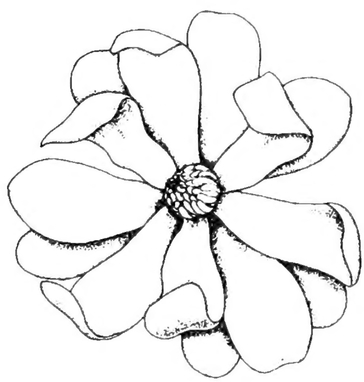

The Gardens' Bulletin
Singapore

VOL. 61 (1) 2009

ISSN 0374-7859

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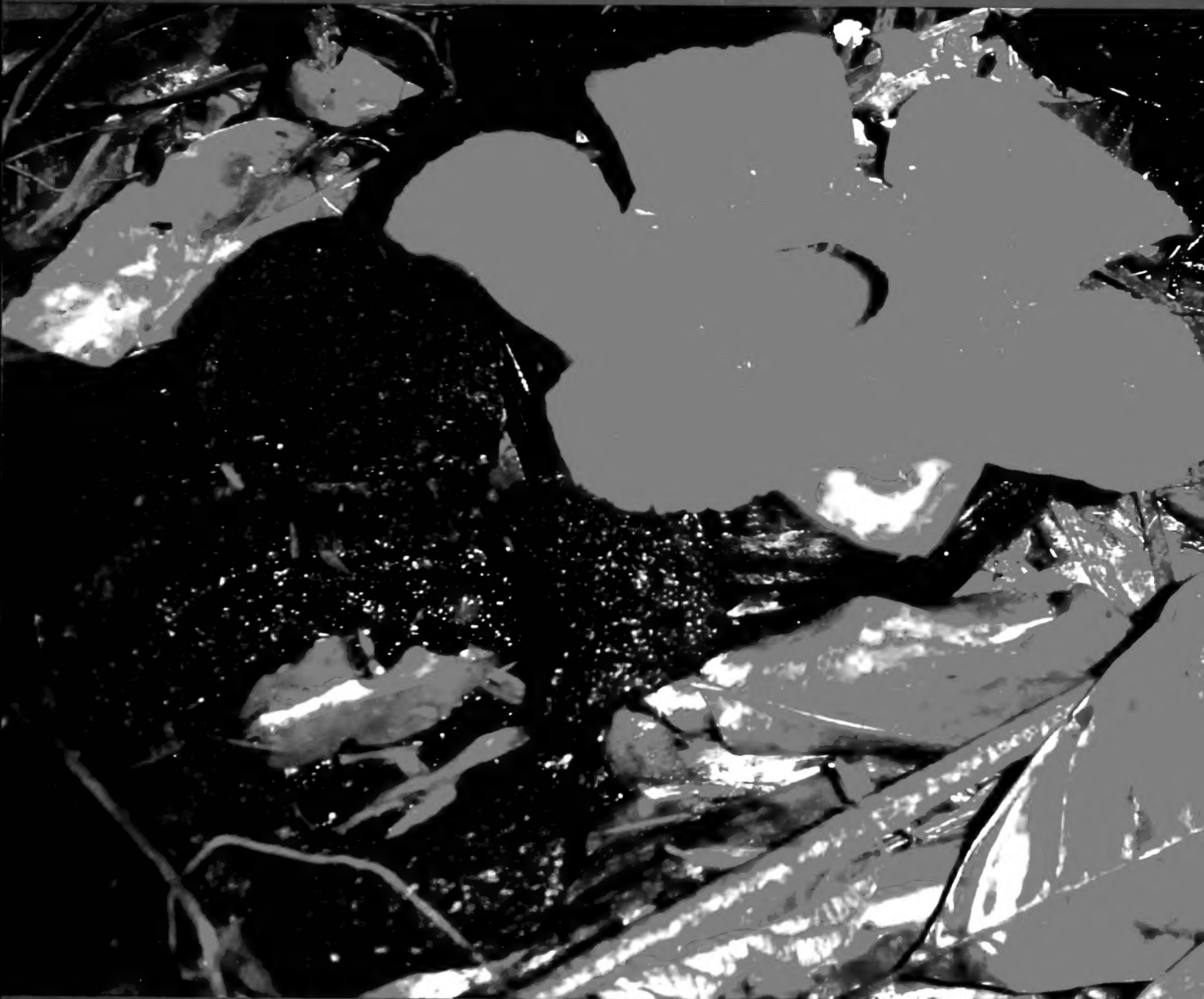

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[Cover photo : *Rafflesia aurantia* (see p. 20); photo by Danilo S. Balete]

The Gardens' Bulletin
Singapore

VOL. 61 (1) 2009 ISSN 0374-7859

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Date of publication: October 2009

Published and copyrighted by

National Parks Board
Singapore Botanic Gardens
1 Cluny Road
Singapore 259569

Printed by **Oxford Graphic Printers Pte Ltd**

Rhododendron sojolense Argent (Ericaceae), A New Species of *Rhododendron* Subgenus *Vireya* from Sulawesi, Indonesia

G. ARGENT

Royal Botanic Garden Edinburgh, EH3 5LR, Scotland, U.K.

Abstract

Rhododendron sojolense Argent (Ericaceae) is described as a new species of subgenus *Vireya* section *Euvireya* from Mt. Sojol on the northern arm of the island of Sulawesi, Indonesia. Comparisons with related species are made.

Introduction

There has been considerable recent botanical fieldwork on the island of Sulawesi in recent years, which has produced a number of new taxa. It is an island of extraordinary complexity in its geological history and biological diversity (Mendum and Atkins, 2004). Professor Sleumer's Flora Malesiana account (Sleumer, 1966) described 25 species of Vireya Rhododendron of which 19 were considered endemic. This number was increased to 28 species in a review of the Rhododendrons of Sulawesi (Argent, 2007), but remarkably this increase in number was entirely with records of non-endemic species, which underlined biogeographical links with Borneo, Philippines and Maluku. However the species described here is clearly a new endemic. It keys in Sleumer (1966) most closely to *Rhododendron lompohense* J.J.Sm. also from Sulawesi, but *R. lompohense* differs from *R. sojolense* in having white tubular-funnel shaped flowers and rounded not tapering leaf bases. In Argent (2007), it keys to *R. leptobrachion* Sleumer to which it would appear to be more closely related. It differs markedly from this species in that the leaves are revolute, not involute, with shorter and much broader apices; the blades are much broader, about twice as long as broad and not three times as long as broad as in *R. leptobrachion*, and the leaf base although acute, is not decurrent as it is in *R. leptobrachion* (for about half the length of the petiole in that species). The lateral buds, which are prominent in both species, are broad and rounded in the new species, whereas they are slender and very acutely pointed in *R. leptobrachion*, and the flowers are larger, mat pink rather than glossy red. The bracts of the new species are glabrous outside, not hairy as described for *R. leptobrachion*, although the cultivated material of *R. leptobrachion* at RBGE also has the bracts glabrous outside as in this new species. Cultivated material of *R. leptobrachion* in Edinburgh agrees in all other respects with the type specimen of this species held in the Rijksherbarium, Leiden. *R. leptobrachion* has been recorded from Mt. Sojol (Binney, 2003) and it has not been possible to check these claims. It would appear likely that these plants too (probably only collected as living plants) were this new species as all previous records of *R. leptobrachion* are from the central mountains in Sulawesi.

Rhododendron sojolense flowered for the first time in cultivation at the Royal Botanic Garden Edinburgh in May 2005, but it was not considered sufficiently mature to describe until it was seen to be flowering regularly. The cultivated plants are now nearly 1 m high. They grow easily and at present flower just once a year in late Spring or early Summer. Three seedlings were collected in the wild all from the same general locality. The two additional (non-type) collections differ only in having green rather than pink flower buds. Mt. Sojol the locality for this new species is an isolated peak on the northern arm of Sulawesi. It is a remote location requiring several days walk to reach the montane forest and it has not been well collected. The lower slopes have been greatly denuded of vegetation by agriculture, but there is still a good area of humid mossy forest around the summit.

Rhododendron sojolense Argent, *sp. nov.*

Rhododendroni leptobrachioni *similis, a qua alabastris lateralibus brevibus rotundatis haud tenuibus acutis, foliis revolutis non involutis apicibus multo latioribus brevioribusque et corolla longiore rosea non rubra differt.* – **Holotypus:** Indonesia, Sulawesi, Mt Sojol, in mossy forest, 2000–3000m, locally common as an epiphyte (BO; iso, E, L. SING). **Figs. 1-3.**

Figure 1. Colour illustration of the inflorescence of *Rhododendron sojolense* (based on type specimen).

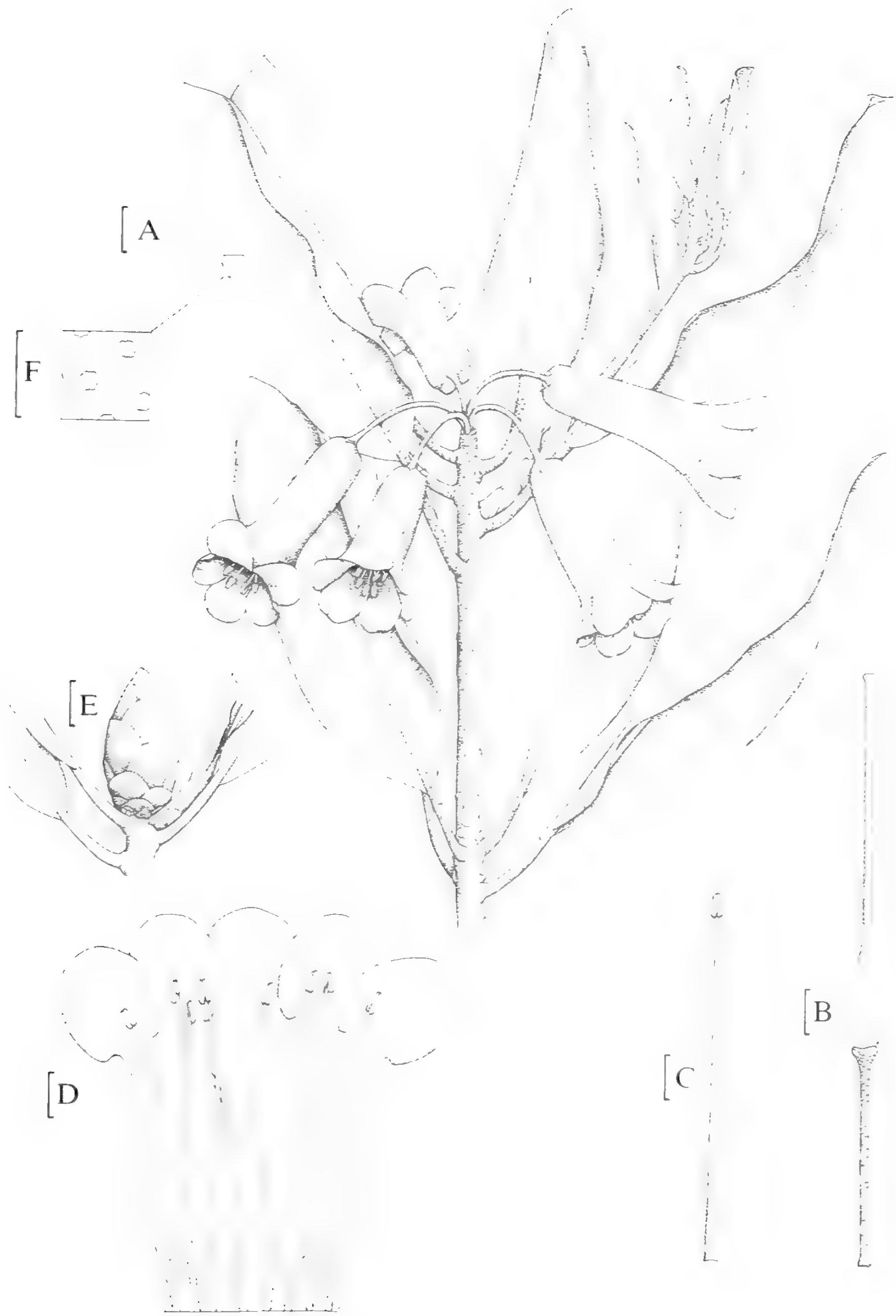

Figure 2. A. Habit with inflorescence; B. Pistil with pedicel; C. Stamen; D. Corolla viewed from the inside with stamens; E. Inflorescence bud; F. Close-up to show scales on the underside of the leaf. All drawings based on type specimen.

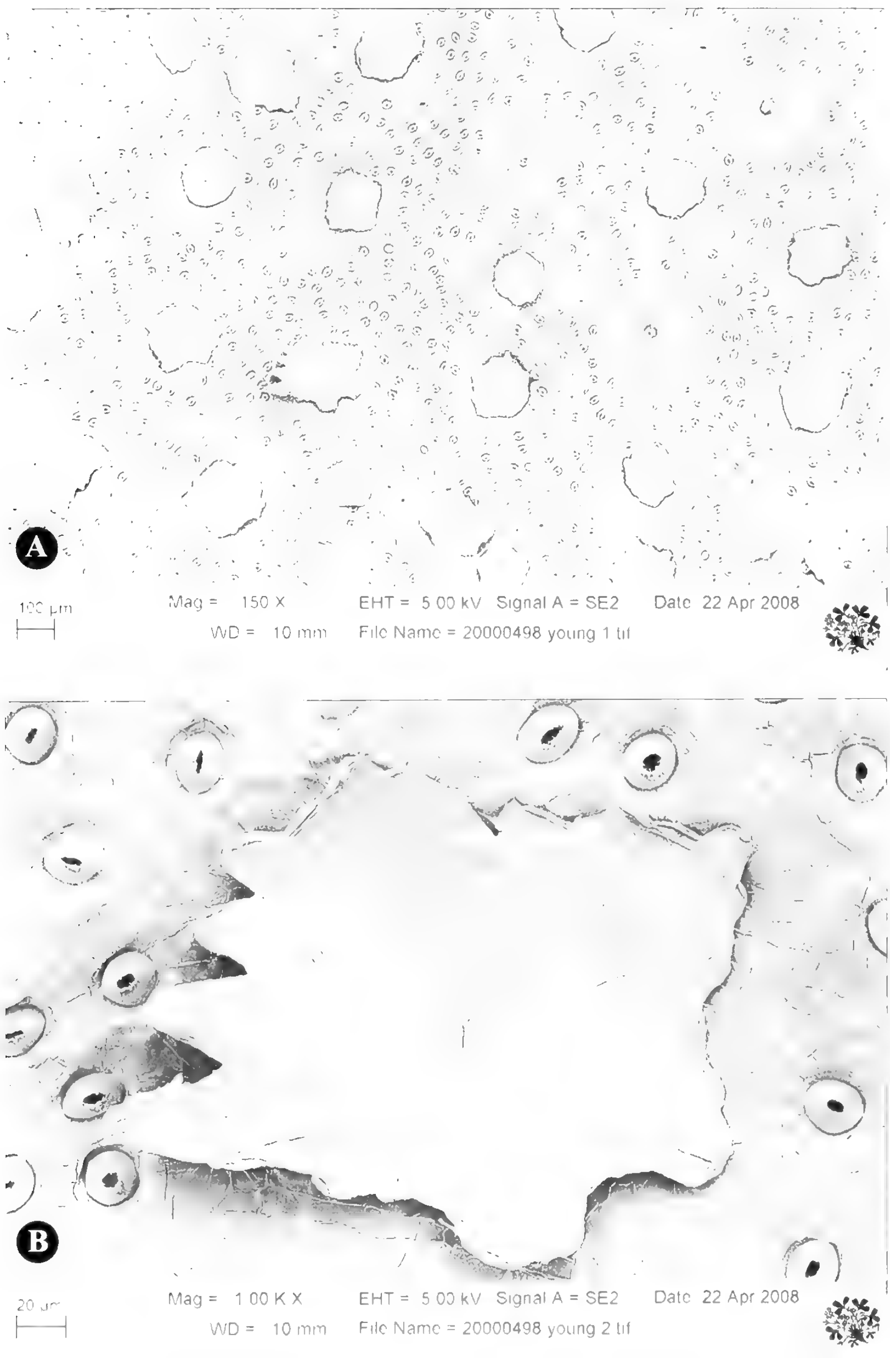

Figure 3. A. Scanning electron microscopic view of the leaf underside showing the distribution of the scales; B. SEM close-up showing the shape of a typical leaf scale (based on type specimen).

Subgenus *Vireya*, section *Euvireya*

Erect **shrub**. Twigs rounded, 3-5 mm in diameter, laxly silvery scaly, becoming glabrescent, without simple hairs, purplish-red when fresh, with prominent rounded lateral buds in the axils of the upper leaves and occasionally along the stems; internodes 5-12 cm. **Leaves** 3-6 together in loose pseudo-whorls at the upper 1-3 nodes. Blade 65-180 × 29-55 mm, elliptic, broadly elliptic, or slightly obovate; apex broadly acute to obtuse, occasionally broadly apiculate; margin entire, strongly and broadly revolute, often to half the width between midrib and margin; base broadly to narrowly tapering, densely scaly on both sides when young, glabrescent above, more persistently and laxly to subdensely scaly beneath. Scales silvery, with a relatively wide transparent marginal zone star-shaped to subcircular, centre minute and slightly impressed, brown. Mid-vein narrow raised above in the proximal 1/3, impressed distally, strongly and obtusely prominent beneath for most of its length, often purplish; lateral veins 6-10 per side, irregular, spreading at ca 45°, obscurely inarching, with additional shorter intermediate veins all minutely raised, minutely grooved above, more slender and hardly raised beneath. Petiole 14-25 × 3-4 mm, rounded above, purple, densely scaly. **Flower** buds to 32 × 15mm, ovoid to conical-ovoid, smooth, dull red, glabrous apart from some scales on the bract margins. Outer bracts to 25 × 12 mm, ovate to ovate-oblong, the outer often splitting to become emarginate, inner ones spathulate, glabrous inside. Bracteoles 15-20 × *ca* 0.3 mm, linear, densely hairy. **Inflorescence** 7-10-flowered, an open umbel, the flowers half-hanging to hanging. Pedicels 15-24 × *ca* 1.25 mm, pink, slender, laxly to densely scaly, without hairs. Calyx 3-4 mm in diameter, obliquely disc-shaped, densely scaly outside. Corolla 45-50 × 30-35 mm, tubular, bright matt pink; tube 25-38 × 9-12 × 10-12mm, cylindrical, straight, very prominently and deeply sulcate in the proximal ½, glabrous outside, sub-densely shortly hairy inside with retrorse (proximally pointing) hairs; lobes 12-15 × 12-15 mm, sub-circular or emarginate, overlapping to 3/4, half-spreading. Stamens irregularly arranged, exserted to *ca* 10 mm; filaments linear, pink, densely sub-patently hairy in the proximal 3/4, glabrous distally; anthers brown, *ca* 3 × 1 mm, oblong. Disc prominent, yellow, deeply lobed, long hairy on the upper side otherwise glabrous. Ovary 8 × 4 mm, sub-cylindrical, green, but densely covered in long appressed silver hairs, which completely cover small scales, tapering distally; style slender, deflected to the lower side when young, pale pink, *ca* 26mm, hairy in the proximal 2/3 not scaly; stigma capitate. **Fruit** 20-30 × 5-6 mm, cylindrical, slightly curved, sub-densely hairy and scaly. **Seeds** 3.8 mm, without tails 0.8-1 mm, the longest tail 1.8mm, the tails highly crimped.

The type specimen was collected by Smith and Galloway (# 101, RBGE Accession 20000498) as living material on 27 Feb 2000. The plant *flowered* in cultivation in Edinburgh, May–June. Additional materials: RBGE accessions 20080948 & 20080949. Both from the same locality.

Acknowledgements

I would like to thank Louise Galloway, Mary Mendum and Paul Smith for their companionship on the expedition on which this species was collected and for safely collecting and growing the living material upon which the description is based. I am grateful to Anna Dorwood for ably drawing Fig. 1; Frieda Christi for producing the scanning electron micrographs and to Robert Mill for rendering the diagnosis into Latin. The colour photograph was taken by Lynsey Wilson. The expedition on which this plant was collected was supported by LIPI the Indonesian Institute of Sciences (Lembaga Ilmu Pengetahuan Indonesia) and funded by the Royal Botanic Garden Edinburgh.

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Additional Novel Taxa of *Syzygium* and *Tristaniopsis* from Sabah and Sarawak, and a Surprising Discovery of *Shorea contorta*

P. S. ASHTON

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Abstract

A further five species and two subspecies of *Syzygium*, and one subspecies of *Tristaniopsis* (Myrtaceae) are described as a precursor to the account of the family in the *Tree Flora of Sabah and Sarawak*. *Shorea contorta* Vidal is here recorded form Borneo for the first time.

Introduction

Since publishing new species of *Syzygium* (Ashton, 2007) and *Tristaniopsis* (Ashton, 2007) as precursors to my forthcoming account of Myrtaceae for the Tree Flora of Sabah and Sarawak (Soepadmo *et al.* (eds.), continuing), I have had the opportunity to examine the unidentified material at the herbaria of Singapore (SING) and Forest Research Institute Malaysia (KEP). Additional novelties, published here, have inevitably resulted, though reassuringly few. Striking is the addition of one further entity apparently endemic to the astonishing ultramafic Bukit Tawai Forest Reserve of NE Sabah, already replete with the endemics, *S. cornuflorum* P.S.Ashton, *S. soepadmo* P.S.Ashton and *Tristaniopsis merguensis* (Griff.) PeterG.Wilson & J.T.Waterh. ssp. *tavaiensis* P.S.Ashton. All these species have morphologically similar sister entities, often in nearby forests. A further novel species confined to ultramafics is more widespread in NE Sabah. These distributions, and many others published in the Tree Flora in other families, emphasize the important opportunities that Bukit Tawai provides for molecular and other approaches to examine speciation processes in tropical rain forest, and the vital necessity of satisfactory conservation and protection from fire, which has been a scourge of smaller ultramafic sites in Northeast Borneo.

This communication also provides me with the opportunity to make an unexpected new addition to the Dipterocarpaceae of Sabah and Sarawak, whose account in the Tree Flora was already published (Ashton, 2004): *Shorea contorta* Vidal [syn. *Pentacme contorta* (Vidal) Merrill & Rolfe, *SAN 127272*, Awang Amin Segun, Kepayang, Kuala Penyu, Sabah (K)]. The label states the habitat solely as 'lowland'. The tree was 10 m tall.

The specimen consists of the leafy shoot of an immature individual, with the distinct narrow raceme of the species, and equally distinct fallen fruit, glabrous throughout again suggesting immaturity. Kuala Penyu is on the coast of SW Sabah, at the northernmost tip of the Klias peninsula. The Klias peninsula is close to the northernmost extension in the coastal lowlands of the Neogene basin, which, running southwest to the Lambir Hills in Miri District, NE Sarawak, is so rich in tree species endemic to yellow sandy soils. This is the habitat which, with many mixed peat swamp entities, characterizes the geographical distribution named by Corner (1960) the Riau Pocket. This habitat is therefore quite different from the fertile clay loams so characteristic of the Philippine lowland mixed dipterocarp forest within which *S. contorta* was one of the most widespread and characteristic species. It is possible though that the collecting locality lies further inland, on clay loams more similar to many Philippine soils. With its recalcitrant seed and demanding seedling, it seems unlikely to have been introduced, though that cannot be ruled out. Otherwise, this is an example of a rare sweepstakes dispersal event, as unlikely in its way as that of the baobab, which have dispersed from Madagascar onto Australia. I beseech any visitor to Kuala Penyu to seek out this plant again: molecular genetic evidence might be revealing.

1. ***Syzygium claviflorum*** (Roxb.) Walpers ex Steudel, Nomencl. Bot., ed 2 (1841) 657.
Basionym: *Eugenia claviflora* Roxb., Fl. Ind. Ed. 2, 2 (1832) 488. – **Lectotype:** Maynmar, E. Chittagong, *Wallich 3575B* (K).
-*Syzygium longiflorum* Wall., Cat. (1831) 3575B, *nom. nud.*

Note: E. claviflora Roxb. Is, first, a validly published name, as is evident from the specimen of *Wallich 3575B* in the East India Company Herbarium at K. There are two sheets: one with two specimens in early post-anthesis, numbered A and B, the other a single fine specimen in anthesis numbered 3575B and annotated *Syzygium claviflorum* Wall., and *Eugenia claviflora* Roxb. in Roxburgh's handwriting. A further label is attached in another hand, noting E. Chittagong as provenance. This second specimen is therefore formally recognized here as lectotype.

1a. ***Syzygium claviflorum* subsp. *tavaiense*** P.S.Ashton, *subsp. nov.*
Subspecies novum a species typico ramulis crassioribus lamina ca 13 x 6 cm ampliore coriacissima petiolo crassiore costis tertiariis supra magis prominentibus elevatis floribus minoribus differt. – **Holotypus:** Borneo, Sabah, Sandakan, Telupid, Bukit Tawai Forest Reserve, *Zainudin 5012*, in flower (KEP)

Small smooth-barked **tree**. Differing from ssp. claviflorum as follows: **Twig** at first *ca* 3 mm diameter, stout; **leaf** blade *ca* 13 x 6 cm, broader, thickly leathery, base obtuse to broadly wedge-shaped hardly tapering into stalk, stalk *ca* 3 mm diameter; secondary veins not furrowed above, tertiary veins more distinctly raised above than beneath; **flower** to 8 mm long smaller.

Distribution and ecology: Based on two collections apparently simultaneously gathered from the same tree, the type and *Bojo & Cheksum OB 040*, from Tawai F.R., on ultrabasic substrate.

2. ***Syzygium flagrimonte*** P.S.Ashton, *sp. nov.*
Syzygio napiformi *(Koorders & Valeton) Merr. & L.M. Perry affinis sed frutex lamina minima obtusa petiolo 4 mm longo caudice receptaculi gracillimo facile distinguitur.* – **Holotypus:** Borneo, Sarawak, Mulu National Park, Gunung Api, summit ridge, 1600 m, *Argent & Jermy 1017* (A).

Shrub to 80 cm tall. Parts hairless. **Twig** *ca* 1 mm, round at first, round, wrinkled, drying blackish. **Leaf** blade 15-30 × 10-22 mm, elliptic, thinly leathery, black dotted beneath, pitted above, drying pale ochreous brown; base wedge-shaped terminating abruptly at *ca* 4 mm long, slender black-drying stalk; apex obtuse to subacuminate; veins dense, subequal, main veins 8-10 pairs, ascending, obscure above, slender but distinctly elevated beneath; tertiaries obscure; intramarginal vein within 1 mm of margin. **Flower** (post-anthesis) to 11 × 4 mm, comprising a 3 × 4 mm tapering, pale, buff, drying receptacle on a *ca* 1 mm diameter, slender, tapering pseudostalk; sepal lobes 4, 0.8 × 0.8 mm, small, l deltoid distant around the calyx rim; style extended to *ca* 4 mm. **Fruit** unknown.

Distribution and ecology: Known only from the type, in upper montane forest on the exposed karst and rocky summit ridge of Gunung Api ('fire mountain' – probably on account of occasional lightning fires implying occasional severe drought); at 1600 m.

Note: A distinctive upper montane, apparent a point endemic within the *S. attenuatum* group, distinguished from *S. napiforme*, which appears to be its sister species, by its habit and leaves, and unusually slender pseudostalk.

3. ***Syzygium georgeae*** P.S.Ashton, *sp. nov.*
Syzygio castaneo *(Merr.) Merr. & L.M. Perry affinis sed lamina ovata cordata nervis supra depressis lobis calycis in flore distinctis ovatis valde differt.* – **Holotypus:** Borneo, Sabah, S. Meliau, Telupid, Tawai Forest Reserve, *E. Soepadmo, T. Khalkausas, R. George, B.S. John & S. Davol* (*FRI 41256*, SING).

A small **tree** with many scrambling branches, to 10 m tall, 15 cm diameter, with smooth grayish white bark. Parts hairless. **Twig** 1-2 mm diameter apically, slender, at first distinctly narrowly 4-winged. **Leaf** blade 4.5-6 × 2-3.2 cm, ovate-lanceolate, thinly leathery, satiny, drying golden-brown and finely black dotted beneath, dark yellow-brown and densely minutely pitted above; base shallowly cordate, subsessile with a stalk *ca* 1 mm long, drying black; apex acute to subacuminate; venation distinct beneath, drying blackish, forming a net with the tertiaries, veins subequally slender and hardly raised beneath, distinctly furrowed above, *ca* 11 main pairs with many irregular intermediates branching among the tertiaries; intramarginal vein *ca* 1 mm within margin, hardly arched. **Panicle** to 3-terminal, to 5 cm long, *ca* 1 mm diameter in flower, quadrangular; bracts minute caducous. **Flower** bud *ca* 4 × 3 mm, small, club shaped with slender pseudostalk; sepal lobes 4, ovate, subacute, hyaline towards margins, clasping corolla; stamens many; style *ca* 3 mm long. **Fruit** not seen.

Distribution and ecology: Known only from the type. Common along a stony occasionally flooded river bank on ultramafic substrate.

Notes: Clearly related to *S. castaneum*, I only recognize it from that variable species owing to its conspicuously different leaf shape with its venation distinctly furrowed on its upper surface. This is one more distinct sister ecospecies of ultramafic substrates, for which the Tawai Forest Reserve provides the richest repository.

Named in honour of Rena George, a young Sarawakian field botanist of extraordinary promise who died in the field while following her avocation.

4. ***Syzygium oblanceolatum*** (C.B. Robinson) Merr., Philip. J. Sc. 79 (1951) 405.
Basionym: *Eugenia oblanceolata* C.B. Robinson, Philip. J. Sc. 4, C (1909) 400. – **Lectotype:** Philippines, Samar, *loc. incert., Cuming 1676* (BM).

Key to subspecies -
1. Leaf blade *ca* 23 cm long, oblanceolate; main veins *ca* 14 pairs 2
   Leaf blade to 17 cm long, elliptic, base cuneate; main veins 6-10 pairs ....ssp. ***kinabaluense***

2. Leaf base subcordate to cordate .... ssp. ***oblanceolatum*** (Philippines)
   Leaf base abruptly tapering, occasionally cuneate .... ssp. ***kihamense***

4a. ***Syzygium oblanceolatum* ssp. *kihamense*** (Merrill & Perry) P.S. Ashton, *stat. nov.*

Basionym: *S. kihamense* Merrill & Perry, Mem. Amer. Ac. 18 (1939) 150; Burgess, Timbers of Sabah (1966) 412. – **Holotype:** Borneo, Kalimantan, W. Kutei, near Kiham, Batu Bong, *Endert 2341* (BO; iso, K).

-*S. petakense* Merrill & Perry, *loc. cit.*, Beaman, Pl. Mt Kinabalu 5 (2004) 223. – **Holotype:** Borneo, E. Kalimantan, W. Kutei, near Long Petak, *Endert* 4063 (BO).

Tree. Parts hairless. **Twig** *ca* 3 mm diameter, stout with long internodes, sharply 4-angled, smooth, dark red-brown. **Leaf** blade *ca* 23 x 6 (12-24 × 4-8) cm, large, oblanceolate, densely minutely pitted above, sparsely black dotted beneath, drying dull rust brown, paler above; base wedge-shaped, tapering into *ca* 5 mm long stout stalk; acumen to 5 mm long, broad, tapering, twisted down; veins unequal, main veins *ca* 14 pairs, prominent and distinctly raised more so beneath, furrowed along their crests above, ascending, with few shorter intermediates; tertiaries evident throughout; intramarginal vein 1-4 mm within margin, hardly raised, weakly arched. **Panicle** axillary to ramiflorous, with to 10 cm long straight erect rachis, to 6 cm long basal branches and shorter branches above, quadrangular. **Flowers** in dense terminal clusters, subtended by 2 pairs of bracteoles; buds to 4 × 3 mm, obovoid to spherical, without distinct pseudostalk; sepal lobes 4, 2 × 3 mm, broadly ovate acute, more or less warty, hyaline along margin; stamens many; style extended 5 mm. **Fruit** ripening white, to 15 × 12 mm, ellipsoid, sessile, with 7 mm diameter, prominent apical calyx crown.

Ecology: In mixed dipterocarp forest on fertile clay loams including black volcanic soils, at low altitude, below 800 m.

Distribution: Northeast Borneo, E. Kalimantan, Pulau Laut and throughout Sabah [Balong Tawau (*San 30139*); Kalabakan (*San 91444*); Diwata, Lahad Datu (*San 39968*); Segama Rd, Lahad Datu (*San 31616*); Sandakan (*San 10186*); Sepulut, Keningau (*San 101325*); Pangi (*San 27439*); slopes of Bt Batanga, Sipitang (*San 16622*)].

Note: Related to *Syzygium papillosum* (Duthie) Merr. & L.M. Perry of Peninsular Malaysia and southern Kalimantan, in which the twig is round, leaf more leathery with deeply cordate base. *S. kihamense* and *S. petakense*, both collected by Endert in West Kutei, East Kalimantan differ in no consistent way.

4b. ***Syzygium oblanceolatum* ssp. *kinabaluense*** P.S.Ashton, *ssp. nov.*
A species typico lamina elliptica basim versus cuneata 6.7-17 x 3.5-7.5 cm minore costis lateralibus utrinsecus 6-10 differt. – **Holotypus:** Borneo, Sabah, Ranau, Km 58 Kinabalu-Tambunan Rd, 5°47'N, 116°20'E, 1450 m asl, in flower, *J.S. Beaman 7937* (K).

Differing from the two other subspecies as follows: leaf blade 6.5-17 x 3.5-7.5 cm, generally elliptic, base cuneate; veins 6-10 pairs, lax in arrangement.

Ecology: Apparently quite common in lower montane forest, at 1450-1700 m.

Distribution: Endemic to Gunung Kinabalu and the northern Crocker Range [Kundasang (*San 28884*); Mesilau, Kinabalu (*San 48001, 42835, RSNB 4214*); Tenompok (*SFN 26942*); Ranau, Kinabalu N.P. (*San 79580*)].

5. ***Syzygium praestantilimbum*** P.S.Ashton, *sp. nov.*
Syzygio rosulento *(Ridl.) Merr. & L.M. Perry clare affinis sed arbuscula partibus glabris lamina enorme coriacissima petiolo ca 8 mm longo paniculis, 4 cm longis conspicue distinguitur.* – **Holotypus:** Borneo, Brunei Darussalam, Labi, path to Bukit Teraja, *Peng. Mohamad (BRUN 18339,* SING*).*

Treelet to 8 m tall, occasionally reaching the canopy, 60 cm diameter, with drooping branches bearing the huge leaves on long internodes. Parts hairless. **Twig** *ca* 3 mm diameter, round to compressed, dark warm brown. **Leaf** blade *ca* 25 × 14 (20-35 × 12-16) cm, elliptic, leathery, dull, drying mauve-brown obscurely minutely pitted above, rust-brown obscurely minutely dotted beneath; base wedge-shaped terminating abruptly at the 7-12 mm long, 3 mm diameter, stout black-drying stalk; apex to 12 mm, slender acuminate; veins unequal, main veins *ca* 17 pairs with a few shorter less prominent intermediates, deeply furrowed above, prominent beneath; tertiaries lax, more or less distinctly raised beneath, hardly sunken above; intramarginal veins 1(2) pairs, somewhat arched, *ca* 6 mm within margin. **Inflorescence** to 4 cm long, 3-terminal or 1-axillary, round, singly branched, flowers clustered at branch endings; bracts and bracteoles to 2 × 2 mm, ovate-deltoid, acute, subpersistent. Post-anthesis **flower** calyx 5 × 4 mm, obovoid to top-shaped without distinct pseudostalk, with 4, 2 × 2 mm deltoid sepal lobes, hyaline at margins, becoming reflexed; stamens many; style extending 4 mm. Young **fruit** to 6 mm diameter, spherical, subsessile and densely clustered, wrinkled on drying, ripening pinkish white.

Ecology: Local but sometimes abundant as an understorey tree, in mixed dipterocarp forest on deep yellow sandy soils, in a habitat shared with other understorey trees sharing large leathery leaves, including S. *velutinum* A.P. Davis.

Distribution: Known from the type, Andulau Forest Reserve in Brunei Darussalam *(BRUN 18283)* and from sterile collections *(Field herbarium numbers AG 02747, AG 03847, AG 3210-058)* from the large research plot in Lambir N.P. at Miri in Sarawak.

Note: Closely resembling *S. rosulentum* in the herbarium but a small subcanopy tree with much larger leathery leaf and shorter inflorescence. The inflorescence in both species is, as Merrill defines it in his key to the genus (1939, 141), with flowers in dense heads, each flower 'subtended by two decussate and approximate pairs of bracts'. Examination of atypical inflorescences of species with this character persuades me that it is caused by extreme shortening of the terminal branchlets of a panicle. The two taxa co-exist in the same stands.

6. ***Syzygium tubiflorum*** P.S.Ashton, *sp. nov.*
Syzygio zeylanico *(L.) DC.*, S. kinabaluense *(Stapf) Merr. & L.M. Perry late affinis sed lamina nervis obscuris calyce in flore fructuque leve terete satis distincta.* – **Holotypus:** Boreno, Sabah, Maliau Basin, top ridge, 1220 m, coll. *Maig, Sidikin & Jeprin* (*MB 904,* SING).

Treelet to 5 m tall. Parts hairless. **Twig** 0.5-1 mm diameter apically, very slender, narrowly but distinctly 4-winged, drying dark brown to blackish, smooth. **Leaf** blade 15-40 × 3-15 mm, lanceolate, small, leathery, drying pale grey-brown, faintly densely pitted above, densely prominently black dotted beneath; base wedge-shaped, tapering into ca 4 mm long, 0.5 mm diameter, very slender stalk; apex to 12 cm long slender acuminate; venation obscure above the sunken midrib excepted, unequal, the *ca* 6 pairs of irregularly disposed main veins evident beneath only, slender and hardly raised. **Inflorescence** *ca* 15 mm long, 1 mm diameter, erect, singly branched, round terminal or axillary panicle; bracts to 7 × 1 mm, lorate-lanceolate, falling early. **Flowers** unknown. Young fruit 5 × 2 mm, torch-shaped, subsessile, without distinct pseudostalk, without ribs, smooth, drying black; sepal lobes 4, deltoid, minute, falling early; bracteoles *ca* 3 mm long, linear, fugaceous.

Distribution and ecology: Known only from the type, from the Meliau summit ridge at 1220 m.

Note: A distinct entity in the *S. zeylanicum* group, but at once distinguished by its leaf venation, smooth, round young fruit, and early falling bracts and bracteoles. As a member of that group and as the fruit indicates, the flower for which it is named, though as yet unknown, must possess an elongate tubular psedostalk devoid of the sharp angles characteristic of the elongate pseudostalks of sister species.

7. ***Syzygium valentissimum*** P.S.Ashton, *sp. nov.*
Lamina magna coriacissima costis lateralibus subaequalibis ramulis quadrangularibus paniculis erectis crassis gemmis obconicis facile distinguitur. – **Holotypus:** Borneo, Sabal-Balai Ringin Forest Reserve, Klingkang Range, Sri Aman, in flower bud, *Julaihi & al.* (*S. 83369*, KEP).

Canopy **tree** to 30 m tall; bark brown. Parts glabrous. **Twig** *ca* 4 mm diameter apically, at first quadrangular, smooth, dark chocolate-brown. **Leaf** blade 7-15 × 5-6 cm, ovate to lanceolate, thickly leathery yet margin hardly inrolled, drying dark chocolate-brown dull below, somewhat glistening above; base broadly wedge shaped tapering into *ca* 15 mm long, 3 mm diameter, stout black-drying stalk; apex to 8 mm long down-turned acuminate; veins subequal, main veins *ca* 18 pairs with many intermediates, tertiary veins reticulate, venation overall finely but distinctly more or less equally raised on both surfaces. **Panicles** to 5-terminal or subterminal axillary, to 11 mm long (immature), ascending, stout, quadrangular, 2-branched. **Flower** bud (young) to 5 × 4 mm, obconical without distinct pseudostalk; sepals 4, *ca* 3 × 4 mm, broadly hemispherical, obtuse, cupped, broadly imbricate and tightly clasping corolla; stamens many. **Fruit** unknown.

Distribution and ecology: On the lower sandstone slopes, in mixed dipterocarp forest, of the Kingkang range (the type) and Gunung Buri (*S. 43414, Ilias Pa'ie*), respectively to the north and south of the Serian-Sri Aman road in West Sarawak.

Note: At once distinguished by its relatively large thickly leathery leaf with subequal veins, quadrangular twigs, and stout erect panicles with obconical buds. The leaves recall *S. selukaifolium* P.S.Ashton of NE Sarawak in which the twig is terete and the panicle axillary with torch-shaped buds, and *S. merrillii* (C.B. Rob.) Merr., which shares the buds and panicle of *S. selukaifolium*, but in which the twig is also quadrangular.

8. ***Tristaniopsis microcarpa*** P.S.Ashton, Gard. Bull. Sing. 57 (2005) 273.
– **Holotype:** Borneo, Look Mengulang, P. Sakar, in flower, *H.S. Martyn* (*San 21623*, K).

8a. ***Tristaniopsis microcarpa* ssp. *corymbosa*** P.S.Ashton, *ssp. nov.* Tristaniopside microcarpa *late similis sed lamina coriacissima, ramuli caduci lamina infra inflorentia alabastrique persistenter alutaceo-cinerascentibus.* – **Holotypus:** Borneo, Sabah, Telupid, mile 87½, Hap Seng logging area, in flower, *Kodoh & Tarmiji* (*San 8366,* K).

Small **tree** to 20 m tall, to 40 cm diameter, with red brown peeling bark. **Twig** at first, leaf beneath, inflorescence and flower bud persistently densely buff cinereous. **Leaf** blade (8-)16-35 × (3.5-) 6-12 cm, oblanceolate, thickly leathery.

Distribution and ecology: Endemic to ultramafic substrates in eastern Sabah, on rocky sites often beside rivers [the type; Telupid, Bt. Tawai (*SAN 13451, FRI 41309*); Telupid, S. Ruku-Ruku (*SAN 70315*)]; also at 850 m on the Mt. Silam summit (*SAN 63945*) and in lower montane *kerangas* at 1000 m on G. Lutong, Meliau basin (*FRI 36238*).

Notes: Differing from subspecies *microcarpa* only in leaf texture and indumentum, and possibly smaller stature at maturity. It appears to occur on shallower, more humic soils. A specimen (*FRI 41309*) was misidentified as *T. merguensis* ssp. *tavaiensis* in the original description of that entity (Ashton, 2006).

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Rafflesia aurantia (Rafflesiaceae): A New Species from Northern Luzon, Philippines

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Abstract

A new Philippine species of *Rafflesia* from the Sierra Madre Mountain Range of northeastern Luzon is described. *Rafflesia aurantia* is the ninth presumed endemic species thus far described from the Philippines, and the fifth reported from the island of Luzon. This species is apparently allied to *R. tengku-adlinii* of Sabah - both are small-sized and their overall color is similar. Biogeographical considerations and the morphological differences between our new species and *R. tengku–adlinii*, however, strongly support the recognition of two distinct evolutionary lineages/species. The conservation status of the fast disappearing lowland dipterocarp forests in northeastern Luzon, particularly the type locality in the Quirino Protected Landscape (QPL) is also discussed and suggests that the new species may be highly threatened.

Introduction

The Philippines is fast emerging as the global center of *Rafflesia* diversity relative to its land area with the recent description of five more new species after the publication of *R. speciosa* Barcelona & Fernando (2002) from Antique Province in Panay Island. These newly described species are, *R. mira* Fernando & Ong (= *R. magnifica* Madulid, Tandang & Agoo), from Compostela Valley Province in Mindanao reported in 2005, *R. baletei* Barcelona & Cajano from Camarines Sur Province in Luzon (Barcelona *et al.*, 2006), *R. lobata* Galang & Madulid (2006) from the Central Panay

Mountains, and *R. leonardi* Barcelona & Pelser from Cagayan Province in Luzon (Barcelona *et al.*, 2008).

The recent rediscoveries of *R. manillana* Teschem. (Madulid and Agoo, 2008; Madulid *et al.*, 2008) and *R. philippensis* Blanco [*as R. banahawensis* Madulid, Villariba-Tolentino & Agoo (2007) and as *R. banahaw* Barcelona, Pelser & Cajano (2007; see also Barcelona *et al.*, 2009)] in their type localities as well as new populations of the presumed extinct *R. schadenbergiana* in Mindanao (Lays, 2006; Barcelona *et al.* 2008a, 2009) has tremendously increased our knowledge of the diversity and geographic distribution of this enigmatic plant group. A summary of our current knowledge on Philippine *Rafflesia* including their taxonomy, ecology, geographical distribution, and conservation status is detailed in Barcelona *et al.* (2009).

In 2004, a biodiversity survey that we conducted in the lowland forests of the western edge of the central portion of the Sierra Madre Mountain Range in northeastern Luzon, now designated as the Quirino Protected Landscape (QPL) in Quirino Province, resulted in the discovery of yet another population of *Rafflesia*. Comparison with currently known Philippine *Rafflesia* species and with that of the morphologically similar *R. tengku-adlinii* of Borneo strongly supports the recognition of a new species from Luzon, which we describe below.

Rafflesia aurantia Barcelona, Co & Balete, *sp. nov.*
Rafflesiae tengku-adlinii *Mat-Salleh & Latiff (ex Sabah) colori aurantae perigonii propemodum mentiens, sed ab ea sufficienter differt processibus disci centralis florum marium polymorphis et varie ramosis complanatis dispositis horizontaliter, processibus florum feminarum confertis complanatis dispositis verticaliter, ramentis longioribus (7-10 mm longis) glabris varie ramosis apicibus capitatis nec clavatis, antheris insigniter paucioribus (12-14).* – **Holotypus:** Philippines. Luzon, Quirino Province, Sierra Madre Mountain Range, Quirino Protected Landscape, Nagtipunan Municipality, Barangay Matmad, Sitio Mangitagud, 16° 03' 22.5" N, 121° 28' 39.7" E, ca 450 m, disturbed lowland dipterocarp forest, *ca* 5 m away from embankment of boulder-strewn creek, 11 Jun 2004, *Bartolome & Balete 2543* (PNH, spirit collection, one male and one female flowers; isotypes, US, PUH, SING, two dissected mature buds and four immature buds in different stages of development). **Figs. 1-3.**

Mature **flower** buds 8.5-9 cm in diameter covered with atrocastaneous bracts; cupule of mature flowers light brown, 2.2 cm tall, 6.3 mm wide. Open flower *ca* 20 cm in diameter when fresh. **Perigone** lobes orange, 4.5-5.5 cm long, 6.3-7.7 cm wide, distantly disposed, outer surface uniformly covered with fine

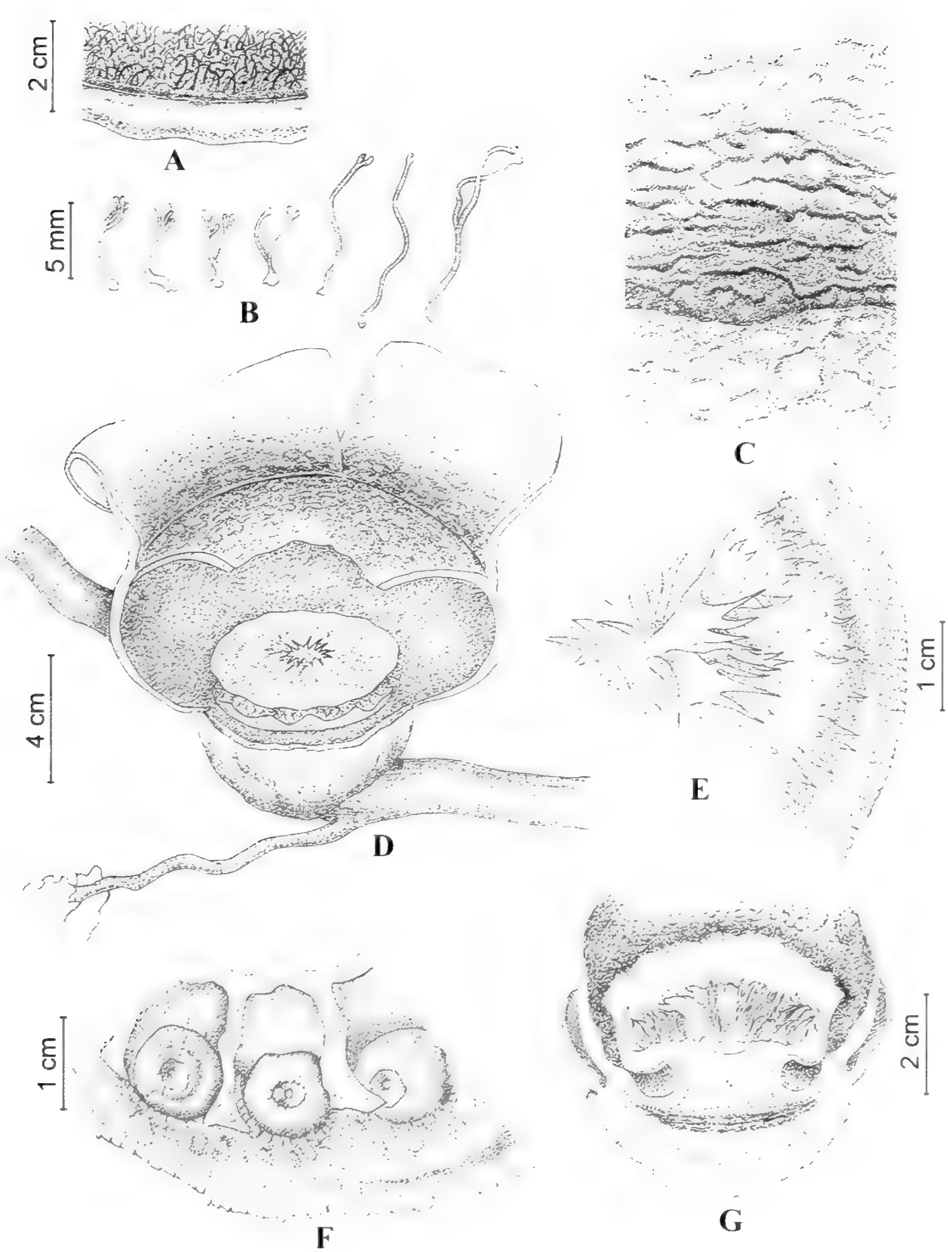

Figure 1. *Rafflesia aurantia*. A. Lanate ramenta en masse; B. Variably-sized and branched ramenta; C. Magnified outer surface of diaphragm and perigone lobe showing ridged, areoles-forming ornamentations; D. Partially-open male flower; E. Male flower disk showing polymorphic processes with central ones vertically-flattened and horizontally oriented; F. Semi-globular anthers embedded in deep sulci; G. Longitudinal section of a female flower showing lunate ovary and dense, vertically-oriented, and laterally-flattened processes.

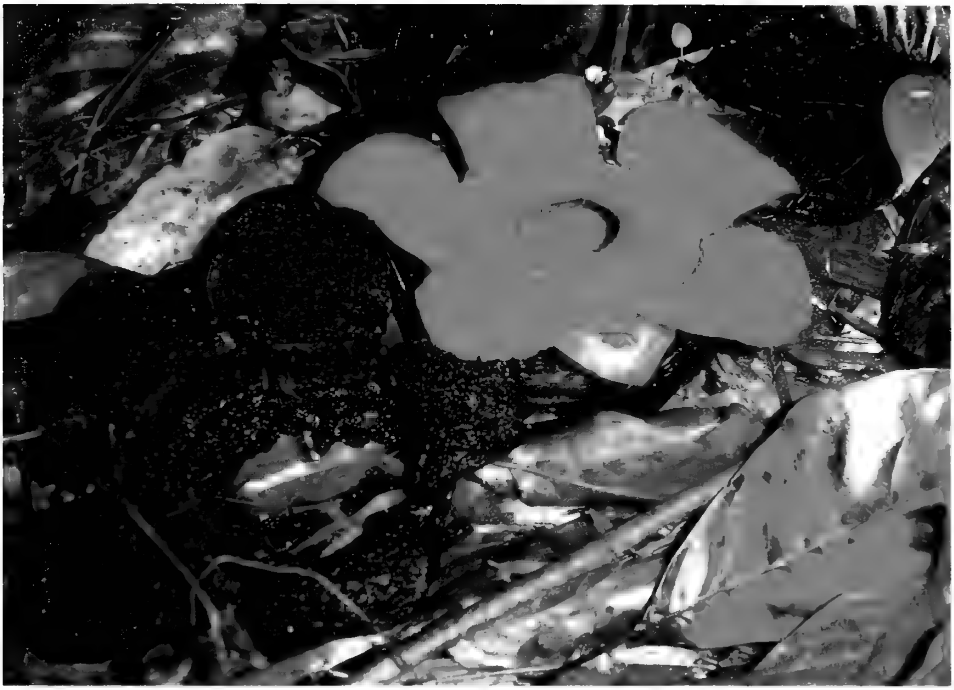

Figure 2. *Rafflesia aurantia*, a fully expanded flower next to a senescent one (Photo: Danilo S. Balete).

Figure 3. *Rafflesia aurantia*, an early senescent flower next to a developing bud (Photo: Danilo S. Balete).

warts that are of sharp-edged, areoles-forming ornamentations when fresh, these turning into blunt ridges in alcohol-preserved specimens. **Diaphragm** concolorous and similarly ornamented as perigone lobes (except along the aperture rim), pentangular, *ca* 10 cm across; windows absent; aperture 3-3.5 cm in diameter. Lower surface of diaphragm (except along the aperture margin) covered with uniformly lanate, glabrous ramenta that are rather sparse towards the aperture, becoming dense towards the base of the floral cavity, 7-10 mm long, slender, unbranched to furcate, entirely glabrous, tips swollen. Disk 5.5-6 cm across, *ca* 6 mm thick; neck of column *ca* 3 cm tall. Disk processes flattened, polymorphic; centrally disposed ones 5-10 mm long, variably branched, horizontally-oriented in the male flowers, dense, flattened, and vertically-oriented in the **female flower**; peripheral ones much smaller, 0.5-2 mm long, narrowly lanceolate, spinose, or markedly reduced into tubercles, tips tufted with golden brown hairs. Anthers of **male flowers** 12-14, semi-globular, each hidden in a deep sulcus; anther pores *ca* 2.5 mm across. Ovary of female flowers lunate, *ca* 3.5 mm long, *ca* 5 mm wide (fig. 1A-G).

Etymology: This species is named after the orange coloration of the flowers.

Ecology: Plants of *R. aurantia* have all been found parasitic on prostrate stems and underground roots of the host liana *Tetrastigma* (which unfortunately was not collected) and has never been found yet to grow on the climbing stems of the host. Some murid rodents that may possibly be the seed dispersers of *Rafflesia* recorded in-situ include *Apomys*, *Bullimus* and *Rattus everetti*, whereas flower visitors observed were metallic bottle flies.

Distribution and habitat: So far known only from the type locality. The population was concentrated in disturbed lowland dipterocarp forest along the lower slopes of Mungiao Mountains, in the vicinity of the headwaters of Cagayan River, northeastern Luzon's principal drainage system and the Philippines' longest river. With a prevailing canopy of 12-25 m and occasional emergents to *ca* 40 m in height, this forest is dominated by *Shorea* spp. and *Anisoptera thurifera* (Dipterocarpaceae). Several species of *Lithocarpus* (Fagaceae), *Syzygium* (Myrtaceae), *Litsea* and *Cinnamomum* (Lauraceae) dominate the subcanopy layer. Open grasslands and agricultural areas are located merely half a kilometer away.

Conservation status: Though observed to be common locally, this new species is thus far known only from a single population. The sporadic collections of plant specimens by R.C. McGregor in 1912 at nearby Dupax to the north, and Ramos and Edaño in 1925 at Mt Alzapan to the east are the only historical botanical records notable in this part of Luzon. Small-scale logging for certain premium timber species as well as forest clearings for swidden agriculture are rather prevalent in the area. However, it is the commercial open-pit mining (chiefly for gold and copper) that poses the gravest threat for this *Rafflesia* habitat. Despite the establishment of an approximately 206,875 ha new protected area, the Quirino Protected Landscape (Presidential Decree No. 548 dated 9 February 2003), about 30,930 ha of these were recently excised in favor of mining, resulting in the fragmentation of QPL into three parcels.

Taxonomic and biogeographical notes: Rafflesia aurantia closely resembles *R. tengku-adlinii* of Borneo in size, flower color, habit, and the absence of windows. It is, however, different from the latter by its lanate, entirely glabrous, and substantially longer (7-10 mm, longest in the genus) ramenta that are sparse towards the diaphragm and absent near the aperture rim, its polymorphic, flattened, irregularly and sometimes horizontally disposed, and multi-branched processes, and fewer anthers (12-14). In *R. tengku-adlinii*, the ramenta extend to the diaphragm (in fact, they are visible near the diaphragm aperture), are significantly shorter (3-5 mm), and covered with fine bristles. Ramenta characters, such as disposition, morphology, and length, show little variation within species and are therefore useful characters for distinguishing species of *Rafflesia* (Nais, 2001:18-19; Mat Salleh, 1991:10). In addition to being different in characters of the ramenta, *R. aurantia* is also distinguished from *R. tengku-adlinii* by disk process morphology. The processes of *R. tengku-adlinii* are much reduced relative to those of *R. aurantia* and they are more or less solitary and regular in disposition. Furthermore, *R. tengku-adlinii* has more anthers than *R. aurantia* (20 in the holotype of the former, the only specimen described and measured in the protologue). Determining the anther number in most species of *Rafflesia* (except those in *R. manillana* and *R. lobata* where the wide diaphragm aperture exposes the anther impressions on the floor of the floral tube) is destructive in nature. Perhaps because of its rarity, only the holotype of *R. tengku-adlinii* was measured and described in detail. In addition, the fine, sharp-edged, areoles-forming ornamentations (warts?) on the outer surface of the perigone lobes and diaphragm in fresh flowers of *R. aurantia* are different from the quite distinctive pustular warts on the perigone lobes of fresh flowers of *R. tengku-adlinii*. In addition, the geographic distributions of *R. tengku-adlinii* (Sabah, Borneo) and *R. aurantia* (northern Luzon), coupled with the generally low dispersal ability of *Rafflesia* do not strongly support gene flow between these disjunct populations to occur. The short anthesis, pollen germinability and longevity (Nais and Wilcock in Nais 2001: 58), the low seed viability (Nais and Wilcock, 1999 in Nais 2001: 78-80), and the obligate parasitic nature of

Rafflesia make gene flow unlikely, although long distance dispersal events in the past cannot be discounted. We therefore presume that both populations are reproductively isolated. Although Luzon may have been connected to Northern Borneo and Sabah via the Sulu-Cagayan Arc before the Miocene, i.e. *ca*. 50 million years (MY) ago (Hall, 2002: 381), there is no evidence of the existence of *Rafflesia* (or its immediate ancestor) during this time. The age of the stem-lineage of Rafflesiaceae was estimated by Davis *et al.* (2007) to be 46 MY old, whereas the age of the crown group genus *Rafflesia* was estimated by Barkman *et al.* (2008) to be 12MY old, with most species divergences having occurred within the last 1-2 MY. Hence, the scenario that both Borneo and Northern Luzon populations may represent relicts of a more widely distributed species (vicariance) in the past is unlikely.

Some *Rafflesia* species, (e.g., *R. arnoldii* in Peninsular Malaysia, Borneo, & Indonesia and *R. speciosa* in Panay & Negros Islands) do defy transoceanic barriers. However, these islands were historically connected during the Pleistocene when the sea level was much lower than today and, in the case of Panay and Negros, represent land bridge islands that, together, form a single Pleistocene aggregate island complex sharing many endemic fauna (Wikramanayake *et al.*, 2002).

Thus, both *R. tengku-adlinii* and *R. aurantia* are likely examples of morphologically semi-cryptic species, and possibly, an example of extreme convergence in distantly related lineages. Studies on the accelerated rates of floral evolution using molecular markers in 15 species (out of the 26 currently recognized species) of *Rafflesia* by Barkman *et al.* (2008) reveals that genetic affinity is closer among those species found in the same geographic region than those that are morphologically similar but found in different geographic regions. Likewise, preliminary maximum likelihood analyses of both nuclear and mitochondrial markers of five species of Philippine *Rafflesia* (*R. manillana, R. leonardi, R. schadenbergiana, R. speciosa, and R. lobata*) and *Rafflesia* species from Peninsular Malaysia and Borneo have recovered the Philippine species as a monophyletic clade sister to all the other species of *Rafflesia* (B. van Ee, pers. comm.).

Biodiversity in Luzon's Sierra Madre Mountain Range

The Sierra Madre Mountain Range constitutes the largest block of lowland forest remaining anywhere in the Philippines. It also boasts one of the country's richest bird fauna, including some of the most rare and threatened, such as the Philippine Eagle (*Pithecophaga jefferyi*) and the Isabella Oriole (*Oriolus isabellae*) (Danielsen *et al.*, 1992; Mallari *et al.*, 2002). Mammal diversity is also remarkably high and recent surveys strongly suggest that the Sierra Madre is a unique center of mammal endemism (Danielsen *et al.*, 1992; Rickart *et al.*, 1998; Heaney, pers. comm.). Herpetological diversity in the Sierra Madre appears similarly high, and distinct from that of the Cordillera Central, southern Luzon, or the Bicol Peninsula (Brown *et al.*, 2000; Diesmos *et al.*, 2005; Diesmos and Brown, unpublished data).

Many Philippine endemic plants are also found to occur in the Sierra Madre mountain range, most notable of which is *Podosorus angustatus* Holttum, a monotypic endemic fern genus known only from the type. At the 16-ha Palanan Forest Dynamics Plot, one of the large-scale forest plots coordinated by the Smithsonian Center for Tropical Forest Science (CTFS) and Arnold Arboretum of Harvard University, 142 out of 323 tree species recorded are Philippine endemics (Co *et al.*, 2006), with 5 species thought to be possibly new to science.

The discovery of *Rafflesia* in the Sierra Madre Mountain Range and on other similar lowland habitats in the Philippines highlights the importance of this fast disappearing forest type in the conservation of the country's threatened biodiversity (Tan *et al.*, 1986).

Acknowledgements

We thank the indigenous Bugkalot community of Barangay Matmad; the Municipal Government of Nagtipunan, Mayor R.K. Camma and Municipal Councilor Y. Ebenga for hosting us; the regional, provincial, and municipal offices of the Department of Environment and Natural Resources (DENR) in Quirino under Foresters W. Malvar and H. Toribio; Forester J. Corpuz joined us at the study site; Ms. E. Pasion (Community Organizer for Quirino Province of the Sierra Madre Biodiversity Corridor Program, CI-Philippines) helped in the preparatory logistics especially for securing the collecting permit.

We thank M. Roy ('Aloy') M. Duya, L. Valenzuela-Duya (Conservation International- Philippines), P. Alviola (UPLB-MNH), J. Sarmiento (Laksambuhay Conservation, Inc.), W. Reyes (Wildlife Conservation Society of the Philippines), and A. Benedict Oli (University of the Philippines at Los Baños). Their comradeship and company in the field is indispensable. To them, we dedicate the discovery of this new species. We also thank Mr. N. Diego Jr. (PNH) for the line drawing illustration, Mr. M.G. Price who provided the Latin diagnosis, and Drs. P.B. Pelser, L.R. Heaney, and R.M. Brown for reviewing earlier drafts of the manuscript.

Financial support was provided by the Critical Ecosystem Partnership Fund (CEPF), and the United States Agency for International Development (USAID) for the series of biological surveys conducted by CI-Philippines with partners in Quirino Province as well as other parts of the Sierra Madre Biodiversity Conservation Corridor.

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Seven New Species of *Begonia* from Sumatra

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Abstract

Seven new *Begonia* species are described from northern and western Sumatra: *Begonia gracilicyma* Irmsch. ex M.Hughes (unplaced to section), *Begonia laruei* M.Hughes (sect. *Petermannia*), *Begonia multijugata* M.Hughes (sect. *Petermannia*), *Begonia pasamanensis* M.Hughes (sect. *Reichenheimea*), *Begonia puspitae* Ardi (sect. *Reichenheimea*), *Begonia tuberculosa* Girmansyah (sect. *Platycentrum*) and *Begonia verecunda* M.Hughes (sect. *Bracteibegonia*). The conservation status of each species is assessed.

