velutinous. Leaves chartaceous to coriaceous, typically drying pale grey-green or grey-brown above, light brown below with darker midrib and veins, midrib and laterals more or less flush or very slightly sunken above, prominent beneath, upper lamina with short brown curled hairs in youngest leaves, soon lost except along midrib, lower lamina with curled chocolate-brown hairs, generally dense on the veins, sometimes longer straighter hairs present, lower lamina with pale granular appearance under tomentum, lamina ovate lanceolate to oblong obovate, 6–30 × 2–14.5 cm, base truncate, rounded or broadly obtuse, apex obtuse, rounded, slightly acuminate or slightly emarginate, lateral veins 7–23 pairs, looping obscurely, tertiary venation visible from below; petiole 10–20 mm long, 2–6 mm thick. Inflorescence axillary or terminal. Pedicels 5–20 mm long, 1–3 mm thick, densely brown woolly, medial bract c. 2 × 1 mm long, apex acute, sepals slightly connate at the base, triangular, 2 × 2–3 mm, apex obtuse, brown woolly outside, outer petals coriaceous, ovate lanceolate, 10–22(–40) × 3–6 mm, outside with brown woolly tomentum, inside with very short pale grey woolly tomentum on upper parts, lower glabrous and papillate; inner petals ovate lanceolate, 8–19 × 3–5 mm, base excavate, externally with pale grey short woolly tomentum, inside woolly also in upper portion, lower part glabrous and papillate, stamens many, c. 1 mm long, carpels many. Fruiting pedicel 12–30 mm × 2–4 mm, monocarps to 20 or more, globose, 2–2.5 cm diameter, apex rounded or minutely apiculate, drying dark brown, dense brown woolly tomentum, stipe to 3.5 cm long, 2 mm thick. Seeds several, dark brown shiny, 12–14 × 9–11 × 4–5 mm.

Distribution. Malay Peninsula and Borneo. In Borneo recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest at 300–900 m.

Notes. This is a variable species and there has been formal recognition of a number of entities at varietal rank. However the varieties appear to represent fairly arbitrary divisions of the variation, particularly in terms of number of lateral vein pairs and flower size. I therefore reduced the varieties to synonymy.

9. *Fissistigma latifolium* (Dunal) Merr.
(Latin, *lati-* = broad, wide; *folius* = leaved)

Philipp. J. Sci., C. 15 (1919) 132. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 72. Sinclair, Gard. Bull. Singapore 14 (1955) 359. Kessler & van Heusden, Rheedia 3 (1993) 64. Irawan, Floribunda 2(7) (2005) 181. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 85. *Unona latifolia* Dunal, Monogr. Anonac. (1817) 115. — *Uvaria latifolia* (Dunal) Blume, Fl. Jav. Anon. (1828) 37, t. 15. — *Melodorum latifolium* (Dunal) Hook.f. & Thomson, Fl. Ind. (1855) 177. Ridley, Sarawak Mus. J. 1(3) (1913) 90. Merrill, J.

Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. Masamune. Enum. Phan. Born. (1942) 285. TYPE: Based entirely on *Cananga sylvestris* III *latifolia*, Rumphius. Herb. Amb. 2 (1741) 198.

Uvaria longifolia Blume. Bijdr. (1825) 13, non *Uvaria longifolia* Sonn. (1782). TYPE: Java. *Anon. s.n.* (lectotype, designated by Turner (2011b), L (ex Herb. Blume et Herb. Groningen) (barcode no. L 0186878)).

Annona rufa C. Presl. Rel. Haenk. 2 (1830) 75. — *Melodorum rufum* (C. Presl) Merr., Philipp. J. Sci., C. 3 (1908) 223. — *Fissistigma rufum* (C. Presl) Merr., Philipp. J. Sci., C. 15 (1919) 132. Merrill. Enum. Philipp. Fl. Pl. 2 (1923) 174. TYPE: Philippines, Luzon. *T.P.X. Haenke s.n.* (holotype: PR[×2] (sheet no. 360883); isotype: HAL).

Melodorum molissimum Miq., Fl. Ned. Ind., Eerste Bijv. 3 (1861) 374. TYPE: Sumatra, Lampongs. *J.E. Teijsmann s.n.* [Herb. Bogor. 4252] (holotype: U; isotype: BO).

Melodorum borneense Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 36. Ridley. Sarawak Mus. J. 1(3) (1913) 88. Merrill. J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 261. Masamune. Enum. Phan. Born. (1942) 287. — *Fissistigma borneense* (Miq.) Merr., Philipp. J. Sci., C. 15 (1919) 131. Kessler & van Heusden. Rheedea 3 (1993) 63. Irawan. Floribunda 2(7) (2005) 176. TYPE: Borneo. *P.W. Korthals s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L0186730)).

Melodorum clementis Merr., Philipp. J. Sci., C. 3 (1908) 136. TYPE: Philippines, Lake Lamao, Camp Keithley, July 1907. *M.S. Clemens s.n.* (lectotype, designated by Turner (2011b), US (barcode no. 00098807); isolectotypes: B, M).

Large woody climber. Twigs relatively smooth, persistently hairy with dense red-brown tomentum on young twigs, generally paler with age. Leaves chartaceous to coriaceous, drying dark brown to grey brown above, brown below with main veins a rather redder shade, midrib flush above, laterals very slightly sunken above in dry leaves, midrib prominent, rather broad and flat, beneath, laterals raised beneath, glabrous above, below densely red-brown hairy on the main veins, lamina and minor veins with long fine, not completely straight, hairs, lamina surface granular, papillate or cob-webbed, lamina ovate oblong to elliptic oblong, 8–28 × 3–10 cm, base slightly cordate, truncate, rounded or broadly obtuse, apex notched, broadly obtuse, or very shortly acuminate. Inflorescence axillary or terminal, few- to many-flowered panicles. Pedicel 1–2.5 cm long, 1–2 mm thick, dense short red-brown hairy, medial bract ovate, 2–5 × 1–3 mm, hairy outside, sepals triangular 2.5–4 × 3–4 mm, hairy outside, outer petals coriaceous, ovate lanceolate, 9–15 × 5–7 mm, densely red-brown hairy outside, inside densely short brown woolly on edges and near margins, centrally and basally generally, glabrous, black or dark brown, slightly papillate or verrucose, inner petals much thinner than outer petals, ovate lanceolate, 7–8 × 3 mm, more or less glabrous except for scattering of brown woolly hairs near apex externally, drying black or dark

brown, papillate outside, smoother within, stamens many, drying white, apex acute, carpels many. Fruiting pedicel c. 2 cm long, 3 mm thick, monocarps to 20 or more, globose, to 2.5 cm diameter, with irregular raised blunt-topped, ridges, surface densely brown hairy, stipe to 4 cm long, 2 mm thick. Seeds several, semi-circular or ellipsoid in outline with one or two flat or convex faces, c. 12×8 – 10×4 mm, drying dark brown, smooth.

Distribution. Widespread from Indo-China to the Moluccas. In Borneo recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland and hill forest to 1500 m, including peat swamps.

Notes. The name *Fissistigma latifolium* is entirely based on Rumphius's *Cananga sylvestris* III *latifolia*. There is no original material or illustration available and I have not seen any specimen of *Fissistigma latifolium* collected from Ambon that would be a potential neotype. I have seen a specimen from nearby Ceram that is fairly close to *F. latifolium*.

Two collections from Sabah (SAN 35802, SAN 59263) are more like the Philippines form of *F. latifolium* than the typical Borneo form. A couple of specimens from Mount Kinabalu (Clemens & Clemens 40781, SAN 86075) seem to be a narrow-leaved form of *F. latifolium*, but there are no fruiting specimens available to confirm this placement.

10. *Fissistigma longipetalum* (Ridl.) Merr.

(Latin, *longi* = long, *petala* = petal)

Philipp. J. Sci., C. 15 (1919) 133. Irawan, Floribunda 2(7) (2005) 187. — *Melodorum longipetalum* Ridl., Bull. Misc. Inform. 1912 (1912) 387. Ridley, Sarawak Mus. J. 1(3) (1913) 92. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. Masamune, Enum. Phan. Born. (1942) 287. TYPE: Borneo, Sarawak, Kuching, 11 January 1893, G.D. Haviland 2102 [Ngaian leg.] (holotype: K (barcode no. K000574672); isotypes: BM, SAR, SING).

Large woody climber. Twigs drying black or dark brown, longitudinally wrinkled, young parts covered with golden brown woolly tomentum. Leaves glaucous below, thinly chartaceous, drying pale grey brown to dark brown above, or a mixture of shades, pale or mid-brown below, midrib and laterals flush to slightly sunken above in dry leaves, prominent beneath, fringe of erect pale hairs on midrib above, adpressed golden brown hairs on lamina and nerves beneath, lamina ovate to ovate lanceolate, $4\text{--}8 \times 1.5\text{--}3$ cm, base obtuse to rounded, apex acute to acuminate, more rarely obtuse, lateral veins 9–12 pairs, arching forward, more or less parallel, looping obscurely, tertiary venation scarcely visible to the naked eye; petiole 6–10 mm long, 1 mm thick. Inflorescence axillary. Pedicels 7–20 mm long, 1 mm thick, golden brown woolly,

sepals triangular, c. 3.5×2 mm, red-brown or golden brown hairy outside, glabrous inside; outer petals coriaceous, ovate lanceolate, $25\text{--}30 \times 4$ mm, outside with slight central longitudinal ridge, covered in adpressed golden brown hairs, inside very short pale curly hairs, sparse on papillate portion near base; inner petals ovate lanceolate, c. 12×4 mm, base deeply concave, externally covered with dense, very short brown curly hairs, inside more or less glabrous, stamens many, carpels many. Fruiting pedicel 12×3 mm, with short brown hairs, monocarps to 5, globose or ellipsoidal, to 2.5×2 cm, apex rounded to broad short beak, drying brown with irregular bumps and wrinkles, densely covered with short brown hairs, stipe 10–20 mm long, c. 4 mm thick. Seeds c. 5, lunar c. $12\text{--}13 \times 8 \times 5$ mm, drying brown, shiny.

Distribution. Endemic to Borneo where it is known from Kalimantan and Sarawak.

Ecology. Lowland forest to 600 m.

11. *Fissistigma manubriatum* (Hook.f. & Thomson) Merr.

(Latin, *manubriatum* = handle, heft)

Philipp. J. Sci., C. 15 (1919) 134. Sinclair, Gard. Bull. Singapore 14 (1955) 355. Kessler & van Heusden, Rheedea 3 (1993) 60. Irawan, Floribunda 2(7) (2005) 184. — *Melodorum manubriatum* Hook.f. & Thomson, Fl. Ind. (1855) 118. Ridley, Sarawak Mus. J. 1(3) (1913) 88. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. Masamune, Enum. Phan. Born. (1942) 287. TYPE: Peninsular Malaysia, Penang, s. dat., *G. Porter s.n.* [EIC 6456A] (lectotype, designated by Turner (2011b), K (barcode no. K000574630); isolectotypes: BM, K-W).

[*Uvaria manubriata* Wall., Numer. List (1832) no. 6456, *nom. nud.*].

Melodorum korthalsii Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 37. Ridley, Sarawak Mus. J. 1(3) (1913) 88. — *Fissistigma korthalsii* (Miq.) Merr., Philipp. J. Sci., C. 15 (1919) 132. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 261. Masamune, Enum. Phan. Born. (1942) 287. TYPE: Borneo, Martapoera, s. dat., *P.W. Korthals s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L 0182131)).

Melodorum bancanum Scheff., Natuurk. Tijdschr. Ned.-Indie 31 (1869) 343. TYPE: Type: Bangka, prope Muntok et Blienjoe detexit Teysmann.

Large woody climber. Twigs drying black or dark brown with shallow longitudinal fissures, brown or red-brown woolly tomentum, dense on young parts, generally persistent. Leaves chartaceous to subcoriaceous, drying silvery grey or dark grey-brown, shiny, above, golden brown beneath, midrib and lateral more or less flush above, prominent beneath, lower lamina and nervature covered with dense, long fine tomentum giving a furry feel with hairs generally running towards margin parallel to

the lateral nerves, sometimes relatively sparse, but always present, above glabrous except for fringe of red-brown or pale hairs along midrib, lamina lanceolate to narrowly oblong obovate, 5–20 × 1.5–6.5 cm, base rounded to obtuse, apex acute or more rarely acuminate, lateral veins 9–14 pairs, tertiary venation obscure below, visible from above; petiole 8–10 mm long, 1–2 mm thick. Inflorescence axillary or terminal. Pedicels 10–15 mm long, 2 mm thick, densely golden brown woolly hairy, medial bract clasping, ovate, c. 6 × 5 mm, densely hairy outside, glabrous, black, inside; sepals triangular or ovate, 6–8 × 5–7 mm, apex broadly acute, densely hairy outside, glabrous inside, outer petals coriaceous, ovate lanceolate, 15–20 × 6–9 mm, apex blunt, outside woolly hairy, inside with very short pale woolly tomentum on upper portions otherwise glabrous and dark brown; inner petals ovate lanceolate, c. 12 × 5 mm, apex acute, base concave, externally with short greyish wool, brown pimply inside, stamens many, carpels. Fruiting pedicel 10–15 mm × 4–5 mm, monocarps to 20 or more, globose to ovoid, c. 2 × 2.5 cm diameter, densely woolly brown hairy, apex rounded to broadly nipped, stipe 1–5.5 cm long, 2–3 mm thick. Seeds c. 10–12, brown shiny, c. 11 × 7 × 3 mm.

Distribution. Malay Peninsula, ?Sumatra and Borneo. In Borneo widespread, occurring in Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

12. *Fissistigma montanum* I.M. Turner
(Latin, pertaining to mountains, montane)

Nordic J. Bot. 27 (2009) 364. TYPE: Borneo, Brunei, Pagon Ridge, 5000 ft, April 1958, P.S. Ashton BRUN 2343 (holotype: K (barcode no. K000580482); isotypes: BRUN, L).

Fissistigma sp. 1: Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 15.

Fissistigma sp. 1: Beaman et al., Pl. Mt. Kinabalu 4 (2001) 85.

Large woody climber. Twigs drying dark, black, grey or brown, often with abundant, pale rather irregular lenticels, youngest parts with dense curly brown tomentum, becoming paler with age. Leaves chartaceous to coriaceous, drying dark brown, brown or grey brown above, brown or reddish brown below, midrib flush to slightly sunken above, prominent beneath, laterals immersed above, raised beneath, leaves glabrous above except for fringe of pale or brown hairs along midrib, below brown hairy, often dense, hairs very curly, lower lamina surface relatively smooth, not granular or papillose, lamina elliptic, ovate or obovate, 4–11 × 2–4.5 cm, base truncate, rounded, obtuse or acute, apex notched to very shortly acuminate, lateral veins 10–20 pairs, arching forward and looping obscurely, tertiary venation obscure from both surfaces in dry

leaves, petiole 8–14 mm long, 1–2 mm thick. Inflorescence terminal or leaf-opposed. 1- to few-flowered panicle. Pedicel 1–2.5 cm long, c. 1 mm thick, covered with dense brown curly hairs, medial bract tiny, sometimes absent, sepals broadly triangular, 2–4 × 3–4 mm, outer petals coriaceous but relatively thin, ovate, 15 × 7, externally densely short red-brown hairy, inside with very short pale brown hairs on edges and upper and marginal areas, otherwise glabrous, minutely papillate, drying brown, inner petals, 13 × 5 mm, dense pale brown hairy outside, inside relatively glabrous, drying dark brown or black, stamens many, carpels many, brown hairy. Fruiting pedicel 1–2 cm long, c. 4 mm thick, monocarps to 25 or more, globose, to 2 cm in diameter, covered with dense, very short, red-brown woolly tomentum, stipe to 2 cm long, 3 mm thick. Seeds several.

Distribution. Endemic to Borneo. Recorded from Sarawak, Sabah and Brunei.

Ecology. Hill and montane forest at 1000–2600 m.

13. *Fissistigma multivenium* (Diels) I.M. Turner
(Latin, *multi* = many, *vena* = vein)

Nordic J. Bot. 27 (2009) 363. — *Melodorum multivenium* Diels. Notizbl. Bot. Gart. Berlin-Dahlem 11 (1931) 85. TYPE: Borneo, Sarawak, Bellaga, *O. Beccari* PB 3789 (holotype: FI-B; isotypes: B(fragment), K).

Fissistigma kingii var. *tomentosum* Airy Shaw. Bull. Misc. Inform. Kew 1939 (1939) 288. Masamune. Enum. Phan. Born. (1942) 284. Sinclair. Sarawak Mus. J. 5 (1951) 600. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 85. TYPE: Borneo, Sarawak, Bellaga, *O. Beccari* P.B. 3789 (holotype: K (barcode no. K000574683); isotype: FI-B).

Large woody climber. Twigs drying black with shallow longitudinal wrinkles or latticing, with brown woolly tomentum, dense on young parts, generally persistent. Leaves chartaceous to subcoriaceous, drying grey brown, dark brown or grey-green above, brown beneath, midrib slightly sunken above in dry leaves, prominent beneath, lateral nerves more or less flush above, prominent beneath, glabrous above except for some very short brown or pale hairs along midrib, lamina below with brown woolly hairy, usually dense enough to give a soft feel, lamina oblong obovate, 10.5–20 × 4.5–8 cm, base obtuse, truncate, rounded or slightly cordate, apex apiculate or acuminate, lateral veins 21–23 pairs, angles forward almost parallel and straight, looping obscurely, tertiary venation, despite tomentum, usually visible from below, faint above; petiole 15–17 mm long, 3 mm thick. Inflorescence axillary or terminal. Pedicels 13–36 mm long, densely brown woolly hairy, medial bract ovate, 4–6 × 3–4 mm, apex obtuse, densely hairy outside, glabrous, inside: sepals slightly connate at base, broadly ovate, 3–5 × 5–7 mm, apex obtuse, densely hairy outside, glabrous within, outer petals coriaceous, ovate lanceolate, 12–15 × 5–8 mm, apex blunt, outside woolly hairy, inside with very short pale grey woolly tomentum near margins.

otherwise glabrous and black, papillate near the base; inner petals ovate lanceolate, 10–13 × 2–6 mm, base excavate, externally with short greyish woolly patches, brown verrucose inside, stamens many, carpels many. Fruiting pedicel 2–3 cm × 2–3 mm, monocarps to 15 or more, globose, often rather irregular, c. 1 × 1.5 cm diameter, apex rounded or apiculate, stipe 2–4 cm long, 1–2 mm thick. Seeds 1–several, brown smooth, shiny, 8–11 × 7–8 × 3 mm.

Distribution. Endemic to Borneo, occurring in Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

14. *Fissistigma paniculatum* (Ridl.) Merr.

(Latin, bearing panicles)

Philipp. J. Sci., C. 15 (1919) 134. — *Melodorum paniculatum* Ridl., Bull. Misc. Inform. 1912 (1912) 386. Ridley, Sarawak Mus. J. 1(3) (1913) 90. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. Masamune, Enum. Phan. Born. (1942) 287. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 15. TYPE: Borneo, Sarawak, Kuching, *G.D. Haviland 1845* (holotype: K (barcode no. K000574667); isotype: K).

Large woody climber. Twigs drying dull dark grey, shallow longitudinal wrinkles, youngest parts densely red-brown hairy. Leaves chartaceous to subcoriaceous, drying dark brown or grey brown above, brown to light brown below with midrib and laterals darker, midrib flush to very slightly sunken above in dry leaves, prominent beneath, laterals flush above, prominent beneath; lower lamina with long red-brown hairs under which lamina surface pale and granular or minutely wrinkled, young leaves hairy above but soon lost except for pale or brown hairs on midrib, lamina elliptic or oblong elliptic, 2.5–13 × 2–5.5 cm, base broadly obtuse to rounded, apex rounded, obtuse, apiculate or acuminate, lateral veins 8–15 pairs, arching forward, looping obscurely, tertiary venation scalariform, clearer from below in dry leaves, petiole 6–12 mm long, c. 2 mm thick. Inflorescences axillary or terminal. Pedicel 1–3 cm long, c. 1 mm thick when dry, densely red-brown hairy, medial bract triangular to ovate, 2–3 × 1.5–2 mm, apex acute, red woolly outside, glabrous within, sepals triangular or ovate, 2–3 × 2.5–3 mm, apex acute, hairy outside, glabrous within, outer petals coriaceous, ovate, 7–10 × 4–6 mm, red-brown hairy outside, inside with short pale brown or whitish hairs densest on edges and near margins, more or less glabrous and drying black or dark brown in central portion, rather variable in surface texture, sometimes papillate or rugulose, inner petals excavate, ovate or ovate lanceolate, 6–7 × 2–4 mm, very short pale hairs on upper part inside and out, otherwise glabrous, drying black or dark brown, inside rather bumpy, stamens many, c. 1 mm long, carpels many hairy. Fruiting pedicel to 2 cm × 3 mm, monocarps c. 6, globose or ellipsoidal, 2 × 1.5–2 cm, apex rounded, drying wrinkled, red-brown woolly hairy, stipe to 5.5 cm long by 2 mm thick.

Distribution. Endemic to Borneo where it has been recorded from Brunei, Kalimantan, Sabah, Sarawak.

Ecology. Lowland and hill forest to 900 m including heath and peatswamp forest.

15. *Fissistigma rugosum* J.Sinclair

(Latin, wrinkled or folded)

Sarawak Mus. J. 5 (1951) 600. TYPE: Borneo, Sarawak, Kuching, s. dat., *G.D. Haviland s.n.* (holotype: SAR).

Cyathocalyx borneensis Boerl., Icon. Bogor. (1899) t. 56. Ridley, Sarawak Mus. J. 1 (1913) 76. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 266. Masamune, Enum. Phan. Born. (1942) 281. TYPE: Borneo, Sebalouw, *J.E. Teijsmann s.n.* [Herb Bogor. no. 10838] (holotype: BO (BO-1346836); isotypes: K, L).

Fissistigma sp., Merrill, Univ. Calif. Publ. Bot. 15 (1929) 72.

Melodorum rubiginosum auct. non (A. DC.) Hook.f. & Thomson, Ridley, Sarawak Mus. J. 1 (1913) 91, p.p. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262, p.p. Masamune, Enum. Phan. Born. (1942) 288, p.p.

Large woody climber. Twigs drying somewhat irregular in cross section, smooth, brown or blackish, young parts with dense short erect brown tomentum, relatively persistent. Leaves chartaceous or coriaceous, drying dark brown, medium brown or pale grey-brown above, brown, grey-brown or pale grey-brown below with midrib and laterals generally a darker shade, midrib above with a prominent central ridge even if midrib is slightly channelled in dry leaf, laterals also very slightly raised above in dry leaves, midrib and laterals prominent beneath, lamina glabrous above except for scattered pale hairs in young leaves, below lamina with dense, very short adpressed tomentum with a sparser cover of longer pale brown hairs which are denser on the nerves, lamina ovate to oblong ovate, 13.5–37 × 7–20 cm, base rounded to truncate, apex broadly obtuse to shortly acuminate, lateral veins 15–28 pairs, arching forward, more or less parallel, looping relatively more distinctly than other *Fissistigma* species in Borneo, tertiary venation subscalariform, distinct from both surfaces in dry leaves, petiole 15–25 × 2–5 mm. Inflorescences axillary or terminal. Pedicel 7–20 mm long, 2 mm thick, densely brown adpressed hairy, medial bract tiny, broadly triangular c. 1 × 1.5 mm, hairy outside, sepals broadly triangular, c. 1.5 × 2 mm, hairy outside, glabrous within, outer petals c. 8 × 4 mm, covered with adpressed brown hairs externally, short woolly hairs cover upper portion internally, inner petals c. 5 × 2.5 mm, concave, dense very short adpressed hairs outside, glabrous within, stamens 1–1.5 mm long, carpels many. Fruiting pedicel 20–22 mm long, c. 3 mm thick, monocarps ripening bright yellow, to 4 or more, globose, c. 2.5 cm diameter, drying brown, rugose, covered with

very dense, very short brown hairs, apex rounded to broadly bluntly apiculate, stipe to 12 mm long, 5 mm thick. Seeds several, drying dark brown, shiny, smooth, c. $15 \times 9 \times 4-5$ mm.

Distribution. Endemic to Borneo where it is known from Brunei, Kalimantan, Sarawak.

Ecology. Lowland forest to 400 m.

FRIESODIELSIA Steen.

(K.R.E. Fries (1876–1966), Swedish botanist;

F.L.E. Diels (1874–1945), German botanist; both Annonaceae specialists)

Bull. Jard. Bot. Buitenzorg, sér. 3. 17 (1948) 458. van Steenis, Blumea 12 (1964) 353. *Polyalthia* section *Oxymitra* Blume, Fl. Javae Anonac. (1830) 71. *Oxymitra* (Blume) Hook.f. & Thomson, Fl. Ind. (1855) 145, non *Oxymitra* Bisch. ex Lindenb. (1829). Sinclair, Gard. Bull. Singapore 14 (1955) 447. TYPE: *Polyalthia cuneiformis* (Blume) Blume (\equiv *Guatteria cuneiformis* Blume, \equiv *Oxymitra cuneiformis* (Blume) Hook.f. & Thomson, \equiv *Friesodielsia cuneiformis* (Blume) Steen.).

Woody climbers. Leaves often glaucous beneath, with paired glands in the edge of the lamina near the insertion of the petiole, tertiary venation scalariform. Inflorescences leaf-opposed or supra-axillary, single-flowered. Flowers bisexual, buds conical, sepals 3, valvate, more or less connate at base, petals valvate, two whorls of 3, inner much shorter than outer, outer petals spreading at maturity, inner petals cohering about reproductive structures, stamens many, connectives with truncate prolonged apex, carpels many, ovules 1–5, lateral. Fruits cylindrical, ellipsoidal or globose, thin-walled, nipple-tipped, stipitate. Seeds 1–few, in cross-section quartered by the longitudinal walls of the endosperm.

Distribution and diversity: Some 50–60 species. Tropical Africa and Asia, though the African species may belong in a separate genus. Nine species recorded from Sabah and Sarawak.

Key to *Friesodielsia* species

- 1a. Leaves typically more than 20 cm long, base of lamina obtuse slightly decurrent to petiole, petiole 15 mm or more long, outer petals thin and flat, monocarps more than 3 cm long *F. formosa*
- b. Leaves generally smaller than 20 cm long, lamina base often rounded or auriculate, petiole less than 15 mm long, outer petals thick and generally triangular or rhomboidal in cross section, monocarps less than 3 cm long 2

- 2a. Leaves with tightly adpressed hairs beneath, often giving a golden sheen to the lamina *F. biglandulosa*
- b. Leaves hairy or not beneath, but not with a golden sheen 3
- 3a. Sepals with ridges radiating externally from base 4
- b. Sepals without visible ridges externally 5
- 4a. Leaves chartaceous, drying dark brown above, glaucous beneath, monocarps sessile, stipe to 3 mm long *F. affinis*
- b. Leaves coriaceous, drying mid-brown above, beneath hairy brown overlying glaucous lamina, monocarps stipitate, stipe more than 3 mm long *F. excisa*
- 5a. Leaves not exceeding 8.5 × 3.5 cm *F. ovalifolia*
- b. Leaves typically bigger than 8.5 × 3.5 cm 6
- 6a. Leaves glaucous beneath, though this may be obscured by brown pubescence 7
- b. Leaves not glaucous beneath *F. acuminata*
- 7a. Lamina hairy beneath, or if glabrous then under ×15 or greater magnification has a granular appearance 8
- b. Lamina glabrous beneath and under magnification relatively smooth and not granular *F. glauca*
- 8a. Leaves typically more than 6 cm wide, flower pedicel to 15 mm long, monocarps drying dark brown with rusty pubescence *F. grandifolia*
- b. Leaves not exceeding 6 cm wide, flower pedicel 20 mm or more long, monocarps drying warm brown with rusty pubescence *F. borneensis*

1. *Friesodielsia affinis* (Hook.f. & Thomson) D.Das

(Latin, neighbouring, akin to)

Bull. Bot. Survey India 5 (1963) 93. — *Oxymitra affinis* Hook.f. & Thomson, Fl. Brit. India 1 (1872) 70. Sinclair, Gard. Bull. Singapore 14 (1955) 450. TYPE: Peninsular Malaysia, Malacca, 12 April 1867, *A.C. Maingay 1851* [Kew distribution no. 59] (lectotype, designated by Turner (2009), K (barcode no. K000691787)).

Fissistigma magnisepalum Irawan, Floribunda 2(7) (2005) 184, as '*magnisepala*'. TYPE: Borneo, East Kalimantan, Long Iram Subdistrict, Maruwai, Block Lampunut, 19 March 1999, *P. Kessler 2621* (holotype: BO[×2] (sheet nos BO-1318961, BO-1318960), isotypes: K, L, WAN).

Large woody climber. Twigs drying black, latticed, youngest parts densely red-brown or dark brown hairy. Leaves chartaceous, glaucous beneath, drying dark brown above, grey-brown beneath with red-brown midrib and laterals, expanding leaves densely hairy, soon lost above except for fringe on midrib and main nerves, below hairy on lamina, giving a furry feel, and densely hairy on midrib and laterals, hairs generally slightly curved or kinked, lamina oblong elliptic to oblong obovate, 5–19(–26) × 2.5–8.5(–10) cm, base rounded to slightly cordate, apex broadly truncate apiculate to acuminate, midrib and lateral nerves slightly sunken above in dry leaves, prominent beneath, lateral nerves 7–11 pairs, tertiary venation scalariform, distinct from below, less clear from above. Petiole 5–6 mm long, 2–3 mm thick. Inflorescences single-flowered, extra-axillary. Flowers, pedicel 5–8 mm long, 1 mm thick, densely red-brown hairy, medial bract ovate to 8 mm long, 5 mm wide, base sometimes cordate (n.b. bracts and sepals may enlarge after anthesis), sepals free, ovate, c. 6 × 6 mm, base truncate, apex obtuse to rounded, red-brown hairs inside and out, nerves visible as raised ridges externally, outer petals coriaceous, ovate lanceolate, 2–5 cm long, excavated at base, inner petals shorter with a very short claw, stamens many, carpels many. Monocarps glaucous, 10 or more, drying brown with a greyish bloom, ellipsoidal, c. 10 × 8 mm, apiculate, covered with red-brown hairs when young, becoming glabrescent, stipe c. 3 mm long, 1–2 mm thick. Seed 1, ellipsoidal, c. 10 × 7 mm, longitudinal groove.

Distribution. Malay Peninsula and Borneo. In Borneo widespread but little collected with specimens from Kalimantan, Sabah and Sarawak.

Ecology. Lowland and hill forest to 800 m.

2. *Friesodielsia biglandulosa* (Blume) Steen.

(Latin, *bi* = two, *glandulosa* = bearing glands; pair of glands at leaf base)

Blumea 12 (1964) 358. Kessler & van Heusden, Rheede 3 (1993) 66. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 15. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 86. — *Guatteria biglandulosa* Blume, Fl. Javae Anonaceae (1828) 102, t. 51. — *Monoon biglandulosum* (Blume) Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 19. — *Oxymitra biglandulosa* (Blume) Scheff., Natuurk. Tijdschr. Ned.-Indië 31 (1870) 341. Ridley, Sarawak Mus. J. 1(3) (1913) 88. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 258. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 73. Airy Shaw, Bull. Misc. Inform. Kew 1939 (1939) 288. Masamune, Enum. Phan. Born. (1942) 291. Sinclair, Gard. Bull. Singapore 14 (1955) 459. — *Polyalthia biglandulosa* (Blume) Hook.f. & Thomson, Fl. Brit. Ind. 1 (1872) 65. — *Richella biglandulosa* (Blume) R.E. Fr. in Engl. & Prantl, Nat. Pflanzenfam., ed. 2, xvii a. II. (1959) 139. TYPE: Java, in montibus provinciae Bantam.

Large woody climber. Twigs drying black or dark grey, striate or latticed, youngest parts with adpressed golden brown hairs, soon lost. Leaves chartaceous to coriaceous,

drying dark brown above, rarely grey-brown or pale brown, paler brown below with darker midrib and lateral veins, midrib slightly sunken above in dry leaves, prominent beneath, lateral veins very slightly raised above, raised beneath, lamina beneath with tiny, tightly adpressed, yellow-brown hairs, sometimes sufficiently dense to give a golden or coppery sheen to leaf underside, sometimes very sparse but can be found with a lens, lamina elliptic or oblong elliptic to obovate, 5–26 × 2–11 cm, base cuneate, obtuse, truncate to slightly rounded, glands visible as darkened patches in lamina edge near petiole attachment; lateral veins 7–13 pairs, arching forward, looping indistinctly, tertiary venation scalariform, distinct from both surfaces in dry leaves. Petiole 5–13 mm long, 1–3 mm in diameter. Inflorescences of solitary flowers, extra-axillary or on short twiggy, irregularly branched shoots with few flowers. Pedicel 5–10 mm long, c. 1 mm thick, drying dark brown, adpressed golden brown hairs, medial bract to 3 × 1 mm, sepals free, ovate lanceolate, 5 × 1 mm, adpressed coppery brown hairs, outer petals green, lanceolate, to 30 × 6 mm, base spoon-shaped, central ridge externally just visible, covered with dense adpressed pale hairs externally, glabrous internally, inner petals cream, coherent at edges, ovate lanceolate, 10 × 3–4 mm, apex acute, some adpressed hairs externally, central ridge evident, stamens numerous, c. 1 mm long, top of connective flat to slightly convex, carpels many, pubescent. Fruiting pedicel to 20 mm long, 2 mm thick, monocarps to 20, ripening yellow, ellipsoidal, 15–20 × 9 mm (rarely 2-seeded monocarps cylindrical to 30 mm long, with slight constriction between seeds in dry state) drying black, minutely bumpy, apex rounded, apiculate, stipe to 20 mm long, 1 mm thick, some adpressed brown hairs particularly near apex and on stipe. Seeds 1, rarely 2, ellipsoidal, c. 15–18 × 7–8 mm, drying brown, smooth with a longitudinal groove.

Distribution. Malay Peninsula, ?Sumatra and Borneo. In Borneo collected from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland to montane forest to 900 m, including heath and peat swamp forest.

3. *Friesodielsia borneensis* (Miq.) Steen.
(of Borneo)

Blumea 12 (1964) 358. Kessler & van Heusden, Rheedeia 3 (1993) 66. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 86. — *Oxymitra borneensis* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 30. Ridley, Sarawak Mus. J. 1(3) (1913) 88. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 258. Masamune, Enum. Phan. Born. (1942) 291. Sinclair, Sarawak Mus. J. 5 (1951) 606. TYPE: Borneo, Martapoera, s.dat., *P.W. Korthals s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L 0037935)).

Oxymitra oxyphylla Miq., Ann. Mus. Bot. Lugd. Bat. 2 (1865) 29. Ridley, Sarawak Mus. J. 1(3) (1913) 89. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 259. Masamune, Enum. Phan. Born. (1942) 292. — *Friesodielsia oxyphylla* (Miq.)

Steen., *Blumea* 12 (1964) 361. TYPE: Borneo, Dano-Bahang, s.dat., *P.W. Korthals s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L 0187213)).

Oxymitra beccarii Diels, Notizbl. Bot. Gart. Berlin-Dahlem 11 (1931) 85. — *Friesodielsia beccarii* (Diels) Steen., *Blumea* 12 (1964) 358. TYPE: Borneo, Sarawak, Bintulu, September 1867, *O. Beccari P.B. 3742* (holotype: FI-B[×2](Erb. Becc. nos. 305 and 305A); isotypes: B, M).

Large woody climber. Twigs drying dark grey to black, striate or latticed, rusty tomentose when young. Leaves glaucous beneath, chartaceous, drying dark brown above, grey-brown or red-brown below, obovate to oblong obovate, 3.5–16 × 2–6 cm, base rounded to slightly auriculate, apex obtuse to shortly acuminate, midrib slightly sunken above in dry leaves, prominent beneath, lateral veins 9–11 pairs, flush above, prominent beneath. Petiole 3–10 mm long, 1–2 mm thick. Inflorescences single-flowered, extra-axillary. Flowering pedicel, 2–3 cm long, very slender, sepals c. 6 × 5 mm, hairy, outer petals coriaceous, flat, ovate lanceolate, to 6 cm long, c. 6 mm wide, base excavated, hairy externally, central ridge, glabrous internally, inner petals c. 8 × 4 mm, markedly acuminate, stamens many, carpels many. Fruiting pedicel 3–8.5 cm long, monocarps to 20 or more, globose to ellipsoidal, 8–12 × 7 mm, drying red- or mauve-brown with rusty pubescence, sometimes more or less glabrous, minutely apiculate, stipe 6–13 mm long, more than 1 mm thick. Seeds 1, ellipsoidal c. 7–11 × 6 mm.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo this species has been recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. Material of this species outside Borneo is referred to var. *sumatrana*.

4. *Friesodielsia excisa* (Miq.) Steen. (Latin, cut out)

Blumea 12 (1964) 359. — *Oxymitra excisa* Miq., Ann. Mus. Bot. Lugd. Bat. 2 (1865) 32. Ridley, Sarawak Mus. J. 1(3) (1913) 89. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 259. Masamune, Enum. Phan. Born. (1942) 291. Sinclair, Gard. Bull. Singapore 14 (1955) 452. — *Richella excisa* (Miq.) R.E. Fr. in Engl. & Prantl, Nat. Pflanzenfam., ed. 2, xvii a. II. (1959) 171. TYPE: Sumatra, *P.W. Korthals s.n.* (lectotype, designated by Turner (2009), L (barcode no. L0182297)).

Fissistigma cordifolium Irawan, Floribunda 2(7) (2005) 176. TYPE: Borneo, West Kalimantan, Gunung Palung Nature Reserve, 21 June 1986, *van Balgooy & van Setten 5559* (holotype: BO (sheet no. BO-1372431); isotype: L).

Large woody climber. Twigs drying black, striate or latticed, persistently tomentose with short, dense, brown or red-brown hairs. Leaves chartaceous to coriaceous, densely brown hairy below covering a glaucous lamina, drying mid-brown above, generally darker brown below because of the tomentum, lamina oblong to obovate, or even obdeltoid, 9–36 × 5–15 cm, base rounded to slightly cordate, apex truncate or even emarginate to obtuse acuminate, midrib and lateral nerves sunken above in dry leaves, prominent beneath, 10–13 pairs of laterals, tertiary venation scalariform, readily discernable from both surfaces, many orders of venation visible below, all slightly raised, short pale hairs on lamina above lost with age but persisting on midrib and laterals, dense hairs below, rather hooked or curled. Petiole 5–10 mm long, 3–4 mm thick. Inflorescences single-flowered, extra-axillary. Flower, pedicel 5–12 mm long, 1–2 mm thick, densely brown hairy, medial bract ovate 5–7 × 6 mm, apex acute, sepals ovate, c. 6 × 6 mm, apparently enlarging after corolla drops, apex obtuse to rounded, red-brown hairs, veins raised externally, outer petals coriaceous, ovate lanceolate, 14–16 × 7–8 mm; inner petals coriaceous, ovate lanceolate, c. 12 × 6 mm, apex acute, stamens many, carpels many. Monocarps ripening red, to 20 or more, ellipsoidal, 15 × 9 mm, or more rarely if two-seeded to 20 mm long, drying dark brown, glabrous except for near apex and on stipe, stipe to 9 mm long, 2 mm thick. Seed 1 or rarely 2, ellipsoidal, c. 13 × 8 mm.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest to 500 m, including peat swamps.

5. *Friesodielsia formosa* I.M. Turner

(Latin, handsome, beautiful)

Edinburgh J. Bot. 66 (2009) 366. TYPE: Borneo, Central Kalimantan, headwaters of S. Kahayan, 5 km north-west of Tumbang Sian logging camp, 26 April 1988, *J.S. Burley et al.* 832 (holotype: K (barcode no. K000580218); isotypes: E, L, SAR, SING).

Large woody climber. Twigs drying black or rather dirty brown, striate or latticed, with raised brown lenticels, darker and smoother when young, more or less glabrous. Leaves chartaceous, glaucous beneath, glabrous, drying dark brown or rather patchy dull brown above, red-purple brown beneath, sometimes with a greyish wash, with midrib and laterals dark brown or black, lamina oblong elliptic to oblong obovate, 17–33 × 6–10 cm, base obtuse, slightly decurrent to petiole but not auriculate, apex obtuse to slightly acuminate, midrib sunken above and prominent beneath, lateral veins c. 15 pairs, immersed above, prominent beneath, tertiary venation distinct from both surfaces in dry leaves, more so from above, less distinctly scalariform than other species in Borneo. Petiole 15–22 mm long, 2–3 mm thick, drying dark, shallowly furrowed. Inflorescences axillary or supra-axillary, few-flowered or solitary. Flowers fragrant,

pedicel 15–40 mm long, c. 0.5 mm thick, drying black, striate, tiny medial bract c. 1 mm long, sepals free, broadly ovate, 6–10 × 8 mm, tending to reflex at anthesis, apex blunt, drying black or dark brown, outer petals yellow or cream, reflexing at anthesis, thin, ovate lanceolate, 40–50 × 15–20 mm, drying very dark brown, sparse covering of tiny brown adpressed hairs on both surfaces, pale spots externally, inner petals ovate, 10–11 × 8 mm, apex acute, drying black with sparse very tiny brown adpressed hairs, stamens many, c. 2 mm long, carpels c. 6–10, c. 2 mm long, stigmas globose, hirsute. Fruiting pedicel to 4.5 cm long, 2 mm thick, monocarps 1–7, ripening orange-red, stipe green, ellipsoidal 4–5 × 1.5–2 cm, drying dark brown, deeply, irregularly wrinkled, wrinkles with rounded not sharp-edged margins, glabrous, apiculus scarcely discernible, stipe drying black, 2–3 cm long. Seed 1, c. 3 × 1.5 cm.

Distribution. Endemic to Borneo where it is known from Kalimantan and Sarawak.

Ecology. Lowland forest to 200 m, including on limestone.

6. *Friesodielsia glauca* (Hook.f. & Thomson) Steen.

(Greek, *glaukos* = bluish grey or bluish green; with the powdery bloom as on grapes)

Blumea 12 (1964) 359. — *Oxymitra glauca* Hook.f. & Thomson, Fl. Ind. 1 (1855) 146. Ridley, Sarawak Mus. J. 1(3) (1913) 88. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 259. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 176. Masamune, Enum. Phan. Born. (1942) 291. Sinclair, Gard. Bull. Singapore 14 (1955) 460. — *Richella glauca* (Hook.f. & Thomson) R.E.Fr. in Engl. & Prantl, Nat. Pflanzenfam., ed. 2, xvii a. II. (1959) 139. TYPE: Peninsular Malaysia, Prince of Wales Island [Penang]. s. dat., *Anon.* [W.E. Phillips] *s.n.* (holotype: K (barcode no. K000691773)).

Oxymitra diadema Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 31. Ridley, Sarawak Mus. J. 1(3) (1913) 89 as '*diadema*'. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 258, as '*diadema*'. Masamune, Enum. Phan. Born. (1942) 291, as '*diadema*'. — *Friesodielsia diadema* (Miq.) Steen., Blumea 12 (1964) 358. TYPE: Borneo, Mt Sakoembang, *P.W. Korthals s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L 0182284)).

Oxymitra linderifolia Ridl., Bull. Misc. Inform. Kew 1912 (1912) 385. Ridley, Sarawak Mus. J. 1(3) (1913) 89. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 259. Masamune, Enum. Phan. Born. (1942) 292. — *Friesodielsia linderifolia* (Ridl.) Steen., Blumea 12 (1964) 360. TYPE: Sarawak, Kuching, 19 April 1893, *G.D. Haviland 2333* (lectotype, designated by Turner (2012), K (barcode no. K000691760); isolectotypes: BM, K, SAR, SING).

Oxymitra argentea J.Sinclair, Gard. Bull. Singapore 14 (1955) 461. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 15. — *Friesodielsia argentea* (J.

Sinclair) Steen., *Blumea* 12 (1964) 358. Beaman et al., *Pl. Mt. Kinabalu* 4 (2001) 86. TYPE: Peninsular Malaysia, Trengganu, Bukit Kajang, 14 November 1935, *E.J.H. Corner SFN 30457* (holotype: SING (barcode no. SING 0048676); isotype: K).

Large woody climber. Twigs drying black, striate or latticed, when young smooth and brown, variably hairy, sometimes densely brown tomentose. Leaves chartaceous, glaucous below, drying dark brown above, grey-brown beneath, lamina glabrous or glabrescent, hairs more frequent on veins and midrib below, lamina obovate or oblong obovate to lanceolate, 4–21 × 1.5–8 cm, base obtuse, rounded or truncate, apex broadly and rather shortly acuminate, midrib and lateral nerves flush to slightly sunken above in dry leaves, prominent beneath, laterals 7–13 pairs. Petiole 5–9 mm long, 0.5–2 mm thick. Inflorescences, single or few-flowered, extra-axillary. Flower, pedicel 15–35 mm long, less than 1 mm thick, widening distally, very short dense brown pubescence, medial bract ovate c. 3–5 mm long, apex acute, sepals free, ovate, 4–6 × 2–4 mm, apex acute, hairy; outer petals coriaceous, ovate lanceolate, 20–40 × 4–7 mm, excavated at base internally, adpressed brown hairs externally, inner petals ovate acuminate 10–12 × 2–3 mm, central ridge externally, stamens many, carpels many. Fruiting pedicel 6–60 mm long, c. 1 mm thick; monocarps 20–25 or more, ripening red, globose or ellipsoidal 8–11 × 7–8 mm, apiculate, drying black or rusty brown, red-brown pubescent when young, sometimes persisting, stipe 4–20 mm long, c. 1 mm thick. Seeds 1, ellipsoidal, c. 7–10 × 6–7 mm.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo collected from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. There is considerable variation in the material here recognised under the name *Friesodielsia glauca*, both within Borneo and across its range. Some of the entities included appear quite distinct but intermediate forms occur. *Friesodielsia linderifolia* is close to typical *F. glauca* and is certainly a synonym of it.

7. *Friesodielsia grandifolia* (Merr.) I.M. Turner, *Edinburgh J. Bot.* 66 (2009) 369. *Oxymitra grandifolia* Merr., *J. Straits Branch Roy. Asiat. Soc.* 85 (1922) 179. Merrill, *Univ. Calif. Publ. Bot.* 15 (1929) 72. Masamune, *Enum. Phan. Born.* (1942) 291. TYPE: Borneo, Sabah, Sandakan, September–December 1920, *M. Ramos 1910* (lectotype, designated by Turner (2009b), BO (sheet no. BO-13593592)).

Oxymitra latifolia auct. non Hook.f. & Thomson, *Sinclair, Sarawak Mus. J.* 5 (1951) 607.

Friesodielsia latifolia auct. non (Hook.f. & Thomson) Steen.: Beaman et al., *Pl. Mt. Kinabalu* 4 (2001) 86.

Large woody climber. Twigs drying dark grey, younger twigs woolly hairy. Leaves chartaceous, glaucous or brown hairy below, drying dark brown, occasionally mid-brown, above, brown or grey-brown below, lamina oblong, oblong obovate or obovate, 12–30 × 4–14 cm, base slightly cordate to rounded, apex rounded, obtuse to acuminate, midrib slightly sunken above in dry leaves, raised below, lateral nerves 12–16 pairs, flush to slightly sunken above, raised beneath, tertiary venation clear from both surfaces unless hidden by tomentum below. Petiole 5–10 mm long, 2–4 mm thick. Inflorescence single-flowered, extra-axillary. Flower, pedicel 15–20 mm long, 1 mm thick, rusty tomentose, sepals free, triangular 5–8 × 5–7 mm, apex blunt to acute, rusty hairy, outer petals coriaceous, flat, oblong lanceolate, c. 32–45 × 8–10 mm, base excavated, externally with brown hairs, densest near base, central ridge discernible but not prominent, internally glabrous, minutely papillate inside excavation, inner petals coherent, ovate acuminate, c. 8–10 × 4–6 mm, glabrous except for a few scattered hairs externally with a slight central ridge, minutely papillate inside, stamens many, carpels many. Fruiting pedicel 10–20 mm long, 1–2 mm thick, monocarps to 25 or more, globose to ellipsoidal, 12–13 × 8 mm, to 17 mm long in two-seeded monocarps, drying black or dark brown with rusty hairs particularly dense near apex and on stipe, stipe to 13 mm long. Seeds, 1 or rarely 2, ellipsoidal, c. 10–12 × 6–7 mm.

Distribution. Endemic to Borneo where it is recorded from Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest, also on limestone.

8. *Friesodielsia korthalsiana* (Miq.) Steen.

(Pieter W. Korthals (1807–1892), Dutch botanist who collected widely in Malesia)

Blumea 12 (1964) 360. — *Oxymitra korthalsiana* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 29. Ridley, Sarawak Mus. J. 1(3) (1913) 89. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 259. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 73. Masamune, Enum. Phan. Born. (1942) 292. TYPE: Borneo, Banjoewiran, *P.W. Korthals s.n.* (lectotype, designated by Turner (2011b), L (barcode L 0182331)).

Oxymitra acuminata Merr., J. Straits Branch Roy. Asiat. Soc. 85 (1922) 180. Masamune, Enum. Phan. Born. (1942) 291. — *Friesodielsia acuminata* (Merr.) Steen., Blumea 12 (1964) 357. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 86. TYPE: Borneo, Sabah, Sandakan, September–December 1920, *M. Ramos 1567* (lectotype, designated by Turner (2011b), BO (sheet no. BO-1349528); isolectotypes: BM, GH).

Large woody climber. Twigs black, striate or latticed, youngest with short brown woolly tomentum, soon lost. Leaves chartaceous, drying brown, generally dark or rich brown, above, cinnamon brown beneath, ferruginous hairy above when very young, soon hairs confined to midrib and laterals above, more or less glabrous below,

lamina oblong obovate, 6–16.5(–25) × 2–5.5(–9) cm, base truncate or rounded to slightly cordate, apex obtuse to acuminate, sometimes markedly so, midrib and lateral nerves slightly sunken above in dry leaves, prominent beneath, 8–13 lateral pairs, tertiary and higher-order venation distinct from both surfaces in dry leaves. Petiole 5–7 mm long, 1–2 mm thick. Inflorescence single-flowered, extra-axillary. Flower, pedicel 1–6.5 cm long, slender, c. 0.5 mm thick, medial bract linear-lanceolate 2–3 mm long, 1 mm wide, hairy adaxially, sepals ovate, 4–7 × 3 mm, apex sometimes acuminate, outer petals coriaceous, lanceolate, c. 36 × 6 mm, flat externally except for a faint central longitudinal ridge, adpressed brown hairs, inside with central ridge and excavated base, more or less glabrous, inner petals, ovate lanceolate, 10 × 4 mm, apex acuminate, glabrous, faint central longitudinal ridge, stamens many, carpels many, red hairy. Fruiting pedicel to 12 cm long, monocarps 10 or more, ellipsoidal to cylindrical, 11–17 × 7 mm, apiculate, drying black or brown with rusty pubescence, stipe 10–16 mm, less than 1 mm thick. Seed 1, ellipsoidal c. 10–15 × 5–6 mm.

Distribution. Endemic to Borneo, where it has been collected from Kalimantan and Sabah.

Ecology. Lowland forest.

Notes. A number of collections from montane forest at 1000–1500 m on Mt Kinabalu (Sabah) (*Clemens & Clemens* 3766, 26205, 30534, 30866, 34022, *Matamin Rumutom* 279) have narrow leaves and long pedicels, but may belong here.

9. *Friesodielsia ovalifolia* (Ridl.) I.M. Turner
(Latin, oval-leaved)

Blumea 55 (2010) 118. — *Melodorum ovalifolium* Ridl., Bull. Misc. Inform. Kew 1912 (1912) 387. Ridley, Sarawak Mus. J. 1(3) (1913) 92. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. Masamune, Enum. Phan. Born. (1942) 287. — *Fissistigma ovalifolium* (Ridl.) Merr., Philipp. J. Sci., C. 15 (1919) 134 — *Oxymitra ovalifolia* (Ridl.) J. Sinclair, Sarawak Mus. J. 5 (1951) 607. — *Richella ovalifolia* (Ridl.) Steen., *Blumea* 12 (1964) 357. TYPE: Borneo, Sarawak, near Kuching, 17 May 1894, *G.D. Haviland & C. Hose* 3151 (lectotype, designated by Turner (2010b), K (barcode no. K000574639)).