Introduction

There are currently 45 species of *Begonia* known from Sumatra (Hughes, 2008a). This is certainly a vast underestimate of the true number, largely as a result of a lack of recent work on the genus and the propensity *Begonia* has for generating narrow endemics (Hughes, 2008b), but also due to the relatively low collection density over much of the island (Laumonier, 1997). However the extensive collections by de Wilde and de Wilde-Duyfies have provided much insight into *Begonia* diversity in the Gunong Leuser environs. Given the relentless pressure on forest habitats throughout Southeast Asia (Sodhi, 2004), there is an urgent need to provide taxonomic data as a basis for conservation efforts.

During recent expeditions to Sumatra, seven new species of *Begonia* have been discovered and are described here. They belong to sect. *Petermannia* (2 species); *Reichenheimea* (2 species); *Bracteibegonia* (1 species) and *Platycentrum* (1 species); there is a further rather enigmatic species which is unplaced to section. In common with most other *Begonia* from Sumatra, these new taxa are found in the mountainous spine of the island along the Barisan Range, and also from the mountains in North Sumatra and Aceh (Fig 1). Herbarium material indicates that there are still a considerable number of undescribed taxa in sections *Bracteibegonia* and *Reichenheimea* from these areas, which may represent largely endemic radiations. The Tigapulu Mountains are also likely to harbour further endemic taxa, although the areas which remain most under-explored are the mountains and limestone karst regions in northern Aceh, from which hardly any material has been seen. All specimens cited are available as digital images via Hughes & Pullan (2007); Doorenbos *et al.* (1998) was consulted to assist with sectional placement.

Begonia gracilicyma Irmsch. ex M.Hughes, *sp. nov.* (not placed to section) B. divaricatae *maxime similis, sed foliis plus elongatis et minus dentatis, floribus parum rubescentibus non albis neque roseis differt.* – **Typus:** Sumatra, Padang, Ajer Mantjoer, *O. Beccari PS610* (holo, FI; iso, B, FI, K, L). **Fig. 2B.**

Plant erect, branching **herb**, 40 to 70 cm high. **Stem** woody, especially at base, glabrous, *ca* 5 mm wide, internodes 5-10 cm apart. Stipules lanceolate, 10-12 × 3 mm, glabrous, with a filiform extension at the tip, deciduous. **Leaves** alternate; petiole 1.5-5 cm long, glabrous; lamina elongate-lanceolate, strongly asymmetric, basifixed, cordate at base, lobes not overlapping, one lobe much larger giving an angular appearance, 10-18 × 2.5-5.5 cm, midrib 8-13 cm long, venation palmate-pinnate, upper surface matt green, glabrous; underside pale green sometimes marked with red, glabrous; margin glabrous, denticulate; apex acuminate. **Inflorescence** appearing adnate on the petioles, protandrous, bisexual; bracts 1-3 mm long, margin entire, deciduous. **Male flowers**: pedicel 5 mm, glabrous; tepals 4, outer tepals orbicular, white with a reddish tinge on the reverse, glabrous, *ca* 4 mm in diameter, margin entire; inner tepals oblong-obovate, white, 4 × 2 mm; androecium yellow, symmetric; stamens *ca* 30; filaments slightly fused at base, 0.75 mm long; anther about as long as the filament, dehiscing through slits about half the length of the anther, hooded, connective not extended. **Female flowers**: pedicel 10 mm long; ovary 3 locular, with three equal wings, placentae entire; tepals 5, pale green, 5 mm long, margin entire; stigma with three styles joined at the base, U-shaped, persistent. **Fruit** brown, dehiscent, pendulous on a hair-like pedicel when dry, rounded at base, truncate to retuse at the apex; wings extending along the pedicel, equal, 14 × 5 mm; capsule shape oval, length 8-9 mm, width 5 mm. **Seeds** unknown.

Other specimens examined: **Sumatera Barat**: Mt. Tandikat, 23 vii 1955, *W. Meijer 3812* (L); *ibid.*, 1955, *W. Meijer 391?* (BM); Talaman, *H.A.B.*

Bunnemeijer 372 (B, BO); Anai Nature Reserve, 9 xi 1991, *Anda collectors 25* (ANDA); *ibid.*, 9 xi 1991, *Anda collectors 37* (ANDA); *ibid.*, 23 xii 1983, *Niniek & Wardi 458* (BO); *ibid.*, 21 iii 1990, *Anda collectors 90* (ANDA); Anak Air Ambacang Badak, 15 viii 1995, *H. Okada 2004* (ANDA); Bukit Tambun Tulang, 8 xi 1998, *Anda collectors s.n.* (ANDA); *ibid.*, 29 x 1988 - 31 x 1988, *Anda collectors s.n.* (ANDA); *ibid.*, 7 xi 1998, *Anda collectors 15* (ANDA); *ibid.*, v 2006, *Anda collectors 17* (ANDA); *ibid.*, 8 xi 1998, *Anda collectors 18* (ANDA); *ibid.*, 8 xi 1998, *Anda collectors 23* (ANDA); *ibid.*, 28 iii 1987, *Anda collectors 24* (ANDA); *ibid.*, 8 xi 1998, *Anda collectors 42* (ANDA); *ibid.*, 26 v 1991, *Anda collectors 45* (ANDA); *ibid.*, 10 xi 1991, *Anda collectors 47* (ANDA); Bungus–Cindakir, 25 v 2002, *Anda collectors 35* (ANDA); Desa Sipisang, 19 xii 1992, *Anda collectors 21* (ANDA); *ibid.*, 6 iv 1997, *Anda collectors 23B* (ANDA); *ibid.*, 19 xii 1992, *Anda collectors 25* (ANDA); *ibid., 19* xii 1992, *Syofyan et al. 31* (ANDA); *ibid., Anda collectors 33* (ANDA); *ibid.*, 5 iv 1997, *Anda collectors 35* (ANDA); *ibid.*, 5 iv 1997, *Anda collectors 41* (ANDA); *ibid.*, 17 viii 1995, *Anda collectors 503* (ANDA); Gunung Gadut, 15 xii 1987, *H. Okada 4629* (ANDA); Gunung Gadut, Bt. Batu Bajolang, 12 i 1983, *M. Hotta, et al. 1326* (A, L); *ibid.*, 12 i 1983, *M. Hotta, et al. 1320* (ANDA); Gunung Gadut, Bukit Gambir, 15 xii 1987, *H. Okada 4625* (ANDA); Kandang Ampat, Kabupaten Padang Pisang, 27 xi 1994, *Anda collectors 10* (ANDA); *ibid.*, 27 xi 1994, *Anda collectors 5* (ANDA); Muko-muko, 5 x 1986, *Witnarti* 24 (ANDA [3]); Padang Pariaman, 30 iv 2004, *D. Girmansyah* 380 (BO); Road to Rimbo Panti, 27 v 2007, *M. Hughes & D. Girmansyah MH1407* (BO, E); Taman Hutan Raya, Ladang Padi, 16 v 1993, *Anda collectors 112* (ANDA); *ibid.*, 18 xii 2004–19 xii 2004, *Anda collectors 112*? (ANDA); *ibid.*, 22 v 2007, *M. Hughes & D. Girmansyah MH1403* (BO, E [3]); *ibid.*, 24 v 2003, *Anda collectors 23* (ANDA); *ibid.*, 24 v 2003, *Anda collectors 23* (ANDA); *ibid.*, 4 v 2002, *Anda collectors 27* (ANDA); *ibid.*, 24 v 2003, *Anda collectors 27*? (ANDA); *ibid.*, 14 vi 1998, *Anda collectors 29* (ANDA); *ibid.*, *D. Girmansyah, et. al. 3* (BO, E); *ibid.*, 16 v 1993, *Anda collectors 38* (ANDA); *ibid.*, 4 v 1998–5 v 1998, *Anda collectors 46* (ANDA); *ibid.*, 5 v 2002, *Anda collectors 72* (ANDA); Tambun Tulang, 10 xi 1991, *Anda collectors s.n.* (ANDA); *ibid.*, 29 x 1983, *Eliwiratma 09* (ANDA); *ibid.*, 10 xi 1991, *Anda collectors 43* (ANDA); *ibid.*, 10 xi 1991, *Anda collectors 51* (ANDA); *ibid.*, 10 xi 1991, *Anda collectors 52* (ANDA).

Distribution and ecology: Sumatera Barat: Agam, Padang Pariaman, Tanah Datar, Padang. At altitudes of 150 to 750 m (Fig 1). Terrestrial forest floor herb found in steep lower and mid-montane forest.

IUCN category: LC. *Begonia gracilicyma* is found at a number of sites within the Gunung Singgalang Protection Forest and the Kerinci Seblat National

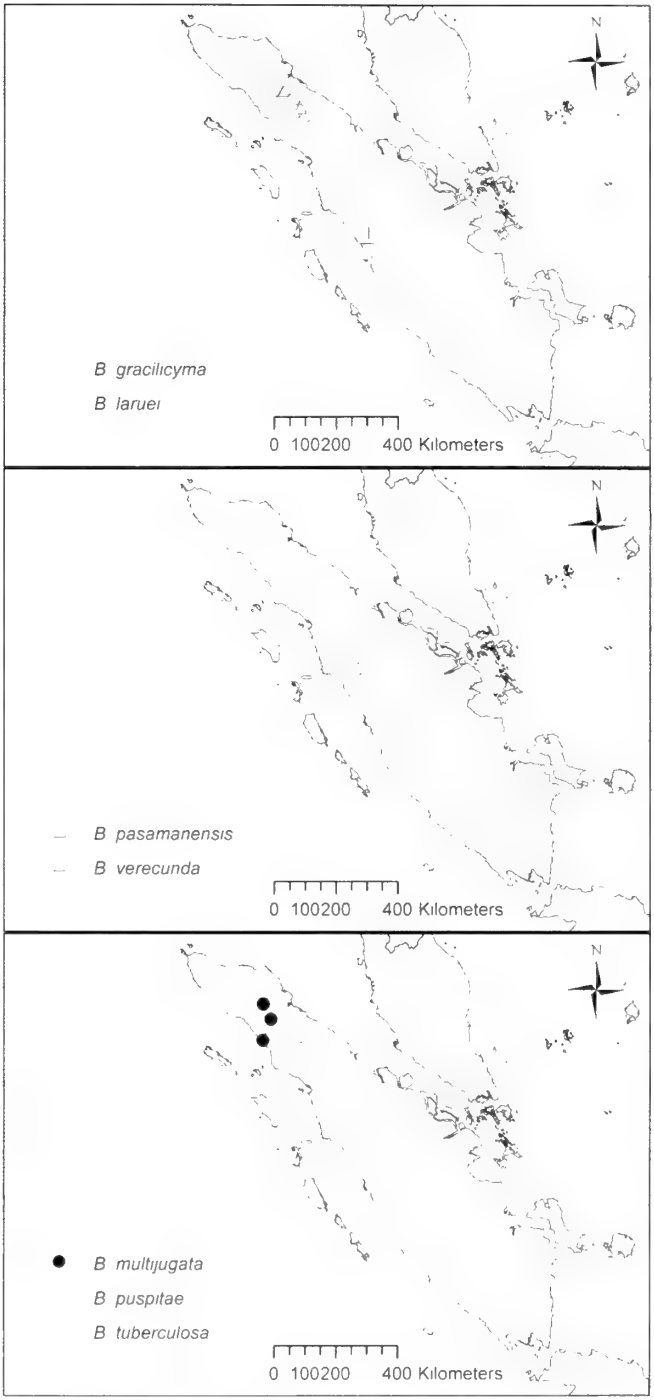

Figure 1. Distribution of *B. gracilicyma, B. laruei* (top); *B. pasamanensis, B. verecunda* (middle); *B. multijugata, B. puspitae, B. tuberculosa* (bottom).

Park.

Notes: Acording to unpublished manuscripts in the Berlin herbarium archives, Irmscher first coined the name *Begonia bünnemeijerii* for this species, based on a collection by H.A.B. Bünnemeijer from "Talaman". However, this epithet was later crossed out on the manuscript and specimens, and replaced with *B. gracilicyma*, referring to the hair-like nature of the peduncles and pedicels when dry. For unknown reasons, the taxon was left out of a paper by Irmscher (1953) which included several other new species from Sumatra, hence the name is validated here. The species is distinct from all other species currently described from Sumatra in its elongate leaf shape with a very large basal lobe which gives the lamina a distinctive outline, especially when pressed (Fig. 2). The leaves are tissue-thin and translucent when dry. Its highly branched growth form is suggestive of an affinity with *B. divaricata* Irmsch., also from the Padang region, which grows at much higher altitudes (around 1500–1700 m). The combination of caulescent habit, protandrous inflorescences and entire placentae makes *B. gracilicyma* impossible to place comfortably in any of the existing Asian sections of the genus. Irmscher annotated his manuscript with the unpublished section *Merrillia*, although we refrain from validating this name here; further study, including molecular work, is required before allocating *B. gracilicyma* to a section. "Anda collectors" refers to the large number of student collectors from the University of Andalas in Padang.

Begonia laruei M.Hughes, *sp. nov.* Sect. *Petermannia*
Ab omnibus speciebus Begoniae sectionis Petermanniae insulae Sumatrae foliis lobatis et habitu majore distincta. – **Typus:** Sumatra, North Sumatra Prov., Gunung Sibayak, 12 v 2007, 3° 13′ 38′′ N 98° 31′ 2′′ E *M. Hughes & D. Girmansyah MH1389* (holo. E; iso. BO, ANDA). **Fig. 2A.**

Plant erect, 50–100 cm high. **Stem** woody, especially at the base, glabrous, *ca.* 8 mm wide, internodes 4–10 cm apart. Stipules lanceolate, *ca.* 8 mm long, caducous. **Leaves** alternate; petiole 2.5–8 cm long, glabrous; lamina lanceolate, strongly asymmetric, usually with 2–4 pointed lobes extending to around 1–5 cm, basifixed, cordate at base, lobes not overlapping, 11–25 × 3.5–10 cm, midrib 9–15 cm long, venation palmate; upper surface dark green with silver markings between the veins or uniform green, glabrous; underside pale green, glabrous; margin glabrous, with small teeth between the lobes, apex acuminate. **Inflorescence** protogynous, bisexual, terminal, cymose, branching up to 6 times; bracts 4 × 5 mm, entire or slightly retuse, deciduous. **Male flowers**: pedicel 4 mm, glabrous, tepals 4; outer tepals reddish or dirty pink, more so towards the base, sometimes white, orbicular, truncate at base,

Figure 2. A. *Begonia laruei* (main picture and flowers, Ketambe Research Station environs; variegated leaf, inset, Gunung Sibayak; female flowers, top left, male, top right); B. *Begonia gracilicyma* (Padang, Ladang Padi; ripe fruit, top right; male flower, botom right; female flower after fruit set, bottom left); C. *Begonia puspitae* (cultivated in Bali Botanic Garden (main picture) and Bogor Botanic Garden (inset flowers); male flowers, left, front and side view; female, right); D. *Begonia verecunda* (Ketambe Research Station environs; male flower, top left; female flower, bottom right; ripe fruit, bottom left).

ca 5 × 5 mm, margin entire; inner tepals *ca* 4 × 2 mm, paler than the outer; androecium symmetric, yellow; stamens *ca* 30; filaments short, on a column; anthers hooded, *ca.* 1 mm long, lower ones sub-sessile, upper ones on a short filament. **Female flowers**: pedicel *ca* 4 mm long; ovary 3 locular, with three equal wings, placentae bifid; tepals 5, obovate, *ca* 8 × 4 mm, margin entire; stigma with three styles, deciduous. **Fruit** truncate to slightly retuse at base, pale brown, dehiscent, pendulous, usually borne in pairs; wings equal, bases not extending along the pedicel, rounded at the tips, 14 × 6 mm; capsule shape broadly oval, 12 × 9 mm. **Seeds** barrel shaped, 0.3 mm long.

Other specimens examined: **Aceh**. Gunung Ketambe, 16 v 1972, *de Wilde & de Wilde-Duyfjes 12006* (BO, L [2]); *ibid.*, 19 vii 1972, *de Wilde & de Wilde-Duyfjes 13814* (BO, L); Gunung Leuser Nature Reserve, Gunung Mamas, 7 ii 1975, *de Wilde & de Wilde-Duyfjes 14632* (L); Gunung Leuser Nature Reserve, Ketambe Research Station, 28 vii 1979, *de Wilde & de Wilde-Duyfjes 19206* (BO); Lau Alas, 6 vi 1972, *de Wilde & de Wilde-Duyfjes 12627* (BO, L); Mamas River, 27 vi 1979, *de Wilde & de Wilde-Duyfjes 19164* (BO [2], L); Blang Kedjeren, 15 ii 1937, *C.G.G.J.v. Steenis 337* (BO); Bur ui Papandji, 23 vi 1930, *Frey-Wyssling 45* (BO); Gajolanden, 21 iii 1937, *C.G.G.J.v. Steenis 9914* (BO, L). **Sumatera Utara**. Brastagi, 3-17 iv 1925, *H.S. Yates 1400* (BO); Dolok Singgalang, 25 v 1922, *J.A. Lorzing 8863* (BO); Gunung Sibayak, 7 xii 1988, *P.J.A. Kessler 105* (B, L [2]); *ibid.*, 5 x 1928, *J.A. Lorzing 14038* (BO); Gunung Sinabung, 14 v 2007, *M. Hughes & D. Girmansyah MH1398* (BO, E); Lae Banalsal, 17 xi 1941, *H. Surbeck 554* (L); Sarinembah, 28 vi 1918, *H.H. Bartlett & C.D. La Rue 200* (A, L); Karoland, Petjeren, 22 vi 1928, *C. Hamel & Rahmat Si Toroes 782* (A); Bandar Baru, Sungai Tepi, 20 v 1981, *W. Meijer 15803* (BO, L).

Distribution and ecology: Aceh: Gayo Lues, Aceh Tengara. Sumatera Utara: Langkat, Karo, Simalungen. At altitudes of 400-1400 m. Terrestrial forest floor herb found in lower and mid-montane forest.

IUCN category: LC. The bulk of the distribution of *Begonia laruei* lies within the Gunung Leuser National Park, where it is known from a number of different localities.

Notes: Irmscher annotated a specimen (BO) of this taxon with the unpublished name *B. bartlettii*. However, as there is already a *B. bartlettiana* it has been decided to commemorate the second collector Carl Downey La Rue, who made the first herbarium collection of this species with H.H. Bartlett whilst working as a botanist for the U.S. Rubber Co. in Asahan. In common with many species in sect. *Petermannia*, *B. laruei* is usually found as single plants scattered throughout the forest, though small colonies can occasionally be found. On the herbarium sheet its leaves are instantly recogniseable, being lobed to a greater or lesser extent (Fig. 2). The fruit shape is also quite distinctive, being wider than long and fairly woody, and often slightly retuse at both ends. There is variation in the leaf variegation, with some populations (e.g., Gunung Sibabyak) having leaves which are heavily blotched with silver on a dark green background with a thin silver margin, whereas others have paler leaves with no markings (e.g., Gunung Sinabung vicinity) or red veins on the upper surface (Ketambe environs).

Begonia multijugata M. Hughes *sp. nov.* Sect. *Petermannia*
A B. atricha fructibus minoribus et multijugatis diagnoscenda. – **Typus:** Sumatra, Aceh, Gunung Leuser Nature Reserve, Air Panas, 18 iii 2008, 3° 41' 44'' N 97° 39' 31'' *E P. Wilkie, M. Hughes, A. Sumadijaya, S. Rasnovi, Marlan & Suhardi PW768* (holo, BO; iso, E, SING). **Fig. 3B.**

Erect glabrous **herb** to 50 cm high. **Stem** slightly woody when dry, glabrous, 5-8 mm wide, internodes 5-20 cm apart, red. Stipules lanceolate, *ca* 20 × 6 mm, with minute glandular hairs on the reverse, with a very small extension at the tip, deciduous. **Leaves** petiole 1.5-6 cm long, glabrous; lamina ovate-lanceolate, asymmetric, basifixed, cordate at base, lobes not overlapping, length 12-22 cm, width 5-9 cm, midrib 10-17 cm long, venation palmate-pinnate; upper surface dark green with white spots between the veins, glabrous, underside wine-red, glabrous; margin glabrous, toothed at the end of the veins with smaller teeth between, apex acuminate. **Inflorescence** very compressed, protogynous, bisexual; bracts translucent white. **Male flowers**: pedicel length 10 mm, glabrous; tepals 2, white, glabrous, 6 mm long, obovate, margin entire; androecium pale yellow, symmetric, almost conical; stamens 30, filaments shorter than the anther at the base, becoming slightly longer toward the apex, anther 0.75 mm long, obovate, hooded, dehiscing through short slits less than half the length of the anther, connective retuse. **Female flowers**: pedicel up to about 1 cm long; ovary 3 locular, with three equal wings, wings rounded-triangular, 2-3 mm wide, placentae bifid; tepals 5, white, obovate-orbicular, 6 mm long, margin entire; stigma yellow, with three styles, once spirally twisted, deciduous. **Fruit** pale brown, dehiscent on all 3 faces, borne in a cluster of up to 5 pairs, each pair *ca* 5 mm apart; wings narrow, capsule broadly elliptic, 7-9 × 6-7 mm. **Seeds** rounded-barrel shaped, 0.25 mm long.

Other specimens examined: **Aceh**. Gajolanden, 25 ii 1937, *C.G.G.J.v. Steenis 9291* (BO, L); Lau Alas, 2 vi 1972, *de Wilde & de Wilde-Duyfjes 12537* (L [2]); Kloet Nature Reserve, 10 vii 1985, *de Wilde & de Wilde-Duyfjes 19910* (BO, L).

Distribution and ecology: Aceh: Gayo Lues, Aceh Tenggara, Aceh Seletan. At altitudes of less than 400 m (Fig. 1). Terrestrial herb found in lowland forest.

IUCN category: LC. As the entire known range of this species is within the Gunung Leuser National Park, it should be considered as Least Concern as long as the Park remains intact.

Notes: Vegetatively this glabrous species closely resembles *B. atricha*, both in leaf shape and colouring (dark green with evenly spaced white spots between the veins). However the infructescence differs considerably, being a congested cluster of small, paired fruits which make the species instantly recogniseable when fertile (Fig. 3): *B. atricha* has large bell-shaped fruits borne singly on long thin pedicels. *B. multijugata* is usually found as solitary plants on the forest floor. The eipthet refers to the paired fruits, being derived from *jugatus*, meaning yolked together in pairs.

Begonia pasamanensis M.Hughes, *sp. nov.* Sect. *Reichenheimea*
A B. stictopoda foliis plus late ovatis et adpressis, pedicellis pilosis differt. – **Typus:** Sumatra, West Sumatra, Road to Padang, 29 v 2007, 0° 2' 32'' N 100° 13' 5'' E *M. Hughes & D. Girmansyah MH1419* (holo. E; iso. BO, ANDA) **Fig. 3A**.

Repent **herb**, *ca* 20 cm tall. **Stem** rhizomatous, 3 mm wide, internodes 0.3-1 cm apart. Stipules persistent, triangular, *ca* 7 × 3 mm, glabrous, with a filiform extension at the tip, semi persistent. **Leaves** alternate; petioles densely hairy, 3-20 cm long, unequal on the same plant, being much longer on older leaves; lamina broadly ovate, basifixed, asymmetric, base cordate with lobes overlapping *in vivo*, length 4-9 cm, width 3.5-8 cm, midrib 3-6 cm long, venation palmate, upper surface mid green to blackish green, reddish when young, usually paler along the veins, glabrous, smoothly bullate between the veins, underside wine-red, hairy on veins only, margin with occasional short hairs, entire to denticulate, apex obtuse. **Inflorescence** cymose, axillary, protogynous, bisexual; bracts sub-orbicular, 1.5-3 mm long, 1.5-3 mm wide, margin fimbriate, deciduous. **Male flowers**: pedicel length 6 mm, hairy, tepals 4; outer tepals sub-orbicular, white or pale pink, with scattered colourless hairs, truncate at base, margin entire; inner tepals oblong-obovate, white; androecium yellow, symmetric; stamens *ca*. 50; filaments fused at base into a short column, 1 mm long, subequal; anther shorter than the filament, length 0.75-1 mm long, oblong, dehiscing through slits longer than half the length of the anther, slightly hooded, connective retuse. **Female flowers**: pedicel; ovary with three equal wings, 3 locular, placentae entire; bracteoles absent; tepals 3 or 4, white or pale pink with scattered colourless hairs; outer sub-orbicular 8-10 mm in diameter, often deeper pink at the base externally; inner tepals oblong-obovate, 7-10 mm long, *ca* 3 mm wide; stigma with three styles, styles deep yellow, u-shaped, stigmatic surface spiral. **Fruit** truncate at base, recurved and held horizontally at maturity; *ca* 8 × 14 mm in total, capsule orbicular, *ca* 6 mm in diameter; wings rounded, equal to subequal. **Seeds** barrel shaped, 0.25 mm long.

Other specimens examined: **Sumatera Barat**. Rimbo Panti National Park, 28 v 2007, *M. Hughes & D. Girmansyah MH1411* (BO, E); *ibid*., 28 v 2007, *M. Hughes & D. Girmansyah MH1411A* (BO, E); *ibid*., 28 v 2007, *M. Hughes & D. Girmansyah MH1416* (BO, E); *ibid*., 28 v 2007, *M. Hughes & D. Girmansyah MH1417* (BO, E); *ibid*., 12 vi 1953, *J.v. Borssum Waalkes 1730* (BO, L); Road to Padang, 29 v 2007, *M. Hughes & D. Girmansyah MH1421* (BO, E); Road to Rimbo Panti, 27 v 2007, *M. Hughes & D. Girmansyah MH1410* (BO, E).

Distribution and ecology: Sumatera Barat, endemic to Pasaman, at altitudes of 200–500 m (Fig. 1). Lithophytic herb, on steep rocky banks with clay soil or on rocks near streams.

IUCN category: LC. Although *B. pasamanensis* has quite a narrow distribution, it is found within the Rimbo Panti Nature Reserve and the Malampah Alahan Panjang Nature Reserve. It also has the potential to colonise roadside banks where there is canopy cover and suitable substrate (clay soil on limestone).

Notes: In life this species has leaves which are slightly raised between the veins, with the veins on the upper leaf surface being a shade paler than the lamina. It grows gregariously on steep banks along the main road through the Rimbo Panti Nature Reserve (Fig. 3), where it co-occurs with a species tentatively identified as *B. stictopoda* (Miq.) A.DC. Although superficially similar, *B. pasamanensis* can be distinguished by its smaller, more broadly ovate leaves which are usually much darker and have a blunter apex; those of *B. stictopoda* are more elongate, especially on younger plants when their size is more similar. *B. pasamanensis* also tends to have its petioles and leaf laminas appressed against the substrate. As well as these vegetative characters, *B. pasamanensis* has hairy pedicels, as opposed to glabrous in *B. stictopoda*. Several plants along the roadside through Rimbo Panti were intermediate between the two species, and it is possible that this artificial environment has brought the species together where they would otherwise not naturally co-occur. However, large hybrid swarms were not observed. Observations in the field show that *B. pasamanensis* and some other Sumatran species in sect. *Reichenheimea* have fruits which are recurved at maturity, with one wing pointing downwards and the other two forming a small splash-cup.

Figure 3. A. *Begonia pasamanensis* (Rimbo Panti Nature Reserve: female flowers, inset); B. *Begonia multijugata* (Gunung Leuser Nature Reserve, Air Panas: male flower, top left; female flower, bottom left: ripe fruits, bottom right); C. *Begonia tuberculosa* (Gunung Sinabung: male flower, top right; female flower, bottom right).

Begonia puspitae Ardi, *sp. nov.* Sect. *Reichenheimea*
Ab omnibus speciebus Begoniae sectionis Reichenheimeae insulae Sumatrae foliis supra pilosis et stipulis gaudentibus pilis plumosis differt. – **Typus:** Sumatra, West Sumatra, Gunung Silungkang, Suaka Alam Batang Pangean, 28 viii 2005, *D.M. Puspitaningtyas DM1742* (holo, BO). **Fig. 2C.**

Repent **herb** *ca* 20 tall. **Stem** rhizomatous, glabrous, internodes *ca* 5 mm apart. Stipules persistent, broadly triangular *ca* 13 × 7 mm, covered with branched hairs 0.5-1.5 mm long. **Leaves**, petiole 7-22 cm long, green, with dense white to pink hairs up to 3 mm long; blade very asymmetric 8–22 × 5–13.5 cm, reddish green or green between the veins above and pale green below, broadly ovate, base cordate, margin hairy, denticulate, tip acuminate, venation palmate, pilose on both surfaces, hairs white, 1-2 mm long. **Inflorescence** axillary, cymose, covered with white dense hairs 0.5-1 mm, primary peduncle longer than the leaves, *ca* 23-28 cm long, protandrous; bracts ovate, *ca* 3 × 5 mm, white at base and pale green at tip, outer surface covered with dense pink hairs, *ca* 1 mm long, margin serrate and hairy, tip acuminate ending with a hair, falling before the male flowers open. **Male**

Flowers: pedicel 12-17 mm; tepals 2, white, sub-orbicular 7-8 × 8-9 mm, margin entire, tip rounded, with reddish stiff hairs 0.5-1 mm long externally; androecium yellow, symmetric, column *ca* 0.5 mm; stamens *ca*. 35; filaments *ca* 1 mm long; anthers yellow, elliptic, 0.8 mm long, tip truncate, opening by slits as long as the anther sac. **Female flowers**: pedicel 15-20 mm, greenish red; ovary pale pink to white, *ca* 4 mm long, wings 3, unequal, locules 3, placentation axile, placentae entire; tepals 2, white, glabrous, sub-orbicular 7-9 × 8-9 mm, margin entire, tip rounded; styles 3, styles and stigma yellow, *ca* 3.5 mm. **Fruits** with pedicel 2 cm long; dehiscent, capsule oval *ca* 7 mm long, hairless, locules 3, wings 3, unequal, splitting between locules and wings. **Seeds** barrel shaped, *ca* 0.5 mm long, collar cells ca 1/5 length of the seed.

Distribution and ecology: Sumatera Barat, only known from the type locality, Gunung Silungkang, between 600–700 m altitude (Fig 1).

IUCN category: DD. There is not enough information on the current condition and protection status of the type locality.

Notes: B. puspitae is unusual in having branched hairs covering the stipules, and thus, differs from the other known Sumatran species in sect. *Reichenheimea*. The presence of a fairly dense indumentum of short hairs on the upper leaf surface also marks it as distinct from other Sumatran species in this section (Fig. 2). The epithet is after the collector, Dwi Murti Puspitaningtyas.

Begonia tuberculosa Girmansyah, *sp. nov.* Sect. *Platycentrum*
A B. areolata *petiolis albopilosis, foliis mollibus et variegatis, radicibus tuberculosis differt.* – **Typus:** Sumatra, North Sumatra, Gunung Sinabung, 3° 10' 33'' N 98° 23' 31'' E *M. Hughes & D. Girmansyah MH1394* (holo, E; iso, E [2], BO, ANDA). **Fig. 3C**

Repent **herb** *ca* 45 cm high, with small *ca* 5 mm diameter tubercles on the roots. **Stem** rooting at the nodes, hairy, more so towards internodes, *ca* 6 mm wide, internodes up to 20 cm apart though usually shorter. Stipules lanceolate, 10 mm long, 5 mm wide, hairy, with a filiform extension at the tip, persistent. **Leaves** alternate but appearing opposite subtending the inflorescence; petioles around 10 cm long, with dense grey-white hairs becoming very light brown on drying; lamina ovate with an extended tip, basifixed, cordate at base lobes not overlapping, *ca* 13 × 8 cm, midrib *ca* 9 cm long, venation palmate, asymmetric, upper surface mid green with dark purple or sometimes dark green patterning along the veins, upper surface hairy all over, underside with red hairs denser on the veins, fading with age, margin fimbriate–denticulate. **Inflorescence** cymose, terminal, bisexual; bracts *ca* 5 mm long, margin fimbriate, caducous. **Male flowers**: pedicel 15 mm, hairy; tepals 4, outer tepals sub orbicular, white with pale pink on the reverse, hairy, hairs denser towards the base, truncate to rounded at base, *ca*. 10 × 10 mm, margin entire, inner tepals oblong-elliptic, white, *ca* 15 × 8 mm; androecium yellow, symmetric; stamens *ca*. 80–100; filaments, 1.5-2 mm long, equal, fused at the base into a short column; anther shorter than the filament, *ca* 1.5 mm long, oblong elliptic, dehiscing through slits longer than half the length of the anther, connective extended. **Female flowers**: pedicel *ca* 2 cm long; ovary 3 winged, one wing much enlarged, covered in quite stout pinkish hairs, 2 locular; tepals 5, white, ovate *ca* 10 × 8 mm, with pinkish hairs on the reverse; stigmas 2, pale yellow-green or yellow, stigmatic surface convulted. **Fruit** not seen mature. **Seeds** unknown.

Other specimen examined: **Aceh**. Mamas River, 11 vii 1985, *de Wilde & de Wilde-Duyfjes 19075* (L).

Distribution and ecology: Aceh: Aceh Tenggara. Sumatera Utara: Karo. At altitudes of 1200–1400 m (Fig 1). Terrestrial herb of mid-upper montane forest, found in rich humus and often at the base of tree trunks.

IUCN category: VUD2. *Begonia tuberculosa* is currently known from only 2 sites, one of which (Gunung Sinabung) is being encroached despite being in the Leuser Ecosystem Conservation Area. The other site in the Gunung Leuser National Park is considered safe. It is recommended that (i) protection of the forest on Gunung Sinabung, especially at the lower elevations, be made a priority and (ii) the species be brought into cultivation.

Notes: *B. tuberculosa* is instantly recognisable as a member of sect. *Platycentrum*, with its two-locular fruit and large androecium on a short column. Its closest affinity is probably with *B. areolata* Miq., a widespread species at 1000–1800m in Sumatra and Java, as it shares the unusual character of having a pair of opposite leaves subtending the inflorescence. As well as having tubercles on the roots, *B. tuberculosa* differs from *B. areolata* in having variegated leaves (Fig. 3) and grey-white (not red) hairs on the petiole, which contrast with the claret-red hairs on the underside of the lamina. The lamina margin is also less lobed than *B. areolata*, and feels very different to the touch, being soft and velvety rather than bristly and bumpy. Sect. *Platycentrum* is especially species rich in Peninsular Malaysia (Kiew, 2005), and *B. tuberculosa* and other species in the section from Sumatra and Java probably represent a link with that flora, especially species with bullate leaves such as *B. wyepingiana* and *B. vallicola*.

Begonia verecunda M.Hughes *sp. nov.* Sect. *Bracteibegonia*
Differt a B. bracteata *stipulis angustis lanceolatis acuminatis (haud late ovatis); a* B. lepidella *fructibus recurvatis.* – **Typus:** Sumatra, Aceh, Gunung Leuser Nature Reserve, Ketambe Research Station, 7 iii 2008, 3° 40' 46'' N 97° 38' 37'' E *P. Wilkie, M. Hughes, A. Sumadijaya, S. Rasnovi, Marlan & Rabusin PW623* (holo, BO; iso, E, SING). **Fig. 2D.**

Low growing **herb**, 20 cm high. **Stem** slightly woody, densely hairy, *ca* 3 mm wide, internodes 1-2 cm apart. Stipules narrowly lanceolate, 10 mm long, with a filiform extension at the tip, laxly deciduous, appearing very narrow and almost filiform when dry. **Leaf** petiole around 1 cm long, densely hairy; lamina ovate-lanceolate, asymmetric, basifixed, cuneate to rounded on one side, lobed on the other, the short basal lobe crossing the petiole slightly, total length 6.5-10 × 3-4 cm, venation palmate-pinnate, upper surface dark green, usually glabrous but sometimes with one or two short fleshy hairs, underside deep red or pale green, with short fairly robust hairs on the veins, appressed in the direction of the apex, becoming sparser on the smaller veins, margin entire to minutely denticulate, apex acute. **Inflorescence** a short and compact cyme, protogynous, bisexual; bracts persistent at the base. **Male flowers**: pedicel length 5-10 mm, glabrous; tepals 4; outer tepals sub-orbicular, glabrous, 9 mm long, white tinged with deep pink, colouring zygomorphic, with top of flower being darker; margin entire; inner tepals white, *ca* 6 × 3 mm; androecium yellow, symmetric; stamens 30; filaments slightly fused at base, unequal, shorter or longer than the anther; anther about 1 mm long, oblong obovate, dehiscing through slits less than half the length of the anther, hooded, connective slightly retuse. **Female flowers**: pedicel *ca* 6 mm long; tepals 5, white tinged with pink, much deeper on the reverse, colouring zygomorphic, darker towards the top, elliptic-ovate, 7 mm long, margin entire; persistent and closed during fruit maturation, eventually deciduous; ovary green with the adaxial wing tinged deep pink, 3 locular, placentae bifid; stigma yellow, deciduous. **Fruit** dehiscent, recurved at maturity; wings subequal, 3-4 mm wide, the adaxial wing the larger; capsule shape narrowly elliptic, slightly curved, length 10 mm, width 4 mm. **Seeds** barrel shaped, 0.25 mm long.

Other specimens examined: **Aceh.** Gunung Leuser Nature Reserve, 16 v 1972, *de Wilde & de Wilde-Duyfjes 12010* (K, L); Gunung Leuser Nature Reserve, Air Panas, 18 iii 2008, *P. Wilkie, M. Hughes, A. Sumadijaya, S. Rasnovi, Marlan & Suhardi PW779* (BO, E, SING); Gunung Leuser Nature Reserve, Gunung Mamas, 7 ii 1975, *de Wilde & de Wilde-Duyfjes 14640* (L); Gunung Leuser Nature Reserve, Ketambe Research Station, 7 iii 2008, *P. Wilkie, M. Hughes, A. Sumadijaya, S. Rasnovi, Marlan & Rabusin PW617* (BO, E, SING); *ibid.*, 7 iii 2008, *P. Wilkie, M. Hughes, A. Sumadijaya, S. Rasnovi, Marlan & Rabusin PW621a* (SING); Lau Alas, 28 v 1972, *de Wilde & de Wilde-Duyfjes 12370* (L); *ibid.*, 4 ii 1975, *de Wilde & de Wilde-Duyfjes 14487* (L); *ibid.*, 21 iii 1975, *de Wilde & de Wilde-Duyfjes 15683* (L).

Distribution and ecology: Aceh: Aceh Tenggara. At altitudes of around 200–400 m (Fig 1). Terrestrial herb found scattered on the forest floor in lowland forest.

IUCN category: LC. As the entire known range of this species is within the Gunung Leuser National Park, it should be considered as Least Concern as long as the Park remains intact.

Notes: The epithet is derived from *verecundus* meaning shy or demure, referring to the way the female flowers close their tepals and bow away from sight after pollination (Fig. 2). The short petioles and peduncles, dense indumentum, bicoloured flowers and elongate fruit with quite narrow wings are characteristic for sect. *Bracteibegonia*. Judging from other herbarium collections, the variation in this section on Sumatra appears to be at once both complex and subtle, and there are undoubtedly many other species waiting to be described. Tepal number, colour and shape as well as fruit position at maturity are important characters in this group.

Acknowledgements

The support of the M.L. MacIntyre Trust, the Sibbald Trust, the Royal Botanic Garden Edinburgh Small Projects Fund, the Davis Expedition Fund, the Percy Sladen Memorial Trust and SYNTHESYS (grants NL-TAF 1608, FR-TAF 1416 and DE-TAF 2181) is gratefully acknowledged. This research would not have been possible without the support of the Indonesian Ministry of Research and Technology (RISTEK), the Indonesian Institute of Sciences (LIPI), Direktorat Jenderal Perlindungan Hutan dan Konservasi Alam (DITJEN PHKA), Bandan Pengolola Kawasan Ekosystem Leuser (BPKEL), Universitas Sumatera Utara and Universitas Syiah Kuala. A. Sumadijaya and S. Rasnovi are thanked for their assistance in the field. The curators of herbaria A, ANDA, B, BM, BO, E, K, L, MICH, P, SING and U are thanked for facilitating access to specimens. This research was supported by the National Parks Board, Singapore. Two anonymous referees are thanked for their comments and improving the manuscript.

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A New Record for the Flora of Vietnam: *Geodorum citrinum* Jacks. (Orchidaceae)

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Abstract

Geodorum citrinum Jacks. is a new record for the orchid flora of Vietnam.

Introduction

Geodorum Jacks. (Orchidaceae) is a small genus in Vietnam, represented by five species (Averyanov and Averyanova, 2003; Ban *et al.*, 2005).

During the years 2004-2008 several expeditions have been organized in the Thai Nguyen province. Many plants have been added to the orchid living collection of the Institute of Ecology and Biological Resources (IEBR). Among them a new record in the genus *Geodorum* (Orchidaceae) for the Flora of Vietnam has been made. Thus the genus *Geodorum* in Vietnam consists of six species.

***Geodorum citrinum* Jacks.** Andr. Bot. Rep. 3, t. 626 (1811); Seidenf. in Opera Bot. 72: 55, fig. 28 (1983). **Figs. 1A-G, Plate 1A-D.**

Terrestrial **herb**, **stem** short and erect, with ovate pseudobulb; 2-4 alternate **leaves** with sheathing footstalks, ovate or oblong, 19-24 × 5-6.5 cm, apex acute; scape lateral, erect, racemes terminating in a cernuous spike, with 5-6 flowers; **flowers** 4.5-5 cm in diameter; pedicel plus ovary 1.3-1.5 cm long; sepals lanceolate, apex obtuse or acute, white green, 2.5-2.7 × 0.8-0.9 cm; petals ovate-oblong, apex obtuse, white, 2.1-2.4 × 0.8-1.1 cm; labellum ovate, 2.1-2.3 × 1.5-1.7 cm, entire, base concave and glabrous, surface yellow, with red-purple longitudinal stripes on epichile; column 3 mm long, column-foot somewhat curved, with purple veins, 5 mm long; operculum white with two violet prickles. **Pollinia** 2, ovaliform, wax-yellow.

Specimen examined: **Vietnam**. Thai Nguyen Province, Dinh Hoa district, terrestrial in evergreen forest, 500-600 m alt., flowering from April to June, *Huyen 518* (HN).

Geodorum citrinum is here newly reported for the Flora of Vietnam. The plant was identified using Seidenfaden's (1983) treatment and Pham

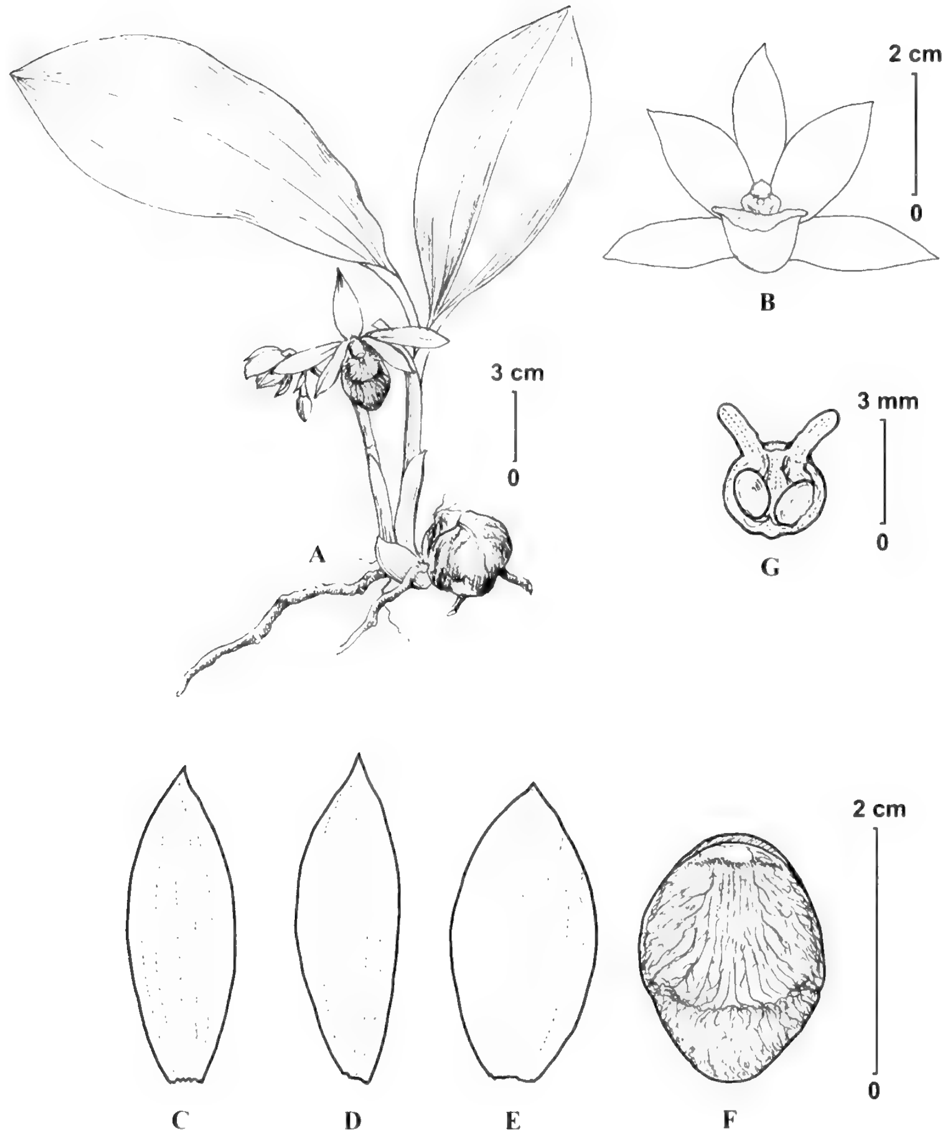

Figure 1. *Geodorum citrinum* Jacks. A. Plant habit; B. Flower front view; C. Dorsal sepal; D. Lateral sepal; E. Petal; F. Lip; G. Operculum and pollinia.

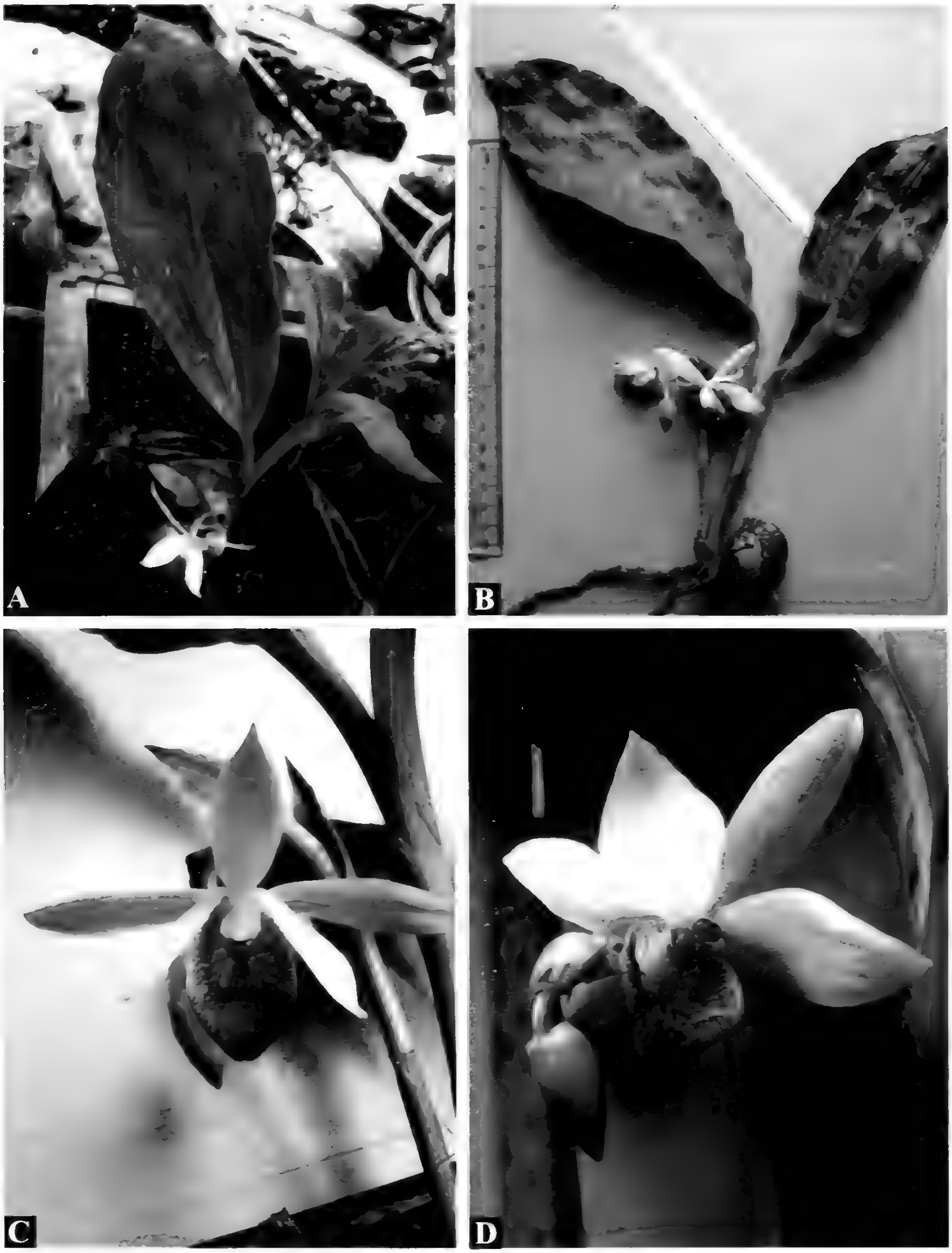

Plate 1. *Geodorum citrinum* Jacks. A-B. Plant habit; C-D. Close-up of a single flower.

(2000). Our material has white-green flowers, turning yellow with age and with some purple markings on the lip and column.

The species is also distributed in the neighbouring countries Thailand and Malaysia, and in Bangladesh and Myanmar.

Acknowledgments

The authors are grateful to Prof. Le Xuan Canh at IEBR for assistance in the field work, and to Dr. Chin See Chung and Dr. B.C. Tan for providing access to the Singapore Herbarium (SING). This work was partially supported by a Singapore Botanic Gardens Research Fellowship.

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A New Species of *Fissidens* (Bryopsida, Fissidentaceae) from Peninsular Malaysia

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Abstract

A new moss species collected from Peninsular Malaysia, *Fissidens benitotanii* Z.Iwats., K.-T.Yong & Tad.Suzuki is described. The species belongs to subgenus *Fissidens* section *Fissidens*. Most of the members in sect. *Fissidens* have smooth laminal cells, except for a few species, which included this newly described species, possess unipapillose laminal cells. *Fissidens benitotanii* is easily distinguished from other *Fissidens* species in the region by the following characteristics: narrowly lanceolate leaves with shortly excurrent costa, thin limbidia that disappear near leaf apex, and unipapillose laminal cells with distinctive sharp papilla.

Introduction

Iwatsuki and Mohamed (1987) reported 24 species of *Fissidens* for Peninsular Malaysia and Singapore in a revision of the genus. Recently, we discovered an interesting species while studying some of the *Fissidens* specimens collected by one of the co-authors, K.-T. Yong from Peninsular Malaysia. After studying the specimens carefully, and comparing them with related known species, we reached the conclusion that one of the specimens represents a new species belonging to subgen. *Fissidens* sect. *Fissidens*. However, this plant specimen in question is different from the typical members of sect. *Fissidens* in having distinctly unipapillose laminal cells.

Fissidens benitotanii Z.Iwats., K.T.Yong & Tad.Suzuki, *sp. nov.*
Sterilis. Caulis 4.5-5.0 mm longus, cum foliis 2.0-2.5 mm latus. Folia 9-13 juga, anguste lanceolata, 1.3-1.7 mm longa, 0.25-0.35 mm lata; apice acuto; costa excurrenta; cellulae laminarum unipapillosa; marginibus limbatus.

– **Holotypus:** Peninsular Malaysia, State of Perak, Belum Royal Park, Upper Belum Region, upstream of Kenarong River, lowland forest, alt. 200-300 m, on soil, 30 Jul 2003, coll. *K.-T. Yong 4660* (KLU; isotype in NICH, SING). **Figs. 1, 2.**

Medium-sized plant for the genus. **Stems** simple, 4.5-5.0 mm long, 2.0-2.5 mm wide with leaves; axillary hyaline nodules not differentiated; in cross-section cortical cells small and thick-walled, central strand weakly differentiated. **Leaves** 9-13 pairs, more or less densely arranged; middle to upper leaves narrowly lanceolate, 1.3-1.7 mm long, 0.25-0.30 mm wide, narrowly acute at apex; base of dorsal lamina rounded, not decurrent; costa stout, shortly excurrent; margin almost entire, but finely crenulate by projection of cells near apex; vaginant lamina about 1/2 of the leaf length. Limbidia usually 1-2 rows of elongate cells near apical laminae, 3-4 rows of cells on vaginant laminae; in cross-section 1-2 cells thick; lacking near leaf apices. Laminae in cross-section 1 cell thick; cells of apical lamina quadrate to hexagonal, 8-12 μm long, moderately thick-walled, sharply unipapillose; cells of vaginant laminae similar to those of apical laminae, but larger and longer toward base. **Dioicous**?; male plants and **sporophytes** not found.

The species name, *Fissidens benitotanii*, is dedicated to Dr. Benito C. Tan, an active bryologist in Asia who has spent many years studying the tropical Asiatic bryophytes, particularly the moss species, and have contributed many important papers to the study of Asiatic moss flora. In addition, the honoree, B.C. Tan, is a mentor of K-T. Yong, one of the co-authors of this paper, in his study of the moss flora of Malaysia.

The new species, *Fissidens benitotanii*, is placed within subgenus *Fissidens* sect. *Fissidens* (cf. Suzuki and Iwatsuki, 2007) that is characterized by the presence of limbidia on the apical, dorsal and vaginant laminae. By and large, the species in sect. *Fissidens* are known to have smooth laminal cells, but there are exceptional cases where a small number of them have papillose laminal cells. Those species with unipapillose laminal cells are thus far only been reported from the tropical areas; for example, *Fissidens angustifolius* Sull. (syn. *F. dixonianus* E.B. Bartram) is found in Fiji Islands, Central and South America (cf. Iwatsuki and Suzuki, 1996; Pursell, 2007), and *F. raiatensis* E.B. Bartram (cf. Whittier and Miller, 1967) from Society Islands.

The new species, *F. benitotanii*, can be distinguished from *F. angustifolius* and *F. raiatensis* by its limbidia disappearing at the leaf apex, its narrowly lanceolate leaves with acute apices, and the shortly excurrent costa (Fig. 1g), whereas *F. angustifolius* has percurrent costa, and limbidia always reaching the leaf tips. Also, papilla on the laminal cell of *F. benitotanii* is much sharper comparing with that of *F. angustifolius*. Hyaline nodules are

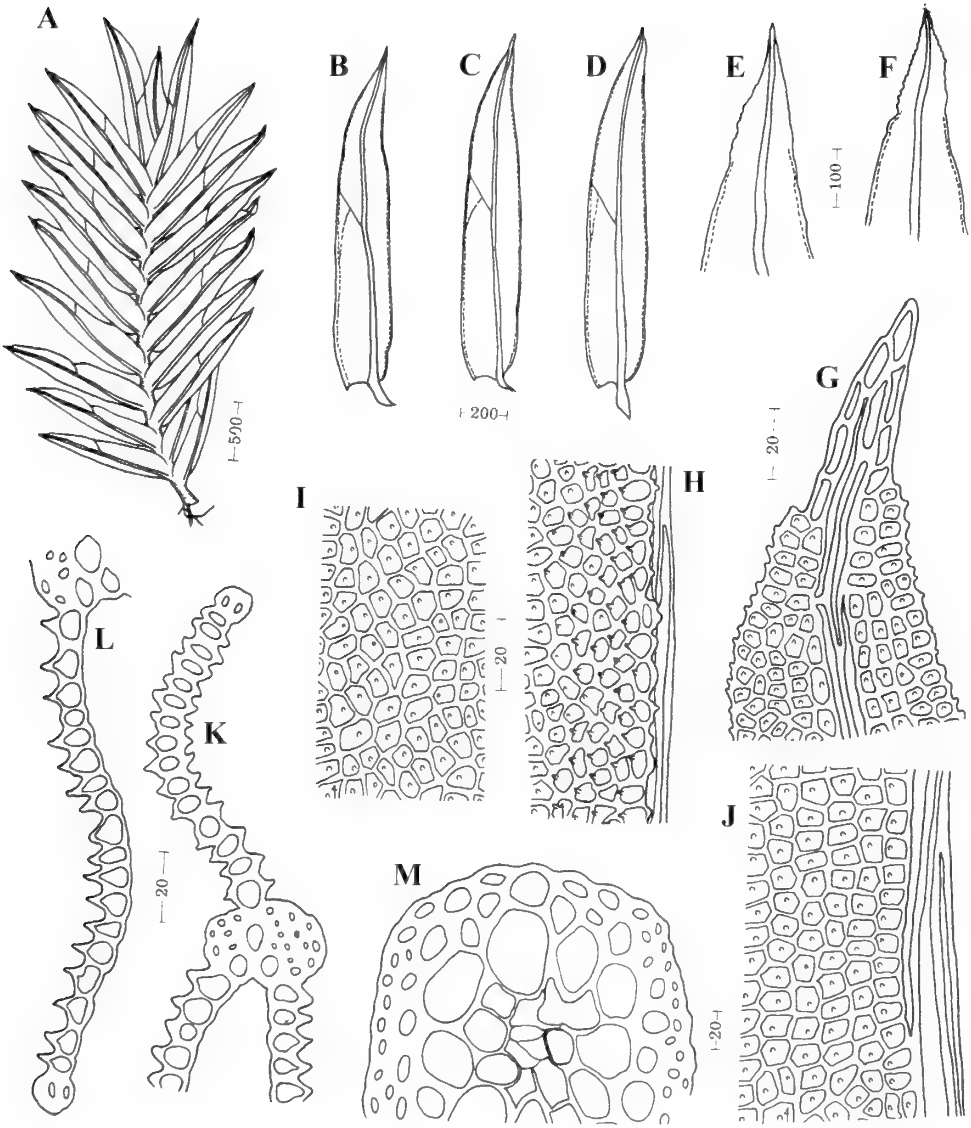

Figure 1. *Fissidens benitotanii* Z.Iwats., K.-T.Yong & Tad.Suzuki. A. Plant. B-D. Leaves. E-F. Leaf apices; G. Cells at leaf apex; H. Marginal cells of apical lamina; I. Cells of apical lamina. J. Cells at margin of vaginant lamina; K-L. Cross-sections of leaf; M. Cross-section of stem. All figures drawn from the isotype specimen (*K.-T. Yong 4660* in NICH). Scale bars in µm.

present on the stems of *F. angustifolius*, but are absent in *F. benitotanii*.

The type material for *F. benitotanii* is sterile, with no sporophytic structure. We made a few attempts to search for the archegonia and antheidia of this species, but were not successful. Sexuality of this species is probably dioicous.

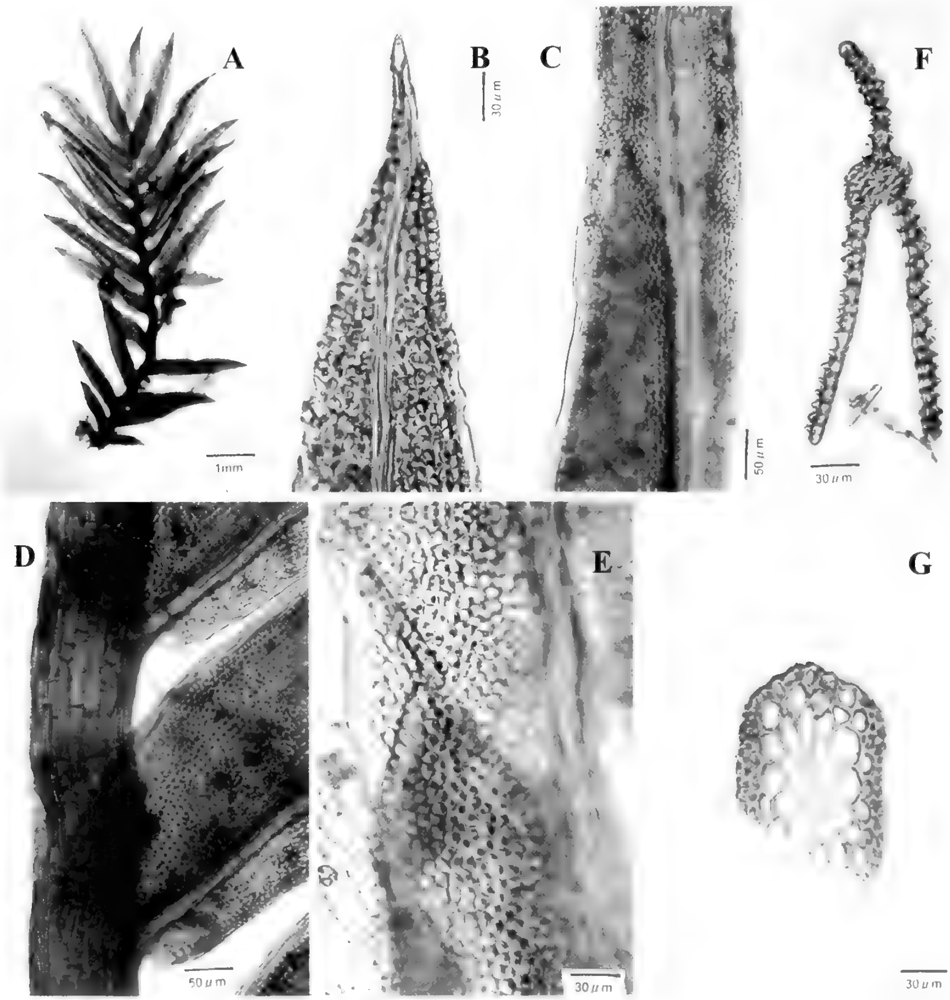

Figure 2. *Fissidens benitotanii* Z.Iwats., K.-T.Yong & Tad.Suzuki. A. Plant; B. Leaf apex; C. Median part of leaf; D. Basal part of leaf; E. Papillose cells at middle of leaf; F. Cross-section of leaf; G. Cross-section of stem; All figures were from the isotype specimen (*K.-T. Yong 4660* in NICH).

Acknowledgements

Grateful acknowledgement is made to the Japan Society for the Promotion of Science for financial support made available through a Grant in Aid for Scientific Research © (no. 19570098) and a research grant provided by University of Malaya, Malaysia. The authors also like to express their appreciation to Madam Patricia Loh who helps us to improve the English text.

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Taxonomic Studies of Podostemaceae of Thailand. 3. Six New and a Rediscovered Species

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Abstract

Podostemaceae is an ecologically and morphologically unusual aquatic plant family. By examination of new collections from Thailand, we describe seven species, two of which are new species assigned to *Terniopsis* of Tristichoideae (*T. chanthaburiensis, T. minor*), four are new species assigned to *Hydrobryum* and *Polypleurum* of Podostemoideae (*H. phetchabunense, P. insulare, P. prachinburiense, P. sisaketense*), and one is *Zeylanidium lichenoides* rediscovered. In total, two subfamilies, 10 genera, and 42 species with four varieties occur in Thailand. A key to all the species is provided.

Introduction

Podostemaceae is an aquatic angiosperm family distributed in the tropics and subtropics of the world. The family is unusual ecologically and morphologically. Plants grow submerged on rock surfaces during the rainy season, and they flower and set fruits, while protruding and drying above the water, during the following dry season when the water level becomes low. The plants either adhere to the rocks by ribbon-like or crustose roots developed from the hypocotyl in most species with rudimentary or no primary shoots and roots, or by crustose or multi-branched adventitious shoots in rootless species. Kato (2004, 2006) and Koi *et al.* (2008) reported nine genera and 35 species from Thailand, the largest species number in Asia. In this paper, we describe six new species referred to four genera and a poorly known species, based on new molecular and morphological data and new collections. Molecular phylogenetic data (S. Koi, unpubl. data) are useful to identify species that are morphologically slightly different from its close relatives. As a result, 10 genera and 42 species assigned to two subfamilies occur in Thailand, indicating again the highest diversity of Podostemaceae in Asia. A key to all the species of Thailand is provided.