Large woody climber. Twigs drying dark grey or blackish, striate or latticed, youngest parts densely brown woolly hairy. Leaves chartaceous, drying dark brown above, brown or grey with brown veins below, scattered pale hairs on young leaves above, soon lost except for along midrib, similar below but brown hairs more persistent, lamina elliptic or elliptic oblong to slightly obovate, 2.5–8.5 × 1.5–3.5 cm, base rounded, truncate or slightly cordate, apex emarginate, obtuse or shortly acuminate, midrib sunken above, prominent beneath, lateral veins 7–8 pairs, flush above, prominent beneath,

tertiary venation distinct from both surfaces. Petiole 4–5 mm long, to 1 mm thick. Inflorescence single-flowered, extra-axillary. Pedicel 15–30 mm long, very slender, c. 0.4 mm thick, tiny medial bract, red-brown woolly hairy; sepals free, triangular, c. 3 × 3 mm, apex acute, red-brown woolly hairy, outer petals yellow, coriaceous, c. 2 cm long, 5 mm wide, brown woolly hairy outside with slight external central ridge, base excavated internally, glabrous inside; inner petals glabrous, ovate lanceolate, 6 × 2 mm, apex sharply acuminate; stamens many, carpels many. Fruiting pedicel c. 3 cm long, 1 mm thick, monocarps to 10 or more, ellipsoidal, 10–12 × 7 mm, brown hairy, apiculate, stipe 12–15 mm long. Seed 1, ellipsoidal, c. 9–11 × 5–6 mm.

Distribution. Endemic to Borneo where it appears restricted to the Kuching area of Sarawak (*Haviland & Hose 3141, 3151; Hewitt A.7.13, S 27795*), though *Church et al. 818* from Central Kalimantan may be this.

Ecology. Lowland forest.

MITRELLA Miq.

(diminutive of Greek, *mitra* = mitre, cap)

Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 38. Sinclair, Gard. Bull. Singapore 14 (1955) 364. *Polyalthia* section *Kentia* Blume, Fl. Javae Anonac. (1830) 71. *Polyalthia* section *Schnittspahnia* Rchb., Deut. Bot. Herb.-Buch., *nom. superfl.* *Melodorum* section *Kentia* (Blume) Hook.f. & Thomson, Fl. Ind. (1855) 122. *Unona* section *Kentia* (Blume) Baill., Hist. Pl. 1 (1868) 213. TYPE: *Polyalthia kentii* (Blume) Blume (= *Unona kentii* Blume, = *Mitrella kentii* (Blume) Miq.)

Woody climbers. Leaves tertiary venation reticulate. Inflorescences axillary or terminal, solitary or more rarely paired. Flowers bisexual, sepals 3, valvate, connate or not, petals valvate, two whorls of 3, inner much shorter than outer petals, stamens many, connectives with truncate or obtuse apex, carpels 6–15, ovules 1–many, biseriate. Fruits ellipsoidal or globose, stipitate. Seeds 1–many, smooth, shiny, sometimes pitted.

Distribution and diversity: About six species. Thailand and Malay Peninsula through to New Guinea and Australia. Three species in Borneo.

Notes. I find it difficult to see meaningful distinctions between *Mitrella* and *Pyramidanthe*. *Mitrella dielsii* appears to bridge the gap in morphological terms between *Mitrella kentii* and *M. clementis* on the one hand, and *Pyramidanthe prismatica* on the other. However I refrain from making a formal reduction feeling a wider morphological survey and molecular analyses are required to undertake this step. However I include *P. prismatica* in the key below. I do not follow Ban (1974b) in including *Sphaerocoryne* in *Mitrella*.

Key to *Mitrella* and *Pyramidanthe* species

- 1a. Leaves when dry with secondary and intersecondary nerves clearly visible from below, outer petals ovate, dark brown velvety outside, monocarps strongly muricate, dark brown velvety *M. dielsii*
- b. Leaves when dry with indistinct secondary veins from below, outer petals ovate lanceolate, or if ovate not dark brown velvety outside, monocarps smooth to weakly muricate, not dark brown velvety 2
- 2a. Outer petals ovate lanceolate, calyx cup with rim more or less flat or with very broadly obtuse points, inner petals more or less glabrous, monocarps cylindrical or ellipsoidal, more than 3 cm long, seeds smooth *P. prismatica*
- b. Outer petals ovate or, if ovate lanceolate, calyx cup with relatively sharp points, inner petals hairy, at least on edges, monocarps globose or ellipsoidal, not exceeding 1.5 cm long, seeds pitted 3
- 3a. Outer petals ovate, inner petals covered with hairs on the outside *M. kenti*
- b. Outer petals ovate lanceolate, inner petals with hairs confined to the edges and margins *M. clementis*

1. *Mitrella clementis* (Merr.) I.M. Turner

(Latin, *clementis clemens* in genitive case) = of gentility, mildness, mercy; commemorative of Joseph Clemens (1862–1936), a Methodist minister, originally from England, who served with the US Army, and his American wife Mary Strong Clemens (1873–1968), who together collected plants professionally).

Malayan Nat. J. 61 (2009) 273. — *Fissistigma clementis* Merr., J. Straits Branch Roy. Asiatic Soc. 85 (1922) 178, Merrill, Univ. Calif. Publ. Bot. 15 (1929) 71, Masamune, Enum. Phan. Born. (1942) 284. TYPE: Borneo, Sabah, Sandakan and vicinity, September–December 1920, *M. Raimos* 1474 (lectotype, designated by Turner (2009c), K (barcode no. K000574737); isolectotypes, A[*2], BM, L, US).

Large woody climber. Twigs drying black or dark brown, striate or latticed, very youngest parts with some sparse red-brown hairs. Leaves chartaceous, drying grey-brown above, matt middle brown to pale grey-brown beneath, sparse small adpressed hairs on lamina below, glabrous above, midrib slightly sunken above in dry leaves, prominent beneath, laterals flush on both surfaces, lamina elliptic to oblong lanceolate, 3.5–11 × 1.5–3.5 cm, base obtuse, apex acuminate, 10–12 pairs of laterals, arching forward, looping obscurely, reticulations relatively indistinct. Petiole 5–12 mm long, 0.5–1 mm thick. Inflorescences single-flowered or more rarely in pairs, axillary. Flower, pedicel 5–7 mm long, c. 1 mm thick, with golden brown adpressed hairs, sepals connate, c. 2 × 3 mm, apiculate, outer petals, ovate lanceolate, 15–25 × 6 mm outside covered with short brown or pale hairs, inside excavated, very short

pale woolly hairs, excavation glabrous; inner petals ovate lanceolate, c. 5×2.5 mm, glabrous externally except for a very short pale wool along the margins and near the apex, stamens many, carpels many. Fruiting pedicel to 10 mm long, 1–2 mm thick, calyx persistent, monocarps to 8 or more, globose, ellipsoidal or rather irregular, $8\text{--}12 \times 6\text{--}10$ mm, drying brown sometimes minutely wrinkled, stipe, generally shorter than the seed-bearing portion of the monocarps, 3–4 mm long, c 1 mm thick. Seeds c. 4, discoid or hemispherical, c. 6–7 mm diameter, drying dark brown, shiny, pitted.

Distribution. Endemic to Borneo where it has been collected from Brunei, Kalimantan, Sabah and once from Sarawak (*S* 52509).

Ecology. Lowland forest, once from 1800 m in Sabah.

Notes. This species has been consistently confused with *M. kentii*. The flowers of the two species differ markedly in the shape of the outer petals. *Mitrella kentii* generally has more coriaceous leaves, but some collections have narrow, chartaceous leaves almost indistinguishable from *M. clementis*. The fruits are also very similar though *M. clementis* seems to have somewhat larger, but relatively shorter-stiped, monocarps with generally more seeds.

2. *Mitrella dielsii* J.Sinclair

(F.L.E. Diels (1874–1945), German botanist)

Gard. Bull. Singapore 15 (1956) 14. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 18. — *Melodorum beccarii* Diels, Notizbl. Bot. Gart. Berlin-Dahlem 11 (1931) 85, non *Melodorum beccarii* Scheff. (1885). TYPE: Borneo, Sarawak, near Sungai Igan, October 1867, *O. Beccari P.B.* 3899 (holotype: FI-B; isotype: B(fragment)).

Large woody climber. Twigs drying very dark brown, uniform in colour, longitudinally striate, very youngest parts with dense, very short, curly dark red-brown tomentum. Leaves coriaceous, drying dark brown shiny above, matt brown beneath with darker redder-brown midrib and laterals, lamina hairy below, usually sufficiently so to give a felty feel, hairs curly, brown or red-brown, densest along nerves, expanding leaves with pale hairs above, soon lost, midrib slightly sunken above in dry leaves, prominent below, laterals flush above, raised slightly beneath, lamina ovate, ovate lanceolate or oblong elliptic, $5\text{--}19 \times 2.5\text{--}7$ cm, base obtuse, rounded or truncate, apex acuminate, lateral veins 10–15 pairs, arching forward, looping indistinctly, reticulations visible from both surfaces in dry leaves. Petiole 12–16 mm long, c. 2 mm thick. Inflorescences single-flowered, axillary. Pedicel 5–6 mm long, c. 2 mm thick, densely covered with curly brown hairs, sepals connate, broadly triangular, $2\text{--}3 \times 5$ mm, hairy outside, outer petals coriaceous, ovate, $16\text{--}19 \times 9\text{--}12$ mm, basally excavate on the inside, externally dark brown velutinous, internally covered with very short pale grey woolly hairs

except the glabrous excavation, inner petals concave, ovate, $5 \times 3-4$ mm, drying dark brown, more or less glabrous, stamens many, c. 1.5 mm long, apex of connective acute, carpels c. 10, c. 2 mm long, drying black, glabrous, stigma very short. Fruiting pedicel to 10 mm long, 6 mm thick, calyx persistent, monocarps to 9 or more, ellipsoidal, c. 3.5×2.5 cm, strongly muricate, densely covered with very short curly dark brown hairs, stipe to 7 mm long, 4 mm thick. Seeds to 12 or more, 2 rows, drying smooth, brown, flat, $11-13 \times 8 \times 2-4$ mm.

Distribution. Endemic to Borneo where it is known from Brunei and Sarawak.

Ecology. Apparently restricted to peatswamp forest.

3. *Mitrella kentii* (Blume) Miq.

(William Kent, 1779–1827, Dutch gardener, first curator of the Botanic Garden in Buitenzorg, Java)

Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 39. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 260. Masamune, Enum. Phan. Born. (1942) 289. Sinclair, Gard. Bull. Singapore 14 (1955) 365. Kessler & van Heusden, Rheedeia 3 (1993) 71. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 18. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 91. *Unona kentii* Blume, Bijdr. (1825) 16. — *Polyalthia kentii* (Blume) Blume, Fl. Javae Anonac. (1830) 77. — *Melodorum kentii* (Blume) Hook.f. & Thomson, Fl. Ind. 1 (1855) 116. Ridley, Sarawak Mus. J. 1(3) (1913) 93. — *Fissistigma kentii* (Blume) Merr., Philipp. J. Sci., C. 15 (1919) 132. TYPE: Java, *Anon. s.n.* (lectotype, designated by Turner (2011b), L (ex herb. Blume) (barcode no. L 0183051)).

[*Uvaria elegans* Wall., Numer. List (1832) no. 6474, *nom. nud.*]

Uvaria mabiformis Griff., Notul. 4 (1854) 709. — *Fissistigma mabiforme* (Griff.) Merr., Philipp. J. Sci., C. 15 (1919) 133. TYPE: Peninsular Malaysia, Malacca, Aloor Gajah, *Verupha s.n.* [Kew Distib. no. 389] (lectotype, designated by Sinclair (1955), K (barcode no. K000574743)).

Melodorum elegans Hook.f. & Thomson, Fl. Ind. 1 (1855) 122. — *Fissistigma elegans* (Hook.f. & Thomson) Merr., Philipp. J. Sci., C. 15 (1919) 131. TYPE: Peninsular Malaysia, Penang, 1822, *Anon.* [N. Wallich] *s.n.* [EIC 6474A] (lectotype, designated by Turner (2011b), K ex herb. Hook. (barcode no. K000574739); isolectotypes: C, CAL, CGE, E, GZU, K, K-W, L, NY, PH).

Melodorum pisocarpum Hook.f. & Thomson, Fl. Ind. 1 (1855) 123. TYPE: Peninsular Malaysia, Malacca, *s. dat.*, *W. Griffith s.n.* (lectotype, designated by Turner (2011b), K ex herb. Hook. (barcode no. K000574741)).

Orophea borneensis Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 26. Ridley, Sarawak Mus. J. 1(3) (1913) 87. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 265. Masamune, Enum. Phan. Born. (1942) 290. TYPE: Borneo, *W.H. de Vriese s.n.* (lectotype, designated by Keßler (1988), L (barcode no. L 0038052; isolectotype: L).

Large woody climber. Twigs drying blackish, dark brown or dark grey, sometimes with shallow longitudinal wrinkles or latticing, youngest parts with red-brown or pale hairs. Leaves chartaceous to subcoriaceous, drying pale grey brown to almost black above, uniform matt brown, midrib generally rather pale brown, glabrous above, below with tiny adpressed, red-brown or pale hairs, hairy on lamina and along nerves, midrib very slightly sunken below, raised beneath, lateral nerves flush above, very slightly raised beneath, lamina elliptic. ovate or ovate lanceolate, 5–13 × 2.5–6 cm, base obtuse, apex shortly acuminate, lateral nerves 9–13 pairs, arching forward, looping obscurely, reticulations visible from both surfaces in dry leaves. Petiole 8–16 mm long, 1–2 mm thick. Inflorescences 1–3-flowered, axillary. Pedicel 5–7 mm long, c. 1 mm thick, widening distally, drying dark brown with decumbent red-brown or brown hairs, medial bract absent, sepals connate, c. 2 × 3 mm, forming shallow triangular dish, externally red-brown hairy, glabrous within, outer petals coriaceous, ovate to elliptic, 9–11 × 5–9 mm long, externally very densely covered with very short red-brown hairs, inside very short pale grey woolly except lower part of excavation, inner petals concave ovate, c. 5 × 2.5 mm, pale grey woolly outside, glabrous within except for long pale hairs from upper part, stamens many, 1–1.5 mm long, carpels many, glabrous. Fruiting pedicel 7–12 mm long, 1.4–2 mm thick, calyx persistent, monocarps to 12, globose or irregular, c. 7 mm diameter, drying brown, relatively smooth, glabrous, apex typically rounded, stipe 4–7 mm long, c. 1 mm thick. Seeds two or more, hemispherical, pitted, drying brown, c. 5 mm diameter.

Distribution. Malay Peninsula, Java and Borneo. In Borneo recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland and heath forest to 300 m.

Notes. See *M. clementis* for distinctions with that species and *Sphaerocoryne affinis* likewise.

PYRAMIDANTHE Miq.

(Greek, *pyramis*, *pyramidos* = pyramid, *anthos* = flower)

Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 39. Sinclair, Gard. Bull. Singapore 14 (1955) 362. *Unona* section *Pyramidanthe* (Miq.) Baill., Hist. Pl. 1 (1868) 213. *Melodorum* section *Pyramidanthe* (Miq.) Kurz, J. As. Soc. Bengal 43 (1870) 56. TYPE: *Pyramidanthe rufa* Miq.

Woody climbers. Leaves coriaceous, lateral nerves distinct, tertiary venation laxly reticulate. Flowers axillary. Sepals 3, valvate, united in a flat disc, petals in 2 whorls of 3, outer triquetrous, much longer than inner, stamens with a truncate, dilated apex, carpels 5–6. Monocarps stipitate, tuberculate. Seeds in 2 rows, shiny.

Distribution and diversity: One species, *Pyramidanthe prismatica* (Hook.f. & Thomson) Merr., found in Malay Peninsula, Sumatra and Borneo.

Notes. See comments under *Mitrella* regarding status of the genus and for a key including *P. prismatica*.

1. *Pyramidanthe prismatica* (Hook.f. & Thomson) Merr.

(Latin, having several longitudinal angles and intermediate flat surfaces)

J. Straits Branch Roy. Asiat. Soc., Spec. No. (1921) 262. Masamune, Enum. Phan. Born. (1942) 296. Sinclair, Gard. Bull. Singapore 14 (1955) 362. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 22. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 97. — *Melodorum prismaticum* Hook.f. & Thomson, Fl. Ind. (1855) 121. Ridley, Sarawak Mus. J. 1(3) (1913) 88. — *Fissistigma prismaticum* (Hook.f. & Thomson) Merr., Philipp. J. Sci., C. 15 (1919) 135. TYPE: Peninsular Malaysia, Penang, August 1822, N. Wallich s.n. [EIC 6455] (lectotype, designated by Turner (2011b), K-W; isolectotypes: BM, CGE).

[*Uvaria prismatica* Wall., Numer. List (1832) no. 6455, *nom. nud.*]

Oxymitra bassiifolia Teijsm. & Binn., Natuurk. Tijdschr. Ned.-Indie 25 (1863) 419, as ‘*bassiaeifolia*’. TYPE: Bangka, near Panyas, s.dat., J.E. Teijsmann s.n. [Herb. Bogor. no. 17645] (lectotype, designated by Turner (2011b), BO (sheet no. BO-1408032); isolectotype: BO (sheet no. BO-1408033)).

Pyramidanthe rufa Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 39. TYPE: Borneo australis in Martapoera; Sumatra occidentalis: Korthals

Melodorum cylindricum Maingay ex Hook.f. & Thomson, Fl. Brit. Ind. 1 (1872) 80. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 261. Masamune, Enum. Phan. Born. (1942) 284. — *Fissistigma cylindricum* (Maingay ex Hook.f. & Thomson) Merr., Philipp. J. Sci., C. 15 (1919) 131. Merrill, Univ. Calif. Publ. Bot. 15 (1929) 71. TYPE: Peninsular Malaysia, Malacca, 1865–1866, A.C. Maingay 1507 [Kew Distrib. no. 78] (holotype: K (barcode no. K000574661); isotype: CAL).

Melodorum maingayi Hook.f. & Thomson, Fl. Brit. Ind. 1 (1872) 80. Ridley, Sarawak Mus. J. 1(3) (1913) 90. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. Masamune, Enum. Phan. Born. (1942) 287. — *Fissistigma maingayi* (Hook.f.

& Thomson) Merr., Philipp. J. Sci., C. 15 (1919) 133. TYPE: Peninsular Malaysia, Penang, s.dat., *A.C. Maingay s.n.* [Kew Distrib. no. 108] (holotype: K (barcode no. K000574660)).

Pyramidanthe rufa var. *parvifolia* Boerl., Icon. Bogor. 1 (1899) 131, t. 44. — *Pyramidanthe prismatica* var. *parvifolia* (Boerl.) Merr., J. Straits Branch Roy. Asiat. Soc., Spec. No. (1921) 263. Masamune, Enum. Phan. Born. (1942) 297. TYPE: Borneo, Sarawak, nr Kuching, 1892, *G.D. Haviland 421* (lectotype, designated by Turner (2011b), BO (sheet no. BO-134059)).

Melodorum rigidum Ridl., Bull. Misc. Inform. 1912 (1912) 386. Ridley, Sarawak Mus. J. 1(3) (1913) 91. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 262. Masamune, Enum. Phan. Born. (1942) 288. — *Fissistigma rigidum* (Ridl.) Merr., Philipp. J. Sci., C. 15 (1919) 135. Sinclair, Sarawak Mus. J. 5 (1951) 600. TYPE: Borneo, Sarawak, near Kuching, *G.D. Haviland 421* [Garai leg.] [d.k.m.a.] (lectotype, designated by Turner (2012), K (barcode no. K000574656)).

Large woody climber. Twigs drying black or dark brown, with shallow longitudinal wrinkling or latticing, sometimes with raised brown lenticels, youngest parts with dark brown adpressed tomentum. Leaves chartaceous to coriaceous, drying dark brown to almost black above, brown to pale brown below with darker midrib and lateral veins, midrib slightly sunken above in dry leaves, prominent beneath, lateral veins very slightly raised on both surfaces, lamina glabrous above, variably hairy below from tiny adpressed to dense erect hairs, lamina oblong elliptic to obovate, 8–23.5 × 3.5–8 cm, base obtuse to rounded, apex acuminate, lateral veins 10–14 pairs, arching forward, looping indistinctly. Petiole 9–20 mm long, 2–3 mm in diameter. Inflorescences axillary. Pedicel 7–10 mm long, c. 1.5 mm thick, widening distally, red-brown adpressed hairy, tiny medial bract near the base of the pedicel, sepals connate, c. 2 × 5 mm, spreading, forming an almost circular salver under the corolla, externally brown or red-brown hairy, outer petals ovate lanceolate, to 40 × 8 mm, outside covered with dense short golden brown hairs, inside very short pale grey woolly except for lower part of excavation which is glabrous, inner petals ovate lanceolate, c. 7 × 4 mm, glabrous except for a few pale hairs near apex externally, drying brown, minutely wrinkled externally, more deeply wrinkled internally, stamens many, 1–1.5 mm long, connective apex polygonal, carpels many c. 2.5 mm long, sparsely hairy, stigma frilly. Fruiting pedicel to 10 mm long, 5 mm thick, calyx persistent, monocarps to 20 or more, often fewer, globose, ellipsoidal or cylindrical, 3.5–4.5 × 1.5–2.5 cm, drying relatively smooth to muricate, sometimes covered with short golden brown tomentum, stipe 8–10 × 2–4 mm. Seeds many, 2 rows, drying smooth, shiny dark brown, c. 10–12 × 6 × 2–4.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo widespread, recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

SPHAEROCORYNE (Scheff. ex Boerl.) Scheff. ex Ridl.
(Greek, *sphaera* = ball, globe, sphere, *coryne* = club)

J. Straits Branch Roy. Asiat. Soc. 75 (1917) 8. *Polyalthia* section *Sphaerocoryne* Scheff. ex Boerl., [Cat. Pl. Phan. 1 (1899) 26, *nomen*] Icon. Bogor. 1 (1899) 196. TYPE: *Polyalthia siamensis* Boerl. (= *Sphaerocoryne siamensis* (Boerl.) Ridl.).

Unona subgenus *Mesnyi* Pierre, Fl. Forest. Cochinch. (1881) t. 17. TYPE: *Unona mesnyi* Pierre, *nom. illegit.* (= *Polyalthia aberrans* Maingay ex Hook.f. & Thomson).

Woody climbers or scandent shrubs, sometimes erect shrubs. Twigs glabrous or hairy. Leaves chartaceous to coriaceous. Inflorescences 1- or 2-flowered, terminal or axillary. Flowers bisexual, sepals 3, valvate more-or-less connate at the base, persisting in fruit, petals valvate in two whorls of 4, inner only slightly smaller than outer, stamens numerous, connective truncate, carpels numerous, ovules 1–2. Fruits monocarps many, stipitate. Seeds 1–2.

Distribution and diversity: Indo-China to the Philippines. Three species of which one species, *Sphaerocoryne affinis*, recorded from Borneo.

1. *Sphaerocoryne affinis* (Teijsm. & Binn.) Ridl.
(Latin, neighbouring, akin to)

J. Straits Branch Roy. Asiat. Soc. 75 (1917) 8. — *Polyalthia affinis* Teijsm. & Binn., Natuurk. Tijdschr. Ned.-Indië 27 (1864) 37. TYPE: Java, cult. in Hort. Bot. Bogor., s.dat., *Anon. s.n.* [Bogor. distrib. no. 113] (neotype, designated by Turner (2011b), L (barcode no. L0197456)).

Monoon submitratum Miq., Ann. Mus. Lugd. Bat. 2 (1865) 16. — *Polyalthia submitrata* (Miq.) Ridl., Sarawak Mus. J. 1(3) (1913) 82. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 257. Masamune, Enum. Phan. Born. (1942) 295. TYPE: Borneo, Moeara Karrau, *P.W. Korthals s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L 0184462)).

Polyalthia aberrans Maingay ex Hook.f. & Thomson, Fl. Brit. Ind. 1 (1872) 67. — *Unona mesnyi* Pierre, Fl. Forest. Cochinch. (1881) t. 17, *nom. superfl.* — *Popowia mesnyi* Craib, Bull. Misc. Inform. Kew 1914 (1914) 5, *nom. superfl.* — *Mitrella mesnyi* (Craib) Bân, Bot. Zhurn. 59(2) (1974) 244, *nom. superfl.* — *Popowia aberrans* (Maingay ex Hook.f. & Thomson) Pierre ex Finet & Gagnep., Bull. Soc. Bot. Fr. Mem. 4(2) (1906) 109. — *Sphaerocoryne aberrans* (Maingay ex Hook.f. & Thomson) Ridl., J. Straits Branch Roy. Asiat. Soc. 75 (1917) 8. — *Melodorum aberrans* (Maingay ex Hook.f. & Thomson) J. Sinclair, Gard. Bull. Singapore 14 (1953) 41. Sinclair, Gard. Bull. Singapore 14 (1955) 332. — *Mitrella aberrans* (Maing. ex Hook.f. & Thomson)

Bân, Bot. Zhurn. 59(2) (1974) 244. TYPE: Peninsular Malaysia, Malacca, 28 April 1868, *A.C. Maingay 3141* [Kew distrib. no. 110] (lectotype, designated by Turner (2011b), K (barcode no. K000380043)).

Melodorum clavipes Hance, J. Bot. 15 (1877) 328. — *Sphaerocoryne clavipes* (Hance) Craib, Bull. Misc. Inform. Kew 1922 (1922) 168. TYPE: Cambodia, s.dat., *L. Pierre 19770* (holotype: BM (barcode no. BM000554028)).

Polyalthia siamensis Boerl., Cat. Pl. Phan. (1899) 26. — *Sphaerocoryne siamensis* (Boerl.) Ridl., J. Straits Branch Roy. Asiat. Soc. 75 (1917) 8. TYPE: Java, cultivated in Hort. Bot. Bogor. sub XI.A.71 and XI.A.41.

Dasymaschalon scandens Merr., Philipp. J. Sci., C. 10 (1915) 238. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 175. TYPE: Philippines, Palawan, Taytay, May 1913, *E.D. Merrill 9277* (lectotype, designated by Turner (2011b), K (barcode no. K0006911800)).

Tree or scandent shrub. Twigs drying brown, shallowly striate or latticed, glabrous but for a few pale hairs on the youngest parts. Leaves chartaceous, glaucous beneath, drying brown or grey-brown above, sometimes shiny, paler and duller beneath with midrib a contrasting red-brown, glabrous above, below with a scattering of pale adpressed hairs, sometimes almost glabrous, midrib flush above in dry leaves, prominent beneath, lateral nerves slightly raised on both surfaces, lamina elliptic, 4–14.5 × 1.5–5 cm, base acute, apex acuminate, lateral veins 14–18 pairs, tertiary venation clearly visible from both surfaces. Petioles 4–8 mm long, c. 1 mm thick. Inflorescences single-flowered, axillary. Flowers pedicel 15–16 mm long, c. 1 mm thick, widening distally, drying brown, striate, more or less glabrous, medial bract c. 1.5 × 1 mm, with sparse pale hairs, perianth sometimes 4-merous, sepals slightly connate at base, broadly ovate, c. 2 × 4 mm, drying black, sparse, short adpressed pale hairs outside, glabrous within, petals rather thick, outer petals broadly ovate, c. 7 × 6 mm, covered with short dense pale hairs, glabrous near base inside, inner petals c. 6 × 5 mm, hairy outside, more or less glabrous within, stamens many, carpels many, 1–1.5 mm long, white hairs near apex. Fruits pedicel 2–2.5 cm long, c. 1 mm thick, widening distally, calyx persistent, monocarps to 25 or more, ellipsoidal, typically drying 8–9 × 5–6 mm, 2-seeded fruits to 13 mm long, minutely beaked, drying dark red-brown, minutely pimpled, glabrous except for a few short pale hairs near the apex, stipe very slender, 8–14 mm long, c. 0.5 mm thick. Seeds 1, rarely 2, ellipsoidal, c. 8 × 6 mm, drying smooth, pale brown.

Distribution. Indo-China, Thailand, Malay Peninsula, ?Java, Borneo and the Philippines. In Borneo recorded from Sabah and once from Kalimantan (type of *Polyalthia submitrata*).

Ecology. Lowland forests to 200 m altitude.

Notes. This species has generally been overlooked among material from Borneo.

Mostly collected in fruit, specimens have generally been confused among a group of superficially similar small-leaved species including *Mitrella kentii*, *Desmos acutus* or *D. dunalii*, and *Uvaria micrantha*. *Mitrella kentii* and *M. clementis* have adpressed hairs on the lower lamina unlike *S. affinis* which has a very sparse indumentum. The stipes of the monocarps also appear less slender in the *Mitrella* species. The *Desmos* species have moniliform monocarps, but in some poor specimens care must be taken to identify fruits with more than one seed. *Uvaria micrantha* has stellate pubescence but the hairs are small and may be difficult to see in the field. The confusable *Desmos* and *Uvaria* species do not have the calyx persisting in fruit like *Sphaerocoryne* (and *Mitrella*).

UVARIA L.

(Latin, *uva* = cluster, cluster or bunch of grapes; alluding to clustered fruits)

Sp. Pl. (1753) 536. Sinclair, Gard. Bull. Singapore 14 (1955) 199. Zhou et al., Syst. Biodivers. 7 (2009) 249–258. Zhou et al., Bot. J. Linn. Soc. 163 (2010) 33–43. LECTOTYPE: *Uvaria zeylanica* L. (designated by Hutchinson (1923)).

Marenteria Noronha ex du Petit-Thouars, Gen. Nova Madag. (1806) 18. TYPE: non designatus.

Cyathostemma Griff., Notul. Pl. Asiat. 4 (1854) 707. Utteridge, Blumea 45 (2000) 377. TYPE: *Cyathostemma viridiflorum* Griff.

Ellipeia Hook.f. & Thomson, Fl. Ind. (1855) 104. Sinclair, Gard. Bull. Singapore 14 (1955) 230. TYPE: *Ellipeia cuneifolia* Hook.f. & Thomson.

Anomianthus Zoll., Linnaea 29 (1858) 324. TYPE: *Anomianthus heterocarpus* (Blume) Zoll.

Tetrapetalum Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 23. TYPE: *Tetrapetalum volubile* Miq.

Rauwenhoffia Scheff., Ann. Jard. Buitenz. 2 (1885) 21. TYPE: *Rauwenhoffia siamensis* Scheff.

Uva Kuntze, Rev. Gen. 1 (1891) 7, *nom. superfl.*

Uvariella Ridl., Fl. Malay. Penins. 1 (1922) 22. TYPE: *Uvariella leptopoda* (King) Ridl.

Ellipeiopsis R.E. Fr., Ark. Bot. ser. 2. 3 (1955) 41. TYPE: *Ellipeiopsis ferruginea* (Buch.-Ham. ex Hook.f. & Thomson) R.E. Fr.

Dasoclema J. Sinclair, Gard. Bull. Singapore 14 (1955) 273. TYPE: *Dasoclema siamensis* (Craib) J. Sinclair.

Balonga Le Thomas, Adansonia sér. 2, 8 (1968) 106. TYPE: *Balonga buchholzii* (Engl & Diels) Le Thomas.

Woody climbers with stellate or caespitose hairs. Twigs glabrous or stellate hairy. Leaves chartaceous to coriaceous. Inflorescences fascicles or solitary flowers, terminal, leaf-opposed, rarely cauliflorous. Flowers bisexual, trimerous, rarely dimerous, sepals valvate, often connate, petals imbricate in two whorls, sometimes connate at the base, stamens numerous, outer sometimes sterile, truncate, carpels few to many, ovules few to many, uni- or biseriate. Fruits few to many stipitate, subglobose to ellipsoidal monocarps. Seeds few to many, in 2 rows.

Distribution and diversity: More than 100 species across the Old World tropics from Africa to Australia. 19 species recorded from Borneo.

Notes. For both nomenclatural and taxonomic reasons, Utteridge (2000) reduced *Tetrapetalum* to *Uvaria*. Recent molecular phylogenies have provided the critical weight for a number of other satellite genera to gravitate into an enlarged *Uvaria* (Zhou et al. 2009, 2010). Most relevant to the student of Bornean Annonaceae, *Cyathostemma* and *Ellipeia* have been reduced to *Uvaria*, unfortunately with many epithet changes.

Key to *Uvaria* species

- 1a. Plants cauliflorous with inflorescences arising from main stem 2
- b. Plants not cauliflorous 3

- 2a. Calyx entirely enclosing flower in bud, petals reflexing at anthesis and more than 1 cm long, monocarps drying brown *U. monticola*
- b. Calyx not entirely enclosing flower in bud, petals not reflexing at anthesis, less than 1 cm long, monocarps drying black *U. griffithii*

- 3a. Inflorescences, generally arising on branches behind leaves, congested cymes of 4–20 (sub)sessile flowers *U. excelsa*
- b. Inflorescences, generally arising among leaves, not congested cymes, flowers distinctly pedicellate 4

- 4a. Inner petals distinctly shorter than outer petals, monocarps smooth, stipitate with lateral attachment of stipe and apiculus 5
- b. Petal whorls equal or subequal in length, monocarps sessile or stipitate with more or less basal attachment, apiculus terminal or absent 6

- 5a. Lateral nerves looping obscurely, lower lamina not distinctly rough to the touch, monocarps less than 2 cm long *U. cuneifolia*
- b. Lateral nerves looping distinctly within the margin of the leaf, lower lamina distinctly rough to the touch, monocarps more than 2 cm long .. *U. schefferi*
- 6a. Living leaves brown beneath *U. lanuginosa*
- b. Living leaves not brown beneath 7
- 7a. Leaves scabrous on upper surface *U. javana*
- b. Leaves not scabrous above 8
- 8a. Twigs densely covered with hairs 9
- b. Twigs glabrous or with sparse hairs 11
- 9a. Twigs and leaves pilose, with long (1–3 mm) erect, straight red brown hairs *U. hirsuta*
- b. Twigs and leaves hairy but not pilose 10
- 10a. Flowers more than 5 cm across, monocarps cylindrical with longitudinal ridges *U. grandiflora*
- b. Flowers less than 3 cm across, monocarps globose *U. curvistipitata*
- 11a. Flowers dimerous, monocarps stipitate, with stipe shorter than seed-bearing portion, cylindrical, rough to the touch but without longitudinal ridges *U. borneensis*
- b. Flowers trimerous, monocarps (sub)sessile or if stipitate then globose or ellipsoidal, or if cylindrical then with stipe longer than seed-bearing portion or bearing longitudinal ridges 12
- 12a. Petals more than 2 cm long, erect at anthesis, monocarps (sub)sessile and muricate, with a distinct lateral apiculus *U. verrucosa*
- b. Petals spreading or relexing at anthesis, or if not spreading or reflexing then less than 1 cm long, monocarps distinctly stipitate and not muricate, or if sessile and muricate (*U. beccarii*) then without a lateral apiculus 13
- 13a. Petals spreading at anthesis and at least 10 mm long, monocarps muricate, or if not muricate cylindrical and drying black, or globose ellipsoidal with stipe c. 1 mm thick 14
- b. Petals not spreading and less than 10 mm long, monocarps not muricate, if monocarps cylindrical then drying brown, or globose and ellipsoidal with very slender stipe c. 0.3 mm in diameter 17
- 14a. Petals white or yellow, monocarps sessile and muricate *U. beccarii*
- b. Petals red, monocarps distinctly stipitate, muricate or not 15

- 15a. Calyx entirely covering flower in bud, petals connate at base, monocarps cylindrical, smooth, drying black *U. concava*
- b. Calyx not entirely covering flower in bud, petals free at base, monocarps globose to ellipsoidal, drying brown..... 16
- 16a. Leaves with lateral nerves looping indistinctly in dry leaves, pedicel of flower 10 mm or less in length, monocarps muricate.....*U. lobbiana*
- b. Leaves with lateral nerves looping distinctly in dry leaves, pedicel of flower 15 mm long or more, monocarps not muricate *U. littoralis*
- 17a. Leaves typically less than 4.5 cm wide, stipe of monocarp very slender (c. 0.3 mm diam.) *U. micrantha*
- b. Leaves typically more than 4.5 cm wide, stipe of monocarp relatively thick (2 mm or more) 18
- 18a. Inflorescence subtended by a persistent foliose bract, monocarps with stipe shorter than seed-bearing portion *U. argentea*
- b. Inflorescence bract not foliose, monocarps with stipe longer than seed-bearing portion *U. clementis*

1. *Uvaria argentea* Blume

(Latin, silvery)

Fl. Javae Anonaceae (1830) 24. Ridley, Sarawak Mus. J. 1(3) (1913) 73. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 253. Masamune, Enum. Phan. Born. (1942) 297. — *Uva argentea* (Blume) Kuntze, Rev. Gen. Pl. 1 (1891) 7. — *Cyathostemma argenteum* (Blume) J. Sinclair, Sarawak Mus. J. 5 (1951) 599. Sinclair, Gard. Bull. Singapore 14 (1955) 220. Utteridge, Blumea 45 (2000) 382. TYPE: Java, *J.C.A. van Hasselt s.n.* (holotype: L).

Uvaria bracteata Roxb., Fl. Ind. (1832) 660. — *Uva bracteata* (Roxb.) Kuntze, Rev. Gen. Pl. 1 (1891) 7. TYPE: *Roxb. Icon. 2290* (lectotype, designated by Utteridge (2000), K).

Uvaria gomeziana A. DC., Mem. Soc. Phys. Genève. 5 (1832) 203. TYPE: Burma, Tavoy, 8 September 1827, *W. Gomez 197* [N. Wallich 1279, EIC 6459] (lectotype, designated by Turner (2011a), K-W).

[*Cyathostemma nitidum* Bakh.f., Blumea 12 (1963) 61, *nom. inval.*]

Woody climber to 5 m long. Twigs densely pubescent when young, becoming glabrous with age. Leaves chartaceous to subcoriaceous, glabrous except for midrib above,

oblong-lanceolate, 10–15 × 4.5–6 cm, base cuneate or rounded, apex acute, lateral nerves 12–14 pairs. Petioles 3–5 mm long, c. 1 mm thick. Inflorescences, 1–4 flowered, opposite leaves, basal bract foliose, orbicular, 7–9 × 7–9 mm, sepals coriaceous, broadly ovate, 2 × 3 mm, apex obtuse, densely pubescent, petals broadly ovate, 5 mm long, stamens many, carpels many. Monocarps oblong-ellipsoid, c. 4 × 3 cm, apex rounded, drying slightly constricted between seeds, tuberculate with longitudinal ridges, stipe to 2.5 cm long, c. 5 mm thick. Seeds more than 6 in 2 rows.

Distribution. Bangladesh and Burma to Java and Borneo. In Borneo sparsely collected from Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

2. *Uvaria beccarii* Attan., I.M.Turner & R.M.K.Saunders

(Odoardo Beccari (1843–1920), Italian naturalist and author of *Nelle Foreste di Borneo*)

Novon 21 (2011b) 161, Fig. 1. TYPE: Borneo, Sarawak, Mt Matang, 1863–1865, *O. Beccari P.B. 1648* (holotype: K; isotypes: BO, FI-B).

Large woody climber. Twigs dark grey or grey-brown, striate or latticed, young twigs densely brown stellate hairy. Leaves chartaceous to subcoriaceous drying dark brown, brown or grey-brown above, dark brown to brown below, midrib slightly sunken above in dry leaves, prominent beneath, lateral nerves more or less flush above, prominent beneath, glabrous above except for hairs on midrib above, densely stellate hairy on nerves below, with scattered hairs on lower lamina. Lamina elliptic to narrowly oblanceolate, 6–14 × 2–5.5 cm, base obtuse, truncate or rounded, apex acuminate, lateral nerves 11–14 pairs, looping obscurely well within the margin, tertiary venation areolate, visible from below, indistinct from above. Petiole 3–5 mm long, 1–2 mm thick. Inflorescence subopposite leaves, single-flowered. Flower pedicel 12–22 mm long, 1 mm thick, densely brown stellate hairy, basal bract lanceolate c. 16 × 2 mm, brown hairy abaxially, sparsely hairy adaxially, medial bract ovate, c. 3 × 2 mm, hairy outside, glabrous within, calyx completely covering flower bud, sepals at anthesis triangular, c. 6 × 6 mm, drying dark brown, outside with brown hairs densest near the base, inside with small pale hairs, petals white or pale yellow, reflexing at anthesis, oblong-ovate c. 10 × 5 mm, apex blunt, densely pale brown hairy on both surfaces, stamens many truncate, carpels many hairy. Fruiting pedicel c. 2.5 cm long, 4 mm thick, drying striate, brown stellate hairy, monocarps to 15 or more, sessile, pyriform, muricate, often with flat oblique faces basally, apex rounded, to 3.5 × 2.5 cm, drying brown, covered with short dense golden brown tomentum. Seeds several, ellipsoidal with one or two flattened faces, 12 × 6–8 × 3–6 mm, drying smooth, brown, shiny.

Distribution. Endemic to Borneo, where it has been collected from Brunei, Sabah and Sarawak.

Ecology. Lowland dipterocarp forests (primary and disturbed), near streams and freshwater swamps; 30–720 m.

Notes. Beccari appears to have recognised that the his collection represented a new species and distributed the material under the name '*Uvaria vallombrosana*', the proposed epithet deriving from the name of the house, 'Vallombrosa', he had built on Mt. Matang in Sarawak.

Fruiting material of *U. beccarii* is morphologically similar to that of *U. verrucosa*, although the two species are unlikely to be confused if flowering material is available. *Uvaria verrucosa* fruits are borne on shorter peduncles and pedicels, and the monocarps are smaller and subglobose with an apiculate apex, and have fewer seeds.

3. *Uvaria borneensis* (Merr.) Utteridge (of Borneo)

Blumea 45 (2000) 393, as '*borneense*'. — *Tetrapetalum borneense* Merr., Univ. Calif. Publ. Bot. 15 (1929) 64. Masamune, Enum. Phan. Born. (1942) 297. Sinclair, Sarawak Mus. J. 5 (1951) 608. TYPE: Borneo, Sabah, Tawau, October 1922–March 1923, *A.D.E. Elmer 21211* (lectotype, designated by Utteridge (2000), K (barcode no. K000691249); isolectotypes: A, B, BISH, BM, BO, C, CM, DS, IBSL, L, MICH, MO, NY, P, S, U, Z).

Uvaria lambirensis (K. Momose) Utteridge, Blumea 45 (2000) 393, as '*lambirensis*'. — *Tetrapetalum lambirensis* K. Momose, Blumea 43 (1998) 117. TYPE: Borneo, Sarawak, Miri, Lambir Hills National Park, 1 April 1996, *K. Momose 5069* (holotype: KYO; isotypes: BM, BO, K, L).

Large woody climber. Young twigs rusty stellate hairy. Leaves chartaceous to coriaceous, hairy on midrib and veins above when young, ovate to ovate lanceolate, 7.5–27 × 3–12 cm. base rounded to truncate, apex acuminate. Inflorescence supra-axillary or behind leaves, pedunculate to 10 mm, usually with 1 or 2 flowers. Pedicel to 3 cm, often much shorter, densely stellate tomentose. Often drying with longitudinal wrinkles. Clasping medial bract c. 3 mm long; sepals 2, orbicular, 8–10 mm across, 4 mm long; petals 4, green, membranous, concave, oblong ovate, 13 × 10 mm; stamens many, carpels many. Monocarps to 30 or more, ellipsoidal, c. 3 × 2 cm, drying brown, minutely wrinkled, densely covered with very short hairs, apex blunt, stipe to 2 cm long. Seeds many, flattened, c. 15 × 10 × 3 mm, smooth, shiny.

Distribution. Endemic to Borneo. Known from Sarawak, Sabah and Kalimantan.

Ecology. Lowland forest.

4. *Uvaria clementis* (Merr.) Attan., I.M.Turner & R.M.K.Saunders

(Latin, *clementis* (*clemens* in genitive case) = of gentility, mildness, mercy; commemorative of Joseph Clemens (1862–1936), a Methodist minister, originally from England, who served with the US Army, and his American wife Mary Strong Clemens (1873–1968), who collected plants professionally).

Novon 21 (2011) 166. — *Artabotrys clementis* Merr., J. Straits Branch Roy. Asiat. Soc. 85 (1922) 174. Masamune, Enum. Phan. Born. (1942) 280. TYPE: Borneo, Sabah, Sandakan and vicinity, September–December 1920, *M. Ramos 1667* (lectotype, designated by Attanayake et al. (2011), K; isolectotype: A).

Uvaria parviflora Hook.f. & Thomson, Fl. Ind. 1 (1855) 103, non *U. parviflora* A. Rich. (1831), nec *U. parviflora* (Michx.) Torr. & A. Gray (1838). — *Uva parviflora* Kuntze, Rev. Gen. Pl. 1 (1891) 8. — *Cyathostemma hookeri* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61(2) (1892) 10, nom. superfl. Ridley, Sarawak Mus. J. 1(3) (1913) 73. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 263. Masamune, Enum. Phan. Born. (1942) 297. Sinclair, Gard. Bull. Singapore 14 (1955) 223. Utteridge, Blumea 45 (2000) 386. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 83. TYPE: Peninsular Malaysia, Prince of Wales Island (Penang), *W.E. Phillips s.n.* (lectotype, designated by Attanayake et al. (2011), K (barcode no. K 000615957)).

Large woody climber. Twigs becoming glabrous with age. Leaves drying brown or grey-brown, coriaceous, sparsely pubescent below, oblong to obovate, 12–20 × 5.5–8 cm, base cuneate, apex acute to acuminate, lateral nerves 12–17 pairs. Petiole 4–7 mm long, 1–3 mm thick. Inflorescence opposite leaves, 3- or 4-flowered. Pedicel to 12 mm long, minutely verruculose, basal and medial bracts minute, sepals ovate 2.5–3 × 2.5–5 mm, petals, elliptic to ovate, 4–6 × 2–3 mm, stamens many, carpels many. Monocarps to 20 or more, globose or ellipsoidal, 3–4 cm long, c. 2–2.5 cm diameter, glabrous, drying dark red-brown, apex rounded, stipes 2–5 cm long. Seeds up to 8.

Distribution. Malay Peninsula and Borneo. In Borneo collected from Sarawak, Sabah and Kalimantan.

Ecology. Lowland forest.

Notes. Fruiting specimens can be difficult to distinguish from those of *U. concava* but the monocarps of *U. concava* dry black whereas those of *U. clementis* are a reddish brown in the dry state.

5. *Uvaria concava* Teijsm. & Binn.

(Latin, *concava*, curved inwards, hollowed out)

Natuurk. Tijdschr. Ned.-Indië 3 (1852) 331. Teijsmann & Binnendijk, Ned. Kruidk.

Arch. 3 (1855) 406. — *Uva concava* (Teijsm. & Binn.) Kuntze, Rev. Gen. Pl. 1 (1891) 8. TYPE: Java, cult. in Hort. Bot. Bogor., *S. Binnendijk s.n.* [Herb. Bogor. 17623] (lectotype, designated by Turner (2011b), BO (sheet no. BO-1824857)).

Uvaria lurida Hook.f. & Thomson, Fl. Ind. 1 (1855) 101. — *Uva lurida* (Hook.f. & Thomson) Kuntze, Rev. Gen. Pl. 1 (1891) 8. TYPE: India, Assam, Khasia, 2000 feet, 2 October 1850, *J.D. Hooker & T. Thomson 2468* (lectotype, designated by Turner (2011b), K (barcode no. K000380703)).

?*Uvaria sessiliflora* Rchb.f. & Zoll., Linnaea 29 (1858) 306, 312. TYPE: Java, Hort. Bot. Bogor., *H. Zollinger 1412* (isotype: P (barcode no. P00260015) (n.v.)).

Uvaria stellata Merr., Publ. Bur. Sci. Gov. Lab. 29 (1905) 14. TYPE: Philippines, Luzon, Province of Benguet, Twin Peaks, May 1904, *A.D.E. Elmer 6322* (lectotype, designated by Turner (2011b), K (barcode no. K000691146); isolectotypes: NY, P, US).

Unona leytensis Elmer, Leafl. Philipp. Bot. 5 (1913) 1744. — *Uvaria leytensis* (Elmer) Merr., Philipp. J. Sci., C. 10 (1915) 230. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 155. TYPE: Philippines, Mindanao, Province of Agusan, Cadadbaran (Mt Urdanete), September 1912, *A.D.E. Elmer 13880* (lectotype, designated by Turner (2011b), L (barcode no. L0190815); isolectotypes: BM, BO, CAL, GH, K, L, NA(ex MOAR), NY, P, U, US).

Uvaria nudistellata Elmer, Leafl. Philipp. Bot. 5 (1913) 1746. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 156. TYPE: Philippines, Palawan, Puerto Princesa (Mt Pulgar), April 1911, *A.D.E. Elmer 13015* (lectotype, designated by Turner (2011b), L (barcode no. L0190867); isolectotypes: A, BISH, BM, CAL, K, L, MO, NSW, NY, U, US, Z).

Uvaria sympetala Merr., Univ. Calif. Publ. Bot. 15 (1929) 63. Masamune, Enum. Phan. Born. (1942) 298. TYPE: Borneo, Sabah, near Tawao, October 1922–March 1923, *A.D.E. Elmer 21090* (lectotype, designated by Turner (2011b), UC (sheet no. 289957); isolectotypes: A, BISH, BM[×2], BO, C, CM, DS, GH, K, L, M, MICH, MO, NY, P, PH, S, SING, U, UC, Z).

Large woody climber. Foliage largely glabrous. Twigs dark brown or grey-brown, latticed. Leaves drying olive green-grey, elliptic to lanceolate, 12–20 × 6–7 cm, base cuneate to rounded, apex acute to acuminate, reticulations very distinct from above. Petioles 5–10 × 1–2 mm. Inflorescence terminal, flowers solitary. Pedicel to 2 cm, covered with very short adpressed brown stellate hairs, sepals connate, entirely covering flower bud, splitting, petals red-brown, connate at base, obovate c. 15 mm long, concave, stamens many, carpels many. Monocarps many (40 or more), drying black, cylindrical, 4 × 1.5 cm, glabrous except for a scattering of very tiny brown stellate hairs, stipe to 7 cm long. Seeds many.

Distribution. India to Australia including the Malay Peninsula, Sumatra, Java, Borneo and the Philippines. In Borneo only recorded from Sabah.

Ecology. Lowland forest.

Notes. The monocarps drying black distinguish fruiting specimens from the otherwise similar *U. clementis* that has monocarps drying a reddish brown.

6. *Uvaria cuneifolia* (Hook.f. & Thomson) L.L.Zhou & al.
(Latin, *cuneatus* = wedge-shaped, *folius* = leaf)

Syst. Biodivers. 7 (2009) 255. — *Ellipeia cuneifolia* Hook.f. & Thomson, Fl. Ind. 1 (1855) 104. Ridley, Sarawak Mus. J. 1(3) (1913) 76. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 254. Masamune, Enum. Phan. Born. (1942) 283. Sinclair, Gard. Bull. Singapore 14 (1955) 230. TYPE: Peninsular Malaysia, near Malacca, *W. Griffith s.n.* (lectotype, designated by Turner (2011b), K (barcode no. K000382203)).

Ellipeia gilva Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 9. — *Uvaria gilva* (Miq.) L.L. Zhou & al., Syst. Biodivers. 7 (2009) 255. TYPE: Borneo, *W.H. de Vriese s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L 0484299)).

Uvaria laha Miq., Fl. Ned. Ind., Eertse Bijv. (1861) 369. — *Ellipeia laha* (Miq.) Miq., Ann. Mus. Lugd.-Bat. 2 (1865) 10. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 254. Masamune, Enum. Phan. Born. (1942) 283. TYPE: Sumatra, West Sumatra, Palembang near Tubuan, Ogau-ulu, *J.E. Teijsmann s.n.* [Herb. Bogor. 3811] (holotype: U (barcode no. U 0000268); isotype: BO (sheet no. BO-1349058)).