Taxonomy

Terniopsis chanthaburiensis M. Kato & Koi, *sp. nov.*

Terniopsis malayana *ramulis ramosis similis, sed pedicellis longioribus differt*; T. brevis *plantis parvis, ramulis usque brevibus, ad 3.5 mm longis similis, sed pedicellis longioribus differt.* – **Holotypus**: Southeastern Thailand. Chanthaburi Prov., Klong Yai, Pong Nam Ron District, 150 m alt., 12°56' N, 102°28' E, fl. Mar 2005, *T. Wongprasert 771601* (BKF; isotype, TNS). **Fig. 1.**

Figure 1. *Terniopsis chanthaburiensis*. A. Ramuli on flank of root; B. Reproductive shoot unit (at right), a flower comprises lobed calyx, two stamens and an ovary on pedicel; Based on *Kato et al. TL-1402* (1A), *Wongprasert 771601* (1B). Scale bars = 1 mm.

Root creeping, monopodially branched, flattened-subcylindrical, 0.5-1 mm wide; **ramuli** on both flanks of root, 3-6 mm long, simple or to 5 times branched; **leaves** in 3 ranks, oblong-elliptic, univeined, middle leaf to 1 mm × 0.5 mm, lateral leaf to 1-2 mm × 0.5-0.8 mm. **Flowering shoots** 1-4 per shoot unit, associated with 4-5 ramuli to 5 mm long; pedicel with 2 bracts at base, 5-10 mm long; calyx membranaceous, 3-lobed 1/2 to base, 2/3-3/4 length of ovary; stamens 2, as long as ovary or shorter, *ca* 1.5 mm long; ovary obovoid-ellipsoid, *ca* 2 mm long, *ca* 1 mm thick, 3-locular; stigmas 3, separated from each other, cristate, 0.3 mm long; **capsule** stalked (stalk to 10 mm long), trigonous, ribs 9.

Other specimens examined: Southeastern Thailand. Chanthaburi Prov.: Klong Yai, Pong Nam Ron District, 150 m alt., 12°56' N, 102°28' E, st. Mar, *M. Kato et al. TL-1402* (BKF, TNS); fl.-buds Jan, *M. Kato et al. TL-1607* (BKF, TNS).

Ecology and distribution: On rocks in stream; vegetative plants submerged in the rainy season, and reproductive plants exposed in the air in the dry season; known only from the type locality.

Notes: Phylogenetically, this is a sister taxon to *T. malayana, T. brevis* and *T. minor*, and together, sister to the clade of *T. ubonensis* in eastern Thailand and *T. sessilis* in eastern central China (S. Koi, unpubl. result). This indicates that small morphological changes occurred in the diversification of *Terniopsis*: Thai species, in particular, *T. brevis*, *T. chanthaburiensis*, and *T. minor*, are little distinguished from the Chinese *T. sessilis* (Chao, 1980; Kato and Kita, 2003), but *T. chanthaburiensis* is distinct in the long pedicel. Also, *T. chanthaburiensis* is similar to *T. malayana* in the branched ramuli on the floriferous root, bud differs in having the long pedicel.

Terniopsis minor M. Kato & Koi, *sp. nov.*
A T. brevis *simile, sed radicibus latioribus, ramulis longioribus, ad 3.5 mm longis, stigmatibus linearis differt.* – **Holotypus**: Southeastern Thailand. Trat Prov., Klong Kaeo waterfall, Bo Phloi village, Bo Rai Distr., 12°37'29" N, 102°34'54" E, 170 m alt., fl. Jan 2007, *M. Kato, S. Koi, N. Katayama & T. Wongprasert TL-1609* (BKF, isotype, TNS). **Fig. 2.**

Root creeping, monopodially branched, flattened-subcylindrical, 0.7-1.5 mm wide; **ramuli** on both flanks of root, 4-7 mm long, simple; **leaves** in 3 ranks, oblong-elliptic, middle leaf to 1 mm × 0.3 mm, lateral leaf to 1.1 mm × 0.3 mm. **Flowering shoot** associated with single ramulus 1-3 mm long; pedicel with 2 bracts at base, 1.5-3 mm long; calyx membranaceous, 3-lobed 1/4 to base, as long as ovary; stamens 2, as long as ovary, 1-1.5 mm long; ovary obovoid-ellipsoid, 1-1.5 mm long, *ca* 0.7 mm thick, 3-locular; stigmas 3, separated from each other, linear-oblong, apex cristate, to 0.4 mm long; ovules *ca* 20 per locule; **capsule** stalked (stalk 2-3 mm long), trigonous, ribs 9.

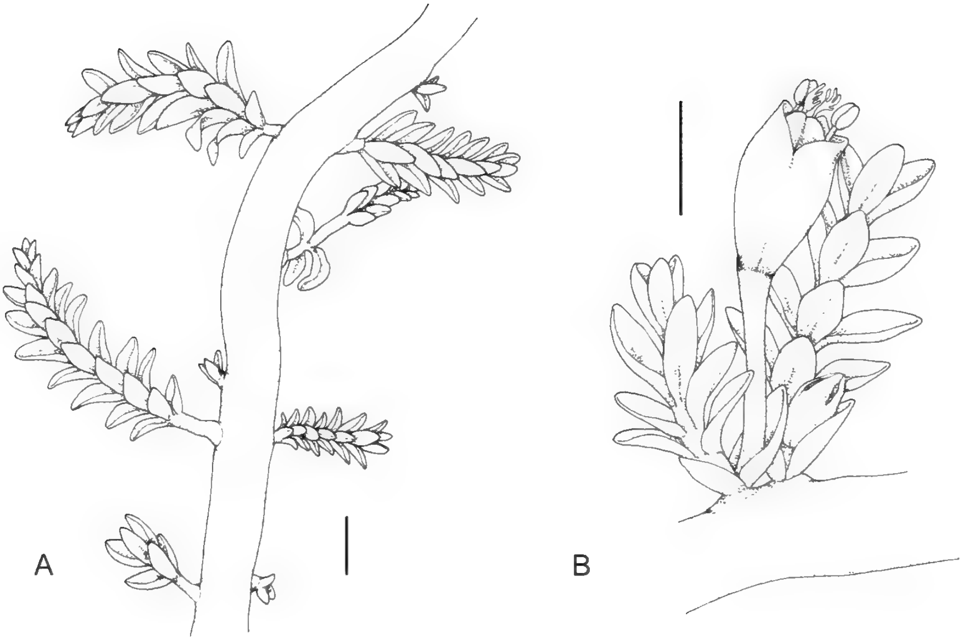

Figure 2. *Terniopsis minor*. A. Ramuli on flank of root; B. Two reproductive shoot units; left one with flower comprising lobed calyx, two stamens and ovary on pedicel; right one with flower bud. Based on *Kato et al. TL-1609*. Scale bars = 1 mm.

Other specimens examined: Nakhon Ratchasima Prov., Haew Narok Waterfall, Khao Yai National Park, 14°17' N, 101°24' E, 360 m, st. Dec, Jan, *Kato et al. TL-60, TL-309* (BKF, TNS); fl. Jan, *TL-1535* (BKF, TNS); st., fl. & fr. Jan, *R. Imaichi et al. TKF-25* (BKF, TNS). Chanthaburi Prov., Klong Yai, Pong Nam Ron District, 150 m alt., 12°56' N, 102°28' E, fl.-buds Jan, *M. Kato et al. TL-1608* (BKF, TNS). Trat Prov., Sato stream, Klong Sato, Bo Rai District, 12°42' N, 102°25' E, st., fl. & fr. Jan, *S. Koi et al. TKF-22* (BKF, TNS); Pong Nam Ron stream, Klong Yai, Pong Nam Ron District, 12°56' N, 102°28' E, st. Jan, *S. Koi et al. TKF-23* (BKF, TNS).

Ecology and distribution: On rocks in stream; vegetative plants submerged in the rainy season, and reproductive plants exposed in the air during the dry season; known only from the type locality and its vicinity.

Note: This species is phylogenetically sister to *T. brevis* and morphologically close to it also. However, it differs from *T. brevis* only in having wider roots, longer ramuli, and linear-oblong stigmas.

Polypleurum sisaketense M. Kato & Koi, *sp. nov.*
A congenris stigmatibus semiorbiculatis differt, P. wongprasertii, P. longifoliis, P. phuwuaensis *et* P. rubroradicans *floris sessilibus, bracteis filiformibus, basi vanigatis simile, sed a* P. wongprasertii *ovulis plura, a* P. *longifoliis foliis brevioribus, a* P. phuwuaensis *spathellis brevioribus, a* P. rubroradicans *ovuliis plura differt.* – **Holotypus:** Eastern Thailand. Si Sa Ket Prov., Phoolaor waterfall, Kantharalak Dist., 14°27'17" N, 104°39'21" E, 180 m alt., fl. Jan 2006, *M. Kato, S. Koi & T. Wongprasert TL-1502* (BKF; isotype, TNS). **Fig. 3.**

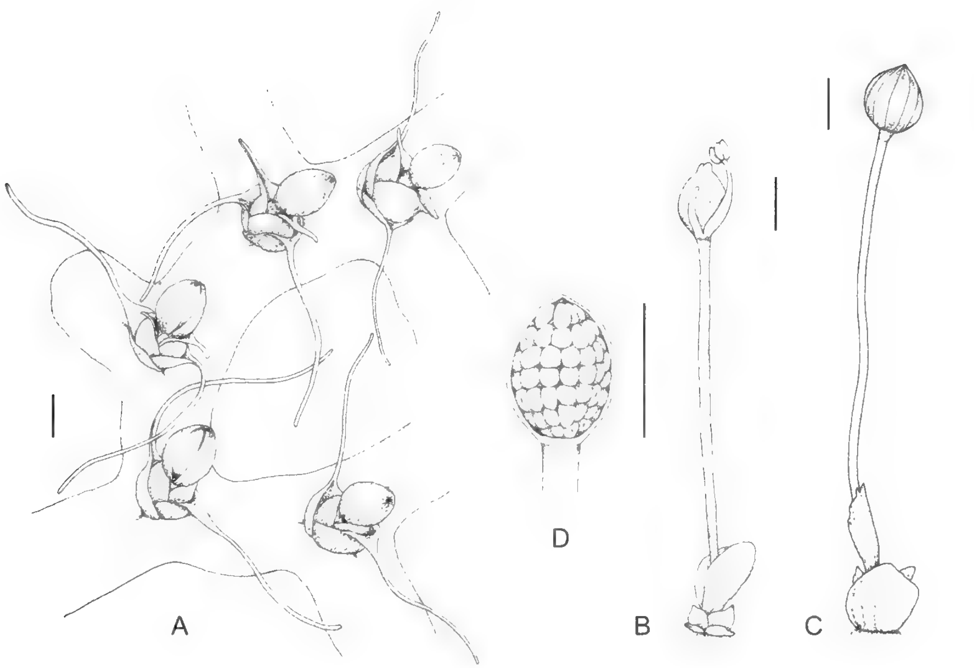

Figure 3. *Polypleurum sisaketense*. A. Flower buds enclosed by spathellas subtended by bracts at sinuses of root branches; two spathellas are rupturing; B. Flower comprising two tepals (one seen), one stamen and one ovary on pedicel with spathella and bracts at base; C. Fruit with spathella and bracts; D. Seeds in capsule with valve removed. All figures based on *Kato et al. TL-1502*. Scale bars = 1 mm.

Root ribbon-like, 2-3 mm wide, branched, with tufts of leaves on dorsal surface exclusively at sinuses between root branches; **leaves** 2-4 per tuft, 5-20 mm long, base sheath-like, scars forming mounds, distal part needle-like, relatively thick (*ca* 0.2 mm), caducous. **Flowering shoot** on dorsal surface at sinuses between root branches; bracts 2-4, sheath-like, papillate, needle-like with sheath-like base or ovate with needle-like part caducous; **flower** 1, bud covered by spathella, spathella 1.5-2 mm long, papillate, ruptured near apex and also split longitudinally at anthesis, ellipsoid, narrowed to base; pedicel 4-8 mm long; tepals 2, 1 on each side of stamen, *ca* 0.5 mm long; stamen 1, inserted at base of ovary, 1.5-1.8 mm long, as tall as ovary; ovary 2-locular, globose-ellipsoid, slightly flattened, 1-1.5 mm long; stigmas 2, hemicircular, flattened, 0.1-0.2 mm long and wide, subequal (stigma facing stamen larger); ovules covering entire septum surface, 40-70 per locule; **capsule** stalked (stalk 5-10 mm long), subsymmetric, ribs *ca* 12.

Ecology and distribution: On rocks near waterfall; vegetative plants submerged in the rainy season, and reproductive plants exposed in the air in dry season; known only from the type locality.

Notes: Although it is difficult to distinguish this species from other congeners in most characters, it differs mainly in having semicircular, flattened stigmas. Phylogenetically it forms a clade together with *P. longifolium*, *P. phuwuaense* and *P. erectum*, but the clade has no obvious sister clade (S. Koi, unpubl. data).

Polypleurum prachinburiense M. Kato & Koi, *sp. nov.*
A congenris alabastris globosis differt. – **Holotypus:** Southeastern Thailand. Prachingburi Prov., Kaeng Wung Sai, Kaeng Hin Phoeng waterfall, Na Dee Dist. Prachinburi Prov., 14°10' N, 101°43' E, 70 m alt., fl. & fr. Jan 2007, *M. Kato, S. Koi, C. Tsutsumi, N. Kitagawa & T. Wongprasert TL-1601-1* (BKF; isotype, TNS). **Fig. 4.**

Root ribbon-like, 2-4 mm wide, branched, with tufts of leaves on dorsal surface exclusively at sinuses between root branches; leaves 2-4 or more per tuft, 10-25 mm long, base sheath-like, ovate, papillate, distal part needle-like. **Flowering shoots** on dorsal surface at sinuses between root branches; **flower** buds, along with bracts, globose; bracts 2(-4), ovate, mucronate or rarely needle-like, papillate, thick; flower 1, bud covered by spathella, spathella papillate, 1-1.5 mm long, ruptured near apex at anthesis; pedicel 4-8 mm long; tepals 2, 1 on each side of stamen, 0.7-1 mm long; stamen 1, inserted above base of ovary, 1.5-2 mm long, slightly longer than ovary; ovary 2-locular, ellipsoid, slightly flattened, 1-1.5 mm long; stigmas 2, narrowly conical, pointed, 0.2-0.4 mm long, subequal; ovules covering all or most of septum surface, 15-20 per locule; **capsule** stalked (stalk 5-9 mm long), subsymmetric, ribs 12-14.

Other specimens examined: Southeastern Thailand. Prachingburi Prov., Takro waterfall, 35 m alt., 14°11' N, 101°36' E, fl. & fr. Mar, *M. Kato et al. TL-1404* (BKF, TNS); fl. Jan, *M. Kato et al. TL-1611, TL-1612* (BKF, TNS);

Figure 4. *Polypleurum prachinburiense*. A. Flower buds enclosed by spathellas subtended by bracts at sinuses of root branches; B. Flowers with spathellas and bracts at sinuses of root branches; a flower comprises two tepals (one seen), one stamen and one ovary on pedicel with spathella and bracts at base; C. Fruit with spathella and bracts; D. Seeds in capsule with valve removed. Based on *Imaichi et al. TIK-20* (4A) and *Kato et al. TL-1601-1* (4B-D). Scale bars = 1 mm.

Kaeng Hin Phoeng waterfall, Na Dee Dist., 14°10' N, 101°43' E, 70 m alt., fl. Jan, *M. Kato et al. TL-1534* (BKF, TNS); fl. & fr. Jan, *M. Kato et al. TL-1601-2, TL-1601-3, TL-1602, TL-1603, TL-1604* (BKF, TNS); fl. Jan, *R. Imaichi et al. TIK-20* (BKF, TNS).

Ecology and distribution: On rocks in stream; vegetative plants submerged in the rainy season, and reproductive plants exposed in the air in the dry season; known only from the type locality and its vicinity.

Notes: This species is characterized by the globose flower-buds with usually a single pair of mucronate bracts. In this character it differs from the most closely related *P. wongprasertii* whose bracts are attenuate at the apex. In the other characters it is most similar to *P. wongprasertii*. *P. prachinburiense* forms a clade together with *P. wongprasertii*, *P. ubonense*, *P. sisaketense*, *P. longifolium*, *P. phuwuaense* and *P. erectum*, but their inter specific relationship are not clean (S. Koi, unpubl. data).

Polypleurum insulare M. Kato & Koi, *sp. nov.*
A P. wallichio, P. schmidtiano *et* P. longistyloso *foliis et floribus supra radicibus ad omnem ramificatinem differt, a* P. wongprasertii *radicibus angustioribus, bracteis parvioribus, pedicellis brevioribus, ovariis parivioribus differt.* – **Holotypus:** Southeastern Thailand. Trat Prov., Khlong Phu waterfall, Ko Chang, 12°04'04" N, 102°18'53" E, 125 m alt., fl. & fr. Jan 2004, *M. Kato, S. Koi & T. Wongprasert TL-1512* (BKF, isotype, TNS). **Fig. 5.**

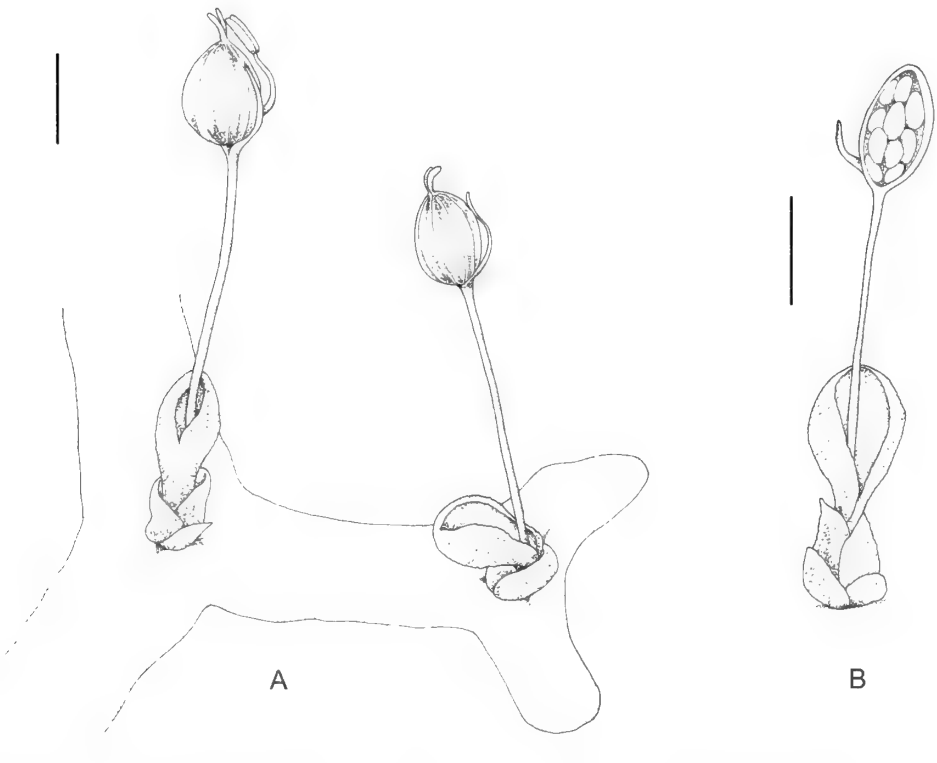

Figure 5. *Polypleurum insulare*; A. Flowers with spathellas and bracts at sinuses of root branches; a flower comprises two tepals (one seen), one stamen and one ovary on pedicel with spathella and bracts at base; B. Fruit with spathella and bracts. Based on *Kato et al. TL-1512*. Scale bars = 1 mm.

Root ribbon-like, 1-2 mm wide, branched, with tufts of leaves on dorsal surface exclusively at sinuses between root branches; **leaves** 3-5 per tuft, 5-15 mm long, base sheath-like, ovate, papillate, persistent, forming a mound around leaves, distal part needle-like, caducous. **Flowering shoot** on dorsal surface at sinuses between root branches; bracts 2-4, papillate, ovate, obtuse, small (to 0.7 mm long) or rarely with needle-like tips; **flower** 1, bud covered by spathella, spathella 1.5-2 mm long, papillate, appressed, ruptured near apex and also split longitudinally at anthesis; pedicel 2-3 mm long; tepals 2, 1 on each side of stamen, *ca* 1 mm long; stamen 1, *ca* 1 mm long, as tall as ovary; ovary 2-locular, ellipsoid, slightly flattened, *ca* 1 mm long; stigmas 2, linear, narrowed to apex, 0.2-0.3 mm long; ovules on septum surface except in central area, 10-12 per locule; **capsule** stalked (stalk 2.5-4 mm long), subsymmetric, ribs 8-12.

Other specimens examined: Southeastern Thailand. Trat Prov., Khlong Phu waterfall, Ko Chang, 12°04'04" N, 102°18'53" E, 90 m alt., st. Feb, *M. Kato et al. TL-1304* (BKF, TNS); Tharn Mayom waterfall, Ko Chang, 12°04'17" N, 102°20'57" E, 160 m alt., st. Jan, *M. Kato et al. TL-1521*(BKF, TNS); Tharn Mayom waterfall, Ko Chang, 12°04'17" N, 102°20'42" E, 235 m alt., st. Jan, *M. Kato et al. TL-1526* (BKF, TNS); Klong Phloo, Ko Chang, fr. Feb, *F. Konta & T. Wongprasert s.n.* (BKF, TNS); Ko Kut, 12°35' N, 101°31' E, *Charoenphol et al. 5115* (AAU, BKF, K).

Ecology and distribution: On rocks in streams; vegetative plants submerged in the rainy season, and reproductive plants exposed in the air during the dry season; known from Ko Chang and Ko Kut, the two offshore islands in southeastern end of Thailand.

Notes: Kato (2006) wrongly identified specimens (*F. Konta & T. Wongprasert s.n.*) from Ko Chang and *Charoenphol et al. 5115* from Ko Kut to be *P. wongprasertii*. *Charoenphol et al. 5115* was also wrongly identified as *P. schmidtianum* (Cusset, 1992). A comparison with new collections and a molecular phylogenetic result shows that plants of the islands are distinct from the continental species and are to be separated as a new species. In a phylogenetic tree, *P. insulare* is isolated from *P. wongprasertii* as equally as from *P. erectum*, *P. longifolium*, *P. phwuaense*, *P. prachinburiense* and *P. sisaketense*, and distant from *P. schmidtianum*. *Polypleurum insulare* differs from *P. wongprasertii* by its narrower roots, very short bracts, shorter pedicels, and smaller ovaries, and from those closely or distantly related species by the diagnostic characters shown in Key. There are now two species, *P. insulare* and *P. schmidtianum*, occurring on the small offshore islands in southeastern Thailand.

Zeylanidium lichenoides (Kurz) Engler
Nat. Pflanzenfam. 2nd ed. 18a (1930[1928]) 62; van Royen, Danks Bot. Arkiv 23 (1965) 165; Cusset, Adansonia 14 (1992) 31; Mathew & Satheesh, Aquat. Bot. 57 (1997) 265, f. 15, 16. – **Typus**. *Parish s.n.*, Martaban, Myanmar (CAL, not seen).

Roots ribbon-like, 1-2 mm wide, branched, with tufts of leaves or flowering shoots at sinuses of root branches; **leaves** linear, 20-30 mm long, ensiform, *ca* 5 per tuft in 2 files. **Flowering shoots** solitary, appressed; bracts 4-5 in 2 files, uniform but basal ones smaller, basal part ovate to ovate-lanceolate, 0.8-1.5 mm long, distal part linear, 5-7 mm long, caducous; each flower bud enclosed by spathella, spathellas ellipsoidal, 1.2-1.8 mm long, longitudinally split at anthesis, persistent: **flowers** erect; pedicels horizental at base, upright upwards, 1.2-1.5 mm long; tepals 2, one on each side of stamen, linear, 0.5-0.8 mm long; stamens 2 with flattened andropod, branched 1/3-1/4 from tip, 1.8-2.0 mm long, as long as pistil; anthers ellipsoidal, *ca* 0.5 mm long; ovaries single, sessile, unilocular, ellipsoidal, 1.2-1.8 mm long, *ca* 1.0 mm wide; stigmas 2, forked above or at base, equal, narrowly triangular, entire, *ca* 0.5 mm long; ovules 82-115 per ovary, born on whole flat placentas; **capsule** stalked (stalk 1.6-2.0 mm long), ellipsoidal, 1.5 mm long, *ca* 1.0 mm wide, 8-ribbed, dehiscing by 2 unequal valves.

Other specimens examined: Northern Thailand. Chiang Mai, Huay Kaew stream, Mae On, 600 m alt., 18°51.8' N, 99°18.0' E, st. fl.-buds, fl. & fr. Dec., *S. Koi & T. Wongprasert TK-02, TK-04, TK-05* (BKF, TNS); Huay Kaew stream, Mae On, 650 m alt., 18°52.9' N, 99°17.5' E, fl. & fr. Feb, *M. Kato et al. TL-1703, TL-1704* (BKF, TNS).

Ecology and distribution: On rocks in stream; sterile plants submerged and flowering and fruiting plants exposed; N Thailand, SE Myanmar, NE and S India.

Notes: This is the second report of *Zeylanidium* from Southeastern Asia, and northern Thailand is the eastern margin of distribution. It was recorded for the first time from Doi Suthep and Doi Inthanon, Chiang Mai, in northern Thailand (van Royen, 1965). But we have not collected the genus in these areas and did not examine specimens cited by van Royen. The identification here is based on our morphological observation and molecular data (S. Koi, unpubl. data).

Species identification is tentative, because we did not examine the type and authentic specimens, particularly from southeastern Myanmar and northeastern India. Comparison of Cusset's (1992) and Mathew and Satheesh's (1997) descriptions and our collection suggests that the Thai specimens may be referable to *Zeylanidium lichenoides*, but final identification requires detailed comparison. The species delimitation is another issue, because our preliminary phylogenetic data suggest a large molecular difference between Thai and southern Indian plants.

Hydrobryum phetchabunense M. Kato & Koi, *sp. nov.*
Hydrobryum loeicum *bracteis 2-4, spathellis irregulariter ruptis, stigmatibus linearibus, curvatis, acutissimibus, ovulis 5-8 in quoque loculo, capsulis 16-20-costatis simile, sed paginis radicibus circum folia annularibus, protrudentibus, pedicellis apicipus bracteis altioribus differt.* – **Holotypus:** Northeastern Thailand. Phetchabun Prov., Thadphramba waterfall, Nam Nao Natl. Park, 750 m alt., 16°45' N, 101°39' E, fl. & fr. Feb 2004, *M. Kato & T. Wongprasert TL-1102* (BKF; isotype, TNS). **Fig. 6.**

Root crustaceous, irregularly lobed, raised annually around tufts of patent leaves; leaves 1-4 per tuft, needle-like, terete, 2-3.5 mm long. **Flowering shoots** appressed, with **flower** solitary at tip; bracts uniform, 2-4, ovate, 1-1.5 mm long; spathella smooth-surfaced, irregularly ruptured near apex at anthesis; ovary-stalk (pedicel) 0.5-1.0 mm long, young one shorter; tepals 2, one on each side of stamen, linear, *ca* 1.5 mm long; stamens 2, branched below middle, 2-3.5 mm long, common andropod (filament) shorter than ovary; ovary 2-locular, ellipsoid, 1.5-2 mm long; stigmas 2, equal, *ca* 0.5 mm long, linear, pointed, curved; ovules on marginal surface of septum, 5-8 per locule; **capsule** stalked (stalk 1-1.5 mm long, higher than top of bracts), ellipsoid, flattened, ribs 16-20.

Other specimen examined: Northeastern Thailand. Phetchabun Prov., Thadphramba waterfall, Nam Nao Natl. Park, 750 m alt., 16°45' N, 101°39' E, fl. & fr. Jan, *S. Koi et al. TKF-01* (BKF, TNS).

Ecology and distribution: On rocks in stream; vegetative plants submerged in the rainy season, and reproductive plants exposed in the air in the dry season; known only in type locality.

Notes: The plant *TL-1102* was treated as *Hydrobryum loeicum* on the basis of its few and large ovules (4-8 per locule), many (16-20) ribs on the capsule, and linear, pointed stigmas (Kato, 2004). However, *H. phetchabunense* is distinguished from *H. loeicum* in the raised rings on the upper surface of root around the tufts of leaves, and the higher pedicels than the top level of the uppermost bracts. A molecular phylogenetic analysis shows that *H. petchabunense* is sister to the clade of *H. loeicum* and *Diplobryum*

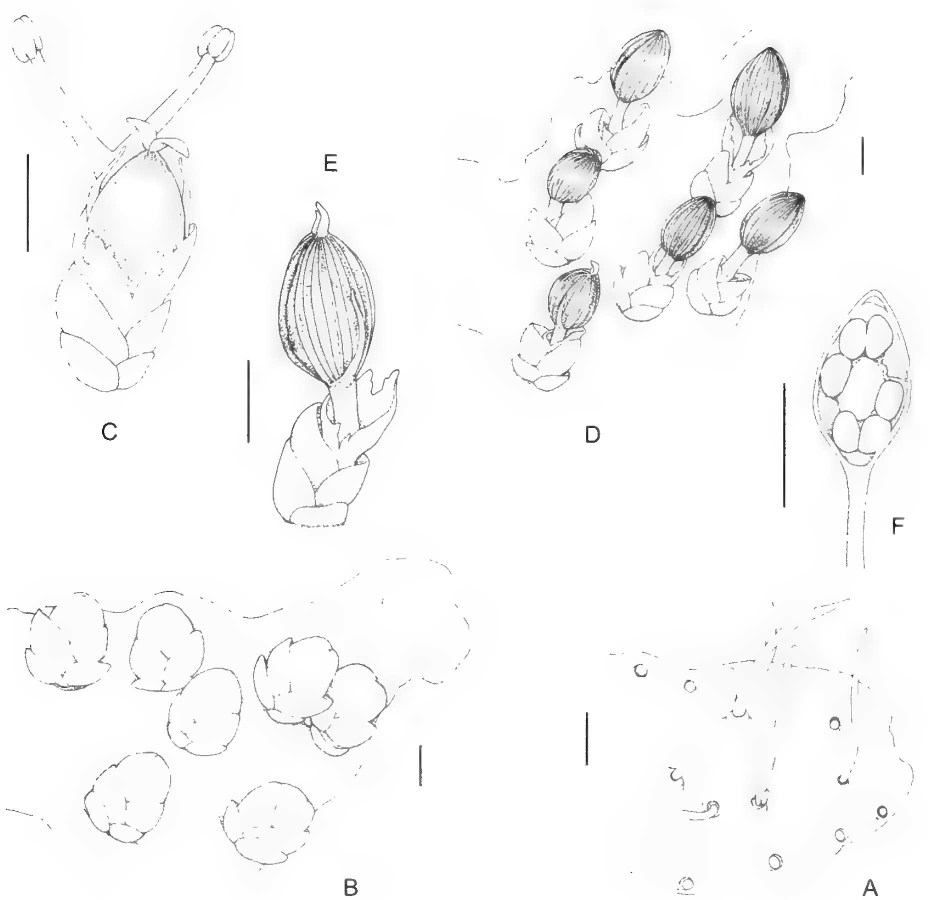

Figure 6. *Hydrobryum phetchabunense.* A. Leaves scattering on crustose root; B. Flower buds enclosed by spathellas subtended bracts appressed to crustose root; C. Flower comprising two tepals, two stamens with forked filament, and one ovary on short pedicel (not seen) subtended by spathella and bracts; D. Fruits with spathellas and bracts on crustose root; E. Fruit with spathella and bracts; F. Seeds (six on placenta) in capsule with valve removed. Based on *Kato & Wongprasert TL-1102.* Scale bars = 1 mm.

vientianense, but not very close to *H. loeicum* (S. Koi, unpubl. result). The three species are similar in having linear stigmas and up to 20 ribs on the capsule. However, in *H. phetchabunense*, like in *H. loeicum*, the spathella is smooth-surfaced (vs. papillate in *H. vientianense*), the stamens are shorter (vs. 4-5 mm), the ovules are fewer (vs. 9-27 per locule), and the stigmas are shorter (vs. 0.6-1 mm) (see also Key below). Thus, *H. phetchabunense* is similar to *H. loeicum*, although the latter is sister to *H. vientianense*.

Key to the species of Podostemaceae of Thailand

The key to all species of Podostemaceae of Thailand combines the results of studies of Kato (2004, 2006) and the present study.

1. Flowers 3-merous (perianth 3-lobed, stamens 2 or 3, ovary 3-locular, stigmas 3); leaves flattened, oblong or ovate, univeined .... Subfamily **Tristichoideae** (2)
1. Flowers 2-merous (tepals 2, filiform, stamens 1-2, ovary 1-2-locular, stigmas 2); leaves filiform or vertically flattened, not veined .... Subfamily **Podostemoideae** (12)

2. Root subcylindrical or ribbon-like; shoot subcylindrical, simple or ramified; cupule absent, flower bud instead embraced by bracts 3
2. Root absent; shoot crustose or rarely broadly ribbon-like, leafy on dorsal surface and at margin (not on ventral surface); flower bud covered by leafy cupule 9

3. Reproductive shoot-complex comprising 3 branches, middle vegetative, 2 laterals floriferous; flowering shoot 4-5 mm long with leaves below flower many, in 6 ranks, carinate .... ***Cussetia diversifolia***
3. Reproductive shoot-complex comprising 1-4 floriferous and 1-5 vegetative branches, not arranged in above mode; flowering shoot short with 2 or several bracts thick or membraneous, flat 4

4. Vegetative shoots to 5 cm long, many times branched, sparsely leafy, distal part comprising ramuli; bracts several .... Terniopsis ramosa
4. Vegetative shoots to 2 cm long, composed of ramuli with tristichous imbricate leaves, proximal part of shoot a few times branched; bra 5

5. Root 2-10 mm wide; ramuli 3-90 mm long; stamens 5-6 mm long; ovules 8-12 per locule .... ***Terniopsis ubonensis***
5. Root 0.2-1.5 mm wide; ramuli less than 20(-30) mm long; stamens 1-4 mm long; ovules more than 13 6

6. Pedicels 5-10 mm long .... ***Terniopsis chanthaburiensis***
6. Pedicels 1.5-4 mm long 7

7. Roots 0.2-1 mm wide; ramuli 2.2-3.5 mm long .... ***Terniopsis brevis***
7. Roots 0.7-4 mm wide; ramuli 3-20 mm long 8

8. Ramuli 4-7 mm long; stamens 1-1.5 mm long .... ***Terniopsis minor***

8. Ramuli 3-20 mm; stamens 2-4 mm long .... ***Terniopsis malayana***

9. Shoot 3-10 mm wide or wider; dorsal leaves arranged in branched longitudinal rows; pedicel 5-8 mm long, 2.5-4 times as long as ovary... 10
9. Shoot to 2.5 mm wide; dorsal leaves in 1-2 inconspicuous rows; pedicel 1.5-4 mm long, 1-2 times as long as ovary 11

10. Dorsal leaves dense, fimbriate; lateral leaves narrowly deltoid, to 1.5 mm long; ovules *ca* 30 per locule .... ***Dalzellia ubonensis***
10. Dorsal leaves sparse, separate; lateral leaves deltoid-lanceolate, to 2 mm long; ovules 50-60 per locule .... ***Dalzellia ranongensis***

11. Shoots 1.5-2.5 mm wide; pedicel 1.5-2 mm long, as long as ovary; ovules 50-60 per locule .... ***Dalzellia kailarsenii***
11. Shoots 1-1.5 mm wide; pedicel 2-7 mm long, longer than ovary (1.3-1.5 mm); ovules 30-50 per locule .... ***Dalzellia angustissima***

12. Roots subcylindrical or ribbon-like 13
12. Roots crustose 29

13. Bracts 3-4-lobed or digitate; capsules globose, smooth (or weakly striped) or ellipsoid, ribbed 14
13. Bracts simple; capsules ellipsoid, slightly flattened, 8-15-ribbed 17

14. Holdfasts present on ventral surface of root under tufts of leaves; tufts of leaves and flowering shoots borne on flank of root between successive root branches and at sinuses of root branches 15
14. Holdfast absent; tufts of leaves and flowering shoots only at sinuses of root branches; bracts 3-4-lobed or digitate 16

15. Bracts linear-oblong, with 2 small lateral basal lobes; capsules globose, smooth .... ***Paracladopus chiangmaiensis***
15. Bracts digitate; capsules ellipsoid, 12-14-ribbed .... ***Paracladopus chathaburiensis***

16. Bracts 3-4-lobed, lobes semicircular, thin, smooth ...... ***Cladopus taiensis***
16. Bracts digitate, segments finger-like, thick, papillate with silica .... ***Cladopus fallax***

17. Stamens 2; capsule-ribs 8 18
17. Stamen 1; capsule-ribs 8-15 20

18. Tufts of leaves and flowering shoots at sinuses between root branches; bracts ovate or ovate-lanceolate base, apex portion linear, caducous; capsule-valves unequal .... ***Zeylanidium lichenoides***
18. Tufts of leaves and flowering shoots on flanks of root between successive root branches; bracts lanceolate or ovate-lanceolate, apex obtuse or sometimes acute; capsule-valves equal .... ***Polypleurum wallichii*** (19)

19. Roots *ca* 5 mm wide; leaves to 5(-10) mm long; pedicels 5-8 mm long; ovary to 2.5 mm long .... **var. *wallichii***
19. Roots *ca* 3 mm wide; leaves to 2.5 mm long; pedicels to 2-4 mm long; ovary 1.2-1.5 mm long .... **var. *parvum***

20. Tufts of leaves borne between successive root branches; capsule-ribs 8-12 21
20. Tufts of leaves or shoots borne exclusively at sinuses of root branches; capsule-ribs 10-15 22

21. Roots 2-4 mm wide; pedicels 6-7 mm long; ovary protruding from spathella at anthesis, 2-locular; stigmas much shorter than ovary; capsule-ribs 8 .... ***Polypleurum schmidtianum***
21. Roots 1-1.5 mm wide; pedicels to 1 mm long; ovary mostly enclosed in spathella at anthesis, 1-locular; style plus stigmas as long as ovary or longer; capsule-ribs 10-12, inconspicuous .... ***Polypleurum longistylosum***

22. Shoots prominent with leaves exposed on elongate stems; flowers always or occasionally multiple per shoot 23
22. Shoots comprising tufts of leaves, lacking stems; leaf-bases embedded within root; flower always 1 per shoot 24

23. Roots 1-1.5 mm wide; shoots to 5 cm long, simple, erect; leaves 15-30 mm long; ovules 15-30 per locule .... ***Polypleurum erectum***
23. Roots 2.5-4 mm wide; shoots to 18 cm long, branched, bent at base and floating; leaves 30-70 mm long; ovules 50-70 per locule .... ***Polypleurum longicaule***

24. Bracts 4-6; pedicels 10-15 mm long; spathellas 4-6 mm long .... ***Polypleurum phuwuaense***
24. Bracts 2-4(-6); pedicels 2-8 mm long; spathellas 2-3 mm long 25

25. Complex of flower bud and bracts not globose; bracts usually obvious, attenuate at apex or attenuate tip caducous .... ***Polypleurum wongprasertii***

25. Complex of flower bud and bracts globose; bracts inconspicuous (ovate or elliptic), not attenuate to apex, basal bracts rarely attenuate 26

26. Roots 1-2 mm wide; stalk of capsule 2.5-4 mm long .... ***Polypleurum insulare***
26. Roots 2-3 mm wide; stalk of capsule 4-10 mm long 27

27. Stigmas semicircular; ovules 40-70 per locule ... ***Polypleurum sisaketense***
27. Stigmas narrowly conical, subdeltoid or deltoid-ovate; ovules 15-22 per locule 28

28. Leaves 20-40 mm long; stigmas subdeltoid or deltoid-ovate .... ***Polypleurum longifolium***
28. Leaves 10-25 mm long; stigmas narrowly conical, pointed .... ***Polypleurum prachinburiense***

29. Flowering shoots erect; bracts in 4 ranks, dimorphic, ventral (facing root) bilobed, dorsal simple 30
29. Flowering shoots appressed or oblique or only flowers erect; bracts in 2 ranks, uniform, simple or trilobed 31

30. Capsules 2-2.5 mm long, ribs 12-16 .... ***Hanseniella heterophylla***
30. Capsules 1.5-2 mm long, ribs 8 .... ***Hanseniella smitinandii***

31. Bracts trilobed with middle lobe much longer than lateral lobes .... ***Thawatchaia trilobata***
31. Bracts simple with tips obtuse or sometimes acute or acuminate 32

32. Stamens 2 with forked filament 33
32. Stamen 1 with simple filament 42

33. Bracts linear-lanceolate, acuminate; stigmas unequal 34
33. Bracts deltoid, elliptic or ovate, obtuse or acute; stigmas equal or subequal 35

34. Roots (crusts) *ca* 0.5 mm thick, not markedly raised around tufts of leaves; bracts 2-3; stigmas unequal, forked below middle .... ***Hydrobryum bifoliatum***
34. Roots (crusts) to *ca* 1 mm thick, prominently raised around tufts of leaves; bracts 4-6; stigmas markedly unequal, forked above middle .... ***Hydrobryum kaengsophense***

35. Leaves oblique or appressed, tough; bracts deltoid, acute at apex; stigmas subequal .... ***Hydrobryum tardhuangense***
35. Leaves patent, soft (but tough in *H. khaoyaiense*); bracts ovate or elliptic, obtuse at apex; stigmas equal 36

36. Stigmas obovate, cristate .... ***Hydrobryum griffithii***
36. Stigmas linear or oblong, entire 37

37. Spathella papillate 38
37. Spathella smooth 40

38. Ovary 1-locular .... ***Hydrobryum somranii***
38. Ovary 2-locular 39

39. Ovules 4-8 per locule .... ***Hydrobryum loeicum***
39. Ovules 8-28 per locule .... ***Hydrobryum vientianense***

40. Ribs on capsule 16-20 .... ***Hydrobryum phetchabunense***
40. Ribs on capsule 12-14 41

41. Stigmas subentire, oblong or narrowly deltoid-lanceolate, emarginated, truncate, or obtuse at tip; ovules 12-20 on septum surface except in small lower central area; leaves 10-20 mm long .... ***Hydrobryum chiangmaiense***
41. Stigmas entire, linear, pointed at tip; ovules 11-15 on marginal surface of septum; leaves to 3 mm long .... ***Hydrobryum japonicum***

42. Ovary 2-locular; placentation axile; leaves somewhat tough .... ***Hydrobryum khaoyaiense***
42. Ovary 1-locular; placentation pseudo-central; leaves soft .... ***Hydrobryum micrantherum*** (43)

43. Roots (crusts) 0.1-0.2 mm thick; bracts 2-4; ovary *ca* 1.5 mm long; ovules 9-13 per placenta .... **var. *micrantherum***
43. Roots (crusts) 0.2-0.3 mm thick; bracts 3-5; ovary 1.5-2 mm long; ovules 13-23 per placenta .... **var. *crassum***

Acknowledgments

We thank T. Santisuk, T. Wongprasert, S. Suddee, H. Akiyama, R. Fujinami, R. Imaichi, N. Katayama, Y. Kita, and C. Tsutsumi for their help in the field studies, and curators of the Herbaria, Aarhus University (AAU), Royal

Forest Department (BKF), Bangkok, and Royal Botanic Gardens (K), Kew for helping me examine specimens. Plant illustrations were drawn by M. Kinoshita. This study was supported by a Grant-in-Aid for Scientific Study from the Japan Society for the Promotion of Science.

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Three New Species of Gesneriaceae from Kelantan, Malaysia

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Abstract

During a botanical expedition in 2007 to the Gunung Tera area in Kelantan, NE Peninsular Malaysia, three new species of Gesneriaceae were discovered: *Henckelia kelantanensis* Kiew, *H. pauziana* Kiew, and *Ridleyandra kelantanensis* Kiew.

Introduction

A botanical expedition to the little known Gunung Tera area in Kelantan, the northeastern state of Peninsular Malaysia, was organised in February 2007 as part of the Flora of Peninsular Malaysia Project. The area lies within the Stong State Forest Park and includes several small peaks of which the highest is Gunung Tera (5°21'N 101°54'E) at 1556 m. The terrain is dissected by steep-sided valleys with torrential rocky streams. Granite cliff faces are common in the area. During the expedition 332 species of vascular plants were collected, of which 21% were species endemic to Peninsular Malaysia and 16% were new records for the state of Kelantan (Chew *et al.*, 2009). Gesneriaceae was well represented with 16 species, only Orchidaceae (29 species), Rubiaceae (27 species), Gramineae (22 species) and Zingiberaceae (17 species) were more speciose. Three species of Gesneriaceae proved new to science and are described below.

1. ***Henckelia kelantanensis*** Kiew, *sp. nov.*
Ab Henckelia nivea *(Kiew) A. Weber floribus majoribus (30 mm longis et distaliter 15 mm latis nec 21 mm longis et 5 mm latis), paucinervis (paribus 17-18 nec 20-31) et capsulis longioribus (5-8 cm nec 2-3.5 cm longis) differt.* – **Typus:** Peninsular Malaysia, Kelantan, Gunung Stong, 18 May 1988, *Kiew RK 2736* (holotype, SING; isotype, KEP).

Herb, unbranched or sometimes with a short branch. **Indumentum** of uniseriate, multicelluar, eglandular hairs, on the young stem and lower lamina surface and on veins dense and *ca* 1 mm long, on upper lamina surface and calyx *ca* 0.5 mm long; uniseriate, multicelluar, glandular hairs on the pedicels dense and *ca* 0.5 mm long, on the outside of the corolla sparse and *ca* 0.5 mm long, and on the ovary and capsule dense and *ca* 0.5 mm long. **Stem** woody, 30-50 cm tall, 3-4 mm diam. **Leaves** alternate, internodes 1-1.5 cm long, lamina softly hairy, pale beneath, narrowly lanceolate or slightly oblanceolate, 12-15.75 × 2.75-4 cm, base narrowed ultimately to a narrow deeply serrate wing or sometimes with a petiole *ca* 6-8 mm long, margin finely serrate, apex narrowly acute, lateral veins 17-18 pairs. **Flowers** epiphyllous, solitary or in a series of 1-3 flowers, on the midrib and displaced 1-4 mm from the leaf axil; pedicels 5.5-7.75 mm long; calyx divided almost to base, lobes 5, narrowly acute, 2.5-3 mm long; corolla white with 2 yellow nectar guides in the throat, gibbous, *ca* 3 cm long, base narrowly tubular *ca* 1.5 cm long and *ca* 2 mm wide, distal *ca* 1.5 cm dilating to *ca* 1 cm wide across the mouth, lobes 5, rounded, upper two erect, *ca* 7 mm diam., lower 3 spreading, 7-8 × 7-9 mm; ovary purple, slender, narrowing towards the stigma, *ca* 2.5 cm long, stigma peltate, discoid, *ca* 1 mm diam. **Capsules** slender, curved downwards, 5-8 cm long, 1.5 mm thick.

Habitat: Hill dipterocarp forest, 740-800 m altitude, very common on banks, slopes and the base of granite rock faces.

Additional specimen examined: Kelantan, Gunung Stong Tengah Forest Reserve, Batu Hampar, *Yao et al. FRI 55768* (KEP).

Distribution: Endemic in Peninsular Malaysia, known only from the Gunung Stong area in Kelantan.

Notes: Henckelia kelantanensis belongs to a group of species [*H. corneri* (Kiew) A.Weber, *H. lilacina* (Ridl.) A.Weber and *H. nivea* (Kiew) A.Weber] that have soft, distantly spaced, alternate leaves and epiphyllous flowers. Among these, it most resembles *H. nivea* in its large, gibbous, white corolla. However, it is distinct from this species in its larger flowers (21 mm long and 5 mm wide in *H. nivea*), fewer-veined leaves (20-31 pairs in *H. nivea*) and longer capsules (2-3.5 cm long in *H. nivea*).

2. ***Henckelia pauziana*** Kiew, *sp. nov.*
Ab Henckelia craspedodroma *(Kiew) A. Weber foliis paucinervis (paribus 21-29 nec 39-51) et floribus infundibularibus majoribus 25-30 mm longis orificio, 10-15 mm lato (nec tubularibus, ca 12 mm longis orificio, ca 5 mm lato) differt.* –**Typus:** Kelantan, Stong Tengah Forest Reserve, Batu Hampar to Cobra Camp (5° 20.03'N, 101° 55.14'E), 8 Feb 2007, *Chew et al. FRI 53513* [holotype, KEP (flower); isotypes KEP (fruits), K, L, SAN, SING]. **Fig. 1.**

Figure 1. [illegible]

Erect unbranched **herb**. **Indumentum** of dense, pearly, silky, uniseriate hairs, to 1.5 mm long on the upper portion of the stem, on petioles, midrib above and beneath and on lower surface of veins; of dense, white, stalked glandular hairs, c. 0.2–0.3 mm long on peduncles and calyx; with short and dense hairs on the ovary, persisting on the capsule. **Stem** woody, 2–12 cm tall, 2–3 mm diam. **Leaves** in a tuft at the top of the stem, lamina glabrous above, slightly bullate, in life dark green and glossy above, beneath white with scintillating hairs, narrowly oblanceolate, 7.5–11.5 × 1.75–3 cm, base narrowed into a narrow, deeply serrate wing, margin serrate, glabrous, teeth 3–4 × 2–3 mm, sometimes slightly falcate, apex acute, midrib and lateral veins impressed above, lateral veins 21–24 pairs, parallel to each other, curving towards the margin to between the teeth, prominent beneath; young leaves sessile, petioles lengthening to 2.5 cm long in the older lower leaves. **Inflorescences** 1-flowered, axillary; **flowers** pendent; peduncles, pedicels, bracts and calyx maroon; peduncles 3.5–4 cm long; bract pair linear-lanceolate, c. 4 × 2.5 mm, margin wavy, apex acute; pedicels 2–4 mm long; calyx divided to base, slightly hispid, lobes 5, narrowly lanceolate, 2.5–4 × 0.4–0.7 mm, tip acute; corolla funnel-shaped, white tinged pale lilac, lobes deeper pale lilac, throat with 2 conspicuous yellow nectar guides, 2.5-3 cm long, basal 0.7-1 cm narrowly tubular and *c.* 2 mm wide, above dilating to 1-1.5 cm wide, lobes 5, upper two erect, rounded, *ca* 6-7 mm diam., lower 3 spreading, broadly oblong with a rounded apex, *ca* 6-8 × 5 mm; nectary forming a broad ring around the base of the ovary, *ca* 0.5 mm high; ovary slender, to 15 mm long, style thread-like 8-10 mm long, stigma peltate, *ca* 0.5 mm diam. **Capsules** slender, straight, 3-5 cm long, *ca* 1 mm thick.

Habitat: Upper hill dipterocarp forest at *ca* 895 m altitude, locally common, on a steep slope with accumulation of leaf litter.

Distribution: Endemic in Peninsular Malaysia, known only from the type locality.

Notes: Henckelia pauziana resembles *H. craspedodroma* (Kiew) A.Weber in its foliage with short petioles and relatively narrow, glossy laminas with parallel, deeply impressed lateral veins that end between the teeth of the serrate margin and dense shaggy hairs along the upper surface of the midrib. However, it is distinct from this species by a combination of characters shown in Table 1.

Table 1. Differences between *Henckelia pauziana* and *H. craspedodroma*

Character	*Henckelia pauziana*	*Henckelia craspedodroma*
Stem ht (cm)	to 12	to 100
Lateral veins (pairs)	21-29	39-51
Teeth (mm)	3-4 x 2-3	1-2 x 2-4
Bract shape	foliose	ligulate
length (mm)	6-8	3-3.5
No. flowers	1	1-several
Corolla shape	funnel-shaped	tubular
colour	pale lilac	pale violet cream
length (mm)	25-30	*ca* 12
width at mouth (mm)	10-15	*ca* 5

This species is named in honour of Pauzi Husin, eco-guide whose intimate knowledge of the Stong State Forest Park led to the discovery of several new species, including this one.

3. **Ridleyandra kelantanensis** Kiew, *sp. nov.*
Ab Ridleyandra longisepala *(Ridl.) A.Weber laminis foliorum brevioribus*

usque 14 x 4.5 cm (nec 15-30 x 4-7 cm), pedunculis usque 7 cm longis (nec 8-12 cm), sepalis usque 5 mm longis (nec 10-15 mm) et corollis ca 3 cm longis (nec usque 5 cm) differt. – **Typus:** Malaysia, Kelantan, Stong Tengah Forest Reserve, path to Camp Cobra (5° 20.07'N, 101° 55.16'E), 8 Feb 2007, *Chew et al. FRI 53518* (holotype, KEP; iso E, L). **Fig. 2.**

Figure 2. *Ridleyandra kelantanensis* Kiew, Gesneriaceae (photo: Chew M.-Y.).

Unbranched **herb**. **Stem** woody, becoming decumbent, erect portion 15-19(-30) cm tall, *ca* 4 mm diam. **Indumentum** of reddish brown, dense, uniseriate, multicellular hairs, *ca* 0.5 mm long, dense and hispid on upper portion of stem, petioles, lower surface of midrib, peduncles, pedicels and sepals. **Leaves** in pairs, clustered in a rosette at the top of the stem, above up to 3-4 mm apart, below to 4.5 cm apart; petioles 1-1.75 cm long; lamina mid-green above, slightly paler beneath, glabrous, slightly bullate, oblanceolate, 8.5-14 × 3-4.5 cm, narrowed to base, margin dentate, teeth falcate, 4-5 × 3-5 mm and 2-6 mm apart, apex acute; midrib and veins slightly impressed above, prominent beneath, lateral veins 14-20 pairs. **Flowers** solitary; peduncles, pedicels and sepals maroon and covered in fine white hairs, peduncles 4.75-7 cm long; bract pair broadly lanceolate, 2-3 × 1-1.5 mm, pedicels (4-) 7-8 mm; sepals free, lanceolate, *ca* 5 × 3 mm, tip acute; corolla funnel-shaped, tube *ca* 2 cm long, *ca* 4 mm wide at base, dilating to 10-12 mm wide at the mouth, upper lobes deep blue and recurved, rounded, *ca* 10-11 × 9-10 mm, lower lobes white with 3 major and a few minor blue stripes, oblong, 8-12 x 9-10 mm, apex rounded; stamens 4 in 2 pairs; ovary 1.75-2 cm long, stigma slightly bilobed, 2 mm across. **Capsules** slightly curved downwards, glabrous, 4-4.5 cm long, *ca* 1.5 mm thick; sepals caducous.

Habitat: Locally common in upper hill dipterocarp forest on steep banks with peaty soil at 900-1000 m altitude.

Distribution: Endemic in Peninsular Malaysia, Kelantan, known only from the type collections.

Notes: In flower colour and pattern it resembles *Ridleyandra longisepala* (Ridl.) A.Weber but it differs in its overall smaller size: *R. longisepala* grows to 1 m tall, has laminae 15-30 x 4-7 cm long, peduncles 8-12 cm long, sepals 10-15 mm long and a corolla *ca* 5 cm long. It is also different in its leaf margin (*R. longisepala* has a margin that is doubly serrate) and in the presence of a distinct pedicel (absent in *R. longisepala*). Weber (1998, '1997') used this last as a key character in separating *Ridleyandra* species, that is, whether the bracts were immediately below the sepals (pedicel not discernable) or were some distant below the sepals (i.e., the flower has a distinct pedicel).

The resemblance of the corolla markings to those of *Ridleyandra longisepala* is remarkable. Weber has drawn attention to several unrelated species of *Ridleyandra* having the same corolla coloration, namely deep purple with an almost black throat, and suggested that this be due to having the same pollinator. This is likely to be the case with *Ridleyandra kelantanensis* and *R. longisepala* although, as in the case of all *Ridleyandra* species, the pollinators remain unknown.

The two species also have different habitats and distributions: *Ridleyandra longisepala*, is known only from the Main Range at Cameron Highlands, Pahang, and grows in upper montane forest at 1700 m, whereas *R. kelantanensis* grows in upper hill dipterocarp forest to 1000 m.

Acknowledgements

The expedition was funded by the Ministry of Science, Technology and Innovation under the Flora of Peninsular Malaysia Project No. 01-04-01-000 Khas at Forest Research Institute Malaysia (FRIM). The author is indebted to the State Forestry Department of Kelantan for permission to make botanical collections; to the FRIM expedition team (Kamarudin Saleh, Chew M.-Y., Yao T.L., Mustafa Data and Angan Atan) and to Pauzi Husin and the Baha Adventure Team whose help in the field contributed in large measure to the success of the expedition; to the curators of the herbaria of the Royal Botanic Gardens at Edinburgh and Kew, and the Singapore Botanic Gardens, for permission to examine specimens in their care; and to Chew M.Y. for photographing the new species under difficult field conditions and to M.J.E. Coode for correcting the botanical Latin.

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A Review of the Genus *Plocoglottis* (Orchidaceae) in Thailand

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Abstract

A review of the genus *Plocoglottis* in Thailand is presented. Five species are recognised. Four of them, *P. javanica*, *P. lowii*, *P. quadrifolia* and *P. gigantea*, are widespread in Malesia and have their northernmost limit of distribution in Peninsular Thailand, and *P. javanica* is also known in Vietnam. The fifth, *P. bokorensis* is also found in Cambodia, Laos and Vietnam and is in Thailand known from a few widely scattered localities in the central, eastern, southeastern, southwestern and northern regions.

Introduction

Plocoglottis Blume is a terrestrial orchid genus of 40 to 45 species and is centred in Malesia, ranging from the Andaman Islands, southern Myanmar, Thailand, Cambodia and Vietnam eastwards as far as New Guinea, Bismarck Archipelago and the Solomon Islands. Plants of this genus are found in lowland, hill and lower montane forest up to about 1200 m. Based on all of the available evidence (including morphological, anatomical and molecular data) the genus was placed in tribe Collabieae of subfamily Epidendroideae, although it was pointed out that further studies on this tribe are needed (Pridgeon *et al.*, 2005: 116).

Plocoglottis is represented in Thailand by five uncommon species. In the first detailed treatment of the orchids of Thailand [see Seidenfaden and Smitinand 1959-1965: The Orchids of Thailand - A Preliminary List], only two species were listed, namely *P. javanica* Blume and *P. quadrifolia* J.J. Sm. (incorrectly identified as *Phaius longipes* (Hook.f.) Holttum). In the years following this initial publication a further three species were added, and in a brief overview of the Thai species of the genus (Seidenfaden, 1972), all five species that are currently accepted were already listed.

A detailed review of the older literature and a discussion of the taxonomic history of all of the species is provided in a later detailed treatment (Seidenfaden, 1986). Though invaluable to the professional botanist as well as the orchid-enthusiast, Seidenfaden's contributions did not include taxonomic descriptions which are provided in the present review.

Four of the Thai species, *P. javanica, P. lowii* Rchb. f., *P. quadrifolia* and *P. gigantea* (Hook. f.) J.J. Sm. are widespread in the western part of Malesia (with *P. lowii* even ranging further eastwards to New Guinea in eastern Malesia), and have the northernmost limit of their distribution area in Peninsular Thailand and Vietnam (*P. javanica* only). The distribution area of the fifth Thai species, *P. bokorensis* (Gagnep.) Seidenf., is very different. This species is only found in Thailand and Indochina, and while widespread (but widely scattered) in the northern half of Thailand it does not seem to occur in the Peninsula of Thailand.

The plants of the genus *Plocoglottis* are sympodial herbs with or without pseudobulbs, and arise from short creeping rhizomes. Two different plant habits can be distinguished. In *P. javanica* and *P. lowii* the plants have narrowly-fusiform pseudobulbs with one apical leaf (rarely two), while the other species have elongate reed-like stems with several leaves. The erect or spreading leaves are generally plicate and have often long petioles. Inflorescences are lateral and arise at the base of the leafy stem. They are usually as long as to clearly longer than the leafy shoot. The medium-sized flowers have free sepals and petals, and a fleshy lip with an interesting explosive mechanism. This lip is united with the gynostemium base by two elastic flanges and snaps upwards when touched.

The present review is a precursory paper for a later contribution to the Flora of Thailand. No attempt has been made to provide a complete monographic treatment as very little material from outside of Thailand has been seen.

Key to *Plocoglottis* in Thailand

1. Plant with one leaf (rarely two leaves) on top of a narrowly-fusiform pseudobulb 2
1. Stems reed-like with four or more leaves 3

2. Petioles mostly 20–40 cm long. Side- margins of the lip entire .... 1. ***P. javanica***
2. Petioles shorter. Lip side margins erose-serrate, two conical calli near the lip front margin .... 2. ***P. lowii***

3. Lip side margins fimbriate or erose .... 3. ***P. quadrifolia***
3. Lip side margins entire 4

4. Stems up to 1 m tall, without pseudobulbs. Sides of lip much recurved, lip broadest near the middle .... 4. ***P. gigantea***

4. Stems up to 50 cm tall, with prominent bottle-shaped basal pseudobulbs to 8 cm tall. Sides of lip not much recurved, lip broadest near the apex .... 5. ***P. bokorensis***

1. ***Plocoglottis javanica*** Blume

Bijdr. (1825) 381; Seidenfaden & Smitinand, Orch. Thailand (1961) 348; Seidenfaden, Bot. Tidsskr. 67 (1972) 108; Opera Bot. 89 (1986) 69; Seidenfaden & Wood, Orch. Penins. Malaysia & Singapore (1992) 181; Comber, Orch. Java (1990) 104; Orch. Sumatra (2001) 292. -**Types**: Indonesia, Java, Seribu, *Blume* s.n. (syn, L); Indonesia, Java, Mt. Salak, *Blume* s.n. (syn, L). **Fig. 1**.

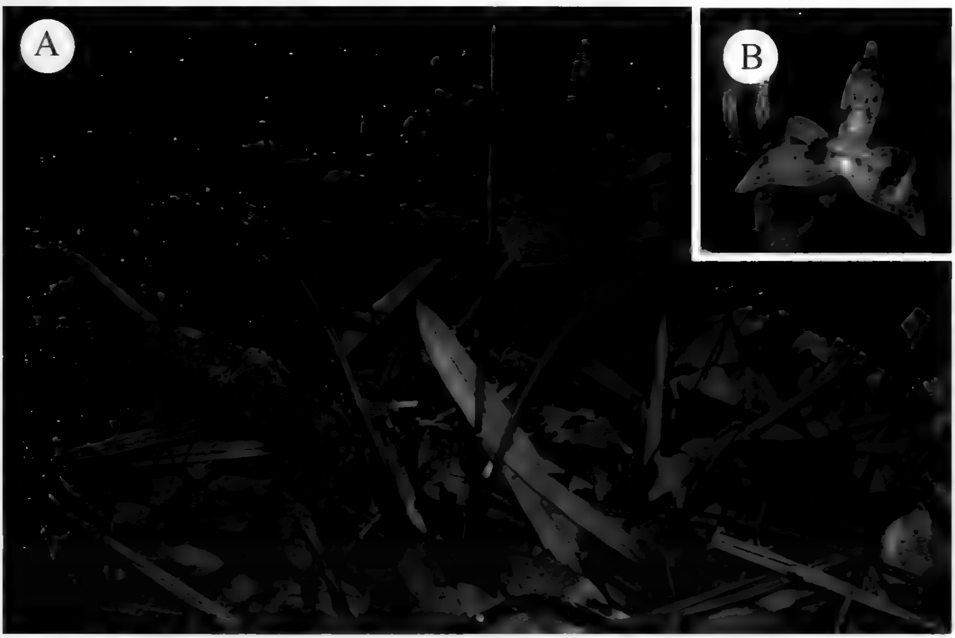

Figure 1. *Plocoglottis javanica* Blume with solitary leaf (photo taken in Singapore). A. Plant; B. Flower. Photo: H. Kurzweil (HK 2774 voucher in SING).