Large woody climber. Twigs longitudinally wrinkled or latticed, drying dark brown, young twigs densely short stellate hairy, glabrescent with age. Leaves chartaceous, drying dark above uniform brown beneath, or various shades of brown, lamina above with uniform but sparse covering of pale stellate hairs, lost with age, dense brown tomentum on midrib and nerves, beneath dense covering of stellate red-brown hairs, giving a felty feel, or almost glabrous except for a few hairs along the midrib, leaves ovate to obovate to more typically oblanceolate, 5–25 × 2–10 cm, base rounded, apex acuminate, lateral veins 15–20 pairs, arching forward, looping obscurely within the margin. Petioles 4–5 mm long, to 3 mm thick. Inflorescences terminal, many-flowered. Flowers pedicel 11–14 mm long with short dense red-brown stellate tomentum, basal bracteole narrowly ovate to 8 mm long, clasping medial bract to 3–4 mm long, sepals broadly triangular to ovate, 4 mm long, 4–5 mm across, apex obtuse, rusty stellate outside; petals creamy yellow, outer petals broadly ovate, 17 × 11 mm, apex obtuse, inner petals triangular, 4 mm long, 5 mm wide; stamens numerous, carpels many. Fruits pedicel to 20 mm long, 2 mm thick, monocarps to 20 or more, compressed ovoid, 15 × 8–10 × 6 mm, drying pale brown, shortly tomentose, minutely bumpy, apiculus lateral, stipe to 15 mm long. Seeds 1.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo collected from Sabah and Sarawak, and probably Kalimantan.

Ecology. Lowland forest.

7. *Uvaria curvistipitata* Attanayake & al.

(Latin, *curvi-* = curved, *stipitatus* = with a stipe or short stalk; curved stipes to the monocarps)

Novon 21 (2011) 164, fig. 3. TYPE: Borneo, Sabah, Labuk and Sugut, west side of Bukit Doji pass from Telupid to Ulu Karamuak, 25 October 1968, *S. Kokawa & M. Hotta 435* (holotype: SAN; isotypes: KYO, L).

Large woody climber. Twigs drying dark brown or black, latticed, younger parts with dense, quite coarse, brown hairs. Leaves chartaceous to coriaceous, drying brown or grey brown above, often rather patchy, brown beneath, midrib slightly sunken above in dry leaves, prominent beneath, lateral nerves more or less flush above, prominent beneath, variably hairy above, sometimes restricted to veins, densely hairy beneath, lamina (oblong-)elliptic to typically obovate, 8–25 × 4–13 cm, base truncate, rounded or auriculate, apex shortly acuminate, lateral nerves 13–17 pairs, arching forward, looping obscurely within margin, tertiary venation visible from below, obscure from above. Petiole 5–8 mm long, 2–5 mm thick, densely hairy. Inflorescence subopposite leaves, several-flowered, peduncle c. 1 cm long. Flowering pedicel c. 8 mm long, 2.5 mm thick, densely hairy, medial bract very broadly elliptic, 3 × 8 mm, with short brown hairs, sepals broadly triangular, c. 5 × 7 mm, connate at base, hairy externally, petals, whorls similar, ovate, c. 8 × 8 mm, covered on both surfaces with short brown hairs, stamens many, carpels many. Fruiting pedicel c. 10 mm long, 4 mm thick, monocarps to 25 or more, globose to ellipsoidal, 1.5–2 × 1.5 cm, apex rounded, sometimes with some longitudinal ridges, densely brown hairy, stipe to 3.5 cm long, 3 mm thick. Seeds c. 6 in 2 rows, ellipsoidal, flattened on one or two faces, 11–12 × 7–8 × 4–6 mm, drying brown, smooth, shiny, glabrous.

Distribution. Endemic to Borneo. Collected from Kalimantan and Sabah.

Ecology. Lowland forest to 200 m.

8. *Uvaria excelsa* (Hook.f. & Thomson) King

(Latin, lofty, high)

J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61(2) (1893) 22. Ridley, Sarawak Mus. J. 1(3) (1913) 74. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 253. Masamune, Enum. Phan. Born. (1942) 297. — *Mitrephora excelsa* Hook.f. &

Thomson, Fl. Ind. 1 (1855) 114. Ridley, Sarawak Mus. J. 1(3) (1913) 86. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 263. Masamune, Enum. Phan. Born. (1942) 289. — *Kinginda excelsa* (Hook.f. & Thomson) Kuntze, Rev. Gen. Pl. (1891) 7. — *Cyathostemma excelsum* (Hook.f. & Thomson) J. Sinclair, Gard. Bull. Singapore 14 (1955) 226. Kessler & van Heusden, Rheedia 3 (1993) 60. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 14. Utteridge, Blumea 45 (2000) 384. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 83. TYPE: Peninsular Malaysia, Penang, *G. Porter s.n.* [EIC 6477] (holotype: K (barcode no. K000691369); isotypes: CGE, K, K-W, WU).

[*Uvaria excelsa* Wall., Numer. List (1832) no. 6477, *nom. nud.*]

Tetrapetalum volubile Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 1. Ridley, Sarawak Mus. J. 1(3) (1913) 73. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 254. Masamune, Enum. Phan. Born. (1942) 297. TYPE: Borneo, 1857, *W.H. de Vriese s.n.* (holotype: L[×3] (barcode nos. L0037889, L0037900, L0037901); isotype: U).

Uvaria confertiflora Merr., Univ. Calif. Publ. Bot. 15 (1929) 61. Masamune, Enum. Phan. Born. (1942) 297. TYPE: Borneo, Sabah, Tawau, October 1922–March 1923, *A.D.E. Elmer 21081* (lectotype, designated by Utteridge (2000), L (barcode no. L0037902); isolectotypes: A, BISH, BM[×2], BO, C, CM, DS, K, MICH, MO, NY, P, PH, S, SING, U, UC, Z).

Large woody climber. Twigs pubescent becoming glabrous with age. Leaves coriaceous, glabrous above except on midrib, below variably pubescent from extremely densely so, to almost glabrous, becoming less hairy with age, but apparently a lot of variability between plants or populations in hairiness: lamina oblong-obovate 13–22 × 6–12 cm, base cordate, apex acute or acuminate, lateral nerves 8–11 pairs. Petiole 7–12 mm long, 1–3 mm thick. Inflorescence clustered cymes of 4–20 flowers, on twigs behind leaves or supra-axillary. Pedicels 0–5 mm long, bracts coriaceous, pubescent, ovate, sepals 2 or 3, connate at base, coriaceous, suborbicular 2–4 × 3–5.5 mm, densely pubescent, petals 4 or 6, broadly ovate, 5–6 × 5–6 mm, apex obtuse, stamens many, carpels many. Monocarps to 20 or more, ripening yellow orange, densely pubescent, globose, 2–2.5 cm diameter, tuberculate, stipes to 3 cm long. Seeds c. 12 in two rows, semi-circular in outline with two flat faces and one convex, c. 14–16 × 8–10 × 5 mm, drying brown.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. Sometimes confused with *Polyalthia chrysotricha* Ridl., though this is a tree not a climber.

9. *Uvaria grandiflora* Roxb. ex Hornem.

(Latin, *grandis* = large, *florus* = flower, with large flowers)

Hort. Hafn., Suppl. (1819) 141. Kessler & van Heusden, *Rheedea* 3 (1993) 85. Beaman et al., *Pl. Mt. Kinabalu* 4 (2001) 98. TYPE: India, cultivated in the Calcutta Botanic Garden, April 1818, *Anon. s.n.* (lectotype, designated by Turner (2011b), C).

[*Uvaria grandiflora* Roxb., Hort. Bengal. (1814) 43, *nom. nud.*]

Unona grandiflora DC., Prodr. 1 (1824) 91. — *Uva grandiflora* (DC.) Kuntze, Rev. Gen. Pl. 1 (1891) 8. TYPE: India, Bengal, 1821, *Leschenault de la Tour s.n.* (holotype: G-DC (barcode no. G00201447)).

Uvaria purpurea Blume, Bijdr. (1825) 11. Ridley, *Sarawak Mus. J.* 1(3) (1913) 75. Merrill, *J. Straits Branch Roy. Asiat. Soc. Spec. No.* (1921) 254. Merrill, *Enum. Philipp. Fl. Pl.* 2 (1923) 156. Masamune, *Enum. Phan. Born.* (1942) 298. TYPE: In sylvis humilioribus Javae Insulae. Floret Nov Dec, nomen kadjang.

Uvaria platypetala Champ. ex Benth., Hooker's *J. Bot. Kew Gard. Misc.* 3 (1851) 257. TYPE: Hong Kong, East Point, low jungle near the Buddhist Temple, East Point, 1850, *J.G. Champion* 38 (holotype: K (barcode no. K000380694)).

Uvaria rhodantha Hance ex Walp., *Ann. Syst. Bot.* 2 (1851) 19. TYPE: Hong Kong, April 1852, *H.F. Hance* 933 (neotype, designated by Turner (2011b), BM; isoneotype: CGE).

?*Uvaria purpurea* var. *subbiflora* Miq., *Fl. Ned. Ind., Eerste Bijv.* 3 (1861) 368. TYPE: Sumatra austr. secus flumen Tarabangi (Teijsmann).

?*Uvaria flava* Teijsm. & Binn., *Natuurk. Tijdschr. Ned.-Indië* 25 (1863) 419. — *Uvaria purpurea* var. *flava* (Teijsm. & Binn.) Scheff., *Natuurk. Tijdschr. Ned.-Indië* 31 (1869) 4. TYPE: Bangka, Teijsmann.

?*Uvaria purpurea* var. *alba* Scheff., *Natuurk. Tijdschr. Ned.-Indië* 31 (1869) 4. TYPE: Sumatra, Priaman, Diepenhorst.

Uvaria purpurea var. *tuberculata* King, *J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist.* 61(2) (1892) 18. — *Uvaria grandiflora* Roxb. ex Hornem. var. *tuberculata* (King) J. Sinclair, *Gard. Bull. Singapore* 14 (1955) 203. TYPE: Peninsular Malaysia, Perak, August 1883, *King' Collector* [H.H. Kunstler] 4786 (lectotype, designated by Turner (2011b), K (barcode no. K0003809129); isolectotype: CAL).

Uvaria rubra C.B. Rob., *Bull. Torrey Bot. Club* 35 (1908) 68. Merrill, *Enum. Philipp. Fl. Pl.* 2 (1923) 156. TYPE: Philippines, Mindanao, Prov. Davao, Santa Cruz, 29 June

1905, *R.S. Williams 3042* (holotype: NY (barcode no. 00059991); isotypes: NY[×2]).

?*Uvaria cardinalis* Elmer, *Leafl. Philipp. Bot.* 5 (1913) 1748, as '*cardinales*'. Merrill, *Enum. Philipp. Fl. Pl.* 2 (1923) 156. TYPE: Philippines, Luzon, Sorzogon, *A.D.E. Elmer 7317* (holotype: PNH (destroyed)).

Large woody climber. Twigs golden hairy when young, becoming glabrous with age. Leaves typically hirsute, chartaceous, obovate to (ob)lanceolate, 9–30 × 3–15 cm, base rounded to cordate, apex acuminate. Petiole 4–7 mm long, 2–3 mm thick. Inflorescence subopposite leaves, usually solitary, occasionally more than one flower. Pedicel to 2.5 cm long, basal bract foliose to 3 cm long, medial bract to 2 cm long, calyx entirely enclosing flower in bud, splitting into three orbicular sepals, 2 cm across, petals fleshy, red-purple (white or yellow reported from outside Borneo), ovate to obovate, 30 × 15 mm, stamens many, carpels many. Monocarps to 30 or more, cylindrical 5 × 1.5 cm, longitudinally ridged, covered in dense adpressed hairs, stipe to 1 cm. Seeds to 20 or more in two rows, more or less semi-circular, c. 10 × 5 × 3 mm, drying brown.

Distribution. From Burma and China, through Indochina to Java and the Philippines. In Borneo collected from Kalimantan, Sabah and Sarawak (only known from Gunung Subis).

Ecology. Lowland forest.

10. *Uvaria griffithii* L.L.Zhou & al.

(William Griffith (1810–1845), English surgeon and botanist)

Syst. Biodivers. 7 (2009) 255. — *Cyathostemma viridiflorum* Griff., *Not. Pl. Asiat.* 4 (1854) 707. Sinclair, *Gard. Bull. Singapore* 14 (1955) 221. Kessler & van Heusden, *Rhedeia* 3 (1993) 62. Utteridge, *Blumea* 45 (2000) 390. Beaman et al., *Pl. Mt. Kinabalu* 4 (2001) 83. TYPE: Peninsular Malaysia, Malacca, *W. Griffith s.n.* [Kew Distribution no. 432] (lectotype, designated by Utteridge (2000), K (barcode no. K000582099)).

Cyathostemma scortechinii King, *J. Asiat. Soc. Bengal, Pt. 2. Nat. Hist.* 61(2) (1893) 9. — *Cyathostemma viridiflorum* var. *scortechinii* (King) Ridl., *Fl. Malay Penins.* 1 (1922) 27. TYPE: Peninsular Malaysia, Perak, Gopeng, *King's Collector* [H.H. Kunstler] 5857 (lectotype, designated by Utteridge (2000), K (barcode no. K000380130); isolectotypes: BM, CAL, SING).

Large woody climber. Twigs slightly hairy when young, otherwise glabrous. Leaves typically drying grey above, grey-brown or brown below, coriaceous, glabrous except for midrib above, oblong-elliptic to oblong-lanceolate, 12–17 × 5.5–8 cm, base rounded, apex acute. Petiole 6–12 mm long, c. 2 mm thick. Inflorescence cauliflorous, many-flowered cymes, peduncles pendulous, 2.5–8 cm long, densely pubescent. Pedicel 6–9

mm long, bracts coriaceous, long-persistent, 3–4 mm long, sepals broadly ovate, 3 × 3–5 mm, connate at base, petals broadly ovate, greenish yellow, 5–6 × 4–5 mm, apex acute, stamens many, carpels many. Monocarps to 10 or more, cylindrical-ellipsoidal, drying black, stipes to 2 cm. Seeds 7–10 in 2 rows, semi-circular, c. 10 × 5 × 3 mm.

Distribution. Malay Peninsula, Sumatra and Borneo. In Borneo, once from Sarawak and a few collections from Kalimantan.

Ecology. Lowland forest.

11. *Uvaria hirsuta* Jack

(Latin, hairy)

Malay Misc. 1 (1820) 46. Sinclair, Sarawak Mus. J. 5 (1951) 608. Sinclair, Gard. Bull. Singapore 14 (1955) 203. — *Uvaria blumeana* Steud., Nomencl. 2 (1841) 737. *nom. superfl.* — *Uva hirsuta* (Jack) Kuntze, Rev. Gen. Pl. 1 (1891) 8. TYPE: Peninsular Malaysia, Penang, 1822, *N. Wallich s.n.* [EIC 6458B] (neotype, designated by Turner (2011b), K-W (barcode no. K000442828); isoneotypes: ?BM, ?K (barcode no. K000739195).

Uvaria velutina Roxb. ex Blume, Bijdr. (1825) 13, *non U. velutina* DC. in Dunal (1817). — *Uvaria hirsuta* Blume, Fl. Javae Anonac. (1830) 22, t. 5, *non U. hirsuta* Jack (1820), *nec U. hirsuta* Vell. (1829). TYPE: Java, West Java, Kuripan, *C.L. Blume s.n.* (holotype: L (sheet no. 898.63-384)).

Uvaria trichomalla Blume, Fl. Java. Anonac. (1830) 42, t. 18. TYPE: Java, West Java, Tjikao, *Kuhl & van Hasselt 1837* (holotype: L).

Guatteria pilosa Roxb. ex G. Don, Gen. Hist. 1 (1831) 100. — *Uvaria pilosa* (Roxb. ex G. Don) Roxb., Fl. Ind. 2 (1832) 665. TYPE: ?Moluccas, *W. Roxburgh s.n.* [EIC Herb. 6458A] (lectotype, designated by Veldkamp (2011), K-W (barcode no. K000442826)).

Large woody climber. Twigs pale grey-brown, latticed, covered with 1–3 mm long, more or less straight, red-brown hairs. Leaves characeous to subcoriaceous, upper surface slightly rough to the touch, pilose below, drying brown, grey-brown or blackish brown above, brown below, midrib and laterals more or less flush to the surface above, prominent beneath, lamina elliptic, oblong-elliptic, obovate or oblong obovate, 5–24 × 3–8 cm, apex shortly or bluntly acuminate but very tip often a distinct slender apiculus, base truncate, obtuse, rounded or auriculate, lateral veins 9–13 pairs, arching forward and looping obscurely within the margin, tertiary venation indistinct, particularly from above. Petiole 3–6 mm long, 1–3 mm thick. Inflorescences among leaves, supra-axillary, generally single-flowered. Flowering pedicel, 2–3 cm long, red-brown pilose, medial bract lanceolate 4–10 × 1.5–3 mm, red-brown pilose on both surfaces, denser

outside, petals dark red, ovate c. 10×8 mm, stamens many, carpels many. Fruiting pedicel to 2.5 cm long, 2 mm thick, monocarps to 8, globose, ellipsoidal or cylindrical, 2–5 cm long, c. 1.5 cm diameter, densely covered with red-brown hairs, stipe 2–3.5 cm long, c. 2 mm thick. Seeds 12 or more in 2 rows, with two flat faces and one convex, $6-8 \times 5 \times 4$ mm, drying brown, smooth.

Distribution. Burma, Thailand, Malay Peninsula, Java and Borneo. In Borneo from Sarawak.

Ecology. Lowland forest.

12. *Uvaria javana* Dunal
(of Java)

Monogr. Anonac. (1817) 91, pl. 14. Merr., Univ. Calif. Publ. Bot. 15 (1929) 62. Masamune, Enum. Phan. Born. (1942) 297. Sinclair, Gard. Bull. Singapore 14 (1955) 216. TYPE: Hab. in Java Lahaie (v.s.h. Deless.).

[*Uvaria ochroleuca* Zoll., Linnaea 29 (1858) 304, 307, *nom. inval.* (cf. ICBN Art. 34.1(b))]

?*Uvaria javana* var *blumei* Boerl., Cat. Pl. Phan. (1899) 13. TYPE: Java, cult. in Hort. Bot. Bogor. sub XI.A.44.

Uvaria larep auct. non Miq.:Merrill (1929: 62). Masamune (1942) 298.

Large woody climber. Twigs drying dark brown to black, smooth, longitudinally wrinkled or latticed, youngest parts covered in dense erect brown stellate pubescence. Leaves chartaceous to subcoriaceous, typically with a scabrous feel above, though some specimens are relatively smooth, drying grey-brown or grey above, brown or pale brown below with venation a darker shade, midrib very slightly sunken above in dry leaves, prominent below, lateral nerves more or less flush above slightly raised beneath, typically pubescent with a dense fringe of hairs on midrib above with scattered stellate hairs on upper lamina, below densely brown stellate hairy on nerves, lower lamina with dense pale stellate hairs giving a felty feel, otherwise pubescence relatively sparse, lamina elliptic, oblong-elliptic or obovate, $6-16.5 \times 3-9.5$ cm, base obtuse, truncate or rounded, apex (rarely emarginate) obtuse to shortly acuminate, lateral nerves 7–13 pairs, looping indistinctly within the margin; tertiary venation generally difficult to see unaided. Petiole 3–7 mm long, 1–3 mm thick, densely hairy. Inflorescences supra-axillary or on twigs behind leaves, single-flowered. Flowering pedicel 6–30 mm long, densely brown stellate hairy, medial bract ovate $3-4 \times 3$ mm, stellate hairy abaxially, glabrous adaxially, sepals triangular, c. 4×4 mm, apex obtuse to rounded, hairy outside, glabrous within, petals yellow, reflexing right back to pedicel

at anthesis, whorls similar, ovate-oblong $10\text{--}12 \times 5\text{--}6$ mm, apex obtuse, densely hairy on both surfaces, drying pale brown, stamens many $1.5\text{--}2$ mm long, connective apex tongue-like, carpels many, c. 2 mm long, hairy, stigma drying black. Fruiting pedicel $1.5\text{--}2$ cm long, $5\text{--}6$ mm thick, monocarps to 35 or more, ellipsoidal typically with slight concavity on one long side and convexity on the other, to 4.5×3 cm, drying brown with dense, very short pale brown tomentum, markedly rugulose particularly in immature fruit, apex rounded, stipe, typically shorter than seed-bearing portion of monocarp, $0.5\text{--}2$ cm long, c. 4 mm thick. Seeds many, in two rows, ellipsoidal, flattened, $10\text{--}12 \times 7\text{--}8 \times 4$ mm, dark brown, smooth, shiny.

Distribution. Malay Peninsula, Java and Borneo. In Borneo collected from Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

13. *Uvaria lanuginosa* Ridl.

(Latin, woolly, downy)

Bull. Misc. Inform. Kew 1912 (1912) 382. Ridley, Sarawak Mus. J. 1(3) (1913) 75. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 253. Masamune, Enum. Phan. Born. (1942) 298. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 23. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 99. TYPE: Borneo, Sarawak, near Kuching, 13 November 1894, *G.D. Haviland & C. Hose 3334*, 13 November 1894 (holotype, K (barcode no. K000380301); isotypes, BM, SAR).

Large woody climber. Leaves red-brown woolly floccose above and below when young, mature leaves coriaceous becoming glabrous above, very densely brown stellate hairy below, felty to the touch, ovate to obovate $7\text{--}13 \times 3\text{--}6$ cm, base rounded, apex acuminate. Inflorescence axillary, supra-axillary or below leaves on twigs, few flowered. Pedicels to 1.5 cm long, sepals, broadly triangular, 7×7 mm, apex blunt, petals yellow ovate, $10\text{--}15 \times 5\text{--}10$ mm, stamens many, carpels many. Fruits unknown.

Distribution. Endemic to Borneo. Collected from Brunei and Sarawak.

Ecology. Lowland forest.

14. *Uvaria littoralis* (Blume) Blume

(Latin, of the seashore)

Fl. Javae Anonac. (1830) 26. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 253. Merr., Univ. Calif. Publ. Bot. 15 (1929) 61. Masamune, Enum. Phan. Born. (1942) 298. — *Unona littoralis* Blume, Bijdr. (1825) 16. — *Uvaria gamopetala*

Zoll., *Linnaea* 29 (1858) 304, 310, *nom. superfl.* TYPE: in Bataviae locis stagnosis. Floret Febr. Martio.

[*Uvaria macrophylla* Roxb., Hort. Bengal. (1814) 43, *nom. nud.*]

Gutteria cordata Dunal, Monogr. Anonac. (1817) 129, t. 30. — *Uva cordata* (Dunal) Kuntze, Rev. Gen. Pl. 1 (1891) 8. — *Uvaria cordata* (Dunal) Alston, Handb. Fl. Ceylon 6(suppl.) (1931) 4, *non U. cordata* Schumach. & Thonn. (1827). Sinclair, Gard. Bull. Singapore 14 (1955) 207. TYPE: *Uvaria zeylanica* (herb. Deless.), Hab in Java (v.s.h. Deless.)

Uvaria ovalifolia Blume, Fl. Javae Anonaceae (1830) 27, tab. 8. Ridley, Sarawak Mus. J. 1(3) (1913) 75. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 253. Bygrave in Coode et al., Checkl. Fl. Pl. Gymnosp. Brunei (1996) 23. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 99. TYPE: van Hasselt cataractam Ramu prov. Bantam.

Uvaria macrophylla Roxb. ex Wall., Pl. As. Rariores 2 (1830) 22, pl. 122. TYPE: India, cultivated in Calcutta Botanic Garden, *N. Wallich s.n.* [EIC 6487A], lectotype, designated by Turner (2011b), K-W (barcode no. K000442833); isolectotypes: BM, CGE).

Uvaria rufescens A.DC., Mem. Soc. Phys. Genève, 5 (1832) 202. TYPE: Burma, Prome, 1826, *N. Wallich 130* [EIC 6487B] (lectotype, designated by Turner (2011a), K-W (barcode no. K000442832)).

Unona camphorata Blanco, Fl. Filip. (1837) 468. TYPE: Philippines, [Alabat Island, December 1916], *Anon. s.n.* [Merrill: Species Blancoanae No. 1057] (neotype, designated by Turner (2011b), K; isoneotypes: L, P, US (barcode no. 00688554)).

Uvaria sorzogonensis C. Presl, Rel. Haenk. 2 (1835) 76. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 157. TYPE: Philippines, Luzon, Sorzogon, *T.P.X. Haenke s.n.* (holotype: PR[×2] (sheet nos. 212920A and 212920B)).

?*Uvaria acrantha* Miq., Fl. Ned. Ind., Eerste Bijv. 3 (1861) 368. — *Uvaria ovalifolia* Blume var. *acrantha* (Miq.) Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 7. TYPE: Sumatra austr. in prov Lampongs prope Kebang, Teijsmann.

?*Uvaria macrophylla* var. *glabrior* Miq., Fl. Ned. Ind., Eerste Bijv. 3 (1861) 368. TYPE: Bangka, Teijsmann.

?*Uvaria ovalifolia* var. *borneensis* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 7. Kessler & van Heusden, Rheedea 3 (1993) 86. TYPE: Borneo australis Korthals.

?*Uvaria ovalifolia* var. *normalis* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 7.

Uvaria littoralis var. *miquelii* Boerl., Cat. Pl. Phan. (1899) 14, *nom. superfl.* TYPE: Java, Sumatra, Borneo

?*Uvaria ovalifolia* var. *racemiflora* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 7. Ridley, Sarawak Mus. J. 1(3) (1913) 75. TYPE: Borneo australis in regione fluminis Doessan, Korthals.

Magnolia fasciculata P. Parm., Bull. Sci. France Belg. 27 (1896) 204, 265. TYPE: India [probably wrongly localised], *s.dat.*, *T.S. Ralph s.n.* (lectotype, designated by Turner (2011b), P (barcode no. P00260050)).

Large woody climber. Twigs with very short brown hairs when young, becoming glabrous and darkening with age. Leaves chartaceous to subcoriaceous, stellate hairy along veins and lamina beneath when young, becoming glabrous except along midrib above, ovate to ovate lanceolate, 13–31 × 7–13 cm, base truncate to rounded, apex acute to acuminate. Petiole 3–13 mm long, 1–4 mm thick. Inflorescence terminal or supra-axillary, 3–4-flowered cymes. Pedicel 1.5–4 cm long, densely brown hairy, basal and medial bract 3 mm long, 5 mm wide, calyx connate forming a triangular cup, sepals c. 5 mm long, petals red or red-yellow, oblong to obovate, 10 mm long by 7 mm wide, inner whorl often slightly narrower, stamens many, often reduced to staminodes or even petaloid structures. Monocarps many, ripening orange, globose or ellipsoidal, c. 1 cm diameter, drying black or brown, glabrous, sometimes minutely beaked, stipe to 3 cm long. Seeds 1 to several, flattened on one or both faces, 7–8 × 5–6 × 4 mm, smooth, light brown, shiny.

Distribution. From Sri Lanka and India to New Guinea. In Borneo collected from Brunei, Kalimantan, Sabah and Sarawak. Much collected in Sabah.

Ecology. Lowland forest.

15. *Uvaria lobbiana* Hook.f. & Thomson

(Thomas Lobb, 1820–1894, British plant collector who collected widely in tropical Asia, including Borneo over the period 1845–1856)

Fl. Ind. 1 (1855) 100. Sinclair, Gard. Bull. Singapore 14 (1955) 208. Kessler & van Heusden, Rheedeia 3 (1993) 86. — *Uva lobbiana* (Hook.f. & Thomson) Kuntze, Rev. Gen. Pl. 1 (1891) 7. TYPE: Peninsular Malaysia, Malacca, 1845, *W. Griffith s.n.* (lectotype, designated by Turner (2011b), K (barcode no. K000380689)).

Uvaria subrepanda Wall. [Numer. List. (1832) no. 6483, *nom. nud.*] ex Hook.f. & Thomson, Fl. Ind. 1 (1855) 101. — *Uva subrepanda* (Wall. ex Hook.f. & Thomson) Kuntze, Rev. Gen. Pl. 1 (1891) 8. TYPE: Singapore, 1822, *N. Wallich s.n.* [EIC 6483] (lectotype, designated by Turner (2011b), K-W (IDC microfiche WA667/19) (barcode no. K00044825); isolectotype: CAL).

Uvaria psychocalyx Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 4. Ridley, Sarawak Mus. J. 1(3) (1913) 74. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 254. Masamune, Enum. Phan. Born. (1942) 298. — *Uva psychocalyx* (Miq.) Kuntze, Rev. Gen. Pl. 1 (1891) 8. TYPE: Borneo, Poeloe Lampei, *P.W. Kortniels s.n.* (lectotype, designated by Turner (2011b), L (barcode no. L0195619)).

Large woody climber. Twigs with tiny adpressed stellate hairs, becoming glabrous with age. Leaves generally glabrous, some adpressed stellate hairs along veins and midrib above, ovate, obovate to oblanceolate, 7–24 × 3–9 cm. Inflorescence subopposite leaves, one or a few flowered. Petiole 3–7 mm long, 1–3 mm thick. Pedicel 3–10 mm long, densely brown hairy, sepals broadly orbicular, 5–6 mm long, 7–10 mm wide, densely tomentose, petals red, broadly ovate to oblong, 10 × 9 mm, verruculose, densely pale tomentose, stamens many, carpels many. Monocarps very numerous (60 or more), globose or ellipsoidal, to 3 × 2 cm, drying muricate, stipe to 7 cm long. Seeds c. 5, generally with two flattened faces and one convex, c. 10 × 8 × 3–5 mm, drying brown, smooth.

Distribution. Burma, Thailand, Malay Peninsula, Sumatra and Borneo. In Borneo recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

16. *Uvaria micrantha* (A.DC.) Hook.f. & Thomson
(Greek, *micros* = small, *anthos* = flower)

Fl. Ind. (1855) 103. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 155. Masamune, Enum. Phan. Born. (1942) 298. — *Guatteria micrantha* A. DC., Mem. Soc. Phys. Genève 5 (1832) 218. — *Uva micrantha* (A. DC.) Kuntze, Rev. Gen. Pl. 1 (1891) 8. — *Cyathostemma micranthum* (A. DC.) J. Sinclair, Gard. Bull. Singapore, 14 (1955) 225. Utteridge, Blumea 45 (2000) 388. TYPE: Burma, Martaban, Amherst, 17 June 1827, *W. Gomez 15* [N. Wallich 1287, EIC 6449] (lectotype, designated by Utteridge (2000), K-W: islectotypes: BM, G).

Polyalthia triticans A. DC., Mem. Soc. Phys. Genève 5 (1832) 216. TYPE: Burma, Tavoy, 7 August 1827, *W. Gomez 49* [N. Wallich 1288, EIC 6430] (lectotype, designated by Turner (2011a), K-W: islectotypes: G (barcode no. G00237293)).

Anavagorea sumatrana Miq., Fl. Ned. Ind., Eerste Bijv. 3 (1861) 382. — *Uvaria sumatrana* (Miq.) Kurz, Rep. Veg. Andaman Isl., App. A (1870) 8. — *Uva sumatrana* (Miq.) Kuntze, Rev. Gen. Pl. 1 (1891) 8. — *Cyathostemma sumatranum* (Miq.) Boerl., Icon. Bogor. 1 (1899) 126, t. 58. TYPE: Sumatra, Lampongs, near Tegineneng, *J.E. Teijsmann s.n.* [Herb. Bogor. no. 4383] (holotype: L; isotypes: GH, K, U).

Popowia nitida King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61(2) (1892) 92. TYPE: Andaman Islands, South Andaman, Hobdaypur, 4 July 1891, *G. King s.n.* (lectotype, designated by Utteridge (2000), K (barcode no. K000739196); isolectotype: K (barcode no. K000739197)).

Large woody climber. Young twigs hairy, becoming glabrous with age. Leaves chartaceous to subcoriaceous, glabrous above except on midrib, sparsely hairy beneath, oblong elliptic, 5–14 × 2–4.5 cm, base cuneate to rounded, apex acute to acuminate. Petiole 2–3 mm long, c. 1 mm thick. Inflorescence subopposite leaves, 2-flowered. Pedicel 2–7 mm, pubescent, sepals broadly ovate 2.5 mm long, petals ovate, 4–5 × 3 mm, stamens many, carpels many. Monocarps to 25 or more, irregularly globose, 12–20 × 10 mm, glabrous, stipe 3–10 mm long, drying very slender c. 0.3 mm thick. Seeds 1–2, rather irregular in shape with 1 or 2 flat faces, c. 5 × 4 × 3 mm, drying brown, smooth.

Distribution. Widespread from Burma and the Andaman Islands to the north coast of Australia. In Borneo recorded from Sabah and Kalimantan.

Ecology. Lowland forest.

Notes. In fruit this species can be confused with *Sphaerocoryne affinis*, but the presence of stellate hairs will confirm whether a specimen is *Uvaria*

17. *Uvaria monticola* Miq.

(Latin, mountaineer)

Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 5. Ridley, Sarawak Mus. J. 1(3) (1913) 74. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 253. Masamune, Enum. Phan. Born. (1942) 298. TYPE: Borneo, Gunung Balaran, *P.W. Korthals s.n.* (holotype: L (barcode no. L 0038219)).

Uvaria scandens C.B. Rob., Bull. Torrey Bot. Club 35 (1908) 69. Merrill, Enum. Philipp. Fl. Pl. 2 (1923) 157. TYPE: Philippines, Mindanao, Prov. Davao, Santa Cruz, 5 May 1905, *R.S. Williams 2764* (holotype: NY (barcode no. 00059993); isotypes: NY, US).

Uvaria cauliflora Ridl., Bull. Misc. Inform. Kew 1912 (1912) 382. Ridley, Sarawak Mus. J. 1(3) (1913) 74. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 253. Masamune, Enum. Phan. Born. (1942) 297. Beaman et al., Pl. Mt. Kinabalu 4 (2001) 98. TYPE: Borneo, Sarawak, Tegora, *s.dat.*, *G.D. Haviland 417* [c.k.q.a.] [Garai leg.] (lectotype, designated by Turner (2012), K (barcode no. K000380300); isolectotype: K (barcode no. K000380298)).

Uvaria elmeri Merr., Univ. Calif. Publ. Bot. 15 (1929) 61. Masamune, Enum. Phan. Born. (1942) 297. Kessler & van Heusden, Rheedia 3 (1993) 85. TYPE: Borneo, Sabah, Tawao, October 1922–March 1923. *A.D.E. Elmer 20870* (lectotype, designated by Turner (2011b)). UC (sheet no. 289944); isolectotypes: A, BISH, BM, BO, C, CM, DS, GH, L, M, MICH, MO, NY, P, PH, S, SING, U, UC, US, Z).

Uvaria sp.: Merr., Univ. Calif. Publ. Bot. 15 (1929) 63.

Large woody climber. Twigs brown with tightly adpressed stellate hairs when young. Leaves with hairs along veins and midrib above, becoming glabrous with age, ovate to obovate or oblanceolate, 10–30 × 6–12 cm, base rounded to cuneate, apex acuminate. Petiole 2–11 mm long, 1–3 mm thick. Inflorescences mostly cauliflorous, multi-flowered fascicles or branching leafless twigs from near stem base. Pedicel to 6 cm long, 1 mm thick when dry, densely brown stellate hairy, medial bract c. 10 × 5 mm, flower buds c. 1 cm diameter, entirely enclosed within calyx, splitting irregularly during anthesis, petals yellow-green, membranous, oblong-ovate, 15 × 10 mm, densely brown hairy, reflexing with age, stamens many, carpels many. Monocarps to 25 or more, irregularly cylindrical, not strongly ridged, to 6 × 2 cm, apex rounded, drying brown becoming glabrous with age, rough to the touch, stipe to 2 cm. Seeds to 20 or more in 2 rows, roughly flattened semicircles, c. 13–15 × 7–10 × 3–5 mm, drying brown.

Distribution. Borneo and the Philippines. In Borneo widely collected from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

Notes. In probably the only published study of pollination in an annonaceous climber from Borneo, Nagamitsu & Inoue (1997) discovered that this species (as *Uvaria elmeri*) is mainly pollinated by cockroaches that visit the flowers to feed on stigmatic exudate and pollen.

18. *Uvaria schefferi* L.L.Zhou & al.

(R.H.C.C. Scheffer (1844–1880), Dutch botanist, Director of Buitenzorg Botanic Gardens)

Syst. Biodivers. 7 (2009) 255. — *Ellipeia coriacea* Scheff., Ann. Jard. Bot. Buitenzorg 2 (1885) 4. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 254. Masamune, Enum. Phan. Born. (1942) 283. TYPE: Borneo, pris de Montrado, *J.E. Teijsmann s.n.* [Herb. Bogor. 10842] (holotype: BO (sheet no. BO-1350684)).

Large woody climber. Twigs drying dark grey or black with very tightly adpressed brown stellate hairs (like tiny mites). Leaves chartaceous to coriaceous, drying

typically dark brown above, mid-brown below with darker midrib and veins, lamina below with uniform distribution of dark dots which are clumps of long stellate hairs set in dense covering of stellate scales, giving a rough feel to the leaf, some collections are glabrescent beneath, young leaves have a uniform but sparse scattering of very fine, pale hairs above, soon dropping, oblong elliptic to obovate, $4.5\text{--}30 \times 1.7\text{--}10$ cm, base cuneate to obtuse, apex acuminate, midrib sunken above, prominent beneath, lateral veins 10–20 pairs, looping distinctly within the margin. Petioles $6\text{--}16 \times 1\text{--}3$ mm. Inflorescences terminal or subopposite leaves, 1–several-flowered. Flower pedicels 5–8 mm (possibly longer), densely brown stellate hairy, sepals broadly ovate, 5×7 mm, densely brown adpressed stellate hairy outside, inside tomentum paler brown, outer petals, ovate, c. 3.5×2 cm, densely short brown stellate hairy except for glabrous minutely verrucose patch near base on inner surface, inner petals lanceolate c. 2.5×1 cm, densely short brown stellate hairy except near base adaxially, stamens many, c. 1.5 mm long, apex of connective truncate, flat, polygonous, carpels many, c. 1 mm long, drying black with brown stellate hairs. Fruiting pedicels 15–30 mm long, to 3 mm thick, monocarps 3–5, ovoid, $2.5\text{--}4 \times 2\text{--}3.5 \times 2$ cm, ripening orange, drying red-brown, scurfy, apiculus lateral, stipe to 3 cm long. Seeds 1, black shiny, shaped like an orange segment with a blunt end, $3 \times 2 \times 1.2$ cm, pale hilum at blunt end.

Distribution. Endemic to Borneo where it has been collected from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland and hill forest to 1800 m.

19. *Uvaria verrucosa* Scheff.

(Latin, warty)

Ann. Jard. Bot. Buitenzorg 2 (1885) 3. Ridley, Sarawak Mus. J. 1(3) (1913) 74. Merrill, J. Straits Branch Roy. Asiat. Soc. Spec. No. (1921) 254. Masamune, Enum. Phan. Born. (1942) 298. TYPE: Borneo, Soengei-aja (Kapoeas), *J.E. Teijsmann s.n.* [Herb. Bog. no. 8192] (holotype: BO (sheet no. BO-1455790)).

Large woody climber. Twigs drying dark brown or dark grey-brown, striate or latticed, younger parts with small adpressed brown stellate hairs (like small mites with many legs). Leaves chartaceous to subcoriaceous, drying dark brown to pale grey-brown above, brown to dark brown below, midrib slightly sunken above in dry leaves, prominent below, lateral veins more or less flush above, slightly raised below, laminae elliptic to obovate, $6\text{--}12.5 \times 2\text{--}4$ cm, base acute, obtuse or rounded, apex obtuse to acuminate, glabrous above except for hairs on midrib, below with a scattering of tiny stellate hairs, densest on midrib base and petiole, lateral veins c. 14 pairs, arching forward and looping within margin, tertiary venation reticulat, generally indistinct. Petiole 2–5 mm long, c. 1 mm thick. Inflorescence subopposite leaves, sometimes appearing terminal when located above the last mature leaf on a twig, 1–2-flowered.

Flowering pedicel 3–8 mm long, c. 1 mm thick, densely brown stellate hairy, basal bract ovate, c. 7 × 4 mm, apex acute, distinct central nerve, hairy on both surfaces, medial bract (1–2), membranous, ovate, c. 15 × 15 mm, apex obtuse, hairy on both surfaces, sepals thin, ovate, c. 10 × 8 mm, apex obtuse, hairy on both surfaces, outer petals lanceolate, c. 40 × 11 mm, apex blunt, densely brown hairy on both surfaces except for a rounded glabrous patch near the base internally, inner petals slightly narrower (c. 7 mm), margins reflex but the petals appear to remain erect at anthesis, stamens many, c. 1.5 mm long, apex domed, villose, papillate, carpels many. Fruiting pedicel 6–10 mm long, 2–3 mm thick, monocarps to 10 or more, sessile to subsessile (stipe 1–2 mm long), globose to ellipsoidal, c. 10–15 × 10–15 mm, distinct lateral apiculus, drying dark brown, muricate, tuberculate, densely covered with dark brown stellate hairs. Seeds 2.

Distribution. Endemic to Borneo. Recorded from Brunei, Kalimantan, Sabah and Sarawak.

Ecology. Lowland forest.

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References

- Appanah, S., Gentry, A.H. & LaFrankie, J.V. (1993) Liana diversity and species richness of Malaysian rain forests. *J. Trop. Forest Sci.* 6: 116–123.
- Attanayake, A.M.A.S., Turner, I.M. & Saunders, R.M.K. (2011) Two new species of *Uvaria* (Annonaceae) from Borneo, with a new nomenclatural combination. *Novon* 21: 161–168.
- Ban, N.T. (1974a) Critical notes on some species of the genus *Desmos* Lour. (Annonaceae). *Bot. Zhurn.* 59: 1766–1780.
- Ban, N.T. (1974b) Critical notes on the genera *Melodorum* Lour., *Mivella* Miq. and *Rauwenhoffia* Scheff. *Bot. Zhurn.* 59: 237–245.
- Bygrave, P.C. (2000) *Molecular systematics of the Annonaceae* Juss. Ph.D. thesis, University of Reading, UK.
- Chatrou, L.W., Pirie, M.D., Erkens, R.H.J., Couvreur, T.L.P., Neubig, K.M., Abbott, J.R., Mols, J.B., Maas, J.W., Saunders, R.M.K. & Chase, M.W. (2012) A new subfamilial and tribal classification of the pantropical flowering plant family Annonaceae informed by molecular phylogenetics. *Bot. J. Linn. Soc.* 169: 5–40.

- DeWalt, S.J., Ickes, K., Nilus, R., Harms, K.E. & Burslem, D.F.R.P. (2006) Liana habitat associations and community structure in a Bornean lowland tropical forest. *Pl. Ecol.* 186: 203–216.
- Gentry, A.H. (1991) The distribution and evolution of climbing plants. In: Putz, F.E. & Mooney, H.A. (eds) *The biology of vines*. Pp. 3–49. U.K., Cambridge: Cambridge University Press.
- Hutchinson, J. (1923) Contributions towards a phylogenetic classification of flowering plants. II. *Bull. Misc. Inform. Kew* 1923: 241–261.
- Irawan, B. (2005) Malesian species of *Fissistigma*. *Floribunda* 2(7): 173–189.
- Jessup, L.W. (2007) Annonaceae. In: Wilson, A.J.G. (ed) *Flora of Australia* 2: 18–57.
- Johnson, D.M. (2003). Phylogenetic significance of spiral and distichous architecture in the Annonaceae. *Syst. Bot.* 28: 503–511.
- Jongkind, C.C.H. & Hawthorne, W.D. (2005) A botanical synopsis of the lianas and other forest climbers. In: Bongers, F., Parren, M.P.E. & Traoré, D. (eds) *Forest climbing plants of West Africa: diversity, ecology and management* 19–39.
- Kessler, P.J.A. (1988) Revision der Gattung *Orophea* Blume (Annonaceae). *Blumea* 33: 1–80.
- Kessler, P.J.A. (1993) Annonaceae. In: Kubitzki, K., Rohwer, J.G. & Bittrich, V. (eds) *The families and genera of vascular plants* 2: 93–129.
- Merrill, E.D. (1919) On the application of the generic name *Melodorum* of Loureiro. *Philipp. J. Sci., C.* 15: 125–137.
- Nagamitsu, T. & Inoue, T. 1997. Cockroach pollination and breeding system of *Uvaria elmeri* (Annonaceae) in a lowland forest in Sarawak. *Amer. J. Bot.* 84: 208–213.
- Nurainas (2004) *Artabotrys* (Annonaceae) in Sumatra. *Floribunda* 2(5): 117–127.
- Putz, F.E. & Chai, P. (1987) Ecological studies of lianas in Lambir National Park, Sarawak, Malaysia. *J. Ecol.* 75: 523–531.
- Safford, W.E. (1912) *Desmos* the proper generic name for the so-called Unonas of the Old World. *Bull. Torrey Bot. Club* 39: 501–508.
- Sinclair, J. (1955) A revision of the Malayan Annonaceae. *Gard. Bull. Singapore* 14: 149–516.
- Turner, I.M. (2009a) *Artabotrys* (Annonaceae) in Borneo: new species and new synonyms. *Folia Malaysiana* 10: 59–88.
- Turner, I.M. (2009b) A new species and a new combination in *Friesodielsia* (Annonaceae) of Borneo. *Edinburgh J. Bot.* 66: 365–370.
- Turner, I.M. (2009c) New species and nomenclatural combinations in *Polyalthia*, *Meiogyne* and *Mitrella* (Annonaceae) from Borneo. *Malayan Nat. J.* 61: 267–276.
- Turner, I.M. (2010a) Novelties in the Annonaceae of Borneo: new species of *Artabotrys*, *Polyalthia* and *Pseuduvaria* and a new combination in *Desmos*. *Malayan Nat. J.* 62: 359–369.
- Turner, I.M. (2010b) *Richella* in Malesia re-visited. *Blumea* 55: 118–119.
- Turner, I.M. (2011a) Alphonse de Candolle's Mémoire sur la famille des Anonacées: date of publication and typification. *Phytotaxa* 32: 43–56.
- Turner, I.M. (2011b) A catalogue of the Annonaceae of Borneo. *Phytotaxa* 36: 1–120.
- Turner, I.M. (2012) The plant taxa of H.N. Ridley, 4. The primitive angiosperms (Austrobaileyales, Canellales, Chloranthales, Laurales, Magnoliales, Nymphaeales and Piperales). *Gard. Bull. Singapore* 64: 221–256.
- Utteridge, T.M.A. (2000) Revision of the genus *Cyathostemma* (Annonaceae). *Blumea* 45: 377–396.
- Veldkamp, J.F. (2011) The nomenclature of *Uvaria velutina* Roxb. ex Blume (Annonaceae). *Gard. Bull. Singapore* 62: 301–306.
- Wang, J., Chalermglin, P. & Saunders, R.M.K. (2009) The genus *Dasymaschalon* (Annonaceae) in Thailand. *Syst. Bot.* 34: 252–265.

- Zhou, L., Su, Y.C.F. & Saunders, R.M.K. (2009) Molecular phylogenetic support for a broader delimitation of *Uvaria* (Annonaceae), inclusive of *Anomianthus*, *Cyathostemma*, *Ellipeia*, *Ellipeiopsis* and *Rauwenhoffia*. *Syst. Biodivers.* 7: 249–258.
- Zhou, L., Su, Y.C.F., Chalermglin, P. & Saunders, R.M.K. (2010) Molecular phylogenetics of *Uvaria* (Annonaceae): relationships with *Balonga*, *Dasoclema* and Australian species of *Melodorum*. *Bot. J. Linn. Soc.* 163: 33–43.

Appendix. List of specimens examined.

Material was seen from the following herbaria: A, BM, BO, GH, K, KEP, L, SAR, SAN, SING.

- Abbe**, E.C.; 10267: *U. beccarii* (K); 12074: *P. prismatica* (A, K). **Abdul Rahim**; A343: *U. littoralis* (K, SING); A446: *A. suaveolens* (K, L, SING); A493: *Fiss. fulgens* (A, K, SING). **Abu Bakar**; 4241: *A. suaveolens* (K, SING). **Afriastani**, J.J.; 1200: *U. littoralis* (K). **Alston**, A.H.G.; 13100: *Fr. excisa* (BM). **Ambriansyah**; AA 647: *A. macropodus* (K, L). **Ambriansyah & Arbainsyah**; AA 145: *M. kentii* (K); AA 223: *Fiss. latifolium* (K); AA 279: *A. ochropetalus* (K, L); AA 284: *U. borneensis* (K); AA 286: *U. lobbiana* (K); AA 336: *M. clementis* (K); AA 486: *U. javana* (K); AA 648: *D. chinensis* (K); AA 724: *M. clementis* (K); AA 987: *U. argentea* (K); AA 1176: *D. chinensis* (K); AA 1272: *A. ochropetalus* (K, SAN); AA 1646: *D. dumosus* (K, L); AA 1660: *U. excelsa* (K); AA 1675: *Fiss. elmeri* (K, SAN); AA 1703: *M. clementis* (K); AA 1822: *D. dumosus* (K, SAN); AA 2132: *Fr. borneensis* (K). **Ambri[ansyah] & Arifin**; AA 337: *Fr. biglandulosa* (K, L); AA 338: *M. clementis* (K); AA 345: *U. lobbiana* (K); AA 349: *A. ochropetalus* (K, L); AA 474: *U. monticola* (K); AA 934: *U. littoralis* (K); W 344: *Fr. glauca* (L); W 705: *Fiss. manubriatum* (K); W 811: *U. littoralis* (K); W 815: *A. suaveolens* (K); W 871: *Fiss. manubriatum* (K); W 876 (K): *Fiss. manubriatum* (K); W 995: *U. monticola* (K). **Ambri et al.**; AA 1219: *A. suaveolens* (SAN); AA 1482: *U. littoralis* (K); AA 1498: *A. suaveolens* (SAN); AA 1590: *A. suaveolens* (L, SAN). **Amdjah**; 005: *A. suaveolens* (K); 50: *A. suaveolens* (K); 805: *A. suaveolens* (K); 865: *U. lobbiana* (K); 878: *D. acutus* (A, K, SING); 883: *Fr. korthalsiana* (L); 885: *A. suaveolens* (L); 914: *U. littoralis* (K). **Andau**, D.; 242: *U. grandiflora* (K); 270: *U. monticola* (K); 303: *A. suaveolens* (K, SAN); 590: *A. suaveolens* (K); 817: *U. littoralis* (K); 888: *U. littoralis* (K). **Anderson**, J.A.R.; 4024: *D. dumosus* (SAR); 4201: *Fiss. montanum* (K, L, SAN, SAR, SING); 8396: *D. chinensis* (K, SAR, SING); 8562: *M. dielsii* (K, SING); 9289: *P. prismatica* (K, SING); 9708: *M. dielsii* (K); 9730: *P. prismatica* (K, SING); 12532: *U. hirsuta* (K); 13285: *A. sarawakensis* (K, L). **Andrews**, S.; 737: *U. monticola* (K); 778: *A. costatus* (K). **Angian**; 7757: *D. chinensis* (K, SING); 10481: *U. littoralis* (L, SING). **Apostol**; 6743: *U. littoralis* (K, SING); 7688: *D. chinensis* (K, SING). **Arbainsyah**; AA 1851: *A. gracilis* (K); 1945: *U. excelsa* (K). **Argent**, G.; 93132: *P. prismatica* (K); 93163: *P. prismatica* (K); 94120: *U. schefferi* (K). **Argent, G. & Ruskani**; 5013: *A. ochropetalus* (A, K). **Argent, G. & Saridan**, A.; 9326: *Fr. affinis* (K, L); 9376: *A. ochropetalus* (K, L, SAN); 9390: *U. verrucosa* (K). **Argent, G. et al.**; 93123: *A. ochropetalus* (K, L, SAN). **Arifin, Z. & Ambriansyah**; B 1539: *Fiss. elmeri* (K, SAN). **Arifin, Z. & Arbainsyah**; B 1344: *A. polygynus* (L). **Arifin & Insyah**; AA 1049: *A. suaveolens* (L, SAN). **Arifin et al.**; AA 1106: *A. suaveolens* (SAN); AA 1697: *U. grandiflora* (K). **Arsat**; 1064: *U. littoralis* (A); 1336: *U. littoralis* (K). **Azmi**, R.; RA 389: *S. affinis* (L).