Terrestrial **herbs**, evergreen, pseudobulbous. **Pseudobulbs** narrowly conical, terete, 4-10(-12) × 0.5-1 cm, *ca* 4 cm apart on a creeping rhizome to 1 cm thick, enclosed by fibrous leaf sheaths. **Leaf** 1, on the apex of the pseudobulb, elliptic-lanceolate, acute or acuminate, 46-61 × 6.8-9.4(-11.1) cm, plicate, glabrous; with petioles (13.5-)20-40 cm long. **Inflorescences** 46-70(-81) cm long, arising from the base of the leafy shoot, usually extending beyond the leaves, glabrous below, pubescent or rarely glabrous above; peduncles to 50 cm long; sterile bracts 3-5, lanceolate-oblong, tubular, acute, 1.5-3 cm long, subglabrous, two or three of them clustered at the stem base and the rest scattered higher up; raceme lax or semi-dense, 10- to 15-flowered; rachis gradually elongating to 30 cm long; floral bracts ovate-lanceolate, acute, much shorter than the pedicel plus the ovary, 6.5-10 × 2-2.3 mm. **Flowers** to 17 mm broad; yellow, blotched reddish, also reported as brown, lip largely yellow. Pedicel plus ovary ca 15 mm long, glabrous or pubescent. Sepals ovate-lanceolate, shortly acuminate, spreading, concave; median sepal 5-veined, 10-15 × 4-6 mm; lateral sepals 7-veined, 13-15 × 2-5 mm. Petals linear-falcate, acute, 5-veined, 10-15 × 2.2-2.9 mm, spreading, their tips curved forwards. Lip ovate-lanceolate, shallowly 3-lobed in the apical part, 8-9 × 7-8 mm, basally joined with the gynostemium, margins entire; midlobe an acute tip 0.5-2.5 mm long; side-lobes flabellate, obtuse, *ca* 2 × 3.5 mm. Gynostemium straight, stout, 5.5-6.2 mm long, apically broadly winged, stigma cavity large.

Specimens examined: Peninsular Thailand, Pattani Province, Kao Kalakiri, *Kerr 0554* (K [fragment]); ibid., Songkhla Province, Klawng Pi, *Kerr 0614* (BK, C, K); ibid., Yala Province, Betong, *Maknoi 130* (QBG).

Illustrations: Seidenfaden (1986): fig. 34a-d; Seidenfaden & Wood (1992): fig. 78a; Comber (1990): pl. on page 104; Comber (2001): pl. on page 292; Pridgeon *et al.* (2005): pl. 45.

Habitat and flowering time: Rare in evergreen forest up to about 700 m. Flowering in April and from July to August.

Distribution: Peninsular Thailand (3 collections seen); also in Vietnam, the Andaman Islands, Malaya, Java, Sumatra and Borneo.

Notes: This species is similar to the much more common *Plocoglottis lowii*. Differentiating characters of the two species are the lip side margins which are entire in *P. javanica* but erose or fimbriate in *P. lowii*. The length of the petiole of the leaves can in most cases also be used to distinguish between the two species as *P. javanica* has usually an elongate petiole of (13.5-)20-40 cm while the leaf petiole of *P. lowii* is usually much shorter (up to 14 cm). Also the hairiness of the rachis has been used to differentiate between the two species (Seidenfaden, 1986: 69), but was here found not to be very significant as a few exceptions occur.

2. ***Plocoglottis lowii*** Rchb.f.
Gard. Chron. (1865) 434; Seidenfaden, Bot. Tidsskr. 67 (1972) 109; Opera Bot. 89 (1986) 70; Seidenfaden & Wood, Orch. Penins. Malaysia & Singapore (1992) 181; Comber, Orch. Sumatra (2001) 292; Beaman & al., Orch. Sarawak (2001) 383. – **Type:** Borneo, without locality, *Low* s.n. (W).

-*Plocoglottis porphyrophylla* Ridl., Trans. Linn. Soc. London, Bot. 3 (1893) 368. -Type: Peninsular Malaysia, Pahang, Pekan, *Ridley 394* (holo, SING!).

Terrestrial **herbs**, evergreen, pseudobulbous. **Pseudobulbs** narrowly conical, green to dark violet, 5-8(-15) × 1.1-1.5(-2) cm, *ca* 3 cm apart on a creeping rhizome; enclosed by fibrous leaf sheaths. **Leaves** 1(-2)(-3?, see 'Notes' below), on the apex of the pseudobulb, elliptic-lanceolate, acute, 30-59 × 4.5-12 cm, plicate, glabrous, green or purple above, purple underneath; petioles (3-)6-14 cm long. **Inflorescences** 62-121 cm long, arising from the base of the leafy shoot, much taller than the leaves, pubescent, violet, once here observed with a side-branch; peduncles 48-84 cm long; sterile bracts 5-8, scattered along the flowering stem and a few clustered at its base, lanceolate-oblong, lower tubular, upper spreading, acute, (1.2-)1.6-4.5 cm long, glabrous or pubescent; raceme lax, 20- to 30-flowered, producing flowers for many weeks with 1-2 open at a time; rachis 14-36.5 cm long; floral bracts ovate-lanceolate, acuminate, green-violet, 6-11.7 × 1.8-6 mm, much shorter than the pedicel plus the ovary, pubescent. **Flowers** to 30 mm in diameter; yellowish and greenish, with red or brown lines and blotches, bulging area on the inside of the lateral sepals mostly shiny red, petals also reported as reddish purple, lip epichile sometimes red, gynostemium light yellow; all parts except lip pubescent on both sides though gynostemium usually sparsely so. Pedicel and ovary 10-15 mm long, pubescent. Sepals oblong-lanceolate, subacute or acuminate, spreading; median sepal 7-veined, 10-16(-17) × 4-5.6 mm; lateral sepals 9-13 × (4.9-)5-7 mm, deflexed, tips inwards-curved, with a more or less pronounced bulging area on the sides that face each other. Petals narrowly triangular-lanceolate, spreading, gradually narrowed towards the tip, acute, 5- or 7-veined, 9.5-16.3 × 2-4.5 mm. Lip ovate, 3-lobed in its upper part, (5-)5.5-8 × 5-8.3 mm, spreading, united with the gynostemium at the base, with two pronounced apical conical calli, margins fimbriate or erose; midlobe an acute tip, (1-)1.3-2.5 × 0.7-1.3 mm; side-lobes triangular, obtuse, 1.5-1.8 × 1.5-2 mm. Gynostemium 4.5-8 mm long, straight, stout, pubescent. **Fruit** elongate-ellipsoid, 22-40 × 3-8 mm, pubescent.

Illustrations: Seidenfaden (1972): fig. 27a-c; Seidenfaden (1986): fig. 35a-d; Seidenfaden & Wood (1992): figs. 78b-e; Comber (2001): pl. on page 292; Beaman *et al.* (2001): pl. 28D.

Habitat and flowering time: In evergreen forest, freshwater swamp forest, bamboo forest or sometimes in swampy grassland to 300 m elev. The few detailed collector's notes indicate limestone as bedrock. Flowering in April, June-July and October-February.

Specimens examined: Peninsular Thailand, Chumphon Province, Langsuan, *Kerr 0652* (C, C [spirit], K); ibid., Surat Thani Province, Chaiya District, *Maxwell 87-151* (L); ibid., Krabi Province, *Niyomdham 1746* (C spirit]); ibid., Krabi Province, Bang Kram Forest Reserve, *Larsen et al. 43403* (AAU); ibid., Krabi Province, Bang Kram Forest Reserve, *Larsen & al. 43782* (C [spirit]); ibid., Krabi Province, Kow Pra-Bahng Krahm Wildlife Sanctuary, *Maxwell 06-38* (Sc.ChM.Univ. = Herbarium of the Science Faculty of Chiang Mai University, Sc.ChM.Univ. [spirit]); ibid., Krabi Province, *Thaithong 1794* (BCU [spirit]); ibid., Krabi Province, Khao Nop Ju Jee, *Thorut 245* (BCU [spirit]); ibid., Nakhon Si Thammarat Province, *Williams et al. 1361* (BKF [spirit]); ibid., Trang Province, Thung Khai, *Larsen & al. 43982* (AAU, C [spirit], SING) [in bud, identification uncertain]; ibid., Trang Province, Thung Khai, *Larsen & al. 43985* (AAU); ibid., Trang Province, Thung Khai Botanical Garden [cultivated ?], *Mauric 5* (BKF); ibid., Trang Province, Tung Kai, *QBG 10003* (QBG [spirit]); ibid., Trang Province, Thung Khai, *Suddee 391* (BKF [s]); ibid., Songkhla Province, Khao Keo, *Kerr 0627* (K); Tako, Langsuan, *Put 1753* (K).

Distribution: Peninsular Thailand (16 collections seen); also in the Andaman Islands, Malaya, Sumatra, Borneo, Moluccas and New Guinea.

Notes: This species is very distinct with its mostly solitary short-petioled leaf and the erose or fimbriate side margins of the lip. This and further distinguishing characters are also listed under the preceding species. The Thai plants listed here clearly match Reichenbach's (1865) original description. The bulging area on the lateral sepals referred to above is, however, subject to variation in the species.

A specimen from Trang (*Larsen & al. 43982*, AAU, C [spirit], SING) was collected in the bud stage, and was interpreted as a representative of a new species because of its unusual habit with three leaves on top of the pseudobulb (G. Seidenfaden, notes in his working files). While it will probably never be possible to identify the plant accurately due to the absence of flowers, it appears that the habit is not really unique as specimens with two leaves occur occasionally (though rarely) in this species. A flower bud that Seidenfaden had opened was found in the spirit collection at C, and exhibits the fringed side margins of the lip typical of this species. It therefore appears likely that the specimen is merely a slightly unusual representative of *Plocoglottis lowii*.

3. ***Plocoglottis quadrifolia*** J.J.Sm.

Bull. Jard. Bot. Buitenzorg III: 8 (1926) 36; Seidenfaden, Bot. Tidsskr. 67 (1972) 109; Opera Bot. 89 (1986) 70; Seidenfaden & Wood, Orch. Penins.

Malaysia & Singapore (1992) 181; Comber, Orch. Sumatra (2001) 290; N. Vaddhanaphuti, Wild Orch. Thailand (2005) 208. – **Type:** Indonesia, Sumatra, Agam, Boekit Batoe Banting, *Groeneveldt 873* (holo, L!).
-*Phaius longipes auct., non* (Hook.f.) Holtt.; Seidenfaden & Smitinand, Orch. Thailand (1961) 329.

Terrestrial **herbs**, evergreen, **stems** reed-like, 30-40 cm tall, with leaves in the upper half, lower half with sheathing leaves. **Leaves** 5-7, lanceolate-elliptic, acute, acuminate, blades 11.5-21 × (1.6-)2-3.5 cm, plicate, glabrous, petiole to 1.5 cm long; leaves generally green with some purple. **Inflorescences** 67-92 cm tall, arising from the base of the leafy shoot, much taller than the leafy shoots, softly-pubescent; peduncles to 58 cm long; sterile bracts 7-8, scattered along the flowering stem and a few clustered at its base, lanceolate-oblong, acute, 1.6-5 cm long, glabrous or hairy, sheathing at the base and their upper part spreading; raceme lax, 10- to 25-flowered; rachis 14-37 cm long, pubescent; floral bracts ovate-lanceolate, acuminate, 8-10 × 2-4 mm, mostly much shorter than the pedicel plus the ovary, sometimes yellowish purple. **Flowers** to 29 mm in diameter; mostly yellow with a red tinge, lateral sepals distally yellow and basally shiny red, lip yellow with red markings, apical half often pink, violet or red, gynostemium yellow or white. Pedicel and ovary 7-18 mm long, densely pubescent. Sepals ovate-lanceolate, subacute, 7- or 9-veined, spreading, hairy on the outside; median sepal 18-25 × 5.2-8 mm; lateral sepals 13-22 × 5-10 mm, with a shiny bulging area on the sides that face each other. Petals very narrowly ovate-lanceolate, subacute, spreading, 3- to 7-veined, 18-25 × 3-5 mm, glabrous. Lip quadrangular but narrowed towards the base, 3-lobed in the apical half, 8-12 × 8-12 mm, united with the gynostemium at the base, glabrous, margins fimbriate; midlobe a reflexed apical tooth, 0.95-2 × 1.2-2 mm; sidelobes triangular or square, obtuse, 2-5 × 3.5-5 mm, with obscure or prominent apical calli. Gynostemium straight, 9-11 mm long, slender, rostellum a short blunt beak.

Specimens examined: Peninsular Thailand, Surat Thani Province, Koh Pa-ngan, *Put 756* (B, BK, C, C [spirit], K, P); ibid., Nakhon Si Thammarat Province, Khao Luang, *Geesinck & Santisuk 5483* (C, C [spirit], L); without locality, *Thaithong 1374* (BCU [spirit]).

Illustrations: Seidenfaden & Smitinand (1961): fig. 252 [as *Phaius longipes* (Hook.f.) Holtt.]; Seidenfaden (1986): fig. 36a-e; Seidenfaden & Wood (1992): fig. 78f; Comber (2001): pl. on page 290; N. Vaddhanaphuti (2005): pl. on page 208.

Habitat and flowering time: Found in rock crevices in disturbed evergreen forest, often along waterfalls. The plants are usually found in lower hill forests up to 500 m. Flowering in May.

Distribution: Peninsular Thailand (3 collections seen), also in Malaya and Sumatra.

Notes: Characteristic features of this species are the reed-like stems with several leaves, the median sepals which are about 18-25 mm long and the fimbriate lip side margins. As already pointed out by Smith (1926: 37), the species is close to *Plocoglottis lowii* but differs from it vegetatively.

4. ***Plocoglottis gigantea*** (Hook.f.) J.J.Sm.
Repert. Spec. Nov. Regni Veg. 32 (1933) 228; Seidenfaden, Bot. Tidsskr. 67 (1972) 109; Opera Bot. 89 (1986) 70; Seidenfaden & Wood, Orch. Penins. Malaysia & Singapore (1992) 183; Comber, Orch. Sumatra (2001) 291. -*Alismorkis gigantea* (Hook.f.) Kuntze, Revis. Gen. Pl. 2 (1891) 650. -Basionym: *Calanthe gigantea* Hook.f., Fl. Brit. India 5 (1896) 856. – **Types:** Peninsular Malaysia, Perak, *Kings collector 10277* (syn, K!; isosyn, BM); Peninsular Malaysia, Perak, *Wray 2932* (syn, K!).
-*Plocoglottis foetida* Ridl., J. Linn. Soc., Bot. 32 (1896) 319. –Type: not designated.

Terrestrial **herbs**, evergreen, **stems** reed-like, to 100 cm tall, with leaves in its upper half, lower half with sheathing leaves only, stems pubescent. **Leaves** 6-12, lanceolate, acuminate, blades 19-30 × (1.9-)4.2-7.3 cm, plicate, shortly hairy, sheathing at the base, sessile. **Inflorescences** erect, to over 1 m tall, arising from the base of the leafy shoot, slightly longer or shorter than the leafy stem, pubescent; sterile bracts 7-9, tubular, lanceolate-oblong, acute, 2.3-2.5 cm long, glabrous or sparsely pubescent; raceme lax, many-flowered; rachis 18-23 cm long; floral bracts triangular, acuminate, acute, 10-15 × 8-9 mm, shorter than the pedicel plus the ovary, pubescent. **Flowers** to 38 mm long, yellow blotched reddish, lip cream or white and turning yellow as the flower ages; sepals and petals fleshy, densely pubescent on the outside and sparsely so on the inside; flowers reported to have a foetid smell. Pedicel and ovary 18-20 mm long, densely pubescent. Sepals lanceolate, acute, 20-23 × 8-10 mm, pubescent; median sepal spreading; lateral sepals deflexed. Petals similar to the petals, slightly smaller, facing forwards. Lip elliptic, shallowly 3-lobed in its upper part, 9-10 mm long, united with the gynostemium at the base, concave, sides much recurved, lip broadest near the middle; midlobe a triangular tooth, deflexed, to 3 × 2 mm long; side-lobes obscure, obtuse, to 2 mm long. Gynostemium 6-9 mm long, straight, stout. **Fruit** ellipsoid, *ca* 5.2 × 1.4 cm.

Specimen examined: Peninsular Thailand. Narathiwat Province. Hala-Bala Forest Reserve, *Niyomdham 7189A* (BKF [spirit]).

Illustrations: Seidenfaden (1986): fig. 37a-c; Seidenfaden & Wood (1992): fig. 78g-h.

Habitat and flowering time: The habitat of the single Thai collection has not been recorded. However, in Malaya the plants are found in moist places in lowland forest and flower in February.

Distribution: Peninsular Thailand (1 collection seen), also in Peninsular Malaysia, Borneo and Sumatra.

Notes: *Plocoglottis gigantea* is well-characterised by its tall stems which lack pseudobulbs at the base. The hairy flowers have a concave lip, which is broadest near the middle and has strongly recurved side margins.

This species is in Thailand known only from a single collection made in the Province of Narathiwat in the extreme south of the country in 2004. The species was originally included in the list of the Thai *Plocoglottis species* (Seidenfaden, 1972: 109; 1986: 70, fig. 37a-c) because of a literature reference made by Haniff (1916: 353) who recorded the species for "Setol" (= Satun). Haniff was, however, not sure about the identity of his plant.

The flowers have been reported to have a foetid smell, which Ridley based his species name *Plocoglottis foetida* on (which is considered synonymous with *P. gigantea*).

5. ***Plocoglottis bokorensis*** (Gagnep.) Seidenf.
Dansk Bot. Ark. 33 (1979) 219; Opera Bot. 89 (1986) 71; Opera Bot. 114 (1992) 105. –Basionym: *Bulbophyllum bokorense* Gagnep., Bull. Mus. Natl. Hist. Nat. II: 22 (1950) 399. – **Type:** Cambodia. Bokor, *Poreé-Maspero s.n.* (P). **Fig. 2**.
-*Plocoglottis mirabilis* Seidenf., Bot. Tidsskr. 65 (1970) 336; Bot. Tidsskr. 67 (1972) 109. –Type: Thailand, Khao Yai National Park, 1300 m, *Cumberlege 926* (C!).

Terrestrial **herbs**, evergreen, stems reed-like, 40-50 cm tall, with several leaves in its upper half, lower half with sheathing leaves, arising from distinct pseudobulbs. **Pseudobulbs** bottle-shaped to conical, 7-8 × 3-4 cm, with internodes 3.5-4 cm, dark olive-green and becoming purplish brown when old. **Leaves** (5-)8-10, elliptic-lanceolate, acute, without prominent petioles, blades 8-16.5 × 1.9-3.5 cm, plicate, glabrous, basally sheathing, blades wavy. **Inflorescences** 30-51 cm long, arising from the base of the pseudobulb, mostly

Figure 2. *Plocoglottis bokorensis* (Gagnep.) Seidenf. with reed-like stem (photo taken in Khao Yai National Park, Thailand). A. Plant, note the prominent pseudobulbs (arrowhead); B. Inflorescence; C. Flower. Photo: S. Chantaranorrapint (Buakhlai 70 voucher in BCU).

slightly taller than the leafy stem, pubescent; sterile bracts 5-8, scattered along the flowering stem and a few clustered at its base, lanceolate-oblong, tubular, acute, 2.7-4 cm long, glabrous; raceme lax, 7- to 15-flowered; rachis (7-)13-20 cm long; floral bracts ovate-lanceolate, acuminate, 8-12 × 3-5.5 mm, shorter than the pedicel plus the ovary, pubescent, glossy whitish green. **Flowers** pale pink or yellow with red blotches, lip uniformly yellow or whitish-yellow with purple markings at the base. Pedicel and ovary 15-28 mm long, pubescent. Sepals oblong-lanceolate, navicular, subacute or acute, 5- or 7-veined, pubescent on the outside, glabrous and glossy on the inside, spreading; median sepal hooded, 13-20 × 5-7 mm; lateral sepals similar but slightly narrower, mucronate. Petals narrowly oblong, obtuse, 3- or 5-veined, (11.5-)12.3-18.5 × 2.6-5 mm, glabrous. Lip ovate, shallowly 3-lobed, 7.5-11 × 8.5-12 mm, widest in its recurved upper part, sides not much recurved, base with a distinct cavity formed by the flanges (which join the lip to the gynostemium) and the bases of lip and gynostemium; midlobe triangular, 0.6-1 × 0.5-1.5 mm; side-lobes triangular, obtuse, ca 3 × 2-2.5 mm. Gynostemium 4.5-7 mm long, glabrous, stigma triangular or heart-shaped.

Specimens examined: Northern Thailand, Nan Province, Doi Phu Kha National Park, *Srisanga 2584* (QBG); Eastern Thailand, Nakhon Ratchasima Province, Khao Yai National Park, *Cumberlege 926* (C [spirit]); Southwestern Thailand, Phetchaburi Province, Kaeng Krachan National Park, *Middleton & al. 3291* (BKF [spirit]); Central Thailand, Nakhon Nayok Province, Khao Yai National Park, *Buakhlai 70* (BCU [spirit]); Southeastern Thailand, Trat Province, Kao Kuap, *Put 2978* (K).

Illustrations: Seidenfaden (1970): fig. 14a-e [as *Plocoglottis mirabilis* Seidenf.]; Seidenfaden (1986): fig. 38a-e, pl. Vb; Seidenfaden (1992): figs. 56a-e.

Habitat and flowering time: The only available detailed collector's record (*Srisanga 2584*, QBG!) indicates that the plants grew in dry evergreen forest at an altitude of 800 to 1100 m. Plants in Khao Yai National Park are reported to grow in a more humid environment. Flowering takes place between May and July.

Distribution: In several widely scattered localities in northern, eastern, southwestern, central and southeastern Thailand, also in Cambodia, Laos and Vietnam.

Notes: This species is characterized by its reed-like stems which have prominent pseudobulbs at the base. The lip shape is a distinguishing feature from *Plocoglottis gigantea*, as it is generally widest in its apical part and has entire and only little decurved side margins. The Thai plants were originally described as *P. mirabilis*, which was later found to be conspecific with *Bulbophyllum bokorense* Gagnep.

Plocoglottis bokorensis is interesting from a phytogeographical point of view. It is known from several widely scattered localities in northern, eastern, southwestern, central and south-eastern Thailand, and is therefore the only Thai *Plocoglottis* species which is apparently absent from the Peninsula.

Acknowledgements

I am grateful to the curators of the herbaria AAU, B, BK, BCU, BKF, C, K, L, QBG, and the Science Faculty of Chiang Mai University for making their collection available for study. Staff in Thai herbaria have helped in many ways, particularly Dr. O. Thaithong and Miss S. Wongpakam (both BCU), Dr. S. Suddee (BKF) and Dr. S. Watthana and Dr. P. Suksathan (both QBG). Thanks to S. Chantaranorrapint for letting me use his photographs of *Plocoglottis bokorensis*. I further thank the National Research Council of Thailand for issuing a research permission.

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Nepenthes pitopangii (Nepenthaceae), a New Species from Central Sulawesi, Indonesia

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Abstract

A new *Nepenthes species, N. pitopangii*, from Sulawesi Tengah, is described.

Introduction

Cheek and Jebb (2001) recognised eight species of Nepenthaceae for Sulawesi, of which four species are endemic. These numbers are comparatively low compared to the neighboring island of Borneo, where there are more than 30 species, of which 70% are endemic. The lack of species richness in Nepenthaceae in Sulawesi is yet to be examined in detail, but may be due to a combination of biogeographical and ecological factors, or simply a lack of detailed botanical exploration of the island.

In 2006, photos by Jonathan Newman of an unidentified taxon of *Nepenthes* from Central Sulawesi, which were not readily assignable to any presently known species, first appeared on the internet (http://www.cpukforum.com/forum/index.php?showtopic=17326&hl=). Field visits to the site in 2007 (S. McPherson and G. Bourke) and in 2008 (C. Lee and S. McPherson), and examination of herbarium materials at Universitas Tadulako, Palu (CEB) indicated that this plant represents a new species of *Nepenthes*, which we describe below. The description that follows combines measurements taken from the herbarium specimens at Universitas Tadulako (which are sterile), with measurements of the inflorescence made from living material in the field.

Nepenthes pitopangii Chi.C. Lee, S. McPherson, G. Bourke & M. Mansur, *spec. nov.*

Nepenthi glabratae *similis sed ascidiorum superiorum infundibuliformium* *alis reductis differt* – **Holotypus:** Lore Utara District, Poso Regency, Central Sulawesi, 30 May 2007, *RP 2054* (CEB). **Fig. 1.**

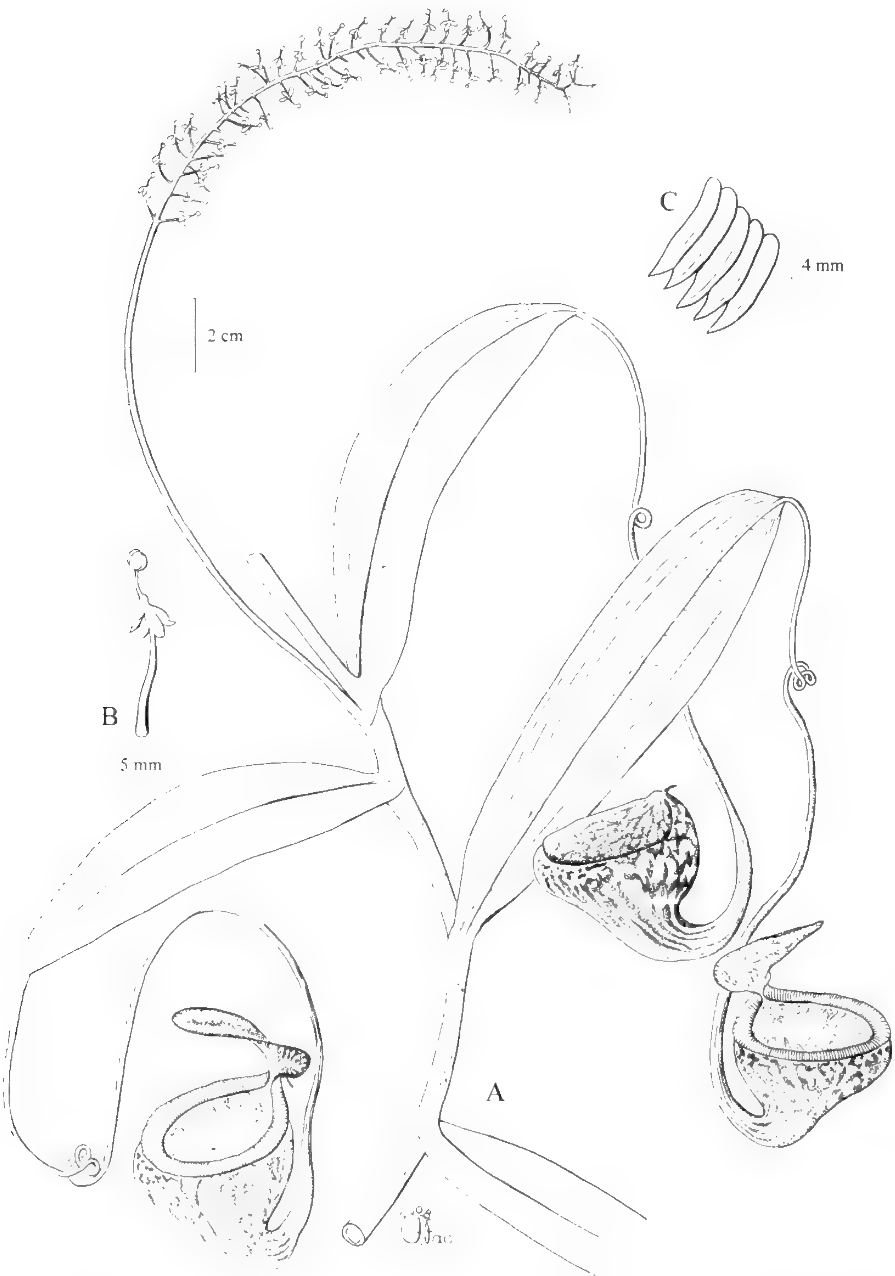

Fig. 1. *Nepenthes pitopangii*. A. Climbing stem with upper pitcher and male inflorescence; B. Male flower; C. Peristome teeth. All from living specimens. (drawing by Joseph Pao).

Terrestrial **climber** to *ca* 2 m tall. Climbing **stems** cylindrical to slightly triangular in cross-section, particularly towards the developing shoot, 3-5 mm diam., internodes (4.1-) 6.4-9 cm long. **Leaves** of the climbing stems chartaceous, sessile, lanceolate, apex acute, (10.1)11.5-14.4 (15.6) cm long, (2)2.5-2.9 (3.4) cm wide; base clasping stem for about 2/3 its circumference; longitudinal veins 3-4 on each side of the midrib, pennate nerves inconspicuous; tendrils with a curl in the middle, 24-25 cm long. Rosette **pitchers** unknown. Upper pitchers wholly infundibuliform, 3.8-4.5 cm high, 3.3-3.7 cm wide, slightly contracted just below the mouth; pitcher mouth horizontal in front and slightly elevated towards the lid attachment; **peristome** cylindrical, 1-3 mm wide, with distinct ribs, *ca* 0.45 mm apart, each rib terminating in a blunt rounded tooth on the inner margin; interior of pitcher without waxy zone, glandless immediately below peristome (*ca* 4 mm), otherwise evenly covered with glands *ca* 200 per cm^2, yellow in color above pitcher fluid, black in color where immersed; lid suborbicular, 2.9 by 2.8 cm, held horizontally over pitcher mouth, sides somewhat raised, lower surface without appendages, evenly distributed with small crater-like rimmed glands; spur simple, *ca* 1.5 mm long. Male **inflorescence** (measurements taken from living specimens) a raceme, 37 by 2.5 cm; peduncle 18 cm long, 0.3 cm diam. at base, pedicels 7-9 (-11) mm long, each bearing a single **flower**, bracts usually absent but occasionally towards base of inflorescence pedicels with small filiform bract, *ca* 0.5 mm long inserted at about half the length of the pedicel, tepals elliptic, *ca* 2 mm long, staminal column 2.5-3.0 mm long. Female inflorescence and **fruit** unknown. **Indumentum** absent on all parts of plant except for the developing pitcher and tip of the tendril, which are covered with caducous silver-brown hairs. Color of living specimens: leaves light green with red margins and red midrib on upper and lower surface; stems dark red to purple with green spots; tendril red; upper pitchers pale yellow with orange-red stripes, interior if pitcher and underside of lid pale yellow; peristome orange-red.

Habitat: Secondary vegetation in submontane forest at an altitude of 1800 m.

Distribution: Lore Lindu National Park, Central Sulawesi.

Conservation Status: The geographical range of *N. pitopangii* is not yet established (see below). Although the population from which all collections and observations have been made consists of a single plant, it is unlikely that this species does not grow elsewhere. We therefore propose an IUCN Red List classification of "data deficient" (DD) until further detailed field surveys can be conducted.

Notes: This species has a number of characteristics in common with *N. glabrata* Turnbull & Middleton, another montane species from Central Sulawesi. These species share a similar leaf shape, pitcher lid, inflorescence, colouration and lack of indumentum in nearly all parts. They appear to be very closely related, but *N. pitopangii* differs in the unusual, widely infundibular upper pitchers, as well as being more robust in all parts. Communication with R. Pitopang, collector of the type specimen, confirmed that the specimens in CEB were collected from the same individual plant as the one on which the field observations were made by the present authors, this being the only plant at the type locality. Given that no other plants of *N. pitopangii* have been found to date, nothing is known about intraspecific variation within the taxon and the possibility that this plant is a natural hybrid cannot be ignored. However, we have discounted a hybridogenic origin for *N. pitopangii*, as it does not display any morphological characteristics that suggest one. All natural hybrids of *Nepenthes* recorded to date bear some obvious similarities to either parent, but although *N. pitopangii* is sympatric with *N. maxima* and *N. tentaculata*, it has little in common with these. The only other species in Sulawesi with infundibular upper pitchers are *N. maxima* and *N. eymae* and all known natural hybrids involving these bear petiolate leaves, triangular lids, and/or appendages on the undersurface of the lid (C. Lee, pers. observation), none of which are present in *N. pitopangii*. Moreover, the upper pitchers of *N. pitopangii* are more widely infundibuliform than those of *N. maxima* or *N. eymae*. Based on these observations, we have no doubt that *N. pitopangii* is not a natural hybrid.

Field observations in the surrounding area and nearby mountains (S. McPherson & G. Bourke in 2007 and C. Lee & S. McPherson in 2008) did not reveal any additional plants of *N. pitopangii*, despite the presence of extensive mossy forest in which *N. maxima* and *N. tentaculata* occurred. It is therefore presumed that the principal habitat for this species may be at lower elevations (below 1600 m) or perhaps, as with *N. glabrata*, it occurs in submontane to montane scrub on ultramafic outcrops. Many species of *Nepenthes* are opportunistic colonizers of disturbed areas, such as road embankments with seedling recruitment primarily taking place before the heavy growth of other plants. It is possible that the type specimen for this species originated from a stray seed that germinated in a habitat, which had only recently been cleared. The thick growth of ferns and other plants at this site would normally impede the successful growth of a *Nepenthes* seedling.

The phenology, ecology and geographical range of *N. pitopangii* is difficult to ascertain until more wild plants are discovered, but observation conducted at the type locality showed that prey items in the upper pitchers consisted primarily of small dipterans (particularly midges) and small numbers of other insects such as wasps, ants, earwigs, and beetles.

Nepenthes pitopangii represents an interesting contribution to the flora of Sulawesi, suggesting that more detailed explorations of the island may yield further insights into patterns of diversity and endemism in Nepenthaceae there, as well as further discoveries of new taxa. Detailed field observations on other populations of *N. pitopangii*, should these be found, will add greatly to our knowledge of this taxon.

This species is named for Dr. Rahmadanil Pitopang, curator of the herbarium of Universitas Tadulako, who has studied the flora of Central Sulawesi for over 18 years.

Specimens of other species examined: -***Nepenthes glabrata***: Res. Manado. O. aft. Poso. Tusschen. Biv. III N uitlooper, van G. Loemoet, 3 Sep 1938, *Eyma 3585* (BO); E. Celebes, G. Loemoet, North Spur, 1938, *Eyma 3585a* (BO); Menádo O.A. Póso, Bózo–Póena, 1700-1800m, 10 Aug 1937, *Eyma 1604* (BO). -***Nepenthes hamata***: Res. Menado. O. aft. Kolonedale, tusschen Tomongkobae, *Eyma 3969* (BO); Gunung Loemut, *Eyma 3573* (BO); Poso, Gunung Loemut, *Eyma 3643* (BO); Tomongkobae, *Eyma 3970* (BO); Gunung Poka Pindjang, *Kjellberg 1492* (BO); Mt. Roroka Timbu, summit region, alt 2450 m, *Balgooy 3335* (BO).

Acknowledgements

The authors would like to extend their gratitude towards Dr. Rahmadanil Pitopang, for kindly providing access to study the type specimens, and to Jonathan Newman for assisting with location data and maps. Special thanks to Dr. Andreas Fleischmann for providing the latin diagnosis.

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Jebb, M. & M. Cheek. 2001. Nepenthaceae. *Flora Malesiana* **15**: 1-157.

Old Hats Are Better: New Considerations and Taxonomic Changes in the Southeast Asian *Gardenia tubifera* Complex (Rubiaceae)

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Abstract

Gardenia tubifera sensu Corner is revised over its entire range in Southeast Asia. It is a heterogeneous complex of three distinct taxa, *G. elata* Ridl., *G. subcarinata* (Corner) Y.W.Low (elevated from varietal status) and *G. tubifera* Wall., mainly distinguished by calyx form, fruit size and ecological distribution. Two new varieties are described, *G. elata* var. *longipedicellata* K.M.Wong (from the Philippines) and *G. subcarinata* var. *sumatrana* Y.W.Low (from Sumatra). A key for identification, descriptions, nomenclatural notes, illustrations and exsiccatae examined for all recognised taxa are provided. *Gardenia elata* is lectotypified.

Introduction

Gardenia tubifera Wall. sensu Corner (1939) is a heterogeneous taxon including elements that are small to medium-sized trees occurring in swamps and hill forests. Two varieties were recognised, namely, *G. tubifera* var. *subcarinata* Corner (with a narrowly keeled calyx tube) and *G. tubifera* var. *tubifera* (with a smooth calyx tube). Subsequently, *G. tubifera* var. *tubifera* was further divided (Wong 1982, 1989) into two forms, *G. tubifera* var. *tubifera* forma *tubifera* and *G. tubifera* var. *tubifera* forma *elata* (Ridl.) K.M.Wong.

For the present work, taxonomic treatments by Corner (1939) and Wong (1982, 1989) pertinent to the *G. tubifera* complex were reviewed. This led to the distinctions reported here, including the resurrection of *G. elata* Ridl., a narrower circumscription of *G. tubifera* and the elevation of Corner's *G. tubifera* var. *subcarinata* to species level.

In this study, specimens of *G. tubifera s.l.* from 14 herbaria (A, BKF,

BO, BRUN, IBSC, K, KEP, KLU, L, NY, SAN, SAR, SING and US) were examined. A new variety is proposed for *G. subcarinata* from Sumatra in Indonesia and another new variety for *G. elata* from Luzon in the Philippines. Also, field observations of *G. elata* var. *elata*, *G. subcarinata* var. *subcarinata* and *G. tubifera* were made to complement the findings from the herbarium study.

Characters and species distinctions

Corner (1939) was convinced that *G. tubifera* was a very variable species with regard to leaves, flowers and fruits. He adopted a broad concept for *G. tubifera*, in which he included *G. elata* Ridl., *G. resinifera* Korth. and *G. speciosa* Hook.f. as synonyms. His justification for this was largely based on the calyx tube length, corolla tube length, and diameter across corolla lobes in the open flower, the last of which he referred to as the 'limb' (more precisely, limb span), which overlapped in the several taxa he considered. In reaching this conclusion, Corner had considered earlier distinctions using these characters by Hooker (1880), King and Gamble (1903) and Ridley (1923), using measurements given by these authors, as well as from additional specimens that were available. In so doing, and without the benefit of a broader character survey including more species of *Gardenia*, Corner did not attempt to use other characters for species distinction.

In the same paper, Corner (1939) also named another taxon with keeled calyx tubes as a variety of *G. tubifera*. This taxon had corolla tube length and 'limb span' that also fell within the range accepted by him for *G. tubifera*.

The status of *Gardenia tubifera* var. *subcarinata* Corner

The most general characters that easily distinguish many species of *Gardenia* appear to be those associated with calyx morphology. For example, in Malaysia, there are three species of *Gardenia* with keeled calyces, namely, *G. carinata* Wall., *G. chanii* Y.W.Low and *G. pterocalyx* Valeton. They can be easily differentiated based on the form of the keels, for example, *G. carinata* has keels resembling large triangular wings at the top of the subcylindrical tube; *G. chanii* has keels resembling narrow elongate wings stretching down the length of the tube to the top of the hypanthium only, the tube being widely flared towards its apex; and *G. pterocalyx* has keels resembling narrow elongate wings stretching down both the tube and the hypanthium, the tube tightly ensheathing and not flared-out. The same characters were useful in Hawaii (St. John and Kuykendall, 1949), where two species of *Gardenia* with keeled calyces, *G. mannii* St.John & Kuykendall (keels with a laterally prolonged, narrowed proximal part ending in a spathulate apical lobe) and *G. remyi* Mann. (keels resembling butterfly wings and without a prolonged, narrowed proximal part), were distinguished.

We have also found that distinctive keel features are useful in recognising individual species in our study. Additionally, there are also consistent differences in other characters. For example, in distinguishing *G. chanii* from *G. pterocalyx* (Low and Wong, 2007), leaf apex shape, domatia type, leaf size, fruit pedicel length and corolla tube length provided consistent differences in addition to calyx keel form. In fact, other than the placement of *G. tubifera* var. *subcarinata* (with a slightly keeled calyx tube that often shows clear marginal lobes) in a taxon that otherwise has a completely smooth and subtruncate calyx tube, Wong (1982, 1989) also distinguished species effectively based on calyx morphology, in particular, the tube and keel form. It is true that a very small number of specimens of typical *G. tubifera* sometimes display faint, rib-like traces along the calyx tubes, but these are never laminate structures protruding from the calyx surface as are keels, as defined here; similarly, dried fruits can be ribbed but not keeled.

We know of no other instances where *Gardenia* species have so great a variation in calyx form to include both smooth (unkeeled) and keeled calyx tubes. In examining the probability that *G. tubifera* var. *subcarinata* has been injudiciously grouped with typical *G. tubifera* (and therefore should be recognised as a distinct species), we searched for other differences between them. As, indeed, a number of such consistent differences exists (Table 1). We conclude that *G. tubifera* var. *subcarinata*, with an easily distinguished calyx form, should be recognised as a distinct species from *G. tubifera*. This is here recognised as *G. subcarinata* (Corner) Y.W.Low *comb. et stat. nov.*

The two forms of *Gardenia tubifera* var. *tubifera* sensu Corner

Notwithstanding the distinctiveness (and usefulness) of calyx morphology in distinguishing taxa, pairs of species with very similar calyx morphology are known to occur that, nevertheless, can be well differentiated by other characters. For example, *G. coronaria* Buch.-Ham. and *G. thailandica* Tirveng. (both in the Myanmar-Thailand area but with overlapping distribution in the isthmus region of the Thai-Malay Peninsula) cannot be distinguished by their calyces as both have membraneous, sheathing calyx tubes with oblique mouths. However, *G. coronaria* has longer corolla tubes (5.6-8.5 cm long) and bigger corolla lobes (3-6 cm long, 2.2-3.4 cm broad), whereas *G. thailandica* has shorter corolla tubes (3-5.8 cm long) and smaller corolla lobes (1.5-2.1 cm long, 1-1.6 cm broad).

Another example is provided by *G. beamanii* Y.W.Low (north and northwest parts of Borneo) and *G. griffithii* Hook.f. (Malay Peninsula, Sumatra and Borneo), both with long and smooth calyx tubes sheathing the corolla tube and with flared mouths. These species are distinguished by the black dried exudate at shoot tips, puberulent lower leaf surface and longer flower pedicels (0.5-0.8 cm long) of *G. beamanii* and the yellowish amber-brown exudate at shoot tips, short-hairy lower leaf surface and shorter flower pedicels (0.2-0.4 cm long) of the latter species.

We therefore conclude that it is possible for well-differentiated species to share very similar calyx forms, but we wish to highlight that in such cases it should still be possible to find a number of other consistent, easily observable, differences in both vegetative and reproductive parts. In other words, the distinctions between species are not slight or restricted to a single character. Corner (1939) did not emphasize fruit size as a potential species difference, especially in the case of *G. tubifera* sensu stricto (with smaller fruits not exceeding 3 cm across) and *G. elata* (with larger fruits (3-)4-6.5 cm across). We have conducted numerous surveys of these two species in both Peninsular Malaysia and Borneo and find the fruit size difference is highly consistent with other distinguishing features as outlined above (Table 1). In addition, the ecology may also be indicative. *G. tubifera* var. *tubifera* forma *elata* is generally a lowland to hill forest taxon preferring drier sites although they do (more rarely) occur in swamp forest areas, as observed by Corner (1939). They can grow into trees of impressive size (to over 30 m tall: *Ridley 11332*). In contrast, *G. tubifera* var. *tubifera* forma *tubifera* is a typically coastal estuarine and swamp forest species, and a much smaller tree (up to about 13 m tall).

The two forms of *G. tubifera* var. *tubifera* recognised by Wong (1982, 1989) were distinguished also based on the hairiness of veins on the lower leaf surface, leaf width, calyx tube length, corolla tube length, fruit size and habitat. Table 1 shows that, whereas leaf width, calyx tube length and corolla tube length are not consistent in their differences, further differences in flower and fruit pedicel thickness, calyx mouth width and fruit size (verified through the present study) indeed help in distinguishing these two rather distinct taxa.

G. tubifera var. *tubifera* forma *elata* (previously *G. elata*) has a puberulent midrib and secondary veins on the lower leaf surface, thicker (2-3 mm) flower pedicels, a much wider calyx mouth [8-13(-15) mm], thicker fruit pedicels [(2-)4-10 mm], and larger fruits [(3-)4-6.5 cm]. In contrast, *G. tubifera* var. *tubifera* forma *tubifera* was distinguished by having a glabrous midrib and secondary veins on the lower leaf surface, more slender flower pedicels (1-2 mm), a narrower calyx mouth (5-8 mm), more slender fruit pedicels (1.5-4 mm), and smaller fruits (2.4-3 cm).

In summary, these two taxa are differentiated by a suite of consistent characters (Table 1), including various features of the reproductive parts,

Table 1. A comparison of habitat and morphological characters among *G. subcarinata, G. elata* and *G. tubifera.*

	G. subcarinata	*G. elata*	*G. tubifera*
Provenance	Malay Peninsula & Sumatra	Nicobar Islands, Thailand, Malay Peninsula, Sumatra, Borneo, Sumbawa & Philippines	Thailand, Malay Peninsula, Sumatra & Borneo (Kalimantan only)
Ecology	lowland forest	lowland forest	coastal estuarine & swamp forest
Leaf blade, length (cm)	(4.5-)7-14	(4.3-)10-22.5(-27)	4.5-12.5(-21)
Leaf blade, width (cm)	(1.9-)2.2-4.6	(2-)4-11(-12)	2.3-5.6(-6.3)
Leaf blade, pairs of secondary veins	7-12	(7-)14-22	9-15(-17)
Lower leaf surface, pubescence on midrib & secondary veins	puberulent	puberulent	generally glabrous (very rarely sparsely minute puberulent)
Flower pedicel, length (cm)	0.1-0.5	0.1-0.4(-1)	0.2-0.5
Flower pedicel, thickness (mm)	1.2-1.8	2-3	1-2
Calyx tube, length (cm)	0.4-0.7	(0.6-)1.4-2.5(-3.5)	0.6-1.5(-1.9)
Calyx tube, width at mouth (mm)	4-8	8-13(-15)	5-8
Calyx tube, pubescence	puberulent	puberulent	sparsely puberulent to subglabrous
Calyx tube, keels presence	8-9 narrow keels present along the tube	keels absent	keels absent
Corolla tube, length (cm)	4.6-6.8	(4.5-)7-15	(2.4-)3.9-9.4
Corolla tube, width at middle (mm)	1.5-3	2.5-5	1.5-3
Corolla lobes, length (mm) 12-21	12-21	(16-)32-45(-50)	14-29
Corolla lobes, width (mm)	6-13	10-20(-24)	7-18
ameter at or near maturity (cm)	1.5-2.5(-2.7)	(3-)4-6.5	2.4-3
Fruit pedicel, length (cm)	0.1-0.4	0.2-1(-1.5) or more	0.2-1.5
Fruit pedicel, thickness (mm)	2.5-3	(2-)4-10	1.5-4

instead of just smaller differences that would be expected among forms of the same species or variety. The different ecological distributions of these taxa also support a more fundamental distinction. We propose that their original distinction as species, *G. elata* Ridl. and *G. tubifera* Wall., should be restored.

Two new varieties in the *Gardenia tubifera* complex

Based on similar considerations, we propose a new variety of *G. elata* from Luzon material, and also a new variety of *G. subcarinata* from Sumatra. These two new taxa differ from their respective typical varieties in only minor details and distribution, rather than by the larger suites of characters that consistently separate taxa at the species level (see key below).

The new variety of *G. elata* has longer flower pedicels (0.7-1 cm) compared to the typical *G. elata* (only 0.1-0.5 cm long). On the other hand, although the new variety of *G. subcarinata* has the keeled calyx tube form of typical *G. subcarinata*, it differs in that the keels do not protrude beyond the calyx tube margin (in typical *G. subcarinata*, the calyx keels protrude, as distinct lobes, about 2 mm beyond the calyx tube margin). Otherwise, these two taxa are indistinguishable from their typical forms.

Key to taxa in the *Gardenia tubifera* complex

1. Calyx outer surface keeled 2
1. Calyx outer surface smooth or at most very faintly ribbed upon drying (the ribs resembling longitudinal veins, not laminate keel structures) 3

2. Calyx keels ending in distinct spur-like expansions protruding up to 2 mm beyond the calyx tube margin (Malay Peninsula and Singapore) .... ***G. subcarinata* var. *subcarinata***
2. Calyx keels not forming expanded apical portions and not protruding beyond the calyx tube margin (Sumatra) .... ***G. subcarinata* var. *sumatrana***

3. Veins on the lower leaf surface glabrous (very rarely sparsely minute puberulent); calyx mouth of open flowers *ca* 5-8 mm wide; mature fruit *ca* 2.4-3 cm across (coastal estuarine to swamp forests only) ..... ***G. tubifera***
3. Veins on the lower leaf surface puberulent; calyx mouth of open flowers *ca* 8-13(-15) mm wide; mature fruit *ca* (3-)4-6.5 cm across (typically lowland to hill forests, very rarely swamp forest) 4

4. Pedicels of open flowers *ca* 0.1-0.4(-0.5) cm long (Borneo, Malay Peninsula, Nicobar Islands, Philippines, Singapore, Sumatra, Sumbawa, Thailand) .... ***G. elata* var. *elata***
4. Pedicels of open flowers *ca* 0.7-1 cm long (Philippines: known only in Luzon from the Cagayan, Isabela and Rizal provinces) .... ***G. elata* var. *longipedicellata***

Taxonomic enumeration

1. *Gardenia elata* Ridl. var. ***elata***
J. Straits Branch Roy. Asiat. Soc. 79 (1918) 81. – **Type:** Singapore, Bukit Timah, 1898, *Ridley 11332* (lecto, K, hic designatus; isolecto, SING). **Fig. 1.**
-*Gardenia tubifera* var. *tubifera* forma *elata* (Ridl.) K.M.Wong, Gard. Bull. Singapore 35 (1982) 22, Tree Fl. Malaya 4 (1989) 349; Coode et al., Checkl. Fl. Pl. Gymnosperms Brunei Darussalam 270 (1996), *quoad Ashton BRUN 1008, Ashton S 7834, Niga 52, Niga 63, Sands 5869, Simpson 2007, Wong WKM 571.*
-*Randia speciosa* Hook., Icon. Pl. 5 (1852) t. 824, *nom. illeg., haud Randia speciosa* DC., Prodr. 4 (1830) 388; *Gardenia speciosa* Hook.f., Fl. Brit. Ind. 3 (1880) 117, King & Gamble, J. Asiat. Soc. Beng. 72 (2) (1903) 220, Ridley, Fl. Malay Penin. 2 (1923) 83, *nom. illeg., haud Gardenia speciosa* Salisb., Prodr. Stirp. Chap. Allerton (1796) 63, *nec Gardenia speciosa* Roxb. ex Wight & Arn., Prodr. Fl. Ind. Orient. (1834) 422. -Type: Hook., Icon. Pl. 5 (1852) t. 824 (*Randia speciosa* Hook.).
-*Gardenia lobbii* Craib, Fl. Siam. 2 (1932) 120. (Craib proposed this as nom. nov. for *G. speciosa* Hook.f.). See above.
-*Gardenia longiflora* S.Vidal, Revis. Pl. Vasc. Filip. (1886) 153, *nom. illeg.*; Merrill, Enum. Philipp. Fl. Pl. (1923) 530; *haud Gardenia longiflora* Ruiz & Pav., Fl. Peruv. 2 (1799) 67, t. 219, *nec Gardenia longiflora* (Salisb.) Dryander in Aiton, Hortus Kew., ed. 2, 1 (1810) 368. -Type: Luzon, Camarines Province, Paracale, Jan 1884, *Vidal 832* (open flower & fruit) (isotype, K).
-*Gardenia longituba* Ridl., J. Bot. 72 (1934) 274. -Type: British North Borneo, Kudat, Jul 1885, *Fraser 164* (flower bud) (holotype, K).
-"*Gardenia glutinosa*" *auct. non* Teijsm. & Binn. (1866): Elmer, Leafl. Philipp. Bot. 4 (1912) 1331: *quoad Elmer 13064.*
-"*Gardenia tubifera*" *auct. non* Wall. ex Roxb. (1824): Corner, Gard. Bull. Straits Settlem. 10 (1939) 46, *pro parte: quoad G. speciosa* Hook.f. & *G. elata* Ridl. in syn.; Corner, Wayside Trees of Malaya 1 (1952) 541; Anderson, Checkl. Trees Sarawak 297 (1980); Kessler et al., Secondary Forest Trees of Kalimantan, Indonesia (2000) 135, *quoad* Fig. 134.

Tree to *ca* 30 m high, trunk to *ca* 119 cm diameter, not buttressed. **Bark**

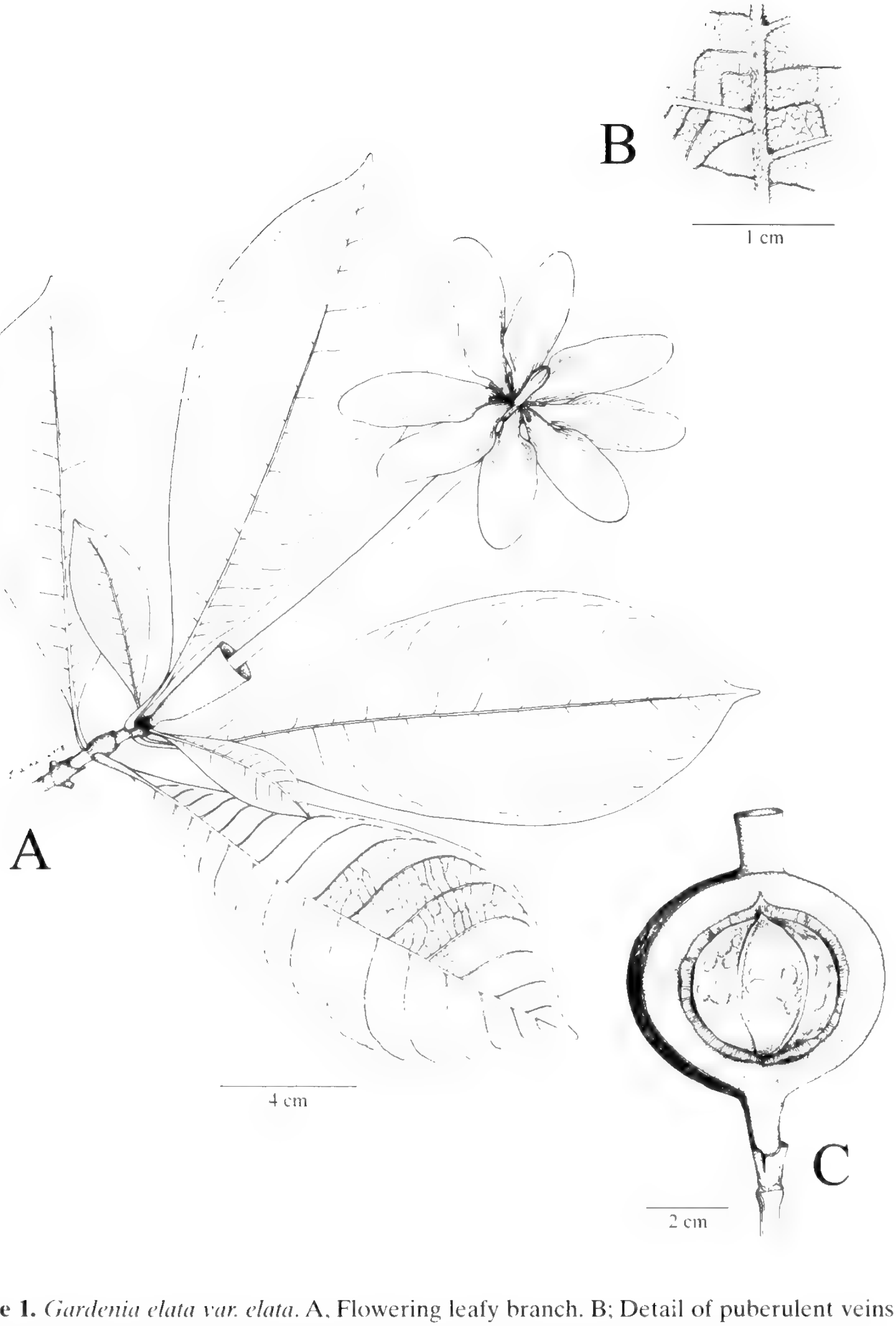

Figure 1. *Gardenia elata var. elata*. A, Flowering leafy branch. B; Detail of puberulent veins on lower leaf surface; C, Longitudinal section of fruit, calyx shown intact. [A & B from *Symington 24190* (SING); C from *Sigin & Ismail SAN 100264* (L)].

smooth, light grey-brown to dark brown. **Stipules** connate into a cylindrical tube, (0.4-)0.6-1.5 cm long, apex 2-lobed to subtruncate, outside puberulent and generally coated with resin (this sloughing off in older material), inside with a mixture of dark-coloured colleters and scattered fine translucent trichomes densely covering the basal half (trichomes slightly longer than the colleters) and glabrous in the upper half. Petiole (0.3-)1.1-3.5(-3.8) cm long, 1-2(-2.5) mm thick, evenly covered with puberulent hairs, sometimes conspicuously resin-coated. **Leaf** lamina obovate to rarely elliptic, (4.3-)10-22.5(-27) cm long, (2-)4-11(-12) cm wide; leaf base cuneate to rarely oblique; leaf apex cuspidate; thinly coriaceous; conspicuously coated with resin when young; midrib flat to sunken and minutely puberulent to subglabrous on upper side, prominent and puberulent on lower side; secondary veins (7-)14-22 pairs, flat and subglabrous on upper side, prominent and puberulent on lower side, vein axils on the lower side with ciliate tuft-domatia to hairy pocket domatia; tertiary venation scalariform. **Flowers** solitary. Pedicel 0.1-0.4(-1) cm long and 2-3 mm thick in open flowers, reaching 0.2-1(-1.5) cm long and (2-)4-10 mm thick at fruit maturity. **Calyx** narrowly obconical to somewhat spindle-shaped, the apex often slightly oblique and torn into two acute portions with corolla emergence, the tube subsequently slightly flared outward and often appearing subtruncate in the open flower; medium green; (0.6-)1.4-2.5(-3.5) cm long, 4-6 mm wide at the base, becoming 8-13(-15) mm wide at the apex; outside densely puberulent at the base and sparsely puberulent to subglabrous in the upper part, often coated with resin; inside glabrous for most of the upper part to about 0.7 cm from the tube margin, densely covered with a mixture of dark-coloured colleters and translucent trichomes at the basal half (trichomes longer than colleters and especially conspicuous as a dense fringe at the very base of the calyx); without lobes; surface smooth, without keels or ribs. Corolla hypocrateriform, cream turning light yellow, then deep to orange yellow; tube (4.5-)7-15 cm long, 2.5-5 mm wide at the mid-portion, 6-13 mm wide at the throat, outside glabrous to sparsely puberulent, inside largely glabrous except for a zone of dense ribbon-like translucent hairs from the throat to around the middle of the tube; lobes 8-10, oblanceolate to obovate, (16-)32-45(-50) mm long, 10-20(-24) mm wide, contorted to the left in the bud stage, glabrous on both sides. Stamens 8-10, inserted just below the corolla throat and between corolla lobes, dorsifixed; filaments very short to inconspicuous; anthers 7-10 mm long, *ca* a third to half of its length exserted; pollen in tetrads. Style (4.5-)9-15.5 cm long, glabrous; stigma club-like with 5-8 lobes initially cohering together, (4-)6-8 mm long, 3-5 mm wide, wholly exserted; ovary with several parietal placentas. **Fruits** globose, rarely depressed globose or obovoid, (3-)4-6.5 cm long, (3-)4-7 cm wide, surface in mature specimens smooth; calyx persistent at fruit apex, the tube to 1-2.5 cm long, 0.8-1.5 cm wide at the mouth; when ripe splitting irregularly to expose dark coloured seeds embedded in a bright yellow-orange pulp. **Seeds** many, irregularly angular-elliptic, flattened, 5-6 mm long, 4-7 mm wide, testa surface fine-areolate.

Habitat and ecology: Lowland forests preferring drier sites (including ultramafic and volcanic soils in north Borneo and the Philippines), very rarely in freshwater swamp forest.

Distribution: Widespread from the Nicobars, Thailand, Malay Peninsula, Bangka, Sumatra, Sumbawa, Borneo to the Philippines (including Palawan) (Fig. 2).

Proposed IUCN conservation assessment: *Gardenia elata* is a widespread species although not commonly encountered, so that the status Least Concern (LC) is still appropriate. However, with forest conversion rates increasing steadily in the region, this status needs reassessment periodically.

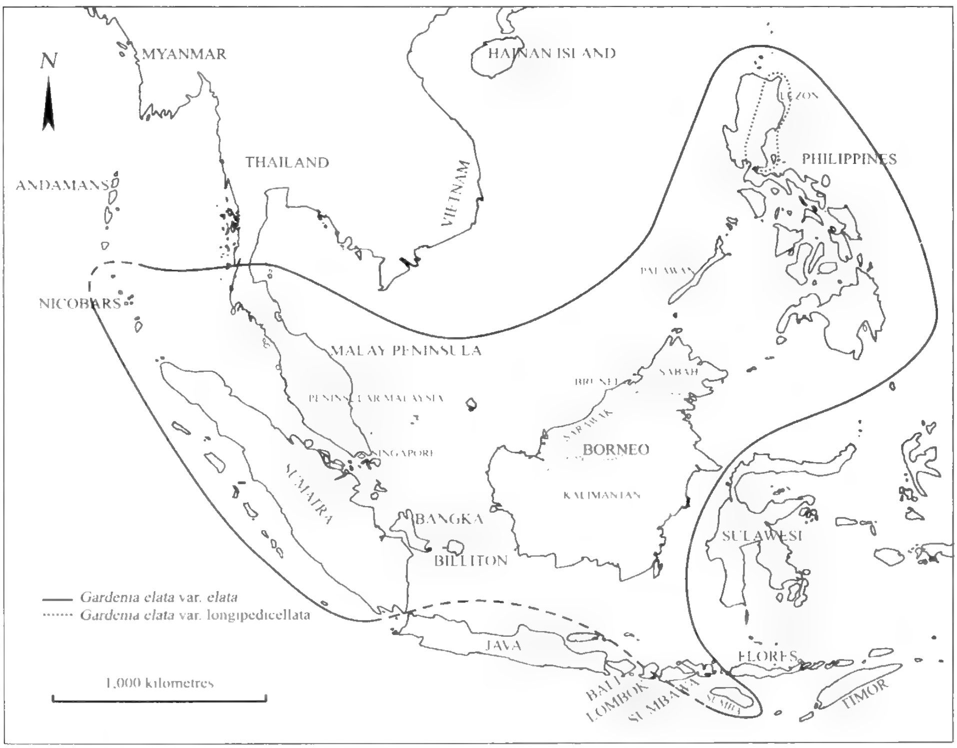

Figure 2. Range of *Gardenia elata* var. *elata* (indicated by solid line, with uncertain parts represented by dashed lines) and the area of occurrence of *G. elata* var. *longipedicellata* on Luzon island, the Philippines (within dotted line).

Notes: When Ridley first published *G. elata*, he cited only three specimens, namely, *Ridley 11332* (Bukit Timah, Singapore), *Wray 4266* (Selama, Perak) and *Hose 229* (Baram, Borneo). As there was no particular type indicated, all three specimens cited are syntypes. Corner (1939) considered *G. elata* a synonym of *G. tubifera* Wall. In recognising *G. elata* as a form of *G. tubifera* var. *tubifera*, Wong (1982) recorded *Wray 4265* (Selama, Perak, SING) as one of the syntypes, instead of *Wray 4266* as stated by Ridley (1918). King and Gamble (1903) had also listed *Wray 4265* under *G. speciosa* Hook.f., also a synonym of *G. elata*. It has now been confirmed that *Wray 4266* (SING) is a species of *Brachylophon* (Malpighiaceae) (Serena Lee, *pers. comm.*). As lectotypification is required for this species under Article 9.9 of the International Code of Botanical Nomenclature (McNeill *et al.*, 2006), we have avoided choosing the Wray specimen but instead select *Ridley 11332* (K) as the lectotype.

Gardenia longituba Ridl., overlooked by Corner (1939), was considered closely related to *G. longiflora* S.Vidal by Ridley; in fact, both these names are synonyms of *G. elata*. Ridley's description of *G. longituba* as having an unusually hairy stigmatic head was erroneous: close examination of the type material, *Fraser 164* (Kudat, British North Borneo, K), shows that the otherwise smooth stigmatic head was in fact occluded by external fibres, possibly from paper or cardboard material used when preparing herbarium specimens. This taxon perfectly matches *G. elata*.

Specimens examined: BRUNEI: **Belait District.** Andulau Forest Reserve, compartment 5, 10 Jun 2008, *Low et al. LYW 180*, fruits (BRUN, KLU); Belait river, upstream from the Malayan river, 23 Oct 1988, *Wong WKM 571*, flower (A, BRUN, KEP), flowers (L, SAN); Bukit Sawat, Sungai Mau, along Sungai Belait, 15 Oct 1991, *Simpson 2007*, fruit (A, BRUN, KEP, L, SAN, SING); Sukang, Kampong Sukang, 21 Jul 1993, *Sands et al. 5869*, fruit (A, BRUN, SAN, SING); Sungai Mau, 18 Aug 1988, *Nangkat NN 52*, fruit (A, BRUN, SAN, SING); ibid., 28 Jan 1989, *Nangkat NN 63*, flower (KEP, L, SAN, SING), flowers (A, BRUN), fruit (SING); **Muara District.** Berakas Forest Reserve, 31 Sept 1959, *Ashton BRUN 1008*, fruit (BRUN, SING); ibid., 12 May 1957, *Ashton S 7834*, flower (A, BO, BRUN, KEP, SAR). INDIA: **Nicobar Islands.** North Nicobars, Katchall Island, 17 May 1975, *Chakrakanly 2557*, flower (L). INDONESIA: **Java.** Cult. Hort. Bogor V.10.49, 1903, Anon. s.n., flower (A); Tjibodas, sine date, Anon. s.n., flowers (IBSC). **Kalimantan. East Borneo.** Berau, Inhutani area, Km 37 near transect I, plot 6, 7 Oct 1997, *Ambriansyah et al. Berau 841*, fruit (A), fruits (L); Commisi Kap. Genderen Stort., Gunung Samenggaris, Dec 1912, *Amdjah 1094*, flower (K, SING), flowers (A, BO 2 sheets), fruit (BO); Lojanan to Tenggarong road, Kampung Rempaya, 26 Oct 1995, *Ambri et al. AA 1416*, flower (A, K, KEP, L, SAN); Sei. Seluang, 20 km from Wanariset, Waduk road, 11 Jul 1995, *Ambri et al. AA 1291*, fruit (A, BO, SAN), fruits (L); **South Borneo.** Sungai Wain region, North of Balikpapan, Oct 1950, *Kostermans 4323*, immature fruit (A); **West Borneo.** Pontianak, Bentiang, Gunung Sekaju, West of Kampung Madamang, 6 Nov 1980, *Shea 27578*, fruit (A); West Koetai, 21 Aug 1929, *Endert 2765*, fruit (A, BO). **Sumatra,** Bangka, Lombok Besar, 1 Sep 1949, *Kostermans & Anta 282*, fruit (A, KEP), fruits (L, NY, SING); East Coast, Asahan, Kuala Masihi, Apr 1927, *Yates 2397*, flower (L, US), flowers (A, NY, SING); North Siberut Island, Gunung Simapipit, 26 May 1994, *Afriastini 2737*, fruit (K), fruits (L); Palembang, 16 Dec 1916, *Lambach 1354*, flowers (BO); Riau, Tigapuluh Mountains, 15 km Southwest of Talanglakat, Rengat-Jambi road, vicinity of Sungai Serisih, 24 Nov 1988, *Burley et al. 1680*, fruit (KEP, L, NY, SING), fruits (A); South Sumatra, Barisan Range, Seleman Enim, Bukit Seburong near Muara Dua, 15 Mar 1972, *de Vogel 1299*, fruits (L); Southeast Sumatra, Lampung, Way Kambas, 3 Feb 1972, *Mochtan 24A*, fruits (L); West of North Sumatra, Simaloer Island, 1 Nov 1918, *Achmad 709*, fruit (L). **Sumbawa,** Central Sumbawa, Dompu, Raba Baka Trail to Matuatoi, 6 Jun 1961, *Soejarto 60*, fruits (BO); West Sumbawa, Semongkat Atas, 17 km South of Sumbawa Besar, 2 May 1961, *Kuswata 112*, fruit (BO, SING), fruits (A, BO). MALAYSIA: **Peninsular Malaysia. Johor,** Kota Tinggi, Sungei Bang, 13 Mar 1966, *Sinclair 10863*, flowers (US 2 sheets); Mawai to Jemilang Road, Sungai Berassau, 6 Feb 1935, *Corner 28736*, fruits (SING), Sungai Kayu near Sungai Sedili, 10 Mar 1937, *Kiah SFN 32368*, fruits (A, SING), Sungai Sedili, 28 Mar 1937, *Corner 32440*, flower (BO), flowers (A, SING 3 sheets). **Kedah,** Koh Mai Forest Reserve, 3 Apr 1938, *Kiah SFN 35148*, flowers (A, SING 2 sheets); Ulu Muda Forest Reserve, 21 Jan 1969, *Chan FRI 6777*, fruit (A). **Kelantan,** Kuala Krai, Taman Negara, Kuala Koh Headquarters, 30 Mar 1995, *Latiff et al. 4168*, flower (K, L); Ulu Lebir Forest Reserve, 12 Aug 1970, *Suppiah FRI 11681*, fruit (L 2 sheets). **Melaka,** Chaban, 28 Sep 1885, *Alvin 2364*, fruits (SING); Kemandore, 14 Jul 1917, *Burkill 2509*, fruits (SING). **Negeri Sembilan,** Pasoh Forest Reserve, 6 Jul 1988, *LaFrankie 3032*, fruits (A); ibid., 16 Jul 2008, *Wong & Zulkapli* s.n., leafy branch (KLU). **Pahang,** Rompin, Pulau Tioman, Sungai Asah to waterfall, 29 Apr 1995, *Zainudin & Bedul 5477*, flowers (L), Ulu Sungai Sat, 11 Jul 1970, *Mohd Shah & Mohd Noor MS 1833*, fruit (A, L, US), fruits (SING). **Perak,** Gopeng, Apr 1884, *King's collector 5830*, flower (L); Gunong Bubu via Trong, 27 Apr 1970, *Suppiah FRI 11673*, fruit (K, L), near Selangore, Apr 1886, *King's collector 8736*, flowers (K); Selama, 1894, *Wray 4265*, flowers (SING). **Selangor,** Gombak, 27 Jun 1960, *Poore 185*, fruit (KLU); Kajang, Bukit Enggang, 9 Apr 1930, *Symington 24190*, flower (SING); Sungai Buloh, 1891, *Ridley* s.n., fruits (SING); Sungai Buloh Reserve, 25 Mar 1919, *Abu 3313*, flowers (SING).

Terengganu, Kuala Trengganu, Jerteh, Gunung Tebu Forest Reserve, compartment 65, 12 Oct 1971, *Zainuddin FRI 17945*, fruit (A, L, SING), Kuala Trengganu, logging school area, 14 Nov 1978, *Suppiah FRI 28251*, fruit (A). **Sabah. Beaufort,** Membakut, Kampung Binsulok Forest Reserve, 23 Apr 1984, *Ag. Amin & Haya SAN 102465*, flower (A, KEP, L, SAN, SING), flowers (SAN); **Beluran,** Tongod, Ulu Sungai Pinangah, 16 Oct 1984, *Amin et al. SAN 107143*, fruit (SAN 2 sheets); **Kalabakan,** Benaword logged over area, 11 Apr 1980, *Fedilis & Sumbing SAN 91785*, fruit (SAN); Maliau Basin, Rafflesia Camp to Resak Island, 26 Apr 2000, *Ming et al. MB 283*, fruit (KEP, SAN); **Keningau,** Shang Lian logging area, LANAS, 16 Oct 1986, *Mantor SAN 118392*, fruit (SAN) fruits (SAN); **Kinabatangan,** Gunung Rara Forest Reserve, Maliau river, 11 Apr 1996, *Puff 960411-1/2*, flowers (SAN); Lamag, Gunong Lotung, 5 miles Southeast of Inarat, 7 May 1976, *Cockburn SAN 83039*, flower (A, KEP, SAN, SING); Lamag, Sogo-sogo, Kampung Tongod, 22 Nov 1979, *Madani SAN 91125*, flower (K, KEP, SING), flowers (SAN); Lamag, Tanegang Kechil, 26 May 1965, *J. Singh & Eging SAN 51864*, flowers (K, SAN, SING); Sukau, Sungai Menanggul, 13 May 1996, *Azmi et al. RA 512*, flower (L), flowers (KEP), flower & flower bud (K, SAN); **Kuala Penyu,** Kepayan, 20 Aug 1993, *Ag. Amin SAN 127290*, fruit (K), fruits (SAN); Mempakul, Malikai, 25 Feb 1937, *Mail 7060*, flower (A, SING); **Kudat,** without locality, 7 Aug 1885, *Fraser 164*, flowers (K); Berambangan, 9 Jul 1962, *Brand SAN 30870*, fruit (SAN); Dumpirit, *Balajadia*, 7 Feb 1933, *NBFD 2843*, flower (BO), flowers (A); **Lahad Datu,** Mile 17.7 of Kalumpang-Tawau road, 16 Sep 1962, *Chai SAN 29828*, fruit (BO, KEP, SAN, SING); Pulau Sakar, 16 Mar 1961, *H.S.M. & D. Brand SAN 24552*, flower (SING), flowers (SAN), flowers & fruit (BO, KEP.); **Nabawan,** Sepulut, Sepulut Forest Reserve, Labang, 17 Oct 1988, *Fedilis & Sumbing SAN 125652*, fruit (SAN); Sungai Tibow, 18 Jul 1984, *Fedilis & Sumbing SAN 105342*, fruit (SAN); **Papar,** Mandahan Forest Reserve, 8 Jul 1987, *Ag. Amin SAN 103348*, immature fruit (SAN), fruits (K); **Ranau,** without locality, 23 Feb 1990, *Majawat SAN 125800*, fruit (KEP, L); Bongkud, 26 Mar 1986, *Amin et al. SAN 105640*, flower (A, K, KEP, SAN, SING); **Sandakan,** Kretam, Sungai Kulamba, 9 Apr 1984, *Sundaling SAN 55998*, flower (A, L, SAN 2 sheets); Labuk Road Forest Reserve, 11 Feb 1993, *Wong WKM 2600*, flowers (SAN); Sepilok Forest Reserve, Jalan Hg. Tanjong Cpt. 13, 24 Sep 1968, *Patrick SAN 63508*, fruit (L), fruits (SAN); Sungai Dagat, 14 Jul 1987, *George et al. SAN 120736*, fruit (K, KEP), fruits (SAN); Sungai Malikop, 25 Aug 1984, *Sigin & Ismail SAN 100264*, fruit (L, SAN); Telupid, Kampung Wonod, 19 Mar 1974, *Aban & Saikeh SAN 79413*, flower (A, K, SING) flowers (A, KEP, SAN); **Semporna,** Bodgaya, 6 May 1939, *Valera SHN 10263*, flower (SING), flowers (KEP); Semporna, Mile 25 of Pagagau Road, 11 Mar 1965, *J. Singh et al. SAN 48883*, flower (NY), flowers (SAN); **Sipitang,** Melaliah, 19 Oct 1961, *Md. Thaufeck SAN 27148 No. 19*, fruit (BO, SING), fruits (SAN); **Tawau,** Bombay Burmah Timber Company Concession, Sub-compartment no. 2 of Compartment no. 1, 28 Nov 1954, *Wood SAN A3973*, fruit (KEP), flowers & fruits (L); Elphinstone Province, Oct 1922-Mar 1923, *Elmer 20544*, fruit (A 2 sheets, IBSC, L, NY, SING); Mostyn, Tengkayu Waterfall, Sabah Timbers Company, 28 May 1965, *Madani SAN 47171*, flower (K), flowers (SAN); Kalabakan Road, Mile 12, 26 Jul 1962, *Aban SAN 30557*, fruit (L, SAN), fruits (KEP); **Tenom,** Mandalom Forest Reserve, 17 Sep 1986, *Mantor SAN 116647*, fruit (SAN 2 sheets). **Sarawak.** without locality, 1865-1868, *Beccari 3250*, flower (K), sine date, *Native Coll. 214*, flowers (US); **1st Division,** Kuching, Matang, Aug 1912, *Anderson 6*, flowers (SING); Kuching, Matang Road, 10 Jul 1964, *Salleh 12092*, flower (A, K, NY); Mount Matang, 27 Oct 1929, *J. & M.S. Clemens 22334*, flower (K, SAR), flowers (A, K, NY); Kuching, Santubong, 19 Nov 1904, *Egon 252*, fruit & flower (SAR); Simunjan, Serian to Simanggang Road, Ulu Simpang Sabal Aping, Gunong Gaharu, 9 Oct 1974, *Ilias & Azahari S 35687*, fruit (KEP, L, SAN, SAR); 26th Mile Bau/ Lundu Road, Sampadi Forest Reserve, 17 Jun 1968, *Jugah S 24948*, flower (SAN) flowers (A, K, SAR); **2nd Division,** Sri Aman, 95th Mile, Kampong Pungor Tapang, 9 Mar 1981, *Ilias S 42712*, fruit (KEP, L, SAN); **3rd Division,** Kapit, Balleh, Ulu Sungai Mengiong, Apan Entelit, 14 Mar 1996, *Rantai et al. S 74211*, fruit (K, KEP, SAN, SAR, SING); **4th Division,** Bintulu, Nyabau Catchment Area, 22 Jun 1966, *Sibat S 24617*, flower (A, BO, KEP, SAN, SING), flowers (K, SAR); **5th Division,** Baram district, Miri river, Feb 1895, *Hose 506*, flowers (K, L). PHILIPPINES: **Busuanga.** without locality, Sep 1922, *Ramos Bur. Sci. 41218*, immature fruit (K, L); NE of Coron, 2 km north of San Nicolas, along Wayan Creek, 29 Jun 1984, *Bourell 2439*, fruit (A). **Culion,** without locality, 29 Apr 1931, *Herre 1085*, flowers (A), flower & flower buds (NY); Apr 1931, *Herre 1088*, fruit (NY). **Luzon,** Camarines Province, Paracale, Jan 1884, *Vidal 832*, flower & fruit (K); Laguna Province, Dahican River, Sep 1912, *Ramos 1325*, fruit (A, L, NY, SING); Tayabas Province, May-Jun 1916, *Cailipan For. Bur. 25640*, fruit (K, US); Lucban, May 1907, *Elmer 7732*, fruit (A). **Mindanao,** Zamboanga, Feb 1908, *Whitford & Hutchinson For. Bur. 9492*, flower (NY, US). **Palawan,** without locality, May 1913, *Merrill 1360*, flower bud & fruit (A, NY, SING); Bataraza, Bgy. Sumbiling, Sitio Gamayon, Bulanjao Range, 8°33'N 117°24'E, 21 Mar 1995, *Soejarto & Madulid 9030*, fruit (A, PNH); Puerto Princesa, Irawan, Impapai hills above BFD Field Station, 9°51'N 118°37'E, 26 Jun 1992, *Soejarto & Fernando 7750*, flower & flower buds (K, NY); Irawan, Irawan River Valley, Tatanarom, road to Benguet mine, Mt Beaufort, 9°50'N 118°40'E, 16 Jul 1988, *Soejarto & Madulid 6066*, fruit (NY, SING, US); Irawan R. valley head, 19 Mar 1984, *Ridsdale SMHI 145*, flower bud (A, BO, K, KEP, L); lower slopes of Mt Beaufort, 30 Mar 1984, *Ridsdale SMHI 291*, flowers & flower bud (A, BO, K, L, SAN); Puerto Princesa, Mt Pulgar, Apr 1911, *Elmer 13064*, flower (NY, US), flower & immature fruit (A); Pulot, Massin River, 12 km N. Brooks Point, 23 Oct 1985, *Ridsdale 998*, fruit (A, L 2 sheets); Taytay, May 1913, *Merrill 1279*, flower (A, NY, SING); Taytay, island on Lake Manguao, *ca* 10 km SE of Taytay town, 10°50'N 119°33'E, 30 Jan 1991, *Soejarto & Fernando 7419*, fruit (A, PNH); valley stream leading into NNW bay of lake, 7 Apr 1984, *Ridsdale SMHI 357*, fruit (A, BO, KEP, L, SAN). **Panay,** Capiz Province, Oct-Nov 1925, *Edano Bur. Sci. 46123*, fruits (A, BO, NY, SING). **Sibuyan,** Capiz Province, Magallanes, Mt Giting-Giting, Mar 1910, *Elmer 12103*, flower & flower buds (A) flower (NY, US). **Tawi-tawi,** Sulu Province, Jul-Aug 1924, *Ramos & Edano Bur. Sci. 44127*, fruit (A, NY, SING, US). SINGAPORE: Bukit Timah, 1898, *Ridley 11332*, flower (K, SING), Bukit Timah Reserve, tree no. 166, 21 Jul 1938, *Ngadiman SFN 35595*, fruit (A); Gutta Valley, 1907, *Ridley* s.n., fruit (SING). THAILAND: **Peninsular Thailand,** Narathiwat, Waeng, Klong A-re-ma, 3 May 1999, *Puudja 561*, flower (BKF); Pattani, Banang, 22 Jul 1923, *Anon. 7275*, fruit (K); Sukinin District, Tomo Mine, 25 Dec 1999, *Wongprasert 9912-38*, fruit (BKF); Trang, Talay Songkong, 19 Mar 1915, *Vanpruk 661*, flower (BKF), flowers (K).

1a. ***Gardenia elata*** var. ***longipedicellata*** K.M.Wong, ***var. nov.***
A var. typica pedicellis floris longioribus (7-10 mm longis) differt. **-Typus:** Luzon, Cagayan Province, May 1921, *Ponce For. Bur. 28435* [holo, A (sheet 1 of 2); isotypi, A (sheet 2 of 2), US]. **Fig. 3.**

Habitat and ecology: Lowland forests (including on ultramafic soils).

Distribution: Endemic to the Philippines, Luzon (Cagayan, Isabela and Rizal provinces) (Fig. 2).

Proposed IUCN conservation assessment: Vulnerable due to very few known, small or restricted populations (VU D2).

Note: This is recorded as a tree reaching about 15 m high. It shares much similarity with the typical variety, differing only by its longer (0.7-1 cm) flower pedicels compared to those of *G. elata* var. *elata* (only 0.1-0.4(-0.5) cm long).

Specimens examined: PHILIPPINES: **Luzon,** Cagayan Province, May 1921, *Ponce For. Bur. 28435*, open flower (A, 2 sheets; US); ibid., Jan-May 1915, *Velasco For. Bur. 24116*, open flower & fruit (US); Isabela Province, Mar 1910, *Bernardo For. Bur. 15478*, flower (L), Kapuntian, San Jose, San Mariano, 16°59.7'N 122°2.3'E, sine date, *Barbon et al. PPI 13137*, immature

Figure 3. Close-up of flower of *Gardenia elata* var. *longipedicellata* from Bernardo For. Bur. 15478 (L).

fruit (L); Isabela Province, Palanan, Digallorin, Divinisa camp site, 16°30'N 122°26'E, 10 Apr 1992, *Ridsdale et al. ISU 479*, flower bud (A, BO, K, L); Rizal Province, Feb 1905, *Ahern's Collector For. Bur. 2673*, fruit (NY, SING, US); ibid., May 1907, *Ramos Bur. Sci. 2689*, open flowers (US).

2. ***Gardenia subcarinata*** (Corner) Y.W.Low, *comb. et stat. nov.*
Basionym: *Gardenia tubifera* var. *subcarinata* Corner, Gard. Bull. Straits Settlem. 10 (1939) 48; Gard. Bull. Singapore 35 (1982) 22; Tree Fl. Malaya 4 (1989) 349. – **Type:** Penang, Government Hill, Feb 1889, *Curtis 686* (holo, SING 0048397; iso, SING 0048383). **Fig. 4A-C.**
-"*Gardenia resinifera*" *auct. non* Roth, Nov. Pl. Sp. (1821): Ridley, Fl. Malay Penin. 2 (1923) 83.
-"*Gardenia tubifera*" *auct. non* Wall. ex Roxb. (1824): King & Gamble, J. Asiat. Soc. Beng. 72 (2) (1903) 219 (as "Form 2").

Tree, to *ca* 15 m high, trunk to *ca* 76 cm diameter, not buttressed. **Bark** smooth, light grey-brown to dark brown. **Stipules** connate into a cylindrical tube, 0.2-0.4 cm long, apex 2-lobed to subtruncate, outside puberulent and generally coated with resin (this sloughing off in older material), inside with a mixture of dark-coloured colleters and scattered fine translucent trichomes densely covering about three quarters of the surface from the base (trichomes slightly longer than the colleters) and glabrous in the upper part. Petiole (0.5-)0.6-1.5 cm long, 1-2 mm thick, evenly covered with puberulent hairs, sometimes conspicuously resin-coated. **Leaf** lamina obovate (4.5-)7-14 cm long, (1.9-)2.2-4.6 cm wide, leaf base cuneate, apex cuspidate, thin-coriaceous, conspicuously coated with resin when young; midrib slightly raised to flat and puberulent on upper side, prominent and puberulent on lower side; secondary veins 7-12 pairs, flat to sunken and glabrous on upper side, prominent and puberulent on lower side, vein axils on the lower side with hairy pocket domatia; tertiary venation scalariform. **Flowers** solitary. Pedicel 0.1-0.3 cm long and 1.2-1.8 mm thick in open flowers, reaching 0.1-0.4 cm long and 2.5-3 mm thick at fruit maturity. **Calyx** obconical, slightly flared outwards at the apex; medium green; 0.4-0.7 cm long, 2-3.5 mm wide at the base, becoming 4-8 mm wide at the apex; outside densely puberulent, often coated with resin; inside glabrous for most of the upper half, densely covered with a mixture of dark-coloured colleters and translucent trichomes at the basal half (trichomes longer than colleters and especially conspicuous as a dense fringe at the very base of the calyx); marginal lobes 7-9, subtriangular to rounded, about 0.5-1 mm high; keels present, generally alternating with the calyx lobes, forming narrow spurs at the apex that protrude up to 2 mm beyond the calyx tube margin, narrowing gradually towards the base of the calyx limb but not extending downward to the hypanthium. Corolla hypocrateriform, cream turning light yellow, then deep to orange yellow; tube to 4.6-6.8 cm long, 1.5-3 mm wide at the mid-portion, 7-8 mm wide at the throat, outside glabrous to puberulent, inside largely glabrous except for sparse ribbon-like translucent hairs in narrow zones between stamens from the throat to just below the anthers; lobes 6-9, oblanceolate to obovate, 12-21 mm long, 6-13 mm wide, contorted to the left in the bud stage, glabrous on both sides. Stamens 6-9, inserted just below the corolla throat and between corolla lobes, dorsifixed; filaments very short to inconspicuous; anthers 5-7 mm long, c. a third to half of its length exserted; pollen in tetrads. Style 7.5-8 cm long, glabrous; stigma club-like with 3-4 lobes initially cohered together, 2-5 mm long, 1.5-3 mm wide, wholly exserted; ovary with several parietal placentas. **Fruits** subglobose, 1.5-2.5(-2.7) cm long, 1.8-3 cm wide, surface in mature specimens smooth; calyx persistent at fruit apex, the tube to 0.5-0.7 cm long, 0.5-0.6 cm wide at the mouth, with low keels from its mouth to the base, not extending downward to the fruit proper, forming apical spurs projecting 0.5-1 mm beyond the calyx margin; when ripe splitting irregularly to expose dark coloured seeds embedded in a bright yellow-orange pulp. **Seeds** many, irregularly angular-elliptic, flattened.

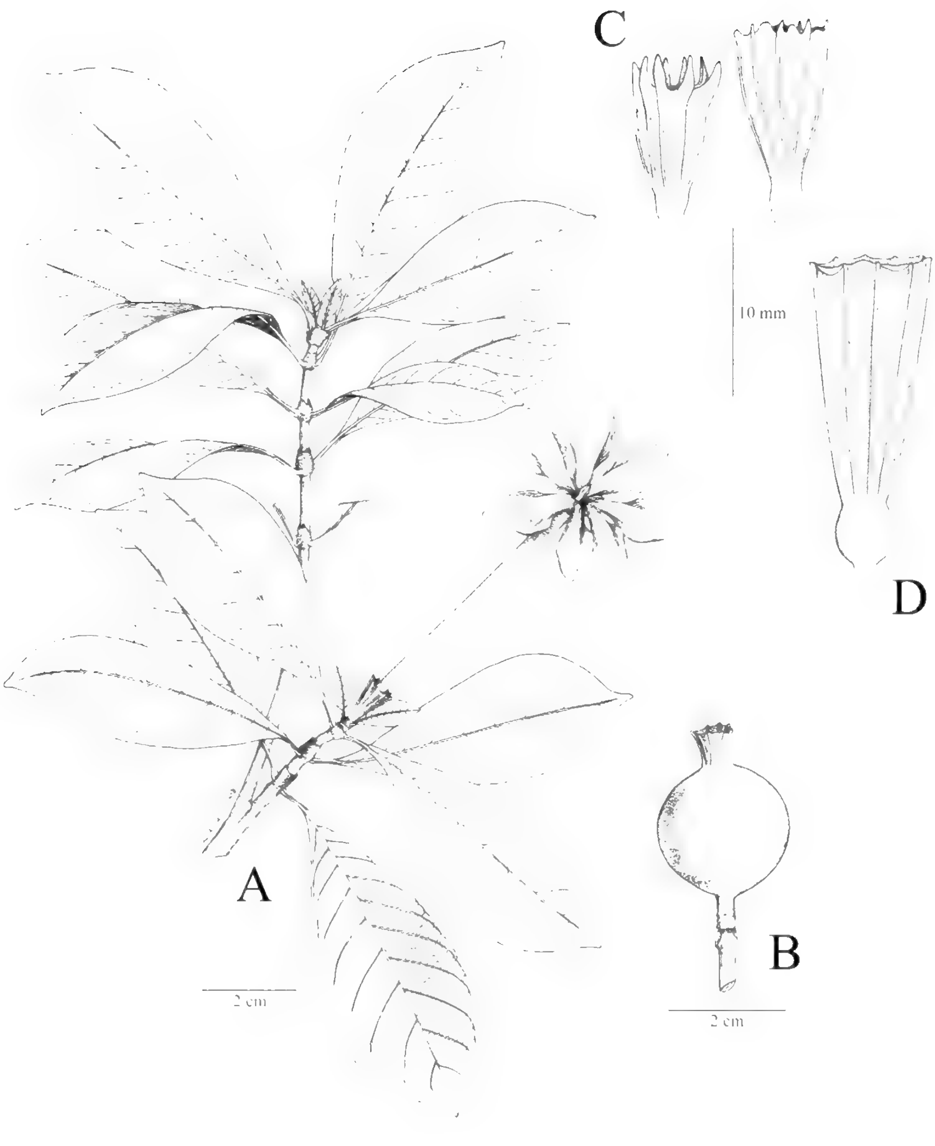

Figure 4. *Gardenia subcarinata*. A-C. *Gardenia subcarinata* var. *subcarinata*: A. Leafy branches, one terminated by a solitary flower; B. Fruit with persistent calyx; C. Calyx with protruding apical keels of the less common (left) and the more common condition (right). D. *Gardenia subcarinata* var. *sumatrana*, calyx without protruding apical keels. [A from *T. & P. 389 (KL 2989)* (L); B from *Curtis 686* (SING barcode no. 0048386); C from *Ngadiman SFN 34926* (A) (left) and *Zahir KEP 99132* (A) (right); D from *Rahmat 1727* (A)].

Habitat and ecology: Lowland forest, sea level to about 1750 ft [533 m].

Distribution: Endemic to the Malay Peninsula (Fig. 5).

Proposed IUCN conservation assessment: Vulnerable due to fragmented and declining area (VU A4ac).

Note: The type material for this taxon requires clarification. Corner (1939) designated *Curtis 686* in the Singapore Herbarium, collected from Government Hill (=Penang Hill) in Penang, Peninsular Malaysia, as the type of his *G. tubifera* var. *subcarinata* (the basionym of the species). However, in the Singapore Herbarium there are six sheets with this number, but differently dated. Two of the sheets are dated February of 1889, one of which has Corner's handwriting on it, stating "Type". These are the two sheets considered to represent the type material of the species, and the sheet bearing Corner's type annotation is considered the holotype, the other regarded as an isotype sheet (see designations above). Another two sheets are dated March, 1890, from the same locality but without any annotation by Corner. The remaining two sheets are dated July, 1893, also without annotation by Corner. Quite clearly, Curtis had assembled material from three different gatherings from Government Hill and given them all his number 686. Only the two sheets dated February, 1889, are to be accepted as type material.

Specimens examined: MALAYSIA: **Peninsular Malaysia. Johor.** Bandar Tenggara, Linggiu Forest Reserve, 23 Jul 1991, *Lasmy FRI 35917*, flower (A, L, SING). **Kedah.** Bukit Enggang, Bukit Enggang Forest Reserve, 4 Dec 1969, *Everett FRI 13766*, fruit (L), fruits (A); Pedu, road from Pedu to Belatik, 15 May 1995, *Zainudin & Baidal Mohd 5541*, flowers (L). **Pahang.** Raub, Sungai Sempam, 15 Apr 1970, *Soepadmo 666*, fruit (BO, KUL); Taman Negara, path to Terangan hide, 1 Apr 1975, *Cigan FRI 23851*, flower (A, L, SING); Taman Negara, trail from Terenggan to Kumbang Salt Lick, 1 May 1975, *Balgooy 2603*, flower (NY), flowers (L); Ulu Krau, Gunung Benom Game Reserve, 22 Apr 1967, *Zainal KEP 99132*, flower (A). **Penang.** without locality, Mar 1881, *King's collector 1474*, flower (L); Government Hill, Feb 1889, *Curtis 686*, flowers & fruit (SING [sheet nos. 0048397 and 0048383]); ibid., Mar 1890, *Curtis 686*, flowers & fruits (SING [sheet nos. 0048386 and 0048520]); ibid., Jul 1893, *Curtis 686*, flowers (SING [sheet nos. 0048524 and 0048394]); Telok Bahang, Pantai Acheh Forest Reserve, 15 Sep 1966, *Chelliah KEP 98143*, fruits (A); Tiger Hill, 18 Nov 1950, *Sinclair SFN 39095*, flowers & fruit (L, SING); ibid., 18 Nov 1950, *Sinclair 6765*, fruit (US). **Perak.** Sungai Kerian Estate, 29 May 1938, *Spare SFN 34574*, fruits (A); Taiping, 30 Oct

1969, *Everett FRI 13596*, fruits (A), Taiping, Maxwell Hill, 27 Feb 1983, *Khairuddin FRI 31835*, flower & fruit (A); Maxwell Hill road, 30 Oct 1969, *Kochummen FRI 2919*, fruit (A). **Selangor,** Kanching Forest Reserve, 25 Oct 1979, *Kochummen FRI 11496*, flower & fruit (A); Kuala Selangor, Sungai Tinggi, 18 Oct 1937, *Md Nur 34129*, flower & fruits (A), fruit (L); Kuala Lumpur to Kuala Selangor, 27 May 1971, *T. & P. 389 (KL2989)*, flowers (L, SING). **Terengganu,** Dungun, Bukit Bauk Forest Reserve, 19 Nov 1978, *Chan FRI 25155*, fruit (A), Bukit Bauk, 27 May 1986, *T. & P. 1017 (KL 3517)*, fruit (L); ibid., 25 Jul 2006, *Low et al. LYW 131*, leafy branch (KLU). SINGAPORE: Garden Jungle, 9 Dec 1889, *Ridley 2588*, flowers (SING); Bukit Timah, 4 Apr 1938, *Ngadiman SFN 34926*, flowers (A, L).

2a. ***Gardenia subcarinata*** var. ***sumatrana*** Y.W.Low, *var. nov.*
A var. typica carinis calycis non extentis supra apicem tubus calycis differt. – **Typus:** North Sumatra, Bila, Estate Aek-Buro, 15 Oct 1928, *Lörzing 14218* (holo, SING; isotypi, A, L). **Fig. 4D.**

Habitat and ecology: Lowland forest (sea level to about 3281 ft [1000 m]).

Distribution: Endemic to Sumatra (Fig. 5).

Proposed IUCN conservation assessment: Vulnerable due to very few known, small or restricted populations (VU D2).

Note: This is recorded as a tree reaching about 20 m high. It shares much similarity with the typical variety, differing only in the keels on the flower calyx tube, which do not expand into spur-like projections apically. In contrast, in *G. subcarinata* var. *subcarinata*, the keels on the calyx tube form conspicuous spur-like expansions at their apex.

Specimens examined: INDONESIA: **Sumatra,** East Coast Sumatra, vicinity of Rantau Parapat, Bila, 28 Mar-10 May 1932, *Rahmat Si Toroes 1727*, flower (A, NY, US); North Sumatra, Bila, Estate Aek-Buro, 15 Oct 1928, *Lorzing 14218*, flowers (A, SING), flowers & fruit (L); North Sumatra, Sibolangit, 1-4 Apr 1918, *Bruinier 4*, flowers (L); Baven Bandarbarat, 11 Aug 1918, *Lorzing 5914*, flowers (L); Palembang, Banjoeasin, 16 Nov 1915, *Grashoff 826*, flowers (L).

3. ***Gardenia tubifera*** Wall. ex Roxb.
Fl. Ind. ed. Carey & Wall. 2 (1824) 562 – **Type:** Singapore, Oct 1822, *Wallich Catalogue no. 8266*, (holo, K-W; isotypes, K, sheets no. K000173277 & K000173278). **Fig. 6.**

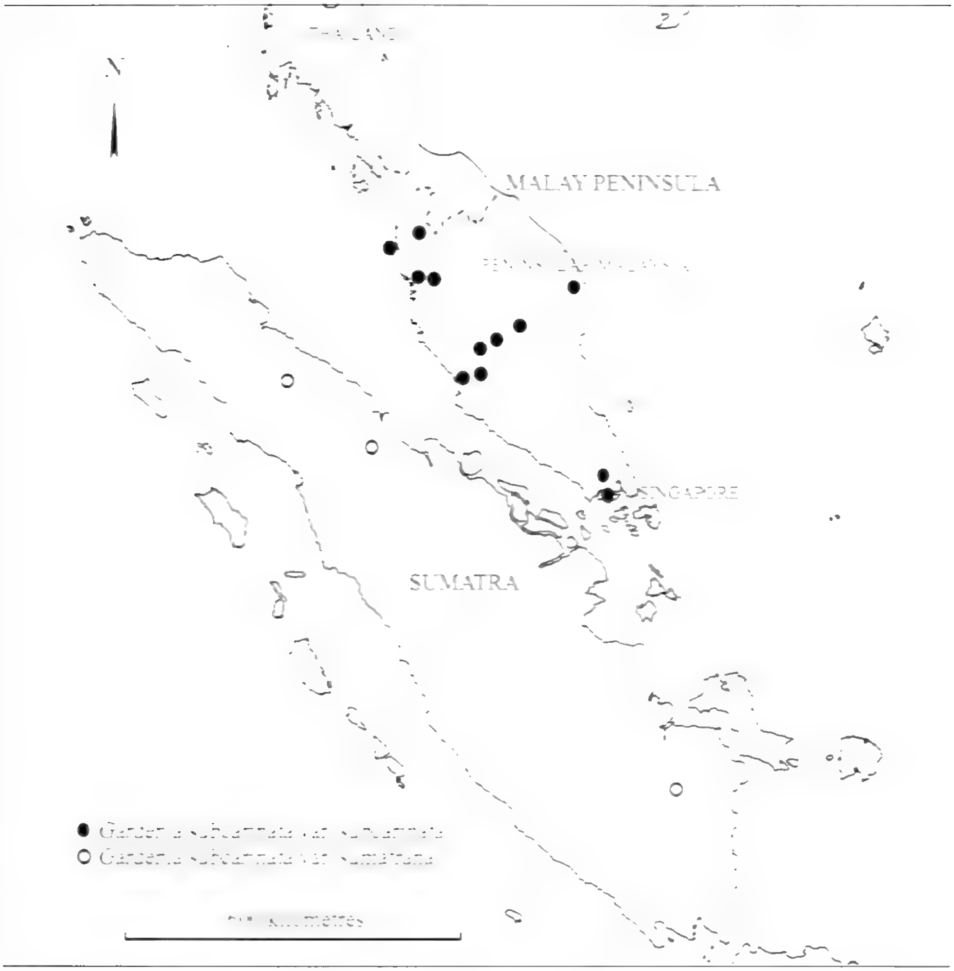

Figure 5. Distribution of *Gardenia subcarinata* var. *subcarinata* and *G. subcarinata* var. *sumatrana* in West Sundaland area.

-*Gardenia tubifera* "form 1" & "form 3" sensu King & Gamble, J. Asiat. Soc. Beng. 72 (2) (1903) 219, *non* "form 2" (= *G. subcarinata*).

-*Gardenia tubifera* sensu Corner, *pro parte*, Gard. Bull. Straits Settlem. 10 (1939) 46, Wayside Trees of Malaya 1 (1952) 541, excl. *G. speciosa* Hook.f. & *G. elata* Ridl.

-*Gardenia resinifera* Korth., Ned. Kruidk. Arch. 2 (1851) 191, *nom. illeg.*, *non* *Gardenia resinifera* Roth, Nov. Pl. Sp. (1821) 150, *nec* *Gardenia resinifera* *sensu* Ridley, Fl. Malay Penin. 2 (1923) 83. – Type: Borneo, *Korthals* s.n. (syntype, L, 4 sheets).

-*Gardenia glutinosa* Teijsm. & Binn., Cat. Hort. Bot. Bogor. (1866) 119, *nom. invalid.*

Tree to *ca* 13 m high, trunk to *ca* 46 cm diameter, not buttressed. **Bark** smooth, light grey-brown to dark brown. **Stipules** connate into a cylindrical tube, 0.4-0.7 cm long, apex 2-lobed to subtruncate, outside puberulent and generally coated with resin (this sloughing off in older material), inside with a mixture of dark-coloured colleters and scattered fine translucent trichomes densely covering the basal half (trichomes longer than the colleters) and glabrous in the upper half. Petiole 0.2-1.5 cm long, 1-1.3 mm thick, subglabrous to evenly covered with puberulent hairs, sometimes conspicuously resin-coated. **Leaf** lamina obovate; 4.5-12.5(-21) cm long, 2.3-5.6(-6.3) cm wide; leaf base cuneate; leaf apex cuspidate to rarely rounded; thinly coriaceous; conspicuously coated with resin when young; midrib flat to sunken and glabrous on upper side, prominent and glabrous to very rarely sparsely, minutely puberulent on lower side; secondary veins 9-15(-17) pairs, flat and glabrous on upper side, prominent and glabrous to minutely puberulent on lower side, vein axils on the lower side with hairy pocket domatia; tertiary venation scalariform. **Flowers** solitary. Pedicel 0.2-0.5 cm long and 1-2 mm thick in open flowers, reaching 0.2-1.5 cm long and 1.5-4 mm thick at fruit maturity. **Calyx** narrowly obconical to somewhat spindle-shaped, the apex often slightly oblique and torn into two acute portions with corolla emergence, the tube subsequently slightly flared outward and often appearing subtruncate in the open flower; medium green, 0.6-1.5(-1.9) cm long, 2-4 mm wide at the base, becoming 5-8 mm wide at the apex; outside densely puberulent at the base and sparsely puberulent to subglabrous in the upper part, often coated with resin; inside glabrous for most of the upper part to about 0.5 cm from the tube margin, densely covered with a mixture of dark-coloured colleters and translucent trichomes at the basal half (trichomes longer than colleters and especially conspicuous as a dense fringe at the very base of the calyx), without lobes, surface smooth, without keels but rarely (upon drying) with a few faintly visible longitudinal ribs (probably the main vascular traces). Corolla hypocrateriform, cream turning light yellow, then deep to orange yellow; tube (2.4-)3.9-9.4 cm long, 1.5-3 mm wide at the mid-portion, 5-9 mm wide at the throat, outside glabrous, inside largely glabrous except for narrow patches of sparse ribbon-like translucent hairs from the throat to just below the anthers; lobes 6-9, oblanceolate to obovate, 14-29 mm long, 7-18 mm wide, contorted to the left in the bud stage, glabrous on both sides. Stamens 6-9, inserted just below the corolla throat and between corolla lobes, dorsifixed; filaments very short to inconspicuous; anthers 6-8 mm long, *ca* a third to half of its length exserted; pollen in tetrads. Style (2.5-)4.3-9.7 cm long, glabrous; stigma club-like with 4-5 lobes initially cohering together, (3-)5-7 mm long, 2-4 mm wide, wholly exserted; ovary with several parietal placentas. **Fruits** subglobose, 2.3-3.3 cm long, 2.4-3 cm wide, surface in mature specimens smooth; calyx persistent at fruit apex, the tube to 0.5-

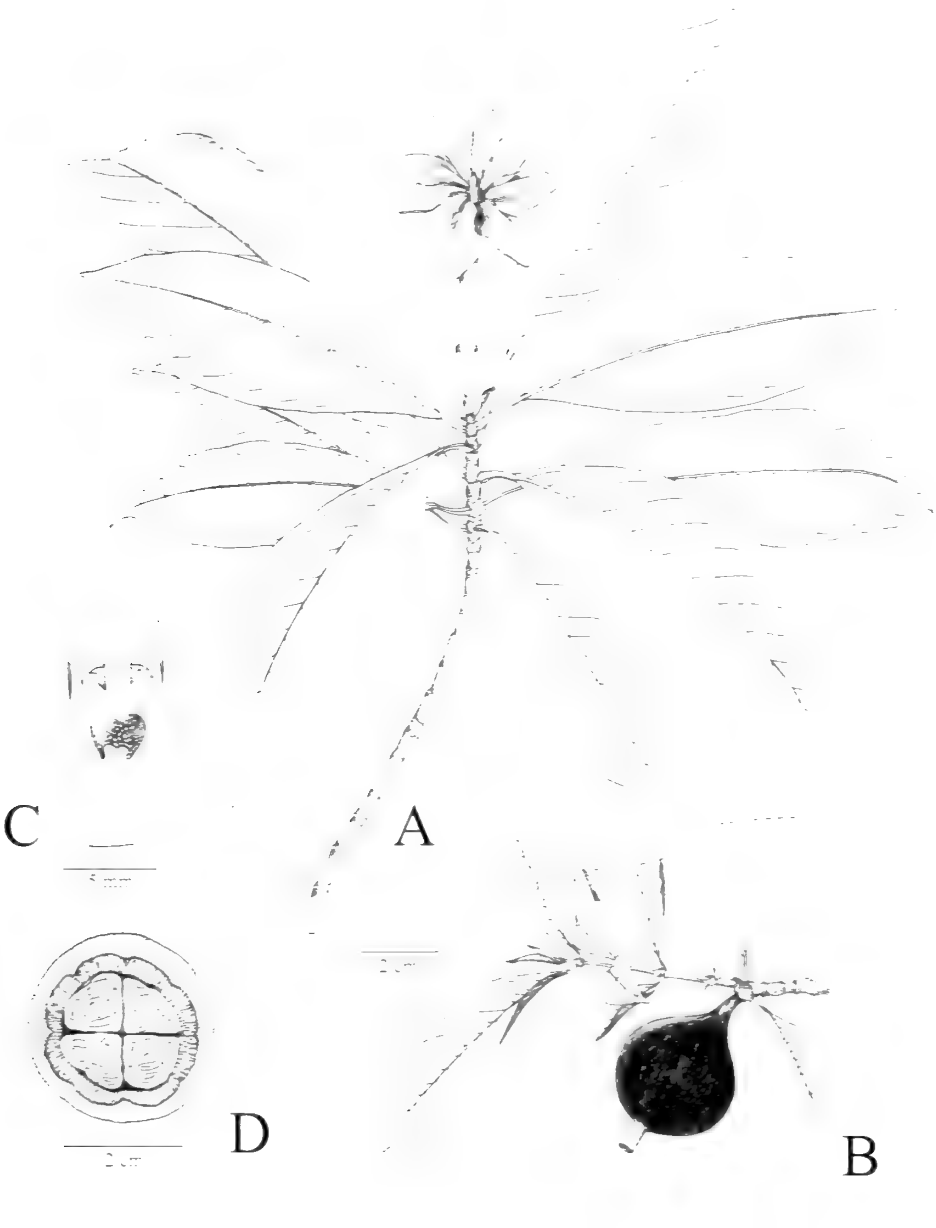

Figure 6. *Gardenia tubifera.* A. Flowering leafy branch; B. Leafy branch with fruit; C. Longitudinal section through lower part of flower including hypanthium; D. Transverse section of fruit. [A from Low *LYW 228*; B from *Low & Zulkapli LYW 163*; C & D from *Low et al. LYW 35* (all KLU)].

1.4 cm long, 0.6-0.8 cm wide at the mouth; when ripe splitting irregularly to expose dark-coloured seeds embedded in a bright yellow-orange pulp. **Seeds** many, irregularly angular-elliptic, flattened, 4-5 mm long, 4-6 mm wide, testa surface fine-areolate.

Habitat and ecology: Confined to coastal estuarine and swamp forest.

Distribution: Widespread from Thailand (Chonburi, Kao Sabab and Peninsular Thailand), Malay Peninsula, Sumatra to Borneo (Kalimantan only) (Fig. 7).

Proposed IUCN conservation assessment: Vulnerable due to fragmented and declining area (VU A4ac).

Note: In the Kew Herbarium, the type material *Wallich Catalogue no. 8266* is represented on three sheets. The first sheet, from Wallich's Herbarium (K-W: a fruiting specimen from Singapore) is not barcoded, but represents the holotype, in accordance with Recommendation 9A.4 of the International Code of Botanical Nomenclature (Vienna Code) (McNeill *et al.* 2006). The second sheet, incorporated from Hooker's Herbarium and bearing Kew barcode K000173277 (also a fruiting specimen), is an isotype. The third sheet contains two different collections; the specimen on the lower half of the sheet (a fruiting specimen) is a duplicate of *Wallich Catalogue no. 8266*, barcoded K000173278, and also represents an isotype, whereas the specimen on the upper half of the sheet is Hervey's collection of 1886 (including a fruit and a flower) and is not a part of the type material.

Specimens examined: INDONESIA: **Kalimantan. Central Borneo,** Kec. Mentaya Hilir Utara Sei Sampit, Bagendang, 25 Feb 1982, *Afriastini 341*, flower (L); Kumai, Sungai Bekunyir, 14 Mar 1975, *Anderson (1975)2*, flowers & fruit (BO 2 sheets); **East Borneo,** Pesiangan Bengka and Muara Kaman, Mahakam river, 24 Aug 2000, *Adriansyah AA 3002*, fruit (A, K); Samarinda, Sungai Pedang Kota Bangun Ulu, 23 Feb 1992, *Ambri & Arifin AA 443*, fruit (A, K); **South Borneo,** Bangarmassing, 1857-1858, *Motley 341*, flowers (K); Maharanda, 1918, *Anon. 15b*, flowers (BO); Pleihari, 22 Aug 1965, *Sauveur 965*, flowers (L); Poeloe Lampei, sine date, *Korthals* s.n., fruits (L); ibid., sine date, *Korthals 2415*, leafy branch (L); ibid., sine date, *Korthals 2416*, leafy branch (L); ibid., sine date, *Korthals 2417*, leafy branch (L); Rantau to Maugasari, 14 Dec 1988, *Giesen 70*, fruit (L), fruits (L); Tanah Laut District, Hutan Kintap base camp, 20 Apr 1985, *Leeuwenberg & Rudjiman 13460*, flowers & fruit (L); Z. O. Borneo (Southeast Borneo), Veenbosch bij Tamban, 10 Oct 1939, *Polak 480*, fruit (A, BO, L, SING); **West Borneo,**

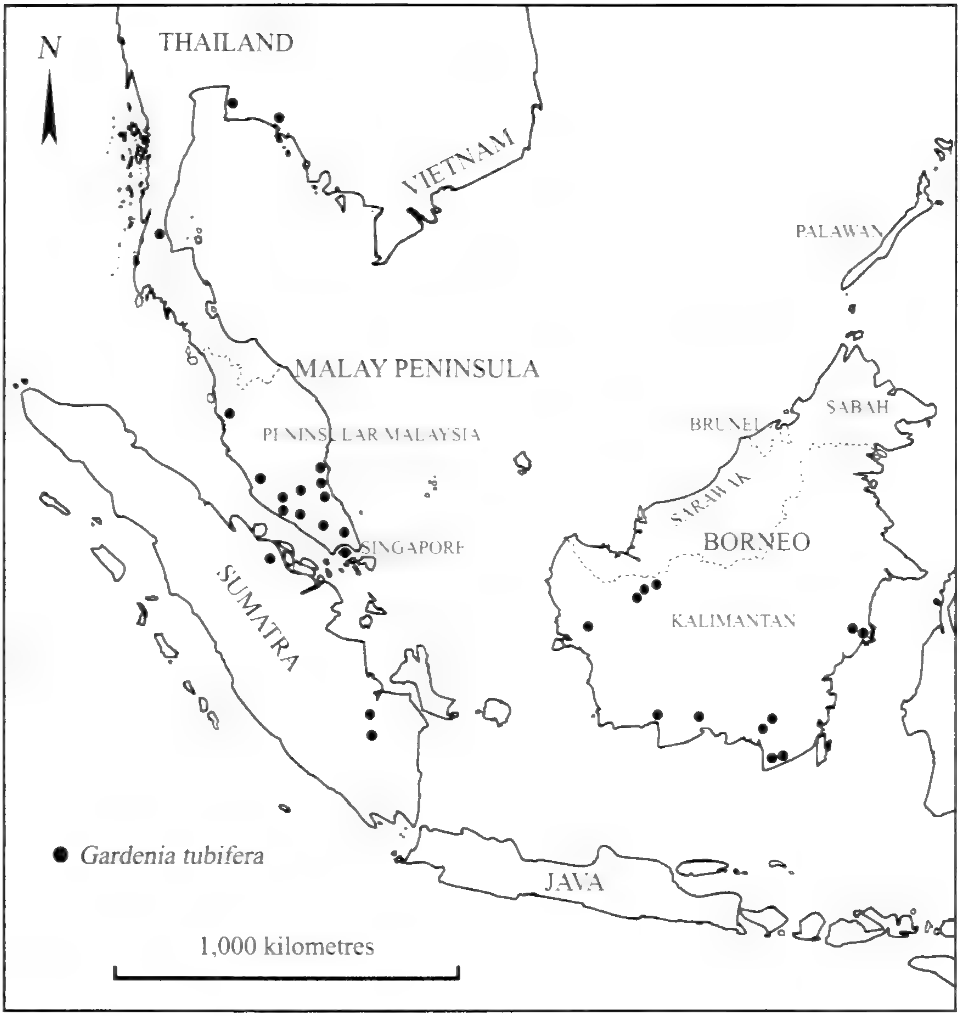

Figure 7. Distribution of *Gardenia tubifera* in the Sundaland area.

Kenepai, sine date, *Teysmann 8332*, fruits (L); Lake Tajan, 22 Oct 1949, *Main 1746*, immature fruit (A, K) fruit (BO); Salimbauw, sine date, *Hallier B 1257*, flowers (L 2 sheets) flower & fruit (L); Soeka Lanting, sine date, *Hallier B 183*, fruit (L); Soengai Kenepai, sine date, *Hallier B 1906*, fruit (L); Sungei Batang Putus, South of Danau Sentarum Wildlife Reserve, 31 Mar 1986, *Giesen 1*, flowers (L) flower & fruit (L); West Koetai, No. 3 near Kampong Sabentoeloeng, 20 Jun 1925, *Endert 1518*, fruits (L 2 sheets), flower & fruit (A, BO, SING). **Sumatra,** Palembang, Sematang, 19 Jan 1920, *Endert E 808*, flowers (L); Palembang, Kajoeagoeng, 29 Mar 1928, *de Voogd 139*, flowers (L 2 sheets); ibid., 23 Jan 1929, *de Voogd 283*, flower (BO); Upper Riau, Pekanbaru, Tenajan Reserve, 11 Aug 1960, *Soepadmo 20*, fruit (K, SING).

MALAYSIA: **Peninsular Malaysia.** without locality, 1862-1863, *Griffith KD 2816*, flower (L), flowers (K). **Johor,** Bekok River, 1880, *Ridley 11139*, flower & fruit (SING); Kluang, 5 Mar 1973, *Hardial Singh & Samsuri HS 1092*, fruit (US), flower & fruit (A); Kota Tinggi, Dec 1892, *Ridley 4209*, flower & fruit (SING), Kota Tinggi, Sungai Bang, 13 Mar 1966, *Sinclair 10863*, flower (A, SING); Kuala Sembrong, 1892, *Lake & Kelsall 4088*, flowers & fruit (SING); Sungai Sedili, Bagan Limau, 18 Feb 1931, *Corner SFN 24625*, flower & fruit (SING), Sungai Sedili, Danau, 27 Mar 1932, *Corner SFN 25971*, flower & fruits (BO, SING). **Kuala Lumpur,** University of Malaya, Rimba Ilmu Botanic Garden, cultivated opposite the medicinal plants section near the front entrance, 24 Dec 2008, *Low LYW 228*, flower (KLU). **Melaka,** without locality, sine date, Anon. s.n., flower (SING), 1845, *Griffith* s.n., flowers & fruit (K, NY), Aug 1886, *Hervey* s.n., flower & fruit (K), sine date, *Lobb 347*, flowers (K), 1871, *Maingay KD 838*, flowers & fruit (K 2 sheets, L), 1871, *Wright* s.n., flowers (K); Bt. Sadanau, Feb 1890, *Derry* 360, flowers & fruit (SING); Merlimau, Jun 1889, *Derry 199*, fruits (SING); Sungai Tebong, South of Bukit Putus, 30 Jan 1916, *Burkill SFN* 1434, flower (SING); 5 miles South of Malacca, Batu Berendam Road, 29 Apr 1961, *Burkill HMB 2640*, fruits (A, SING). **Negeri Sembilan,** 12 miles Simpang Pertang-Kuala Pilah roadside, 2 Sept 1977, *Asri FRI 25738*, fruit (A). **Pahang,** Lubuk Paku, 28 Nov 1924, *Ngadiman SFN 16114*, flower & fruits (SING); Muazam Shah to Menchali Road, road to Kampung Sedaik Asal, 1 May 2008, *Low et al. LYW 167*, fruit (KLU); Pekan, 28 Nov 1929, *Burkill & Haniff SFN 17129*, flowers (A), flowers & fruit (SING); ibid., 20 Aug 1909, *Ridley* s.n., flower (SING); ibid., May 1890, *Ridley 1375*, flower (BO), flowers (BO, SING); Pekan, Nenasi Forest Reserve, 17 Apr 2004, *Ong EL 36*, flower & fruits (KLU 2 sheets); Pekan, Sungai Bebar, 10 Apr 2005, *Low et al. LYW* 35, flower & fruit (KLU); ibid., 30 Oct 2007, *Low & Zulkapli LYW 163*, fruit (KLU); Rompin, Menchali Forest Reserve, 1 May 2008, *Low et al. LYW 169*, fruit (KLU); Tasek Bera, 24 Apr 1980, *Gianno 370*, flower & fruit (KLU); ibid., 7 Sept 2005, *Low et al. LYW 70*, fruits (KLU); ibid., 10 Nov 1975, *Stone et al. 12264*, flower (KLU), flowers (KLU), fruit (NY); Tasek Bera, Kota Iskandar, 1 Feb 1962, *Anon. 1061*, flowers & fruit (KLU); Tasek Bera, near Sungai Bera, 15 Oct 1930, *Henderson SFN 24126*, fruit (NY). **Perak,** Sungai Kerian Estate, 29 May 1938, *Spare SFN 34574*, fruits (SING). **Perlis,** Kangar, Jalan Batu Pahat (cultivated?), 22 Aug 1991, *Zainudin et al. AZ 3825*, fruit (L), leafy branch (K). **Selangor,** Petaling Jaya, Section 16, cultivated inside a bungalow compound (private property), 3 Mar 2006, *Low et al. LYW 164*, flowers (KLU); Sungei Buloh Reserve, Kuala Lumpur, 3 Mar 1923, *Foxworthy 7960*, flowers (SING). SINGAPORE: without locality, sine date, *Burkill 324*, fruits (US), Oct 1822, *Wallich Catalogue no. 8266*, fruit (K 2 sheets, K-W). THAILAND: Chonburi, Sriracha, 4 Feb 1927, *Collins 1407*, fruits (US); ibid., 7 Dec 1927, *Collins 1833*, flower (US 2 sheets); Kao Sabab, 18 Jan 1958, *Sorensen et al. 506*, fruit (BKF, L); Peninsular Thailand, Chumpon, Langsuan, 10 Jan 1977, *Santisuk 908*, fruit (A); Satul, Kuan La Long, 30 Jan 1961, *Ploenchitr 1602*, flower (BKF).

Acknowledgements

We thank the Keepers and Curators of various herbaria for loans and permission to examine materials in their care: Arnold Arboretum, Harvard University (A), Forest Herbarium, Thailand (BKF), Herbarium Bogoriense (BO), Brunei National Herbarium (BRUN), South China Botanical Garden, Guangzhou (IBSC), Royal Botanic Gardens, Kew (K), Forest Research Institute, Malaysia (KEP), University of Malaya (KLU), Nationaal Herbarium Nederland, Leiden (L), University of Michigan (MICH), New York Botanical Garden (NY), Forest Research Centre, Sandakan (SAN), Forest Research Centre, Sarawak (SAR), Singapore Botanic Gardens (SING) and the United States National Herbarium, Washington (US). Help in obtaining literature and digital images was obtained through Datuk C.L. Chan (Kota Kinabalu); Prof. J.H. Beaman, J.J. Wood and Marie Briggs (K); Dr C. Anderson and H. Huggins (MICH), S. Lee (SING), Dr B.W. Eko, Dr Irawati and H. Arief (BO), and A. Bond, Dr A. Davis and S. Dawson (K) kindly assisted with specimen loans and information. Field logistic support was provided through J.T. Pereira, J. Sugau and M. Postar (Sabah); M. Sugumaran, I. Zulkapli, K.T. Yong and I.S. Shanmugaraj (Peninsular Malaysia); H.J. Jamilah, A.K. Muhd. Ariffin, E. Jangarun, P. Azlan and M. Jakaria (Brunei). We are grateful to Prof. C. Puff (University of Vienna) for providing the Latin diagnoses used here. Zainal Mustafa (Rimba Ilmu Botanic Garden) prepared the botanical drawings. This work results from an MSc programme (Y.W.L.) at the Institute of Biological Sciences, University of Malaya, and was supported in part by university research grants PS046-2007C and FS266-2008C.

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A Revision of *Bothriochloa* Kuntze (Poaceae) in Thailand

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Abstract

Bothriochloa Kuntze (Poaceae) has 3 species in Thailand: *B. bladhii, B. ischaemum,* and *B. pertusa.* A key, descriptions, and illustrations are provided.

Introduction

The genus *Bothriochloa* was established by Kuntze in 1891. Its name is derived from the Greek words βοθϱιον (bothrion, a small pit) and χλοη (chloë, young shoot, grass), which refers to the pitted lower glumes of the spikelets in some species of this genus (Bor, 1968). It belongs to the family Poaceae, tribe Andropogoneae, subtribe Sorghinae and comprises about 33 pan(sub)tropical species (Clayton, Harman and Williamson, 2008).

The genus is characterised by a translucent median channel in the joints and pedicels of the raceme. Its nearest relatives appear to be *Capillipedium* Stapf and *Dichanthium* Willemet, and because *B. bladhii* (Retz.) S. T. Blake can hybridise with some species of these two genera. Some have therefore advocated to unite the three into *Dichanthium*, the oldest name (De Wet & Harlan, 1966), but then infrageneric taxa are recognised, e.g., by Roberty (1960), who enumerated these three amongst no less than 12 sections in *Dichanthium*: *Dichanthium* sect. *Amphilophis* (Trin.) Roberty, *Dichanthium* sect. *Bothriochloa* (Kuntze) Roberty, and *Dichanthium* sect. *Dichanthium.*

Bothriochloa can be distinguished from the other two genera as follows:

-Inflorescence composed of subdigitate racemes, rarely paniculate, racemes with more than 8 spikelet pairs. .... ***Bothriochloa***
-Inflorescence a panicle, racemes with 1-5(-8) spikelet pairs ....
.... ***Capillipedium***

-Joints of the rachis and pedicels with translucent longitudinal channels; all spikelet pairs heterogamous .... ***Bothriochloa***
-Joints of the rachis and pedicels without translucent longitudinal channels; spikelet pairs heterogamous, excepting homogamous at basal spikelet pairs .... ***Dichanthium***

For Thailand, Bor (1965) reported *B. glabra* (Roxb.) A. Camus and *B. pertusa* (L.) A. Camus without giving a key or descriptions. Sathagul (1990) in her Master's thesis recorded 6 species: *B. caucasica* (Trin.) C.E. Hubb., *B. glabra, B. insculpta* (Hochst. ex A. Rich.) A. Camus, *B. intermedia* (R. Br.) A. Camus, *B. ischaemum* (L.) Keng, and *B. pertusa* and provided a key and descriptions. Nanakorn and Norsangsri (2001) reported 5 species: *B caucasica, B. glabra, B. intermedia, B. ischaemum,* and *B. pertusa*. However, because this was a mere checklist for Thai grasses there was neither a key nor a description. Later studies have shown that *B. caucasica*, *B. glabra,* and *B. intermedia* are to be considered part of the very polymorphic ("compilospecies": De Wet & Harlan, 1966) *B. bladhii* (Retz.) S.T. Blake.

In the present study in the framework of the Flora of Thailand Project, three species could be distinguished: *B. bladhii*, *B. ischaemum*, and *B. pertusa*. A key, descriptions, and illustrations are presented.

Materials and methods

This study was based on an intensive search through available taxonomic literature and a study of specimens kept at the herbaria in Thailand: the Bangkok Herbarium (BK), the Forest Herbarium, National Park, Wildlife and Plant Conservation (BKF), the Kasin Suvatabhandhu Herbarium, Department of Botany, Chulalongkorn University (BCU), The Herbarium, Department of Biology, Chiang Mai University (CMU), Prince of Songkhla University Herbarium (PSU) and The Herbarium of Department of Botany, Kasetsart University. Several herbaria abroad also were visited: the National History Museum, London (BM), the Royal Botanic Gardens, Kew (K), the Museum National d'Histoire Naturelle, Paris, France (P), the National Herbarium of The Netherlands, Leiden, The Netherlands (L), the Botanical Museum, Natural History Museum of Denmark, University of Copenhagen (C), and the Herbarium, Institute of Biological Sciences, University of Aarhus (AAU). Field work was carried out throughout Thailand during which additional ecological data and localities were recorded.

***Bothriochloa* Kuntze**
Revis. Gen. Pl. 2: 762. 1891. -[*Bothriochloa* sect. *Eubotriochloa* Ohwi, Acta Phytotax. Geobot. 11: 166. 1942, *nom. inval.*]. -*Dichanthium* Willemet sect.

Bothriochloa Roberty, Boissiera 9: 159. 1960. – **Type species**: *Bothriochloa anamitica* Kuntze [= *Bothriochloa bladhii* (Retz.) S.T. Blake].

Andropogon L. sect. *Amphilophis* Trin., Mém. Acad. Imp. Sci. St. Pétersbourg, VI, Sci. Math. 2: 285. (1832) (rank indicated on p. 279). -*Andropogon* L. subgen. *Amphilophis* Trin. ex Hack. in Mart., Fl. Bras. 2(3): 291. 1883. -*Amphilophis* Nash in Britton, Man. Fl. N States: 71. 1901. -*Bothriochloa* sect. *Amphilophis* Ohwi, Acta Phytotax. Geobot. 11: 166. 1942. -*Dichanthium* Willemet sect. *Amphilophis* Roberty, Boissiera 9: 167. 1960.–**Lectotype species** (not resolved). Not *Amphilophis torreyanus* Nash [=*Bothriochloa laguroides* (DC.) Herter var. *torreyana* (Steud.) M. Marchi & Longhi-Wagner, Bol. Inst. Bioci. Univ. Fed. Rio Grade do Sul 57: 52. 1998, f. 6, 19], fide ING (http://ravenel.si.edu/botany/ing/ingForm.cfm), see note.