Bakia, K.; 299: *U. littoralis* (K). **Balajadia, D.**; 3810: *U. excelsa* (K); 3749: *U. littoralis* (K). **Barber, E.**; 127: *U. borneensis* (K); 376: *D. dunalii* (K). **Bartlett, E.**; sn(1893): *A. maingayi* (BM); sn: *Fiss. manubriatum* (BM); sn: *A. gracilis* (BM). **Bayak**; 2117: *U. littoralis* (K). **Beaman, J.H.**; 520: *U. excelsa* (K); 7103: *A. suaveolens* (K); 7178: *A. suaveolens* (K); 7831: *U. littoralis* (K); 9306: *U. littoralis* (K); 11017: *A. roseus* (K); 11834: *Fiss. crassicaule* (K); 11983: *A. suaveolens* (K); 12406: *U. borneensis* (K). **Beccari, O.**; P.B. 232: *Fr. affinis* (K); P.B. 318: *U. cuneifolia* (BO, K); P.B. 381: *A. maingayi* (K); P.B. 393: *P. prismatica* (K); P.B. 554: *A. roseus* (K); P.B. 713: *A. maingayi* (K); P.B. 802: *Fr. grandifolia* (K); P.B. 1041: *Fiss. rugosum* (K); P.B. 1107: *Fr. grandifolia* (K); P.B. 1112: *Fr. biglandulosa* (BM, K); P.B. 1120: *U. monticola* (K); P.B. 1410: *Fiss. rugosum* (K); P.B. 1648: *U. beccarii* (K); P.B. 1760: *U. littoralis* (K); P.B. 1811: *U. clementis* (K); P.B. 2268: *M. kentii* (K); P.B. 2911: *Fr. glauca* (K); P.B. 3190: *A. gracilis* (K); P.B. 3420: *D. acutus* (K); P.B. 3571: *Fr. affinis* (K); P.B. 3740: *M. kentii* (K); P.B. 3742: *Fr. glauca?* (K); P.B. 3748: *A. suaveolens* (K); P.B. 3789: *Fiss. multivenium* (K); P.B. 3899: *M. dielsii* (K); P.B. 3945: *D. acutus* (K); P.B. 3976: *U. cuneifolia* (K). **Bernstein, J.H.**; JHB 520: *U. excelsa* (K). **Brooke, W.M.A.**; 8740: *Fiss. latifolium* (K); 10678: *F. rugosum* (BM, L). **BRUN Series**; BRUN 1: *Fr. glauca* (K); BRUN 546: *Fr. borneensis* (K); BRUN 569: *D. dunalii* (K, SAR); BRUN 606: *U. excelsa* (K); BRUN 2343: *Fiss. montanum* (K, L); BRUN 5209: *A. hirtipes* (K, L); BRUN 5517: *Fr. biglandulosa* (K, L); BRUN 5902: *Fr. biglandulosa* (K); BRUN 15028: *U. excelsa* (SAR); BRUN 15251: *A. suaveolens* (L, SAN); BRUN 15253: *A. maingayi* (K, L, SAN); BRUN 15350: *U. lobbiana* (K, SAR); BRUN 15462: *U. excelsa* (K); BRUN 15501: *U. monticola* (K, SAN, SAR); BRUN 15504: *Fr. glauca* (K, SAN); BRUN 15578: *Fiss. fulgens* (K, SAN, SAR); BRUN 16219: *D. dumosus* (K); BRUN 16270: *U. littoralis* (K, SAN); BRUN 16422: *U. excelsa* (SAN); BRUN 16423: *Fr. excelsa* (K, SAN); BRUN 16430: *A. polygynus* (L, SAN); BRUN 16431: *A. suaveolens* (SAN); BRUN 16521: *U. littoralis* (SAN); BRUN 16633: *P. prismatica* (K SAN); BRUN 16644: *M. clementis* (K, SAN); BRUN 16710: *A. sarawakensis* (K, L); BRUN 16924: *A. suaveolens* (L, SAN); BRUN 16988: *M. kentii* (K, SAN); BRUN 17078: *M. kentii* (K, SAN); BRUN 17310: *U. excelsa* (K); BRUN 17542: *Fiss. rugosum* (SAN); BRUN 17526: *U. monticola* (K); BRUN 17762: *A. ochropetalus* (K); BRUN 115410: *P. prismatica?* (K). **Burley, J.S. & Lee, B.**; 272: *A. costatus* (A, K, L, SAN, SING); 347: *Fr. glauca* (K, SING). **Burley, J.S. et al.**; 731: *Fiss. elmeri* (K, L, SAR, SING); 830: *Fiss. kingii* (K, SAR, SING); 832: *Fr. formosa* (K, L, SAR, SING); 2713: *A. hirtipes* (K, L); 3288: *A. hirtipes* (K, L); 3321: *Fiss. rugosum* (K, SING). **Buwalda, P.**; 7839: *A. roseus* (A, K, L).

Campbell, E.J.F.; EG152: *A. ochropetalus* (L); EG228: *Fr. biglandulosa* (SAN). **Castillo, M.**; 635: *U. monticola* (K). **Chew, W.L.**; CWL 125: *U. monticola* (K, SAN, SING); CWL 297: *Fr. excisa* (K, L SAR, SING); CWL 608: *U. lobbiana* (K, SING); CWL 684: *U. lobbiana* (SAR); CWL 1366: *M. kentii* (K, SING). **Chew, W.L. et al.**; 1846: *Fiss. montanum* (K, SAN, SING). **Church, A.C. et al.**; 482: *A. gracilis* (L, SING); 483: *A. gracilis* (L SING); 612: *D. dumosus* (K, SAR, SING); 661: *U. monticola* (K, SAR, SING); 774: *Fr. affinis* (A, K, SING); 818: *Fr. cf. ovalifolia* (A, BO); 821: *U. clementis* (A, SING); 860: *Fr. formosa* (A, BO, SING); 969: *Fr. formosa* (A, BO, K, SING); 983: *Fiss. kingii* (K, SAR, SING); 1062: *Fr. formosa* (A, BO, SING); 1067: *Fr. formosa* (A, BO, K, SING); 1210: *A. suaveolens* (SING); 1244: *A. hirtipes* (A, L); 1275: *A. gracilis* (L, SING); 1740: *A. hirtipes* (A, K, L, SAN); 2671: *Fiss. manubriatum* (L); 2701: *Fiss. elmeri* (A, K, L). **Clemens, J. & Clemens, M.S.**; 3766: *Fr. korthalsiana* (BM, K); 20150: *Fiss. elmeri*

(A, BM, K, SAR); 20347: *U. lobbiana* (SAR); 20925: *A. suaveolens* (A, L); 21113: *Fr. biglandulosa* (A, K); 21270: *U. sp.* (A); 21276: *Fr. glauca* (A, SAR); 21341: *U. argentea* (A, K, SING); 26008: *U. monticola* (K); 26205: *Fr. korthalsiana* (K, L); 26286: *Fiss. kinabaluense* (A, K, L); 26377: *Fr. biglandulosa* (BM, K); 26407: *Fiss. kinabaluense* (K); 26424: *A. polygynus* (K, L); 26431: *U. schefferi* (K); 26541: *U. clementis* (K); 26620: *A. costatus* (A, K, L); 26701: *A. costatus* (A, K, L); 26811: *Fiss. kinabaluense* (K); 26829: *Fr. biglandulosa* (BM, K, L); 26831: *Fr. biglandulosa* (BM, L); 26877: *D. acutus* (K); 26891bis: *Fiss. kinabaluense* (K); 27436: *Fr. biglandulosa* (BM); 27439: *Fiss. latifolium* (K); 27447: *Fiss. kinabaluense* (K); 28127: *Fiss. montanum* (K); 28328: *Fiss. latifolium* (K); 28435: *A. polygynus* (SING); 28489: *Fiss. latifolium* (K); 28674: *A. kinabaluensis* (SING); 28697: *A. kinabaluensis* (A, BM, K, L, SING); 28764: *A. kinabaluensis* (A, BM, BO, K, SING); 29306: *Fiss. latifolium* (BM); 29341: *A. kinabaluensis* (BM); 29342: *A. costatus* (K, L); 30351: *A. kinabaluensis* (A, K, L); 30367: *Fiss. kinabaluense* (K); 30368: *Fiss. kinabaluense* (K); 30534: *Fr. korthalsiana* (BM); 30651: *Fr. korthalsiana* (A); 30866: *Fr. korthalsiana* (A, K); 31616: *U. sp.* (A, BM, K); 31652: *Fiss. latifolium?* (A, L); 32448: *Fiss. montanum* (K); 33978: *Fiss. montanum* (A, BM); 34022: *Fr. korthalsiana* (A, K, L); 40326: *A. polygynus* (K); 40422: *Fiss. carrii* (A, K, L); 40491: *U. schefferi* (K); 40584: *Fiss. kingii* (K); 40731: *Fr. biglandulosa* (BM, K); 40781: *Fiss. latifolium* (Kinabalu form) (L); 40874: *A. kinabaluensis* (BM); 50348: *A. kinabaluensis* (BM); 50373: *A. polygynus* (A, L); 50379: *A. veldkampii* (A, K); 50469: *A. polygynus* (K, L); 51035: *A. polygynus* (K); 51310: *Fiss. elmeri* (A, BM, K); 51624: *Fiss. elmeri* (A, BM, K). **Clemens, M.S.**; 9670: *U. clementis* (A); 9776: *M. clementis* (A, K); 9783: *U. littoralis* (A); 11158: *A. suaveolens* (K); 11097: *Fr. glauca* (A). **Coode, M.J.E.**; 6353: *A. gracilis* (K); 6444: *U. littoralis* (K, SAN); 6477: *Fiss. fulgens* (K, SAR, SAN); 6758: *U. excelsa* (K); 6770: *A. maingayi* (K, L, SAN); 6981: *U. littoralis* (SAN); 7119: *U. lanuginosa* (K, SAN); 7353: *M. dielsii* (K); 7661: *U. excelsa* (K).

Creagh, C.V.; sn(4/1895): *U. grandiflora* (K); sn(4/1894): *U. littoralis* (K); sn(19/4/1895): *D. chinensis* (K); sn(4/1895): *D. dumosus* (K); sn(4/1895): *Fiss. fulgens* (K). **Cuadra, A.**; A 1151: *A. suaveolens* (K).

Darnton, S.; 100: *U. littoralis* (A). **de Jong, W.**; 723: *P. prismatica* (L). **de Vriese, W.H.**; s.n. (L0484299): *U. cuneifolia* (L); s.n. (L0484297): *U. cuneifolia* (L). **Dilmy, A.**; 1034: *U. griffithii* (L). **Dransfield, J.**; 6284: *U. littoralis* (K); 7154: *Fiss. paniculatum* (K, SAR); 7284: *M. kentii* (K, SAN); 7320: *D. dumosus* (K, SAN, SAR); 7346: *A. suaveolens* (SAN); 7383: *Fiss. kingii* (K, SAR); 7439: *A. suaveolens* (SAN); 7447: *A. suaveolens* (SAN).

Elmer, A.D.E.; 20117: *U. littoralis* (K, SING); 20118: *A. hirtipes* (K, SING); 20138: *A. suaveolens* (K, SING); 20196: *U. littoralis* (K, SING); 20197: *Fr. grandifolia* (BM, K, SING); 20318: *Fiss. fulgens* (K, SING); 20338: *M. clementis* (K); 20407: *Fr. borneensis* (BM, K, SING); 20418: *Fr. grandifolia* (BM, K, SING); 20489: *A. hirtipes* (K, SING); 20516: *Fiss. latifolium* (K, SING); 20525: *D. dumosus* (K); 20604: *U. littoralis* (K, SING); 20732: *U. javana* (K, SING); 20802: *Fr. borneensis* (BM, K, SING); 20814: *Fiss. latifolium* (K, SING); 20857: *U. javana* (SING); 20870: *U. monticola* (K, SING); 20879: *Fr. grandifolia* (BM, K, SING); 20881: *Fiss. elmeri* (K); 21081: *U. excelsa* (K, SING); 21090: *U. concava* (K, SING); 21103: *Fr. glauca?* (K, SING); 21167: *Fr. borneensis* (BM, K, SING); 21181: *Fr. grandifolia* (BM, SING); 21197: *A. ochropetalus* (K, L, SING); 21211: *U. borneensis* (K, SING); 21300: *Fiss. paniculatum* (A, BM, K, SING);

21663: *A. ochropetalus* (K, L, SING); 21689: *Fr. biglandulosa* (BM, K, SING); 21721: *U. monticola* (K, SING). **Endert, F.**; 1551: *U. excelsa* (K); 1610: *Fiss. fulgens* (K); 1935: *Fiss. fulgens* (K); 2234: *U. griffithii* (K); 2244: *M. kentii* (K); 2333: *U. lobbiana* (A, BO, K); 2423: *Fiss. kingii* (K); 2511: *A. polygynus* (A); 2513: *U. littoralis* (K); 2715: *Fr. korthalsiana* (A); 3299: *Fiss. kingii* (A, K); 3312: *M. kentii* (K, SING); 3430: *A. ochropetalus* (K, L); 3904: *Fiss. sp.* (L); 4471: *A. hirtipes* (K); 4793: *A. veldkampii* (K, L); 4836: *M. kentii* (K); 5035: *Fiss. multivenium* (K); 5169: *U. grandiflora* (K). **Enggoh**; 10205: *A. suaveolens* (SING).

Fabia, M.P.; A3060: *Fr. glauca* (K, SING). **Forman, L.L.**; 479: *M. kentii* (K, SING); 997: *U. littoralis* (K, SAN); 1149: *Fr. glauca* (K); 1151: *U. littoralis* (SAN). **Fraser, M.**; 168: *U. littoralis* (K); 185: *U. littoralis* (K). **Frodin, D. & Ismawi**; 2049: *A. suaveolens* (K).

Geesink, R.; 9220: *A. atractocarpus* (L). **Geh, S.Y.**; GSY 309: *Fiss. latifolium* (SING). **Gibbs, L.S.**; 2580: *A. suaveolens* (K). **Giesen, W.**; 137: *A. suaveolens* (L). **Goklin, T.**; 2091: *D. chinensis* (K); 2094: *Fiss. fulgens* (K); 2341: *D. chinensis* (K); 2544: *Fiss. fulgens* (K); 2727: *U. littoralis* (K). **Goverse, E. & Adriansyah**; Berau 446: *M. kentii* (K). **Gregson, J.**; 72: *A. ochropetalus* (SAN); 100: *U. littoralis* (SAN); 137: *U. littoralis* (SAN); Gregson, J. & Bernardus Bala Ola; 72: *A. ochropetalus* (K, SAN).

Haegens, R.M.A.P. & Klazenga, N.; 438: *A. atractocarpus* (K, L, SAR). **Haegens, R.M.A.P. et al.**; 445: *Fiss. kingii* (K). **Hallier, H.**; 815: *M. kentii* (K); 1018: *U. littoralis* (SING); 1080: *A. suaveolens* (K); 3023: *A. hirtipes* (L). **Haviland, G.D.**; 3: *A. gracilis* (K, SING); 403: *U. monticola* (K); 411: *Fiss. manubriatum* (K); 416: *Fiss. fulgens* (K, SING); 417: *U. monticola* (K); 421: *P. prismatica* (K); 422: *U. borneensis* (K); 540: *U. monticola* (SAR); 849: *Fiss. latifolium* (K, SAR, SING); 877: *Fiss. rugosum* (K); 1021: *Fiss. manubriatum* (SAR); 1310: *Fiss. kinabaluense* (K, SING); 1504: *U. cuneifolia* (BO, K, SAR, SING); 1518: *A. suaveolens* in part (K); 1540: *A. suaveolens* (K); 1750: *A. costatus* (K, SING); 1775: *A. pandanicarpus* (K); 1831: *Fr. grandifolia* (K, SING); 1845: *Fiss. paniculatum* (K, SING); 1845bis: *Fiss. paniculatum* (K); 1968: *U. excelsa* (K, SING); 2102: *Fiss. longipetalum* (BM, K); 2103: *Fr. excisa* (K); 2106: *A. hirtipes* (K, SING); 2212: *Fiss. manubriatum* (SAR); 2213: *Fr. excisa* (BM, SING); 2216: *Fr. excisa* (BM, K, L, SING); 2250: *U. clementis* (A, K, SING); 2315: *U. littoralis* (K); 2325: *U. littoralis* (K); 2326: *A. hirtipes* (K); 2333: *Fr. glauca* (BM, K); 3152: *Fr. glauca* (BM, K, SAR); 3334: *U. lanuginosa* (K); 3336: *Fiss. kingii* (BM, K, SAR, SING); b.y.l.a.: *Fiss. rugosum* (K); b.z.d.d.: *A. gracilis* (K); sn(14/3/1893): *A. suaveolens* (K); sn(3/1893): *Fiss. fulgens* (K); sn(9/1892): *A. suaveolens* (K); sn(9/1892): *U. cuneifolia* (K); sn(12/10/1894): *A. roseus* (BO); sn: *P. prismatica* (BM, K). **Haviland, G.D. & Hose, C.**; 3: *A. gracilis* (K); 1629 (26/10/1894): *A. maingayi* (BM, L); 1629 (13/11/1894): *A. maingayi* (K); 1629E (L0180470): *A. polygynus* (L); 2106: *A. hirtipes* (K); 3141: *Fr. ovalifolia* (K, SAR, SING); 3151: *Fr. ovalifolia* (K); 3160: *A. sarawakensis* (K); 3334: *U. lanuginosa* (SAR, SING); 3335: *Fr. glauca* (BM, K, SAR); 3339: *A. suaveolens* (K, SAR); 3340: *A. roseus* (K, SAR); sn (4/12/1894): *A. gracilis* (K). **Hewitt, J.**; 40: *Fiss. fulgens* (SAR); 164: *Fr. ovalifolia* (SAR); 200: *P. prismatica* (K); 209: *Fr. borneensis* (SAR); 347: *Fr. borneensis* (SAR); 348: *Fiss. kingii* (SAR); 538: *Fiss. kingii* (SAR); 912: *Fr. borneensis* (SAR); A.7.13: *Fr. ovalifolia* (SAR); A.12.16: *Fiss. fulgens* (SAR). **Hose, C.**; 83: *U. littoralis* (K); 112: *U. littoralis* (K); 160: *A. sarawakensis* (BM, K); 180: *U. littoralis* (K); 302: *A. sarawakensis* (BM, K); 397: *Fiss. kingii* (A, BM, K); 601: *U. borneensis* (K); 635: *Fiss. fulgens* (K). **Hotta, M.**; 12677: *A. roseus* (L); 12737: *A. roseus* (L).

ITTO/BB 0148: *U. monticola* (SAR).

- Jacobs, M.:** 5138: *U. monticola* (K, SAR); 5234: *Fiss. kingii* (K, SAR, SING); 5362: *Fr. biglandulosa* (K, L, SAR); 5407: *A. polygynus* (L, SING); 5481: *A. suaveolens* (K). **Jaheri:** 320: *A. lanuginosus* (BO). **Jarvie, J.K. & Ruskandi, A.:** 5013: *A. ochropetalus* (A, L, SAN); 5293: *A. roseus* (A, K, L); 5312: *A. veldkampii* (A, L); 5314: *U. excelsa* (A); 5319: *M. kentii* (A, K); 5322: *P. prismatica* (A, K, L); 5730: *A. polygynus* (A, L); 6008: *A. veldkampii* (A, L).
- Kadir, A.:** 2073: *Fiss. kingii* (K, SING). **Kadir, A. & Enggoh:** 10348: *Fr. korthalsiana* (K, SING). **Kalat, A.:** ARK 26: *U. lobbiana* (K); ARK 104: *U. excelsa* (K, SAN, SAR). **Kandilis:** 6245: *A. suaveolens* (A, K, L, SING). **Kartawinata, K.:** 919: *Fr. grandifolia* (K). **Kato, M. et al.:** 20643: *M. clementis* (A); 20731: *U. lobbiana* (A); 23423: *A. suaveolens* (A); 23425: *D. acutus* (BM). **KEP series:** KEP 80018: *Fiss. latifolium* (K, SING). **Kessler, P.J.A.:** PK 287: *A. roseus* (L); 548: *A. ochropetalus* (L); PK 598: *A. ochropetalus* (K, L). **Kessler, P.J.A. et al.:** PK 353: *U. littoralis* (K); PK 617: *Fr. biglandulosa* (L); PK 625: *Fr. borneensis* (L); PK 648: *U. littoralis* (K); PK 819: *U. javana* (K); PK 833: *U. javana* (K); PK 868: *U. javana* (K); PK 890: *A. suaveolens* (K); PK 904: *A. suaveolens* (SAN); PK 908: *M. clementis* (K); PK 914: *U. borneensis* (K); PK 946: *U. borneensis* (K); PK 955: *Fiss. manubriatum* (L); PK 958: *M. clementis* (SAN); PK 993: *A. ochropetalus* (K, L, SAN); PK 997: *A. ochropetalus* (K, L, SAN); PK 1009: *M. clementis* (K, SAN); PK 1040: *M. clementis* (L); PK 1044: *D. chinensis* (K); PK 1046: *Fr. borneensis* (K, L, SAN); PK 1047: *Fr. glauca* (K); PK 1058: *A. ochropetalus* (K, L, SAN); PK 1063: *Fiss. kingii* (K); PK 1074: *Fiss. manubriatum* (K); PK 1103: *U. littoralis* (SAN); PK 1141: *U. grandiflora* (SAN); PK 1157: *M. clementis* (K, SAN); PK 1160: *U. littoralis* (SAN); PK 1170: *U. grandiflora* (K, SAN); PK 1176: *D. chinensis* (K, SAN); PK 1180: *U. micrantha* (K, SAN); PK 1188: *U. javana* (K); PK 1200: *Fiss. multivenium* (K, SAN); PK 1211: *A. suaveolens* (SAN); PK 1213: *U. grandiflora* (K); PK 1224: *U. lobbiana* (K); PK 1228: *M. clementis* (K, SAN); PK 1229: *A. suaveolens* (L, SAN); PK 1342: *A. suaveolens* (SAN); PK 1358: *U. grandiflora* (K); PK 1362: *M. clementis* (K, SAN); PK 1364: *A. suaveolens* (SAN); PK 1369: *U. grandiflora* (K); PK 1374: *A. suaveolens* (SAN); PK 1410: *P. prismatica* (K, SAN); PK 1434: *A. suaveolens* (L, SAN); PK 1441: *Fr. borneensis* (K, SAN); PK 1454: *Fiss. manubriatum* (SAN); PK 1457: *D. dumosus* (K, SAN); PK 1745: *A. suaveolens* (L); PK 1746: *U. littoralis* (K, SAN); PK 1757: *D. chinensis* (K); PK 1855: *M. clementis* (K); PK 1867: *U. littoralis* (K); PK 1922: *A. suaveolens* (L); PK 1928: *A. suaveolens* (L); PK 2018: *Fr. borneensis* (K, SAN); PK 2099: *Fiss. manubriatum* (L); PK 2293: *Fr. excisa* (K, SAN); PK 2312: *M. clementis* (K); PK 2314: *U. excelsa* (SAN); PK 2361: *M. clementis* (K); PK 2362: *A. suaveolens* (SAN); PK 2384: *D. chinensis* (K, SAN, SAR); PK 2425: *A. suaveolens* (L); PK 2621: *Fr. affinis* (BO, K, L, SAN, SAR); PK 2728: *A. gracilis* (K); PK 2740: *M. clementis* (K); PK 2799: *M. clementis* (K); Berau 20: *M. clementis* (K, SAN); Berau 133: *A. lanuginosus* (K, SAN); Berau 241: *U. littoralis* (K); Berau 254: *A. suaveolens* (L); Berau 276 (K): *U. javana* (L); Berau 446: *M. kentii* (SAN); Berau 867: *A. polygynus* (BO, K, L, SAN); Berau 1384: *Fiss. manubriatum* (SAN); Berau 1436: *U. littoralis* (K, SAN); W 898: *Fiss. kingii* (K). **Keith, H.G.:** 3102: *U. monticola* (K). **Kirkup, D.W.:** 330: *A. lanuginosus* (K, L, SAN); 674: *A. hirtipes* (K); 825: *U. littoralis* (K). **KL series:** KL 3598: *U. monticola* (K); KL 3600: *U. monticola* (SING); KL 3602: *Fiss. kingii* (K); KL 3616: *U. lobbiana* (SING). **Kokawa, S.:** 6336: *U. littoralis* (SAN); 6345: *A. suaveolens* (L, SAN); 6347: *U. littoralis* (SAN). **Kokawa, S. & Hotta, M.:**

435: *U. curvistipitata* (SAN); 2605: *D. chinensis* (SAN); 2751: *A. suaveolens* (L, SAN). **Korthals**, P.W.; sn: *D. chinensis* (K); sn(9/1864): *D. dumosus* (K); sn (L0182331): *Fr. korthalsiana* (L); sn (L0182332): *Fr. korthalsiana* (L); sn (L0037935): *Fr. borneensis* (L); sn (L0037936): *Fr. borneensis* (L); sn (L0037937): *Fr. borneensis* (L); sn (L0037938): *Fr. borneensis* (L); sn (L0187212): *Fr. borneensis* (L); sn (L0187213): *Fr. borneensis* (L); sn (L0182284): *Fr. glauca* (L); sn (L0182285): *Fr. glauca* (L); sn (L0182286): *Fr. glauca* (L); sn: *U. argentea* (L); sn (L0180796): *A. sumatranus* (L); sn (L0180797): *A. sumatranus* (L); sn (L0180798): *A. sumatranus* (L); sn (L0187136): *Fr. biglandulosa* (L); sn (L0187137): *Fr. biglandulosa* (L); sn (L0182243): *Fr. biglandulosa* (L); sn (L0182244): *Fr. biglandulosa* (L); sn (L0187138): *Fr. biglandulosa* (L); sn (L0182262): *Fr. ovalifolia?* (L); sn (L0182131): *Fiss. manubriatum* (L); sn (L0182132): *Fiss. manubriatum* (L); sn (L0182133): *Fiss. manubriatum* (L); sn (L0182134): *Fiss. manubriatum* (L); sn (L0187006): *Fiss. manubriatum* (L); sn (L0187007): *Fiss. manubriatum* (L); sn (L0187009): *Fiss. manubriatum* (L); sn (L0186729): *Fiss. latifolium* (L); sn (L0186730): *Fiss. latifolium* (L); sn (L0186731): *Fiss. latifolium* (L); sn (L0187083): *P. prismatica* (L). **Kramadibrata**, K.; 142: *M. clementis* (K). **Kostermans**, A.J.G.H.; 4266: *A. ochropetalus* (K, L); 4272: *A. suaveolens* (SING); 4354: *A. ochropetalus* (K, L); 4375: *A. ochropetalus* (K, L, SING); 4452: *M. kentii* (K); 4508: *U. borneensis* (K); 4665: *D. acutus* (K, SING); 4666: *U. concava* (A, SING); 4733: *U. excelsa* (K, SING); 4919: *U. lobbiana* (A, K, SING); 5001: *A. suaveolens* (SING); 5176: *M. kentii* (K); 5497: *Fr. affinis* (K, L, SING); 5710: *Fiss. multivenium* (L); 5793: *U. monticola* (A, K, SING); 5924: *Fr. formosa* (BO, K); 5975: *Fr. formosa* (BO, K, SING); 6412: *P. prismatica* (K); 6820: *A. sumatranus* (BM, K); 6909: *A. suaveolens* (SING); 6961: *U. grandiflora* (A, K, SING); 6963: *U. monticola* (K); 7107: *Fiss. manubriatum* (K); 7965: *Fiss. manubriatum* (K); 8017: *M. dielsii* (K); 8034: *M. kentii* (K); 8648: *M. clementis* (K, SING); 8788: *Fiss. kingii* (K, SING); 8801: *U. monticola* (L); 9180: *P. prismatica* (K, L, SING); 9577: *A. ochropetalus* (K, L, SING); 9675: *Fr. excisa* (K, SING); 9800: *P. prismatica* (K); 9921: *Fiss. kingii* (K); 10165: *A. suaveolens* (SING); 10172A: *M. kentii* (K); 10495: *U. monticola* (K, SING); 10562: *A. gracilis* (L, SING); 10594: *Fiss. kingii* (K); 10764: *M. kentii* (L); 12620: *Fiss. kingii* (L); 13473: *A. veldkampii* (K, L); 13732: *A. ochropetalus* (K, L, SING); 13905: *Fiss. elmeri* (K, SING); 21245: *U. monticola* (K); 21257: *D. chinensis* (K, SING); 21280: *D. chinensis* (K, SING); 21657: *M. kentii* (K); 21682: *U. lobbiana* (K); 21683: *M. kentii* (K); 82017: *P. prismatica?* (K).

Laman, T.; TL 225: *U. monticola* (A); TL 263: *M. kentii* (K); TL 274: *M. kentii* (K); TL 877: *U. monticola* (A, K); TL 951: *Fiss. fulgens* (A); TL 971: *Fr. biglandulosa* (K); TL 996: *U. monticola* (A); TL 1223: *Fr. borneensis* (A, K, L); TL 1237: *U. monticola* (A); TL 1246: *A. ochropetalus* (K, L); TL 1299: *Fr. excisa* (A, K); TL 1413: *Fiss. fulgens* (L); TL 1763: *Fiss. multivenium* (K). **Lamb**, A.; 305: *U. littoralis* (SAN); ALFB 111/87: *U. grandiflora* (K). **Latupeirissa**, E.R.; 95012: *Fiss. latifolium* (L, SAN). **Leeuwenberg**, A.J.M. & **Rudjiman**; 13048: *Fiss. longipetalum* (L); 13418: *Fiss. manubriatum* (L); 13428: *Fiss. paniculatum* (L); 13431: *A. suaveolens* (L); 13433: *A. suaveolens* (L). **Leeuwenberg**, A.J.M. et al.; 14504: *A. suaveolens* (L, SAN). **Leighton**, M.; 159: *Fr. affinis?* (L); 214: mixed coll. *A. polygynus* & *A. ochropetalus* (L); 242: *Fr. biglandulosa* (L); 259: *Fr. affinis* (L); 353: *Fr. affinis* (K, L); 420: *A. roseus* (L); 1068: *Fr. grandifolia* (L). **Lugas**, L.; 73: *U. littoralis* (K); 131: *U. littoralis* (K); 179: *A. suaveolens* (K); 310: *U. littoralis* (K); 457: *A. costatus* (K); 713: *M. clementis* (K); 1481: *Fr. grandifolia* (K); 1708: *A. costatus* (K, SAN); 1742: *U. littoralis* (K, SAN); 1761: *A. costatus* (K, SAN); 1763: *Fiss. multivenium* (SAN); 2295: *Fr. excisa* (K); 2612: *A. costatus* (K).

- Mahyar**, U.W.: 982: *U. lobbiana* (A, SING). **Maidim**, S. Md.: 1529: *U. littoralis* (K); 1530: *A. suaveolens* (K); 2339: *A. suaveolens* (K). **Mail**, A.: 3972: *A. ochropetalus* (K, SING); 7754: *Fiss. fulgens* (K, SING). **Mat Salleh**, K.: 1740: *Fr. glauca* (SAN); 1955: *U. cuneifolia* (K, SAN); 2119: *U. grandiflora* (SAN); 2414: *M. kentii* (K); 3333: *U. excelsa* (A, SAN). **Md. Shah & Kadim**: MS 1022: *U. micrantha* (K, SING). **Md. Tahir**: 715: *S. affinis* (A). **Meijer**, W.: 2023: *Fr. borneensis* (K, L); 2235: *Fiss. kingii* (K). **Melegrito**: 3353: *U. littoralis* (K). **MB** 449: *U. grandiflora* (K). **Mogea**, J.: 3517: *Fr. glauca* (K); 4016: *A. macropodus* (L); 4023: *U. monticola* (K). **Motley**, J.: 15: *D. chinensis* (K); 39: *Fiss. manubriatum* (K); 76: *U. littoralis* (K); 127: *U. borneensis* (K); 173: *U. littoralis* (K); 326: *D. dunalii* (K). **Museum Dyaks**: 245: *Fiss. latifolium* (SAR); 260: *Fiss. fulgens* (SAR); 381: *U. cuneifolia* (SAR). **Museum Saifatt**: 669: *U. cuneifolia* (SAR).
- Naiang**: 2488: *U. hirsuta* (SAR). **Nais**, J.: 3676: *U. littoralis* (SAN). **Nangkat**, N.: NN 64: *U. littoralis* (K, SAN); NN 239: *A. suaveolens* (L, SAN). **Native collector**: 159: *Fiss. manubriatum* (K); 226: *Fiss. latifolium* (A, K); 852: *Fiss. latifolium* (A); 1794: *A. suaveolens* (A). **Nooteboom**, H.P.: 1207: *Fiss. kingii* (K, L, SAN); 1314: *D. dumosus* (L). **Nooteboom, H.P. & Chai**, P.: 1823: *A. macropodus* (L, SAR).
- Ogata**, K.; Og-B 407: *A. suaveolens* (L); 11392: *Fiss. kingii* (L).
- Paie**, I.: 8464: *Fiss. fulgens* (SAR, SING). **Pannell**, C.M.: 2567: *A. suaveolens* (K). **Pascual**, G.: 1048: *U. monticola* (A). **Pereira**, J.T.; JTP 213: *U. concava* (A, SAN); JTP 396: *U. monticola* (K, SAN); JTP 509: *A. suaveolens* (L, SAN); JTP 514: *U. littoralis* (SAN). **Poklin**: 2727: *U. littoralis* (K). **Poore**, D.; H66: *Fiss. montanum* (K). **Prance**, G.T.; 30612: *U. excelsa* (K); 30698: *A. hirtipes* (K, L, SAN); 30714: *Fr. biglandulosa* (L, SAN). **Puasa**: 1356: *U. littoralis* (K); 2746: *D. chinensis* (K). **Puasa & Angian**: 3828: *Fiss. kinabaluense* (K). **Purseglove**, J.W.: P 3190: *A. gracilis* (K); P 4419: *A. suaveolens* (K, SING); P 4679: *Fiss. paniculatum* (A, K, L, SAR, SING); P 4965: *U. excelsa* (K, SAR, SING); P 5133: *U. monticola* (K, SAR, SING); P 5205: *Fr. glauca* (SAR, SING); P 5402: *A. gracilis* (L, SING); P 5459: *U. littoralis* (SING).
- Rahayu**, M.: 652: *Fr. biglandulosa* (K); 692: *Fr. borneensis* (K). **Ramos**, M.: 1143: *Fiss. fulgens* (K); 1170: *Fr. grandifolia* (K); 1171: *Fr. korthalsiana* (K); 1178: *A. suaveolens* (A, BM, K, L); 1281: *Fiss. elmeri* (A); 1366: *A. polygynus* (A, BM, BO, K, L); 1380: *A. gracilis* (L); 1389: *A. ochropetalus* (K, L); 1465: *A. hirtipes* (BM, K); 1474: *M. clementis* (A, K, L); 1480: *U. clementis* (K); 1499: *Fiss. latifolium* (A, K, L); 1667: *U. clementis* (K); 1734: *A. gracilis* (K); 1793: *Fiss. fulgens* (K); 1910: *Fr. grandifolia* (BO); 1911: *Fr. grandifolia* (BM, K); sn: *Fr. grandifolia* (K). **Reksodihardjo**, S.: 17: *U. littoralis* (K); 90: *Fiss. manubriatum* (K); 97: *P. prismatica* (K); 103: *M. clementis* (K); 731: *Fr. biglandulosa* (L). **Richards**, P.W.: 1192: *Fiss. kingii* (K, SING); 1217: *Fr. glauca* (K, SING); 1258: *A. suaveolens* (K, SING). **Ridley**, H.N.: 12464: *D. dumosus* (B.M., K, SING); sn(1/1915): *U. borneensis* (K); sn(1/1915): *D. chinensis* (K). **Ridsdale**, C.E.: 1980: *Fiss. bygravei* (A, K, L, SAN); 2047: *U. excelsa* (A, K, SAN); Cerol/27: *A. macropodus* (L). **RSNB** series; 4080: *Fiss. montanum* (K, SAN, SING); 4285: *Fiss. montanum* (K, SAN, SING); 4431: *A. kinabaluensis* (K, L, SAN, SING); 4881: *A. costatus* (K); 8382: *A. kinabaluensis* (K, SING). **Rumutom**, M.: 163: *A. suaveolens* (K); 244: *U. concava* (K); 279: *Fr. korthalsiana* (K); 530: *U. concava* (SAN).

S series: S 0436: *Fiss. paniculatum* (SING); S 4024: *D. dumosus* (SAR); S 5277: *Fiss. rugosum* (SAR); S 5387: *Fr. borneensis* (K, SAR); S 5902: *Fr. biglandulosa* (SAR); S 7835: *Fiss. latifolium* (K, L, SAR); S 8464: *Fiss. fulgens* (K); S 9114: *A. suaveolens* (K, SING); S 11021: *M. kentii* (K); S 11999: *Fr. biglandulosa* (K, L, SAR, SING); S 12090: *U. littoralis* (K); S 12319: *M. dielsii* (K, SING); S 12403: *Fr. affinis* (SAR, SING); S 12428: *M. dielsii* (K, SING); S 12519: *U. lobbiana* (SAR); S 12532: *U. hirsuta* (SING); S 13188: *U. lobbiana* (SAR); S 13261: *A. suaveolens* (K, SAN, SING); S 13262: *Fiss. latifolium* (K, SAN, SAR, SING); S 13285: *A. sarawakensis* (SING); S 13286: *U. lanuginosa* (K, SING); S 13288: *Fiss. kingii* (K, L, SAR); S 13728: *U. monticola* (K, SAR); S 13755: *Fr. glauca* (K); S 13756: *U. monticola* (SAR); S 13775: *Fr. borneensis* (SAR, SING); S 14366: *U. monticola* (SAR, SING); S 14780: *U. beccarii* (K, SAR); S 15965: *Fr. biglandulosa* (K, L, SAN, SAR, SING); S 15966: *Fiss. latifolium* (K, SAN, SAR, SING); S 16030: *U. grandiflora* (SAR); S 16279: *U. littoralis* (K, SAN, SING); S 16300: *U. littoralis* (K); S 16323: *Fr. biglandulosa* (A, K, L, SAN, SAR, SING); S 16410: *U. beccarii* (K, SAR, SING); S 16417: *U. excelsa* (K, SAR, SING); S 16666: *Fiss. kingii* (A, K, L, SAN, SAR, SING); S 16969: *A. roseus* (L); S 18364: *M. kentii* (K, SING); S 18434: *Fr. excisa* (K, SAN, SAR, SING); S 18493: *U. lobbiana* (A, K, SAR, SING); S 19129: *Fr. excisa* (K, SAR); S 19270: *A. hirtipes* (K); S 19561: *D. acutus* (K, SAN, SING); S 19647: *Fr. biglandulosa* (K, SAR, SING); S 20272: *U. lobbiana* (SAR); S 20889: *A. hirtipes* (A, K, L, SING); S 20923: *A. venustus* (L); S 20991: *P. prismatica* (K); S 21376: *U. excelsa* (K, SAN, SAR, SING); S 21469: *U. monticola* (A, K, SAR, SING); S 21549: *Fiss. manubriatum* (K); S 21634: *U. littoralis* (SAR); S 22561: *M. dielsii* (SING); S 22619: *U. excelsa* (A, K, SING); S 22770: *Fiss. crassicaule* (K, L, SAR); S 23003: *U. monticola* (A, K, SAR, SING); S 24371: *Fiss. kingii* (K, SAN, SAR, SING); S 24726: *M. kentii* (A, K, SAN, SING); S 25265: *Fiss. kingii* (K, L, SAN, SAR, SING); S 25281: *M. kentii* (K, SING); S 25409: *A. suaveolens* (K, SING); S 25414: *Fiss. rugosum* (SAR); S 25433: *A. suaveolens* (K, SING); S 25436: *Fiss. paniculatum* (K, SAR, SING); S 25440: *Fiss. paniculatum* (SAR); S 25448: *Fr. borneensis* (K, SAR, SING); S 25560: *Fr. excisa* (K, SAR, SING); S 25629: *D. acutus* (K, SAR, SING); S 26041: *U. lanuginosa* (SAR); S 26258: *Fr. ovalifolia* (SAN, SAR, SING); S 26861: *P. prismatica* (K, SING); S 26894: *P. prismatica* (K); S 26958: *A. venustus* (L); S 27003: *Fiss. rugosum* (K, SAR); S 27068: *A. hirtipes* (K, L); S 27180: *Fiss. latifolium* (K, SAN, SAR, SING); S 27220: *Fiss. kingii* (K, SAR); S 27247: *Fiss. kingii* (K, SAR, SING); S 27553: *U. concava* (SAR); S 27588: *Fiss. fulgens* (A, SAR, SING); S 27599: *U. littoralis* (A, K, SAN, SING); S 27674: *U. clementis* (SAR); S 27677: *Fiss. paniculatum* (K, SAR, SING); S 27722: *U. monticola* (K, SAR); S 27749: *A. veldkampii* (K, L); S 27795: *Fr. ovalifolia* (K, SAR); S 27914: *Fr. borneensis* (SAR); S 27935: *Fr. glauca* (K, SAN, SAR, SING); S 28010: *A. maingayi* (K, L, SAN); S 28025: *A. pandanicarpus* (K, L, SAN); S 28103: *Fr. formosa* (K, SAR, SAN, SING); S 28185: *Fr. affinis* (K, SING); S 28488: *A. suaveolens* (K, SING); S 28541: *A. suaveolens* (K, SING); S 28701: *U. monticola* (SAR); S 29261: *U. monticola* (SAR); S 29583: *Fiss. longipetalum* (K, L, SAR); S 29684: *A. maingayi* (A, K, L, SAN); S 29863: *U. lobbiana* (SAR); S 30047: *Fiss. latifolium* (K, SAR, SING); S 31124: *U. monticola* (K, SAR, SING); S 31543: *Fiss. kingii* (K, SAN, SAR, SING); S 31576: *U. lobbiana* (SAR); S 31679: *U. grandiflora* (SAR); S 31743: *U. verrucosa* (K, SAN, SAR, SING); S 31744: *Fiss. kingii* (K, SAR, SING); S 32005: *M. kentii* (K, SAN); S 32106: *Fiss. latifolium* (SAR); S 32139: *A. sarawakensis* (L, SING); S 32176: *M. kentii* (K, SAN, SING); S 32369: *U. borneensis* (K, SING); S 33129: *U. cuneifolia* (A, K, SAR); S 33297: *A. maingayi* (A, K, L); S 33431: *Fr. glauca* (K, SAR); S 33571: *Fiss. rugosum* (K, SAR); S

33748: *U. lobbiana* (A, SAR); S 34274: *Fr. borneensis* (K, SAR); S 34349: *U. monticola* (K, SAR); S 34995: *U. monticola* (SAR); S 35028: *Fr. formosa* (K, SAR); S 35073: *Fiss. elmeri* (A, K, SAR); S 35143: *Fiss. paniculatum* (SAR); S 35288: *U. cuneifolia* (A, K, SAR); S 35345: *Fiss. montanum* (K, L, SAR); S 35632: *Fiss. paniculatum* (K, SAR); S 35681: *U. monticola* (K, L, SAR); S 35743: *Fiss. paniculatum* (K, SAR); S 35788: *U. monticola* (K, SAR); S 36639: *Fiss. rugosum* (K, SAN, SAR); S 36712: *M. kentii* (K); S 36716: *Fiss. manubriatum* (K, SAR); S 36727: *U. monticola* (SAR); S 36826: *U. lobbiana* (K, SAR); S 36863: *U. monticola* (SAR); S 36885: *Fiss. paniculatum* (K, SAR); S 36894: *A. veldkampii* (L); S 37247: *Fr. biglandulosa* (K, L, SAN, SAR); S 37307: *U. cuneifolia* (L, SAR); S 37445: *U. clementis* (K); S 37958: *U. beccarii* (K, SAN, SAR); S 38404: *M. kentii* (K, SAN); S 38446: *A. suaveolens* (K, L, SAN); S 39344: *U. schefferi* (K, SAR); S 39566: *U. monticola* (SAN, SAR); S 39705: *M. kentii* (K); S 39840: *Fiss. brevistipitatum* (K, SAR); S 40078: *U. lobbiana* (SAR); S 40121: *D. acutus* (K, SAN, SAR); S 40123: *U. lobbiana* (K, SAN, SAR); S 40553: *U. lobbiana* (SAR); S 40656: *A. costatus* (K, L, SAN); S 40742: *U. schefferi* (K, SAR); S 40773: *Fiss. rugosum* (K, SAN, SAR); S 41241: *Fr. glauca* (K, SAR); S 41259: *U. borneensis* (K, SAN, SAR); S 41890: *U. littoralis* (K, SAN, SAR); S 41931: *Fiss. manubriatum* (SAR); S 42357: *Fr. formosa* (K, SAN, SAR); S 42563: *Fr. biglandulosa* (K, L, SAR); S 42624: *Fiss. manubriatum* (K, SAN, SAR); S 43014: *A. suaveolens* (K, SAN); S 43022: *M. kentii* (K, SAN); S 43387: *Fiss. longipetalum* (K, SAN, SAR); S 43494: *Fr. borneensis* (K, SAN, SAR); S 43619: *Fr. borneensis* (K, L, SAR); S 43645: *U. monticola* (SAR); S 43716: *Fr. borneensis* (K, L, SAR); S 43726: *U. sp.* (SAN); S 43894: *A. suaveolens* (K, SAN); S 43907: *A. roseus* (L, SAN); S 43926: *U. verrucosa* (SAR); S 44015: *U. monticola* in part (L, SAR); S 44372: *Fiss. fulgens* (K, L, SAR); S 45260: *U. lobbiana* (SAR); S 45276: *A. veldkampii* (L, SAN); S 45350: *A. suaveolens* (K, L, SAN); S 45583: *Fr. biglandulosa* (K, L, SAN, SAR); S 45667: *A. roseus* (K, L, SAN); S 45671: *Fr. borneensis* (K, SAN); S 46308: *Fiss. latifolium* (K, L, SAN, SAR); S 46801: *P. prismatica* (K); S 46893: *Fr. biglandulosa* (K, L, SAR); S 47417: *Fiss. manubriatum* (K, SAR); S 47651: *Fiss. montanum* (K, SAR); S 48014: *A. atractocarpus* (K, L, SAN); S 48037: *Fiss. multivenium* (K, SAR); S 48054: *A. suaveolens* (L); S 48169: *U. cuneifolia* (K, SAN, SAR); S 48343: *Fr. biglandulosa* (K, SAN, SAR); S 48393: *U. monticola* (SAR); S 49037: *Fr. glauca* (K, SAR); S 49373: *U. lobbiana* (K, SAN, SAR); S 49458: *U. monticola* (K, SAR); S 49548: *Fiss. elmeri* (K, L); S 50454: *Fr. biglandulosa* (K, SAR); S 51016: *A. veldkampii* (K, L, SAN); S 51299: *U. monticola* (SAR); S 51463: *Fiss. kingii* (K, SAN, SAR); S 51561: *A. suaveolens* (K, L, SAN); S 52314: *U. monticola* (K, SAN, SAR); S 52340: *U. borneensis* (K, SAN); S 52509: *M. clementis* (K, SAN, SAR); S 52659: *U. littoralis* (SAR); S 52668: *U. cuneifolia* (SAN, SAR); S 53355: *Fr. biglandulosa* (K, SAN, SAR); S 53500: *A. atractocarpus* (L); S 53516: *Fr. biglandulosa* (K, SAR); S 53725: *Fr. biglandulosa* (K, SAN, SAR); S 53908: *Fiss. kingii* (K, SAR); S 54000: *U. schefferi* (SAR); S 54564: *A. maingayi* (K, L, SAN); S 54662: *U. excelsa* (K, SAR); S 56453: *U. monticola* (SAR); S 57104: *Fiss. manubriatum* (K, L); S 57164: *Fiss. kingii* (K, SAN, SAR); S 57672: *Fiss. kingii* (SAN, SAR); S 57834: *Fiss. bygravei* (K, L, SAN, SAR); S 58599: *U. lobbiana* (SAR); S 58897: *Fiss. kingii* (SAR); S 59637: *Fiss. fulgens* (SAR); S 59936: *M. kentii* (K, SAN); S 60572: *Fiss. kingii* (SAR); S 60776: *A. cf. lanuginosus* (L); S 60849: *Fiss. montanum* (SAR); S 60921: *U. schefferi* (SAR); S 61120: *Fiss. kingii* (K, L, SAN, SAR); S 61465: *Fiss. multivenium* (K, SAR); S 62313: *A. atractocarpus* (L, SAN); S 62346: *Fr. glauca* (K, SAR); S 63087: *Fr. glauca* (SAR); S 63251: *U. monticola* (SAR); S 63627: *Fiss. bygravei* (K, L, SAN, SAR); S 63673: *Fr. biglandulosa* (SAN, SAR); S 63698: *Fr. glauca* (K, SAR); S 64063: *A. ochropetalus* (K,