Tufted **perennials**. **Culms** slender. **Leaf** sheath keeled, glabrous; **ligules** membranous; leaf-blade flat. **Inflorescence** subdigitate or paniculate, composed of many racemes, each consisting of several pairs of sessile and pedicelled spikelets; joints and pedicels with a translucent longitudinal groove, flattened, hairy on both margins. Sessile **spikelets** dorsally compressed, elliptic, oblong to lanceolate, 2-flowered, callus short, shortly bearded; lower **glumes** as long as spikelet, smooth or pitted, 7-11-nerved, chartaceous to membranous, pubescent below the middle, laterally 2-keeled, pectinately setose on keel near tip, apex acute, margin inflexed; upper glumes equally long or somewhat shorter, boat-shaped, 3-nerved, 3-keeled, subchartaceous to hyaline, apex acute, margin inflexed; lower lemmas nerveless, hyaline; upper **lemmas** linear, hyaline, continuous with the geniculate and twisted awn; lower **paleas** absent; upper paleas small or absent. Pedicelled spikelet 1- or 2-flowered, the lower male or neuter, the upper neuter or more often suppressed; lower glume chartaceous, glabrous, margin inflexed; upper glume hyaline, glabrous, apex acute, margin inflexed; lower lemmas hyaline, glabrous; awnless.

Distribution: 33 species, throughout the (sub)tropics, 3 in Thailand.

Note: We have not seen Nash (1901), but this lectotypification seems incorrect. *Amphilophis torreyanus* was based on *Andropogon torreyanus* Steud. [(1840), *nom. nov.* pro *Andropogon glaucus* Torr. (1824), non Retz. (1789)]. This species is not to be found in Trinius (1832), where the apparently unranked (but see rank indicated on p. 279) groups are a medley of taxa, now attributed to *Bothriochloa*, *Chrysopogon* Trin. (*Vetiveria* Bory), *Sorghastrum* Nash, and *Sorghum* Moench. A recent paper by Soreng & Pennington (2003) also did not resolve the question of the type species.

Key to the species-

1. Panicle, lowest raceme shorter than main axis of inflorescence .... 1. ***B. bladhii***
1. Subdigitate, lowest raceme longer than main axis of inflorescence 2

2. Upper glumes hairy on the upper part of nerves. Lower glume of sessile spikelet without a circular pit .... 2. ***B. ischaemum***
2. Upper glumes glabrous. Lower glume of sessile spikelet with a distinct circular pit .... 3. ***B. pertusa***

1. ***Bothriochloa bladhii*** (Retz.) S. T. Blake
Proc. Roy. Soc. Queensland 80: 62. 1969. - *Andropogon bladhii* Retz., Observ. Bot. 2: 27. 1781. -*Andropogon annulatus* Forssk. var. *bladhii* (Retz.) Hack. in A. DC., Monogr. Phan. 6: 572. 1889. -*Dichanthium bladhii* (Retz.) Clayton, Kew Bull. 32: 3. 1978. – **Typus**: China, *Bladh s.n. in Herb. Retzius* (LD, holo, 94/019-0745, SI, photo). **Fig. 1.**
-*Andropogon intermedius* R. Br., Prodr. 1: 202. 1810. -*Andropogon intermedius* R. Br. var. *genuinus* Hack. in A. DC., Monogr. Phan. 6: 485, 1889. *nom. inval.* -*Sorghum intermedium* (R. Br.) Kuntze, Rev. Gen. Pl. 2: 792. 1891. -*Amphilophis intermedia* (R. Br.) Stapf, Agric. News (Barbados) 15: 179. 1916; in Prain, Fl. Trop. Afr. 9: 174. 1917. -*Bothriochloa intermedia* (R. Br.) A. Camus, Ann. Soc. Linn. Lyon II, 76: 164. 1931. -*Dichanthium ischaemum* (L.) Roberty subvar. *intermedium* (R. Br.) Roberty, Boissiera 9: 160. 1960. *nom. inval.* -*Dichanthium* compilospecies *intermedium* (R. Br.) De Wet & J.R. Harlan, Amer. J. Bot. 53: 97. 1966. -Type: Australia, *R. Brown 6184* (BM, holo, photo in BRI, K!).
-*Andropogon glaber* Roxb. [Hort. Bengal.: 7. 1814. *nom. nud.*] Fl. Ind. 1: 271. 1820. -*Andropogon intermedius* R. Br. subvar. *glaber* (Roxb.) Hack. in A. DC., Monogr. Phan. 6: 487. 1889. -*Amphilophis glabra* (Roxb.) Stapf in Prain, Fl. Trop. Afr. 9: 172. 1917. -*Bothriochloa glabra* (Roxb.) A. Camus, Ann. Soc. Linn. Lyon II, 76: 164. 1931. -*Dichanthium ischaemum* (L.) Roberty subvar. *glabrum* (Roxb.) Roberty, Boissiera 9: 159. 1960. *nom. inval.* -*Bothriochloa bladhii* (Retz.) S.T. Blake subsp. *glabra* (Roxb.) B.K. Simon, Austrobaileya 3: 79. 1989. -Type: India, Bengal, *Roxburgh, s.n* .(BM, holo; BR, G; *Icon. ined. 1194:* CAL, K).
-*Andropogon punctatus* Roxb., Hort. Beng.: 82. 1814, *nom. nud.*, Fl. Ind. 1: 268. 1820. -*Andropogon perfossus* Nees & Meyen ex Steud., Nomencl., ed. 2, 1: 92. 1840. *nom. nud.* -*Andropogon intermedius* R. Br. var. *punctatus* (Roxb.) Hack. &. subvar. *perfossus* Hack. in A. DC., Monogr. Phan. 6: 487. 1889. -*Bothriochloa intermedia* (R. Br.) A. Camus var. *punctata* (Roxb.) Keng, Clav. Gen. Sp. Gram Prim. Sin.: 244. 1957. *nom. inval.* -*Dichanthium*

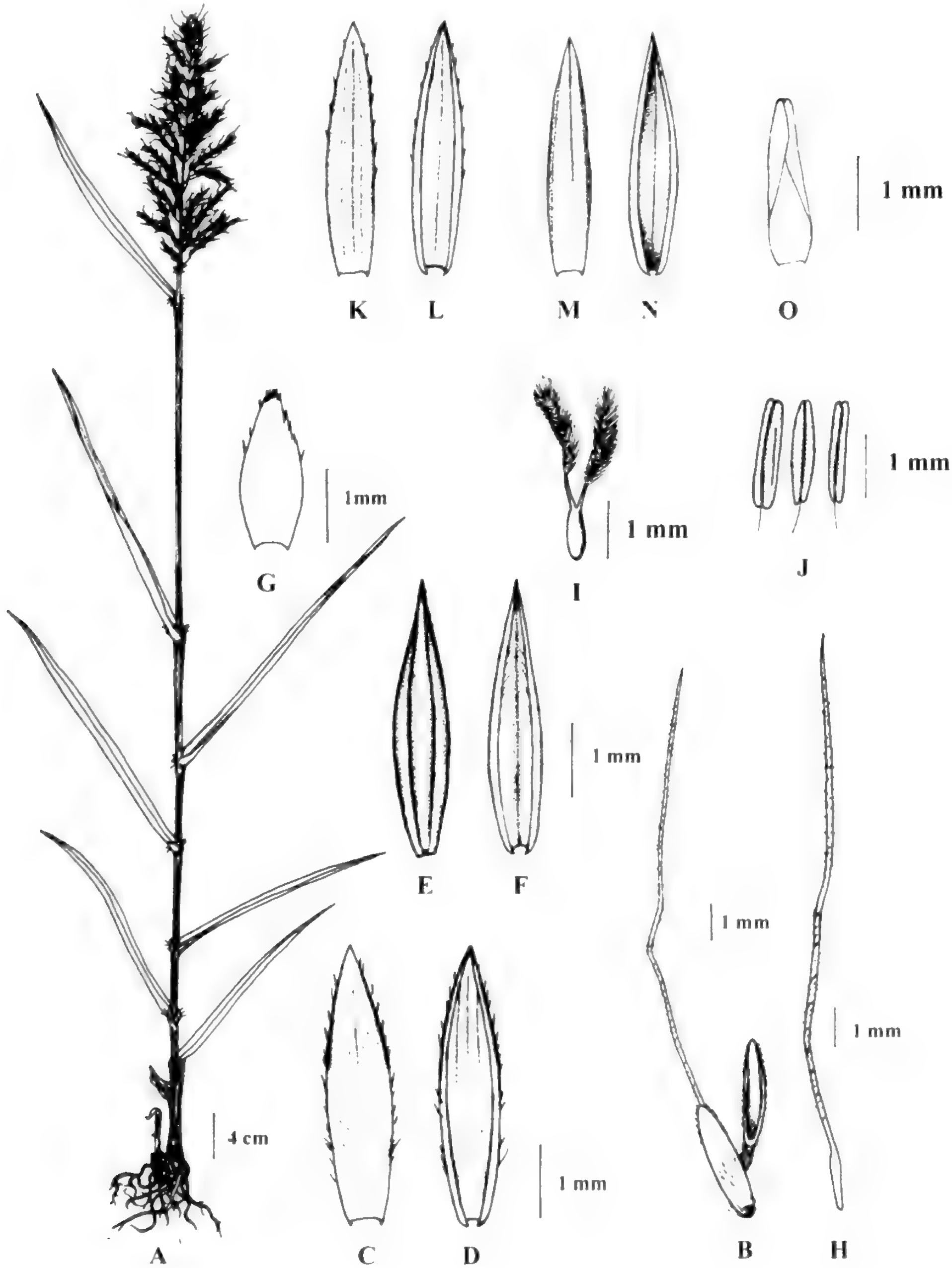

Figure 1. *Bothriochloa bladhii.* A. Habit; B. Spikelet pair; C-J. Sessile spikelet: C-D. Lower glumes; E.-F. Upper glumes; G. Lower lemma; H. Upper lemma; I. Pistil; J. Stamens; K-O. Pedicelled spikelet: K-L. Lower glume; M-N. Upper glumes; O. Lower lemma. [Drawing was based on *O. Neamsuvan 166* (BCU)].

ischaemum (L.) Roberty subvar. *punctatum* (Roxb.) Roberty, Boissiera 9: 160. 1960. *nom. inval.* -*Bothriochloa bladhii* (Retz.) S.T. Blake var. *punctata* (Roxb.) R.R. Stewart, Kew Bull. 29: 444. 1974. -Lectotype: India, "mountain grass" *Roxburgh s.n.* (G, holo), designated by Roberty [Boissiera 9 (1960) 160]; *Herb. Hornemann s.n.*: C; *Roxburgh s.n. ex Herb. Hornemann in Herb. Trinius 283.1*: LE, fragments only, IDC microfiche BT-16/1]; *Icon. ined.* 892 (CAL, K).

-*Andropogon haenkei* J. Presl in C. Presl, Reliq. Haenk. 1: 340. 1830. -*Andropogon intermedius* R. Br. var. *haenkei* (J. Presl) Hack. in A. DC., Monogr. Phan. 6: 486. 1889. -*Bothriochloa glabra* (Roxb.) Stapf subsp. *haenkei* (J. Presl) Henrard, Blumea 3: 456. 1940. -*Dichanthium ischaemum* (L.) Roberty subvar. *haenkei* (J. Presl) Roberty, Boissiera 9: 159. 1960. *nom. inval.* -Lectotype: Philippines, Luzon, *Haenke s.n.* (PR, holo), here designated.

-*Andropogon caucasicus* Trin., Mém. Acad. Imp. Sci. St. Pétersbourg, VI, Sci. Math. 2: 286. 1832. -*Sorghum caucasicum* (Trin.) Griseb. in Ledeb., Fl. Ross. 4: 476. 1853. -*Andropogon intermedius* R. Br. var. *caucasicus* (Trin.) Hack. in A. DC., Monogr. Phan. 6: 486. 1889. -*Bothriochloa caucasica* (Trin.) C.E. Hubb., Bull. Misc. Inform. Kew 1939: 101. 1939. -*Dichanthium caucasicum* (Trin.) S.K. Jain & Deshp., Bull. Bot. Surv. India 20: 133. 1979 ("1978"). -Type: *E. Caucasus, Wilhelms s.n. A° 1827 in Herb. Trinius 178.1*(LE, IDC microfiche BT-16/1).

-*Rhaphis stricta* Nees in Hooker's J. Bot. Kew Gard. Misc. 2: 99. 1850. -*Andropogon leptanthus* Steud., Syn. Pl. Glumac. 1: 391. 1854, non *Andropogon strictus* Host., 1802. -*Chrysopogon strictus* Nees ex B.D. Jacks., Index Kew. 1: 95. 1893; 2: 704. 1895; *nom. inval., in syn.* -Type: *Cuming 1400* (CGE, holo; G, GOET, K!, L!, P, W).

-*Andropogon intermedius* R. Br. subvar. *puberulus* Hack. in A. DC., Monogr. Phan. 6: 487. 1889. -Type: *Not indicated*, material in W to be studied.

-*Andropogon pertusus* (L.) Willd. var. *vegetior* Hack. in A. DC., Monogr. Phan. 6: 481. 1889. -Type: Sudan, *Schweinfurth 1027* (W, holo; K!).

-*Andropogon odoratus* Lisboa, J. Bombay, Nat, Hist. Soc. 4: 123. 1889. -*Amphilophis odorata* (Lisboa) A. Camus, Rev. Int. Bot. Appl. Agric. Trop. 1: 305. 1921. -*Bothriochloa odorata* (Lisboa) A. Camus, Ann. Soc. Linn. Lyon II, 76: 165. 1931. -Type: India, Bombay, *Lisboa s.n.* (BLATT, holo).

-*Amphilophis glabra* (Roxb.) Stapf. var. *paupera* Stapf ex Ridl., Fl. Malay Penins. 5: 209. 1925. -Lectotype: *not resolved*, material in SING to be studied.

Culms erect, stout, up to 2 m high, nodes glabrous or pubescent, internodes terete or grooved on one side. **Leaf** sheaths terete, keeled in the upper part; **ligules** *ca* 1 mm long; leaf blades up to 43 by 1 cm, lower surface glabrous, upper surface scabrous and covered with long hairs at basal part, base subcordate, apex long acuminate, margin scaberulous. **Inflorescence** a large panicle, 12-17 by 4-5 cm, axis up to 15 cm long, primary branches whorled, simple or divided, racemes up to 5 cm long, the lowest raceme shorter than the central axis, joints 1.5-2.3 mm long. Sessile **spikelets** elliptic, *ca* 2.5 mm long, callus 0.2-0.5 mm long; lower **glumes** elliptic to oblong, greenish yellow; 2.5-3 mm long, obscurely 7-9-nerved, occasionally 1-pitted, upper glumes 2.5-3 by 1-1.2 mm, sparsely hairy on upper part of keel, otherwise glabrous; *lower lemmas* lanceolate, 2-2.5 by 0.5-0.7 mm, glabrous, apex obtuse; upper **lemmas** *ca* 1.5 mm long, awn *ca* 1.5 mm long; lodicules *c.* 0.2 mm long; anthers *ca* 1.5 mm long; pedicelled spikelets 2.5-3 mm long, callus short; lower glumes lanceolate, *ca* 3 by 1 mm, 6-nerved, greenish yellow, pectinately setose on keels, apex acute; upper glumes lanceolate, 2-2.8 by 0.5-0.8 mm, 3-nerved; lower lemmas lanceolate, *ca* 2 by 0.5 mm, apex acute; anther *ca* 1 mm long, sometimes barren.

Specimens examined: *S. Lægaard & M. Norsangsri 21875* (AAU); *K. Larsen, S.S. Larsen, C. Niyomdham, W. Ueachirakan & P. Sirirugsa 42528* (AAU); *K. Larsen, S.S. Larsen, A.S. Barfod, W. Nanakorn, W. Ueachirakan & P. Sirirugsa 41757* (AAU); *S. Lægaard & M. Norsangsri 21693* (AAU); *S. Lægaard 21758* (AAU); *J.F. Maxwell 74-597* (AAU, BK); *J.F. Maxwell 85-928* (AAU, PSU); *O. Neamsuvan 166* (BCU); *J. Sadakorn 208* (BK); *T. Smitinand 3416* (BKF); *M. Lazarides 7445* (BKF, K, L); *A. Marcan 1815* (BM); *A.F.G. Kerr 6955, 7987, 9354, 11334, 13558* (BM, K); *Th. Sorensen, K. Larsen & B. Hansen 5481, 5891* (C, K); *J.F. Maxwell 92-567* (CMU, P); *Ch. Charoenphol, K. Larsen & E. Warncke 4878* (K); *T. Smitinand 2035, 6087* (K); *A. Marcan 1589* (K); *A.F.G. Kerr 9331, 19781* (K); *Put 2049* (BM, K); *A.F.G. Kerr 3842* (C, K); *K. Larsen 9993* (C, K) *G. Murata, N. Fukuoka & C. Phengklai* T. *16986* (P).

Ecology: Along roadside, open area, abandon field. Alt. 0-1500 m.

Uses: As a forage grass.

Vernacular name: Ya khaem khok, Ya khi ma

Trade names: Australian bluestem, Forest bluegrass, Long-leaved beard grass.

Distribution: THAILAND. Northern, Chiang Mai, Sukhothai; North-Eastern: Loei; Central: Bangkok, Saraburi, Lop Buri, Nakhon Nayok; Eastern: Nakhon Ratchasima; South-Eastern: Chon Buri, Chantaburi, Sa Kaeo; Southern: Chumphon, Songkhla, Krabi, Yala. Also tropical Africa and Asia, introduced elsewhere.

2. ***Bothriochloa ischaemum*** (L.) Keng

Contr. Biol. Lab. Chin. Assoc. Advancem. Sci., Bot. 10: 201. 1936; Henrard, Blumea 3: 457. 1940. isonym; Mansf. ex Cuénod., Fl. Tunisie: 56. 1954. isonym. -*Andropogon ischaemum* L., Sp. Pl.: 1047. 1753. -*Andropogon ischaemum* var. *genuinum* Hack. in A. DC., Monogr. Phan. 6 (Apr 1889) 475, nom. inval. -*Andropogon digitatus* St.-Lag. in Cariot, Étude Fl., ed. 8, 2: 898. 1early 1889. *nom. superfl.* -*Sorghum ischaemum* (L.) Kuntze, Revis. Gen. Pl. 2: 792. 1891. -*Amphilophis ischaemum* (L.) Nash, N Amer. Fl. 17, 2: 124. 1912. -*Dichanthium ischaemum* (L.) Roberty, Boissiera 9: 160. 1960. -**Lectotype**: S. Europe, *Herb. Linn. 1211.26* (LINN, holo), designated by Marchi & Longhi-Wagner [Bol. Inst. Bioci. Univ. Fed. Rio Grande do Sul 57: 41. 1998] = *Andropogon gerardii* Vitm.; a better choice for stability is *Herb. Burser I, 101* (UPS, holo, microfiche IDC 1064), designated by Scholz [in Cafferty, et al., Taxon 49: 245. 2000]. **Fig. 2.**

-*Andropogon angustifolius* Sibth. & Sm., Prodr. Fl. Graec. 1: 47. 1806. -Type: Greece, *Sibthorp s.n.* (OXF, holo).

-*Andropogon radicans* Lehm., Sem. Hort. Bot. Hamburg.: 16. 1827. -*Andropogon ischaemum* L. var. *radicans* (Lehm.) Hack. in A. DC., Monogr. Phan. 6: 476. 1889. -Type: Cultivated, extant?

-*Andropogon ischaemum* L. var. *songaricus* Rupr. ex Fisch. & Meyen, Enum. Pl. Nov.: 2. 1841. -*Bothriochloa ischaemum* (L.) Keng var. *songarica* (Fisch. & Meyen) Celarier & J.R. Harlan, J. Linn. Soc. Bot. 55: 758. 1958. -*Andropogon ischaemum* L. forma *songaricus* (Fisch. & Meyen) Kitag., Jap. J. Bot. 36: 20. 1961. -Type: Songaria, *Schrenk s.n.* (LE, holo; K).

-*Andropogon ischaemum* L. var. *fallax* Hack. in A. DC., Monogr. Phan. 6: 476. 1889. -Type: Timor (W, holo; "*A. annulatus*" *Kunth Herb.* ex p.).

-*Andropogon taiwanensis* Ohwi, J. Jap. Bot. 12: 652. 1936. -Type: Taiwan, *Shimada 4766* (KYO, holo).

Culms 20-60 cm high, nodes usually bearded. **Leaf** sheaths 4-6 cm long; **ligules** *ca* 1 mm long; leaf-blades 3-10 cm by 2-4 mm, hairy on both surfaces, margin scaberulous. **Inflorescence** subdigitate of 3-8 racemes, axis 0.5-1.5 cm long, the lowest raceme longer than the axis, racemes 4-6 cm long, joints 2-2.5 mm long. Sessile **spikelets** lanceolate, *ca* 4 mm long, callus hairy, *ca* 0.5 mm long; lower **glumes** lanceolate, 3.8-4 by 0.7-1 mm, 7-nerved, green; upper glumes oblong, 3.5-4 by 1 mm, hairy on the upper part of nerves; lower **lemmas** lanceolate, *ca* 3 by 0.5 mm, glabrous, apex acute; upper lemmas *ca* 2 mm long, awn brown, *ca* 1.3 cm long, short hairy; lodicules *ca* 0.3 mm long; anthers 1-1.5 mm long; pedicelled spikelets *ca* 3 mm long; pedicel *ca* 3 mm long, hairy on both margins; lower glumes oblong, 3 by 0.8-1 mm, 9-nerved, hairy on upper half part of keel, apex acute; upper glumes oblong, *ca* 3 by 1 mm, 3-5-nerved, margin ciliolate; lower lemmas obovate, 2-2.5 by 1-1.5 mm,

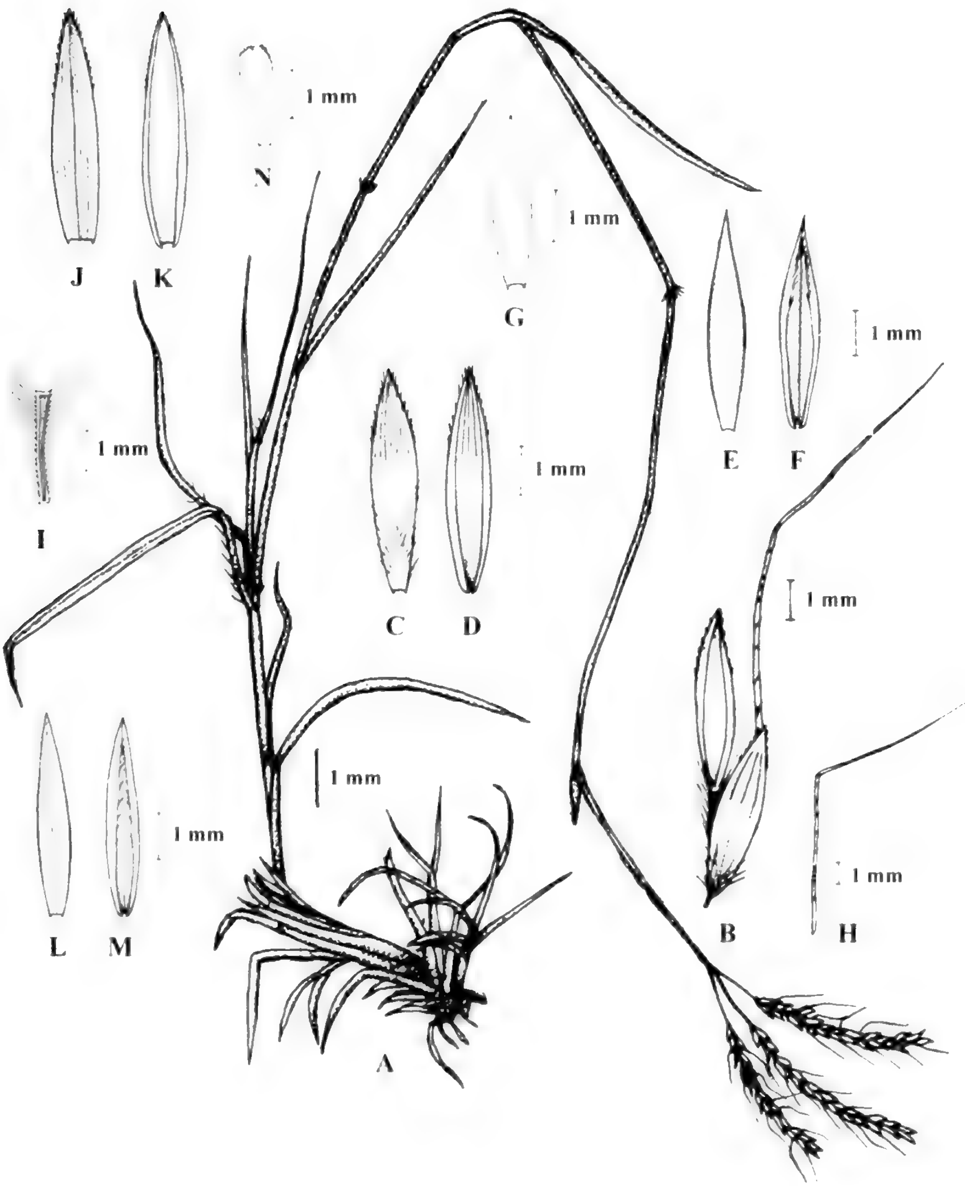

Figure 2. *Bothriochloa ischaemum*. A. Habit; B. Spikelet pair; C-H. Sessile spikelet: C-D. Lower glumes; E-F. Upper glumes; G. Lower lemma; H. Upper lemma; I.-N. Pedicelled spikelet: I. Pedicel; J-K. Lower glumes; L-M. Upper glumes; N. Lower lemma. [Drawing was based on *Y. Sirichamorn* 24 (BCU)].

apex obtuse to truncate; anthers 0.8-1 mm long, or barren.

Specimens examined: *P. Sirirugsa 71* (BCU); *Y. Sirichamorn 24* (BCU); *A.F.G. Kerr 19651, 19701* (K).

Ecology: Open or shady deciduous forest. Alt. 0-300 m.

Uses: Used for erosion control and forage.

Trade names: Old World bluestem, Plains bluestem, Yellow bluestem.

Distribution: THAILAND. Eastern: Buri Ram; Central: Bangkok, Suphan Buri; South-western: Kanchanaburi. Also from S Europe to China, introduced elsewhere.

Notes: This has been introduced in Thailand, but apparently it does not persist. A form with pubescent nodes has been distinguished as var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & J.R. Harlan. This seems hardly worth of any recognition.

3. *Bothriochloa pertusa* (L.) A. Camus
Ann. Soc. Linn. Lyon II, 76: 164. 1931; Maire, Bull. Soc. Hist. Nat. Afrique N. 31: 45. 1940. isonym. –*Holcus pertusus* L., Mant. Pl. 2: 301-302. 1771. - *Andropogon pertusus* (L.) Willd, Sp. Pl. 4(2): 922. 1806. -*Lepeocercis pertusa* (L.) Hassk., Pl. Jav. Rar.: 52. 1848. -*Elionurus pertusus* (L.) Nees ex Steud., Syn. Pl. Glumac. 1: 364. 1854. -*Andropogon pertusus* (L.) Willd. var. *genuinus* Hack. in A. DC., Monogr. Phan. 6: 480. 1889. *nom. inval.* -*Amphilophis pertusa* (L.) Nash ex Stapf, Agric. News (Barbados) 15: 179. 1916; Fl. Trop. Afr. 9: 175. 1917. - *Dichanthium ischaemum* (L.) Roberty subvar. *pertusum* (L.) Roberty, Boissiera 9: 160. 1960. *nom. inval.* -*Dichanthium pertusum* (L.) Clayton, Kew Bull. 32: 4. 1977. – **Lectotype**: "India orientalis". *Herb. Linn. 1212.16* (LINN, holo, designated by Clayton, 1977). **Fig. 3**.
-*Andropogon panormitanus* Parl., Diar. 9 Congress. Scienz. Ital. Venezia. sine pag. 1847; Fl. Ital. 1: 140. 1848. -*Andropogon pertusus* (L.) Willd. var. *panormitanus* (Parl.) Hack. in A. DC., Monogr. Phan. 6: 481. 1889. -*Bothriochloa panormitana* (Parl.) Pilger in Engler & Prantl, Nat. Pfanzenfam., ed. 2, 14e: 161. 1940; Brullo, Giorn. Bot. Ital. 129: 173. 1995. isonym. - Lectotype: Sicily, not resolved.
-*Andropogon angustifolius* auct. non Sibth. & Sm.: Parl., Fl. Palermo 1: 269. 1845.

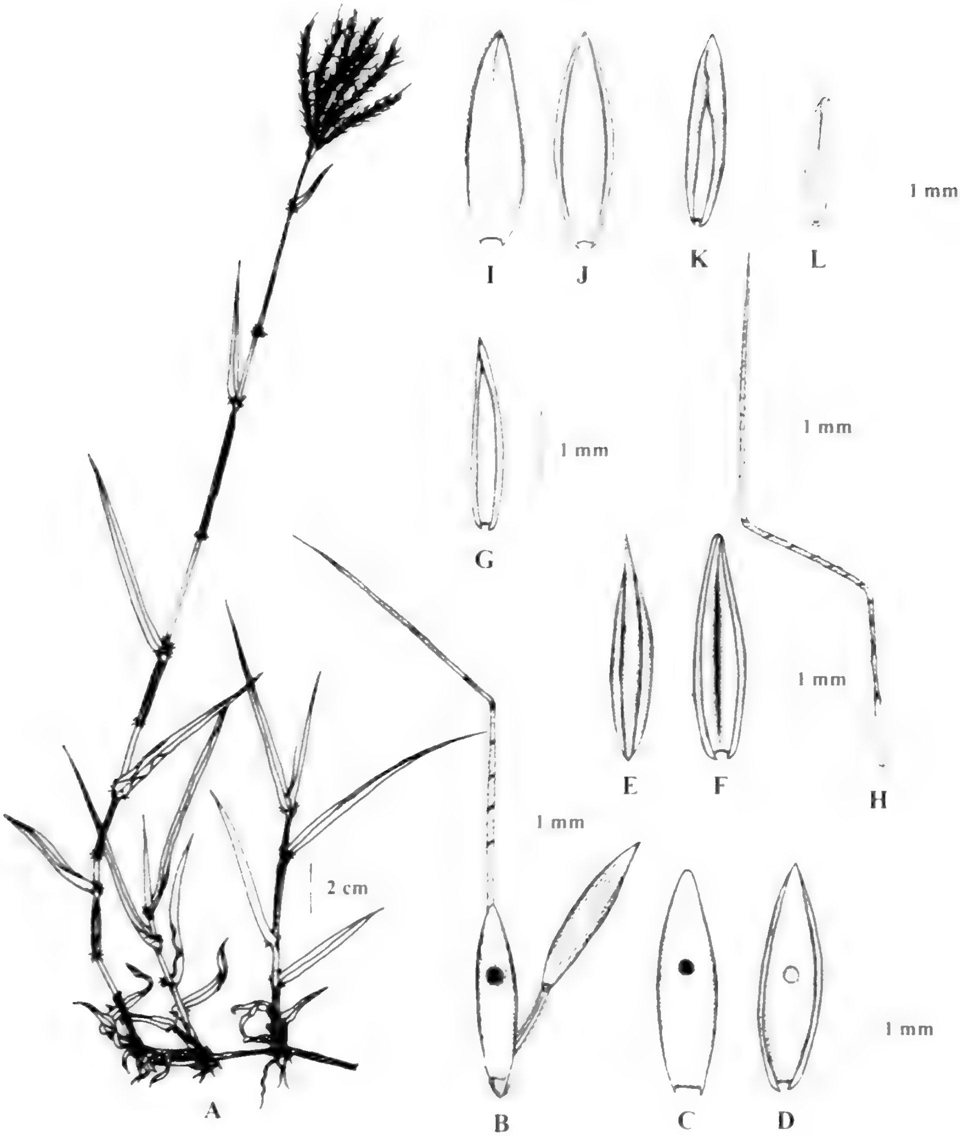

Figure 3. *Bothriochloa pertusa*. A. Habit; B. Spikelet pair; C-H. Sessile spikelet; C-D. Lower glumes; E-F. Upper glumes; G. Lower lemma; H. Upper lemma; I-L. Pedicelled spikelet; I-J. Lower glumes; K. upper glume; L. lower lemma. [Drawing was based on *O. Neamsuvan* 167 (BCU)].

Culms up to 80 cm high, grooved on one side, nodes bearded. **Leaf** sheaths 3-5 cm long; **ligules** 0.5 mm long, tufted hairs on both sides of ligules 3 mm long; leaf blades linear, 3-20 cm by 3 mm, sparsely short hairy on both surfaces, base subcordate to rounded, apex acuminate, margin scaberulous. **Inflorescence** digitate of 3-10 racemes, axis 1-3.5 cm long, racemes 4-5 cm long, the lowest raceme longer than the central axis; joints *ca* 3 mm long. Sessile **spikelets** elliptic to oblong, *ca* 3 mm long, callus 0.4-0.5 mm long; lower **glumes** oblong, 2.5-2.8 by 1 mm, 9-11-nerved, shiny, 1-pitted; upper glumes oblong, 3-3.5 by 1 mm, glabrous; lower **lemmas** broadly ovate, 1.5-2.5 by 0.8 mm, 1-nerved, apex obtuse to truncate, margin ciliate at the upper part; upper lemmas *ca* 2 mm long, 1-nerved; awn 1.5-2 cm long, short hairy; lodicules *ca* 0.2 mm long; anthers 1-1.5 mm long; pedicelled spikelets *ca* 3 mm long; callus *ca* 0.5 mm long, hairy; pedicel *ca* 3 mm long, covered by up to 3.5 mm long hairs on both margins; lower glumes oblong, 3.5 by 1.0-1.2 mm, 10-nerved, dorsally with a purple stripe near apex, 0-3-pitted, apex obtuse; upper glumes elliptic, *ca* 2.5 by 1 mm, 3-nerved; lower lemmas obovate, *ca* 2 by 1 mm, apex acute; anthers 0.8-1 mm long.

Specimens examined: *S. Lægaard* and *M. Norsangsri 21874, 21885* (AAU); *BRD 57* (AAU); *K. Larsen, S.S. Larsen, A.S. Barfod, W. Nanakorn, W. Ueachirakan* and *P. Sirirugsa 41014, 41566* (AAU); *J.F. Maxwell 74-654* (AAU, L); *K. Larsen, T. Smitinand and E. Warncke 1112* (AAU, K); *O. Neamsuvan 167* (BCU); *C. Chermsirivathana 143, 201* (BK); *Put s.n.* (BK); *Y. Paisooksantivatana 813-82* (BK); *A.F.G. Kerr 13432* (BK, BM, K); *M. Lazarides 7434* (BKF, C, K, L); *K. Larsen 8304* (C); *Th. Sørensen, K. Larsen* and *B. Hansen 2061* (C); *Th. Sørensen, K. Larsen* and *B. Hansen 2477* (C, L); *Th. Sørensen, K. Larsen* and *B. Hansen 2516* (C, L, P); *Th. Sørensen, K. Larsen* and *B. Hansen 2031* (C, P); *G. Murata, K. Iwatsuki* and *C. Phengklai T-14816* (L, P); *A.F.G. Kerr 3858* (K); *Dee 8523* (K); *Sommai 63* (The Herbarium of Department of Botany, Kasetsart University).

Ecology: Open areas, along road sides. Alt. 0-1,500 m.

Uses: Forage, resistant to trampling, drought, and grazing.

Vernacular name: Ya tot lueat, Ya hom, Ya hang ma

Trade names: Pitted bluestem, Pitted bluegrass, Seymour grass, Sourgrass, Wiregrass.

Distribution: THAILAND. Northern: Nakhon Sawan; North-Eastern: Phetchabun, Loei Khon Kaen; Eastern: Nakhon Ratchasima, Buri Ram;

Central: Bangkok, Lop Buri, Ayutthaya, Samut Prakan, Saraburi; South-Western: Prachuap Khiri Khan, Kanchanaburi; Southern: Chumphon, Songkhla, Trang. S Africa to Thailand, introduced elsewhere.

Note: In Thailand, this species is very similar to *B. ischaemum*, but it differs from *B. ischaemum* by the pit in the lower glume of the sessile spikelet.

Discussion

Because of the genetical complexity, most recent authors, e.g., Chen and Phillips (2006) have regarded *B. bladhii* as a polymorphic species that includes all forms with an elongate inflorescence axis. Yet, they thought that 2 varieties can be distinguished.

1a. Lower glume of sessile and pedicelled spikelet without a pit on the back .... **var. *bladhii***
1b. Lower glume of sessile and pedicelled spikelet with 1-3 pits on the back .... **var. *punctata***

However, this is not supported by some specimens found in Thailand where pitted and pitless glumes occurred in the same inflorescence. It is congruent with Bhutan specimens (Noltie, 2000). Moreover, the many forms of *B. bladhii* represent a complex species where all grades of intermediate forms appear to be present (Celarier and Harlan, 1955), indicating that this distinction is rather dubious.

For *B. ischaemum*, it is distinguished from *B. pertusa* by its lower glume of the sessile spikelet without a pit. Interestingly, Celarier and Harlan (1955) stated that glumes of the sessile spikelet in *B. ischaemum* may be slender without pits but with a slight tendency toward pitting. It means there is a gradual transition form to *B. pertusa*.

Sathagul (1990) reported *B. insculpta* for Thailand, but her specimen (*Sommai* 63) turned out to belong to *B. pertusa*. From intensively literature review, the morphological characters of these 2 species are very similar, and therefore Celarier and Harlan (1955) regarded them as part of the *B. pertusa* complex.

As mentioned above, it seems that the species boundary within *Bothriochloa* is blurred. Possibly a molecular study of these 3 species groups, *B. bladhii*, *B. ischaemum* and *B. pertusa*, might clarify taxonomic delimitations, but in view of the great number of forms and the widespread distribution of the "species", it seems unlikely that the seminal experiments of Celarier and Harlan can be feasibly repeated.

Bothriochloa bladhii and *B. pertusa* are common and widely distributed throughout Thailand. On the contrary, *B. ischaemum* seems to be rare. Only a few specimens were available in the herbaria and only on a few occasions were seen in the field. As in Thailand it is not considered to be a valuable forage grass, there is a risk that it may become extinct.

Acknowledgements

We would like to thank the Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University (CEB_D_11_2006), the 90th Anniversary of Chulalongkorn University Fund and the Development and Promotion of Science and Technology Talents Project of Thailand (DPST) for funding of this research. We also thank the directors and curators of AAU, BCU, BK, BKF, BM, C, CMU, K, L, P, PSU and The Herbarium of Department of Botany, Kasetsart University for making the specimens available for this study.

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A Revision of *Hemisorghum* (Poaceae, Sorghinae) in Thailand

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Abstract

Hemisorghum C.E. Hubb. (Poaceae, Sorghinae) has a single species in Thailand: *H. mekongense* (A. Camus) C.E. Hubb. It occurs from Burma to Laos and Cambodia. In Thailand it is rare along riverbanks. A lectotype is designated.

Introduction

According to recent literature the genus *Hemisorghum* C.E. Hubb. in Bor (Poaceae, Sorghinae) would contain two species (Clayton and Renvoize, 1986). One, *H. venustum* (Thwaites) C.D. Clayton, occurs in Sri Lanka and the Western Ghats of India, the other, *H. mekongense* (A. Camus) C.E. Hubb., in S Burma, NE Thailand, W Laos, and W Cambodia. However, during the present revision the two turned out to be so different in so many aspects that the first has recently been placed in a new genus, *Lakshmia* Veldk. (Veldkamp, 2009). Clayton and Renvoize (1986) regarded it as basal in the *Sorghinae*, but no molecular studies seem to have been done to support this. At least *H. mekongense* is very similar to *Sorghum* Moench:

1a. Panicle branches bearing long, lax racemes, rachis internodes and pedicels scabrid; lower glume of sessile spikelet thinly coriaceous, flat on the back, margins 2-keeled for most of its length .... ***Hemisorghum***
1b. Panicle branches bearing short, dense racemes, rachis internodes and pedicels ciliate; lower glume of sessile spikelet coriaceous, convex on the back, apically 2-keeled and winged .... ***Sorghum***

Nanakorn and Norsangsri (2001) is the first and only work where *Hemisorghum mekongense* is reported for Thailand. Because this is a checklist no description was given. The present work extends this record with a description, notes, and illustrations.

Materials and methods

This study was based on taxonomic literature and a study of herbarium specimens at the Faculty of Science, Chiang Mai University (CMU), Royal Botanic Gardens, Kew (K), National Herbarium of The Netherlands, Leiden University (L), l'Herbier, Laboratoire de Phanérogamie, Paris (P). Field work was carried out throughout Thailand with specimens deposited in the herbarium of the Chulalongkorn University, Bangkok (BCU).

Hemisorghum C.E. Hubb. in Bor, Grass. Burma, Ceylon, India and Pakistan: 686. 1960. – **Type species**: *Hemisorghum mekongense* (A. Camus) C.E. Hubb.

Tufted **annuals**. Ligule collar-shaped, fringed or ciliolate, membranous; **leaf-**blades linear, broad, flat. **Inflorescence** a lax, espatheate panicle; the lowermost branches solitary to whorled, tenacious, glabrous; racemes long, with numerous pairs of sessile and pedicelled **spikelets**; rachis internodes and pedicels filiform, scaberulous, articulation transversal. Sessile spikelets tardily deciduous, with an obtuse, glabrous callus, dorsally compressed, 2-flowered; lower floret epaleate, neuter; upper floret perfect; lower **glumes** thinly coriaceous, flat on the back, 7-11-nerved, laterally 2-keeled, the margins sharply inflexed; upper glumes dorsally rounded, becoming 1-keeled upwards, 7-nerved, margins inrolled; lower **lemmas** hyaline; upper lemmas finely 1-nerved, awnless; upper **palea** hyaline or suppressed; lodicules cuneate, glabrous; stamens 3. Pedicels free of the rachis. Pedicelled **spikelets** very much reduced to 1 or 2 glumes rarely with a much reduced lemma, barren, deciduous, dorsally compressed, awnless.

Distribution: Monotypic, in Myanmar**,** Thailand, Laos, Cambodia; one in Thailand.

Hemisorghum mekongense (A. Camus) C.E. Hubb. in Bor
Grass. Burma, Ceylon, India and Pakistan: 162, 687. 1960. -*Sorghum halepense* var. *mekongense* A. Camus, Bull. Mus. Hist. Nat. (Paris) 25: 497. 1919. -*Sorghum mekongense* (A. Camus) A. Camus, Fl. Indo-Chine 7: 323, f. 35. 1922. -**Lectotypus**: Muong Mai, Laos, *Thorel s.n.* (P!; designated here). **Fig. 1.**

Culms up to 2 m high, nodes minutely puberulous, with prop roots. **Leaf-**sheaths terete, distally keeled, 10-15 cm long, glabrous; ligules 1-2 mm long; leaf-blades 25-60 by 1-4 cm, glabrous, margin scaberulous, apex long-acuminate. **Panicles** 30-50 cm long, primary branches 5-15 cm long, branched

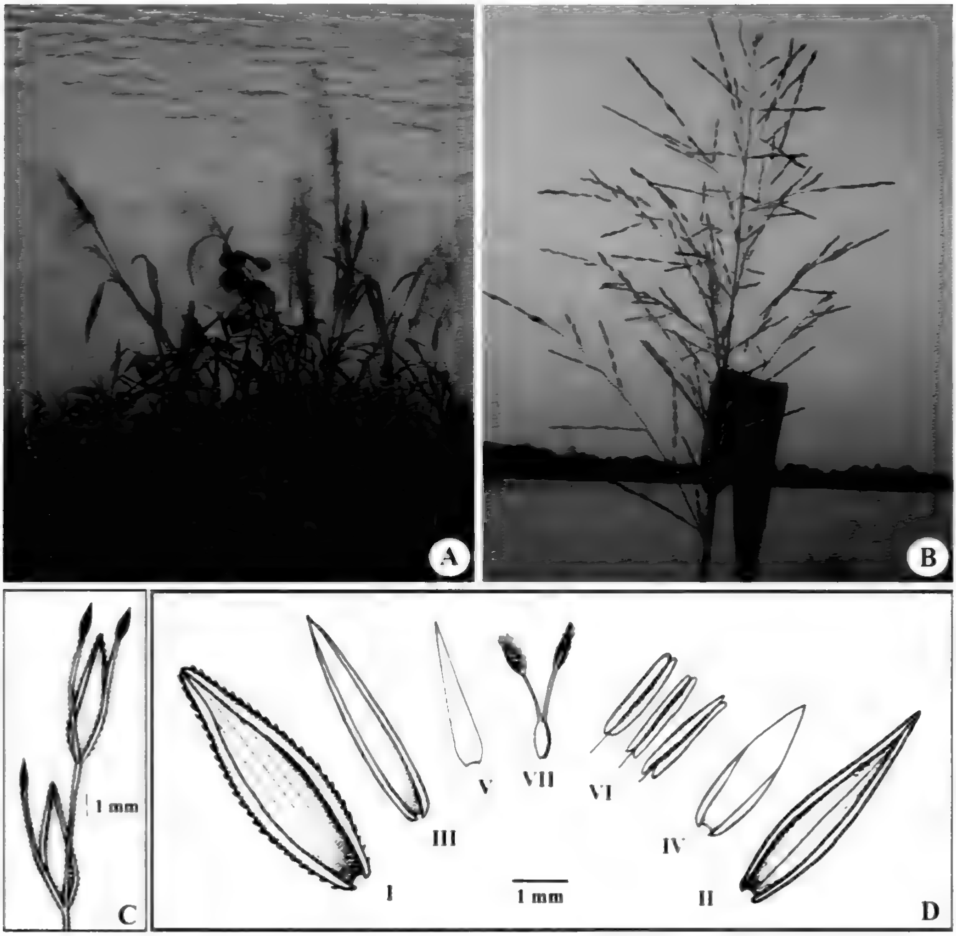

Figure 1. *Hemisorghum mekongense*: A. habitat; B. inflorescence; C. a part of raceme showing sessile and pedicelled spikelets; D. sessile spikelet dissection: I. lower glume, II. upper glume, III. lower lemma, IV. upper lemma, V. upper palea, VI. stamens, VII. pistil.

again, bearing 5-10 racemes; racemes 2-6 cm long, each with 2-7 **spikelet** pairs; rachis internodes slightly shorter than the sessile spikelet, filiform. Sessile spikelets 4-5 mm long, incl. callus; lower **glumes** ovate-lanceolate, 4-5 by 1.5-2 mm, 7- or 9-nerved, puberulous, keels serrate, apex acute; upper glumes lanceolate, 4-4.8 by 1.3-1.5 mm, 7-nerved, apically 1-keeled, chartaceous, puberulous, apex acute; lower lemmas ovate-lanceolate, 3.5-4 by *ca* 1 mm, hyaline, 2-nerved, apex acute; upper lemmas ovate, 2.5-3 by 0.8-1.2 mm; upper **paleas** narrowly ovate-lanceolate, *ca* 2.3 by 0.3 mm, apex narrow, acute; lodicules *ca* 0.3 mm long; anthers 1.5-1.8 mm long. Pedicels filiform, 3-4 mm long, 0.6-0.8 times as long as the sessile spikelet, serrulate on the edges. Pedicelled **spikelets** usually very much reduced, rarely more or less developed; lower glumes narrowly ovate-lanceolate, 0.5-4 by 0.5-1 mm, 0-7-nerved, laterally 2-keeled, keels serrulate, chartaceous, glabrous to sparsely puberulous, margin inflexed, apex acute; upper glumes ovate-lanceolate, 0.5-4 by 0.6 mm, 0-5-nerved, membranous, apex acute, margin hyaline, ciliolate.

Specimens examined: MYANMAR: *Griffith 6825* (K), *Maung Po Khant 13417* (K). THAILAND: *Kerr 21356* (K); *Neamsuvan 262, 263* (BCU). LAOS: *Thorel* s.n. (P); *Maxwell 98-477* (CMU, L). CAMBODIA: *Maxwell 07-459* (CMU).

Collector's notes: Annual. Culms tufted, pale green to stramineous. Blades green to dull dark green above, pale to dull green beneath. Inflorescence axes green. Spikelets cream, very pale green, with green nerves. Stigmas, styles pale light green.

Vernacular name: *Ya Phong* (Nong Khai)

Ecology: Open sandy, weedy area along river, seasonally submerged, 75 m alt., flowering August-May.

Distribution: Myanmar (Tenasserim), Thailand, Northeastern (Nakhon Phanom, Nong Khai), Laos (Attopeu, Bolikhamsai, Champasak, Khammouane, Sayaboury, Vientiane), Cambodia (Kratie).

Notes: In Thailand, *Hemisorghum mekongense* is similar to *Sorghum halepense* (L.) Pers., but the two species can be differentiated in the following key –

1a. Panicles 30-50 cm long. Rachis internode and pedicel serrate. Spikelets rather slender; lower glume of sessile spikelet 2-keeled throughout, keels scabrous .... ***H. mekongense***
1b. Panicles 10-30 cm long. Rachis internode and pedicel ciliate. Spikelets stout; lower glume of sessile spikelet becoming 2-keeled near the tip, keel winged, ciliolate .... ***S. halepense***

Acknowledgements

We would like to thank the Development and Promotion of Science and Technology Talents Project (DPST), the Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University (CEB_D_11_2006) and the 90th Anniversary of Chulalongkorn University Fund for supporting this study. We are grateful to the curators and staff of K, L, and P for making their collections available for this study, and to Mr. James F. Maxwell (CMU) for information on the occurrence of this species in Cambodia. Many thanks to Miss Angkhana Inta for making photographs of the CMU specimens.

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Corticolous Myxomycetes of Singapore

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Abstract

The moist chamber culture technique was employed to detect myxomycetes (plasmodial slime molds) associated with the bark surface of living trees. Twenty-five species of myxomycetes in 13 genera were identified from moist-chambered bark samples collected at three localities in Singapore. Seventeen species are new records for Singapore. One species, *Comatricha pseudonigra* was previously known only from Mitchell River National Park in the state of Victoria, Australia.

Introduction

All previous published reports of myxomycetes (plasmodial slime molds) from Malaysia and Singapore have dealt with species that produce fruiting bodies which are large enough to be detected in the field (Chip, 1921; Sanderson, 1922; Emoto, 1931; Lister, 1931; Nawawi, 1973). Fruiting bodies of "corticolous" (bark-inhabiting) myxomycetes are usually too minute to be detected in nature but can be recovered from the bark of living trees by using the moist chamber technique of Gilbert and Martin (1933). The purpose of this study was to survey the myxomycetes of the bark microhabitat in Singapore.

List of localities

Localities from which bark samples were obtained are listed below. All samples were collected, in Singapore in October of 2007, by Dr. D.R. Reynolds, Mycologist at the University of California, Berkeley, while he was on a Research Fellowship at the Singapore Botanic Gardens.

Locality 1: Singapore Botanic Gardens (SBG)
Locality 2: MacRitchie Reservoir Forest Reserve (MRR)
Locality 3: Bukit Timah Nature Reserve (BT)

Materials and Methods

Samples of dead outer bark were collected from unidentified trees at each locality at a trunk height of approximately 1.5 m and placed in legal-sized paper envelopes. Once dried, they were shipped to the author for moist chamber culturing. There was only enough bark in each sample for a single moist chamber.

Bark samples were placed on filter paper in disposable Petri dishes (9 cm diam.) and flooded with sterile distilled water adjusted to pH 7.0 with KOH. Because substrate pH sometimes affects the abundance and distribution of myxomycetes (Stephenson, 1989; Wrigley de Basanta, 2004), excess water remaining after 24 hours was poured into clean plastic beakers where pH was determined using an Orion model 210A pH meter and low maintenance electrode. Moist chambers were incubated at room temperature (22-25°C) in a laboratory exposed to diffuse daylight and examined daily for a period of five weeks, longer if the bark was still producing fruiting bodies or plasmodia. Small amounts of water were periodically added to each culture to maintain moist conditions. If fruiting bodies of the same species of myxomycete appeared more than once on the same moist chambered bark sample, they were considered to be a single collection.

When mature, fruiting bodies were removed from the moist chambers along with the bit of substrate upon which they developed. Once air-dried, specimens were glued into herbarium quality boxes for permanent storage. Identifications were made using keys by Martin and Alexopoulos (1969) and Mitchell (2004).

Results

Twenty-five species of myxomycetes, many representing new records for Singapore, developed from the moist chambered bark. In the list that follows, myxomycetes are arranged alphabetically by genus and then species. One species, *Comatricha pseudonigra*, was previously known only from the Mitchell River National Park in the state of Victoria, Australia (Moreno *et al.*, 2007).

Nomenclature of Myxomycetes follows Hernandez-Crespo and Lado (2005) and uses the conserved names of a number of genera (Lado *et al.*, 2005) recently approved by the Committee for Fungi (Gams, 2005) of the IAPT. Collection numbers are those of the author (WCR). Specimens are curated at SING Herbarium. Where duplicate specimens exist, they are housed in the MTSU Herbarium (MTSU).

Annotated list of species

Arcyria cinerea (Bull.) Pers., Syn. Fung. (1801) 184. - Locality 1 (SBG): *WCR 9787, 9788* and *9789*, at pH 3.4 - 5.4; Locality 2 (MRR): *WCR 9790, 9791, 9792* and *9793*, at pH 3.4-4.8; Location 3 (BT): *WCR 9794*, at pH 4.1.

Arcyria minuta Buchet, Pat., Mem. Acad. Malgache 6 (1927) 42. - Locality 1 (SBG): *WCR 9795* (slide only), at pH 6. Not previously known from Singapore.

Arcyria pomiformis (Leers) Rostaf., Mon. (1875) 271. - Locality 1 (SBG): *WCR 9796*, at pH 3.4; Locality 2 (MRR): *WCR 9797* and *9798*, at pH 3.4-4.8. Not previously known from Singapore.

Clastoderma debaryanum A. Blytt, Bot. Zeit. 38 (1880) 343. - Locality 1 (SBG): *WCR 9799*, at pH 6; Locality 2 (MRR): *WCR 9800, 9801* and *9802*, at pH 4.1-4.8; Locality 3 (BT): *WCR 9803*, at pH 4.1.

Collaria arcyrionema (Rostaf.) Nann.-Bremek. ex Ing, Ruizia 9 (1991) 26. - Locality 1 (SBG): *WCR 9804* (slide only), at pH 5.4.

Comatricha elegans (Racib.) G. Lister,Guide Brit. Mycet. ed. 3 (1909) 31. - Locality 2 (MRR): *WCR 9806* and *9807*, at pH 3.4 - 4.1.

Comatricha pseudonigra G. Moreno, W.C. Rosing, D.W. Mitch. & S.L. Stephenson, Bol. Soc. Micol. Madrid 31 (2007) 172. - Locality 2 (MRR): *WCR 9808*, at pH 3.7. Previously known only from Mitchell River National Park, Victoria in Australia (37°40'03"S, 149°21'29"E).

Cribraria confusa Nann.-Bremek. & Y. Yamam., Proc. Kon. Ned. Akad. Wetensch., C. 86 (1983) 212. - Locality 1 (SBG): *WCR 9809*, at pH 4.6; Locality 2 (MRR): *WCR 9810, 9811*, at pH 3.8-4.5; Locality 3 (BT): *WCR 9812*, at pH 3.8. Not previously known from Singapore.

Cribraria microcarpa (Schrad.) Pers., Syn. Fung. (1801) 190, emend. Nann.-Brem. K. Ned. Akad. Wet. Proc. C. 69 (1966) 340. - Locality 2 (MRR): *WCR 9813*, at pH 4.8. Not previously known from Singapore.

Cribraria minutissima Schwein., Trans. Am. Phil. Soc. II. 4 (1832) 260. - Locality 2 (MRR): *WCR 9814*, at pH 3.4. Not previously known from Singapore.

Diderma chondrioderma (deBary & Rostaf.) G. Lister in Lister, Mycet. ed. 3 (1925) 258. - Locality 1 (SBG): *WCR 9815*, at pH 6; Locality 2 (MRR): *WCR 9816*, at pH 6.5. Not previously known from Singapore.

Diderma saundersii (Massee) Lado, Cuad. Trab. Fl. Micol. Iber. (2001) 35. - Locality 1 (SBG): *WCR 9817*, at pH 4.7; Locality 2 (MRR): *WCR 9818*, at pH 4.1. Not previously known from Singapore.

Didymium squamulosum (Alb. & Schwein.) Fr., Symb. Gast. (1818) 19. - Locality 3 (BT): *WCR 9819*, at pH 5.7.

Echinostelium minutum de Bary in Rost., Mon. (1874) 215. - Locality 2 (MRR): *WCR 9820, 9821, 9822* and *9823*, at pH 3.4 – 4.8. Not previously known from Singapore.

Hemitrichia calyculata (Speg.) M.L. Farr, Mycologia 66 (1974) 887. - Locality 2 (MRR): *WCR 9824* at pH 4.8. Not known from Singapore but as noted in Martin and Alexopoulos (1969), this species is often mistakenly reported as *H. clavata* (Pers.) Rostaf., which has been reported from Singapore.

Licea biforis Morgan, J. Cinc. Soc. Nat. Hist. 15 (1893) 131. - Locality 2 (MRR): *WCR 9825*, at pH 6.5. Not previously reported from Singapore.

Licea eleanorae Ing, Myxomycetes Britain and Ireland (1999) 50. - Locality 1 (SBG): *WCR 9826*, at pH 6.2. Not previously reported from Singapore.

Licea kleistobolus G.W. Martin, Mycologia 34 (1942) 702. - Locality 1 (SBG): *WCR 9827*, at pH 4.7. Not previously reported from Singapore.

Licea operculata (Wingate) G.W. Martin, Mycologia 34 (1942) 702. - Locality 1 (SBG): *WCR 9828*, at pH 6.2. Not previously reported from Singapore.

Licea rugosa Nann.-Bremek. & Y. Yamam., Proc. Kon. Ned. Adad. Wetensch., C. 90 (1987) 326. - Locality 1 (SBG): *WCR 9829, 9830* and *9831*, at pH 4.1-7. Not previously reported from Singapore.

Macbrideola decapillata H.C. Gilbert, Univ. Iowa Stud. Nat. Hist. 16 (1934) 158, emend. Alexop., Mycologia 59 (1967) 113. - Locality 1 (SBG): *WCR 9832* at pH 6.2; Locality 2 (MRR): *WCR 9833* and *9834* at pH 4.8. Not previously reported from Singapore.

Physarum album (Bull.) Chevall., Fl. Gen. Env. Paris 1 (1826) 336. - Locality

3 (BT): *WCR 9836*, at pH 4.1.

Physarum crateriforme Petch, Ann. Bot. Gard. Peradeniya 4 (1909) 304. - Locality 1 (SBG): *WCR 9837*, at pH 7; Locality 2 (MRR): *WCR 9825*, at pH 6.5. Not previously known from Singapore.

Stemonitis fusca Roth, Mag. Bot. Romer & Usteri 1 (1787) 26. - Locality 1 (SBG): *WCR 9839, 9840* and *9841*, at pH 4.4-6.2.

Stemonitis herbatica Peck, Ann. Rep. N.Y. State Mus. 26 (1874) 75; Ing, Myxomycetes of Britain and Ireland (1999) 202. - Locality 3 (BT): *WCR 9838*, at pH 4.4.

Discussion

Seventeen myxomycete species are reported here as new records for Singapore. Most of these species produce minute fruiting bodies, which at 2 mm or less in total height, are unlikely to be detected in the field. A similar but more extensive study involving moist-chambered bark samples from 12 localities in the state of Victoria, Australia (Rosing *et al.*, 2007) produced twenty-nine new records for Victoria, eight new records for Australia, and one species (*Comatricha pseudonigra*) then new to science, but now known to exist in Singapore. It is unlikely that this species exists only in two locations, southeastern Australia and Singapore, some 6000 km apart. Tropical regions like Southeast Asia remain under-investigated for Myxomycetes. The moist chamber technique for the recovery of corticolous forms remains under-utilized. Further investigations will undoubtedly show that *C. pseudonigra* has an extensive range in the region and that many other species of myxomycetes remain to be discovered.

Stephenson (1989) noted that while most myxomycete species of upland temperate forests of Virginia (USA) appeared to tolerate a wide pH range, members of the Stemonitales tended to develop on more acidic bark than did members of the Physarales and Trichiales, predominating on the acidic bark of two species of conifers. The pH range (3.4-7) of bark samples utilized for the present study is almost identical to that reported by Stephenson (3.3-7.4) for his Virginia study.

Based on the present study, ten bark samples from Singapore produced members of the Stemonitales, ten produced members of the Trichiales, and eight produced members of the Physarales. The mean pH of bark that produced members of the Trichiales was actually lower (4.35) than that producing the bark members of the Stemonitales (4.74), though the pH ranges were almost identical (3.4-6.2) for the bark materials producing members of the Stemonitales and members of the Trichiales (3.4-6). The eight bark samples that produced members of the Physarales had the highest mean pH (5.57) with a pH range of (4.1-7).

The author recently collected myxomycete fruiting bodies, tree bark, ground and aerial litter from a number of sites in Singapore while undertaking a research fellowship at the Singapore Botanic Gardens. It will be interesting to see whether any apparent correlation can be seen between the bark pH and distribution patterns of corticolous myxomycetes in the tropical rain forests of Singapore. Definitely, additional new records of myxomycetes for the island nation will be forthcoming.

Acknowledgements

The author wishes to thank Dr. D.R. Reynolds for collecting the bark materials used in this study. Appreciation is also extended to Drs. S.L. Stephenson and D.W. Mitchell for their assistance with the identification of a number of specimens.

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Ten New Species of *Impatiens* (Balsaminaceae) from Thailand

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Abstract

Ten new species of *Impatiens* (Balsaminaceae), *I. adenioides* Suksathan & Keerat., *I. charisma* Suksathan & Keerat., *I. daraneenae* Suksathan & Triboun, *I. doitungensis* Triboun & Sonsupab, *I. jiewhoei* Triboun & Suksathan, *I. oreophila* Triboun & Suksathan, *I. ruthiae* Suksathan & Triboun, *I. sirindhorniae* Triboun & Suksathan, *I. spectabilis* Triboun & Suksathan, and *I. tigrina* Suksathan & Triboun from Thailand are described and illustrated.

Introduction

The genus *Impatiens* consists of over 1,000 species of annual or perennial herbs widely distributed in tropical and sub-tropical regions of Africa and Asia. A few members of the genus extend into Europe, and Central and North America (Fischer, 2004). In contributions to the Flora of Southeast Asia II, Shimizu (1970) recognized 39 plus 3 doubtful species as native to Thailand. Subsequently many new species were discovered, and were added into the account (Shimizu, 1977, 1991, 2000; Shimizu and Suksathan, 2004) raising the total number of native Thai species to approximately 50. In connection with a revision of the family Balsaminaceae for the Flora of Thailand, intensive collecting in recent years in poorly explored mountain areas as well as material studied in herbaria worldwide have revealed several more undescribed species. Therefore, our assessment of the species diversity in the country may be underestimated, and more species probably await discovery.

In this paper we describes 10 new species using the descriptive terminology of Grey-Wilson (1980), except for the terms *upper pair* and *lower pair* of lateral sepals for which we prefer to use *inner pair* and *outer pair* respectively. *Impatiens sirindhorniae* is, by gracious permission, dedicated to Her Royal Highness Princess Maha Chakri Sirindhorn, in appreciation of her enormous contributions to the conservation of indigenous Thai wildlife.

The new species

1. ***Impatiens adenioides*** Suksathan & Keerat., *sp. nov.*
Impatiens mirabilis *Hook.f. affinis, a qua differt lamina minori elliptica ad oblanceolata coriacea, margine acute serrata, bracteis florium eglandulatis* – **Typus:** S Thailand, cultivated in Bangkok, originally from limestone area in Phatthalung Province, 15 Apr 2009, *K. Keeratikiet & C. Punpreuk 14*6 (holo, QBG; iso, BK, SING). **Fig. 1 & Plate 1A.**

Lithophytic, succulent perennial **herbs,** up to 100 cm tall, with swollen caudiform base, up to 30 cm in diameter, wholly glabrous; **stems** 4-7(-14) upright, 2-3 cm in diameter at the base, moderately branched in upper part. **Leaves** spirally arranged, crowded on the upper part of stem, petiole *ca* 1 cm long; lamina elliptic to oblanceolate, 6-8 × 3-4 cm, coriaceous, apex acuminate, base cuneate, margin acutely serrate, with two glands in the lower half; *lateral veins* 7-10(-12) pairs. **Inflorescence** a stout 6-10(-20)-flowered terminal to subterminal raceme, simple or 2-3(-6) branched, up to 15 cm long, waxy green; the branch subtended by a small lanceolate, biglandular, ± caducous bract, *ca* 5 mm long. **Flowers** waxy yellow, 3-3.4 cm long, pedicels rather thick, *ca* 0.5 cm long, subtended by a green, ovate, mucronate, caducous bract, *ca* 4 mm long; lateral sepals 4, the outer pair rather thick, *ca* 7 × 5.5 mm, ovate, shortly mucronate, the inner pair *ca* 4 mm long, linear-lanceolate, acute, lower sepal *ca* 13 mm long, *ca* 9 mm deep, deeply navicular, entirely yellow, abruptly constricted into a 1 cm-long, slender straight spur, incurved only at the tip; dorsal petal *ca* 10 x 9 mm, suborbicular, shallowly cucullate, with a green crest which is broadest in the middle, apex slightly emarginate; *lateral* united petals connate, entirely yellow; upper petals *ca* 7 × 10 mm, semicircular, apex round; lower petals connate for about half the length, obovate in outline, *ca* 12 × 10 mm, apex deeply bilobed, the lobe apically shallowly emarginated. Ovary glabrous. **Fruit** *ca* 2 cm long, clavate; **seed** unknown.

Additional specimen examined: Thailand, Chumphon Prov., *R. Pooma, V. Cheamchumroon & P. Chantaboon 3514* (BKF).

*Distribution and habita*t: Endemic to peninsular Thailand (Chumphon, Phatthalung). Scattered in lowland, shaded, rugged limestone hills.

*Etymolog*y: The specific epithet, *adenioides* refers to its growth habit, which resembles that of *Adenium* (Apocynaceae).

Notes: *Impatiens adenioides* was introduced to the first author by Kaweesak Keeratikiat and Chuyos Punpreuk, plant lovers from Bangkok who

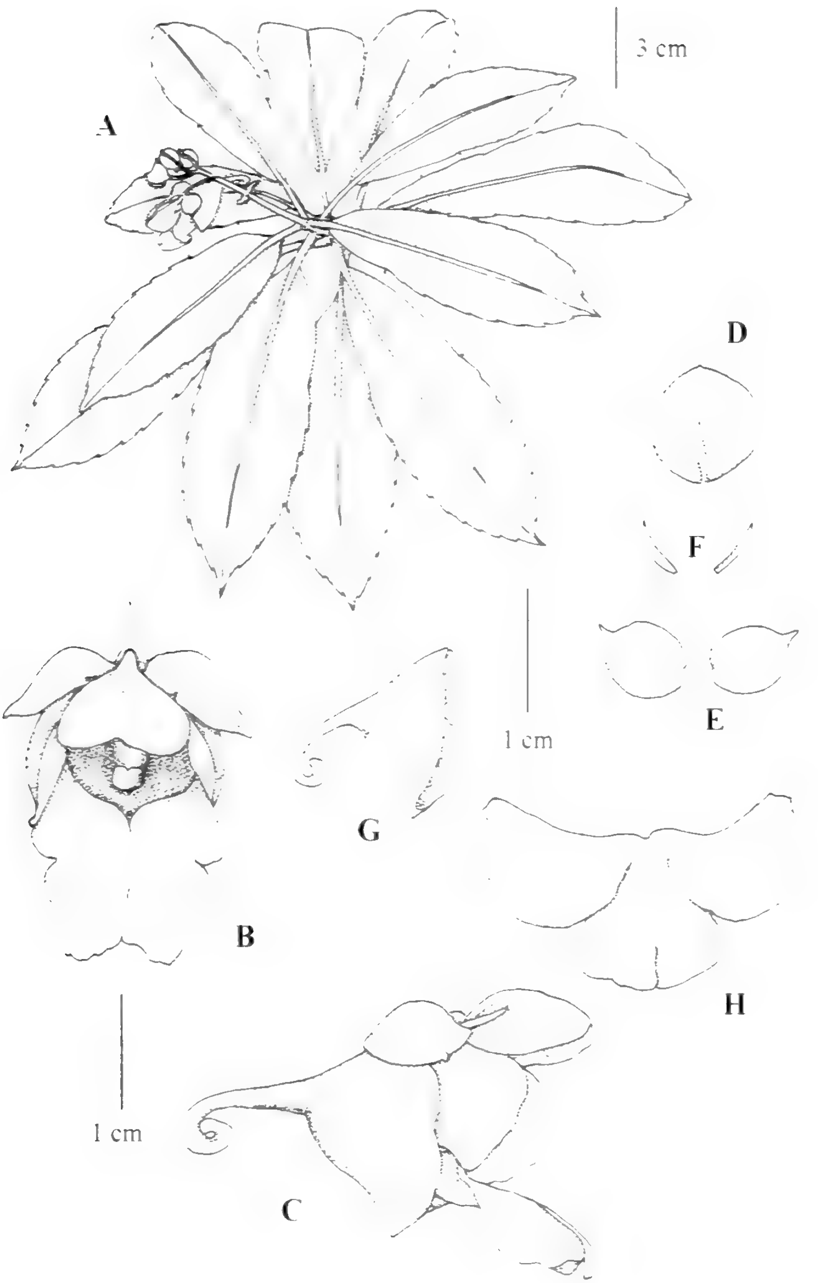

Figure 1. *Impatiens adenioides* Suksathan & Keerat. A. Habit; B. C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Inner lateral sepals; G. Lower sepal; H. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

received the plant from local people in Phatthalung province. Among the other caudex species found in peninsular Thailand, i.e., *I. mirabilis* Hook. *f.*, and *I. opinata* Craib, *I. adenioides* is easily recognized by its elliptic to oblanceolate, thick-leathery lamina, with acutely serrated margin, and also its eglandular flower bracts.

2. ***Impatiens charisma*** Suksathan & Keerat., *sp. nov.*
I. phengklaii *Shimizu & Suksathan affinis, a qua differt cauli alata, petiolis et pedunculis planis, flore petalis cum pari superiori lateralibus connatis et per pares petalorum inferiorium superpositis.* – **Typus:** W Thailand, Kanchanaburi Province, Sai Yok district, 750 m alt, 5 Aug 2008, *P. Suksathan, P. Triboun, H. Boonnuang & K. Keeratikiat 4679* (holo, QBG; iso, BK, SING). **Fig. 2 & Plate 1B.**

Tuberous rooted perennial **herbs,** completely glabrous, tuber up to 15 cm in diameter; **stems** annual, 1-2, erect, unbranched, arising from points at the top of the tuber, to 20 cm long, 4-6 angled, distinctly winged along stem angles. **Leaves** spirally arranged, petiole 3-8 cm long, slightly flat, winged; lamina up to 21 × 10 cm, elliptic, apex acuminate, base cuneate to rounded, sometimes oblique, tapering into narrow wings along petiole and stem, margin shallowly crenate, with two fusiform glands just above the base; lateral veins 7-10 pairs. **Inflorescence** (1-) 2-flowered subumbellate raceme, borne in the upper leaf axils; peduncles up to 10 cm long, flat, terminating in 3-4, light green, narrowly elliptic to lanceolate, persistent bracts. **Flowers** yellow, 4.5-5 cm long, with red tint at spur base; pedicels *ca* 2.5 cm long, slender; lateral sepals 4, the outer pair greenish white, *ca* 1.6 × 1.3 cm long, obliquely ovate, mucronate, the inner pair strongly reduced into yellow, *ca* 3 mm long, obliquely ovate scales; lower sepal *ca* 3 cm long, *ca* 3.5 cm deep, bucciniform, abruptly constricted into a narrow, *ca* 1.5 cm long incurved spur, the tip of spur minutely bifid; dorsal petal *ca* 2.3 × 2 cm, slightly cucullate, broadly obovate to suborbicular, strongly reflexed in the upper half, apex obcordate, with sub-apical mucro; lateral united petals connate; upper petals *ca* 1.6 × 1.3 cm, broadly ovate, short-apiculate at apex; lower petals *ca* 2.7 × 2.4 cm, obovate, shortly apiculate at apex. Ovary glabrous. **Fruit** ellipsoid; **seeds** unknown.

Flowering during the rainy season, between August and October.

Distribution and habitat: Endemic to W Thailand (Kanchanaburi). Growing in shaded limestone crevices along cliffs in mixed bamboo forest, *ca* 750 m alt., rather rare.

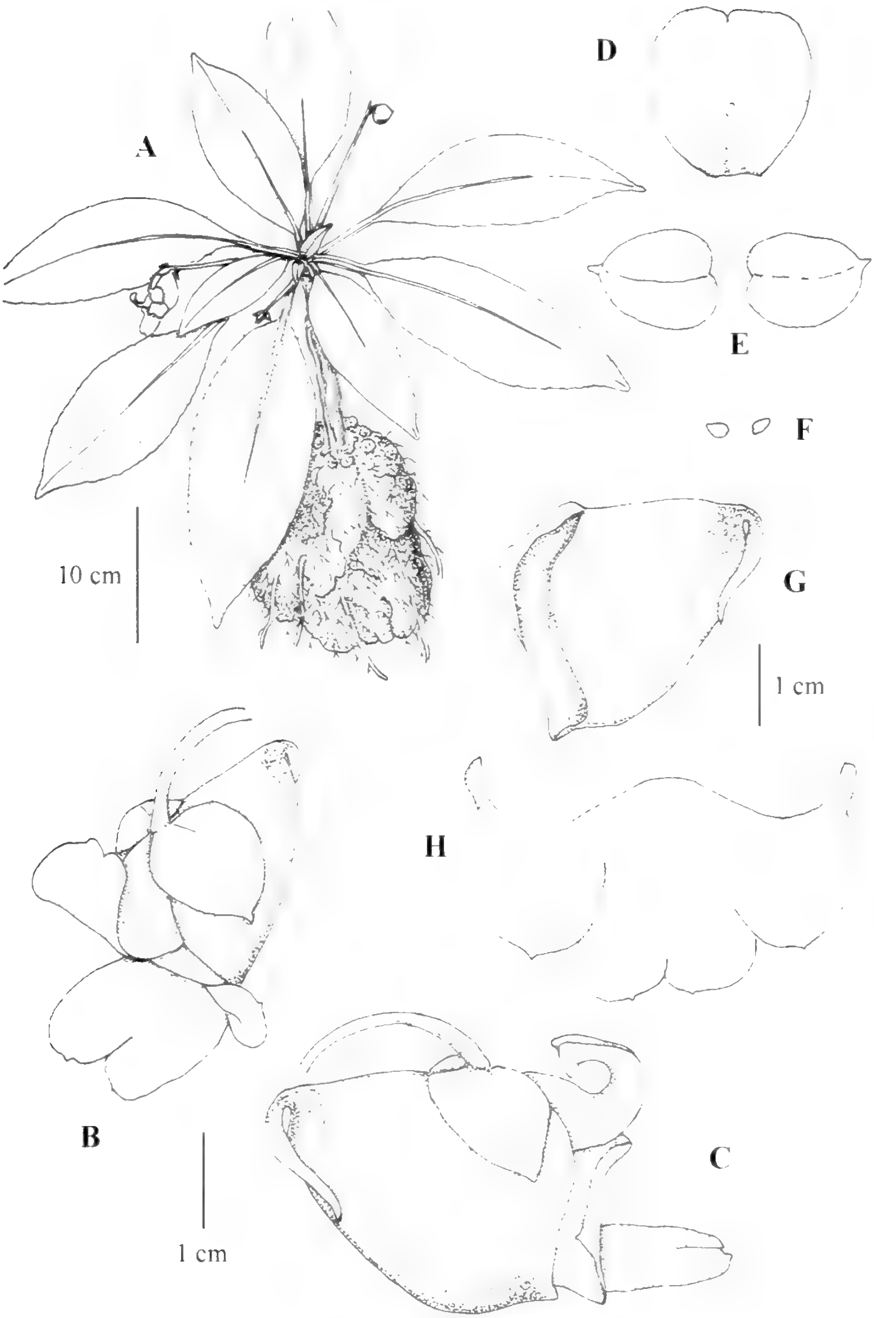

Figure 2. *Impatiens charisma* Suksathan & Keerat. A. Habit; B, C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Inner lateral sepals; G. Lower sepal; H. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

Entymology: The specific epithet, *charisma* - respect and loyalty earned by the performance of good deeds, is dedicated to our beloved king, His Majesty King Bhumibol Adulyadej, Rama IX of Thailand, who has been a tireless advocate for the nature and environment proposing guidelines on the principles of sustainable conservation and the development of natural resources.

Notes: This rare elegant balsam is one of the only two representative of tuberous species found in SE Asia (the other is *Impatiens phengklaii* Shimizu & Suksathan). In both species, the annual stems die back to the tuberous caudex at the end of the growing season (May-November). *Impatiens charisma* is easily distinguished from *I. phengklaii* by having winged stems, flat petioles and peduncles, and the broader upper pair of lateral united petals that at the base overlap to the lower one.

3. ***Impatiens daraneenae*** Suksathan & Triboun, *sp. nov.*
Impatiens hongsonensis *Shimizu affinis, a qua differt floribus distortis roseis, sepalo infero angustiore bucciniformi, petalo inferiori connato oblongo.* – **Typus:** N Thailand, Chiang Mai Province, Chiang Dao district, limestone outcrops along roadside to Mueang Kong, *ca* 850 m alt., 7 Oct 2008, *P. Suksathan & M. Wongnak 4672* (holo, QBG; iso, AAU, BK, BKF, SING). **Fig. 3 & Plate 1C.**

Annual **herbs**, wholly glabrous; **stem** decumbent to erect, dark purplish brown, rather thin, up to 50 cm long, laxly branched, slightly zigzag in upper part. **Leaves** alternate, petiole up to 3.6 cm long; lamina up to 6.7 × 3.9 cm, ovate, apex acuminate, base cuneate to rounded, sometimes oblique, margin crenate-dentate, with two distinct, short-stalked glands at the base; lateral veins 6-7 pairs. **Flower** axillary, solitary or 2-3-fascicled, pendulous under the leaves, distorted, light pink, 4.0-4.2 cm long; pedicels *ca* 1.3 cm long, minutely bracteate at base; lateral sepals 4, the outer pair whitish green, *ca* 5 × 5 mm, obliquely broadly ovate, mucronate, the inner pair strongly reduced into purple, subelliptic scales, *ca* 2 mm long; lower sepal 1.5 cm long, 2.5 cm deep, broadly bucciniform, pinkish white, with pink reticulate veins, clearly visible on the inner surface, abruptly constricted into a narrow, *ca* 8 mm long incurved cylindrical spur, the tip of the spur minutely bifid; dorsal petal *ca* 1.1 × 0.8 cm, obovate, strongly reflexed in the upper half, minutely mucronate, base with a short, green, conical crest; lateral united petals connate, pink, with two yellow patches at the base of lower petals, unequally distorted; upper petals 7-13 × 8-10 mm, obliquely ovate; lower petals connate about two-third of the length, distorted oblong in outline, *ca* 20 × 12 mm, apex deeply bilobed, the lobe apically emarginated. Ovary glabrous. **Fruit** ellipsoid; **seeds** unknown.

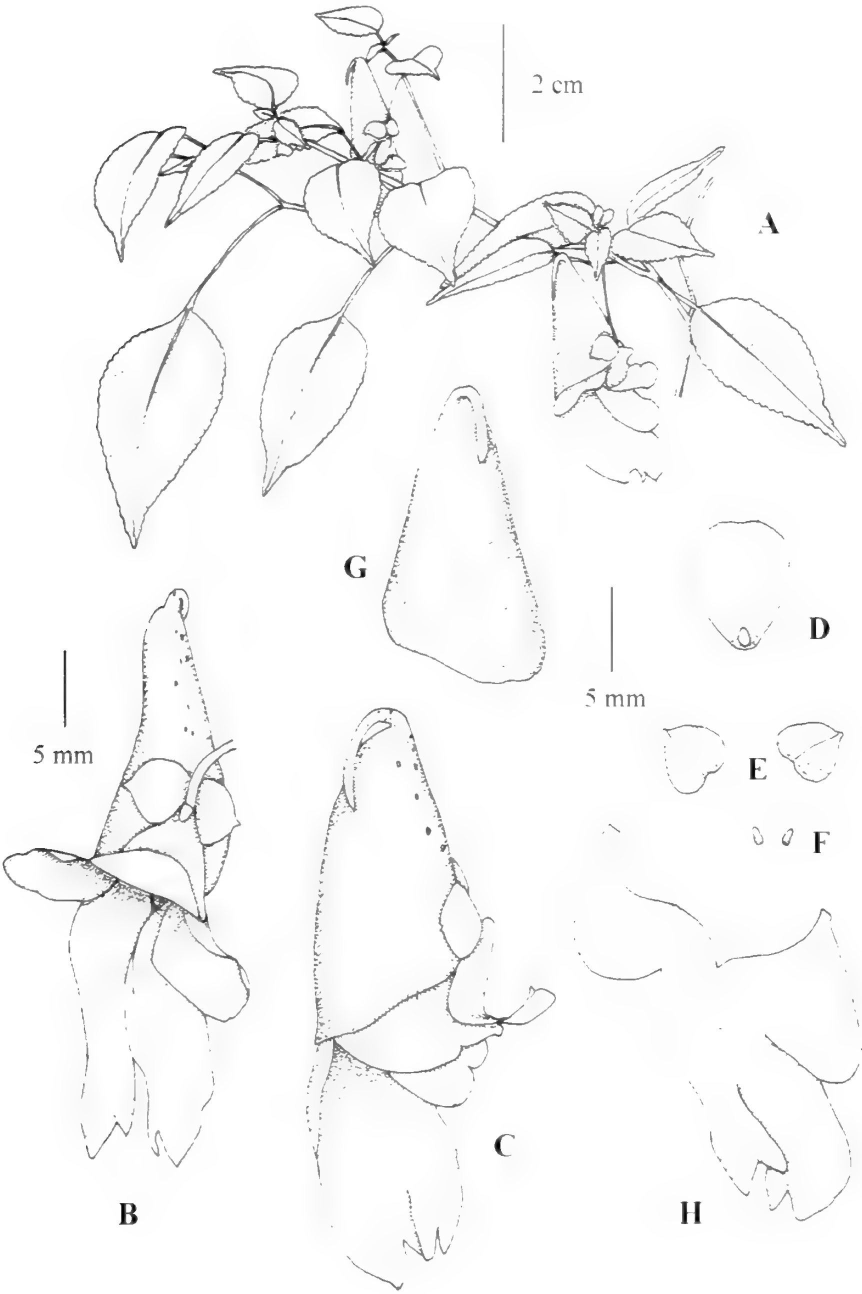

Figure 3. *Impatiens daraneenae* Suksathan & Triboun. A. Habit; B, C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Inner lateral sepals; G. Lower sepal; H. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

Flowering during the rainy season, August-October.

Distribution and habitat: Endemic to N Thailand (Chiang Mai). Growing on limestone outcrop in mixed bamboo forest, *ca* 850 m alt. Locally common, but as yet known only from the type locality.

Etymology: The plant is named in honour of Mrs. Daranee Derojanawong, a plant lover from Bangkok who kindly helped us finding research funding.

Notes: *Impatiens daraneenae* was firstly discovered by the second author during his field work in connection with the revision of the family Gesneriaceae for the Flora of Thailand. It is easily distinguished by its distorted, light pink flower, narrow bucciniform lower sepal, and oblong lower connate petals with two basal yellow patches.

4. ***Impatiens doitungensis*** Triboun & Sonsupab, *sp. nov.*
Impatiens lacinulifera *Y.L.Chen affinis, a qua differt floribus pupureo-roseis, sepalis lateralibus laevibus, calcari apice obtusa, petalo dorsali ad basin cristato, marginis foliorum cum dentibus sinuum prominentibus.* – **Typus:** Thailand, Chiang Rai Province, Mae Sai-Mae Fa Luang district, Doi Tung, limestone crevices near summit, 1,300 m alt., 26 Jul 2008, *P. Triboun, P. Blenchitra & B. Sonsupab 3850* (holo, BK; iso, QBG). **Fig. 4 & Plate 1D.**

Small lithophytic annual **herb**, completely glabrous; **stems** light green, erect, slender, 10-20 cm tall, simple to laxly branched. **Leaves** alternate, crowed on the upper part of stem, petiole 7-10 mm long, light green, with many small red patches; lamina ovate to lanceolate, *ca* 5.0 × 2.5-2.9 cm, apex mucronate, base obtuse to cuneate, sometimes slightly oblique, margin serrulate with prominent sinus-teeth, the two black-tipped basal glands obtuse; lateral veins 6 pairs. **Flowers** axillary, solitary or 2-fascicled, pendulous under the leaves, purplish pink; pedicels *ca* 4 cm long, minutely bracteate at base; lateral sepals 4, the outer pair greenish white to pale pink, *ca* 7 mm long, broadly ovate, mucronate, the inner pair strongly reduced into pink small scales, *ca* 2 mm long; lower sepal *ca* 2.4 cm long, *ca* 2 cm deep, obliquely bucciniform, pale pink, with red veins, clearly visible on the inner surface, abruptly constricted into a narrow, 1.1-1.3 cm-long, white, incurved cylindrical spur; dorsal petal *ca* 1.4 × 1 cm, obovate, strongly reflexed in the upper half, apically emarginate, base with a short, green, subtriangular, pointed crest; lateral united petals connate, entirely pink except for two yellow patches at the base of lower petals; upper petals 1.1-1.2 × 0.8 cm, ovate, apiculate; lower petals *ca* 2 × 1 cm, connate about three-quarters of the length, narrowly obovate in outline, apex 2 lobed, the lobe apiculate. Ovary glabrous. **Fruit** linear, slender; **seeds** unknown.

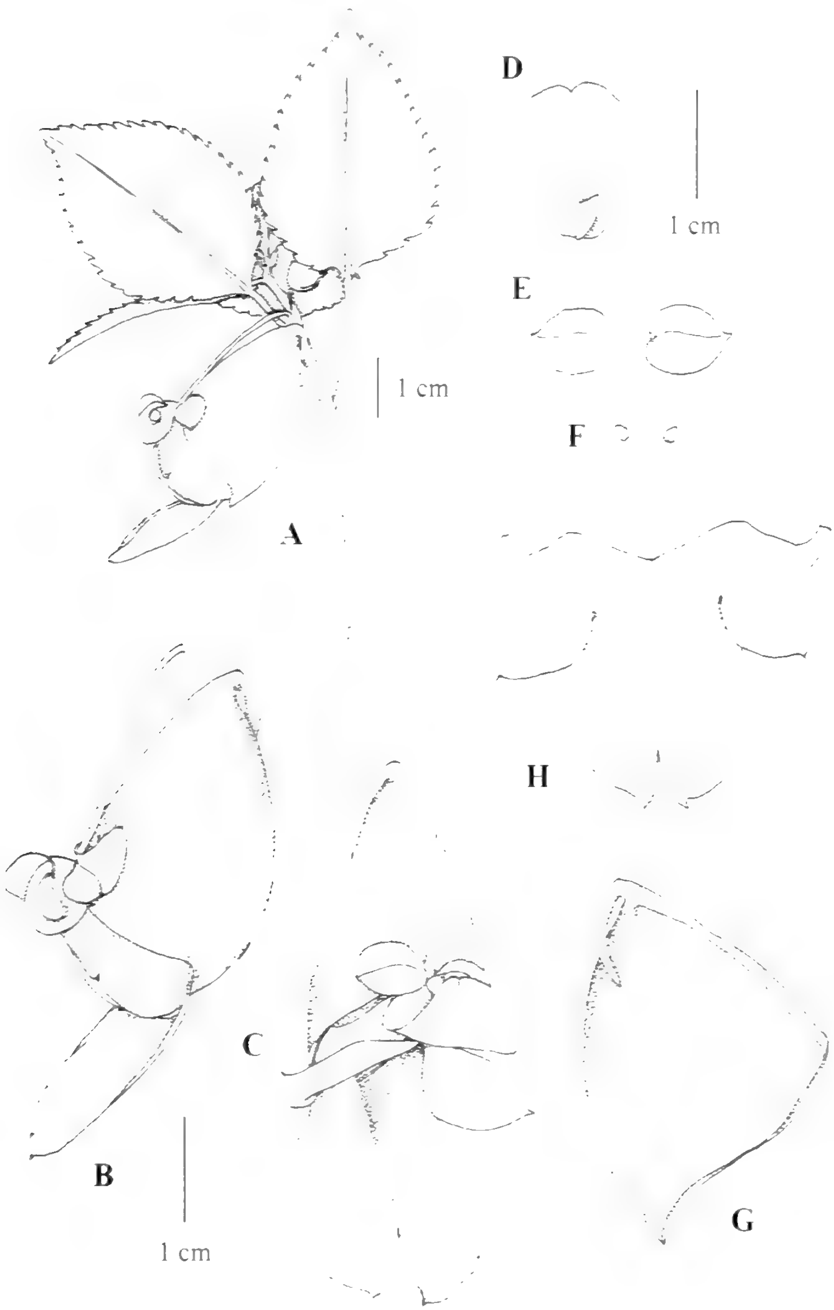

Figure 4. *Impatiens doitungensis* Triboun & Sonsupab. A. Habit; B, C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Inner lateral sepals; G. Lower sepal; H. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

Flowering in rainy season, between July and August.

Distribution and habitat: Endemic to Northern Thailand (Chiang Rai). Growing in open limestone scrub vegetation, on the summit of limestone mountain *ca* 1,300 m alt. As yet known only from the type locality.

Etymology: The specific epithet is named from the type locality at Doi Tung where it was collected.

Notes: *Impatiens doitungensis* resembles the Chinese species *I. lacinulifera* Y.L.Chen but clearly differs in its purplish pink flower with smooth lateral sepals, blunt tipped spur, basally crested dorsal petal, and especially a presentation of prominent sinus-teeth along leaf margin.

5. ***Impatiens jiewhoei*** Triboun & Suksathan, *sp. nov.*
Impatiens nalampoonii *Shimizu affinis, a qua differt floribus violaceo-caeruleis sepalo infero rubro-striato, calcari curvato ad basin adnato cylindrico.* – **Typus:** Thailand, Kanchanaburi Province, Mueang distric, Khao Pun cave, mixed bamboo forest in shaded limestone area, 11 Oct 2008, *P. Triboun*, *H. Boonnuang* & *K. Keeratikiat 3893*, (holo, BK; iso, QBG, SING). **Fig. 5 & Plate 2A.**

Lithophytic annual **herb**, completely glabrous; **stem** decumbent to erect, green to reddish green, rather thin, to 70 cm long, laxly branched, slightly zigzag in upper part. **Leaves** alternate, petiole (1-)2-7.5 cm long; lamina 5-12 × 2.5-6.5 cm, ovate to lanceolate, apex acute to acuminate or blunt, base cuneate to cordate, margin serrate, with two distinct, deltoid glands near the base; lateral veins (4-)5-6 pairs. **Flowers** axillary, solitary or 2 fascicled, pendulous under the leaves, 3-3.2 cm long, violet-blue, with a narrow long, yellow patch at the base of the lower connate petal; pedicels 0.5-1.5 cm long, minutely bracteate at base; lateral sepals 4, the outer pair pale green tinged purple, *ca* 10 × 5 mm long, obliquely ovate, mucronate, the inner pair strongly reduced into narrowly lanceolate, *ca* 3.5 mm-long scales; lower sepal 1.6 cm long, 1.8 cm deep, broadly saccate, pale pink with red striped veins, clearly visible on the inner surface, abruptly constricted into a narrow, cylindric, green, incurved, 1.3 cm long spur, the spur tip dark red; dorsal petal blue, *ca* 1.9 × 1.7 cm, obcordate, slightly cuculate, strongly reflexed in the upper half, base with a short, subtriangular crest; lateral united petals connate, violet-blue, with a narrow longitudinal yellow patch in the middle of the connate lower petal; upper petals *ca* 9 × 7 mm, obovate, apex slightly bilobed; lower petals connate about two-third of the length, broadly ovate in outline, *ca* 2.3

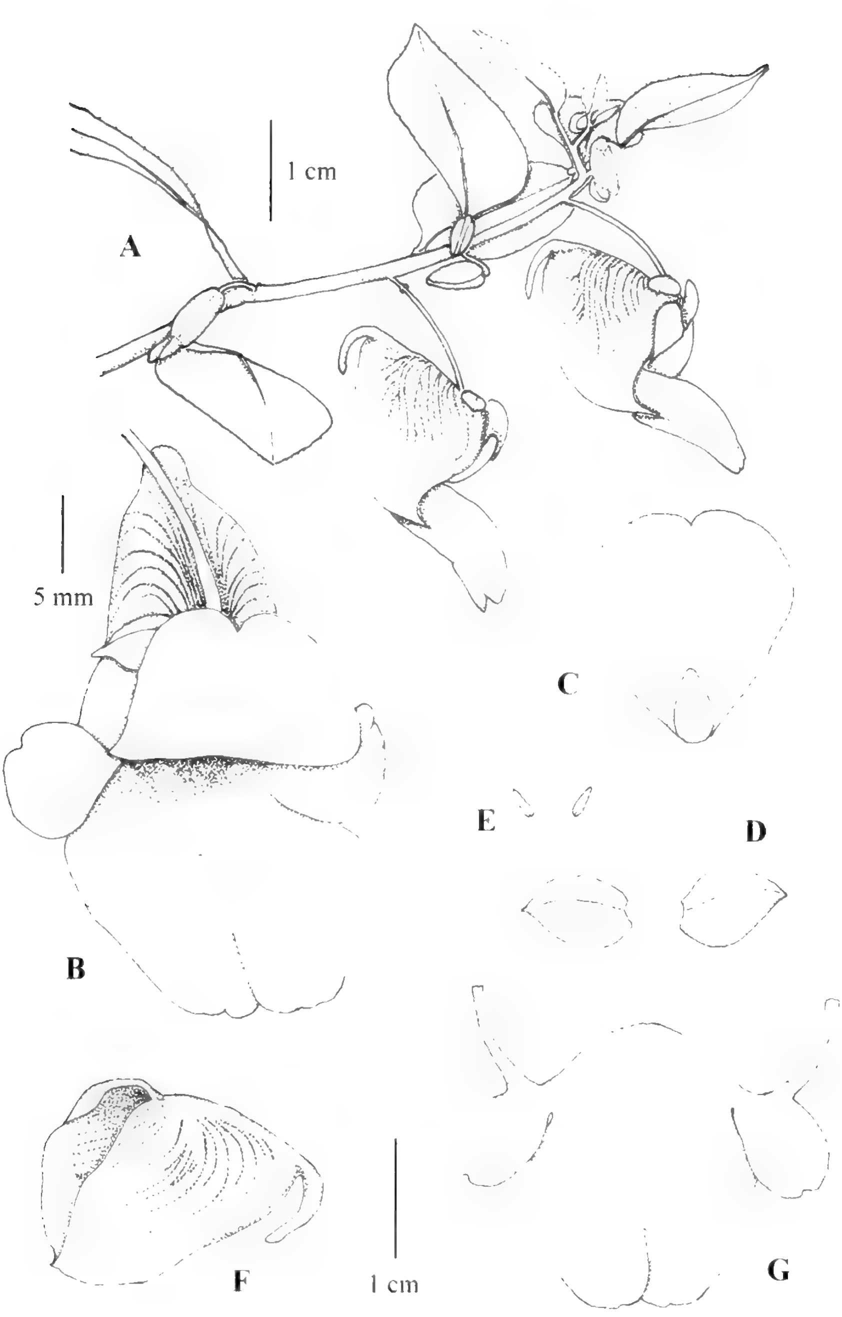

Figure 5. *Impatiens jiewhoei* Triboun & Suksathan. A. Habit; B. Flower; C. Dorsal sepal; D. Outer lateral sepals; E. Inner lateral sepals; F. Lower sepal; G. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

× 1.8 cm, apically bilobed, the lobe shallowly emarginated. Ovary glabrous. **Fruit** linear, 1.5-2.5 cm long; **seeds** unknown.

Flowering during the rainy season, between June and October.

Additional specimens examined: Thailand, Kanchanaburi, Kao Tok, below 50 m. alt., 13 Jul 1930, *A.F.G. Kerr 19549* (BK, K); same province, Tha Salao, *ca* 100 m alt., 10 Jul 1930, *A.F.G. Kerr 19562*, (K); ibid., 10 Jul 1930, *A. Marcan 2497* (K).

Distribution and habitat: Endemic to W Thailand (Kanchanaburi). Growing in shaded mixed bamboo to dry evergreen forest in limestone area, 20-100 m alt., locally abundant, but as yet known only from the type locality.

Etymology: The specific epithet is named in honour of Mr. Tan Jiew-Hoe, the president of Singapore Gardening Society, who kindly encouraged the authors to revise the genus *Impatiens* in Thailand.

Notes: *Impatiens jiewhoei* is one of the most beautiful species, closely related to the N Thailand endemic, *I. nalampoonii* Shimizu. However, the violet-blue flower with red striped lower sepal, and basally adnate, cylindric, curved spur, leave no doubt about its separate identity.

6. ***Impatiens oreophila*** Triboun & Suksathan, *sp. nov.*
Impatiens chinensis *L. affinis, a qua differt floribus albis, calcari recto vel leviter curvato ad apicem obtuso pagina interiori venatio rubro-reticulati.* – **Typus:** Thailand, Kanchanaburi Province, Sangkhla Buri, Khao Radar-Khao Yai, open grassy summit, 1,300-1,400 m. alt., 13 Nov 2008, *P. Triboun, W.J.J.O. De Wilde* and *B.E.E. Duyfjes 4031* (holo, BK; iso, L, QBG). **Fig. 6 & Plate 2B.**

Terrestrial or lithophytic annual **herb**, completely glabrous; **stems** light green, unbranched, erect, 15-45 cm tall, with long internodes, quadrangular in transection. **Leaves** opposite, decussate, 6-9 pairs, scattered along the stem, sessile; lamina narrowly lanceolate, (6-)8.5-11.5 × 1.3-1.8 cm, coriaceous, apex acute or cuspidate, shortly cuneate at base, ± amplexicaul, margin serrate, with two green, retrorse glands at the base; lateral veins 4-6 pairs. **Flower** subterminal axillary, solitary or 2 fascicled, *ca* 3.5 cm long, white; pedicels slender, green, *ca* 4 cm long; lateral sepals 2; the outer pair linear, falcate, white to light green, *ca* 10 × 1 mm, apex acute; the inner pair absent; lower sepal navicular, *ca* 1.4 cm long, 7 mm deep, gradually tapering into a 1.7-2 cm-long, straight or slightly curved spur, white with red reticulated

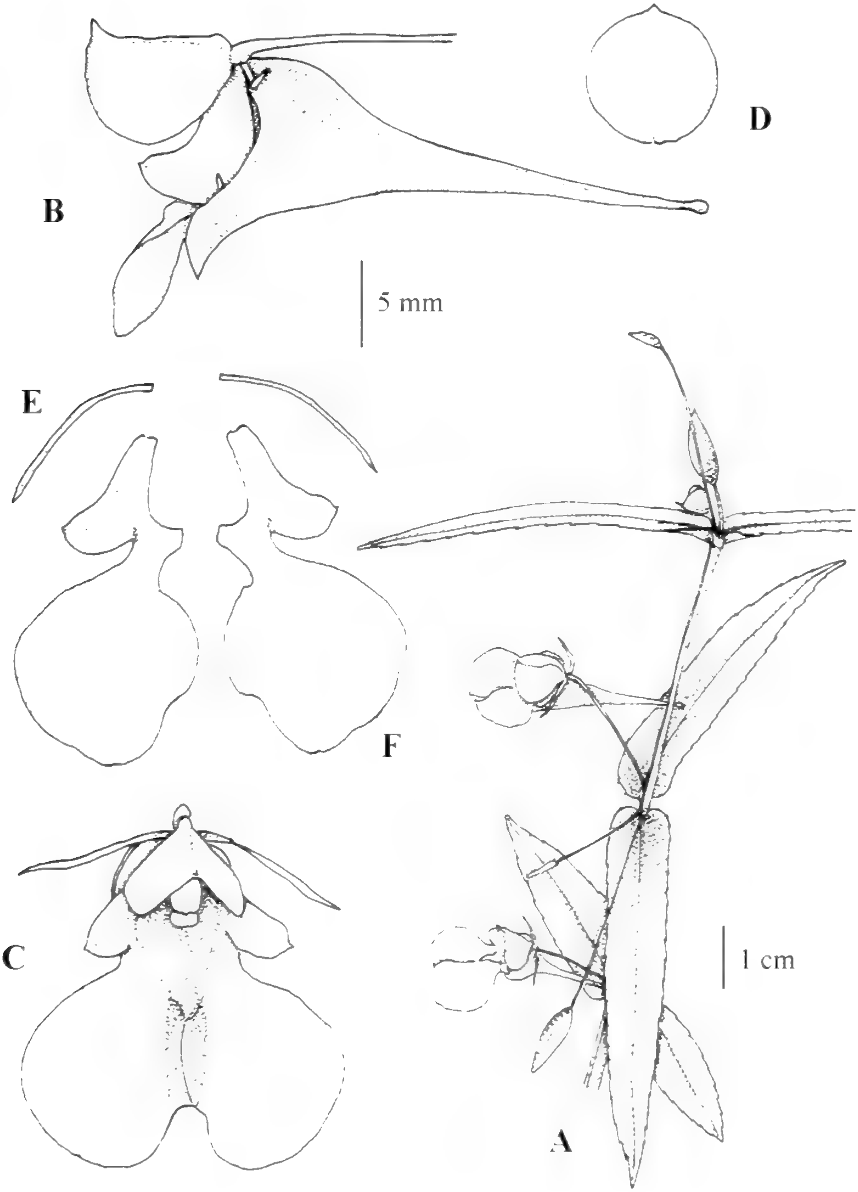

Figure 6. *Impatiens oreophila* Triboun & Suksathan. A. Habit; B. C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

veins , clearly visible on the inner surface, spur tip blunt, *ca* 0.5 mm in diameter; dorsal petal white, *ca* 8 × 7 mm, obcordate, slightly cuculate, apex mucronate, base shortly and slightly crested; lateral united petals free, white, with two violet patches at the base of the lower petals; upper petals *ca* 2 × 2.5 mm, subtriangular, apex round; lower petals obovate, *ca* 1.2 × 0.7 cm. Ovary glabrous. **Fruit** ellipsoid, 1.5-2.5 cm long; **seeds** unknown.

Flowering in late rainy season, between August-October.

Distribution and habitat: Endemic to W Thailand (Kanchanaburi), as yet known only from the type locality. Growing on exposed granite rock crevices as well as among grasses in open grassland near the summit, from 1,300-1,400 m alt.

Etymology: The specific epithet *oreophila* means mountain-loving, which refers to its habitat near the summit of the high mountain.

Notes: Impatiens oreophila is rather closely related to *I. chinensis* L. in having an erect, simple stem, and opposite sessile leaves. However, it is easily distinguished by its white flower, and its straight or slightly curved, blunt-tipped spur, with red reticulated veins on the inner surface.

7. ***Impatiens ruthiae*** Suksathan & Triboun, *sp. nov.*
Impatiens nalampoonii *Shimizu affinis, a qua differt flori rubro-purpureo distorto, sepalis lateralibus viridibus, sepalo inferiori luteo-aurantiaco, anguste bucciniformi.* – **Typus:** Thailand, Loei Province, Nong Hin district, limestone mountain, 715 m alt., 6 Jul 2008, *P. Suksathan, M. Wongnak, H. Boonnuang* and *K. Keeratikiat* 4553 (holo, QBG; iso, AAU, BK, BKF, SING). **Fig. 7 & Plate 2C.**

Lithophytic annual **herb**, completely glabrous; **stems** decumbent to erect, dark purplish brown, rather thin, to 50 cm long, laxly branched, slightly zigzag in upper part. **Leaves** alternate, petiole up to 4 cm long, with two distinctly, short-stalked, filiform glands at the middle or at the apex; lamina up to 10.5 × 5 cm, ovate, apex acuminate, base cuneate to rounded, sometimes oblique; lateral veins 5-7 pairs; margin crenate-dentate. **Flower** axillary, solitary or 2-3-fascicled, pendulous under the leaves, distorted, *ca* 4 cm long, purplish red, with orange-yellow lower sepal; pedicels *ca* 1.3 cm long, minutely bracteate at base; lateral sepals 4, the outer pair whitish green, *ca* 8 mm long, broadly ovate to suborbicular, mucronate, the inner pair strongly reduced into subelliptic, 0.5 mm-long scales; lower sepal *ca* 1.5 cm long, 2.2 cm deep, narrowly bucciniform, orange-yellow, with reticulate red veins, clearly

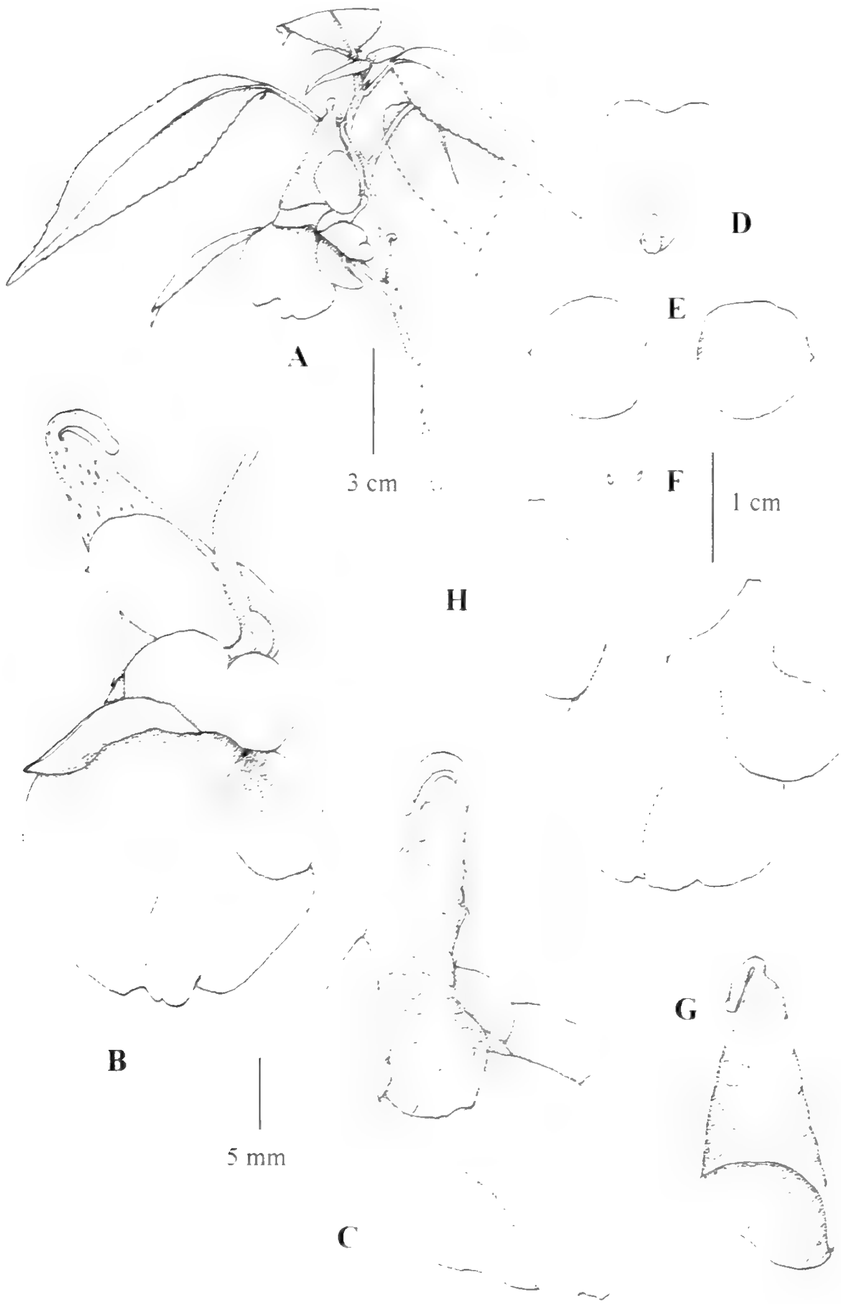

Figure 7. *Impatiens ruthiae* Suksathan & Triboun. A. Habit; B. C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Inner lateral sepals; G. Lower sepal; H. Lateral united petals. (B-C; D-H share the same scale bar). [Drawn by P. Suksathan].

visible on the inner surface, abruptly constricted into a narrow, cylindric, *ca* 5 mm long incurved spur; dorsal petal pink, *ca* 1.4 × 1.1 cm, obovate, slightly cuculate, strongly reflexed in the upper half, apex emarginate, forming a subapical mucro, base with a short, green, subtriangular crest, *ca* 1.5 mm high; lateral united petals connate, purplish red, marked with a broad yellow patch at the base of the lower petals, unequally distorted; upper petals 1-1.2 × 1.3-1.4 cm, obliquely ovate, apex rounded; lower petals 1.7-2 × 1-1.1 mm, oblong, apically emarginated. Ovary glabrous. **Fruit** *ca* 15 × 4 mm, clavate, constricted in the upper part; **seeds** *ca* 1.5 mm long ellipsoid, seed coat pustulate.

Flowering during rainy season, July-September.

Distribution and habitat: Endemic to NE Thailand (Loei). As yet known only from the type locality. Growing on limestone in moist, shaded limestone foothill at *ca* 715 m alt., rather rare.

Etymology: The plant is named in honour of Dr. Ruth Kiew in Malaysia, a botanist and a limestone plant expert who has supported this project.

Notes: *Impatiens ruthiae* is one of the most peculiar species with its burgundy red flowers, a colour rarely found in other Asian species.

8. ***Impatiens sirindhorniae*** Triboun & Suksathan, *sp. nov.*
Impatiens walleriana *Hook.f. affinis, a qua differt caulibus decumbentibus usque ad pendentibus, foliis griseo-viridis ovatis coriaceis, floribus calcaribus profunde navicularibus.* – **Typus:** Thailand, Krabi Province, Plaai Phraya district, vertical limestone cliff, 20-150 m alt., 25 Jun 2007, *P. Triboun*, *P. Blenchitra* and *P. Yothakaew 3801* (holo, BK, iso, AAU, QBG, SING). **Fig. 8, Plates 2D, 3C & D.**

Lithophytic perennial **herb**, forming basal tillers, up to 15 stems, wholly glabrous; **stems** succulent, decumbent to pendulous, greyish to brownish green, glaucous, to 40 cm long, rarely branched. **Leaves** spirally arranged, somewhat crowded on the upper part of stem, petiole 6-7.5 cm long, with two distinct, short-stalked glands at the apex; *lamina* 3.2-4 × 2.8-3.5 cm, ovate, thickly coriaceous, greyish green, apex acute, base truncate to subcordate, margin roughly serrate; lateral veins 3-6 pairs. **Flowers** axillary, solitary, rarely 2-fascicled, large, rather flat, 4.5-4.8 cm wide, light purple; pedicels slender, suberect, 3-6.5 cm long, ± minutely bracteate at base; *lateral sepals* 4, the outer pair whitish green, 6-7 × 3-5 mm long, obliquely ovate, acute, the inner pair strongly reduced into whitish green, cordate to rotund, *ca* 2.5 mm scales; lower sepal 1.6 × 1.6 mm, deep navicular, pale to whitish

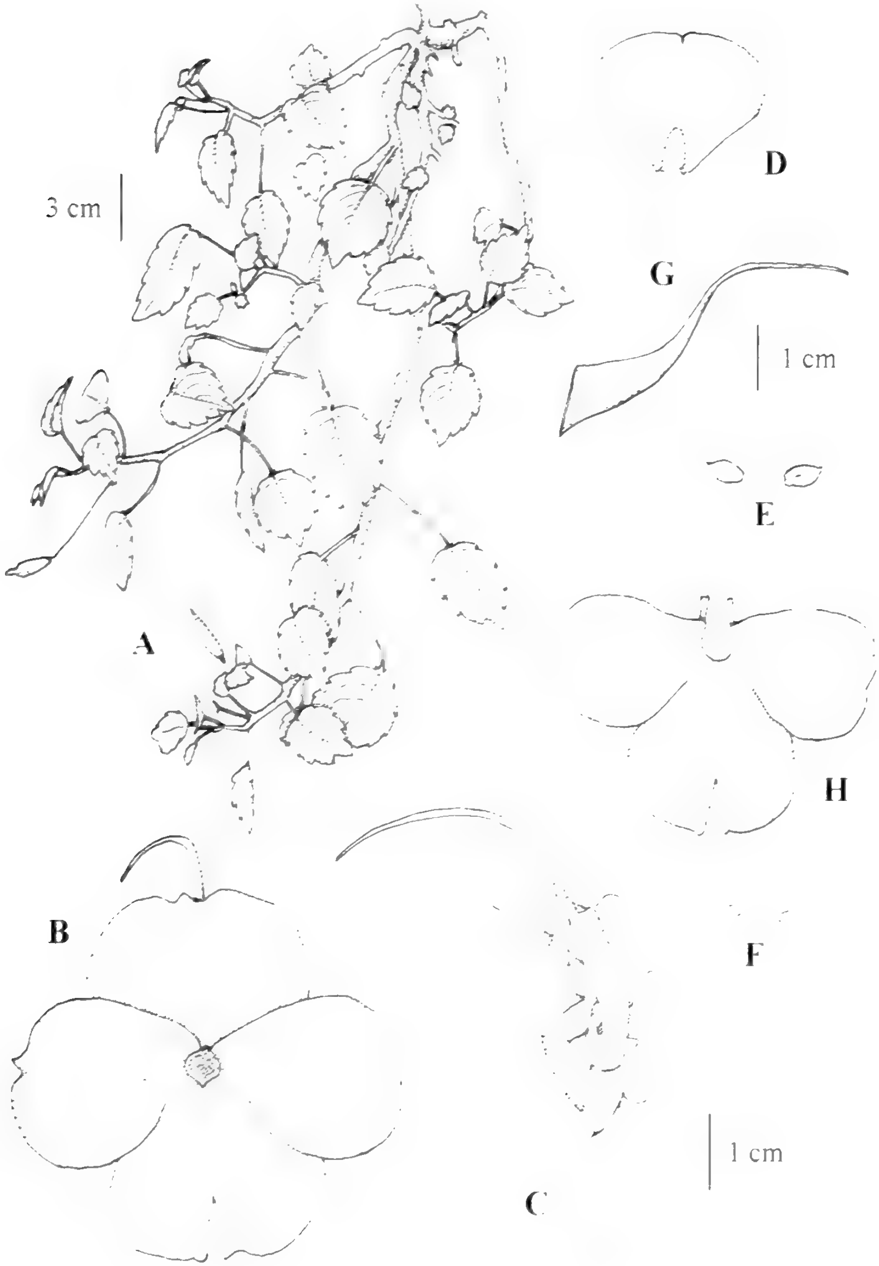

Figure 8. *Impatiens sirindhorniae* Triboun & Suksathan. A. Habit; B. C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Inner lateral sepals; G. Lower sepal; H. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

green, gradually constricted into a narrow, cylindric, curved, *ca* 6 cm long spur; dorsal petal, *ca* 2 × 2.5 cm, depressed obovate, strongly reflexed just above the base, apex cuspidate, base with a short, white, subtriangular crest, *ca* 2 mm high; lateral united petals connate, forming 3 subequal lobes, which are also subequal to the dorsal one; upper petals *ca* 2.5 × 2 cm, obovate, apex cuspidate; lower petals connate for about two-third of the length, depressed obovate in outline, *ca* 2.0 × 2.5 cm, apically bilobed. Ovary glabrous. **Fruit** ellipsoid; **seeds** unknown.

Additional specimen examined: Thailand, Surat Thani Province, Kao Ken, 50 m alt., 27 Mar 1927, *A.F.G. Kerr 12446* (BK, K).

Flowering in rainy season, between June-October.

Distribution and habitat: Endemic to peninsular Thailand (Krabi and Surat Thani). Growing on open or shaded vertical limestone cliffs, 20-150 m alt.

Etymology: The specific epithet is given in honour of Her Royal Highness Princess Sirindhorn for her dedication and encouragement to the environmental sciences and biodiversity conservation in Thailand.

Notes: *Impatiens sirindhorniae* is one of the most beautiful perennial species, easily recognized by its pendulous habit, succulent thick leaves and large light purple flower.

9. ***Impatiens spectabilis*** Triboun & Suksathan, *sp. nov.*
Impatiens walleriana *Hook.f. affinis, a qua differt herba annua, androeceo et gynoecio occultis per bases petalorum, cum apertura angusta, sepalis latioribus.* – **Typus:** Thailand, Kanchanaburi Province, Thong Phaphum, Wat Tha Khanun, on limestone, *ca* 135 m alt., 10 Oct 2008, *P. Triboun*, *H. Boonnuang* and *K. Keeratikiat 3889*, (holo, BK; iso, BKF, K, QBG, SING). **Fig. 9 & Plate 3A.**

Moderately branched, terrestrial or lithophytic, annual **herb**; **stems** decumbent to erect, fragile, up to 40 cm long, often rooting at the lower nodes. **Leaves** alternate, scattered along the stems, petiole 1-3.5 cm long, dull red, finely pubescent to glabrescent; lamina 5-11 × 2-5.5 cm, ovate to lanceolate, apex acute to acuminate, base cuneate to subcordate, sometimes oblique, margin serrate, with two distinct, short-stalked, clavate glands near the base; lateral veins 6-8 pairs. **Flowers** axillary, solitary, rarely 2 fascicled, large, flat, *ca* 4 cm wide, bright pink; *pedicels* slender, suberect, *ca* 3 cm long, minutely bracteate at base; lateral sepals 2(-4), the outer pair dull red, 6-10

× 6 mm long, obliquely broadly ovate, mucronate, the inner pair absent, or strongly reduced into small scales, less than 1 mm long; lower sepal shallowly navicular, 14 mm long, 6 mm deep, white to reddish green, abruptly constricted into a narrow, cylindric, curved, 4.5-4.8 cm long spur; dorsal petal *ca* 1.3 × 1.8 cm, obovate, minutely apiculate, strongly reflexed just above the base, base with a short, red, subtriangular crest, *ca* 2 mm high; lateral united petals partly connate, forming 4 subequal lobes, which are also subequal to the dorsal one; upper petals *ca* 1.7 × 1.3 cm, obovate, minutely apiculate; lower petals connate for about half of the length, slightly obliquely obovate, *ca* 2.3 × 1.5 cm, minutely apiculate; the base of all petals positioned closed to each other forming a small aperture hiding the androecium and gynoecium underneath. Ovary glabrous. **Fruit** clavate; **seeds** many, 1.5-2.1 × 1-1.2 mm.

Additional specimens examined: Thailand, Kanchanaburi Province, Thong Pha Phum distric, Kwai river valley, *ca* 100 m alt., 21 Oct 1984, *J. Dransfield 6218* (K); same district, near Neeckey, near Wangka, 150 m alt., 13 Jun 1946, *G. den Hoed 945* (K); same district, I-Thong, along gas pipe-lines, 21 Nov 1997, *K. Chayamarit 1002* (BKF); same district, Kao Leam dam, 29 Nov 1982, *K. Hiroshike, T. Hiroshi, C. Niyomdham, & T. Wongprasert T-30452* (BKF); same locality, 10 Jul 1981, *T. Santisuk s.n.* (BKF).

Flowering in rainy season, between July-October.

Distribution and habitat: W Thailand (Kanchanaburi). A very common species forming large colonies on mountain slopes and limestone outcrops in lowland dry evergreen and mixed deciduous forests along roadside from Thong Phaphum to Sangkla Buri district. Also observed in Myanmar.

Etymology: The specific epithet refers to its spectacular large pink flower that are easily spotted from a distance.

Notes: A very common but peculiar species, *Impatiens spectabilis* has a very characteristic flower, flat, with a large dorsal petal, and lateral united petals almost equal in size and shape, and especially the androecium and gynoecium that are hidden behind a very narrow aperture formed by petal bases. It would be very interesting to study its floral morphology and pollination.

10. ***Impatiens tigrina*** Suksathan & Triboun, *sp. nov.*
Impatiens charanii *Shimizu affinis, a qua differt flore luteo, sepalis lateralibus libris, calcari simplici.* – **Typus:** Thailand, Udon Thani Province, Ban Paeu district, shaded sandstone table, *ca* 300 m alt., 8 Jul 2008, *P. Suksathan, M. Wongnak, H. Boonnuang* and *K. Keeratikiat 4567* (holo, QBG; iso, BK,

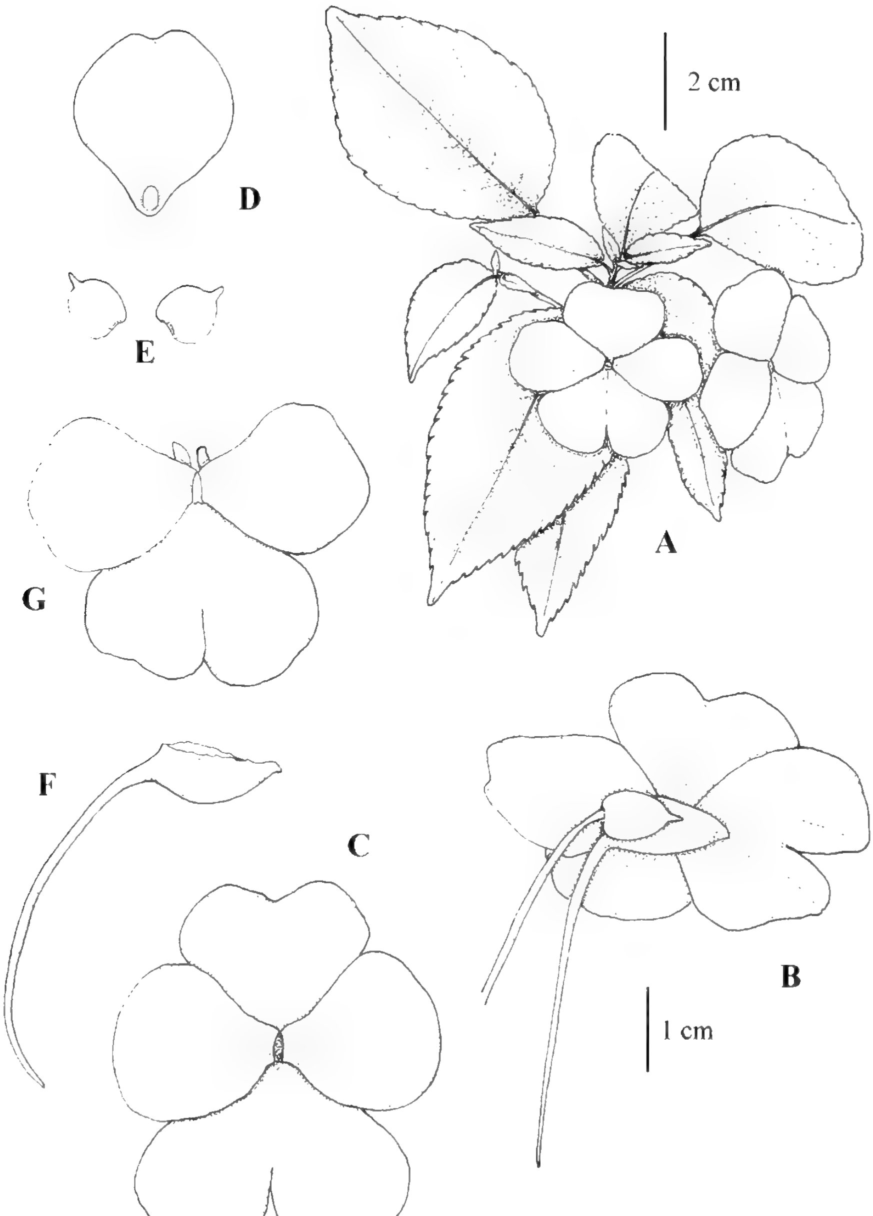

Figure 9. *Impatiens spectabilis* Triboun & Suksathan. A. Habit; B, C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Lower sepal; G. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

SING). **Fig. 10 & Plate 3B.**

Lithophytic annual **herb**, with a green, erect cylindrical main stem, to 30 cm long, *ca* 1.3 cm in diameter, richly branched at the top, completely glabrous; branches of **stem** up to 30 cm long, purplish red or purplish brown, rather thin, up to 30 cm long, slightly zigzag in upper part. Leaves ovate to broadly lanceolate, apex acuminate, base cuneate to round, sometimes oblique, with two distinct, short-stalked, fusiform glands at the base; lateral veins 12-15 pairs; margin crenate-dentate; the basal ones larger, spirally arranged, petiole 8-10 cm long and lamina up to 25 × 10 cm in basal leaves; the upper leaves congested on top of the main stem, smaller, alternately arranged along branches, petiole 5-10 mm long and lamina 7-16 × 2.5-6 cm. **Flowers** axillary, solitary or 2-3-fascicled, pendulous under the leaves, yellow, *ca* 4 cm long, with orange-red transverse stripes on lower sepal; pedicels *ca* 1 cm long, minutely bracteate at base; lateral sepals 4, the outer pair pale green, *ca* 10 × 7 mm long, obliquely broadly ovate, mucronate, the inner pair strongly reduced into small sublanceolate, light green scales, *ca* 2 mm long; lower sepal *ca* 1.6 cm long, 2 cm deep, broadly bucciniform, with orange-red transverse stripes, clearly visible on the inner surface, abruptly constricted into a narrow, 8 mm-long incurved claviform spur, swollen toward the tip; dorsal petal yellow, *ca* 1.6 × 1.2 cm, cuculate, obovate, retuse, with a thick, green, blunt crest in the lower half; lateral united petals connate, entirely yellow; upper petals *ca* 1.5 × 1.6 cm, depressed orbicular; lower petals connate, suborbicular in outline, *ca* 1.8 × 2 cm, with a prominent basally bi-lobed keel, apex emarginate. Ovary glabrous, 4-carpellate. **Fruit** subfusiform, *ca* 2 cm long; **seeds** many, *ca* 3 mm long, oboviod.

Flowering in rainy season, between July-September.

Distribution and habitat: Endemic to NE Thailand (Udon Thani), as yet known only from the type locality. Growing on sandstone in shaded sandstone tables in dry evergreen forest *ca* 300 m alt.

Etymology: The specific epithet, *tigrina*, means like a tiger, referring to its yellow flower with red striped lower sepal.

Notes: *Impatiens tigrina* was first introduced to the first author by Mr. Methee Wongnak, a geographer from Queen Sirikit Botanic Garden. Its growth habit strongly resembles *I. charanii* Shimizu, but the yellow flower with free outer lateral sepals and simple spur leave no doubt of its identity.