L, SAN); S 64120: *U. schefferi* (SAR); S 64121: *U. schefferi* (SAR); S 64648: *U. monticola* (K, SAR); S 64929: *Fr. glauca* (K, SAR); S 64963: *Fiss. latifolium* (SAR); S 65020: *Fr. ovalifolia* (SAR); S 65060: *Fiss. kingii* (K, L, SAN, SAR); S 65838: *Fiss. kingii* (SAR); S 65840: *Fiss. kingii* (SAR); S 65898: *Fr. borneensis* (SAR); S 65972: *Fr. borneensis* (SAR); S 65995: *U. cuneifolia* (SAR); S 66213: *U. javana* (K, SAN, SAR); S 66268: *Fr. borneensis* (SAR); S 66917: *Fiss. longipetalum* (SAR); S 67395: *U. clementis* (SAR); S 67557: *A. sarawakensis* (K, L, SAN); S 68733: *Fiss. rugosum* (K, SAR); S 68936: *U. excelsa* (K, SAN, SAR); S 69529: *D. dumosus* (SAR); S 69940: *U. monticola* (SAR); S 70965: *Fr. biglandulosa* (SAR); S 70982: *U. ?borneensis* (SAR); S 71221: *U. cuneifolia* (SAN, SAR); S 71304: *Fr. biglandulosa* (SAR); S 71502: *U. cuneifolia* (SAR); S 71542: *Fiss. kingii* (SAR); S 71629: *U. schefferi* (SAN, SAR); S 71664: *A. hirtipes* (SAR); S 71748: *Fiss. latifolium* (SAR); S 71954: *Fiss. montanum* (SAR); S 72129: *A. costatus* (SAR); S 72196: *Fiss. latifolium* (SAR); S 72432: *Fiss. cf. kingii* (L, SAN, SAR, SING); S 72541: *U. beccarii* (SAN, SAR); S 72588: *Fiss. rugosum* (SAR); S 72718: *Fr. ovalifolia* (SAR); S 72967: *U. lobbiana* (SAR); S 73364: *Fiss. manubriatum* (K, SAR); S 73705: *A. suaveolens* (K); S 73763: *A. gracilis* (SAN); S 74389: *U. monticola* (SAR); S 74644: *U. monticola* (SAR); S 74973: *Fiss. manubriatum* (SAR); S 75099: *A. atractocarpus* (K, SAN, SAR); S 76671: *Fr. borneensis* (SAR); S 77208: *Fiss. kingii* (SAN, SAR, SING); S 78109: *Fiss. rugosum* (SAR); S 78263: *Fiss. rugosum* (SAR); S 78272: *Fr. biglandulosa* (SAR); S 78316: *U. monticola* (SAR); S 78747: *Fr. borneensis* (SAR); S 79056: *A. sarawakensis* (SAR); S 79113: *Fr. borneensis* (SAR); S 79426: *Fiss. kingii* (SAR); S 79464: *U. lobbiana* (SAR); S 79995: *D. acutus* (SAN, SAR); S 80674: *U. excelsa* (SAN, SAR); S 80953: *A. suaveolens* (L, SAR); S 81252: *D. dumosus* (SAR); S 81280: *A. costatus* (L, SAN, SAR); S 81317: *U. monticola* (SAR); S 81603: *U. cuneifolia* (SAR); S 81631: *Fiss. manubriatum* (SAR); S 82117: *U. lobbiana* (SAR); S 82539: *Fr. excisa* (SAR); S 82825: *Fiss. fulgens* (SAR); S 83219: *U. concava* (SAR); S 83237: *U. lobbiana* (SAR); S 83331: *Fiss. rugosum* (L, SAN, SAR); S 83363: *Fiss. longipetalum* (SAR); S 83388: *U. lobbiana* (SAR); S 83406: *U. monticola* (SAR); S 83484: *A. suaveolens* (L); S 83496: *Fiss. longipetalum* (L, SAR); S 83550: *U. lobbiana* (SAR); S 83584: *U. schefferi* (SAR); S 84231: *U. cuneifolia* (SAR); S 84434: *Fiss. rugosum* (SAR); S 84552: *Fiss. rugosum* (SAR); S 85820: *U. excelsa* (SAR); S 85883: *U. cuneifolia* (SAR); S 86189: *Fr. biglandulosa* (SAR); S 87259: *U. excelsa* (SAR); S 87265: *Fr. ovalifolia* (SAR); S 87300: *D. dumosus* (SAR); S 87644: *Fiss. manubriatum* (SAR); S 87683: *Fiss. kingii* (SAR); S 88105: *A. atractocarpus* (SAR); S 89284: *U. lobbiana* (SAR); S 89404: *U. grandiflora* (SAR); S 89703: *Fr. ovalifolia* (SAR); S 90803: *U. monticola* (SAR); S 90815: *U. monticola* (SAR); S 91077: *U. monticola* (SAR); S 91589: *Fiss. paniculatum* (SAR, SING); S 91755: *U. monticola* (SAR); S 93100: *U. excelsa* (SAR); S 96230: *U. lobbiana* (SAR). SAN series; SAN A 2920: *A. ochropetalus* (K); SAN A 4226: *A. ochropetalus* (K); SAN A 4291: *U. borneensis* (A); SAN A 4380: *A. veldkampii* (A, L); SAN 2699: *U. littoralis* (SAN); SAN 3382: *U. littoralis* (SAN); SAN 7374: *Fiss. elmeri*; SAN 11508: *Fr. affinis* (SAN); SAN 16390: *A. suaveolens* (A, L, SING); SAN 16546: *Fr. glauca* (K, L, SING); SAN 17053: *Fr. biglandulosa* (K, L); SAN 17070: *A. suaveolens* (L); SAN 17079: *U. verrucosa* (K); SAN 17103: *P. prismatica* (A, SAN, SING); SAN 17134: *U. verrucosa* (K, SAN); SAN 17316: *A. ochropetalus* (K, SAN); SAN 17403: *U. monticola* (A, SING); SAN 17404: *A. hirtipes* (A, K, L, SING); SAN 17507: *P. prismatica* (A, K); SAN 17597: *Fr. biglandulosa* (A, L, SING); SAN 18566: *M. clementis* (K, SAN); SAN 19255: *Fr. glauca* (K, SING); SAN 19617: *U. borneensis* (SAN, SING); SAN 19794: *P. prismatica* (K); SAN 19795: *A. suaveolens* (K,

L); SAN 20053: *U. littoralis* (K); SAN 20330: *U. littoralis* (K, SING); SAN 20451: *Fr. glauca* (SAN); SAN 20882: *U. littoralis* (SAN); SAN 20926: *A. suaveolens* (K, L, SAN, SING); SAN 21060: *Fiss. brevistipitatum* (K, SAN); SAN 22793: *U. monticola* (SAN, SING); SAN 23074: *A. suaveolens* (K, L, SAN); SAN 24589: *D. dumosus* (K, SAN, SING); SAN 24592: *A. suaveolens* (L, SAN); SAN 24978: *Fr. borneensis* (K, SAN, SAR, SING); SAN 25044: *U. excelsa* (K, SAN); SAN 25150: *U. concava* (K, SAN); SAN 25608: *U. littoralis* (SAN); SAN 26014: *A. suaveolens* (K, SAN); SAN 26325: *Fiss. multivenium* (K, L, SAN); SAN 26676: *A. costatus* (SAN); SAN 26678: *D. dumosus* (K, SAN, SING); SAN 26679: *U. javana* (SAN); SAN 26755: *D. chinensis* (SAN); SAN 27117: *Fiss. fulgens* (K, L, SAN, SAR, SING); SAN 27124: *U. littoralis* (K, SAN); SAN 27266: *U. littoralis* (K, SAN); SAN 27452: *U. grandiflora* (K, SAN); SAN 27733: *Fr. glauca* (K, SAN); SAN 27739: *U. littoralis* (K, SAN); SAN 27869: *Fr. grandifolia* (K, SAN); SAN 28158: *A. suaveolens* (K, L, SAN, SING); SAN 28161: *A. suaveolens* (SAN); SAN 28339: *D. acutus* (K, SAN, SING); SAN 28381: *U. littoralis* (SAN); SAN 28526: *Fiss. kinabaluense* (K, L, SAN); SAN 29372: *U. littoralis* (K, SAN, SING); SAN 29601: *Fr. borneensis* (K, SAN); SAN 29711: *U. concava* (SAN, SING); SAN 30002: *U. grandiflora* (K, SAN); SAN 30010: *Fr. borneensis* (K, SAN, SAR); SAN 30015: *U. excelsa* (K, SAN, SING); SAN 30151: *A. suaveolens* (SAN); SAN 30152: *P. prismatica* (K, SAN); SAN 30295: *U. littoralis* (K, SAN); SAN 30327: *P. prismatica* (SAN); SAN 30561: *Fiss. bygravei* (K, L, SAN, SAR, SING); SAN 30855: *U. excelsa* (K, SAN); SAN 31082: *U. monticola* (SAN); SAN 31090: *A. roseus* (K, SAN); SAN 31107: *A. suaveolens* (K, SAN); SAN 31320: *Fiss. kingii* (K, L, SAN, SAR); SAN 31322: *Fr. formosa* (SAN); SAN 31663: *D. dumosus* (K, SAN); SAN 31746: *U. littoralis* (SAN); SAN 31988: *P. prismatica* (K, SAN); SAN 32519: *U. cuneifolia* (K, SAN); SAN 32686: *Fr. korthalsiana* (K, SAN, SAR, SING); SAN 32690: *A. suaveolens* (K, SAN, SING); SAN 32739: *Fr. borneensis* (K, SAN); SAN 32752: *U. littoralis* (K, SAN); SAN 32834: *U. borneensis* (K, SAN); SAN 32837: *P. prismatica* (SAN); SAN 33045: *S. affinis* (SAN, SAR); SAN 33192: *A. suaveolens* (K, L, SAN, SING); SAN 33257: *Fr. borneensis* (SAN); SAN 33456: *U. littoralis* (K, SAN, SING); SAN 33659: *S. affinis* (SAN); SAN 33826: *U. borneensis* (K, SAN); SAN 33960: *U. littoralis* (SAN); SAN 33999: *U. littoralis* (K, SAN, SING); SAN 34084: *Fr. borneensis* (K, SAN, SAR, SING); SAN 34135: *Fiss. manubriatum* (K, SAN); SAN 34960: *Fiss. kingii* (K, SAN, SAR, SING); SAN 35396: *Fr. excisa* (K, SAN); SAN 35416: *A. suaveolens* (SAN, SING); SAN 35616: *Fr. biglandulosa* (K, SAN, SING); SAN 35802: *Fiss. latifolium* (Philippines form) (SAN); SAN 35869: *U. monticola* (SAN); SAN 35871: *U. schefferi* (K, SAN, SING); SAN 35914: *Fiss. manubriatum* (K, SAN, SAR, SING); SAN 35917: *M. kentii* (K, SAN, SING); SAN 36859: *P. prismatica* (K); SAN 36863: *M. clementis* (SAN, SING); SAN 37034: *M. clementis* (K, SAN); SAN 37089: *U. verrucosa* (K, SAN, SING); SAN 37741: *A. suaveolens* (K, SAN, SING); SAN 38102: *D. chinensis* (K, SAN); SAN 38390: *D. chinensis* (K, SAN, SING); SAN 39641: *P. prismatica* (SAN); SAN 40263: *A. costatus* (SAN); SAN 40335: *Fiss. elmeri* (K, L, SAN, SAR); SAN 40798: *U. concava* (K, SAN); SAN 40802: *Fiss. fulgens* (SAN, SING); SAN 40837: *U. concava* (SAN, SING); SAN 40846: *D. chinensis* (K, SAN); SAN 41074: *A. veldkampii?* (SAN); SAN 41257: *U. littoralis* (K, SAN); SAN 41357: *U. littoralis* (K, SAN, SING); SAN 41432: *P. prismatica* (SAN); SAN 41655: *U. micrantha* (K, SAN); SAN 41799: *U. schefferi* (K, SAN); SAN 41801: *M. clementis* (K, SAN); SAN 42578: *U. excelsa* (SAN); SAN 42662: *Fr. glauca* (K, SAN); SAN 43015: *S. affinis* (SAN); SAN 43192: *U. littoralis* (K, SAN); SAN 43443: *A. macropodus* (SAN); SAN 44321: *U. excelsa* (K, SAN); SAN 45063: *U. sp.* (SAN);

SAN 46087: *D. dumosus* (K, SAN); SAN 46339: *Fr. korthalsiana* (K, SAN); SAN 47261: *U. grandiflora* (K, SAN); SAN 47422: *U. lobbiana* (K, L, SAN); SAN 47489: *P. prismatica* (SAN); SAN 47864: *A. suaveolens* (K, L, SAN); SAN 48163: *U. excelsa* (K, SAN); SAN 48258: *Fr. glauca* (SAN); SAN 48259: *Fr. glauca* (SAN); SAN 48430: *A. gracilis* (K, SAN); SAN 48566: *A. suaveolens* (SAN); SAN 48591: *A. suaveolens* (K, SAN); SAN 48980: *A. ochropetalus* (SAN); SAN 49173: *U. micrantha* (K, SAN); SAN 49298: *Fiss. kingii* (K, L, SAN); SAN 49359: *A. suaveolens* (K, SAN); SAN 49364: *S. affinis* (K SAN); SAN 49558: *U. sp.* (K, SAN); SAN 49589: *M. kentii* (K, SAN); SAN 49666: *A. roseus* (SAN); SAN 49673: *A. suaveolens* (SAN); SAN 49852: *A. suaveolens* (SAN); SAN 49888: *Fiss. fulgens* (SAN); SAN 49941: *Fr. glauca* (SAN); SAN 49942: *U. littoralis* (SAN); SAN 50360: *P. prismatica* (SAN); SAN 50416: *A. gracilis* (K, SAN); SAN 50461: *U. lobbiana* (SAN); SAN 50492: *U. excelsa?* (SAN); SAN 50555: *S. affinis* (SAN); SAN 50557: *D. chinensis* (K, SAN, SING); SAN 50560: *S. affinis* (SAN); SAN 50976: *A. suaveolens* (K, SAN); SAN 51509: *U. monticola* (SAN); SAN 51630: *A. suaveolens* (SAN); SAN 51652: *D. chinensis* (K, SAN, SAR, SING); SAN 51849: *U. lobbiana* (SAN); SAN 52758: *Fiss. paniculatum* (K, L, SAN, SAR); SAN 52848: *M. kentii* (K, SAN); SAN 53056: *U. littoralis* (K, SAN); SAN 53063: *U. littoralis* (K, SAN); SAN 53422: *Fiss. kingii* (K, SAN, SAR); SAN 53450: *U. verrucosa* (SAN); SAN 54333: *Fr. glauca* (SAN); SAN 54502: *Fiss. kingii* (K, SAN); SAN 54507: *A. ochropetalus* (SAN); SAN 54532: *U. beccarii* (K, SAN); SAN 54634: *U. excelsa* (SAN); SAN 54856: *A. lanuginosus* (SAN); SAN 54917: *U. borneensis* (SAN); SAN 54958: *U. littoralis* (SAN); SAN 55367: *A. suaveolens* (K, L, SAN); SAN 55727: *D. acutus* (SAN); SAN 55773: *U. lobbiana* (K, SAN, SAR, SING); SAN 56191: *Fiss. elmeri* (K, SAN); SAN 56382: *Fiss. carrii* (SAN); SAN 56772: *U. curvistipitata* (SAN); SAN 56821: *Fiss. manubriatum* (K, SAN); SAN 56951: *U. borneensis* (K, SAN); SAN 56972: *U. schefferi* (K, SAN); SAN 57200: *U. littoralis* (SAN); SAN 57256: *U. schefferi* (K, SAN); SAN 57259: *Fiss. elmeri* (K, L, SAN, SAR, SING); SAN 57343: *Fr. korthalsiana* (K, L, SAN, SING); SAN 57374: *Fiss. elmeri* (K, L, SAN, SAR); SAN 57383: *Fiss. manubriatum* (K, SAN); SAN 57391: *U. littoralis* (SAN, SING); SAN 58052: *U. schefferi* (K, SAN); SAN 59263: *Fiss. latifolium* (Philippines form) (SAN); SAN 59589: *U. excelsa* (SAN); SAN 59830: *U. littoralis* (SAN); SAN 60004: *A. suaveolens* (K, SAN, SING); SAN 60026: *U. concava* (SAN); SAN 60039: *U. concava* (K, SAN); SAN 60242: *Fiss. multivenium* (K, L, SAN); SAN 60274: *Fr. glauca* (K, SAN); SAN 60280: *U. concava* (SAN); SAN 60404: *U. concava* (SAN); SAN 60661: *Fiss. carrii* (K, SAN); SAN 60896: *U. borneensis* (SAN); SAN 60940: *U. excelsa* (SAN); SAN 61894: *D. chinensis* (SAN); SAN 62880: *A. suaveolens* (SAN); SAN 64442: *D. chinensis* (SAN); SAN 64464: *D. chinensis* (SAN); SAN 64738: *A. suaveolens* (K, SAN); SAN 64780: *U. cuneifolia* (SAN, SING); SAN 65449: *U. borneensis* (K, SAN); SAN 65480: *Fiss. kingii* (K, L, SAN); SAN 65500: *Fiss. hygravei* (K, L, SAN, SAR, SING); SAN 65925: *U. littoralis* (K, SAN); SAN 66329: *A. macropodus* (SAN); SAN 66697: *U. concava* (SAN); SAN 66814: *U. grandiflora* (SAN); SAN 67224: *U. excelsa* (K, SAN); SAN 67271: *A. suaveolens* (SAN, SING); SAN 67272: *U. concava* (SAN); SAN 67313: *U. littoralis* (SAN); SAN 67318: *A. suaveolens* (K, SAN); SAN 67368: *U. schefferi* (K, SAN); SAN 67436: *U. concava* (SAN); SAN 67456: *Fr. glauca* (SAN); SAN 67468: *A. ochropetalus* (SAN); SAN 67555: *U. concava* (SAN); SAN 67683: *A. ochropetalus* (SAN); SAN 67960: *Fr. borneensis* (SAN); SAN 68191: *A. hirtipes* (SAN); SAN 68499: *Fiss. multivenium* (K, SAN, SING); SAN 68720: *U. monticola* (K, SAN); SAN 68811: *A. macropodus* (SAN); SAN 69118: *U. borneensis* (SAN); SAN 69200: *U. sp.* (K, SAN); SAN 69461: *Fiss. fulgens* (SAN); SAN 69465: *A.*

ochropetalus (SAN); SAN 69532: *U. littoralis* (SAN); SAN 70051: *U. excelsa* (K, SAN); SAN 70583: *A. ochropetalus* (K, L, SAN); SAN 70609: *A. suaveolens* (K, SAN); SAN 70686: *U. verrucosa* (K, SAN); SAN 71177: *A. sp.* (SAN); SAN 71181: *A. suaveolens* (K, SAN, SING); SAN 71272: *A. macropodus* (K, SAN); SAN 71283: *Fiss. kingii* (K, SAN, SAR, SING); SAN 72409: *Fr. glauca* (K, SAN, SAR, SING); SAN 73349: *Fiss. fulgens* (K, SAN, SING); SAN 73676: *U. monticola* (K, SAN); SAN 73821: *Fiss. kingii* (K, SAN, SAR, SING); SAN 74364: *A. roseus* (L, SAN); SAN 74866: *U. littoralis* (K, SAN); SAN 74975: *Fr. affinis* (K, SAN, SING); SAN 75338: *A. ochropetalus* (K, L, SAN); SAN 75645: *A. ochropetalus* (SAN); SAN 75662: *U. littoralis* (K, SAN, SING); SAN 76069: *U. littoralis* (K, SAN); SAN 76088: *U. excelsa* (K, SAN); SAN 76878: *A. macropodus* (K, L, SAN, SING); SAN 76919: *A. hirtipes* (SAN); SAN 77134: *U. grandiflora* (SAN); SAN 77206: *U. grandiflora* (K, SAN, SING); SAN 77652: *A. suaveolens* (K, SAN, SING); SAN 77819: *M. kentii* (K, SAN, SING); SAN 77851: *A. gracilis* (K, SAN); SAN 77873: *U. borneensis* (K, SAN, SING); SAN 77946: *D. chinensis* (K, SAN, SAR, SING); SAN 78027: *P. prismatica* (SAN); SAN 78073: *M. clementis* (K, SAN); SAN 78075: *Fr. excisa* (K, SAN, SING); SAN 78486: *U. littoralis* (SAN); SAN 78517: *A. gracilis* (SAN); SAN 79055: *U. littoralis* (SAN); SAN 79125: *U. littoralis* (SAN); SAN 79170: *Fiss. kinabaluense* (SAN); SAN 79171: *Fr. glauca* (K, SAN, SAR, SING); SAN 79183: *Fr. glauca* (SAN, SAR, SING); SAN 79195: *U. littoralis* (SAN); SAN 79233: *Fr. ?borneensis* (K, SAN, SAR); SAN 79615: *A. ochropetalus* (L, SAN, SING); SAN 79666: *M. clementis* (SAN); SAN 79705: *A. ochropetalus* (SAN); SAN 79796: *M. clementis* (K, SAN); SAN 80014: *P. prismatica* (SAN); SAN 80089: *D. acutus* (SAN); SAN 80214: *A. gracilis* (K, L, SAN); SAN 80237: *U. concava* (SAN); SAN 80259: *Fiss. fulgens* (SAN); SAN 80265: *A. hirtipes* (SAN); SAN 80277: *A. ochropetalus* (SAN, SING); SAN 80316: *P. prismatica* (SAN); SAN 80354: *Fiss. fulgens* (SAN); SAN 80355: *A. suaveolens* (SAN); SAN 80396: *A. ochropetalus* (SAN); SAN 80632: *P. prismatica* (SAN); SAN 80781: *S. affinis* (K, SAN); SAN 80810: *U. excelsa* (K, SAN); SAN 80980: *Fiss. kingii* (K, L, SAN); SAN 81362: *Fiss. bygravei* (K, L, SAN); SAN 81393: *A. ochropetalus* (K, L, SAN); SAN 81444: *Fiss. bygravei* (SAN); SAN 81456: *Fiss. kingii* (K, SAN); SAN 81504: *U. curvistipitata* (K, SAN, SAR); SAN 81923: *A. suaveolens* (K, SAN, SING); SAN 81977: *U. beccarii* (K, SAN); SAN 81997: *U. cuneifolia* (K, SAN); SAN 82035: *Fiss. fulgens* (K, SAN, SING); SAN 82176: *U. concava* (SAN, SING); SAN 82231: *A. veldkampii* (K, L, SAN); SAN 82277: *U. micrantha* (K, SAN); SAN 82415: *Fiss. fulgens* (K, SAN, SAR); SAN 82456: *Fiss. fulgens* (SAN, SAR, SING); SAN 82574: *A. ochropetalus* (K, L, SAN, SING); SAN 82635: *Fr. grandifolia* (SAN); SAN 82657: *A. suaveolens* (SAN, SING); SAN 83513: *A. suaveolens* (K, L, SAN); SAN 83616: *M. kentii* (SAN); SAN 83764: *U. lobbiana* (K, SAN); SAN 84152: *Fr. glauca* (K, SAN, SAR); SAN 84428: *U. concava* (SAN); SAN 84436: *A. suaveolens* (K, SAN); SAN 84477: *U. concava* (SAN, SING); SAN 84583: *A. suaveolens* (SAN, SING); SAN 84597: *U. littoralis* (K, SAN); SAN 84697: *U. clementis* (SAN, SAR, SING); SAN 84744: *A. suaveolens* (SAN, SING); SAN 84795: *Fr. affinis* (K, L, SAN, SAR); SAN 84859: *Fr. glauca* (K, SAN, SAR, SING); SAN 85055: *A. suaveolens* (K, SAN, SING); SAN 85119: *U. monticola* (SAN); SAN 85299: *U. ? javana* (SAN); SAN 85325: *U. littoralis* (SAN); SAN 85365: *Fiss. latifolium* (K, SAN); SAN 85995: *A. suaveolens* (SAN, SING); SAN 86075: *Fiss. latifolium* (Kinabalu form) (L, SAN); SAN 86173: *U. littoralis* (K, SAN); SAN 86195: *A. roseus* (K, SAN); SAN 86201: *A. suaveolens* (K, L, SAN); SAN 86244: *Fr. biglandulosa* (SAN); SAN 86341: *Fiss. fulgens* (SAN); SAN 86404: *Fiss. fulgens* (SAN); SAN 86405: *A. suaveolens* (SAN); SAN 86468: *Fiss. fulgens* (SAN); SAN 86619: *Fiss. manubriatum* (K,

SAN, SING); SAN 86641: *A. suaveolens* (SAN, SING); SAN 86645: *Fr. borneensis* (K, SAN); SAN 86651: *Fr. grandifolia* (K, SAN, SAR); SAN 86687: *U. borneensis* (K, SAN); SAN 86795: *U. littoralis* (SAN); SAN 87341: *U. concava* (SAN); SAN 87377: *Fr. glauca* (SAN); SAN 87379: *U. concava* (SAN); SAN 87761: *A. ochropetalus* (SAN); SAN 87770: *M. clementis* (SAN, SAR); SAN 87837: *A. ochropetalus* (K, L, SAN, SING); SAN 88055: *Fr. biglandulosa* (SAN, SAR); SAN 88117: *U. littoralis* (SAN); SAN 88124: *Fr. glauca* (A, SAN, SAR, SING); SAN 88135: *U. verrucosa* (SAN, SING); SAN 88138: *A. suaveolens* (SAN); SAN 88176: *Fiss. manubriatum* (SAN); SAN 88263: *Fr. glauca* (SAN, SAR); SAN 88271: *A. polygynus* (SAN); SAN 88357: *A. polygynus* (SAN, SING); SAN 88411: *A. suaveolens* (SAN); SAN 88432: *Fr. borneensis* (K, SAN, SAR); SAN 88484: *D. chinensis* (SAN, SAR); SAN 88910: *U. grandiflora* (SAN); SAN 88965: *Fr. glauca* (SAN, SAR, SING); SAN 89042: *U. littoralis* (SAN); SAN 89118: *D. chinensis* (SAN, SAR, SING); SAN 89139: *A. suaveolens* (SAN); SAN 89141: *M. clementis* (SAN, SAR); SAN 89176: *Fr. borneensis* (K, SAN, SAR); SAN 89317: *A. ochropetalus* (SAN); SAN 89516: *A. suaveolens* (SAN, SING); SAN 89745: *P. prismatica* (SAN); SAN 89799: *U. borneensis* (SAN); SAN 89818: *Fr. borneensis* (SAN); SAN 89867: *Fr. glauca* (SAN); SAN 89920: *A. ochropetalus* (SAN, SING); SAN 90152: *A. polygynus* (L, SAN); SAN 90305: *Fr. glauca* (SAN); SAN 90443: *A. polygynus* (SAN); SAN 90669: *Fr. glauca* (SAN); SAN 91078: *D. dumosus* (SAN, SAR); SAN 91080: *U. littoralis* (SAN); SAN 91106: *U. concava* (K, SAN); SAN 91116: *A. gracilis* (SAN); SAN 91358: *D. dumosus* (SAN, SAR); SAN 91359: *Fr. borneensis* (K, SAN, SAR); SAN 91373: *M. clementis* (SAN, SAR); SAN 91389: *U. concava* (SAN); SAN 91401: *U. concava* (SAN); SAN 91420: *A. suaveolens* (K, SAN); SAN 91422: *A. ochropetalus* (SAN); SAN 91433: *A. suaveolens* (K, SAN, SING); SAN 91465: *U. concava* (SAN); SAN 91488: *Fr. glauca* (SAN, SAR, SING); SAN 91745: *A. ochropetalus* (SAN); SAN 91782: *A. ochropetalus* (SAN); SAN 91801: *U. javana* (SAN); SAN 91823: *S. affinis* (SAN); SAN 91828: *U. concava* (K, SAN); SAN 91913: *D. dumosus* (K, SAN, SAR, SING); SAN 91948: *A. lanuginosus* (K, SAN); SAN 92017: *U. excelsa* (K, SAN); SAN 92041: *A. suaveolens* (SAN, SING); SAN 92475: *A. ochropetalus* (L, SAN); SAN 92595: *A. suaveolens* (SAN, SING); SAN 92972: *Fiss. fulgens* (K, SAN, SAR, SING); SAN 92973: *A. polygynus* (L, SAN, SING); SAN 93088: *Fr. grandifolia* (K, L, SING); SAN 93096: *Fiss. brevistipitatum* (SAN, SAR, SING); SAN 93552: *Fiss. cf. latifolium* (K, SAN, SAR); SAN 93980: *U. excelsa* (K); SAN 94050: *A. hirtipes* (K, SAN, SAR, SING); SAN 94457: *U. concava* (SAN); SAN 94477: *A. suaveolens* (SAN); SAN 94664: *Fiss. kingii* (K, SAN, SAR, SING); SAN 94721: *U. borneensis* (SAN); SAN 94762: *S. affinis* (SAN, SAR); SAN 94763: *U. javana* (K, SAN, SAR); SAN 94786: *A. suaveolens* (K, SAN); SAN 94791: *U. littoralis* (SAN); SAN 94799: *Fr. glauca* (SAN, SAR); SAN 94815: *U. lobbiana* (K, SAN, SAR, SING); SAN 94826: *A. suaveolens* (K, SAN); SAN 94835: *Fiss. manubriatum* (K, SAN); SAN 94876: *A. suaveolens* (K, SAN); SAN 94966: *Fr. affinis* (A, K, SAN, SING); SAN 94983: *Fiss. brevistipitatum* (SAN, SAR); SAN 95021: *U. littoralis* (SAN); SAN 95105: *A. ochropetalus* (SAN); SAN 95178: *M. kentii* (SAN); SAN 95310: *U. excelsa* (K, SAN); SAN 95434: *A. ochropetalus* (K, L, SAN); SAN 95552: *Fr. glauca* (SAN, SAR); SAN 95633: *A. polygynus* (L, SAN); SAN 95637: *A. ochropetalus* (L, SAN, SING); SAN 95689: *A. ochropetalus* (L, SAN); SAN 95725: *A. suaveolens* (K, SAN); SAN 95743: *D. dunalii* (K, SAN); SAN 95962: *A. ochropetalus* (SAN); SAN 96010: *A. macropodus* (K, SAN); SAN 96052: *A. ochropetalus* (L, SAN); SAN 96132: *Fr. glauca* (A, K, SAN, SAR); SAN 96158: *Fr. borneensis* (SAN, SAR); SAN 96160: *Fr. glauca* (SAN); SAN 96169: *A. ochropetalus* (L, SAN); SAN 96173: *U. excelsa* (SAN); SAN

96177: *A. macropodus* (K, SAN); SAN 96289: *U. grandiflora* (A, K, SAN, SING); SAN 96353: *A. suaveolens* (K, SAN); SAN 96363: *U. grandiflora* (SAN); SAN 96368: *M. clementis* (SAN); SAN 96389: *Fiss. bygravei* (SAN); SAN 96465: *U. borneensis* (K, SAN); SAN 96492: *A. ochropetalus* (SAN); SAN 96546: *A. gracilis* (K, SAN); SAN 96565: *U. borneensis* (SAN); SAN 96649: *A. ochropetalus* (K, L, SAN); SAN 96870: *Fiss. kingii* (SAN); SAN 96982: *A. ochropetalus* (K, L, SAN); SAN 97014: *M. clementis* (K, SAN, SAR); SAN 97017: *U. grandiflora* (K, SAN); SAN 97313: *U. littoralis* (SAN); SAN 97658: *U. excelsa* (SAN); SAN 97684: *Fr. glauca* (K, SAN, SAR, SING); SAN 99225: *U. littoralis* (SAN); SAN 99417: *U. excelsa* (K, SAN, SAR); SAN 99424: *A. veldkampii* (K, L, SAN); SAN 99452: *U. concava* (SAN); SAN 99639: *U. borneensis* (SAN); SAN 99642: *U. littoralis* (A, K, SAN); SAN 99648: *U. grandiflora* (A, SAN); SAN 99753: *M. clementis* (K, SAN); SAN 99970: *Fiss. fulgens* (SAN); SAN 99995: *U. borneensis* (SAN); SAN 100267: *A. suaveolens* (SAN, SING); SAN 100312: *M. clementis* (SAN); SAN 100331: *U. littoralis* (K, SAN); SAN 100394: *U. concava* (A, K, SAN); SAN 101266: *U. littoralis* (SAN); SAN 101323: *Fiss. latifolium* (SAN); SAN 101458: *A. ochropetalus* (SAN); SAN 101474: *Fr. biglandulosa* (SAN, SING); SAN 101773: *D. chinensis* (SAN); SAN 101797: *U. concava* (SAN); SAN 102214: *U. concava* (SAN); SAN 102372: *M. kentii* (SAN); SAN 102663: *A. suaveolens* (K, SAN); SAN 102711: *U. cuneifolia* (K, SAN); SAN 102743: *U. littoralis* (SAN); SAN 102777: *A. suaveolens* (SAN); SAN 102792: *P. prismatica* (SAN); SAN 103013: *A. suaveolens* (SAN); SAN 103037: *Fiss. fulgens* (SAN); SAN 103087: *P. prismatica* (SAN); SAN 103098: *P. prismatica* (SAN); SAN 103232: *P. prismatica* (SAN); SAN 103273: *A. suaveolens* (SAN); SAN 103285: *U. littoralis* (SAN); SAN 103290: *P. prismatica* (SAN); SAN 103565: *U. monticola* (K, SAN); SAN 103632: *A. suaveolens* (K, SAN); SAN 103825: *U. littoralis* (K); SAN 104062: *U. concava* (SAN); SAN 104063: *A. ochropetalus* (L, SAN, SING); SAN 104313: *Fiss. bygravei* (SAN); SAN 104316: *Fr. biglandulosa* (SAN); SAN 104321: *Fiss. manubriatum* (SAN); SAN 105255: *Fiss. manubriatum* (SAN); SAN 105281: *Fr. biglandulosa* (K, SAN); SAN 105313: *Fr. biglandulosa* (SAN); SAN 105350: *Fiss. manubriatum* (SAN); SAN 105610: *A. suaveolens* (K, L, SAN); SAN 105648: *U. littoralis* (SAN); SAN 105998: *U. clementis* (K, SAN); SAN 106121: *A. suaveolens* (K, SAN); SAN 106704: *U. littoralis* (SAN); SAN 106738: *A. suaveolens* (SAN); SAN 106808: *U. littoralis* (SAN); SAN 106864: *A. polygynus* (SAN); SAN 106934: *U. clementis* (SAN); SAN 106984: *Fr. glauca* (SAN); SAN 107131: *U. littoralis* (K, SAN); SAN 107163: *U. littoralis* (SAN); SAN 107220: *Fr. borneensis* (SAN); SAN 107247: *Fr. glauca* (K, SAN, SAR, SING); SAN 107334: *Fr. formosa* (SAN); SAN 107610: *A. suaveolens* (K, SAN); SAN 107617: *M. clementis* (K, SAN); SAN 107714: *Fr. borneensis* (SAN); SAN 107737: *U. littoralis* (SAN); SAN 108087: *U. littoralis* (SAN); SAN 108114: *A. macropodus* (SAN); SAN 108162: *U. littoralis* (SAN); SAN 108284: *A. ochropetalus* (K, L, SAN); SAN 108469: *Fiss. fulgens* (K, SAN, SAR); SAN 108555: *U. grandiflora* (SAN); SAN 108595: *U. littoralis* (SAN); SAN 108635: *Fr. excisa* (SAN); SAN 108643: *A. ochropetalus* (K, L, SAN); SAN 108711: *Fr. glauca* (SAN); SAN 109284: *U. littoralis* (SAN); SAN 109353: *A. suaveolens* (SAN); SAN 109422: *A. suaveolens* (SAN); SAN 109597: *Fiss. kingii* (SAN); SAN 109643: *U. excelsa* (K, SAN); SAN 109908: *A. suaveolens* (SAN); SAN 109937: *Fiss. brevistipitatum* (SAN); SAN 109980: *D. dumosus* (K, SAN); SAN 109985: *Fiss. multivenium* (SAN); SAN 110000: *U. littoralis* (K, SAN); SAN 110093: *U. argentea* (K, SAN); SAN 110109: *Fr. biglandulosa* (SAN); SAN 110136: *Fiss. kingii* (SAN); SAN 110143: *A. ochropetalus* (SAN); SAN 110145: *D. dumosus* (SAN); SAN 110271: *U. sp.* (SAN); SAN 110272: *A. costatus* (K, L,

SAN); SAN 110334: *Fr. glauca* (K, SAN); SAN 110391: *Fr. affinis* (SAN); SAN 110454: *U. clementis* (SAN); SAN 110856: *Fr. glauca* (K, SAN); SAN 110904: *Fiss. kingii* (K, SAN, SAR, SING); SAN 111013: *A. ochropetalus* (SAN); SAN 111028: *A. suaveolens* (K, SAN); SAN 111037: *D. acutus* (K, SAN); SAN 111109: *A. ochropetalus* (SAN); SAN 111112: *U. littoralis* (SAN); SAN 111248: *A. suaveolens* (SAN); SAN 111420: *P. prismatica* (SAN); SAN 111446: *Fiss. fulgens* (SAN); SAN 111508: *Fr. affinis* (K); SAN 111537: *U. littoralis* (SAN); SAN 111657: *U. verrucosa* (SAN); SAN 112135: *U. borneensis* (SAN); SAN 112195: *U. littoralis* (SAN); SAN 112310: *U. grandiflora* (SAN); SAN 112938: *A. ochropetalus* (K, L, SAN); SAN 113087: *A. suaveolens* (SAN); SAN 113183: *A. suaveolens* (SAN); SAN 113188: *Fr. glauca* (SAN); SAN 113233: *U. verrucosa* (SAN); SAN 113265: *A. hirtipes* (SAN); SAN 113300: *U. schefferi* (K, SAN); SAN 113314: *M. clementis* (SAN); SAN 113330: *A. suaveolens* (K, SAN); SAN 113343: *U. cuneifolia* (SAN); SAN 113482: *U. littoralis* (SAN); SAN 113576: *A. costatus* (SAN); SAN 113741: *Fiss. kinabaluense* (SAN); SAN 113868: *Fr. affinis* (SAN); SAN 113934: *U. monticola* (K, SAN); SAN 113950: *Fiss. kingii* (SAN); SAN 113988: *U. excelsa* (K, SAN); SAN 113994: *A. suaveolens* (K, SAN); SAN 114010: *U. borneensis* (SAN); SAN 114024: *M. clementis* (K, SAN); SAN 114030: *Fr. glauca* (K, SAN); SAN 114042: *Fiss. bygravei* (SAN); SAN 114050: *Fiss. bygravei* (SAN); SAN 114057: *A. suaveolens* (SAN); SAN 114066: *A. roseus* (SAN); SAN 114275: *U. excelsa* (SAN); SAN 114305: *U. littoralis* (SAN); SAN 114313: *U. grandiflora* (SAN); SAN 114875: *Fiss. fulgens* (SAN); SAN 114905: *A. suaveolens* (L, SAN); SAN 115294: *S. affinis* (K, SAN); SAN 115307: *A. gracilis* (SAN); SAN 115392: *P. prismatica* (SAN); SAN 115410: *P. prismatica* (SAN); SAN 115418: *U. littoralis* (SAN); SAN 115576: *A. suaveolens* (SAN); SAN 115616: *P. prismatica* (SAN); SAN 115672: *A. suaveolens* (SAN); SAN 115823: *Fiss. bygravei* (SAN); SAN 115835: *M. clementis* (K, SAN); SAN 115877: *Fiss. brevistipitatum* (K, SAN); SAN 116060: *A. suaveolens* (K, SAN); SAN 116294: *A. suaveolens* (SAN); SAN 116333: *A. suaveolens* (K, SAN); SAN 116369: *A. suaveolens* (SAN); SAN 116414: *A. suaveolens* (SAN); SAN 116433: *U. clementis* (SAN); SAN 116446: *U. littoralis* (SAN); SAN 116450: *A. suaveolens* (SAN); SAN 116618: *A. costatus* (K, SAN); SAN 116646: *A. gracilis* (SAN); SAN 116702: *Fiss. brevistipitatum* (K, SAN); SAN 116719: *A. gracilis* (K, SAN); SAN 116737: *Fr. biglandulosa* (K, SAN); SAN 116866: *A. ochropetalus* (SAN); SAN 116946: *Fr. biglandulosa* (K, SAN); SAN 116964: *U. littoralis* (K, SAN); SAN 117020: *U. littoralis* (SAN); SAN 117033: *Fiss. kingii* (SAN); SAN 117035: *A. suaveolens* (K, SAN); SAN 117128: *A. suaveolens* (K, SAN); SAN 117158: *M. clementis* (K, SAN, SAR); SAN 117355: *A. suaveolens* (K, SAN); SAN 117534: *U. littoralis* (K, SAN); SAN 117542: *A. gracilis* (K, SAN); SAN 117675: *A. macropodus* (SAN); SAN 117822: *U. grandiflora* (K, SAN); SAN 117834: *A. macropodus* (SAN); SAN 117901: *A. suaveolens* (SAN); SAN 117910: *A. suaveolens* (K, SAN); SAN 118225: *A. suaveolens* (K, SAN); SAN 118257: *Fiss. kingii* (K, SAN); SAN 118278: *A. suaveolens* (K, SAN); SAN 118305: *Fr. biglandulosa* (SAN); SAN 118308: *A. suaveolens* (K, SAN); SAN 118411: *D. dumosus* (K, SAN); SAN 118466: *A. suaveolens* (SAN); SAN 118571: *Fiss. brevistipitatum* (A, K, L, SAN); SAN 118574: *Fr. glauca* (SAN); SAN 118612: *Fr. glauca* (K, SAN); SAN 118670: *U. excelsa* (K, SAN); SAN 118730: *A. suaveolens* (K, SAN); SAN 118815: *Fr. glauca* (SAN); SAN 118829: *U. lobbiana* (SAN); SAN 118908: *U. grandiflora* (K, SAN); SAN 118944: *U. littoralis* (K, SAN); SAN 118972: *U. concava* (K, SAN); SAN 119020: *Fiss. fulgens* (K, SAN); SAN 119024: *A. polygynus* (SAN); SAN 119025: *A. suaveolens* (K, SAN); SAN 119371: *Fr. glauca* (K, SAN); SAN 119374: *A. polygynus* (SAN); SAN 119398: *U. sp.* (K, SAN); SAN 119423: *U. excelsa* (K, SAN);

SAN 119442: *Fr. glauca* (SAN); SAN 119493: *U. borneensis* (K, SAN); SAN 119497: *A. suaveolens* (SAN); SAN 119514: *Fr. biglandulosa* (SAN); SAN 119557: *Fiss. brevistipitatum* (SAN); SAN 119613: *A. suaveolens* (SAN); SAN 119715: *A. suaveolens* (K, SAN); SAN 119735: *Fiss. brevistipitatum* (SAN); SAN 119825: *A. suaveolens* (SAN); SAN 119936: *A. gracilis* (SAN); SAN 119976: *Fr. glauca* (K, SAN); SAN 120041: *A. gracilis* (K, SAN); SAN 120069: *Fr. glauca* (K, SAN); SAN 120344: *M. clementis* (K, SAN); SAN 120385: *A. roseus* (K, L); SAN 120444: *U. grandiflora* (SAN); SAN 120667: *D. chinensis* (K, SAN); SAN 120940: *A. suaveolens* (K, SAN); SAN 120990: *A. ochropetalus* (SAN); SAN 121129: *Fr. glauca* (SAN); SAN 121194: *A. suaveolens* (K, SAN); SAN 121491: *A. suaveolens* (SAN); SAN 121609: *A. suaveolens* (K, SAN); SAN 121643: *A. suaveolens* (K, SAN); SAN 121781: *M. clementis* (K, SAN); SAN 121900: *A. suaveolens* (K, SAN); SAN 122034: *A. ochropetalus* (K, L, SAN); SAN 122048: *U. littoralis* (SAN); SAN 122066: *U. excelsa* (SAN); SAN 122084: *Fr. glauca* (K, SAN); SAN 122215: *U. excelsa* (K, SAN); SAN 122217: *A. suaveolens* (K, SAN); SAN 122358: *D. acutus* (SAN); SAN 122390: *M. clementis* (SAN); SAN 122417: *Fr. biglandulosa* (K, SAN); SAN 122483: *U. littoralis* (SAN); SAN 122647: *A. suaveolens* (SAN); SAN 122702: *U. grandiflora* (SAN); SAN 122722: *Fiss. fulgens* (SAN); SAN 122751: *A. suaveolens* (K, SAN); SAN 122760: *U. littoralis* (K, SAN); SAN 122884: *A. suaveolens* (K, SAN); SAN 123129: *A. suaveolens* (K, SAN); SAN 123242: *A. suaveolens* (K, SAN); SAN 123244: *Fr. biglandulosa* (K, SAN); SAN 123368: *A. suaveolens* (K, SAN); SAN 123449: *Fr. biglandulosa* (SAN); SAN 123452: *Fiss. brevistipitatum* (SAN); SAN 123491: *U. grandiflora* (K, SAN); SAN 123595: *A. suaveolens* (K, SAN); SAN 124067: *Fr. glauca* (SAN); SAN 124107: *A. lanuginosa* (SAN); SAN 124313: *U. concava* (SAN); SAN 124315: *A. ochropetalus* (SAN); SAN 124435: *A. suaveolens* (SAN); SAN 124588: *Fr. korthalsiana* (K, SAN); SAN 124640: *U. excelsa* (SAN); SAN 124681: *Fr. borneensis* (SAN); SAN 125345: *M. clementis* (SAN); SAN 125435: *Fiss. bygravei* (SAN); SAN 125626: *A. suaveolens* (SAN); SAN 125629: *Fiss. multivenium* (K, SAN); SAN 125670: *Fiss. kingii* (SAN); SAN 125675: *U. littoralis* (K, SAN); SAN 125676: *A. suaveolens* (K, SAN); SAN 125693: *Fr. glauca* (K, SAN); SAN 125700: *Fiss. bygravei* (K, SAN); SAN 125782: *Fr. grandifolia* (SAN); SAN 125787: *A. gracilis* (SAN); SAN 126103: *U. littoralis* (SAN); SAN 126174: *P. prismatica* (SAN); SAN 126305: *S. affinis* (SAN, SAR); SAN 126386: *A. suaveolens* (K, SAN); SAN 126420: *Fr. glauca* (SAN); SAN 126487: *A. suaveolens* (K, SAN); SAN 126546: *A. suaveolens* (K, SAN); SAN 126716: *Fr. borneensis* (SAN); SAN 126731: *Fiss. fulgens* (SAN); SAN 126796: *Fiss. fulgens* (K); SAN 126847: *S. affinis* (SAN); SAN 126913: *S. affinis* (SAN); SAN 126915: *U. grandifolia* (K, SAN); SAN 127022: *A. suaveolens* (SAN); SAN 127122: *U. littoralis* (SAN); SAN 127364: *P. prismatica* (SAN); SAN 127597: *A. suaveolens* (SAN); SAN 127952: *A. suaveolens* (SAN); SAN 128075: *A. gracilis* (K, SAN); SAN 128125: *A. gracilis* (K, SAN); SAN 128155: *Fr. glauca* (SAN); SAN 128245: *M. clementis* (SAN); SAN 128311: *Fr. biglandulosa* (K, SAN); SAN 128460: *Fr. biglandulosa* (SAN); SAN 128859: *A. polygynus* (SAN); SAN 129337: *A. suaveolens* (K, SAN); SAN 129344: *A. costatus* (K, L, SAN); SAN 129351: *Fiss. carrii* (L, SAN); SAN 129431: *A. suaveolens* (SAN); SAN 129510: *D. acutus* (K, SAN); SAN 129559: *A. ochropetalus* (K, SAN); SAN 129595: *U. littoralis* (SAN); SAN 129933: *A. suaveolens* (SAN); SAN 130000: *A. costatus* (L, SAN); SAN 130103: *U. cuneifolia* (SAN); SAN 130134: *M. clementis* (K, SAN); SAN 130144: *Fiss. kingii* (SAN); SAN 130289: *U. grandiflora* (SAN); SAN 130604: *U. verrucosa* (SAN); SAN 130859: *U. excelsa* (SAN); SAN 130884: *Fiss. manubriatum* (K, SAN); SAN 131106: *U. excelsa* (SAN); SAN 131493: *Fr. biglandulosa*

(L, SAN, SAR); SAN 131515: *Fr. biglandulosa* (K, SAN); SAN 131931: *Fiss. brevistipitatum* (SAN); SAN 132017: *U. littoralis* (SAN); SAN 132255: *Fr. glauca* (SAN); SAN 132360: *U. grandiflora* (SAN); SAN 132626: *A. suaveolens* (SAN); SAN 132687: *Fr. biglandulosa* (SAN, SAR); SAN 132860: *Fiss. kingii* (SAN); SAN 132936: *Fr. glauca* (K, SAN, SAR); SAN 132949: *A. ochropetalus* (K, L, SAN); SAN 133079: *U. excelsa* (SAN); SAN 133165: *U. littoralis* (SAN); SAN 133299: *Fiss. brevistipitatum* (SAN, SING); SAN 133301: *A. macropodus* (SAN); SAN 133340: *Fiss. kingii* (A, K, SAN); SAN 133407: *A. suaveolens* (SAN); SAN 133454: *A. polygynus* (L, SAN); SAN 133461: *U. littoralis* (SAN); SAN 133971: *Fr. excisa* (K, SAN, SAR); SAN 134272: *A. polygynus* (L, SAN); SAN 134410: *Fr. biglandulosa* (A, SAN, SAR); SAN 134484: *U. monticola* (SAN); SAN 134563: *D. chinensis* (K, SAN, SAR); SAN 134815: *U. monticola* (SAN); SAN 135137: *A. costatus* (SAN); SAN 135255: *U. excelsa* (SAN); SAN 135723: *U. borneensis* (SAN); SAN 135822: *Fr. glauca* (SAN); SAN 135848: *M. clementis* (SAN); SAN 135917: *M. clementis* (SAN); SAN 135928: *A. ochropetalus* (L, SAN); SAN 135966: *D. dumosus* (SAN, SAR); SAN 135978: *Fiss. bygravei* (SAN); SAN 136077: *Fiss. bygravei* (L, SAN); SAN 136574: *U. grandiflora* (SAN); SAN 136711: *A. suaveolens* (L, SAN); SAN 136733: *Fr. biglandulosa* (K, L, SAN); SAN 136795: *A. suaveolens* (SAN); SAN 136853: *A. veldkampii* (SAN); SAN 136950: *U. excelsa* (K, SAN); SAN 136998: *Fiss. kingii* (K, SAN); SAN 137121: *M. clementis* (SAN); SAN 138346: *U. littoralis* (SAN); SAN 138410: *A. suaveolens* (SAN); SAN 139193: *A. suaveolens* (SAN); SAN 139291: *Fr. glauca* (SAN); SAN 139350: *A. suaveolens* (SAN); SAN 139526: *A. polygynus* (SAN); SAN 139559: *A. suaveolens* (SAN); SAN 139610: *A. suaveolens* (SAN); SAN 141048: *A. ochropetalus* (SAN); SAN 141487: *A. suaveolens* (SAN); SAN 141639: *U. borneensis* (SAN); SAN 141985: *Fiss. multivenium* (SAN); SAN 142979: *A. hirtipes* (K, L, SAN); SAN 143182: *U. monticola* (SAN); SAN 143349: *Fiss. kingii* (K, L, SAN, SING); SAN 143368: *U. javana* (SAN); SAN 143374: *A. ochropetalus* (SAN); SAN 143377: *D. chinensis* (K, SAN); SAN 143390: *U. littoralis* (SAN); SAN 143460: *Fiss. montanum* (K, L, SAN, SING); SAN 143523: *A. costatus* (K, SAN); SAN 143950: *U. monticola* (SAN); SAN 144055: *U. littoralis* (SAN); SAN 144147: *U. littoralis* (SAN); SAN 144148: *A. suaveolens* (SAN, SING); SAN 144330: *U. littoralis* (K, SAN); SAN 144516: *A. ochropetalus* (SAN); SAN 144753: *U. concava* (SAN); SAN 144767: *U. borneensis* (SAN); SAN 146089: *A. gracilis* (SAN); SAN 146096: *M. clementis* (SAN); SAN 146945: *A. suaveolens* (SAN); SAN 147972: *A. ?veldkampii* (SAN, SAR); SAN 148887: *A. suaveolens* (SAN); SAN 168499: *Fiss. multivenium* (SAN). **SBC** series; SBC 252: *U. lobbiana* (SAR); SBC 606: *U. lobbiana* (SAR); SBC 1479: *U. lobbiana* (SAR). **SFN** series; SFN 10303: *Fr. affinis* (K, SING); SFN 10487: *U. lanuginosa* (K); SFN 10524: *M. kentii* (K); SFN 10532: *Fiss. fulgens* (K, SAR); SFN 25128: *Fiss. latifolium* (K); SFN 25286: *Fr. biglandulosa* (K, SING); SFN 27006: *Fiss. carrii* (SING); SFN 27100: *Fiss. montanum* (SING); SFN 38982: *Fiss. fulgens* (K, SING). **Sibil**, J.; 136: *U. littoralis*; 306: *Fiss. kingii* (K, SAN). **Sidiyasa**, K.; 490: *U. curvistipitata* (L); 600: *M. kentii* (L); 668: *A. lanuginosus* (L); 775: *Fr. biglandulosa* (L); 1188: *U. javana* (K, SAN); 1270: *A. macropodus* (K, SAN); 1285: *U. monticola* (K); 1440: *Fiss. manubriatum* (K); 1602: *Fiss. kingii* (K, L); PBU 333: *A. gracilis* (L); PBU 342: *D. dumosus* (K); PBU 344: *M. kentii* (K); PBU 410: *A. gracilis* (L); PBU 422: *U. excelsa* (K); PBU 673: *A. macropodus* (K, L). **Sidiyasa, K. & Arifin**, Z.; 1602: *Fiss. kingii* (BO); 2003: *M. clementis* (BO). **Sidiyasa, K. & Kochummen**, K.M.; 565: *U. excelsa* (BO). **Sidiyasa, K. et al.**; Berau 1218: *A. suaveolens* (L); Berau 1235: *A. suaveolens* (L); Berau 1254: *A. macropodus* (L); Berau 1257: *A. macropodus* (K, L).

Sidkan, A.; 1101: *U. littoralis* (SAN). **Simpson**, D.A.; 2144: *U. littoralis* (K, SAN); 2617: *U. littoralis* (SAN). **Sinclair**, J.; 10490: *A. polygynus* (L). **Soetisna**, U.; 56: *M. clementis* (K). **Stevens, P.F. et al.**; 6: *D. dumosus* (SAN); 157: *Fiss. rugosum* (A, SAR, SAN); 365: *Fiss. fulgens*; 385: *Fiss. fulgens* (A, K, L, SAN); 400: *A. macropodus* (A, L, SAN); 410: *A. macropodus* (A, L, SAN); 419: *A. hirtipes* (A, L, SAN); 687: *U. littoralis* (A, SAN). **Subok**; 1064: *U. littoralis* (A). **Sugau**, J.; 288: *A. suaveolens* (K, SAN); 320: *U. littoralis* (SAN).

Teo, L.E. & Pachiappan, G.; T & P 1088(KL 3588): *Fr. korthalsiana* (K); T & P 1098 (KL 3598): *U. monticola* (K); T & P 1100 (KL 3600): *U. monticola* (K); T & P 1102 (KL 3602): *Fiss. kingii* (K); T & P 1116 (KL 3616): *U. lobbiana* (K). **Tadong, D.**; 13: *Fr. grandifolia* (K); 150: *D. chinensis* (K); 255: *U. concava* (K); 620: *U. excelsa* (K). **Tadong, L.**; 210: *U. littoralis*; 475: *U. littoralis* (K); 541: *U. littoralis* (K). **Takashi, S.**; 1405: *U. littoralis* (SAN). **Tandom**; 2955: *Fiss. fulgens* (K); 3317: *Fiss. fulgens* (K); 4212: *D. chinensis* (K, SING); 4791: *A. suaveolens* (K). **Teijsmann**, J.E.; 10838: *Fiss. rugosum* (L). **Thomas**, S.A.; 93: *A. suaveolens* (SAN); 232: *A. suaveolens* (SAN). **Tukirin**; 392: *U. schefferi* (K).

USEP; 56: *M. clementis* (K).

Valera, J.; 3819: *S. affinis* (K); 3823: *D. chinensis* (K). **van Balgooy**, M.M.J.; 5837: *A. gracilis* (L); 6083: *Fr. borneensis* (K, L); 6091: *Fiss. manubriatum* (L). **van Balgooy, M.M.J. & Kessler**, P.J.A.; 5923: *M. kentii* (K). **van Balgooy, M.M.J. & van Setten**, A.K.; 5499: *Fr. affinis* (BO, K, L); 5553: *Fr. excisa* (L); 5559: *Fr. excisa* (BO, L). **van Niel**, J.P.; 3906: *A. gracilis* (L); 3913: *Fiss. fulgens* (L); 4069: *Fiss. fulgens* (L); 4072: *Fiss. fulgens* (L); 4259: *M. kentii*; 4278: *Fiss. fulgens* (L); 4361: *Fr. biglandulosa* (L); 4465: *A. roseus* (L). **van Valkenburg**, J.L.C.H.; 1295: *P. prismatica* (K). **van Welzen**, P.C.; 866: *A. ochropetalus* (L). **Veldkamp**, J.F.; 8567: *A. veldkampii* (L); 8577: *A. gracilis* (L); 8574: *Fiss. bygravei* (L, SAR).

Winkler, H.; 2641: *Fiss. manubriatum* (K); 3000: *D. dumosus* (K). **Wiriadinata**, H.; 256: *M. clementis* (A, K); 3540: *Fr. glauca* (A); 3547: *A. ochropetalus* (L); 3550: *U. schefferi* (A, K); 3571: *A. veldkampii* (A, L). **Wong**, K.M.; WKM 109: *Fiss. fulgens* (K, SAN, SAR); WKM 308: *U. excelsa* (K); WKM 570: *U. beccarii* (K); WKM 1554: *A. suaveolens* (L, SAN); WKM 1851: *Fiss. montanum* (K); WKM 2233: *A. suaveolens* (K, SAN, SING); WKM 2319: *U. borneensis* (K, SAN, SING); WKM 2680: *A. ochropetalus* (K, L, SAN); sn: *U. littoralis* (SAN). **Wood, D.D.**; 444: *Fr. ?borneensis* (K); 1231: *Fr. biglandulosa* (A); 1303: *A. ochropetalus* (A); 2202: *Fiss. fulgens* (K). **Wood, G.H.S.**; A2920: *A. ochropetalus* (A, L, SING); A3686: *Fr. korthalsiana?* (K, SING); A4014: *U. grandiflora* (K, SING); A4040: *A. suaveolens* (K, SING); A4291: *U. borneensis* (A, SING); A4380: *A. veldkampii* (A, L, SING). **Wood, G.H.S. & Wyatt-Smith**, J.; A4226: *A. ochropetalus* (L, SING).

Studies in Malesian Gentianaceae II: A taxonomic framework for the *Fagraea* complex, including the new genus *Limahlania*

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ABSTRACT. A molecular phylogenetic study that provided good resolution of the *Fagraea* s.l. complex is the basis for constructing a new taxonomic framework in this group. The lineages identified showed good correspondence with other clades that represent well-established, recently revised genera in the tribe (Potalieae) and subtribe (Potaliinae) in terms of structure and statistical support (monophyly), and possessed recognisable morphological characteristics that were potentially synapomorphic for each monophyletic group. Generic identities are therefore adopted for the clades within this complex, as well as a somewhat isolated lineage, resulting in the definition of *Fagraea* Thunb. s.s.; the reapplication of *Cyrtophyllum* Reinw., *Picrophloeus* Blume, and *Utania* G.Don; and the circumscription of the new genus *Limahlania* K.M.Wong & Sugumaran. A key to the genera of the *Fagraea* complex is presented and nomenclatural notes are provided for each genus, in order to facilitate subsequent revisions. *Limahlania crenulata* (Maingay ex Clarke) K.M.Wong & M.Sugumaran and *U. volubilis* (Wall.) M.Sugumaran are new combinations. Lectotypes are selected for *C. peregrinum* Reinw., *F. ceilanica* Thunb., *Kuhlia morindifolia* Blume, and *P. javanensis* Blume.

Keywords. *Cyrtophyllum*, *Fagraea*, Gentianaceae, *Limahlania*, Malesia, *Picrophloeus*, phylogenetic classification, Potalieae, Potaliinae, *Racemosae*, *Utania*

From clades to genera: taxonomic concepts in the *Fagraea* complex

A new classification for the *Fagraea* Thunb. complex is proposed, based on the results of molecular phylogenetic analyses reported by Sugumaran & Wong (2012). In that study, five distinct lineages were clearly identified within *Fagraea* s.l. that were shown to correspond to other well established genera in the same tribe (Potalieae) (as treated by Struwe & Albert 1997, 2004; Struwe et al. 1994; Struwe et al. 2002), in terms of their monophyly in the molecular phylogenetic analyses as well as circumscription by potentially synapomorphic morphological characters.

The *Fagraea* clade in that study, which includes the type species for the genus, *F. ceilanica* Thunb., is the basis of the 'true' *Fagraea* (*Fagraea* s.s.). *Fagraea*

crenulata Maingay ex Clarke is considered representative of a distinct lineage because in the molecular phylogenetic study, it was only found to associate basally with the *Fagraea* clade by chloroplast gene characteristics, but not in the ITS analysis. It is also morphologically quite well distinguished from *Fagraea* s.s. No special generic name has been associated with this taxon and it is the basis of the new genus *Limahlania* K.M.Wong & M.Sugumaran.

The other clades correspond to genera resurrected from the synonymy of *Fagraea* s.l., and now reapplied to phylogenetically circumscribed entities in the complex. An appropriate name for the *Racemosa* clade of Sugumaran & Wong (2012) appears to be *Utania* G.Don, which was given to replace the illegitimate name *Kuhlia* Reinw. Don (1838) recognised one species, *U. morindifolia* which was later recombined as *Fagraea morindifolia* by Blume (1838). However *F. morindifolia* is a synonym of *F. volubilis* Wall. (Wong & Sugau 1996), which Sugumaran & Wong (2012: Fig. 5) demonstrated as belonging to their *Racemosa* clade. This group is consistently monophyletic in all the analyses with different gene regions.

Another interesting result of the study by Sugumaran & Wong (2012) is the paraphyly of *Fagraea* section *Cyrtophyllum* (Reinw.) Blume as defined by Leenhouts (1962a), which was consistently resolved as two distinct clades. Wong & Sugau (1996) recognised two complexes within this “section” which they differentiated by the exclusively axillary or terminal flowering habit. Indeed, these two complexes are equivalent to the distinct *Gigantea* and *Elliptica* clades, respectively, in the molecular analyses carried out. In the past, Ridley (1918) had regarded this “section” as a separate genus, i.e., *Cyrtophyllum* Reinw., as the species are so different, especially in their habit, in comparison to other epiphytic members of *Fagraea* s.l. For *Cyrtophyllum*, Blume (1826) had included two species, *C. peregrinum* Reinw. and *C. speciosum* Blume. Subsequent classification reduced *C. peregrinum* to a synonym of *F. fragrans* Roxb., and *C. speciosum* to synonymy under *F. elliptica* Roxb. (= *Picrophloeus* Blume now). The molecular analyses of Sugumaran & Wong (2012) show that *F. fragrans* falls within or is closely associated with the *Gigantea* clade, so that the generic name *Cyrtophyllum* is most applicable to the clade.

In the sectional classification of *Fagraea* s.l. (Leenhouts 1962a), both *Picrophloeus* and *Cyrtophyllum* were reduced to synonymy under *Fagraea* section *Cyrtophyllum*. *Picrophloeus* was established with only one described species, *P. javanensis* Blume that was considered synonymous with *F. elliptica*. Thus, the generic name *Picrophloeus* is applicable to the *Elliptica* clade.

Characters for clades: circumscription of genera

Sugumaran & Wong (2012) have surveyed the expression of a number of characters in the *Fagraea* complex, in comparison to other members of the *Potaliinae* (*Anthocleista* and *Potalia*). *Fagraea* s.s. (i.e., the *Fagraea* clade, and excluding *F. crenulata*) (Fig. 1) is distinguished by fruits that produce copious creamy pale yellowish latex in the epidermis and fruit wall. The rest of *Fagraea* s.l. have fruits that have no latex at all



Fig. 1. *Fagraea auriculata*. **A.** Tree with orthotropic complexes of branches. **B.** Each branch segment is potentially terminated by a cyme, here with fruits formed. **C.** A fruit longitudinally cut, revealing how easily the fruit epidermis detaches as a thin peel from the fruit wall, and latex oozing from the cut surface. **D.** Close-up of creamy pale yellowish latex oozing from wound following removal of a fruit calyx lobe. (Photos: K.M. Wong)

(*Utania* or the *Racemosa* clade, equivalent to *Fagraea* section *Racemosae* Benth., and also *Anthocleista* and *Potalia* (Struwe, pers. comm.)), or produce just a translucent gummy sap from the epidermis or wall when bruised (all others in *Fagraea* s.l.). Like *Anthocleista* and *Potalia*, *Fagraea* s.s. has ellipsoid-rounded seeds, contrasting with polygonal seed shapes found in *Cyrtophyllum*, *Limahlania*, *Picrophloeus* and *Utania*. *Fagraea* s.s. includes not only trees, but also species that are epiphytic, hemi-epiphytic and scramblers (life forms that are otherwise not found in the other groups of *Fagraea* s.l. and which are rare in the *Potaliinae* generally).

Limahlania (our new genus represented by *Fagraea crenulata*) has a number of unique characters in the subtribe, such as the development of prickles on the stem or trunk and branches (Fig. 2), and serrulate-crenulate leaf margins. It is also distinguished from all other taxa in the *Fagraea* complex, and also likely in the subtribe, by having Fagerlind's growth architectural model (Hallé et al. 1978; Sugumaran & Wong 2012). This architecture (Fig. 2) is characterised by episodic stem or trunk growth, non-equivalent vegetative axes (i.e., clear differentiation into trunk and branches), and a modular branching system that develops plagiotropically by substitution. In Malesia, the other lineages or clades in the *Fagraea* complex characterised by episodic growth and non-equivalent vegetative axes either develop according to Scarrone's model with orthotropic complexes of branches (*Fagraea* s.s.; the *Elliptica* clade or *Picrophloeus*) (Fig. 1 and 5), or Aubréville's model with branching that is plagiotropic by apposition (Fig. 4) (Hallé et al. 1978; Sugumaran & Wong 2012). These taxa all have a *monopodial* stem or trunk. Other (non-Malesian) taxa in the subtribe are so far documented with *modular* or *sympodial* stem or trunk systems (Hallé et al. 1978); they include the African *Anthocleista* (most species have Leeuwenberg's model) and the American *Potalia* (one species specially analysed corresponds to Chamberlain's model which produces a linear sympodium giving a monocaulous habit; others, including a suite of poorly known species are generally observed to be monocaulous: Struwe & Albert 2004). The apparent exception is a species of *Anthocleista* documented with Scarrone's model (Hallé et al. 1978). Also, Prevost (1978) identifies Koriba's model for the New Caledonian *F. schlechteri*.

On the other hand, *Limahlania* is related to *Fagraea* s.s. in having petiolar sheaths that do not or only slightly fuse at the edges, and a peltate stigma structure. It also resembles *Fagraea* s.s., *Cyrtophyllum* and *Picrophloeus* in having a fruit epidermis that detaches from the fruit wall easily as a peel, unlike in *Utania*, where the epidermis does not easily detach.

Utania (represented in the phylogenetic analyses of Sugumaran and Wong (2012) by the *Racemosa* clade) has the most potentially synapomorphic morphological characters among the *Fagraea* complex or the *Potaliinae*. These include a plant architecture (Roux's model; Hallé et al. 1978) with continuous stem or trunk growth, and plagiotropic branches with distichous leaf arrangement (Fig. 3); non-resinous terminal vegetative buds, and pendulous inflorescences. In comparison, all other members of the *Fagraea* complex or the subtribe have episodic stem or trunk growth, with either orthotropic complexes of branches, or branching that is plagiotropic by apposition or substitution. Other genera in the *Potaliinae* have resinous terminal vegetative buds



Fig. 2. *Limahlania crenulata*, showing Fagerlind's tree architectural model with episodic trunk development (producing branches in distinct tiers) and modular branch development producing a plagiotropic system by substitution (each segment potentially terminated by a cyme) (Photo: K.M. Wong). *Inset:* Trunk with prickles and developing a lightly fissured bark (Photo: M. Sugumaran).



Fig. 3. Growth architecture and flowering in *Utania*. Arrow indicating continuous orthotropic stem growth in *Utania volubilis* following Roux's model, where the shoot has no marked resting period and stem internode lengths are generally similar; and branches are plagiotropic (Photo: K.M. Wong). *Inset:* The pendulous, elongate terminal inflorescences with very condensed side-branches characteristic of the genus, in another *Utania* species (Photo: M. Sugumaran).



Fig. 4. Aubréville's architectural model in *Cyrtophyllum fragrans*. A series of vertical brackets shows distinct growth episodes on the monopodial trunk along which branching intervals generally alternate as shorter and longer episodes. The brackets along the branch system show repeated branch segments that develop plagiotropically by apposition (Photo: K.M. Wong). *Insets:* (*top*) The inflorescences are axillary and do not terminate the growth of branch segments. (*bottom*) Deeply fissured bark of adult. (Photos: M. Sugumaran).



Fig. 5. *Picrophloeus javanensis*. **A.** The tree architectural model of Scarrone found in this genus is typified by orthotropic branch complexes. **B.** Terminal cymes, with long-exserted stamens and styles in the flowers. (Photos: K.M. Wong)

(Struwe, pers. comm.). In structure, the *Utania* inflorescence is an elongate panicle with cymose branching (branches in several pairs, condensed, and distinctly shorter than the rachis). In other members of the *Fagraea* complex and Potaliinae, solitary flowers, 1–few-flowered cymes and branched cymes in which the basal branches are longest (nearly as long as the rachis, and mostly rebranched) occur. In addition, *Utania* fruits (like those of *Anthocleista* or *Potalia*; Struwe, pers. comm.) do not produce any latex, whereas those of other members of the *Fagraea* complex do. As explained above, *Utania* also has polygonal seeds, as in other members of the *Fagraea* complex except for *Fagraea* s.s. itself (which, like other Potaliinae, have ellipsoid-rounded seeds).

Cyrtophyllum (the Gigantea clade in the phylogenetic resolution of the *Fagraea* complex) and *Picrophloeus* (Elliptica clade in the same resolution) have superficial resemblance because of their small flowers and much-protruding stamens and styles (Fig. 5), compared to other groups, which generally have bigger flowers as well as less exerted stamens and styles. The only clear morphological distinction between these two genera is an important one: axillary inflorescences in *Cyrtophyllum* and terminal inflorescences in *Picrophloeus* (Fig. 4 and 5). Wong & Sugau (1996) had recognised these two groups as distinct complexes within the section *Cyrtophyllum* but even earlier, Ridley (1923) had accepted the group with axillary inflorescences (the Gigantea clade) as the distinct genus, *Cyrtophyllum*.

Key to genera formerly placed in *Fagraea* s.l.

- 1a. Inflorescences axillary. Trees with episodic stem / trunk growth, developing a wave-like sympodial branch system with successively higher orders of outwardly directed, then upturned, (indeterminate) branch segments (plagiotropism by apposition) *Cyrtophyllum*
- b. Inflorescences terminal. Trees, shrubs, scramblers or hemi-epiphytes with continuous or episodic stem / trunk growth; branches plagiotropic or orthotropic, if developing a wave-like sympodial branch systems then the branch segments truly modular (determinate) 2
- 2a. Stem / trunk growth continuous. Leaf arrangement on branches distichous. Vegetative terminal buds not resinous. Inflorescence a pendulous flowering cyme with all branches condensed along the rachis. Surface of dried fruits firm and smooth, the epidermis not detaching from the pericarp *Utania*
- b. Stem / trunk growth episodic. Leaf arrangement on branches decussate. Vegetative terminal buds covered with creamy to yellowish resin. Inflorescence without any branching (a solitary flower) or an erect cyme with well-developed branches. Surface of dried fruits wrinkled, the epidermis detaching from the pericarp 3

- 3a. Petiolar sheaths at the base of a leaf pair fully fused to form a cup-like ochrea. Stigma base not expanding conspicuously, the stigma capitate. Stamens and style exerted 40% or more from the corolla mouth *Picrophloeus*
- b. Petiolar sheaths at the base of a leaf pair not fused to slightly fused at the extreme edges and not forming an ochrea. Stigma base expanding into a circular plate-like rim, the stigma appearing peltate. Stamen and style not or only slightly exerted from the corolla mouth 4
- 4a. Stem/trunk bark becoming fissured, densely set with prickles. Leaf margin serrulate-crenulate. Branch system modular, developing plagiotropically by substitution to form a wave-like sympodial system. Seeds polygonal *Limahlania*
- b. Stem / trunk with smooth bark, sometimes becoming cracking-scaly, but never prickly. Leaf margin entire. Branch system non-modular, developing as orthotropic complexes and not wave-like in structure. Seeds ellipsoid-rounded *Fagraea*

Conspectus of genera in the complex

1. *Cyrtophyllum* Reinw.

in Hornschuch, Syll. Pl. Nov. 2 (1825) 8; Blume, Bijdr. Fl. Ned. Ind. (1826) 1022; Ridley, Fl. Malay. Pen. 2 (1923) 421. TYPE SPECIES: *C. peregrinum* Reinw. (= *C. fragrans* (Roxb.) DC.).

Distribution. Bengal, Indo-China, Malay Peninsula, Sumatra, Java, Borneo, Mindoro, Balabac, Palawan, Celebes and north-west New Guinea. Five species known.

NOTES ON TYPIFICATION:

Cyrtophyllum fragrans (Roxb.) DC., Prod. 9 (1845) 31.

Fagraea fragrans Roxb. [Hort. Beng. (1814) 84, *nom. nud.*], Fl. Ind. ed. Wall., 2 (1824) 32; Cammerl., Bull. Jard. Bot. Btzg. III, 5 (1923) 318. TYPE: *Hunter, Wallich Cat. no. 1597E*, "Pullo Penang" (holo K).

Cyrtophyllum peregrinum Reinw. in Hornschuch, Syll. Pl. Nov. 2 (1825) 9; Blume, Bijdr. Fl. Ned. Ind. (1826) 1022. LECTOTYPE (here chosen): *Reinwardt s.n.*, Java (L sheet no. 908.127-246 & barcode L0005030).

Cyrtophyllum was established with a single species, *C. peregrinum*, thus clearly the type. The second species in Blume (1826), *C. speciosum*, is synonymous with *Picrophloeus javanensis* Blume (1826).

The Wallich edition of the *Flora Indica* clearly mentions Hunter's collection from "Pullo Penang" under *F. fragrans*, so that the no. 1597E at Kew is the actual type. There is also material at De Candolle's Herbarium (GDC) numbered 1597A (from Martaban, Burma, not taken as type material) and 1597C (from Penang, Malay Peninsula, a possible isotype). There is a specimen at the Brussels Herbarium (BR, barcode 0000006912710) from the Martius Herbarium, which bears an annotation

stating that this was from Roxburgh's Herbarium and was obtained from an auction at the Linnean Society of London; this is not directly attributable to Hunter as collector and its status as type material is uncertain.

For lectotypification of *C. peregrinum*, it is to be noted that although Reinwardt (1825) in Hornschuch (1825–1828) did not explicitly indicate a specimen together with the species, the article in which his taxa were enumerated, *Nova plantarum indiarum genera*, concerned the plants of Java. Thus, we have selected Reinwardt's specimen for this purpose.

2. *Fagraea* Thunb.

Kongl. Vetensk. Acad. Handl. 3 (1782) 132, t. 4. TYPE SPECIES: *F. ceilanica* Thunb.

Distribution. Sri Lanka, India, across Indo-China, S China and Malesia, to northern Australia and Polynesia. Estimated 55 species.

NOTES ON TYPIFICATION:

Fagraea ceilanica Thunb., Kongl. Vetensk. Acad. Handl. 3 (1782) 132, t. 4. LECTOTYPE (here chosen): *Thunberg s.n.*, "e Ceilona" (UPS no. 004308; iso UPS no. 004309, iso S).

The lectotype (UPS 004308) and isolectotype at S have flowering material, the isolectotype at UPS has fruiting material only. The Stockholm duplicate was annotated "Habitat in Ceylona" in 1778, the year Thunberg completed his Ceylon visit. A specimen at the Linnean Society of London Herbarium (LINN barcode no. LINN-HS292-1) without a clear indication of collector but with Thunberg's species name and publication reference for this name written on it, is a possible isotype.

3. *Limahlania* K.M.Wong & M.Sugumaran, **gen. nov.**

Fagraeae Thunb. *sensu stricto similis sed architectura arboris, caulibus aculeis multis brevibus, foliis serrulatis-crenulatis et seminibus polygonalis differt.* TYPE SPECIES: *L. crenulata* (Maingay ex Clarke) K.M.Wong & M.Sugumaran.

Limahlania is distinguished from allied genera in the *Fagraea* complex by its development according to Fagerlind's architectural model (featuring episodic trunk growth and a modular branch system producing a wave-like sympodial series of axes), stem bark bearing prickles that are shed with maturity, serrulate-crenulate leaf margin, and polygonal seed shape. *Limahlania crenulata* (the Malayan *malabera*), like *C. fragrans* (the *tembusu padang* tree), has become a tree of some horticultural note in Southeast Asia, largely due to its ornamental form, beautiful blooms and adaptability to different site conditions. Both are botanically fascinating trees (Corner 1940; Hallé et al. 1978; Gardner et al. 2011, *sub Fagraea*).

This new genus honours Professor Lim Ah Lan, who has taught and supervised numerous students of plant biology at the University of Malaya, and who has been a most encouraging colleague throughout her long career there, completing in 2012.

Distribution. Malay Peninsula, Sumatra, Borneo (southwest and south Kalimantan), south Indo-China (Cambodia, S Vietnam). A single species.

NOTES ON TYPIFICATION:

Limahlania crenulata (Maingay ex Clarke) K.M.Wong & M.Sugumaran, **comb. nov.**
Fagraea crenulata Maingay ex Clarke in Hooker f., Fl. Brit. Ind. 4 (1883) 83; King & Gamble, J. As. Soc. Beng. 74 (2) (1908) 610; Cammerloher, Bull. Jard. Bot. Btzg. III, 5 (1923) 321; Ridley, Fl. Malay. Pen. 2 (1923) 420; Leenhouts, Fl. Males. I, 6 (2) (1962) 324; Kochummen, Tree Fl. Malaya 2 (1973) 271; Wong & Sugau, Sandakania 8 (1996) 59. TYPE: *Maingay s.n.*, Malacca (K).

Fagraea fastigiata auct. non Blume (1838): Ridley, J. Str. Br. R. As. Soc. 30 (1897) 167 *pro parte*, *quoad* Ridley 7552.

The original description in Hooker's publication only identifies the geographical provenance as "Malacca" for a Maingay collection without indicating number. The unnumbered sheet at K which was accessible to Clarke and Hooker is taken as type. At least two numbered Maingay specimens (1032, 2976) of this species exist at other herbaria (Leenhouts 1962b), so these are not considered type material, although conceivably the notes in Hooker could have meant a representation of this species via a number of Maingay's collections from Malacca, including both numbered and unnumbered material.

4. *Picrophloeus* Blume

Bijdr. Fl. Ned. Ind. (1826) 1019. TYPE SPECIES: *P. javanensis* Blume.

Distribution. Sumatra, Java, Malay Peninsula, Borneo, Celebes, Maluku, New Guinea. Four species.

NOTES ON TYPIFICATION:

Picrophloeus javanensis Blume, Bijdr. Fl. Ned. Ind. (1826) 1020. LECTOTYPE (here chosen): *Blume s.n.*, Java (L: 908.127-201, barcode L0005006).

Blume (1826) provided a brief description in Latin for the genus *Picrophloeus* but not the species *P. javanensis*, which was the sole species listed. A single description, or *descriptio generico-specifica*, for valid publication of both a genus and species, is accepted according to Article 42.1 of the Vienna Code (McNeill et al. 2006), when the genus has but a single species, at least at the time of description. Under the species, Blume stated "*in sylvis altioribus montis Salak*", which is attributable to the specimen *Blume*, Java at the Leiden Herbarium (L: sheet no. 908.127-201). Therefore the genus name *Picrophloeus* and the species *P. javanensis* are to be regarded as validly published.

5. *Utania* G.Don

Gard. Dict. 4 (1838) 663. TYPE SPECIES: *U. morindifolia* (Blume) G.Don (= *U. volubilis* (Wall.) M.Sugumaran).

Kuhlia Reinw. ex Blume, Bijdr. Fl. Ned. Ind. (1826) 777, *nom. illeg.*, non Kunth (1825). *Kentia* Steud., Nomencl. ed. 2 (1840) 845, *nom. illeg.*, non Blume (1838).

Distribution. Indo-China (Cambodia, S Vietnam), the Andaman and Nicobar Islands, Malay Peninsula, Sumatra, Java, Borneo, Celebes, Maluku, the Philippines and New Guinea. Estimated 15 species.

NOTES ON TYPIFICATION:

Utania volubilis (Wall.) M.Sugumaran, **comb. nov.**

Fagraea volubilis Wall. in Roxb., Fl. Ind. ed. Wall. 2 (1824) 36; Wong & Sugau, Sandakania 8 (1996) 40. TYPE: *Jack*, E. Bencoolen (Herb. Wallich, sheet marked "1600. E. Bencoolen" on bottom left) (holo K).

Kuhlia morindifolia Blume, Bijdr. Fl. Ned. Ind. (1826) 777; *F. morindifolia* (Blume) Blume, Rumphia 2 (1838) 32, t. 73; *U. morindifolia* (Blume) G.Don, Gard. Dict. 4 (1838) 663. LECTOTYPE (here chosen): *Anon.* (probably Blume), Java (L: sheet no. 908.127-731, barcode L0005046; isolecto L: sheet no. 908.127-721; isolecto K).

Utania was a new name for the illegitimate *Kuhlia* and was accompanied by a genus description (in English, acceptable under Article 36.1 of the Vienna Code: McNeill et al. 2006). Don listed a single species under his *Utania* as "1. K. MORINDAEFOLIA" (in error for what he should have indicated as "1. U. MORINDAEFOLIA" consistent with the general format of his enumeration of taxa). Under this species, he referred to the locality "Native of Java, at the foot of Mount Salak" and also cited "*Kuhlia morindaefolia* Blum. bijdr. p. 777" (1826), in which there is a description. Thus *Utania* is a validly published genus name and the only one available for use in reference to *Fagraea* section *Racemosae*.

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REFERENCES

- Blume, C.L. (1826) *Bijdragen tot de Flora van Nederlandsch Indië*. Pp. 1020–1022. Batavia: Lands Drukkerij .
- Blume, C.L. (1838) *Rumphia*. Vol. 2. Leiden.
- Commerloher, H. (1923) Die Loganiaceen und Buddleiaceen Niederländisch-Indiens. *Bull. Jard. Bot. Buitenzorg*. Series III, 5 (4): 295–338.
- Candolle, A.P. de (1845) *Prodromus systematis naturalis regni vegetabilis, sive enumeratio contracta ordinum generum specierumque plantarum huc usque cognitarium, juxta methodi naturalis, normas digesta*. Vol. 9. Paris: Sumptibus Sociorum Treuttel et Würtz.
- Corner, E.J.H. (1940) *Wayside Trees of Malaya*. 2 vols. Singapore: Government Printing Office.
- Don, G. (1838) *A General System of Gardening and Botany* [containing a complete enumeration and description of all plants hitherto known with their generic and specific characters, places of growth, time of flowering, mode of culture and their uses in medicine and domestic economy: preceded by introductions to the linnaean and natural systems and a glossary of the terms used; founded upon Miller's Gardener's dictionary and arranged according to the natural system]. Vol. 4. London: J.G. & F. Rivingston.
- Gardner, S., Sidisunthorn, P. & Lai, E.M. (2011) *Heritage Trees of Penang*. Penang: Areca Books.
- Hallé, F. Oldeman, R.A.A. & Tomlinson, P.B. (1978) *Tropical Trees and Forests. An Architectural Analysis*. 411 p. Berlin: Springer-Verlag.
- Hooker, J.D. (1883) *The Flora of British India*. Vol. 4. Pp. 82–85. London: L. Reeve & Co.
- Hornschuch, C.F. (1825–1828) *Sylloge Plantarum Novarum Itemque Minus Cognitarum a Praestantissimis Botanicis adhuc Viventibus Collecta et a Societate Regia Botanica Ratisbonensi Edita*. Vol. 2. Ratisbonae: C.E. Brenck.
- King, G. & Gamble, J. S. (1904) *Materials for a Flora of the Malayan Peninsula*. Pp. 813–822. Calcutta: Baptist Mission Press.
- Kochummen, K.M. (1973) Loganiaceae. In: Whitmore, T.C. (ed.), *Tree Flora of Malaya*. Vol. 2. Pp. 296–275. Kuala Lumpur: Longman Malaysia.
- Kunth, K.S. (1825) *Nova genera et species plantarum*. Vol. 7: 234, t. 652. Lutetiae Parisiorum: sumtibus Librariae Graeco-Latino-Germanico.
- Leenhouts, P.W. (1962a) Loganiaceae. In: Steenis, C.G.G.J. van (ed.), *Flora Malesiana*. Series 1 Vol. 6. Pp. 293–336. Groningen: Wolters-Noordhoff Publishing.
- Leenhouts, P.W. (1962b) Identification Lists of Malaysian Specimens, 18. Loganiaceae. Leyden: Foundation Flora Malesiana.
- McNeill, J., Barrie, F.R., Burdet, H.M., Demoulin, V., Hawksworth, D.L., Marhold, K. et al. (eds) (2006) International Code of Botanical Nomenclature (Vienna Code) adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Ruggell: A. R. G. Gantner Verlag KG [Regnum Veg. vol. 146].
- Prevost, M.-F. (1978) Modular construction and its distribution in tropical woody plants. In: Tomlinson, P.B. & Zimmermann, M.H. (eds) *Tropical Trees as Living Systems*. New York: Cambridge Univ. Press.
- Ridley, H.N. (1897) Malay plant names. *J. Straits Branch Roy. Asiat. Soc.* 30: 31–283.
- Ridley, H.N. (1918) New and rare Malayan plants. *J. Straits Branch, Roy. Asiatic Soc.* 79: 97–98.
- Ridley, H.N. (1923) *The Flora of the Malay Peninsula*. Vol. 2. Pp. 415–422. London: L. Reeve & Co.

- Roxburgh, W. (1814) *Hortus Bengalensis, or a Catalogue of the Plants Growing in the Honourable East India Company's Botanical Garden at Calcutta*. Serampore, Calcutta.
- Roxburgh, W. (1824) *Flora indica, or, Descriptions of Indian plants, by the late William Roxburgh*. Edited by Dr. William Carey; to which are added descriptions of plants more recently discovered by Dr. Nathaniel Wallich. Vol. 2. Serampore: Mission Press.
- Stuedel, E.G. (1840–1841) *Nomenclator botanicus, seu. Synonymia plantarum universalis: enumerans ordine alphabetico nomina atque synonyma, tum generica tum specifica, et a Linnaeo et a recentioribus de re botanica scriptoribus plantis phanerogamis imposita*. Stuttgart: J.G. Cottae.
- Struwe, L., Albert, V.A. & Bremer, B. (1994) Cladistics and family level classification of Gentianales. *Cladistics* 10: 175–206.
- Struwe, L. & Albert, V.A. (1997) Floristics, cladistics and classification: three case studies in Gentianales. In: Dransfield, J., Coode, M.J.E. & Simpson, D.A. (eds.), *Plant Diversity in Malesia, III*. Pp. 321–352. Kew: Royal Botanic Gardens, Kew.
- Struwe, L., Kadereit, J., Klackenberg, J., Nilsson, S., Thiv, M., Hagen, K.B. von & Albert, V.A. (2002) Systematics, character evolution and biogeography of Gentianaceae, including a new tribal and subtribal classification. In: Struwe, L. & Albert, V.A. (eds.), *Gentianaceae—systematics and natural history*. Pp. 21–309. U.K., Cambridge: Cambridge University Press.
- Struwe, L. & Albert, V.A. (2004) A monograph of neotropical *Potalia* (Gentianaceae: Potalieae). *Syst. Bot.* 29: 670–701.
- Sugumaran, M. & Wong, K.M. (2012) Studies in Malesian Gentianaceae I: *Fagraea* sensu lato—complex genus or several genera? A molecular phylogenetic study. *Gard. Bull. Sing.* 64(2): 301–332.
- Thunberg, C.P. (1782) Beskrifning pa et nytt och vackert orter Genus, Kalladt *Fagraea ceilanica*. *Kongl. Vetensk. Acad. Handl.* 3: 132–134, tab. IV.
- Wong, K.M. & Sugau, J.B. (1996) A revision of *Fagraea* (Loganiaceae) in Borneo, with notes on related Malesian species and 21 new species. *Sandakania* 8: 1–93.

Studies in Malaysian Gentianaceae III: *Cyrtophyllum* reapplied to the *Fagraea fragrans* alliance

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ABSTRACT. *Cyrtophyllum* Reinw., one of several distinct lineages among the *Fagraea* complex, is the correct genus to which five species of Southeast Asian trees should be assigned, including the widespread *F. fragrans*. *Cyrtophyllum minutiflorum* K.M.Wong is a new species described here. Two new combinations are made: *C. caudatum* (Ridl.) K.M.Wong and *C. wallichianum* (Benth.) M.Sugumaran & K.M.Wong.

Keywords. *Cyrtophyllum*, *Fagraea fragrans*, Gentianaceae, Malesia, Potalieae, Potaliinae, Southeast Asia

Introduction

The results of a molecular phylogenetic study of the *Fagraea* complex (Sugumaran & Wong 2012) demonstrated the distinctness of a number of generic lineages from *Fagraea* Thunb. s.s. (Wong & Sugumaran 2012). Among these, *Cyrtophyllum* Reinw. and *Picrophloeus* Blume were readily distinguished from *Fagraea* s.s., *Limahlania* K.M.Wong & M.Sugumaran and *Utania* G.Don because the first two genera have flowers with conspicuously exerted styles (typically more than 40% of their length) and filaments (greater than 70% of their length) (Sugumaran & Wong 2012). Also, *Cyrtophyllum* and *Picrophloeus* frequently have cymes bearing numerous small flowers (corollas narrow, the mouth often not more than 10 mm wide), compared to the other genera, which typically have larger flowers (corollas typically much wider) in variable numbers. However, *Cyrtophyllum* has axillary cymes and Aubréville's tree architectural model, whereas *Picrophloeus* and the other three genera all have terminal cymes and consistently other architectural models (Scarrone's in *Picrophloeus* and *Fagraea* s.s., Fagerlind's in *Limahlania*, Roux's in *Utania*) (Sugumaran & Wong 2012; Wong & Sugumaran 2012).

The history of *Cyrtophyllum* is interesting. Ridley (1893) had used the name *C. fragrans* (Roxb.) DC. Later, he described an allied species under *Fagraea*, but nevertheless appreciated (Ridley 1918) that this genus name was available for the alliance of trees that was quite different from *Fagraea*: "It would probably be best to

keep up the genus *Cyrtophyllum* for the Tembusu trees which differ so much from the epiphytic true *Fagraea*s with their fleshy leaves and flowers, and included stamens, from the tall trees with their leaves and flowers and long projecting stamens. The genus *Cyrtophyllum* would thus contain *C. fragrans*..., *C. giganteum*..., *C. wallichii*..., *C. caudatum*..." In his *Flora of the Malay Peninsula* (Ridley 1923), he adopted *Cyrtophyllum* for this group of species. Burkill (1935), on the other hand, took the broad view as Blume (1838) did, and, under *Fagraea*, stated: "*Cyrtophyllum*... which some botanists separate, is not really distinct, and is united here." The uncertainties have found their way as different taxonomic approaches throughout this period, viz., as a section of *Fagraea* (Blume 1838); as a subgenus of *Fagraea* (Miquel 1857); and more recently as Blume's section again but with more discordant elements thrown in (Leenhouts 1962; see also Wong & Sugau 1996).

Here we provide a revision of *Cyrtophyllum*, which includes the well-known tree species in Southeast Asia, *C. fragrans* (synonym *Fagraea fragrans* Roxb.).

Cyrtophyllum Reinw.

in Hornschuch, Syll. Pl. Nov. 2 (1825) 8; Blume, Bijdr. Fl. Ned. Ind. (1826) 1022; Ridley, Fl. Malay. Pen. 2 (1923) 421; Wong & Sugumaran, Gard. Bull. Sing. 64 (2012) 490. TYPE SPECIES: *C. peregrinum* Reinw. (= *C. fragrans* (Roxb.) DC.).

Fagraea sect. *Cyrtophyllum* (Reinw.) Blume, Rumphia 2 (1838) 34 *pro parte* excl. *F. speciosum*; Leenhouts, Fl. Males. I, 6 (1962) 303 *pro parte* excl. *F. elliptica* & *F. umbelliflora*; Wong & Sugau, Sandakania 8 (1996) 7 *pro parte* excl. *F. elliptica*. – *Fagraea* sect. *Parviflorae* Benth., J. Linn. Soc. Bot. 1 (1857) 100 *pro parte quoad* *C. peregrinum*. – *Fagraea* subg. *Cyrtophyllum* (Reinw.) Miq., Fl. Ind. Bat. 2 (1857) 375 *pro parte* excl. *F. sumatrana*.

Medium-sized to large trees usually more than 3 m and some reaching 25–30 m tall. **Trunk** monopodial with episodic growth; developing wave-like sympodial branch systems or 'terminalian' branching with successively higher orders of outwardly directed, then upturned, (indeterminate) branch segments (plagiotropism by apposition) (Aubréville's architectural model *vide* Hallé et al. 1978). Trunk bark becoming fissured in older trees. Vegetative **shoot apices** with light yellowish resin. Leaf arrangement on branches decussate; leaf margin entire; **petiolar sheaths** of a leaf pair fused and forming a shallow cup-like ochrea that loosely clasps the stem; petiolar base auricles absent. **Inflorescence** axillary, a few- to many-flowered and few- to multi-branched cyme, basal branches nearly as long as or longer than rachis. **Flowers** bisexual, small, up to 10 mm wide at the corolla mouth; calyx lobes 5; corolla white to creamy white, corolla lobes 5, overlapping to the right; stamens 5, typically two thirds or more exsert, anthers versatile, sagittate; style typically one third or more exsert; stigma capitate (knob-like). **Fruits** small, subglobose to slightly ellipsoid, up to about 10 mm in diameter; colour at maturity yellow-orange to bright red; with small amounts

of translucent sticky latex in fruit epidermis and fruit wall: epidermis separating as a thin translucent film from pericarp (fruit surface appearing crinkled on herbarium specimen). **Seeds** numerous; placentation axile; polygonal; surface areolate.

Distribution and diversity: Bengal, Burma, Thailand, Indo-China, Andaman Islands, Malay Peninsula, Sumatra, Java, Borneo, Mindoro, Balabac, Palawan, Celebes and north-west New Guinea. Five species known.

Habitat. Lowland forests.

Key to *Cyrtophyllum* species

- 1a. Inflorescence branching to just 1, rarely 2, orders. Corolla tubes 10–25 mm long; stamens with filaments 16–38 mm long; styles 14–55 mm long. 2
- 1b. Inflorescence branching to 2–4 orders. Corolla tubes not exceeding 10 mm long; stamens with filaments 7–17 mm long; styles 9–22 mm long. 3
- 2a. Leaf apex caudate. Calyx 2.5–3 mm across, corolla tube subcylindric (not conspicuously flared in its upper part), 10–12 mm long. (Borneo) *C. caudatum*
- 2b. Leaf apex acuminate. Calyx 3–4 mm across, corolla tube infundibular (flared in its upper part), 12–25 mm long. (Malay Peninsula) *C. wallichianum*
- 3a. Corolla tube infundibular (flared in the upper half), larger (lower narrowed part of corolla 1.5–2(–2.5) mm wide); leaf secondary veins flat or slightly raised on the upper leaf surface in dried material *C. fragrans*
- 3b. Corolla tube subcylindric (not noticeably flared in the upper part), smaller (lower narrowed part of corolla 1–1.5 mm wide); leaf secondary veins flat to frequently sunken on the upper leaf surface in dried material 4
- 4a. Leaves chartaceous, margin conspicuously wavy (more conspicuously so in fresh material), secondary veins forking towards the leaf margin but not forming conspicuous loops; pedicels 3–5 mm long (flowers distinctly pedicellate); corolla tube 7–8 mm long; style 12–22 mm long. (Widespread across Malesia.) *C. giganteum*
- 4b. Leaves coriaceous, margin plane, secondary veins forming distinct loops towards the margin; pedicels 0–1 mm long (flowers sessile); corolla tube 4–5 mm long; style 9–10 mm long. (Restricted to Borneo.) *C. minutiflorum*

1. *Cyrtophyllum caudatum* (Ridl.) K.M.Wong, **comb. nov.** — *Fagraea caudata* Ridl., J. Str. Br. Roy. As. Soc. 79 (1918) 97; Merr., J. Str. Br. Roy. As. Soc. Sp. No. (1921) 491; Wong & Sugau, Sandakaniana 8 (1996) 8; Coode et al. Checkl. Fl. Pl. Gymn. Brunei (1996) 174. TYPE: *Lobb s.n.*, 1853, 'Borneo' (Sarawak) (holo K).

Fagraea fragrans auctt. non Roxb., Leenhouts, Fl. Males. I, 6 (1962) 304 *pro parte*, Ashton, Manual Non-Dipt. Trees Sarawak 2 (1988) 310 *pro parte*, quoad *F. caudata* in syn.

Tree, 6–7 m tall, perhaps bigger; trunk to 2.5 cm diameter or more; **bark** smooth, dark brown. **Leaves** elliptic to slightly oblanceolate; (4–)7–9(–11) cm long, (1.5–)2.5–3.5(–4) cm wide; base cuneate; apex caudate, 1–1.5 cm long; margin plane when fresh and in dried specimens; coriaceous; upper and lower surfaces smooth; midrib prominent below, sunken above; secondary veins 7–9 pairs, upper side faint and immersed in the blade, lower side faint to very slightly sunken or even prominent; tertiary veins faint to inconspicuous; petioles 0.8–2.2 cm long, 1.5–2 mm thick, petiolar sheaths of a leaf pair fused and forming a shallow cup-like ochrea that tightly clasps the stem; petiolar base auricles absent. **Inflorescence** a few-flowered cyme 5–9.5 cm long; peduncle 2.5–6 cm long, 1(–1.5) mm thick; with just a single level (tier) of branching on the main axis, typically not rebranched. **Flower** pedicel 5–10 mm long, c. 1 mm thick; **calyx** (from the base to the lobe apices) 3.5–4 mm long, glabrous, calyx cup 2.5–3 mm wide, calyx lobes erect, 1–1.5 mm long, 1–1.5 mm wide, margins glabrous; **corolla** tube subcylindric, 10–12 mm long, 1.5–2 mm wide near the base, inside glabrous to minutely papillate; corolla lobes broad-ovate to subobovate, 5–6 mm long, 4–5 mm wide; **stamens** inserted at the uppermost third of the corolla tube; filaments 16–18 mm long, exert 11–12 mm in the open flower; anthers not seen; **style** 14–15 mm long, protruding 11–13 mm from the corolla mouth in the open flower; **stigma** c. 0.3 mm across. **Infructescence** peduncle 4–7.5 cm long, 1–1.5 mm thick. **Fruits** (immature) to 5–6 mm across; the base loosely to tightly clasped by the calyx lobes. **Seeds** not examined.

Distribution. Endemic to NW Borneo (SW Sabah, Brunei, Sarawak).

Habitat. Hills and ridges in lowland mixed dipterocarp forest.

Specimens examined: BORNEO. **Brunei.** Belait, Batu Patam, along ridge north of summit, Wong WKM 1060 (BRUN, K, SING). **Sarawak.** Beccari 2956 (K); 1st Div. Gunung Santubong South, Bujang S. 12999 (K, L, SAR, SING); Bako N.P., Lintang path, Chai S. 19707 (A, BO, K, KEP, L, MEL, MOSC, SAN, SAR, SING), Bukit Gondol, Ilias S. 17908 (A, BO, K, KEP, L, SAN, SAR, SING), Md. Shah P. 5647 (A, K, L, SAR, SING); Lobb s.n. 1853 (holo K); 1st Div. Mt. Matang, near Valombrosa, M. & J. Clemens 7783 (K); Mt Mike Low LYW 213 (KLU); Bintulu, Nyabau F.R., Brunig S. 12050 (SAR); Lambir N.P., Sg. Jangkang, Mokhtar et al. S. 47187 (K, KEP, L, MO, SAN, SAR); Kuching, Ulu Sg. Rayu, Yakup S. 7716 (SAR, SING); Kelaung F.R., sine coll. S. 7431 (SAR).

Ridley (1918) observed that the species he was describing under *Fagraea*, when appropriately transferred to *Cyrtophyllum*, should be *C. caudatum*, although that combination was not effected.

2. *Cyrtophyllum fragrans* (Roxb.) DC., *Prod.* 9 (1845) 31; Ridley, *Trans. Linn. Soc. Lond.* 2nd ser. *Bot.* 3 (1893) 323. — *Fagraea fragrans* Roxb. [*Hort. Beng.* (1814) 84, *nom. nud.*], *Fl. Ind.* ed. Wall., 2 (1824) 32; Don, *Gard. Dict.* 4 (1837) 68; Blume, *Mus. Bot.* 1 (1850) 172; Benth., *J. Linn. Soc. Bot.* 1 (1857) 100; Miq., *Fl. Ind. Bat.* 2 (1857) 375; Kurz, *For. Fl. Brit. Burm.* 2 (1877) 205; Clarke in Hooker f., *Fl. Brit. India* 4 (1883) 85; Ahern, *Compil. Timber Tree Philip. Isl.* (1901) 88, pl.; Koord. & Val., *Bijdr.* 9 (1903) 86; Ridley, *J. Str. Br. Roy. As. Soc.* 50 (1908) 121; Elm., *Leaf. Philip. Bot.* 2 (1909) 597; Dop, *Fl. Gén. I.-C.* 4 (1914) 177; Merrill, *J. Str. Br. Roy. As. Soc. Sp. No.* (1921) 492; Cammerl., *Bull. Jard. Bot. Btzg.* III, 5 (1923) 318; Foxw., *Mal. For. Rec.* 3 (1927) 157; Corner, *Wayside Trees Malaya* (1940) 424; Kerr in Craib, *Fl. Siam. En.* 3 (1951) 55; Browne, *For. Trees Sar. & Brun.* (1955) 244, t. 32; Smythies, *Common Sarawak Trees* (1965) 87; Kochummen, *Tree Fl. Malaya* 2 (1973) 273; Cockburn, *Trees Sabah* 1 (1976) 211; Wong & Sugau, *Sandakaniania* 8 (1996) 11; Coode et al. *Checkl. Fl. Pl. Gymn. Brunei* (1996) 174. — *Willughbeia fragrans* (Roxb.) Spreng. *Syst. Veg.* 4 (1827) *Cur. Post.* 71. TYPE: *Hunter*, Wallich *Cat. no.* 1597E, “Pullo Penang” (holo K).

Cyrtophyllum peregrinum Reinw. in Hornschuch, *Syll. Pl. Nov.* 2 (1825) 9; Blume, *Bijdr. Fl. Ned. Ind.* (1826) 1022; DC., *Prod.* 9 (1845) 31; Ridley, *Fl. Malay. Pen.* 2 (1923) 421; Holttum, *Gard. Bull. S.S.* 5 (1931) 189. — *Fagraea peregrina* Blume, *Rumphia* 2 (1838) 34, t. 80; *Mus. Bot.* 1 (1850) 172. LECTOTYPE (Wong & Sugumaran 2012): *Reinwardt s.n.*, Java (L sheet no. 908.127-246 & barcode L0005030).

Fagraea cochinchinensis A. Chev., *Cat. Pl. Jard. Bot. Saigon* 33 (1919) 66, *pro specim.*, Merrill, *Enum. Philip. Fl. Pl.* 3 (1923) 314, *pro specim.*, *non basionym Aidia cochinchinensis* Lour., *Fl. Cochinch.* 1 (1790) 143.

Fagraea fragrans auctt. non Roxb.: King & Gamble, *J. As. Soc. Beng.* 74 (2) (1908) 611 *pro parte*, excl. *Derry* 272; Leenhouts, *Fl. Males.* I, 6 (1962) 304 *pro parte*, Ashton, *Manual Non-Dipt. Trees Sarawak* 2 (1988) 310 *pro parte*, excl. *F. caudata* Ridl., *F. gigantea* Ridl., *F. speciosa sensu* Ridl. *non* Blume, *F. sororia* J.J.Sm., *F. wallichiana* Benth., *F. lanceolata* Wall. in syn.; Kochummen, *Tree Fl. Malaya* 2 (1973) 273 *pro parte*, excl. *Cyrtophyllum lanceolatum*, *Fagraea wallichiana* in syn.; Griffin & Parnell, *Fl. Thailand* 6 (3): 198 *pro parte*, excl. *C. giganteum* Ridl. in syn.

Tree, rarely to just 3–4 m tall, more often big, to 30 m tall; trunk to over 1 m in diameter; **bark** deeply and ruggedly fissured, grey-brown to dark brown. **Leaves** elliptic; (5.5–)7.5–11(–13) cm long, (2–)3.5–4.5(–5.3) cm wide; base cuneate; apex short-cuspidate to caudate; (3–)5–8(–9) mm long; margin plane when fresh (in dried specimens sometimes slightly wavy); chartaceous to thin-coriaceous; upper and lower surfaces smooth; midrib prominent below, flat to slightly raised above; secondary veins (7–)9–12 pairs, upper side faint and immersed in the blade, lower side faint to very slightly prominent; tertiary veins faint to inconspicuous; petioles 1–1.3(–1.6) cm

long, 1–1.5 mm thick. **Inflorescence** (3.5–)4–7(–7.7) cm long; peduncle (2.8–)3–3.5 cm long, 1–1.5 mm thick; with (2–)3(–4) levels (tiers) of branching on the main axis, the branch tiers (2–)3–5(–6) mm apart, lowest tier typically branched to 2(–3) orders. **Flower** pedicel (3–)5–8(–11) mm long, 0.5(–1) mm thick; **calyx** (from the base to the lobe apices) (1.5–)2–2.5 mm long, glabrous, calyx cup (1.5–)2–2.5(–3) mm wide, calyx lobes erect, 1–1.5(–2) mm long, 1–1.5(–2) mm wide, margins glabrous; **corolla** tube somewhat infundibular, (4–)6–8 mm long, lower narrowed part 1.5–2(–2.5) mm wide, upper flared part (3–)4–6(–7) mm wide at the top, the lower narrowed tubular part nearly as long as the upper flared part, inside glabrous to minutely papillate; corolla lobes broad-ovate to subobovate, (3–)4–6 mm long, 2–3(–4) mm wide; **stamens** inserted at the middle of the upper flared part of the corolla tube; filaments (10–)12–16(–17) mm long, exert (8–)10–12(–13) mm in the open flower; anthers 1–1.5 mm long, 0.5–1 mm wide, each anther sac somewhat narrowly ellipsoid; **style** (14–)18–22 mm long, protruding (8–)10–12(–14) mm from the corolla mouth in the open flower; **stigma** c. 0.5 mm across, lobes 2, low and rounded, parting to present two slightly raised, hemispherical, papillate inner surfaces when receptive, not recurving. **Infructescence** peduncle (2.5–)3.5–5(–6.2) cm long, 1–2 mm thick. **Fruit** when mature to 4–6 mm across; the base loosely to tightly clasped by the calyx lobes. **Seeds** 0.5–1 mm across.

Distribution. Principally a mainland SE Asia and W Malesian species: Bengal, Andaman Islands, Burma, Thailand, Indo-China (Laos, Vietnam, Cambodia), Malay Peninsula, Sumatra, Java, Borneo, SW Philippines (the Palawan chain from Balabac NW through Palawan, Culion and Busuanga, and continuing into Mindoro); also Celebes.

Habitat. One of our most commonly encountered trees in West Malesia, *Cyrtophyllum fragrans* establishes easily in open areas and secondary forests including along roadsides. It grows easily on sandy sites, including around sandy tailings of former tin-mines in the Malay Peninsula. It is less commonly found in lowland high forest, but easily encountered in *kerangas* (tropical heath forest) vegetation and coastal or beach forest.

Specimens examined: BORNEO. **Brunei.** Belait, Anduki F.R., *Anderson S. 4941* (SAR), Andulau, Taman Rekreasi Hutan Sungai Liang, *Sugumaran et al. SM 227* (KLU), Sungai Liang, *Hussain HUS 30* (BRUN, SING). **Kalimantan.** Bandjermasin, *Boschwezen 2176* (BO); Sanggau, Pengoedang, *Neth. Ind. For. Service bb 29174* (SING); Sentarum Wildlife Reserve, far north-west corner of Danau, Sungei Seriang, *Giesen 140* (K), western border of Danau, Nanga Kenelang, *Giesen 148* (K); Sungai Kenara, *Hallier 1359* (P, SING). **Sabah.** “N Borneo”, *Vilamil 300* (P); Beaufort, *Cuadra Nbfd A 1377* (K, SING); Gaya Island F.R., *Kuripin SAN 28778* (SING), Gaya island (south), *Aban SAN 57839* (SAN); Jesselton, *Wood 2557* (SING); Kimanis, *Bayak Nbfd 2114* (K); Kota Belud, Kampung Lantige & Abai R. F.R., *Kandilis 7118* (SING); Kuala Penyu, Road to Pantai Tanjung Aru, *Rimi et al. SPN 06605* (KEP); Mempakul, Bangawan, *Abubakar Nbfd 4111* (K, SING); Papar, Mandahan, *Dewol & Termiji SAN 80011* (SAN, SING), *Talip Bidin SAN 80685* (KEP, SAN, SING); Sandakan, below

Mr. Fox House, 50 ft. *Juli SAN 65627* (SAN, SING); Sandakan, below Sabah Hotel, *Sam SAN 25509* (SAN, SING); Sandakan, Chinese Cemetery, *Chow & Aban SAN 75925* (SAN, SING); Sandakan, Elopura, *Agama A 2102* (SING), *Cuadra A 2218* (SING), Darby road, *Cuadra A 3197* (K, SING); Sandakan, Ernestina Road, *Meijer SAN 24941* (SAN, SING); Sandakan, Jalan Kapok, *Clemente 4963* (SING); Sandakan, Leila F.R., 300 ft, *Leopold & Termiji SAN 76680* (SAN, SING); Sandakan, Mile ¹/₄ Derby road, *Aban Gibot SAN 75916* (KEP, SAN); Sandakan, Taman Rimba Sport Complex, *Dewol SAN 105553* (SAN, SING). **Sarawak.** *Beccari 3428* (K); *J. & M.S. Clemens 22561* (P: barcode P03976237); Kuching, Museum Garden, *Mamit S. 33492* (SAR); Kuching, Taman Budaya, *Yahud et al., S. 57555* (K, KEP, L, MO, SAN, SAR); Simunjan, Balai Ringin P.F., *Stipni Bin Dollah S. 303* (SAR, SING), *1705* (SAR); Sadong, Ulu Gunong, *Omar 64* (SING).

BURMA. **Martaban.** *Wallich Cat. no. 1597a* (GDC: barcode G00134008), *Wallich Cat. no. 1597b* (P: barcode P00349660), *Wallich s.n.* (P: barcode P00349658). **Tenasserim & Andamans.** *Helfer 3735* (P: barcode P00349659).

CAMBODIA. *Bejaud 740* (P: barcode P00349636); Dam ta trau, *Poilane 14071* (P: barcode P00349651). **Kompong Thom.** Prey Krabey, reserve Sambo Spieu, *Magnen s.n. 1909* (P: barcode P00349640). **Kompong Spen.** entre Pum Love & Pum Rong, *Poilane 17553* (P: barcode P00349652). Siem Reap, Phnom Kulen, *Martin 221* (P: barcode 00349644).

CELEBES. **Boni.** *Heyne 2863* (BO). **Malili.** 25 m. *Neth. Ind. For. Service Cel IV-86* (SING), *Cel IV-136* (SING), *Cel IV-137* (SING), Tabarano, *Neth. Ind. For. Service bb 32356* (SING). **Moena.** Wapai, *Neth. Ind. For. Service bb 21738* (P: barcode P03976230). **Manado.** Kolonodale, 400 m. *Neth. Ind. For. Service bb 31525* (SING). **Moena.** Makoemoro?, 25 m. *Neth. Ind. For. Service bb 26302* (SING), *bb 26303* (SING).

INDIA. *Roxburgh s.n.* (BR: barcode BR0000006912710).

JAVA. *sine coll.* no date (L); *Blume s.n.* (GDC: barcode G00134012); *Korthals s.n.* (L: barcode L0005029); *Reinwardt, s.n.* (L sheet no. 908.127-246 & barcode L0005030). **Batavia.** Bodjong, *Bakhuizen v d Brink 6354* (SING); Bodjong Ejot, *Bakhuizen v d Brink 6354* (P: barcode P03976232); Buitenzorg, *Hallier 202* (BO), *Welter s.n.* (SING), Moera Enim, *Teysmann 4019* (BO). **Semarang.** Ngarengan kult., *Kalshoven s.n.* (BO). **Soerabaja.** Insel Bawean, *Tambak, Teysmann 1767* (BO).

LAOS. **Banthat** a 12 km de Savannakhet, *Poilane 16384* (P: barcode P00330715), mare a 20 km de Savannakhet, *Vidal 1752* (P: barcode P00330717).

MOLUCCAS. *Smith s.n.* 1796-1805 (BM: barcode 001053465).

PENINSULAR MALAYSIA. **Johor.** Johore Bharu, *Carrick 1406* (SING). **Kedah.** *Rahim KEP 12386* (SING). **Melaka.** Merlimau, *Alvins s.n.* (SING), *Derry 53* (SING). **Negeri Sembilan.** *Cubitt 706* (SING); *Forest Dept. 697* (SING); Angsi Forest Reserve, *Othman KEP 23732* (KEP); Bahau Reserve, *Mat Deris 654* (SING); Port Dickson, Blue Lagoon, *Bremer 1819* (KLU). Cape Rachado F.R., roadside to Light House, *Tsou 207* (NY); Seremban, *Bain 18856* (KEP). **Pahang.** *Ridley 1028* (SING); Kuantan, *Abdul Rahman FMS 4172* (SING), *Mahamud FMS 3729* (SING), *Mohd Soh 15735* (SING); Muazam Shah-Menchali main road, *Sugumaran et al. SM 212*, leafy branch only (KLU); Pulau Berhala, *Burn-Murdoch SFN 303* (SING). **Penang.** *Askey FMS 2554* (SING); "Pullo Penang", *Hunter, Wallich Cat. no. 1597E*, (holo K), *Wallich Cat. no. 1597c* (GDC: barcode G00134009); Sungai Pinang, *Ogata 10344* (KEP); Tasek Gelugor, *Fyfe 29321* (SING); Tulloh (*sic!* = Teluk) Bahang, *Curtis 314* (SING), *Curtis s.n.* 1893 (SING), v 1892 (SING), vii 1892 (SING). **Perak.** Pangkor Island, Telok Nipah, *Chin 3137* (KLU). **Selangor.** Gombak, Klang Gates Quartz Ridge, *Daniel Lee et al. s.n.*, leafy branch only (KLU); Kepong, Forest Research Institute, *Verhevelu FRI 29649* (KEP, SING); Kuala Lumpur, *Ramli KEP 94100* (KEP), Government Hill, *Kalong 17463* (SING), Circular

Road, *Omar 7425* (SING), University of Malaya campus, *Tan Bee Cheok s.n.* (KLU), *Zakiah Hassan s.n.* (KLU). **Terengganu.** Kemaman, *Osman FMS 26996*, FB, FL, 13 vii 1971 (KEP). PHILIPPINES. **Mindoro.** *Merritt 8842* (PNH, US?). **Palawan.** *Curran Bur. For. 4501* (PNH, US?); Aborlan, Iraan Mountains, *Sulit 12512* (SING); Palawan, *Cenabre 29990* (SING); Taytay, *Merrill 1202* (SING), *Roque 30274* (SING). SINGAPORE. *Cantley's Collector s.n.* (SING); Botanic Gardens, *Henderson 1329* (SING); Nature Reserves Sector 17, *Turner et al. NRS 269* (SING); Pulau Pawai, *Sidek S 99* (SING); Surrounding reservoir, *Cantley's Collector s.n.* (SING!). SUMATRA. **Palembang.** *Endert 881* (SING), Moesi-Oeloe, *Endert 160* (BO), *161* (BO). **Riau islands.** Pulau Kundor, *Teruya 1624* (SING). THAILAND. **Bangkok.** *Marcan 707* (SING). **Krabi.** Krabi-Trang Road, *Weerachai Nanakorn WN 514* (SING); Jurin?, *Kerr 8232* (SING). **Surat Thani.** *Prsundej et al. 249* (KLU); Ko Pha-ngan, *Phromdet 25* (P: barcode P00349653). **Narathiwat.** Bacho, *Sangkhachand 184* (P: barcode P00349654); Sungai Padi, *Bourke s.n. 1924* (P: barcode P00349655). Trat. Taphan Hin, *Geesink 6490* (P: barcode P00349656). VIETNAM. *Harmand 804* (P: barcode P00349666). **Minh Hai.** Iles de Poulo Condor, *Harmand 873* (P: barcode P00349668), *Pierre 3699* (P: barcode P00349677). **Tourane.** Quang-Nam, Da-Nang, *J. & M.S. Clemens 3862* (P: barcode P00349662). **Lam Dong.** Dalat & environs, *Squires 889* (P: barcode P00349680). Long. Quang Tri, *Chevalier 41189* (P: barcode P00349663).

A drawing of this species by William Hunter, collector of the type specimen, is on display in the Penang Museum and a picture of this work is found in Gardner et al. (2011: 116). In the past, two other species found in the Malay Peninsula, namely, *C. giganteum* and *C. wallichianum* have been confused with *C. fragrans*. These two species are not as common as *C. fragrans*; for differences, see under those species.

Burkill (1935) used the name *Fagraea cochinchinensis* A.Chev. for this species, but apparently this had been based on *Aidia cochinchinensis* Lour. (a name dating from 1790; Rubiaceae) and was therefore in the first instance misapplied to material of *F. fragrans* (Leenhouts 1962). Arguably, both taxa have some resemblance in their paired leaves and branched cymes of small, cream-coloured to white flowers with exerted styles and stamens.

Holtum (1935) has given an account of the flowering of this species in Singapore, which is gregarious (many or nearly all trees in a population with synchronised flowering). It has two flowering seasons, the main one around mid-year and another towards year's end, the flowers opening several weeks following the bud stage. At such times, it may be appreciated how different nomenclatural systems may converge on an essential trait, for the species epithet in the latinised scientific name refers to fragrant flowers, and its Malay name, *tembusu*, could well allude to the conspicuous sweet-and-sour scent that transpires into more than a hint of fermentation (Malay: *busu*, unpleasantly odorous). Apparently, the flowers last several days even though the stamens are spent after the first day of bloom, thus sustaining and intensifying the perfumed aura around the tree. The fruits, which take a few months to mature to an attractive yellow to red, are probably mainly dispersed by birds or bats (Corner 1940). Of this tree, Ridley (1893: 323) observes that "it is difficult to say whether the tree is more beautiful when covered with flowers or fruits."

3. *Cyrtophyllum giganteum* (Ridl.) Ridl., Fl. Malay. Pen. 2 (1923) 421. — *Fagraea gigantea* Ridl., J. Str. Br. R. As. Soc. 79 (1918) 98; Foxw., Mal. For. Rec. 3 (1927) 157; Burkill, Dict. (1935) 995; Corner, Wayside Trees Malaya (1940) 425; Browne, For. Trees Sar. & Brun. (1955) 245. Kochummen, Tree Fl. Malaya 2 (1973) 273; Cockburn, Trees Sabah 1 (1976) 211; Wong & Sugau, Sandakania 8 (1996) 11; Coode et al. Checkl. Fl. Pl. Gymn. Brunei (1996) 174. LECTOTYPE (Wong & Sugau 1996): *Ridley 8921*, Singapore, Garden Jungle (SING).

Fagraea sororia J.J.Sm. ex Cammerl., Bull. Jard. Bot. Btzg. III, 5 (1923) 319, pl. 5; Heyne, Nutt. Pl. (1927) 1270. LECTOTYPE (Wong & Sugau 1996): *Enderb 44E 1P 515*, Sumatra, Palembang (L; isolecto BO, K, SING).

Fagraea fragrans auctt. non Roxb.: King & Gamble, J. As. Soc. Beng. 74 (2) (1908) 611 *pro parte, quoad Derry* 272; Leenhouts, Fl. Males. I, 6 (1962) 304 *pro parte, Ashton*, Manual Non-Dipt. Trees Sarawak 2 (1988) 310 *pro parte, quoad Cyrtophyllum giganteum* Ridl., *F. gigantea* Ridl., *F. sororia* J.J.Sm., *F. speciosa* (non Blume) Ridl. in syn.

Fagraea speciosa auctt. non Blume: Ridley, J. Str. Br. R. As. Soc. 50 (1908) 122.

Tree, rarely to just 3–4 m tall, more often big, to 30 m tall or more; trunk to over 1 m in diameter; **bark** closely and finely fissured, grey-brown to dark brown. **Leaves** elliptic; (4.4–)5–7(–7.5) cm long, (1.8–)2.2–3(–3.2) cm wide; base cuneate; apex short-cuspidate to caudate; 4–6 mm long; margin conspicuously wavy when fresh and in dried specimens; chartaceous; upper and lower surfaces smooth; midrib prominent below, flat to sunken above; secondary veins 4–6 pairs, upper side faint and immersed in the blade, lower side faint to very slightly prominent; tertiary veins faint to inconspicuous; petioles (0.8–)1–1.5(–2.3) cm long, 1–1.5 mm thick. **Inflorescence** (3.5–)5–6.5(–7.5) cm long; peduncle 3.5–5(–5.5) cm long, 1–1.5 mm thick; with 4–5 levels (tiers) of branching on the main axis, the branch tiers (5–)6–10(–12) mm apart, lowest tier typically branched to (2–)3 orders. **Flower** pedicel 3–5 mm long, 0.3–0.5 mm thick; calyx (from the base to the lobe apices) 1.5–2 mm long, glabrous, calyx cup 1.5–2 mm wide, calyx lobes erect, 1–1.5 mm long, 1–1.5 mm wide, margins glabrous; **corolla** tube subcylindric, 7–8 mm long, 1–1.5 mm wide near the base, upper part very gradually and slightly wider, inside glabrous to minutely papillate; corolla lobes broad-ovate to subobovate, 3–4 mm long, 2–2.5(–3.5) mm wide; **stamens** inserted at the uppermost third of the corolla tube; filaments 13–15 mm long, exsert 12–13 mm in the open flower; anthers 1–1.5 mm long, 0.5–0.8 mm wide, each anther sac somewhat narrowly ellipsoid; **style** (12–)18–22 mm long, protruding (5–)12–14 mm from the corolla mouth in the open flower; **stigma** c. 0.5 mm across, lobes 2, low and rounded, parting to present two slightly raised, hemispherical, papillate inner surfaces when receptive, not recurving. **Infructescence** peduncle (2.5–)3–4(–4.8) cm long, 1–1.5 mm thick. **Fruit** when mature to 4–6(–7) mm across; the base tightly clasped by the calyx lobes. **Seeds** 1–2 mm across.

Distribution. Malay Peninsula, Sumatra, Borneo.

Habitat. Lowland mixed dipterocarp forest.

Specimens examined: BORNEO. **Brunei.** Belalong, Ulu Ropan, 2000–2500 ft, *Ashton BRUN* 5275 (BRUN, K, SING); Tutong, Ulu Tutong, 150 ft, *Ashton BRUN* 908 (BRUN, K, SING). **Kalimantan.** East Kutai, Sangkulirang district, Kerajaan River region, *Kostermans* 34793 (BO, K, L), Sungai Kerajaan, 40 m, *Kostermans* 5804 (BO, SING), Sungai Susuk, 40 m, *Kostermans* 5693 (BO, K, SING); Muara Teweh, Popas?, *Neth. Ind. For. Service* bb 27769 (SING); Nunukan Island, *Kostermans* 8612 (BO, SING), 8955 (BO, SING); S.-O. Borneo, Horyoep?, *Winkler* 2468 (SING); Sanggau, Bindang, *Neth. Ind. For. Service* bb 28143 (BO, K, SING). **Sabah.** Keningau, Nabawan, *Dewol & Karim SAN* 78059 (K, L, SAN, SAR, SING); Sandakan, *Patrick SAN* 25509 (KLU, SAN), Batu Sapi road, *Meijer SAN* 24942 (K, KEP, L, SAN, SAR); Tawau, Apas Road, *Brand SAN* 21500 (SAN, SING), Kawa Road, *Jaswir & Aban SAN* 26277 (BO, K, KEP, L, SAN, SING), Table Estate, 200 ft, *Wood SAN* 16650 (SAN, SING). **Sarawak.** Baram, Melinau Gorge (4°10'N, 114°55'E), 1000 ft, *Chew CWL* 444 (K, SING), Ulu Sungai Melinau Paku, *Anderson* 4085 (K, L, SAN, SAR, SING); Kuching, Bukit Hujan, *Omar* 353 (K, SING); Lawas, Mt Bugoh ridge, *Smythies BRUN* 812 (K); Limbang, Ulu Medamit, 900 ft, *Chai, Wright & Othman S.* 32335 (K, L, SAR, SING); Miri, S. Ukong, 10 m, *Othman S.* 21394 (SING).

PENINSULAR MALAYSIA. *sine coll.* 16711 (KEP); **Johor.** Ulu Endau, Labis F.R., Sungai Jasin, *Ogata KEP* 110427 (KEP). **Melaka.** Air Keroh Botanical Garden, *Sugumaran & Lee SM* 193, leaves and stem bark (KLU), *SM* 194, leaves only (KLU); Bukit Saliokor?, *Derry* 272 (SING). **Negeri Sembilan.** Kuala Kelawang, Triang F.R., *Lau & Jalil FRI* 18249 (KEP). **Pahang.** Kuantan, *Mohd Soh FMS* 15750 (SING), *Rahman* 15738 (SING). **Selangor.** Ayer Hitam F.R., *sine coll.* *KEP* 55873, leaves only (KEP); Kajang, Bangi Reserve, *Foxworthy* 10289 (SING); Sungai Buluh F.R., *Walton FMS* 30770 (KEP). SINGAPORE. **Singapore.** Garden Jungle, *Ridley* 8921 (lecto SING).

SUMATRA. **Palembang.** *Buurman van Vreeden* 77 (BO); *Endert* 44E 1P 429 (BO, L), 44E 1P 515 (BO, K, L, SING), 44E 2P 673 (BO, L); Banjoeasin en Koeboestrecken, *Endert* 44E 2P 706 (BO, K, L); Lematang Ilir, Semangoes, *Neth. Ind. For. Service* bb 32270, leafy branch only (SING); Medan 19, Bengkalis, *Houtvester s.n.* (BO); Moeara Doea Sh., *Grashoff* 400 (BO); Moeara Enim, *Teysmann* 3796 (BO, L); Rawas, *Dumas* 1550 (BO, K), *Grashoff* 1060 (BO, L). **Lampungs.** Kebang, *Teysmann* 4210 (BO, L); Tandj-Penang, *Bruinsma* 12 (BO). **Upper Riau.** Tenajan, Pakanbaru, *Soepadmo* 232 (BO, K, SING).

Cyrtophyllum giganteum and *C. fragrans* have very similar flowers that appear only to have consistently different corolla tube widths. However, several vegetative features are very distinctive, such as the distinctively wavy margins in fresh leaves of *C. giganteum* (*C. fragrans* have leaf margins which are generally plane). There are more pairs of secondary veins in *C. fragrans* (7–9(–11)) that form distinct loops towards the leaf margin but in *C. giganteum* there are fewer pairs of secondary veins (4–6) that fork towards the leaf margin and do not form conspicuous loops. The mature tree form is also often distinguishable: *C. giganteum* develops a very straight and columnar bole like many other lowland forest canopy species, whereas *C. fragrans* usually reaches up to only 30 m and typically develops several erect main branches that are as tall as the main trunk. A well-grown *C. fragrans* tree develops a coarse,

reticulately-sinuously ridged and fissured bark, as pictured in Gardner et al. (2011: 117); but that in a mature *C. giganteum* tree, as shown in Plate 35 of Ashton (1988: 313), is regularly and shallowly fissured.

4. *Cyrtophyllum minutiflorum* K.M.Wong, **sp. nov.** *C. caudato* Ridley similis sed cymis ramosioribus, floribus minoribus tubis corollae brevioribus (4–5 mm longis) et stylis brevioribus (9–10 mm longis) differt. TYPE: *Burley, Tukirin et al.* 3278, 1–6 Jul 1989, Borneo, West Kalimantan province, G. Bentuang area, 5–10 km north of Masa village, ridge SW of G. Bentuang, 1100 m alt. (holo SING: iso A, BO, K).

Tree, documented as 10 m tall; trunk to 15 cm diameter; **bark** texture in mature tree trunk not known. **Leaves** elliptic to slightly lanceolate or oblanceolate; (5–)8–10(–11) cm long, (1–)2–3(–3.5) cm wide; base cuneate; apex acuminate, hardly 0.5 cm long; margin plane in dried specimens; coriaceous; upper and lower surfaces smooth; midrib prominent below, channelled to raised above; secondary veins (4–)5–7 pairs, upper side faint and immersed in the blade, lower side faint to immersed; tertiary veins faint to inconspicuous; petioles (5–)12–18 cm long, 1.5–2 mm thick, petiolar sheaths of a leaf pair fused and forming a shallow cup-like ochrea that tightly clasps the stem; petiolar base auricles absent. **Inflorescence** a few-flowered cyme 8–10 cm long; peduncle 4–4.5 cm long, 1(–1.5) mm thick; with 1(–2) levels (tiers) of branching on the main axis, lowest tier typically branched to 3–4 orders. **Flower** pedicel 0–1 mm long (flowers subsessile), c. 0.5 mm thick; **calyx** (from the base to the lobe apices) c. 1.5 mm long, glabrous, calyx cup c. 1.5 mm wide, calyx lobes erect, c. 0.5 mm long, c. 0.5 mm wide, margins glabrous; **corolla** tube subcylindric, 10–12 mm long, c. 1 mm wide near the base, inside glabrous to minutely papillate; corolla lobes broad-ovate to subobovate, 2.5–3 mm long, c. 2–2.5 mm wide; **stamens** inserted at the uppermost third of the corolla tube; filaments c. 7 mm long, exert c. 5 mm in the open flower; anthers not seen; **style** 9–10 mm long, protruding c. 4 mm from the corolla mouth in the open flower; **stigma** c. 0.1 mm across. **Infructescence** peduncle 4–5 cm long, 1–1.5 mm thick. **Fruit** (immature) c. 2 mm across; the base loosely to tightly clasped by the calyx lobes. **Seeds** not examined.

Distribution. Borneo, W Kalimantan, only known from the type collection.

Habitat. On a ridge at the upper limit of Mixed Dipterocarp Forest or its transition to lower montane forest.

5. *Cyrtophyllum wallichianum* (Benth.) M.Sugumaran & K.M.Wong, **comb. nov.** — *Fagraea wallichiana* Benth., J. Linn. Soc. Bot. 1 (1857) 98; Clarke in Hooker f., Fl. Brit. Ind. 4 (1883) 85; King & Gamble, J. As. Soc. Beng. 74 (2) (1908) 607; Corner, Ways. Trees Malaya (1940) 426; Wong, Saw & Kochummen, Malayan Nat. J. 41 (1987) 267; Wong & Sugau, Sandakania 8 (1996) 12. — *Fagraea lanceolata* Wall.

[Cat. (1829) no. 1599, *nom. nud.*] Schnizl., Iconogr. 2 (1851) t. 131, f. 1, *nom. illeg.*, non Blume (1826); Miquel, Fl. Ind. Bat. 2 (1857) 376; Burkill, Dict. (1935) 995. — *Cyrtophyllum lanceolatum* (Wall.) DC., Prod. 9 (1845) 31, *nom. illeg.*; Ridley, Fl. Mal. Pen. 2 (1923) 421. TYPE: *Wallich Cat. no. 1599*, Penang (holo K; iso BM, GDC).

Fagraea fragrans auctt. non Roxburgh (1824): Kochummen, Tree Fl. Malaya 2 (1973) 273 *pro parte*, *quoad Fagraea wallichiana* Benth. in syn.; Leenhouts, Fl. Males. I, 6 (2) (1962) 304, *pro parte*, Ashton, Manual Non-Dipt. Trees Sarawak 2 (1988) 310 *pro parte*, *quoad Cyrtophyllum lanceolatum* DC., *F. lanceolata* Wall., *F. wallichiana* Benth. in syn.

Tree, rarely to just 3–4 m tall, more often bigger, to 25 m tall; trunk to over 1 m in diameter; **bark** fissured, grey-brown to dark brown. **Leaves** narrow to broadly-elliptic to oblanceolate to obovate; (3.4–)6–10(–13) cm long, (1.4–)2–3(–5) cm wide; base cuneate; apex acute to short-cuspidate; 2–5(–1.2) mm long; margin plane when fresh and in dried specimens; thin-coriaceous; upper and lower surfaces smooth; midrib prominent below, sunken above; secondary veins (4–)5–7 pairs, upper side faint to immersed in the blade, lower side faint to very slightly prominent; tertiary veins faint to inconspicuous; petioles (0.3–)0.8–1.2(–1.7) cm long, 1–1.5 mm thick, petiolar sheaths of a leaf pair fused and forming a shallow cup-like ochrea that tightly clasps the stem; petiolar base auricles absent. **Inflorescence** a few-flowered cyme (2.5–)3–6(–7.8) cm long; peduncle (1.9–)2.3–3.5(–5.3) cm long, 1(–1.5) mm thick; with 1(–2) levels (tiers) of branching on the main axis, the branch tiers 10–14 mm apart, lowest tier typically branched to 1(–2) orders. **Flower** pedicel (4–)5–8 mm long, 1–1.5 mm thick; **calyx** (from the base to the lobe apices) (3–)4–5(–6) mm long, glabrous, calyx cup 3–4 mm wide, calyx lobes erect, 2–3 mm long, 2–2.5 mm wide, margins glabrous; **corolla** tube somewhat infundibular, (12–)20–25 mm long, lower narrowed part 1–2 mm wide, upper flared part 6–8(–10) mm wide at the top, the lower narrowed tubular part nearly as long as the upper flared part, inside glabrous to minutely papillate; corolla lobes broad-ovate to subobovate, (5–)7–8 mm long, 3–4.5(–5) mm wide; **stamens** inserted at the lower end of the upper flared part of the corolla; filaments (27–)30–38 mm long, exert 20–23(–28) mm in the open flower; anthers 1–1.5 mm long, 0.5–1 mm wide, each anther sac somewhat narrowly ellipsoid; **style** (34–)42–45(–55) mm long, protruding 22–25(–30) mm from the corolla mouth in the open flower; **stigma** c. 0.5 mm across, lobes 2, low and rounded, parting to present two slightly raised, hemispherical, papillate inner surfaces when receptive, not recurving. **Infructescence** peduncle 2–2.5(–3) cm long, 1–1.5 mm thick. **Fruit** when mature to 7–9 mm across; the base loosely to tightly clasped by the calyx lobes. **Seeds** 1–1.5 mm across.

Distribution. Endemic to the Malay Peninsula.

Habitat. Lowland forest on hills and ridges.

Specimens examined: PENINSULAR MALAYSIA. **Johor.** Hutan Simpan Labis, Gunung

Beremban, *Wong FRI 30882*, leafy branch only (KEP). **Kedah**, Gunung Jerai, *Kochummen FRI 18086* (KEP, SING), *FRI 29495* (KEP), *KEP 85027*, leafy branch only (KEP), *KEP 94416* (KEP). **Kelantan**, Relai Forest Reserve, *Cockburn FRI 7251* (KEP, SING), *FRI 7280* (KEP, SING), *FRI 7411* (KEP, SING). **Malacca**, *Maingay 1029* (BM, mounted on the same sheet, lower half, as the isotype *Wallich Cat. no. 1599*). **Penang**, *Wallich Cat. no. 1599* (holo K; iso BM, GDC); Govt. Hill, *Curtis s.n.* 1899 (SING), *Ridley 7066* (SING); Moniots Road, *Burkill SFN 3330* (SING), *Curtis 375* (SING); Penang Hill, *Ahmad Shukor AS 91* (SING), *Corner SFN 31597*, leafy branch only (SING), *Low et al. LYW 206*, leafy branch only (KLU), *Nauen s.n.* 1940 (SING), *Samsuri Ahmad SA. 999* (KEP, KLU, SING), *Sidek S. 226* (SING!), *Symington KEP 28043* (SING); Western Hill, *Nauen s.n.* 1940 (SING). **Terengganu**, Ulu Brang, Gunung Padang, *Whitmore FRI 12803* (KEP, SING).

Cyrtophyllum wallichianum is generally a smaller tree (up to 25 m tall) of hills and ridges, compared to *C. fragrans*, which can grow taller (up to 30 m tall) but is typically found on gentler terrain in the lowlands. *C. wallichianum* is vegetatively quite similar to *C. fragrans* but the floral characters are different. The inflorescence of *C. wallichianum* is usually less branched, 1(–2) orders, with fewer flowers; that of *C. fragrans* is generally more branched, 2(–3) orders, and so bears more flowers. The corollas of *C. wallichianum* are much bigger, 12–25 mm long, 6–10 mm wide, whereas in *C. fragrans* they are smaller, (4–)6–8 mm long and 1.5–2(–2.5) mm wide.

As noted by Ridley (1918), *F. caudata* (= *C. caudatum*) which occurs only in Borneo (Sarawak and Brunei), closely resembles *C. wallichianum*. *Cyrtophyllum caudatum* differs from *C. wallichianum* in having more coriaceous, lanceolate-caudate leaves and extremely slender peduncles and pedicels, cylindric corolla tubes and shorter stamens.

Indeterminate material

A taxon that resembles *C. caudatum* and *C. minutiflorum* in leaf characters, but without flowering or fruiting material, occurs in New Guinea. Its habitat, too, is similar: ridge forest in hilly terrain, only even higher at c. 800 m elevation. This is quite possibly a distinct species.

Specimens examined: NEW GUINEA. **Japen Island**, c. 800 m, *Neth. Ind. For. Services bb. 30336* (BO, SING), *bb. 30352* (BO, SING).

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REFERENCES

- Ashton, P.S. (1988) *Manual of the Non-Dipterocarp Trees of Sarawak*. Vol. 2. Kuching, Sarawak: Dewan Bahasa dan Pustaka.
- Blume, C.L. (1838) *Rumphia*. Vol. 2. Leiden.
- Burkill I.H. (1935) *A Dictionary of the Economic Products of the Malay Peninsula*. Fourth print (2002). Vol. 1: 1009–1013. Kuala Lumpur: Ministry of Agriculture and Co-Operatives.
- Corner, E.J.H. (1940) *Wayside Trees of Malaya*. 2 vols. Singapore: Government Printing Office.
- Gardner, S., Sidisunthorn, P. & Lai, E.M. (2011) *Heritage Trees of Penang*. Penang: Areca Books.
- Holtum, R.E. (1935) The flowering of tembusu trees (*Fagraea fragrans* Roxb.) in Singapore, 1928–1935. *Gard. Bull. Straits Settle.* 9: 73–78.
- Leenhouts, P.W. (1962) Loganiaceae. In: Steenis, C.G.G.J. van (ed.), *Flora Malesiana*. Series 1 Vol. 6. Pp. 293–336. Groningen: Wolters-Noordhoff Publishing.
- Miquel, F.A.W. (1857) *Flora van Nederlandsch-Indië*. Vol. 2. Amsterdam.
- Ridley, H.N. (1893) On the flora of the eastern coast of the Malay Peninsula. *Trans. Linn. Soc. London, Bot.* 3: 267–408 & Pl. 61–66.
- Ridley, H.N. (1918) New and rare Malayan plants. *J. Straits Branch Roy. Asiat. Soc.* 79: 97–98.
- Ridley, H.N. (1923) *The Flora of the Malay Peninsula*. Vol. 2. London: L. Reeve & Co.
- Sugumaran, M. & Wong, K.M. (2012) Studies in Malesian Gentianaceae I: *Fagraea* sensu lato—complex genus or several genera? A molecular phylogenetic study. *Gard. Bull. Singapore* 64(2): 301–332.
- Wong, K.M. & Sugau, J.B. (1996) A revision of *Fagraea* (Loganiaceae) in Borneo, with notes on related Malesian species and 21 new species. *Sandakania* 8: 1–93.
- Wong, K.M. & Sugumaran, M. (2012) Studies in Malesian Gentianaceae II: A taxonomic framework for the *Fagraea* complex, including the new genus *Limahlania*. *Gard. Bull. Singapore* 64(2): 481–495.

Studies in Malesian Gentianaceae IV: A revision of *Picrophloeus*

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ABSTRACT. *Picrophloeus* Blume is the correct generic assignment for four species forming one of several distinct lineages in the *Fagraea* complex. They include the widespread Southeast Asian *P. javanensis* Blume, otherwise commonly known by the dubious name *F. elliptica* Roxb. Three new combinations are made for species known only in Borneo: *P. belukar* (K.M.Wong & Sugau) K.M.Wong, *P. collinus* (K.M.Wong & Sugau) K.M.Wong, and *P. rugulosus* (K.M.Wong & Sugau) K.M.Wong.

Keywords. Borneo, *Fagraea elliptica*, Gentianaceae, Malesia, *Picrophloeus*, Potalieae, Potaliinae, Southeast Asia

Introduction

A molecular phylogenetic analysis of the *Fagraea* complex (Sugumaran & Wong 2012) revealed the distinctness of a number of generic lineages from *Fagraea* Thunb. s.s. (Wong & Sugumaran 2012). These included two genera, *Cyrtophyllum* Reinw. and *Picrophloeus* Blume, that are distinguished from the other lineages by their flowers with conspicuously exerted styles (typically more than 40% of their length) and filaments (greater than 70% of their length) (Sugumaran & Wong 2012). *Picrophloeus* is readily distinguished from *Cyrtophyllum* by its terminal cymes (*Cyrtophyllum* has axillary cymes) and Scarrone's tree architectural model (*Cyrtophyllum* is characterised by Aubréville's model) (Sugumaran & Wong 2012; Wong & Sugumaran 2012).

Picrophloeus is presently revised. It includes the widespread *P. javanensis* Blume, which has been much identified with the name *Fagraea elliptica* Roxb., a problematic name here shown to be dubious.

Picrophloeus Blume

Bijdr. Fl. Ned. Ind. (1826) 1019; Wong & Sugumaran, Gard. Bull. Sing. 64 (2012) 492. TYPE SPECIES: *P. javanensis* Blume.

Fagraea sect. *Cyrtophyllum* (Reinw.) Blume, Rumphia 2 (1838) 34 *pro parte* excl. *F. peregrina*; Leenhouts, Fl. Males. I, 6 (1962) 303 *pro parte* excl. *F. fragrans* & *F. umbelliflora*; Wong & Sugau, Sandakania 8 (1996) 7 *pro parte* excl. *F. fragrans*. —

Fagraea sect. *Eufagraea* Blume, Mus. Bot. 1 (1850) 172 *pro parte* quoad *F. kimangu*, *F. picrophloea* & *F. speciosa*. — *Fagraea* sect. *Parviflorae* Benth., J. Linn. Soc. Bot. 1 (1857) 100 *pro parte* excl. *C. peregrinum*. — *Fagraea* subg. *Cyrtophyllum* (Reinw.) Miq., Fl. Ind. Bat. 2 (1857) 375 *pro parte* excl. *F. lanceolata*.

Medium-sized to large trees to about 30 m tall. **Trunk** monopodial with episodic growth, developing orthotropic complexes of branches (Scarrone's architectural model *vide* Hallé et al. 1978). Trunk bark becoming fissured in older trees. Vegetative **shoot apices** with light yellowish resin. Leaf arrangement on branches decussate; leaf margin entire; **petiolar sheaths** of a leaf pair fused to form a shallow cup-like ochrea. **Inflorescence** terminal, a many-flowered and branched cyme, basal branches nearly as long as or longer than rachis. **Flowers** bisexual, small, up to 10 mm wide at the corolla mouth; calyx lobes 5; corolla lobes 5, overlapping to the right, narrowly elliptic to lanceolate; stamens 5, inserted at the corolla mouth, typically two thirds or more exsert, anthers versatile; style typically one third or more exsert; stigma capitate (knob-like). **Fruits** small, subglobose, up to about 10 mm in diameter; colour at maturity yellow-orange to bright red; with small amounts of translucent sticky latex in fruit epidermis and fruit wall; epidermis separating as a thin translucent film from pericarp (fruit surface appearing crinkled on herbarium specimens). **Seeds** numerous, placentation axile; polygonal; surface areolate.

Distribution and diversity: Sumatra, Java, Malay Peninsula, Borneo, Maluku, New Guinea. Four species known.

Habitat. Lowland to lower montane forests.

Key to *Picrophloeus* species

- 1a. Leaf surface drying very coarsely wrinkled (resembling a coarsely pitted surface to the touch). Cymes distinctly pedunculate, the peduncle to 1–1.5 cm long beyond the ultimate leaf pair on the flowering shoot. Flowers sessile (the ultimate floral bracteole immediately below the calyx cup). Corolla tubes 8–11 mm long. Filaments in open flowers 15–18 mm long. Fruits larger, 6–9(–10) mm across
..... *P. rugulosus*
- b. Leaf surface drying smooth or only finely shagreen. Cymes sessile, the basal branches not clearly elevated from the distalmost leaf pair on the flowering shoot and appearing as if they originate from the ultimate leaf axils. Flowers pedicellate (the pedicel at least a short but distinct axis between the ultimate bracteole and the calyx base). Corolla tubes shorter, 3.5–6 mm long. Filaments in open flowers (4)6–11 mm long. Fruits smaller, 3.5–5(–6) mm across 2

- 2a. Leaf apex typically obtuse-rounded to emarginate. Inflorescence typically branched to 5–6 orders. Corolla tube 3.5–4 mm long *P. belukar*
- b. Leaf apex acuminate to cuspidate-caudate. Inflorescence branched to 3–4(–5) orders. Corolla tube 4–6 mm long 3

- 3a. Leaves thick-coriaceous, secondary veins obscure on lower side. Pedicels 0.5–1 mm long. (Restricted to Borneo, submontane to lower montane forest)
 *P. collinus*
- b. Leaves thin-coriaceous, secondary veins distinct and prominent on the lower side. Pedicels 1–2 mm long. (Widespread: Sumatra, Java, Malay Peninsula, Borneo, Moluccas to New Guinea: lower montane forest generally but in the Wallacea region also in the lowlands, including coastal forest) *P. javanensis*

1. *Picrophloeus belukar* (K.M.Wong & Sugau) K.M.Wong, **comb. nov.** — *Fagraea belukar* K.M.Wong & Sugau, Sandakania 8 (1996) 15; Coode et al. Checkl. Fl. Pl. Gymn. Brunei (1996) 174. TYPE: *Saikeh SAN 72151*, Sabah, Beaufort, Beaufort Hill (holo SAN).

F. elliptica auctt.: Leenhouts, Fl. Males. I, 6 (1962) 303 *pro parte*: Cockburn, Trees of Sabah 1 (1976) 210 *pro parte*: Ashton, Manual Non-Dipt Trees Sarawak 2 (1988) 314 *pro parte*: Anderson, Check List Trees Sarawak (1980) 239 *pro parte*. [*Fagraea elliptica* Roxb. *sensu stricto*, Fl. Ind. ed. Wall. 2 (1824) 32, *nom. dub.*]

Tree, to around 30 m tall; trunk to over 1 m in diameter: **bark** fissured, dark grey-brown. **Leaves** obovate to broad-elliptic; 7–22 cm long, 4–13 cm wide; base cuneate; apex obtuse-rounded to emarginate; margin plane to recurved; coriaceous; upper and lower surfaces smooth to finely shagreen; midrib prominent below, rounded to ridged; secondary veins 10–12 pairs, upper side faint and flat or immersed in the blade, lower side faint to immersed, not prominent; tertiary veins inconspicuous; petioles 3–4.5 cm long, stout. **Inflorescence** sessile, the basal branches not clearly elevated from the distalmost leaf pair on the flowering shoot and appearing as if they originate from the ultimate leaf axils, to c. 13 cm long, 15–20 cm across, main axis branched to 5–6 orders, with 5–6 tiers of branches; lowest branches typically 3–5.5 cm long. **Flower** pedicel (above the ultimate bracteole) 1–2 mm long; **calyx** (from the base to the lobe apices) 1–2 mm long, calyx cup 1–2 mm wide; **corolla** salverform; cream to white; corolla tube 3.5–4 mm long, not conspicuously flared, 1–1.5 mm wide, inside glabrous to minutely papillate; corolla lobes 2–3 mm long, c. 1.5 mm wide; **stamens** with filaments 6–8 mm long in the open flower; anthers oblong, c. 1 mm long; **style** 11–15 mm long in the open flower; **stigma** knob-like, c. 0.5 mm across, lobes 2, low and rounded, not recurving. **Fruit** when mature to 3.5–5 mm across; fruit calyx lobes to 1 mm long and wide. **Seeds** c. 1 mm across.

Distribution. Borneo, all districts; Banka (Bangka) Island.

Habitat. Lowland secondary forest, forest gaps, open sites. This species is a conspicuous member of the coastal tropical heath (*kerangas*) forest community of Borneo, easily seen, for example, in the Sandakan, SW Sabah, Brunei and Sarawak 1st Division areas. It is also common in secondary forest and some open degraded sites in Borneo (Wong & Sugau 1996).

Specimens examined: BORNEO. **Brunei.** Belait, Andulau F.R., *Ibris et al. BRUN 15655* (BRUN, SING); Berakas, Berakas FR, *Ashton S. 7816* (BRUN, SING); Tutong, *Smythies BRUN 0836* (SING), Bukit Beruang, *Forman & Blewett 810* (BRUN, K, SING). **Kalimantan.** Bangarmassing, *Motley s.n. 1857* (K); East Kutai, Sungai Bambangan, *Kostermans 6092* (SING); Long Bagun, *Wiradinata 602* (BO, K); Tarakan, *Kostermans s.n. December 1963* (SING). **Labuan.** Botanic Garden, Natural arboretum, *Talip SAN 55629* (SAN). **Sabah.** Beaufort, Beaufort Hill, *Madani SAN 36770* (K, L, SAN, SAR), *Meijer NT 172* (SAN), *Saikeh SAN 72151* (holo SAN), *SAN 72256* (SAN, SING), *72259* (K, L, SAN, SAR, SING). Kg. Inuman, *Mikil SAN 30215* (SAN), Mantanior, *Talib & Marsal SAN 84772* (SAN, SING), mile 52 Mesapul road, *Mikil SAN 34569* (SAN); Jesselton, Gaya Island F.R., *Lajangah SAN 28776* (BO, K, KEP, L, SAN, SAR, SING), *Wyatt-Smith KEP 80298* (K, SING), (Pulau) Gaya, *Sinanggul SAN 40136* (KEP), near Ulu Soyong river, *Aban SAN 57828* (KEP, L, SAN); Jesselton, near hospital, *Tandom Nbfd 2810* (SAN); Kota Kinabalu, Bukit Padang, *Beaman 10822* (K, MSC); Sandakan, *Postar & Ahmad SAN 147987* (SAN), junction of Ernestina Road, *Brand SAN 34698* (BO, K, KEP, L, SAN, SAR, SING), Leila F.R., *Ahwing SAN 39033* (K, L), *Ampuria SAN 32601* (K, L, SAN, SAR, SING), *Jawanting & Ampuria SAN 32601* (SAN, SING), *Kanis & Ding Hou SAN 57451* (K, L, SAN), *Kumin SAN 74160* (K, L, SAN, SAR, SING), *Wong SAN 22901* (K, KEP, L, SAN, SAR); mile 3/4 North Road below Sabah Hotel, *Sam & Ernesto SAN 26522* (SAN), mile 4 Leila F.R., *Dewol & Chow SAN 74258* (K, KEP, L, SAN, SING), Pum station mainline, *Ampon & Madani SAN 47347* (SAN), town, *Meijer SAN 20945* (SAN, SING), Sepilok Laut, *Tamin SAN 131250* (SAN), *Termiji & Paul SAN 85500* (SAN); Sipitang, *Caudra A 3293* (K), Bukit Ulu Sipitang, *Dewol & Termiji SAN 78358* (K, KEP, L, SAN, SAR, SING), SFI area, *Amin SAN 126518* (SAN), forest behind SFI Qrs., *Madani & Amin SAN 86236* (SAN), Sri Beaufort Area, *Dewol SAN 80111* (SAN, SING), Merintaman F.R., *Saikeh SAN 72327* (SAN, SING), Seungau, *Cuadra A 3293* (SING); Tawau, Padang Golf, *Ismail SAN 107761* (SAN); Weston, Bukit Siungau, *Talip SAN 80618* (K, KEP, L, SAN, SAR, SING), Hutan Simpan Siungau, *Amin SAN 126720* (SAN, SING), *SAN 132146* (SAN), Lubok Darat, *Dewol & Karim SAN 78153* (SING), *SAN 78358* (SAN). **Sarawak.** *Moulton's Native Collectors s.n. 1909* (SING); Bukit Lan, *Wright 631* (SAR); Kuching, *Anderson S. 4921* (SAN), *Corner & Brunig 10444* (SAR), *Dickson 3* (SING), Kuching Reservoir, *Anderson & Chai S. 28943* (SAR, SING), Selang, Sungai Pasir, *Rehal S. 2251* (SING); Mukah, Ulu Kenyana, *Ashton S. 19490* (SING); Serian, Sungai Sabal Tapang, *Sinclair SFN 10266* (E, K, L, SAR, SING); Tarum, *Rehal 1750* (SAR).
SUMATRA. **Bangka.** *Jacobs IV-A-127* (SING).

2. *Picrophloeus collinus* (K.M.Wong & Sugau) K.M.Wong, **comb. nov.** — *Fagraea collina* K.M.Wong & Sugau, Sandakania 8 (1996) 19. TYPE: *Aban SAN 50747*, Sabah, Ranau, copper mining area (holo SAN; iso A).

F. elliptica *auett.*: Leenhouts, Fl. Males. I, 6 (1962) 303 *pro parte*; Cockburn, Trees of Sabah 1 (1976) 210 *pro parte*; Ashton, Manual Non-Dipt Trees Sarawak 2 (1988) 314 *pro parte*; Anderson, Check List Trees Sarawak (1980) 239 *pro parte*. [*Fagraea elliptica* Roxb. *sensu stricto*, Fl. Ind. ed. Wall. 2 (1824) 32, *nom. dub.*]

Tree, to around 5 m tall; trunk to c. 25 cm diameter: **bark** fissured, dark brown. **Leaves** elliptic, oblanceolate-obovate; 4–15 cm long, 2–7 cm wide; base cuneate; apex acute; margin plane to slightly recurved; thick-coriaceous; upper and lower surfaces smooth to finely shagreen; midrib prominent below, ridged; secondary veins 7–9 pairs, upper side distinct, lower side obscure; tertiary veins obscure; petioles 1.5–2 cm long, stout. **Inflorescence** sessile, the basal branches not clearly elevated from the distalmost leaf pair on the flowering shoot and appearing as if they originate from the ultimate leaf axils, 6–9 cm long, 11–18 cm across, main axis branched to 4–5 orders, with 5–6 tiers of branches; lowest branches typically 2.5–7 cm long. **Flower** pedicel (above the ultimate bracteole) 0.5–1 mm long; **calyx** (from the base to the lobe apices) 2–3 mm long, calyx cup 1.5–2 mm wide; **corolla** salverform; cream to white; corolla tube 4–6 mm long, not conspicuously flared, 1–1.5 mm wide, inside glabrous to minutely papillate; corolla lobes ovate to lanceolate, 2.5–3 mm long, 1–1.5 mm wide; **stamens** with filaments 8–11 mm long in the open flower; anthers oblong, c. 1 mm long; **style** 9.5–12 mm long in the open flower; **stigma** knob-like, c. 0.5 mm across, lobes 2, inconspicuous. **Fruit** when mature to 3.5–5 mm across; fruit calyx lobes c. 1 mm long and wide. **Seeds** c. 1 mm across.

Distribution. So far known only in the NW Borneo area (Sabah and Sarawak).

Habitat. In sub-montane to lower montane forest.

Specimens examined: BORNEO. **Sabah**. Ranau, Mamut, copper mine, *Beaman 9962* (K, MSC), copper mining area. *Aban SAN 50747* (holo SAN; iso A), Kinabalu N.P., Bundu Tuhan view trail, *Aban SAN 49430* (SAN), Mt Kinabalu, *Ptusa 3506* (K). **Sarawak**. Bt. Sadok, base camp, *Banyeng & Ilias S. 45043* (K, KEP, L, MO, SAN, SAR), summit, *Banyeng & Ilias S. 45059* (K, KEP, L, MO, SAN, SAR); Anap, (Kana) trig point, Bt. Naoung, *Banyeng S. 19401* (A, BO, K, KEP, L, MEL, SAN, SAR, SING); Bintulu, Merurong plateau, *Brunig S. 8791* (K, SAR); Kuching, Matang, Kubah N.P., Gunung Serapi, *Lee S. 54146* (K, SAR), 755 m, *Rantai S. 74271* (SAR, SING), Mt Mike, *Low LYW 260* (KLU); Mt. Dulit, *Richards 1735* (K), Ulu Koyan, *Syngé 1874* (K).

3. *Picroploeus javanensis* Blume, Bijdr. Fl. Ned. Ind. (1826) 1020; Don, Gard. Dict. 4 (1837) 66; DC., Prod. 9 (1845) 32. — *Fagraea picroploea* Blume, Rumphia 2 (1838) 36, *nom. illeg.*, Mus. Bot. 1 (1850) 173; Miq., Fl. Ind. Bat. 2 (1857) 377; Merr., J. Str. Br. Roy. As. Soc. Sp. No. (1921) 492. LECTOTYPE (Wong & Sugumaran 2012); *Blume, s.n.*, Java (L: 908.127-201, barcode L0005006).

Cyrtophyllum speciosum Bl., Bijdr. (1826) 1022; DC., Prod. 9 (1845) 31; Ridl., Fl. Malay. Pen. 5 (1925) 322. — *Fagraea speciosa* (Bl.) Bl., Rumphia 2 (1838) 35, t. 81; Mus. Bot. 1 (1850) 172; Bentham, J. Linn. Soc. Bot. 1 (1857) 100; Merr., J. Str. Br. Roy. As. Soc. Sp. No. (1921) 493; *non sensu* Ridl., J. Str. Br. Roy. As. Soc. 50 (1908) 122 (= *C. fragrans*). TYPE: Blume 1867, Java (iso L: sheet no. 908.127-210).

Cyrtophyllum speciosum Ridl. var. *montanum* Ridl., Fl. Malay. Pen. 5 (1925) 322. TYPE: Henderson SFN 10992, Pahang, Cameron Highlands, Gunung Terbakar, 45000 ft. alt., 9 vi 1923 (holo K; iso SING).

Fagraea kimangu Blume, Mus. Bot. 1 (1850) 173. TYPE : Blume, Java, *kimangle*, *kimangu* (holo L: sheet no. 908.127-507).

F. valida Miq., Fl. Ind. Bat. 2 (1857) 376. TYPE: *Junghunh*, Sumatra, “Panoadjih et Koeta tinggi” (holo L: sheet no. 908.127-625).

F. sumatrana Miq., Fl. Ind. Bat. 2 (1857) 377. TYPE: *Teysmann HB 992*, Sumatra, Payakombo, “kajoe sobo” (holo U: barcode U0003707; iso L: sheet no. 908.127-628).

F. aurantiodora S. Moore, J. Bot. 66 (1928) 105. TYPE: *Brass 642*, Papua New Guinea, Sogere (holo BM, iso K).

F. pseudoelliptica Kanehiro & Hatusima, Bot. Mag. Tokyo 56 (1942) 161, f. 5. TYPE: *Kanehira-Hatusima 12577*, New Guinea, Ayerjat, along Boemi River, about 40 km inland from Geelvink (holo TKU; iso A).

F. pusilliflora Bakh.f. in Backer, Bekn. Fl. Java 7 (1948) fam. 170, p. 13, *nom. nud.*, Blumea 6 (1950) 383. TYPE: *Endert 77E.IP.746*, Sumatra, Palembang (holo L: sheet no. 923.157-1391).

Fagraea elliptica *auctt.*: Miquel, Fl. Ind. Bat. 2 (1856) 376; Koorders & Valetton, Bijdr. 9 (1903) 84; Cammerloher, Bull. Jard. Bot. Btzg. III, 5 (1923) 316; Leenhouts, Fl. Males. I, 6 (1962) 303; Back. & Bakh. f., Fl. Java 2 (1965) 211; Kochummen, Tree Fl. Malaya 2 (1973) 272; Ashton, Manual Non-Dipt. Trees Sarawak 2 (1988) 314; Wong & Sugau, Sandakania 8 (1996) 21; *quoad F. speciosa* Blume, *Cyrtophyllum speciosum* Blume, *F. picrophloeus* Blume & *Picrophloeus javanensis* Blume in syn.; Anderson, Check List Trees Sarawak (1980) 239 *pro parte*.

[*Fagraea elliptica* Roxb. *sensu stricto*, Fl. Ind. ed. Wall. 2 (1824) 32, Fl. Ind. ed. Carey 1 (1832) 462, DC., Prodr. 9 (1845) 30, *nom. dub.*; *Willughbeia elliptica* (Roxb.) Spreng., Syst. Veg. 4 (1827) Cur. Post. 71, *nom. dub.*]

Tree, sometimes to 3–4 m tall but more often bigger, to 10–20 m tall; trunk to about 1 m diameter; **bark** fissured in younger trees, less conspicuously so and dippled-scaly

in older trees, grey-brown to dark brown. **Leaves** elliptic: (8-)11-17(-21) cm long, (3-)4-7(-9.5) cm wide; base cuneate; apex acuminate to short-caudate, 1-3 mm long; margin plane when fresh (in dried specimens sometimes slightly wavy); thin-coriaceous; upper and lower surfaces smooth; midrib prominent below; secondary veins (5-)7-12 pairs, upper side faint and immersed in the blade, lower side faint to very slightly prominent; tertiary veins inconspicuous; petioles (0.5-)1-1.5(2.2) cm long, stout. **Inflorescence** sessile, the basal branches not clearly elevated from the distalmost leaf pair on the flowering shoot and appearing as if they originate from the ultimate leaf axils, (6-)7-10(-12.5) long, 10-20 cm across, main axis branched to 4-5 orders, with 4-5 tiers of branches; lowest branches (3.5-)4-10 cm long. **Flower** pedicel (above the ultimate bracteole) 1-2 mm long; **calyx** (from the base to the lobe apices) 1.5-2 mm long, calyx cup 1.5-2 mm wide; **corolla** salverform: cream to white; corolla tube 4-6 mm long, not conspicuously flared, 0.8-1 mm wide, inside glabrous to minutely papillate; corolla lobes 2.5-3.5(-4) mm long, 0.8-1 mm wide; **stamens** with filaments 7-8 mm long in the open flower; anthers oblong, 1-1.2 mm long; **style** 7-14 mm long in the open flower; **stigma** knob-like, c. 0.5 mm across, lobes 2, low and rounded, parting to present two slightly raised, hemispherical, papillate inner surfaces when receptive, not recurving. **Fruit** when mature to 4-5 mm across; fruit calyx lobes up to c. 1 mm long and wide. **Seeds** 0.5-1 mm across.

Distribution. Sumatra, Java, Malay Peninsula, Borneo, Moluccas, New Guinea.

Habitat. Lower montane forest, but in the Wallacea region also in the lowlands, including coastal forest.

Specimens examined: BORNEO. **Kalimantan.** Sampit, *Kostermans 4663* (SING). **Sabah.** British North Borneo, *Villamil 251* (SING); Mamut Coppermine area, *Postar et al. SAN 147993* (SAN); Mt. Kinabalu, Eastern Shoulder, *Chew, Corner & Stainton 3* (SING).

JAVA. *Blume s.n.* (lecto L: 908.127-201, barcode L0005006), *Blume s.n.* (L: 908.127-507), *Blume 1867* (L: 908.127-210, barcode L0005005). **G. Salak.** 600-1000 m, *Koorders 24247β* (BO), *24461β* (BO), *36689β* (BO). **Preanger.** Tjibodas, 1400 m, *Koorders 42825β* (BO), *40154β* (BO).

MOLUCCAS. **Amboina.** *Robinson 2037* (BO, SING); Boeroe, 300 m, *Neth. Ind. For Service bb 22839* (SING). **Ceram.** 40 km E of Masohi in Wae Ruatan - Wae Ruwata (Ruwa) catchment areas, *Burley, Tukirin & Ismail 4335* (A, BO, K, SING); Kp. Kiandarar, G. Kilia, *Buwalda 5592* (SING). **Halmahera.** Taso-a-Gunung Sembilan, 300 m, *Pleyte 264* (SING). **Morotai.** Mt. Songawo, *Main et Aden 1025* (SING). **Sulabes (Sanana).** Kabauw, 150 m, *Neth. Ind. For Service bb 28875* (SING).

NEW GUINEA. **Ayerjat.** Along Boemi River, about 40 km inland from Geelvink, *Kanehira-Hatusima 12577* (A, TKU). **Mimika Regency.** PT-Freeport Indonesia Concession Area, *Utteridge et al. 458* (SING). **Morobe.** Markham Point, *Womersley & Henty NGF 11681* (SING); Patep, 2300 ft, *Millar NGF 9970* (SING). **Milne Bay.** Rabaraba, junction of Mayu & Ugat River, *Katik, LAE 56309* (SING). **Sepik.** Aitape Subdistrict, along Bliri River, *Darbyshire & Hoogland 8338* (SING); West Sepik District, Telefomin Subdistrict, Prospect Creek near Freida River, *Henty & Foreman NGF 42535* (SING), *NGF 42580* (SING). **Sogere.** *Brass 642* (BM, K). **Wissel Lake Region.** *Eyma 4425* (SING).

PENINSULAR MALAYSIA. **Kedah.** Kuala Muda, Gunung Jerai, *Whitmore FRI 20443* (SING); Jerai F.R., *Abdullah & Motan 73515* (KEP), *Gurun 66405*, leafy branch only (KEP), plantation Jerai, *Gurun 59647* (KEP, SING); Kedah Peak, *Kochummen KEP 94404* (KEP). **Kelantan.** Sungai Keleh, *Henderson 19658* (KEP, SING). **Pahang.** Cameron Highlands, Boh Plantations, *Mohd Nur SFN 32626* (KEP, SING), Gunung Brinchang, *Teo et al., KL 4694* (KEP), Gunung Terbakar, *Henderson SFN 10992* (K, SING), *SFN 31385* (KEP), *Holtum SFN 31385* (SING), *Symington KEP 36219* (KEP, SING); Fraser's Hill, Kiew & Anthony *RK 3483* (SING), Kenari Trail, *Kiew 3335* (KEP); Gunung Tapis, *Chan YC FRI 19906* (KEP, SING); Ulu Kali, *Low LYW 358* (KLU), *Stone 15420*, leafy branch only (KLU).
 SUMATRA. *Achmad 58* (SING), *1515* (SING), *1616* (SING), *Batten s.n. 1940* (SING), *Forbes 3142* (SING); *Yates 2201* (SING); Habinsaran oso. vom Tobasee 1200–1300 m, *Lörzing 6568* (BO). **Asahan.** Loemban Ria, *Rahmat 7352* (SING), *7813* (SING), *7952* (SING), *7962* (SING). **Palembang.** *Ender 77E.1P.746* (L); Lematang Ilir, Semangoes, *Neth. Ind. For Service bb. 31728* (SING), *bb. 31747* (SING), *bb. 32122* (SING); Tjaban F.R., near Muara Enim, *Kostermans 12049* (SING). **Panoadjih & Koeta Tinggi.** *Junghunh s.n.* (L). **Payakombo.** *Teysmann HB 992* (L, U). **Si borong borong.** *Stein Ba/9/73/7* (SING).

Fagraea elliptica Roxb. is a dubious name that has often been applied to the taxon referred to here. This was a name first used in the *Hortus Bengalensis* of Roxburgh (1814) without any description (*nomen nudum*), and later only briefly described in Roxburgh (1824) (*Flora Indica* ed. Wall. 2: 32), highlighting the “terminal corymbs” in this species, in contrast to much more detailed descriptions for other species he described in *Fagraea* in the same work. He also did not definitely state a locality, merely mentioning “native of the Moluccas”.

Roxburgh's unusually brief description for his *F. elliptica* may imply that there were no specimens immediately available to him and that he was awaiting material from the Moluccas collected either by his son (also William Roxburgh) or by Christopher Smith, a less-than-fully compliant nurseryman under Roxburgh Senior's direction but who seemed interested in succeeding him at the Calcutta Botanic Garden (Royal Botanic Gardens Kew 2006, Steenis-Kruseman 1958), or even someone else. The sheets in Kew, where much of Roxburgh's collection is kept, do not include *F. elliptica* collections made from the Moluccas earlier than 1824 which Roxburgh (who died in 1815) or Carey (who edited the first publication of the *Flora Indica*, with two volumes published in 1820 and 1824) or Wallich (whose taxa included in these first volumes were clearly marked as his additions) could have seen. Neither are there any found in the Edinburgh, Geneva, Linnean Society of London, Natural History Museum (London), and Paris herbaria where also Roxburgh material may be found (Forman 1997). Smith collected in the Moluccas between 1796 and 1805 (John Hunnex, Natural History Museum (London), pers. comm.) but we have managed to determine that these collections do not include *F. elliptica*.

There is also no drawing of this taxon among Roxburgh's *Flora Indica* illustrations at Kew (Sealy 1957). The British Museum has a number of drawings that had belonged to Patrick Russell (Roxburgh's friend), and John Fleming (one of Roxburgh's collaborating botanists), but none of these are marked by Roxburgh numbers (Royal Botanic Gardens Kew 2006). At the Library of the Natural History

Museum (London), John Hunnux has managed to locate a painting (in a series of some 180 drawings of plants from the region made by Smith before his death in 1807) that greatly resembled specimens which had been determined as *F. elliptica*. Although this plant is depicted with the same leafy branch habit, terminal inflorescence and floral and other dimensions that suitably represented such *F. elliptica* specimens, the included drawing of a dissected mature corolla tube clearly displays tiny stamens with short anthers inserted on the inner surface of the tube and completely included within. This totally contrasts with *F. elliptica* specimens available generally that had conspicuously long-exserted stamens far exceeding the corolla tube. Was this perhaps a preliminary representation of what Roxburgh had wanted to include but did not do so satisfactorily because details such as the nature of the stamens were still to be confirmed? The rather bright red colour used for the anthers in this painting is unrepresentative for this alliance of plants (in which anthers were typically yellow turning brown, without a red phase), suggesting it may have needed to be specially highlighted.

The description of *F. elliptica* in Roxburgh (1824) is conspicuous by its brevity, hardly three lines in all, omitting mention of the stamens, and not discussing any collection, merely mentioning the Moluccas as a provenance. In contrast, the description of the preceding taxon in the same work, *F. fragrans*, is detailed, including mentioning the exserted stamens, and gives the provenance and a collection number clearly. The later Carey edition of the *Flora Indica* (Roxburgh 1832, vol. 1: 462), repeats the same brevity for *F. elliptica*. In his *Prodromus*, De Candolle (1845: 30 & 32) enumerates both *F. elliptica* Roxb. as well as *Picrophloeus javanensis* Blume, which he was evidently unaware could be synonymous. Candolle notes thus on his page 30:

“13. *F. elliptica* (Roxb. fl. ind. ed. 1824. v.2 p.32), caule..... foliis breviter petiolatis lato-ellipticis laevibus firmis, corymbis terminalibus supra decompositis, corollae tubo cylindrico. in Moluccis. Caet. ign.”

The final notation (Latin: *Caetera ignota* = all the rest unknown) is a telling sign that, decades afterwards, the details of *F. elliptica* had remained enigmatic. By the time of the *Flora of British India* (Clarke in Hooker 1883), this taxon was not enumerated anymore. However, Miquel (1856) still adopted the name *F. elliptica*, with *F. speciosa* Blume (published in 1838) as a synonym, and also enumerated the now-illegitimate *F. picrophloeus* Blume (based on *Picrophloeus javanensis*), providing these names that Malesian botanists then attempted to account for in their region. These names were later accepted by Leenhouts (1962) as synonymous, with *F. elliptica* Roxb. the earliest correct name.

The unsuccessful searches among the various herbaria for specimen material that could be specially related to the brief and uninformative description of *F. elliptica* in Roxburgh (1824), the continuing inability among interested scholars to provide a better description in the decades following this, and the existence of a Smith painting wherein an important discrepancy exists for the very feature that was omitted in the Roxburgh descriptions, must, unfortunately, imply that Roxburgh and his editors were greatly hampered by availability of material and lack of familiarity with this taxon. Here we take the view that *F. elliptica* Roxb. represents a dubious name that cannot be

reasonably ascribed a type specimen from possibly original material. Instead, there is much advantage in employing *P. javanensis* Blume as the correct name for the taxon we intend here, because it is also assigned to the genus name most appropriate to its taxonomy and was validly published in 1826 (just two years following the appearance of *F. elliptica* in Roxburgh's *Flora Indica*), when for years later even Roxburghian scholarly circles could not resolve the enigmatic aspects of *F. elliptica*. Even if familiarity could be claimed for using *F. elliptica* Roxb. in the sense of *P. javanensis*, the former name would still need to be neotypified and a new name combination made in *Picrophloeus*, both of which could be highly contentious propositions.

4. *Picrophloeus rugulosus* (K.M.Wong & Sugau) K.M.Wong, **comb. nov.** — *Fagraea rugulosa* K.M.Wong & Sugau, Sandakania 8 (1996) 22. TYPE: Chai & Ilias S. 27929, Sarawak, 5th Division, Ulu Lawas, Telau, Kota F.R. near Sg. Telau (holo SAN; iso A, BO, K, KEP, L, SAR, SING).

F. elliptica *auctt.*: Leenhouts, Fl. Males. I, 6 (1962) 303 *pro parte*; Cockburn, Trees of Sabah 1 (1976) 210 *pro parte*; Ashton, Manual Non-Dipt Trees Sarawak 2 (1988) 314 *pro parte*; Anderson, Check List Trees Sarawak (1980) 239 *pro parte*. [*Fagraea elliptica* Roxb. *sensu stricto*, Fl. Ind. ed. Wall. 2 (1824) 32, *nom. dub.*]

Tree, to around 15 m tall; trunk to c. 25 cm diameter; **bark** lightly fissured, dark brown. **Leaves** elliptic-obovate; 11–21 cm long, 5–9 cm wide; base cuneate; apex acute; margin recurved when dry; coriaceous; upper and lower surfaces coarsely shagreen; midrib prominent below, rounded or ridged; secondary veins 9–12 pairs, on both sides faint to obscure; tertiary veins obscure; petioles 2–3.5 cm long, stout. **Inflorescence** distinctly pedunculate (its basal branches distinctly elevated from the ultimate leaf pair), to c. 6 cm long, c. 15 cm across, main axis branched to 3–4 orders, with (3–)4–5 tiers of branches; peduncle 1–1.5 cm long; lowest branches typically 2.5–6 cm long. **Flowers** sessile (the ultimate floral bracteole immediately below the calyx cup); **calyx** (from the base to the lobe apices) 3–4 mm long, calyx cup 2–3 mm wide; **corolla** salverform; cream to white; corolla tube 8–10(–11) mm long, not conspicuously flared, 1–1.5 mm wide, inside glabrous to minutely papillate; corolla lobes 4.5–6 mm long, 2–2.5 mm wide; **stamens** with filaments 15–18 mm long in the open flower; anthers oblong, c. 1 mm long; **style** (18–)22–25 mm long in the open flower; **stigma** knob-like, c. 0.5 mm across, lobes 2, inconspicuous. **Fruit** when mature to 6–9(–10) mm across; fruit calyx lobes 2–2.5 mm long and wide. **Seeds** c. 1 mm across.

Distribution. So far known only in, and probably endemic to, the Brunei region (SW Sabah, Brunei and NE Sarawak).

Habitat. Primary *kerangas* and lowland mixed dipterocarp forest up to c. 450 m.

Specimens examined: BORNEO. **Brunei.** Belait, Andulau F.R., Ashton BRUN 628 (BRUN, K,

SING), Andulau Compartment 8, *Wood, Smythies & Ashton SAN 17521* (BRUN, K, SING); Belait, Bukit Puan, *Ashton BRUN 637* (BRUN, K, SING). Sukang, Sungei Kuat, Ulu Belait, *Salleh et al. BRUN 15338* (SING), Sungai Liang, at Ulu Sungai Lumut, *Niga et al. BRUN 15216* (SING); Belait, Teraja, Wasai Wong Kadir, *Ariffin et al. BRUN 15161* (SING); Belait, source of the Sg. Ingei north of Batu Patam, *Wong WKM 1104* (BRUN, K, SING); Ulu Belait, R. Topi, *Ashton BRUN 214* (BRUN, K, SING); Temburong, Temburong River, just upstream from Wong Nguan gorge, *Wong WKM 1702* (BRUN, K, SING), just upstream from Wong Nguan rapids, *Coode 6539* (BRUN, K); Tutong, Bt. Bahak, near LP 338A, *Coode 7029* (BRUN, K); Tutong, Kampong Bukit Beruang, *Niga & Clayton BRUN 15450* (SING); Tutong, Ladan Hill F.R., *Ariffin et al. BRUN 18078* (SING). **Sabah.** Beaufort, Papar-Beaufort road, mile 16.5, *Lajangah SAN 32270* (SAN); Sipitang, Sri Beaufort Area, *Dewol SAN 80111* (KEP, SAN, SAR, SING). **Sarawak.** Baram, G. Mulu N.P., Ulu Sg. Berar, *Chai S. 39595* (A, KEP, L, MO, SAN, SAR), Melinau Gorge (4°10'N, 114°55'E), 1000 ft, *Chew CWL 442* (K, SING), *Ilias S. 16603* (A, BO, K, L, SAN, SAR, SING), near Gunong Api (4°7'N, 114°55'E), 1000 ft, *Chew CWL 1172* (K, SING); Miri, Lambir, proposed N.P., *Awang Morshidi S. 24094* (K, L, SAR, SING), Lambir Hills, *Ilias S. 16603* (SAR, SING); Ulu Lawas, Kota F.R., near Sungai Telau, *Chai & Ilias S. 27929* (holo SAN; iso A, BO, K, KEP, L, SAR, SING).

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REFERENCES

- Blume, C.L. (1838) *Rumphia*. Vol. 2. Leiden.
- Candolle, A.P. de (1845) *Prodromus systematis naturalis regni vegetabilis, sive enumeratio contracta ordinum generum specierumque plantarum huc usque cognitatarum, juxta methodi naturalis, normas digesta*. Vol. 9. Paris: Sumptibus Sociorum Treuttel et Würtz.
- Forman, L.L. (1997) Notes concerning the typification of names of William Roxburgh phanerogams. *Kew Bull.* 52: 523–534.
- Hooker, J.D. (1883) *The Flora of British India*. Vol. 4. Pp. 82–85. London: L. Reeve & Co.
- Leenhouts, P.W. (1962) Loganiaceae. In: Steenis, C.G.G.J. van (ed.), *Flora Malesiana*. Series 1 Vol. 6. Pp. 293–336. Groningen: Wolters-Noordhoff Publishing.
- Miquel, F.A.W. (1856) *Flora Indiae Batavae*. Vol. 2. Lipsiae: Fried. Fleischer.
- Ridley, H.N. (1893) On the flora of the eastern coast of the Malay Peninsula. *Trans. Linn. Soc. London, Bot.* 3: 267–408 & Pl. 61–66.

- Ridley, H.N. (1918) New and rare Malayan plants. *J. Straits Branch Roy. Asiat. Soc.* 79: 97–98.
- Ridley, H.N. (1923) *The Flora of the Malay Peninsula*. Vol. 2. London: L. Reeve & Co.
- Roxburgh, W. (1814) *Hortus Bengalensis, or a Catalogue of the Plants Growing in the Honourable East India Company's Botanical Garden at Calcutta*. Serampore, Calcutta.
- Roxburgh, W. (1824) *Flora indica, or, Descriptions of Indian plants, by the late William Roxburgh*. Edited by Dr. William Carey; to which are added descriptions of plants more recently discovered by Dr. Nathaniel Wallich. Vol. 2. Serampore: Mission Press.
- Roxburgh, W. (1932) *Flora indica, or, Descriptions of Indian plants /by the late William Roxburgh*. Ed. W. Carey. Vol. 1. Serampore: W. Thacker.
- Royal Botanic Gardens, Kew (2006) Roxburgh's Flora Indica. <http://www.kew.org/floraIndica/> (accessed on 13 Jul 2012).
- Sealy, J.R. (1957) The Roxburgh Flora Indica drawings at Kew. *Kew Bull.* 11: 297–399.
- Steenis-Kruseman, M.J. van (1958) Malaysian plant collectors and collections. *Supplement I. Flora Malesiana I*, 5 (4): CCXXXV–CCCXLII (superposed pagination 1–108).
- Sugumaran, M. & Wong, K.M. (2012) Studies in Malesian Gentianaceae I: *Fagraea* sensu lato—complex genus or several genera? A molecular phylogenetic study. *Gard. Bull. Singapore* 64(2): 301–332.
- Wong, K.M. & Sugau, J.B. (1996) A revision of *Fagraea* (Loganiaceae) in Borneo, with notes on related Malesian species and 21 new species. *Sandakania* 8: 1–93.
- Wong, K.M. & Sugumaran, M. (2012) Studies in Malesian Gentianaceae II: A taxonomic framework for the *Fagraea* complex, including the new genus *Limahlania*. *Gard. Bull. Singapore* 64(2): 481–495.

**Studies on Homalomeneae (Araceae) of Peninsular
Malaysia IV:
Homalomena stongensis, a remarkable new species
endemic to Gunung Stong, Kelantan**

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ABSTRACT. *Homalomena stongensis* is described from Gunung Stong, Kelantan, where it is very locally endemic to steep forested slopes. An updated key to Peninsular Malaysian species of Homalomena Supergroup *Homalomena* is provided, and the new species is illustrated.

Keywords. Araceae, *Homalomena*, Homalomena Supergroup, Peninsular Malaysia, Kelantan, limestone

Introduction

Fieldwork focussing on Araceae in Peninsular Malaysia continues to reveal novel species, many seemingly very locally endemic, maybe explaining why they have been overlooked to date. In particular, *Homalomena* appears to be represented by a great many novel taxa in the Peninsula (Ng et al. 2011a; Zulhazman et al. 2011). Frustratingly, most are encountered sterile during fieldwork, necessitating samples being bought into cultivation to flower and enable assessment of their novelty. Recently, one such taxon gathered during an initial survey at Gunung Stong, Kelantan, has flowered in the research collection of the first author, and has proved to be both novel and rather remarkable in its morphology. It is here described.

***Homalomena stongensis* H.Zulhazman, P.C.Boyce & M.Mashhor, sp. nov.**

Species statim distinctissima pedunculo patente declinato spatha ascendenti florens. Praeterea spatha concolor ad anthesin externe medie virida interne clare luteole alba, staminodia interpistillaria filamentose clavata, spadix longe stipitatus, longitudo zonarum pistillatarum cum stipite circa dimidium spadiceis longitudinem distinguenda.
TYPE: Malaysia, Kelantan, Jeli, Gunung Stong State Forest Park, forested flanks of

Jelawang Falls, 18 April 2010, 5°20'29.0"N; 101°58'10.1"E, *Zulhazman* UMK7, (holo, Herbarium Universiti Malaysia Kelantan, Faculty of Earth Science, UMK). (Fig. 1)

Medium, solitary, evergreen, glabrous, bruised tissue strongly aromatic (reminiscent of young mango), herbs to 52 cm tall, shoots pleionanthic. **Stem** up to 26.5 cm tall, c. 4 cm diam., erect, rooting from nodes and at length declinate, older parts clothed with brownish-black papery to fibrous petiole base remains, with the roots penetrating this fibrous layer, active tip erect with oldest leaves spreading. **Leaves** 6–7 together, spirally arranged, and clustered towards shoot tips, older leaves by bending of the petiole with the leaf blade tip touching the ground; **petioles** exceeding the blade, 34–42 cm long, non-sheathing portion D-shaped in cross section, 0.9–1.1 cm diam., above petiolar sheath, base clasping the stem and expanding into an open persistent petiolar sheath, medium green, **petiolar sheath** 11–18 cm, $\frac{1}{3}$ – $\frac{1}{4}$ petiole length, persistent, deep spreading and open, margins hyaline, petiolar sheath for the older leaves, externally shallowly grooved, the groove extending to the insertion of the blade; **leaf blade** ovate-cordate to ovate-lanceolate, 25–30 cm × 18–22 cm, base sagittate to cordate, apex acute with an apiculate tip 6–7 mm long, semi-glossy, older leaves irregularly quilted between the primary lateral veins and these leaves, through recurving of the petioles often with the leaf blade tip touching soil, margins entire and minutely hyaline, adaxially semi-glossy dark green, adaxially paler green; mid-rib less conspicuous adaxially, prominent abaxially, wedged shape at mid-vein cross section and primary lateral veins conspicuously raised abaxially, deeply impressed adaxially; primary lateral veins 11–15 per side, interprimary veins alternating, much less prominent; secondary and tertiary venation invisible. **Inflorescences** 3–5 together, maturing sequentially in a simple synflorescence, initially upright, at anthesis with peduncle spreading-declinate and spathe ascending, fully all declinate after anthesis; peduncle 9–12 cm long, 8.3–9.5 mm diam., at spathe insertion 9–10 mm, dark, somewhat glossy green. **Spathe** unconstricted, ellipsoid-cylindrical, 10.4–10.7 cm long, 0.83–0.95 cm diam. (before anthesis), gaping c. 1.4 cm at anthesis to c. 1.8 cm wide with the rostrum remaining furled and retaining the tip of spadix, with a conspicuous terminal curved rostrum to c. 1.5 cm. **Spadix** c. 7 × 1 cm, obliquely stipitate; stipe 0.9 cm, greenish white. **Pistillate flower zone** cylindrical, c. 3 × 1 cm, pistils somewhat laxly arranged, 2.5 × 1.5–2 mm; **ovary** globose-cylindric, the lowermost ones somewhat obliquely gibbose, ascending, glossy medium green; **stigma** sessile, discoid, flat, translucent white, c. 2 mm diam.; **interpistillar staminodes** c. 2.8 mm long, exceeding pistils, stipe very slender, flexuous, tip tear-drop shaped, white, staminodes associated with distal-most pistils weakly trapezoidal in plan view. **Staminate flower zone** c. 3.9 × 1.1 cm, cylindrical, the tip bluntly weakly tapering, very pale whitish yellow, almost contiguous with the pistillate zone, the interface marked by a few somewhat laxly arranged trapezoidal staminodes; **staminate flowers** weakly and irregularly rhombo-hexagonal, each with 3–5 stamens, 1.8 × 1 × 1.5–2 mm, anthers with 4 distinct thecae, each with a terminal crenate lobe, and overtopped by a large synconnective. **Fruiting spathe** declinate. **Fruits & seeds** not observed.



Fig. 1. *Homalomena stongensis* H.Zulhazman, P.C.Boyce & M.Mashhor. **A. & D.** Flowering plant. Left hand inflorescence at female anthesis; note the spreading-declinate peduncle and erect spathe; right hand inflorescences at early stages of fruiting, note the declinate peduncle and spathe beginning to decline. **B.** Detail of the open petiolar sheath. **C.** Whole plant. **E.** Leaf blade, adaxial view. Note the quilted nature of the blade. **F.** Inflorescence at pistillate anthesis. Note the yellowish tinge to the spathe interior, and the manner in which the rostrum remains closed and retains the tip of the spadix. **G.** Spadix, with spathe removed. **H.** Pistillate flower zone. Note the flexuous interpistillar staminodes. **I.** Staminate flower zone. (Photos: Zulhazman H.)

Distribution. Peninsular Malaysia, Kelantan, Gunung Stong State Forest Park. Locally endemic.

Ecology. Perhumid hill dipterocarp forest along flanks of waterfalls on steep (c. 30°) granite slopes, at 300 m asl.

Notes. *Homalomena stongensis* belongs to the Homalomena Supergroup *sensu* Wong & Boyce (2008) & Ng et al. (2011b). *Homalomena stongensis* is immediately distinctive from all other *Homalomena* so far described from Peninsular Malaysia by flowering with the peduncle spreading-declinate and the spathe ascending. It is further distinguished by the strongly discolorous, spathe - is externally medium green, internally bright yellowish white at anthesis, the filamentous-clavate interpestillar staminodes, long-stipitate spadix, and the combined length of pistillate zone plus stipe accounting for almost half the spadix length.

Key to Peninsular Malaysian *Homalomena*
(Supergroup Homalomena)

- 1a. Peduncle at anthesis spreading-declinate with the spathe erect. Interpestillar staminodes with stipe very slender, filamentous, somewhat sinuous, the head teardrop-shape *H. stongensis*
- b. Peduncle at anthesis erect. Interpestillar staminodes stout, straight, the head ± globose 2

- 2a. Flowering plants large, often exceeding 1 m tall. Spathe 8–14 cm long; spadix 7–13 cm long *H. pontederiifolia*
- b. Flowering plants medium, seldom exceeding 40 cm tall. Spathe 4–6 cm long; spadix 5–6.5 cm long 3

- 3a. Leaf blade abaxially with conspicuous striate pellucid secretory canals running parallel to the primary lateral veins. (S Peninsular Malaysia as far north as S Pahang) *H. curvata*
- b. Leaf blade abaxially without striate pellucid secretory canals. (Kedah, Perlis) *H. truncata*

ACKNOWLEDGEMENTS. The authors would like to acknowledge the Kelantan Forestry Department for allowing them to conduct the study in the Gunung Stong State Forest Park. Special thanks go to Mr. Nik Yuszrin Yusof, Ms. Naziah Zaid, and Ms. Norzielawati Salleh for their kind assistance in our work. This project was funded by Universiti Malaysia Kelantan through the first author’s short-term research grant R/SGJP/A03.00/00279A/001/2009/000021 via the Faculty of Agro Industry and Natural Resources. Thanks are due to J.F. Veldkamp (L) for providing the Latin diagnosis.

References

- Boyce, P.C. & Wong, S.Y. (2008) Studies on Homalomeneae (Araceae) of Borneo I. Four new species and preliminary thoughts on informal species groups in Sarawak. *Gard. Bull. Singapore*, 60: 1–29.
- Ng, K.K., Boyce, P.C. & Sofiman, O. (2011a) Studies on Homalomeneae (Araceae) of Peninsular Malaysia II: An historical and taxonomic review of the genus *Homalomena* (excluding *Chamaecladon*). *Gard. Bull. Singapore* 62: 277–289.
- Ng, K.K., Sofiman O., Boyce, P.C. & Wong S.Y. (2011b) Studies on Homalomeneae (Araceae) of Borneo VIII: Delimitation of additional informal suprageneric taxa for Sundaic *Homalomena*. *Webbia* 66(1): 21–28.
- Zulhazman, H., Mashhor, M. & Boyce, P.C. (2011) Notes on Araceae of Kuala Koh, Kelantan, Peninsular Malaysia. *Gard. Bull. Singapore* 63: 213–218.

BOOK REVIEW: *Etlingera* of Sulawesi. A.D. Poulsen. 2012.

Kota Kinabalu: Natural History Publications (Borneo) Sdn. Bhd. in association with Royal Botanic Garden Edinburgh and Natural History Museum, University of Oslo. 26 cm × 19 cm, hard cover, vii + 278 pp. ISBN 978-983-812-138-5. Price RM 250.

The ginger genus *Etlingera* is well known through the magnificent Torch Ginger cultivated throughout the tropics and used in SE Asian cooking. But there is more to *Etlingera*. The genus is both large and morphologically diverse with the total number of species still pending, but estimated by the author to be 150–200 species. All *Etlingera* species are evergreen and are found mostly in equatorial evergreen forests, growing from lowlands to high altitudes of 2700 m. The distribution of this genus spans over 14,000 km, with its western limit in Northeast India, richly represented across SE Asia and reaching its eastern limit in the Pacific island of Tahiti.

It has been 6 years since Axel Poulsen's previous book *Etlingera of Borneo* (2006, same publisher) and it is obvious that the author has been rather busy getting yet another stunning book out. It is dedicated to the memory of British naturalist Alfred Russel Wallace (1823–1913), an avid explorer, geographer, anthropologist and biologist, who is well known for identifying the Wallace line, dividing the Indonesian archipelago into the ecozones of Asia and Wallacea—a transitional zone between Asia and Australia.

Sulawesi is located in the western part of Wallacea and therefore it is no big surprise that its flora is strikingly different from neighbouring Borneo. The flora is also far less known and this book reflects perfectly the uniqueness and richness of the Sulawesi flora as well as the poor state of our knowledge. Only 4 *Etlingera* species have been known to occur in Sulawesi in 2008, when the author started his work, but the current revision presents 48 taxa—an increase of more than 10 fold! It is noteworthy that Borneo which has only 42 taxa is about 4 times bigger than Sulawesi, and as the author pointed out, he spent far less time in the field in Sulawesi than in Borneo, hinting that more species are yet to be found in Sulawesi. The only species common between the two islands is the ubiquitous Torch Ginger (*Etlingera elatior*). The readers familiar with usually red, orange and yellow Bornean species will be surprised with an entirely different colour palette of cream, pink and yellow-green Sulawesi species instead.

The book is divided into three parts, which are clearly marked by coloured headers. The first part of the book is divided into 5 major chapters. The brief introduction recapitulates basic facts about the genus *Etlingera*, while the second chapter, accompanied by 8 dated maps, explains Sulawesi's complicated geological history and touches on its climate and geology. The third chapter deals with the morphology of an *Etlingera* plant. It describes in detail the characters of vegetative and flowering shoots, flowers, infructescences, fruits and seeds. The five very detailed SEM photographs of stigmas could present somewhat amusing and scary images to the imaginative viewer, while the line-drawing of various fruit types drawn to scale and spreading over two pages is helpful for identification.

The fourth chapter starts with the history of ginger research on Sulawesi, recapitulating the importance of botanists collecting there, for example, C.G.C. Reinwardt, O. Beccari, O. Warburg, the brothers P.B. and K.F. Sarasin, but also mentioning others like F. Gagnepain and K. Schumman, who described species based on others' collections. Informal infrageneric groupings, origin and evolution, the significance of Wallace's Line and affinities to neighbouring islands, as well as ecology, pollination, flexistyly, ethnobotany and conservation issues are also discussed in this chapter.

The last fifth chapter of the introductory part describes material and methods. The author shares the dire situation of starting a revision, with most of the types in the Berlin Herbarium destroyed during the Second World War and how the extensive fieldwork targeting all type localities proved to be a successful strategy, as fertile material was found for all but one species. The comparison between Sulawesi, where the majority of the species are known only from single or very few collections, and Borneo, where multiple collections exist for most of the species, is nicely summarised in Figure 37. Beware of the printing hobgoblin, who switched the signs Borneo and Sulawesi in the chart itself, though the careful reader should not be misled as the legend is well composed. This chapter also discusses the methodology of collecting notoriously difficult gingers with specific notes on *Etilingera*, and explains terminology used in the descriptions, how the collections were measured, as well as the species concept used in this revision. The key to the species is the last item of the introductory part before the real *Etilingera* show starts.

The main bulk of the book is dedicated to the 48 taxa, which are arranged alphabetically. This includes 36 new species, two subspecies, one new name and six new combinations for species, which have been previously recognised as members of other ginger genera, e.g., *Amomum*. Six new synonyms are also recognised. Each taxon has been provided with a detailed description, followed by local names and uses, etymology, ecology and habitat, distribution, conservation status, other material examined, and finally, other notes. This is supplemented by a nice distribution map, drawings of the floral parts and numerous colour photographs showing in great detail the inflorescences, flowers, ligules, fruits and other important characters. In species with complex nomenclature or taxonomy, such as *Etilingera alba*, images of the original herbarium material are also provided with detailed notes on new synonymy and selection of lectotype. The account closes with a list of specimens, some of which may still turn out to be new taxa, but at present there is no adequate material for their description; there is also an accompanying taxonomic note regarding *Amomum* names that have been investigated and proven not to be *Etilingera* species (as many elsewhere have turned out to be the latter genus).

The third and last part of the book is dedicated to acknowledgements and the useful necessities—references, identification list, indexes to vernacular names, uses and scientific names.

Etilingera of Sulawesi is a modern, critical revision based on the author's solid study of herbarium material as well as fieldwork. There is no doubt that the author loves his work, loves his plants and enjoys writing books. Kudos are also due to the

publisher for a beautiful layout, which blends well with the scientific text and ink illustrations, with colour photographs and other pictures of habitats, old maps and some hitherto unpublished historical photographs. I find this book supremely well done, enjoyable throughout and easy to use. Considering the minimal overlap with the previous *Etilingera of Borneo*, the two books together cover some 88 species, which is more than half of the currently known species. And the Etilingeras? Some are simply stunning, while others are enjoyably strange as demonstrated right on the cover of the book, ensuring some 'oohs' and 'aahs' for anyone who picks up this book for serious professional interest, or just out of curiosity.

Jana Leong-Škorničková

Singapore Botanic Gardens

BOOK REVIEW: Flora of Hong Kong. Volume 4. Hong Kong Herbarium & South China Botanical Garden (General editors: Hu Qi-ming, Wu De-lin; Associate editor: Xia Nian-he; Volume editors: Xia Nian-he, Cheung Kwok-wai, Pang Kuen-shum & Yip Kwok-leung). 2011.

Hong Kong: Hong Kong Herbarium, Agriculture, Fisheries and Conservation Department. 30.6 cm × 21.7 cm, hard cover. xv+379 pp. (main text) +65 pp. (Photos 1–673, illustr. glossary). ISBN 978–988–98253–9–3. Price HKD 150.

Volume 4 completes the *Flora of Hong Kong* project, which succeeds two previous floras from long ago, Bentham's *Flora Hongkongensis* (1861) and Dunn & Tutcher's *Flora of Kwangtung and Hongkong* (1912). With around 2100 native species (out of some 3330 total species) in an area of just over 1000 km², Hong Kong's flora is justifiably rich; the territory encompasses elements of both tropical and subtropical regions. China has about 31,500 plant species (treated in the near-completing *Flora of China* project that will be published as 25 volumes of text and 25 volumes of illustrations, which the present *Flora* complements), nearly 12% of the world total, and many plants generally distributed in South China were first described from Hong Kong.

Volume 1 included 10 gymnosperm families sensu Kubitzki (1990) and 75 dicot families; Volume 2, another 56 families; Volume 3, the remaining 29 families; and Volume 4, 40 monocot families. A Master Index in a separate volume was published in 2012. The format is highly accessible, with brief family and genus summaries (contrast these with some frequently lengthy beginning descriptions in the *Flora of China* versions), simple indented (typically artificial) keys (the taxa numbered and presented following the order they are keyed out), species references citing the major relevant accounts, taxon descriptions of up to 200–300 words, and short notes on known localities in Hong Kong, distribution elsewhere, ecology and (where relevant) uses and taxonomy. The *Flora of Hong Kong* represents a generally up-to-date documentation of the plant diversity, with few omissions (e.g., *Vanilla*, Orchidaceae) that have resulted from somewhat contemporaneous research publications.

Volume 4 itself has 673 colour photos spread over 59 pages following the main account. The “big ones” in Volume 4 include Cyperaceae (27 genera, 143 spp., Deng Yun-fei, *Carex* by Ng Sai-chit); Poaceae (95 genera, 227 spp., Xia, Yu Hui, Li Jing, Zhao Nan-xian, Peng Hua); and Orchidaceae (53 genera, 114 spp., Hu Shiu-ying, Corsica Kong). Other contributors include Guo Li-xiu (Arecaceae), Patrick Lai (*Halophila*), Richard Saunders (Burmanniaceae, Phylodraceae), Wang Fa-guo, Xing Fu-wu and Zheng Xi-long (Dioscoreaceae), Yip Kwok-leung (Hydrocharitaceae, Limncharitaceae, Najadaceae), Yu Hui (Araceae), and Zhang Dian-xiang (Burmanniaceae), and a great assortment of the other families were covered by the editors Hu, Wu and Xia, individually.

This is the only modern regional South Chinese flora written in English. It is a major project of the Hong Kong Herbarium, established in 1878 and China's first public herbarium. There are triumphs in different senses. Professor Hu Shiu-ying, Honorary Editor of the *Flora of Hong Kong*, provided the preface, in which she celebrated the completion of this flora, one she began studying in 1968. Professor Hu, whose own

contributions appear in the “modern flora specially prepared for Hong Kong” that she had dreamt of for so long, passed away on 22 May 2012, just a year after Volume 4 appeared.

Orders by mail can be made to the Publications Sales Unit, Information Services Department, Room 402, Murray Building, Garden Rd., Central, Hong Kong, China or through the puborder@isd.gov.hk email address.

K.M. Wong

Singapore Botanic Gardens

BOOK REVIEW: *Private Lives. An Exposé of Singapore's Rainforests.* Wang Luan Keng, Darren C.J. Yeo, Kelvin K.P. Lim & Shawn K.Y. Lum (eds). 2012.

Singapore: Raffles Museum of Biodiversity Research. 21.1 cm × 14.9 cm. 298 pp. Hardcover: ISBN 978-981-07-2472-6, price SGD 35. Paperback: ISBN 978-981-07-2473-3, price SGD 24.

This book is well worth noticing and owning because it celebrates the riches of the rain forest by providing, simply, a well-coordinated string of perspectives and anecdotes that introduce what rain forests are, nicely educating on key aspects of this vegetation formation and its plant and animal life. Its context is, firstly, to draw attention to Singapore's last-remaining natural treasures found in this amazingly complex vegetation type, but it really is a useful book for all of Southeast Asia generally because the material is applicable across the region.

There have been other attempts to present the rain forest to a general audience, but this book, crafted by natural history scientists and conservationists working together, achieves an excellent introduction for both the student as well as the informed general reader. Its size, too, allows for easy carrying about and storage, a veritable mini-compendium of tropical rain forests, their ecological significance, incredible plant and animal diversity, and the importance of further discovery and protection. The book cleverly infuses people-oriented elements to make its point. For example, the introduction does not fail to point out how communities are entrenched in botanical tradition, with roads named after plants, and so on. It is richly illustrated in colour throughout, which is quite necessary in a book with such a broad mission. There are just a few corrections, which the authors themselves take the trouble to point out (in their website <http://exxonmobil.rafflesmuseum.net>) but this in no way diminishes the value of the book.

Logically structured, the Introduction lays out the importance of rain forests in maintaining genetic and species diversity, and as a key carbon sink, without hesitation. Its physical structure contributing to 3-dimensional complexity, to which transitional developmental phases of individual organisms, cohorts and communities give a temporal variability, is nicely presented. "Biotic Features" points out the dominance of tree forms and gives a sketch of the scientific ideas around how such levels of biodiversity are derived, emphasises the dynamic nature of forests through discussing the forest growth cycle and succession, and leads the reader comfortably through a slew of anecdotes about rain forest adaptations among plants. There is a highlight on mass flowering, a key feature of SE Asia's climax forests. "Moving Up" relates about climbing plants and epiphytes. Invertebrates get their own chapter. "Winging It" discusses creatures that fly or glide, as well as the curious adaptations among plants for wind dispersal; "Forest Buffet" tells of feeding strategies among animals; "Sylvan Symphony" recollects the chirps, songs, croaks and choruses contributed by a huge diversity of organisms that make the forest traveller's experience so fascinating.

The night brings a different world, as if the organisms have worked out a time-sharing schedule among themselves. The wonder of nocturnally active animals, the miracle of specialised night vision, and things that glow in the dark capture our attention. "Poisons, Fangs & Claws" bring on the realism of food capture as well as

chemical defences in both plants and animals (here the stinkbugs hold their own), and the weird and wonderful in both plant and animal armature. "Looks Can Be Deceiving" describes camouflage and mimicry, including the cross-kingdom mimicry among plants and animals. The story of decomposition is told via focussing on the agents of decay, and social organisms and ecological interdependence among plants and animals are dealt with using similarly short "stories". Among the last chapters are "Jungle Grocery" that highlights our continued dependence on forest-derived materials and foods, and "Taking Stock, Taking Care", before the final discussion on conserving and managing forests sensibly is presented.

"Eco-Warrior" seems a nice way to complete such an account. It is a salute, presented as a finale to this book, to Dr. Wee Yeow Chin, retired academic but tireless teacher and conservationist, whose own accounts of natural history have sustained interest around nature in Singapore and the region. It reminds us not to be complacent, because, like all things good and wonderful, rain forests can well disappear if we do not take the trouble to understand and protect them.

K.M. Wong

Singapore Botanic Gardens

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Scientific names and author abbreviations. Genus and species names of organisms must be italicised and followed by the authority (with family name in parentheses) when first mentioned in the text or diagnoses. Standards for author abbreviations include:

Brummitt, R.K. & Powell, C.E. (1992) *Authors of Plant Names*. Kew: Royal Botanic Gardens, Kew.

Kirk, P.M. & Ansell, A.E. (1992) *Authors of Fungal Names* [Index to Fungi Supplement]. Wallingford: CAB International.

Herbarium abbreviations (<http://sciweb.nybg.org/science2/IndexHerbariorum.asp>) follow Holmgren, P.K., Holmgren, N.H. & Barnett, L.C. (eds) (1990) *Index Herbariorum. Part 1: The Herbaria of the World* [Regnum Veg. vol. 120]. New York: New York Botanical Garden.

Journal and book title abbreviations. For journals:

Bridson, G.D.R., Townsend, S.T., Polen, E.A. & Smith, E.R. (eds) (2004) *BPH-2: periodicals with botanical content: comprising a second edition of Botanico-Periodicum-Hunlianum*. Pittsburg: Hunt Institute for Botanical Documentation.

For books:

Stafleu, F.A. & Cowan, R. S. (eds) (1976–88) *Taxonomic Literature*. 2nd edition. 7 vols [Regnum Veg. vols 94, 98, 105, 110, 112, 115, 116].

Stafleu, F.A. & Mennega, E.A. (eds) (1992–) *Taxonomic Literature*. Supplements [Regnum Veg. vols 125, 130, 132].

(A useful source of verify ing names of publications is

<http://asaweb.huh.harvard.edu:8080/databases/publication_index.html>. If in doubt, list full titles.

Other abbreviations and units of measurement. If using standard abbreviations and acronyms, give the full term on first mention. Dates are cited as: 1 Jan 2000. SI (metric) units of measurement are used and spelled out except when preceded by a numeral; they are abbreviated in standard form: g, ml, km, etc.

Tables. Tables are numbered in arabic numerals in the order they are first mentioned in the text and carry an indicative legend at the head. Tables are given at the end of the manuscript.

Illustrations. All drawings, maps, graphs and photographic images (individually or collected in a plate) are to be numbered in arabic numerals in the order they are first mentioned in the text, as Fig. 1, Fig. 2, etc. (plate components would be referred to in the text as Fig. 1A, 1B, Fig. 1A–D, etc.). If relevant, scale bars should be used to indicate magnification.

When grouping photographs, the maximum page area 19.5 x 13 cm must be heeded. High resolution digital images may be submitted as *separate* files (line drawings in black and white at 600 dpi, photographs at 300 dpi) sent electronically or in a CD. Do not embed images into the main text file.

References in the text. Citation in the text should take the form: King & Gamble (1886) or (King & Gamble 1886), or King et al. (1886) if more than three authors to a work. Use 2000a, 2000b, etc. if several papers by the same author(s) in one year are cited.

References listed at the end. There, works mentioned in the text are listed alphabetically as follows:

Dallwitz, M.J., Paine, T.A. & Zurcher, E.J. (1999) User 's Guide to the DELTA Editor. <http://biodiversity.uno.edu/delta/> (accessed on 2 Aug. 2010).

Persson, C. (2000) Phylogeny of Gardenieae (Rubiaceae) based on chloroplast DNA sequences from the *rps* 16 intron and *trnL*(UAA)-F(GAA) intergenic spacer. *Nordic J Bot.* 20: 257–269.

Ridley, H.N. (1930) *The Dispersal of Plants Throughout the World*. Ashford, U.K.: L. Reeve.

Smith, A.C. & Darwin, S.P. (1988) Rubiaceae. In: Smith, A.C. (ed) *Flora Viliensis Nova, A New Flora of Fiji* 4: 143–193.

References to web-based resources should include either a doi (digital object identifier) specification or full URL mentioning also the date it was accessed. Use of DNA sequences from GenBank should be acknowledged and the studies for which the sequences were generated should be cited.

Style of nomenclatural summaries. The following style is required:

Gardenia anisophylla Jack ex Roxb., Fl. Ind. ed. Carey & Wall. 2: 561 (1824).

Medinilla alternifolia Blume, Mus. Bot. 1: 19 (1849).

If authors include full bibliographic data for these works in the list of references at the end of the paper, they should also be mentioned in the text briefly, e.g., "Nomenclatural references researched include Blume (1849) and Roxburgh (1824)."

Homotypic synonyms should be provided in a block, stating the type at the end.