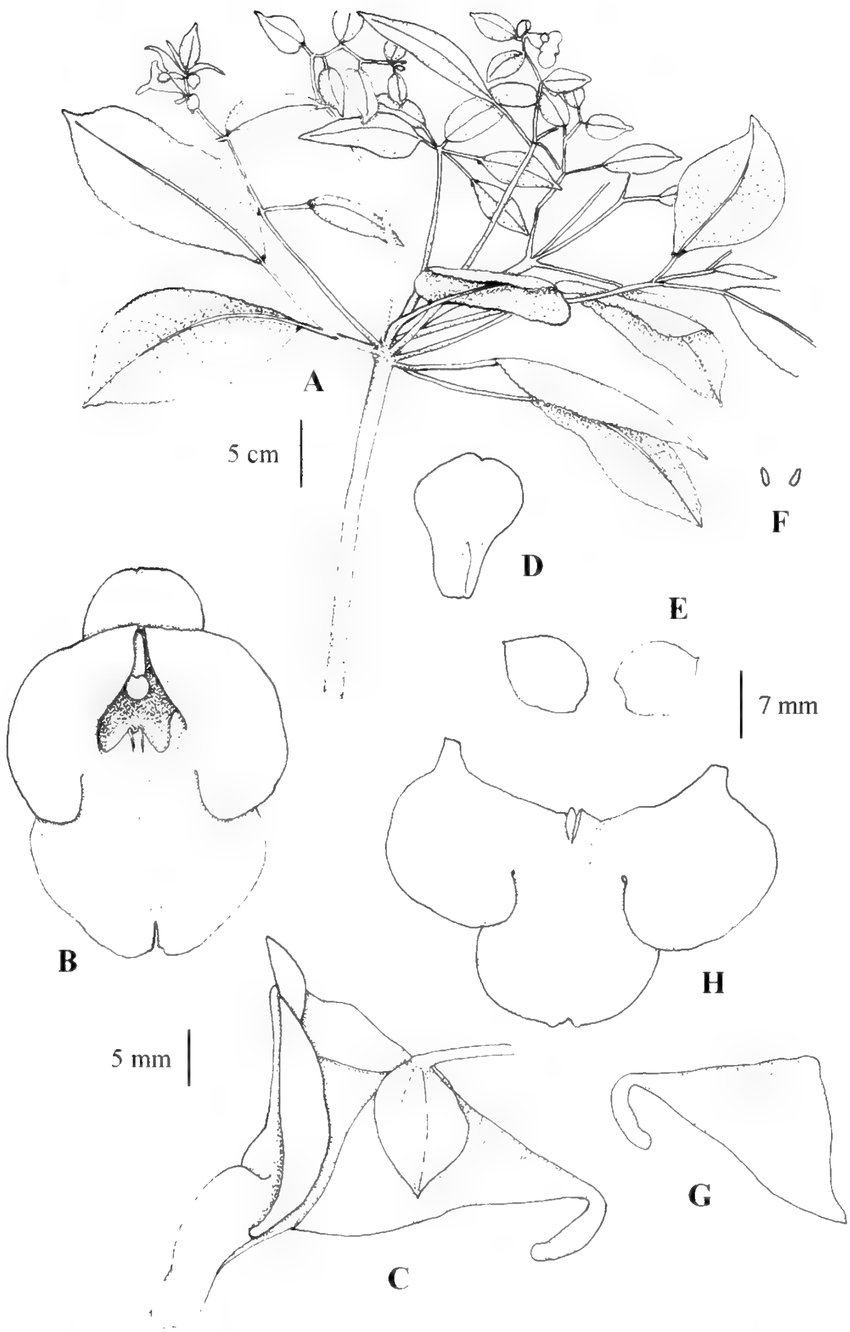

Figure 10. *Impatiens tigrina* Suksathan & Triboun. A. Habit; B, C. Flower; D. Dorsal sepal; E. Outer lateral sepals; F. Inner lateral sepals; G. Lower sepal; H. Lateral united petals. (B-C and D-H share the same scale bar). [Drawn by P. Suksathan.]

Acknowledgements

The authors wish to gratefully acknowledge H. R. H. Princess Maha Chakri Sirindhorn for kindly granting us the permission to name the new *Impatiens* after her. We are grateful to Dr. Benjamin Øllgaard for his kind suggestions and for translating the Latin diagnoses. Thanks are due to the curators and staff of the following herbaria: AAU, BK, BKF, BM, K, P, QBG, and SING for making material available for study and also to Methee Wongnak, Chuyos Punpreuk, Hassachai Boonnuang, and Kaweesak Keratikiat for supplying specimens and participating in the field. Special thanks are also given to Tan Jiew-Hoe and Daranee Derojanawong for financial support and kind advice.

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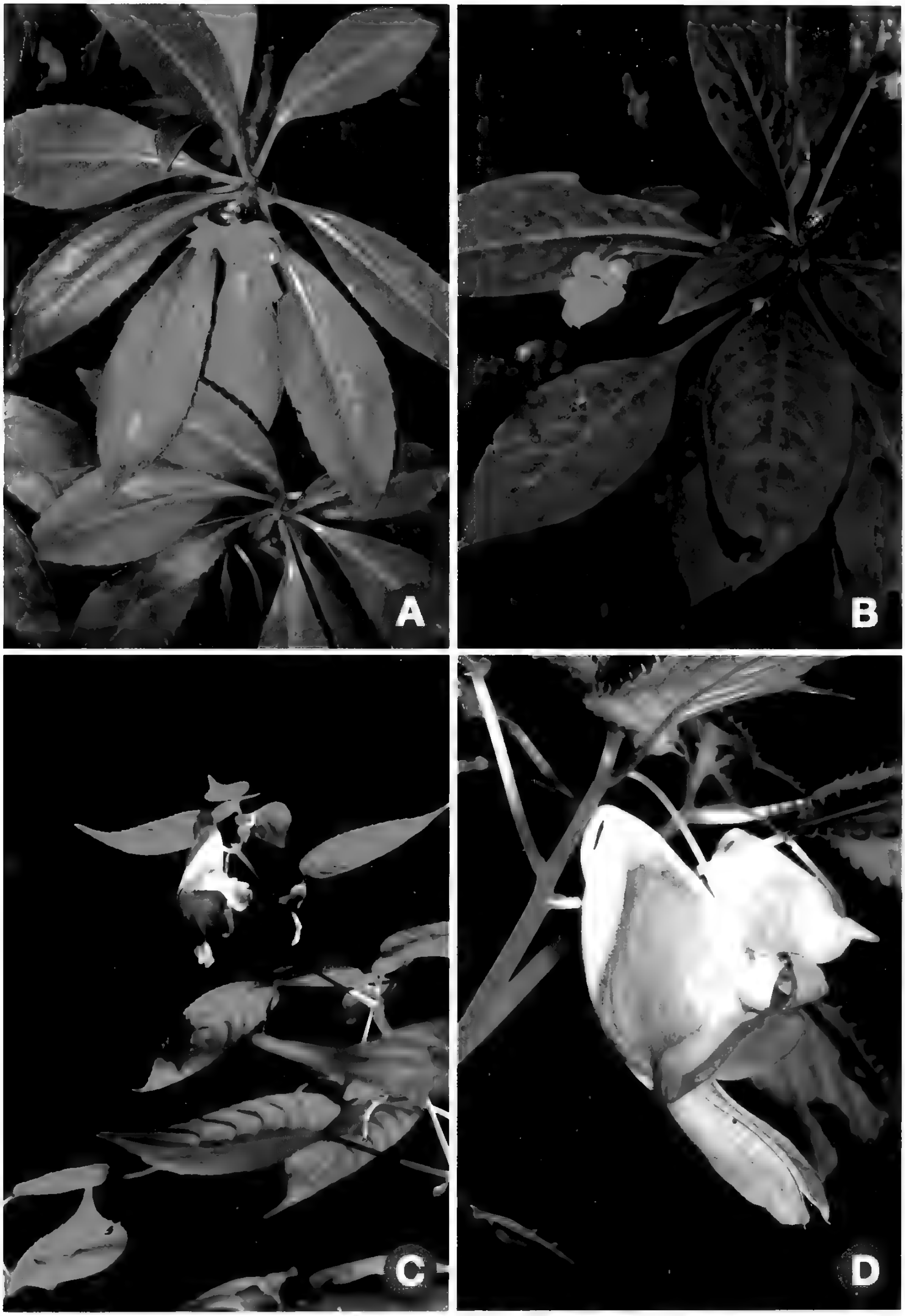

Plate 1. A. *Impatiens adenioides* Suksathan & Keerat.; B. *I. charisma* Suksathan & Keerat.; C. *I. daraneenae* Suksathan & Triboun; D. *I. doitungensis* Triboun & Sonsupab. (Photos: H. Boonnuang).

Plate 2. A. *Impatiens jiewhoei* Triboun & Suksathan; B. *I. oreophila* Triboun & Suksathan; C. *I. ruthiae* Suksathan & Triboun; D. *I. sirindhorniae* Triboun & Suksathan. (Photos: H. Boonnuang).

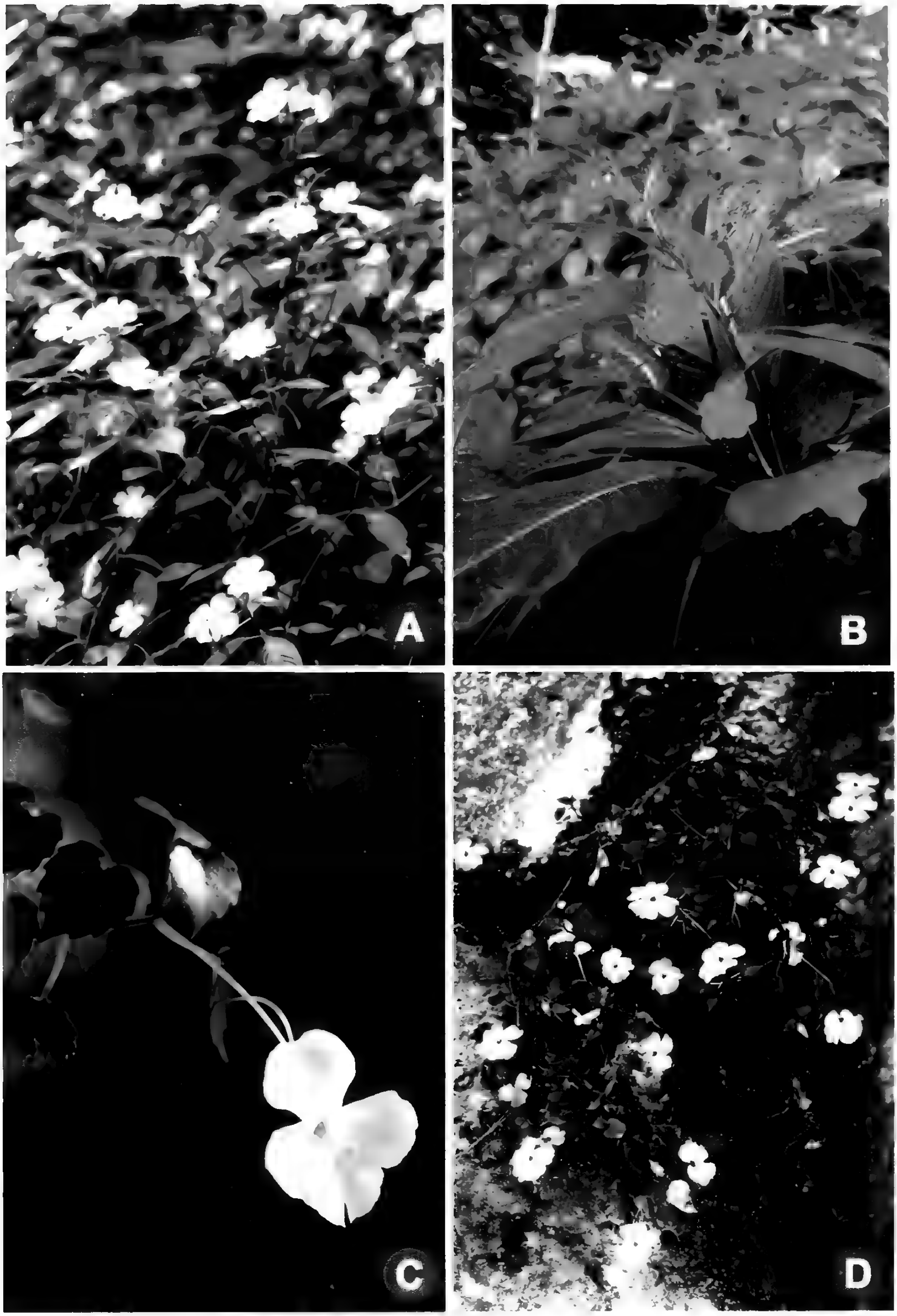

Plate 3. A. *Impatiens spectabilis* Triboun & Suksathan; B. *I. tigrina* Suksathan & Triboun; C-D. *Impatiens sirindhorniae* Triboun & Suksathan (Photos: H. Boonnuang).

A New Species of *Alphonsea* (Annonaceae) from Borneo

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Abstract

Alphonsea borneensis I.M. Turner is described as a new species. It is a medium-sized tree of lowland forest recorded from Sabah and Central Kalimantan.

Introduction

In revising the genus *Alphonsea* for the Tree Flora of Sabah and Sarawak, it became apparent that a number of distinctive fruiting specimens in various collections, notably the Sandakan Herbarium, did not match any of the species included in the revision of the genus by Kessler (1995). A new species is therefore described.

Alphonsea borneensis I.M. Turner, *sp. nov.*
Alphonsea javanicae *similis, foliis chartaceis, fructibus maioribus differt.* – **Typus:** Borneo, Kalimantan, Central Kalimantan, Sintang, HPH km 83-87, along old logging road east of camp (0°49'25.8", 112°3'38.8"), 6 May 1994, *A.C. Church et al. 1344* [holo, K (barcode: K000580481); iso, A [×2], BO, K, L[×2]]. **Figs. 1 & 2.**

Tree to 16 m tall, 20 cm dbh. **Twigs** pale grey or grey-brown, drying longitudinally wrinkled, often with raised lenticels, youngest twigs red-brown with adpressed pale hairs. **Leaves** chartaceous, drying fairly uniformly brown or grey-brown, glabrous, except for short hairs along midrib above; midrib flush to slightly sunken above, prominent below in dry leaves, lateral nerves slightly raised on both surfaces in dry leaves, lamina ovate to (narrowly) elliptic, 4-13 × 1.5-5 cm, base acute to obtuse, apex acuminate, lateral nerves 10-18 pairs, obscure to the naked eye but visible under magnification, looping well within the margin with secondary loops outside, tertiary and higher orders of venation visible under magnification from below, more obscure from above; petiole 2-5 mm long, 0.5-1 mm thick, drying black or dark brown, rugose. **Flowers** unknown. Fruiting pedicel, 8-18 mm long, 3-3.5 mm thick, calyx sometimes persisting. **Monocarps** to 6, ellipsoidal to globose, to 6 × 4

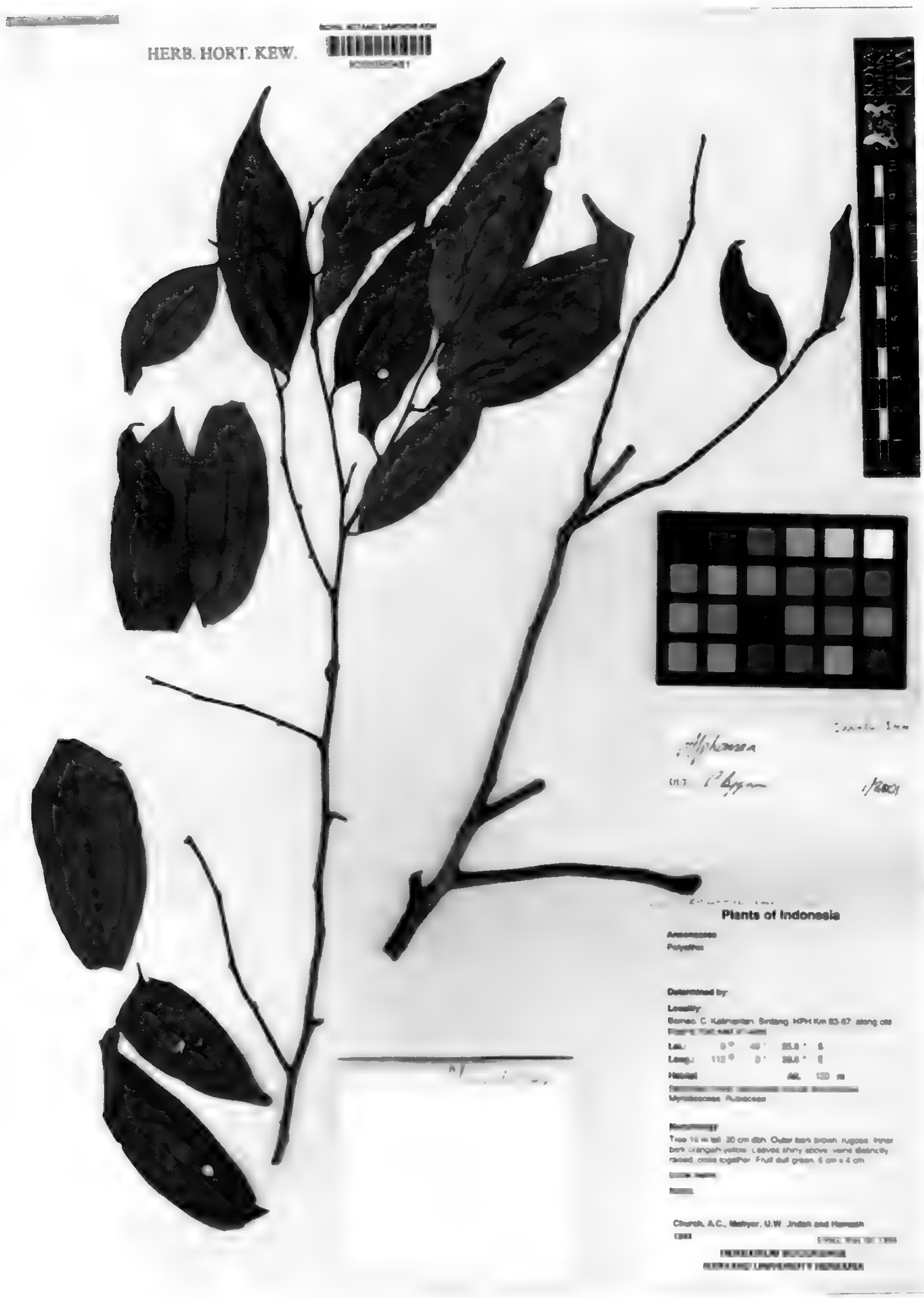

Figure 1. Photograph of the herbarium specimen that forms part of the holotype of *Alphonsea borneensis, sp. nov.* © The Board of Trustees of the Royal Botanic Gardens, Kew. Reproduced with the consent of the Royal Botanic Gardens, Kew.

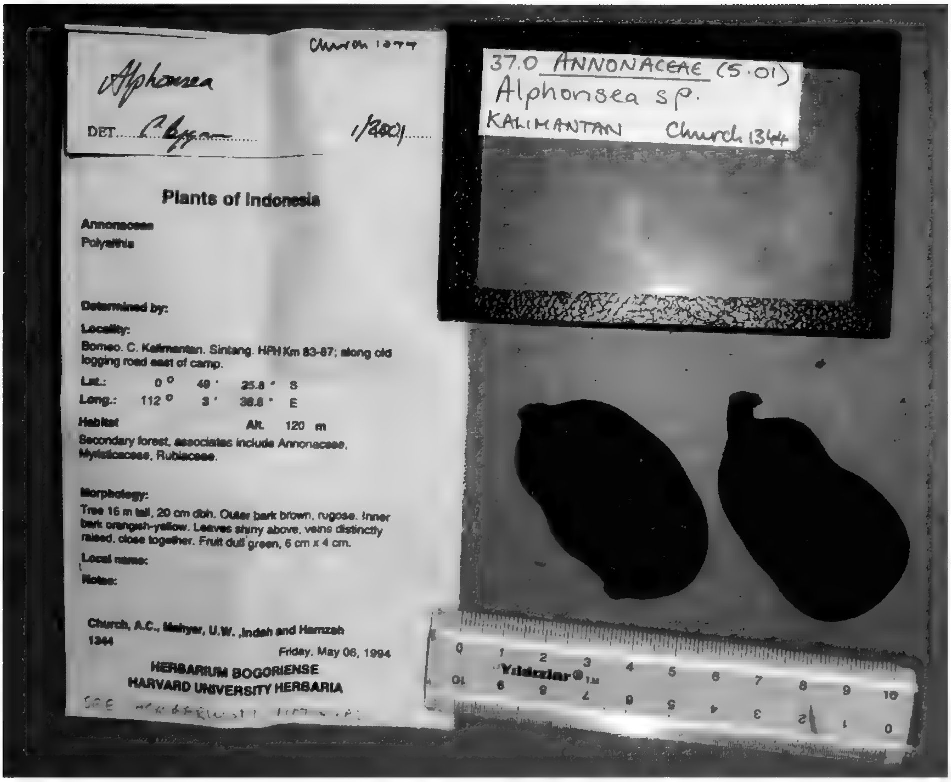

Figure 2. Photograph of the carpological specimen that forms part of the holotype of *Alphonsea borneensis, sp. nov*.

cm, drying black, apex rounded or with short broad nipple, smooth, minutely warty sometimes with very short brown hairs visible under magnification, stipe 3-10 mm long, 6 mm thick. **Seeds** *ca* 8, lunar, *ca* 20 × 10 × 4 mm.

Specimens examined: MALAYSIA, **Sabah**. Ulu Sungai Pingas-Pingas, Keningau District, Interior Division, Sumbing Jimpin, *SAN 122061* (SAN); Upper Sg Miau near Mt Muruk Miau, Sipitang District, Interior Division, *Pius & Dauni*, *SAN 143151* (SAN); Hiaw Fok Logging Area, Marak-Parak on the National Park Boundary, Kota Merudu District, Kudat Division, *Aban Gibot*, *SAN 100010* (SAN [×2]); Sepilok, Sandakan District, Sandakan Division, *de Wilde et al. SAN 144001* (K, SAN); Permodalan Plantation, Sg Kertam, Sandakan District, Sandakan Division, *Aban Gibot*, *SAN 96834* (SAN [×2]); Mostyn, Madai Forest Reserve, Lahad Datu District, Tawau Division, *S. Lantoh*, *SAN 67746* (SAN); Madai, Kunak District, Tawau Division, *Mansus & Suali*, *SAN 117726* (SAN); about 8 miles from Kampung Merungin, Ranau District, West Coast Division, *Leopold & Saikeh*, *SAN 82589* (SAN).

Note: This is a species of lowland forest, with one collection (*SAN 100010*) from lower montane forest on ultrabasic substrate at 1200 m. Quite widely collected in Sabah, once from Central Kalimantan (type).

A pertinent question is why, in the absence of flowers, is this species described in the genus *Alphonsea*? The arborescent form and multi-carpellate and multi-ovulate state of the specimens limits the choice of genus among those occurring in Borneo to *Alphonsea* and its near miliusoid relatives *Mitrephora* and *Pseuduvaria*. Species of the latter two genera typically have leaves with regular 'herring-bone venation' of distinct sets of lateral nerves arching in parallel, whereas *Alphonsea borneensis* has fairly obscure venation, very similar to other Bornean *Alphonsea* species. A number of the specimens listed above have been previously determined as '*Alphonsea* sp.'

The large monocarps of *Alphonsea borneensis* that dry black and apparently glabrous to the naked eye are distinctive. The only other species of *Alphonsea* in Borneo with fruits similar is *A. javanica* Scheff., but it has more cylindrical monocarps to 2.5 cm in diameter whereas those of *A. borneensis* are ellipsoidal, or more rarely globose, and reach 4 cm in diameter. The obvious difference between *A. javanica* and *A. borneensis* is in the leaves. *Alphonsea javanica* has coriaceous leaves with a shiny upper surface, whereas *A. borneensis* has chartaceous leaves with a smooth but not markedly shiny upper surface. The foliage of *A. borneensis* is very similar to that of *A. kinabaluensis* J. Sinclair but the monocarps are much larger and not brown hairy.

Acknowledgements

I am grateful to the Arnold Arboretum, Forest Research Institute of Malaysia and Singapore Botanic Gardens for financial assistance towards this research and Royal Botanic Gardens, Kew, for facilities essential to its completion. Dr J. F. Veldkamp (L) kindly translated the diagnosis into Latin. John Sugau, Joan Pereira and Suzana Sabran are thanked for their help during my visit to Sandakan and for the subsequent loan of material.

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A History of Cananga (Annonaceae)

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Abstract

The history of the name cananga in botanical nomenclature is outlined and clarified. *Cananga odorata* (Lam.) Hook.f. & Thomson, is lectotypified. *Cananga brandisiana* (Pierre) I.M. Turner is proposed for *Cananga latifolia* (Hook.f. & Thomson) Finet & Gagnep., *nom. superfl.* The infraspecific taxonomy of *Cananga odorata* (Lam.) Hook.f. & Thomson is reviewed and the cultivar group names for plants producing ylang-ylang and cananga oil are corrected.

Introduction

Cananga odorata (Lam.) Hook.f. & Thomson (Annonaceae) is a tree native to the tropical Indo-Pacific. It has long been cultivated for its strongly perfumed flowers and is grown widely in the tropics, including in plantations for the production of essential oil. The species and its genus have a long and rather confusing nomenclatural history that has yet to be resolved completely. In this paper we outline that history and attempt to clarify some of the issues and to rectify some of the mistakes.

Etymology and Pre-Linnean Taxonomy

Vernacular names for *Cananga odorata* in two Asian languages have been used internationally in both common and scientific nomenclature. The Malay name kenanga (or cananga in pre-standardised spelling) has been borrowed for the generic name. The Tagalog name alang-ilang or ilang-ilang (now the Filipino standard, B.C. Tan, *pers. comm.*) has been used widely in the Spanish spelling variant ylang-ylang as a common name for the plant or more particularly for the essential oil, which is widely used in perfume manufacture.

The earliest mention of the species now known as *Cananga odorata* in the western scientific literature is in the account of the trees of Luzon island in the Philippines by Georg (Jiří) Josef Kamel (or Camel or latinised to Camellus or Camelli). This was published as an appendix, *Herbarium aliarumque stirpium in insulâ Luzon e Philippinarum*, to John Ray's third volume of *Historia Plantarum* (Ray, 1704). Kamel, a Moravian Jesuit missionary and apothecary, referred to alanguilang (variant spelling of ilang-ilang) under Zhampacae species (p. 83). Kamel's manuscript was accompanied by pen-and-ink drawings of most of the species. The originals of these are divided between the Maurits Sabbe Library, Catholic University of Leuven, Belgium, and the Natural History Museum, London. There are two copies of the drawing for alanguilang in a bound volume in the Sir Hans Sloane collection at the Botany Library of the Natural History Museum. As Figure 1 shows, they very clearly depict *Cananga odorata*.

Georg Everhard Rumphius was the first to employ the name cananga in botanical writings. He had started the manuscript for what later became the *Herbarium amboinense* around 1663, for in August of that year he wrote a request to the Lords XVII, the Board of the Dutch East Indian Company (VOC), in which he announced that he had started on a work in which plants and animals of 'India' (Dutch East Indies) would be described and politely requested that the necessary literature be shipped by VOC vessels from Amsterdam to Amboina (Veldkamp, 2002, p. 12). Because of the political and commercial sensitivity of the subjects treated in the subsequent six-volume manuscript the VOC suppressed it until around 1735, and the publication of the first volume edited by Johannes Burman appeared in 1741.

In the second volume of his *Herbarium Amboinense*, Rumphius (1741) refers to cananga, clearly deriving the name from the Malay bonga cananga (bungah kenanga [kenanga flower] in current spelling). Cananga, cananga domestica or cananga vulgaris as it is referred to in the text and legend to the plate (tab. 65) respectively, is clearly *Cananga odorata*, though the four-part calyx in the drawing is erroneous. Rumphius also described cananga sylvestris (p. 197), a wild form, including under it three entities. None of Rumphius's three 'varieties' of cananga sylvestris has been directly linked to *Cananga odorata* (Merrill, 1917). Cananga sylvestris trifolia (p. 197; t. 66, f. 1) is possibly a species of *Goniothalamus* and is the sole basis for *Uvaria tripetala* Lam. (≡ *Unona tripetaloides* Dunal, *Unona tripetala* (Lam.) DC.). Cananga sylvestris angustifolia (p. 197; t. 66, f. 2) has yet to be identified with certainty but has been validated as *Uvaria ligularis* Lam. (≡ *Unona ligularis* (Lam.) Dunal). Finally, cananga sylvestris latifolia (p. 198) is the basis of *Unona latifolia* Dunal, the basionym of *Fissistigma latifolium* (Dunal) Merr.

François Valentijn, the son-in-law of Rumphius, used parts of the

Herbarium Amboinense manuscript in producing his *Oud en Nieuw Oost-Indiën*. This work was influential for nearly two centuries as a general guide to the Far East and was long used in the training of the employees of the Dutch East Indies Civil Service. Cananga appears for the first time in print in volume 3 (Valentijn, 1726, p. 213) where it is described (Appendix 1 contains an English translation of the text) and figured (tab. 42, see Figure 2). There can be little doubt that Valentijn described *Cananga odorata*.

The genus *Cananga*

Aublet (1775, p. 607, t. 244) was the first botanist to use Rumphius's name at generic rank. He mistakenly considered his new species from South America, *Cananga ouregou* now *Guatteria ouregou* (Aubl.) Dunal, to belong to the same genus as Rumphius's entities. As none of the Rumphian elements was validated when Aublet published *Cananga*, the genus must be typified by *Cananga ouregou* [ICBN (McNeill *et al.*, 2006) Art. 10.3, Ex. 3]. Unfortunately *Cananga* Aubl. pre-dated *Guatteria* Ruiz & Pav. (1794) and so had priority over it as the correct name for the very large neotropical genus. Rafinesque (1815, p. 175) employed *Cananga* as a generic name but without any description or indication of its derivation.

In his taxonomic treatment of *Unona*, Dunal (1817) recognised two ranks of infrageneric taxa without formal indication. One of the lower subdivisions containing nine species, including *Unona odorata* (Lam.) Dunal, he called *Cananga*. Later in the same year de Candolle (1817) followed Dunal's classification, using *Cananga* in exactly the same way as Dunal, though he named both the taxon (*Unonaria*) and rank (section) of the level above *Cananga*. It has generally been considered that *Cananga* here would be at subsectional rank (viz. McNeill *et al.*, 2006; Jessup, 2007) but de Candolle did not indicate a definite rank anywhere in the work. Blume (1830) appears to have been the first to use *Cananga* for a definite infrageneric rank when he referred to *Uvaria* section *Canangae*. As he stated (p.12) that his sections were based on Dunal, this can be regarded as an orthographic variant to be corrected to *Cananga*.

Hooker and Thomson (1855) included a single species, *Cananga odorata* (Lam.) Hook.f. & Thomson, when they described the genus *Cananga* Rumph. ex Hook.f. & Thomson. Despite the absence of a direct reference to Dunal, Hooker and Thomson must be considered to have transferred Dunal's name to generic rank [ICBN Art. 33.3, viz. Ex. 9]. However, the new genus was a later homonym of *Cananga* Aubl. Baillon (1868) clearly recognised this and proposed *Canangium* as a replacement name [*Cananga* Rumph., *nec* Aubl.], but he used it for a section of *Unona* (p. 213), not at generic rank as later authors have assumed. It was King (1892) who first used *Canangium* for the name of a genus recognising *Canangium odoratum* (Lam.) Baill. ex King and describing a second species, *Canangium scortechinii*, which has subsequently been reduced to the synonymy (Corner, 1939) of *Cananga odorata*.

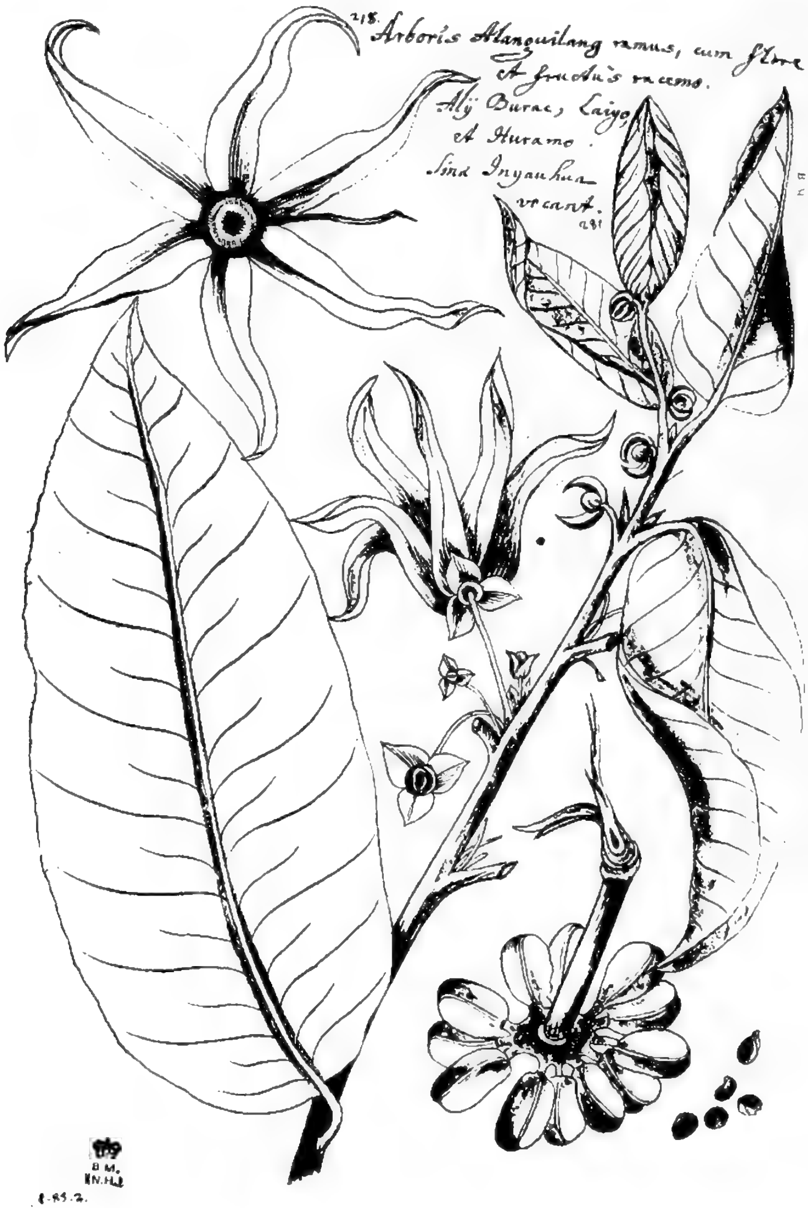

Figure 1. Drawing of alanguilan from G.J. Kamel's manuscript of *Herbarium aliarumque stirpium in insulâ Luzon e Philippinarum* © Natural History Museum, London.

The Nineteenth and early Twentieth Centuries saw confusion among botanists regarding the application of the generic name *Cananga*. It was used both in the sense of *Guatteria* Ruiz & Pav. and *Cananga*, though latterly in the period *Canangium* was generally used for Asian taxa. As early as the International Botanical Congress in Brussels in 1910 (Briquet, 1912), *Guatteria* was proposed and accepted for conservation against *Cananga* Aubl. Later *Cananga* Hook.f. & Thomson was formally conserved against *Cananga* Aubl. (Lanjouw *et al.*, 1952). Conservation of a name leads to automatic rejection of homotypic names of the same rank [ICBN Art. 14.4] so *Canangium* Baill. ex King is rejected as well.

There is still confusion and inaccuracy among the major nomenclatural references (Farr *et al.*, 1979; Greuter *et al.*, 1993; van Setten and Maas, 1999; McNeill *et al.*, 2006) on the citation of *Cananga* and its synonyms, its typification and the status of *Canangium*. The latter is often referred to as an orthographic variant of *Cananga* implying that combinations in *Canangium* can be corrected to *Cananga*, but as we have shown above it was clearly introduced as a substitute name and was not a spelling mistake. Below we give the full citation of the generic name.

Cananga (Dunal) Hook.f. & Thomson, Fl. Ind. (1855) 129, *nom. cons., non Cananga* Aubl., *nom. rejic.*
Basionym: *Unona* [unranked] *Cananga* Dunal, Monogr. Anonac. (Aug-Nov 1817) 96. – **Typus**: *Canangium odoratum* (Lam.) Baill. ex King (lectotype, designated by Hutchinson, 1923) [*Uvaria odorata* Lam., *Unona odorata* (Lam.) Dunal, *Cananga odorata* (Lam.) Hook.f. & Thomson].

Homotypic synonyms:
-*Uvaria* section *Cananga* (Dunal) Blume, Fl. Javae Anonaceae (1830) 13 as '*Canangae*'.
-*Unona* subsection *Cananga* (Dunal) G. Don, Gen. Hist. 1 (1831) 94.
-*Unona* section *Canangium* Baill., Hist. Pl. (Baillon) 1 (1868) 213, *nom. superfl.*
-*Unona* section *Cananga* (Dunal) Pierre, Fl. Forest. Cochinch. (1881) t. 19.
-*Canangium* Baill. ex King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61 (1892) 39, *nom. rejic.*

Heterotypic synonym:
-*Fitzgeraldia* F. Muell., Fragm. (Mueller) 6 (1867) 1. -Type: *Fitzgeraldia mitrastigma* F. Muell., Fragm. (Mueller) 6 (1867) 1.

Figure 2. Drawing of a branch of the Cananga-boom from François Valentijn's *Oud en Nieuw Oost-Indiën*.

The species of *Cananga* (Dunal) Hook.f. & Thomson

The first published post-Linnean mention of *Cananga odorata* is in the account of the Endeavour voyage by John Hawkesworth (1773). Hawkesworth used the travel journals of Captain James Cook and the naturalist Sir Joseph Banks to write the popular account of the expedition. A section on the natural products available in Batavia (Jakarta) in Java, 'Some account of Batavia', is only very slightly changed from the passage in Banks's journal (see Hooker, 1896; Banks, 1980; or http://nla.gov.au/nla.csss-jrnl-banks_remarks-353 *et seq.*) and includes the following entry:

'The Cananga, or Uvaria Cananga, is a green flower, not at all resembling the blossom of any tree or plant in Europe: it has indeed more the appearance of a bunch of leaves than a flower, its scent is agreeable, but altogether peculiar to itself.'

There are no specimens of *Uvaria cananga* in the Banks herbarium (BM). However, *Uvaria cananga* appears in the unpublished manuscript of plants of Java (*Plantae Javanenses*) by Daniel Solander in the Botany Library of the Natural History Museum, London. The entry reads 'Uvaria cananga Fig Pict. Cananga Rumph. Amb. 2 p. 195 t. 65. Valent. ind. n^{o}. 42.' 'Fig Pict.' refers to an outline drawing (pencil with watercolour) of *Uvaria cananga* by Sydney Parkinson (J3 of Diment *et al.*, 1987). The reference to Rumphius's description and illustration of Cananga and Valentijn's plate (Figure 2) and the presence of the Parkinson drawing which is labelled *Uvaria cananga* in pencil leaves little doubt that Banks and Solander intended a new species to include the Rumphian element cananga and using the name as the specific epithet in the Linnean genus *Uvaria*. Because of the rule on tautonymy [ICBN Art. 23.4], this epithet cannot be employed in *Cananga* and the entirely overlooked *Uvaria cananga* poses no threat to the widely used *Cananga odorata*.

The first extensive description of Rumphius's cananga was by Lamarck (1785, p. 595) in his account of *Uvaria odorata*. He referred to three elements, in order: *Cananga*. Rumph. Amb. 2 p. 195. tab 65; *Alanguilan de la Chine*, Sonnerat, and *Arbor saguisan*. Raj. Suppl. Luz. 83. The first is Rumphius's description of cananga. The second is a herbarium specimen collected by Sonnerat. The third refers to Kamel's Luzon trees, but Lamarck made a mistake in citing arbor saguisan, or arbor sagnisan as Kamel actually spelled it. This is *Goniothalamus amuyon* (Blanco) Merr. not *Cananga odorata*, which Kamel described on the same page under Zhampacae species. The identification of arbor sagnisan as *Goniothalamus amuyon* and not *Cananga odorata* is supported by Kamel's use of amuyong or amoyong as the vernacular name of arbor sagnisan, clearly the same name as Blanco (1837, p. 463) employed for the specific epithet of *Uvaria amuyon*; the details of Kamel's description, e.g. scentless flowers; and the presence of a Kamel specimen labelled amuyong in the Sloane Herbarium (Figure 3) which is *Goniothalamus amuyon*. Thanks to Lamarck and a paper by Flückiger (1881), 'arbor saguisan' is often cited, we now know wrongly, as the earliest name for *Cananga odorata*. Below *Uvaria odorata* Lam., the basionym of *Cananga odorata*, is lectotypified by the Sonnerat specimen. The origin of this specimen remains uncertain. It has generally been assumed to be from China, but then why did Sonnerat employ a Filipino name for the plant?

A second species of *Cananga*, ranging from Burma, through

Indochina, to the seasonal parts of northern Malay Peninsula, was first described by Hooker and Thomson (1872, p. 60) as *Unona latifolia*. Pierre (1881, t. 19) noted that this was a later homonym of *Unona latifolia* Dunal, the basionym of *Fissistigma latifolium* (Dunal) Merr. Pierre provided a substitute name *Unona brandisiana* Pierre, honouring Sir Dietrich Brandis, the collector of the type. Surprisingly it seems to have escaped attention that Pierre's name has not been transferred to *Cananga* as it has priority over the widely used *Cananga latifolia* [Hook.f. & Thomson] Finet & Gagnep.

Figure 3. Specimen of amuyong (volume HS 233, p. 81) from the Sloane Herbarium (BM-SL).

1. *Cananga odorata* (Lam.) Hook.f. & Thomson, Fl. Ind. (1855) 130.
Uvaria odorata Lam., Encycl. (Lamarck) 1 (1785) 595. *Unona odorata* (Lam.) Dunal, Monogr. Anonac. (1817) 45, 93, 97, 108, 143 as '*Uvaria odorata*'; *Uvaria javanica* Thunb. [Widmark], Fl. Jav. 2 (1825) 14, 19, *nom. superfl.*; *Canangium odoratum* (Lam.) Baill. ex King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61 (1892) 41. – **Type**: ?China, *Sonnerat s.n.*, annot. Alanguilan de la Chine (lectotype, designated here, P-LAM, barcode no. P00286083).
-*Canangium scortechinii* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 61 (1892) 42. -Type: Perak, *Scortechini 1925* (lectotype, designated here, K, iso, BM, ?CAL, SING).
-*Fitzgeraldia mitrastigma* F. Muell., Fragm. (Mueller) 6 (1867) 1. -*Canangium mitrastigma* (F. Muell.) Domin, Biblioth. Bot. 89 (1925) 670. -Type: Australia, Queensland, Rockingham Bay, *J. Dallachy*. [MEL has several specimens from the type location, including Dallachy specimens labelled *Cananga odorata* and poor specimens from the von Mueller herbarium annotated

'*Fitzgeraldia mitrasacmoides*' and '*Fitzgeraldia calyptrostigma*' with no indication of the collector].
-*Unona ? leptopetala* Dunal, Monogr. Anonac. (1817) 98, 114, 143. Type: Timor, *Leschenault* (?G, ?P) Depicted in Delessert (Icon. Sel. 1 (1821) 23, t. 88).
-*Unona odorata auct. non* (Lam.) Dunal: Blume, Bijdr. (1825) 14. *Unona cananga* Spreng., Syst. Veg. 4(2) (1827) 215. -Type: Java, *Kuhl & van Hasselt in Herb. Blume s.n.* (lectotype, designated here, L, sheet no. 898.60-258).
-*Unona odoratissima* Blanco, Fl. Filip. (1837) 467. -Type: Philippines, Luzon, Province of Rizal, Antipolo, *M. Ramos 466* [Merrill: Species Blancoanae 466] (neotype, designated here, US, barcode no. 688555, isotypes, A, B, BM, BO, CAL, F, GH, K, L, MO, NSW, NY, P, U, UC, W).
-*Unona ossea* Blanco, Fl. Filip. (1837) 467. *Uvaria ossea* (Blanco) Blanco, Fl. Filip. ed. 2 (1845) 322. -Type: Philippines, no material extant.
-*Uvaria axillaris* Roxb., [Hort. Bengal. (1814) 94, *nom. nud.*] Fl. Ind. ed. 1832 (Roxburgh) 2 (1832) 667. -Type: Mauritius, Grand Rivere, M. Rosselle's Garden, *Hardwicke 6* (lectotype, designated here, BM, barcode no. BM 000895029).
-*Uvaria cananga* Banks in Hawkesworth, Voyages in the Southern Hemisphere 2 (1773) 742. -Type: Outline drawing *Uvaria cananga* (del. S. Parkinson) J3 (Diment *et al.*, 1987, reproduced on microfiche 1 of Java Drawings) (lectotype, designated here, BM). *Anon., cultivated tree in BO no XI.B (iii) 20* (L, epitype, designated here, sheet no. 932.47--467; iso, BO). [Dr. Irawati, Director of the Kebun Raya Bogor, informed us that in April 2008 the tree was still living].
-*Uvaria cananga auct. non* Pers.: Pers., Syn. Pl. 2 (1806) 94, excl. Aubl. ref.
-*Uvaria farcta* Wall., Numer. List (1831) no. 6460, *nom. nud.* Voucher: Burma, Kogun near the river Salween, *N. Wallich 1283B* [Herb. Wall. no. 6460] (K-W), 21 March 1827.
-*Uvaria hortensis* Noroña, Verh. Batav. Genootsch. Kunsten 5 (1790) 28, *nom. nud.*
-*Uvaria? subcordata* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 9. -*Canangium odoratum* var. *velutinum* [Blume] Koord. & Valeton, Meded. Lands Plantentuin 61 (1903) 282 (Bijdr. Boomsoort. Java 9 (1903) 282) as '*velutina*'. -Type: Java, [near Kuripan, not found in L]. *Reinwardt s.n.* (neotype, designated here, L, sheet no. 898.63-533). [Leaves and branch only. Labelled as 'Uvaria velutina' by Blume, and annotated by Miquel as Uvaria ? subcordata Miq., and 'Uvaria velutina Bl. non Dun.', 'Jav? Moluccae?']. Pekalongan, Soebah, *Koorders 22570* (epitype, designated here, L; iso BO), 11 May 1896.
-*Uvaria trifoliata* Gaertn., Fruct. Sem. Pl. 2 (1790) 156, t. 114 f. 2. -*Uvaria gaertneri* Dunal, Monogr. Anon. (1817) 40, 41, 87, 89, *nom. superfl.* -Type: E

collect. sem. hort. lugdb. (not located in B, L, TUB); Gaertner's illustration (t. 114 f. 2) (lectotype, designated here). Java, Udjong Kulon Nature Reserve, *Nenga Wirawan 8* (epitype, designated here, L (barcode no. L0185668); iso, A, BO, K, LAE, P, SING), 15 April 1963.
-*Uvaria undulata* cited erroneously in Index Kewensis (Index Kew. 2(4) (1895) 1161) attributed to Lam., Encycl. 1 (1785) 595; a mistake possibly originating with de Candolle [Prodr. 1 (1824) 90].

2. *Cananga brandisiana* (Pierre) I. M. Turner, *comb. nov.*
Basionym: *Unona brandisiana* Pierre, Fl. Forest. Cochinch. (1881) t. 19 as '*brandisana*'. – **Type**: *Brandis s.n.* [K, holotype (not found), isotype, CAL], Burma, Tenasserim, Martaban, hill forests of the Saluen (Salween) River.
-*Canangium brandisianum* (Pierre) Saff., Bull. Torrey Bot. Club 39 (1912) 504 as '*brandesianum*'.
-*Unona latifolia* Hook.f. & Thomson, Fl. Brit. India 1 (1872) 60, *non U. latifolia* Dunal.; *Cananga latifolia* [Hook.f. & Thomson] Finet & Gagnep., Bull. Soc. Bot. Fr. Mém. 4 (1906) 84. *Canangium latifolium* [Hook.f. & Thomson] Pierre ex Ridl., Fl. Malay. Pen. 1 (1922) 44, *nom. superfl.*

Infraspecific taxa of *Cananga odorata*

Despite its cultural and economic importance there has only been one, rather limited, attempt to provide a coherent taxonomic framework for infraspecific variation in *Cananga odorata* (van Steenis in Koolhaas, 1939). Here we can only review the possibilities and names available for various entities.

It is probable that *Cananga odorata* is typified by a cultivated tree as Sonnerat's label noted the use of the flowers for pommade. Though scarcely distinguishable morphologically, the wild tree, at least in parts of its range, may differ from the widely cultivated tree in characteristics such as flower scent (Corner, 1939). The only infraspecific name that might be employed for a wild form seems to be *Canangium odoratum* var. *velutinum* Koord. & Valeton, though Koorders and Valeton (1903) appeared to use this variety to distinguish specimens with more densely pubescent foliage than between wild against cultivated taxa. The weakness of this variety is reflected by Koorders omitting it from his *Excursionsflora von Java* (Koorders, 1912) and the very brief mention (not keyed) in *Flora of Java* (Backer and Bakhuizen van den Brink, 1964, p. 105).

Among cultivated *Cananga odorata* there are several entities which have been named. There is a widely grown garden shrub that is a dwarf form that seems never to set seed. This was first described from cultivated material in Thailand by Craib as *Canangium fruticosum* and subsequently transferred to variety and forma ranks. Although probably never formally validated, the name "Cananga fruticosa" is found in horticultural catalogues and on the Internet.

There are two main commercial products from *Cananga odorata*, ylang-ylang oil and cananga oil. Ylang-ylang production developed in the Philippines and has been commercialised most notably in Madagascar and islands of the Indian Ocean (Yusuf and Sinohin, 1999). Cananga oil is a traditional product from Java and as it is inferior to ylang-ylang in perfumery it seems not to have been grown much outside Java. In a paper by Koolhaas (1939) on the cultivation of *Cananga odorata* (referred to as *Canangium odoratum*) in Java, van Steenis presented an annotated key for the material giving names at the rank forma for various entities. Ylang-ylang trees were referred to forma *genuinum*, with some complication of subforms, and cananga-oil trees to forma *macrophyllum*. Unfortunately, as published after 1 January 1935, all but one of the new combinations are invalid in the absence of a Latin diagnosis [ICBN Art. 36.1]. Recently Yusuf and Sinohin (1999) have used van Steenis's formae as the basis for names in horticultural terms, transferring them to cultivar groups with forma *genuinum* being referred to as Ylang-ylang Group and forma *macrophyllum* as Cananga Group. This seems a sensible approach as clearly these plants are cultigens, however nomenclaturally the change of name was unwarranted and the use of Cananga as a cultivar name, or part thereof, is prohibited under the genus *Cananga* [ICNCP (Brickell *et al.*, 2004) Art. 20.5 (viz. Art. 19.23)]. ICNCP does not preclude the use of cultivar names based on names published prior to 1 January 1959 invalid under ICBN [ICNCP Art. 19.7], so we can use van Steenis's formae to provide replacement group names.

A list of infraspecific taxa of *Cananga odorata*

Cananga odorata var. ***fruticosa*** (Craib) Sincl., Sarawak Mus. J. 5 (1951) 599. -*Canangium fruticosum* Craib, Bull. Misc. Inform. Kew 1922 (1922) 166. -*Canangium odoratum* var. *fruticosum* (Craib) Corner, Gard. Bull. Straits Settlements 10 (1939) 15. -*Canangium odoratum* forma *pumilum* Steenis in Koolhaas, Landbouw (Buitenzorg) 15 (1939) 590 as '*pumila*'. – **Type**: Thailand, Bangkok, *Kerr 4435* (lectotype, designated here, BM, barcode no. 000546881(BM), iso, ABD), 29 April 1920.

Cananga odorata var. ***odorata***
***Cananga odorata* Genuina Group**
-*Canangium odoratum* forma *genuinum* Steenis in Koolhaas, Landbouw (Buitenzorg) 15 (1939) 590 as '*genuina*', *nom. inval. sub.* ICBN Art. 36.1.
-*Cananga odorata* Ylang-ylang Group, Yusuf & Sinohin in Oyen & X. D.

Nguyen, PROSEA 19 (1999) 71, 73

***Cananga odorata* Macrophylla Group**
-*Canangium odoratum* forma *macrophyllum* Steenis in Koolhaas, Landbouw (Buitenzorg) 15 (1939) 590 as '*macrophylla*', *nom. inval. sub.* ICBN Art. 36.1.
-*Cananga odorata* Cananga Group, Yusuf & Sinohin in Oyen & X. D. Nguyen, PROSEA 19 (1999) 71, 73

Acknowledgements

Thanks to Dr Robert Vogt (B), Dr P. Lakshminarasimhan (CAL), Dr Pina Milne and Nimal Karunajeewa (MEL), Cornelia Dilger-Endrulat (TUB) for information on specimens in their respective herbaria, Dr Irawati (Kebun Raya Bogor) for the presence of *Cananga* in the Garden, Judy Warnement and Dr Kanchi Gandhi (HUH) for continuing assistance, and John Hunnex (BM) for help with the Sloane Herbarium.

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Appendix 1. Translation of the description of 'Cananga-boom' from Valentijn's Oud en Nieuw Oost-Indiën.

The flowering trees

The Cananga-tree

In this country there are also large trees which at certain times produce very beautiful fragrant flowers. One of these is the Cananga-tree, which is rather high, beautiful of trunk (which sometimes may be a fathom around), and greyish of bark.

The leaves are in rows on long twigs arranged against each other, about as long as wide, similar to a peach leaf, acute, and full of ribs. The blossom, or flowers, show themselves here and there between the leaves, in bunches, well similar to a somewhat yellow or orange ribbon, which hangs down, consisting of six long narrow weak leaflets[1], about a little finger long, and as wide.

Her true colour at first is pale yellow, having on top as a small peppercorn, from which the fruit comes. They are very strong in scent, which they spread along the whole road where this tree stands, especially towards the night; yet their colour is the most pleasant.

Most of the flowers fall without producing a fruit (a few excepted), and were collected, for nosegays for the young damsels, to carry them in their hair.

The native dries it, too, to smoke it under his tobacco, or to eat them with betel-nut, putting a leaflet[2] with the betel quid.

They also serve to decorate with them the vegetable-bows at the large festivals, and especially an oil has been extracted, which is very strong, fragrant, and useful against many ailments originating from frigidness. The natives also use this oil below their betel-nut, also they mix it together with their *bobori*[3].

The wild does not differ much from the tame, of which we show a branch on No XLII.

[1] certainly refers to 'petals'. cf. Banks's description of Uvaria cananga

[2] petal

[3] Sundanese name for coloured, fragrant ointment, applied to brides, grooms, and against diseases.

Miscellaneous Cucurbit News III

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Abstract

The miscellaneous notes on Cucurbitaceae comprise: (1) the description of a new species in *Kedrostis* from Peninsular Malaysia; (2) three new combinations in *Neoachmandra* from Africa, five new combinations in *Pilogyne* from New Guinea and the Pacific; and (3) a modern description of *Zehneria baueriana*, from Norfolk Isl., western Pacific.

Introduction

Now that the preliminary studies in Cucurbitaceae for the treatment in Flora Malesiana come to an end, some more corollary results are presented here. Previous miscellaneous notes were published in Reinwardtia in 2007 and 2009. A recent, second collection of a *Kedrostis* in central Peninsular Malaysia, deviating from the widespread *K. bennettii* (Miq.) W.J.de Wilde & Duyfjes, prompted us to recognize a new species. Thus, the following three items are addressed here:

(1) *Kedrostis monosperma* W.J.de Wilde & Duyfjes, a new species from Peninsular Malaysia.
(2) New combinations in African *Neoachmandra*, and *Pilogyne* from Malesia and the Pacific.
(3) Assessment on the morphology of the male flower of *Zehneria baueriana* Endl., the type species of the genus *Zehneria* Endl.

(1) A new species of *Kedrostis* from Peninsular Malaysia.

Kedrostis monosperma W.J.de Wilde & Duyfjes, *sp. nov.*

Kedrostidi bennettii *similis, infructescentibus ramosis breviter pedunculatis, fructibus plus gracilibus ovato-oblongis monospermis nitidis (i.s.) differt.* – **Typus:** Peninsular Malaysia, Pahang, Gunung Benom game reserve, Ulu Krau, 23 Apr 1967, *Rahim Ismail KEP 100114* (holo, KEP; iso, K, L, SING). **Figs. 1, 2.**

Climber 5-7 m long, glabrous (except ovary), cystolyths not obvious; monoecious. Tendrils unbranched. **Leaf** petioles 1.5-2 cm long; blade (sub) entire, (broadly) ovate-oblong, 9-13 by 4-7.5 cm, glabrous at both surfaces,

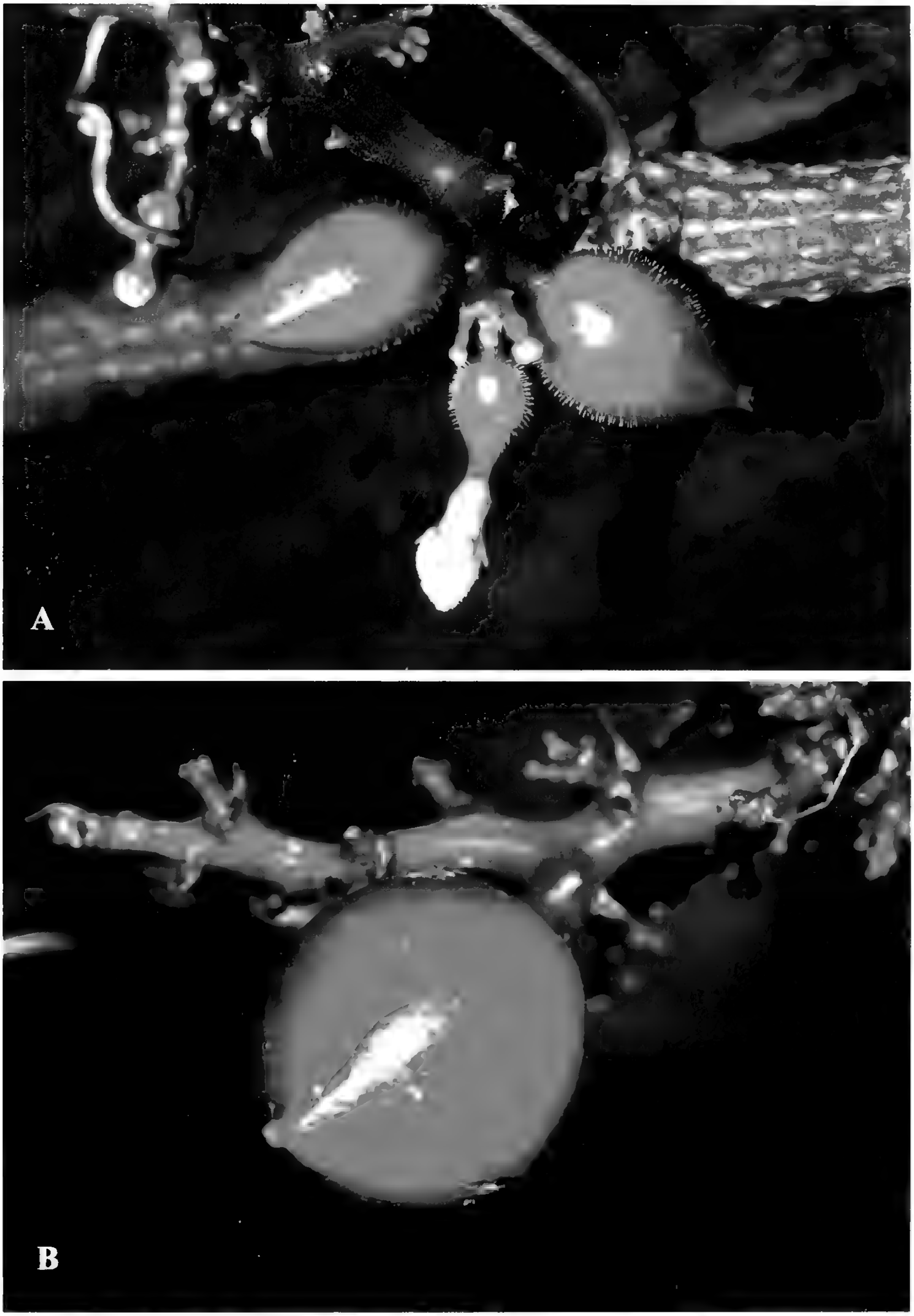

Figure 1. *Kedrostis monosperma* W.J.de Wilde & Duyfjes. A. Female inflorescence with flowers and young fruits; note hairy ovary; B. Infructescence with one ripe fruit. (Both photos taken at Pahang, Ulu Krau, Rezab Hidupan Liar Krau by de Wilde).

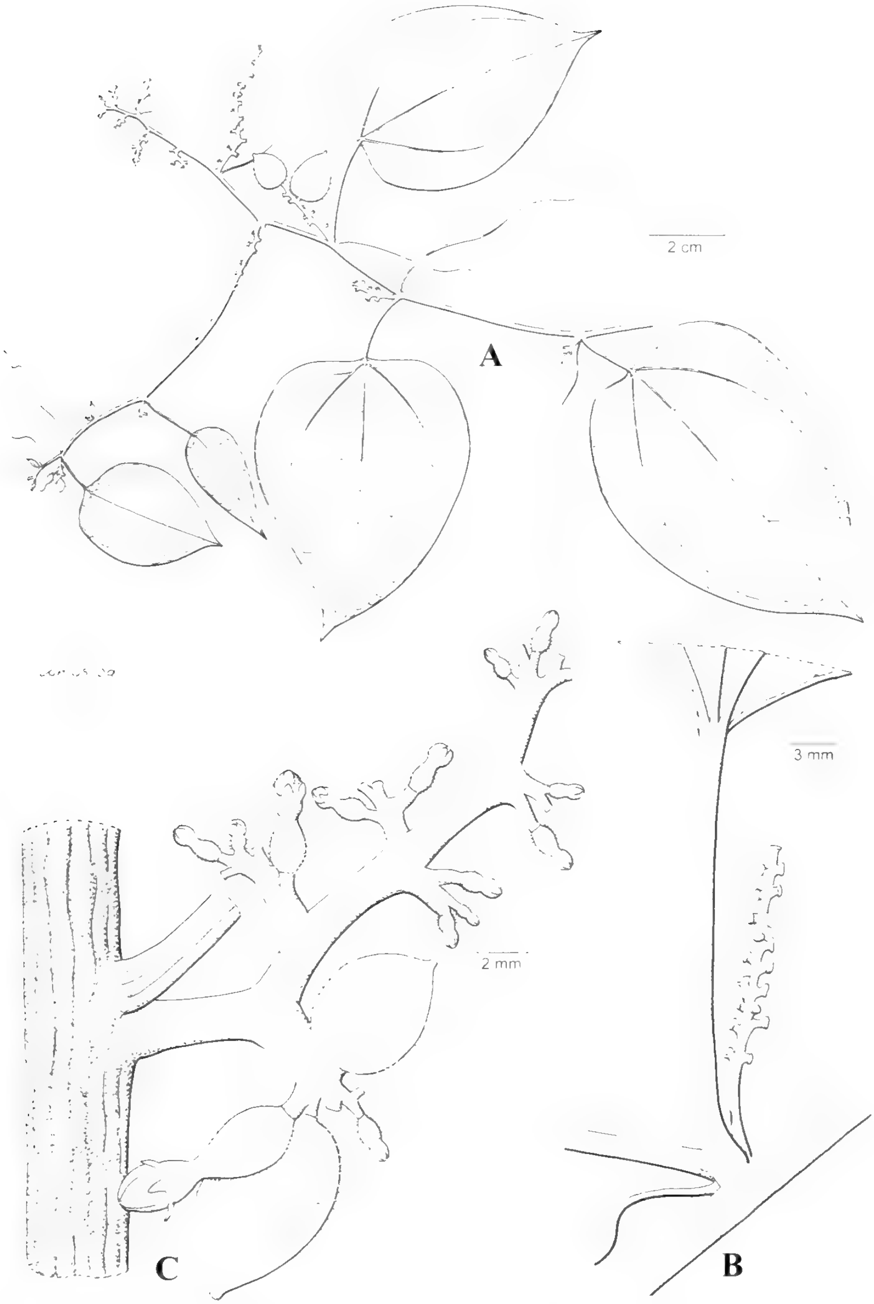

Figure 2. *Kedrostis monosperma* W.J.de Wilde & Duyfjes. A. Apex of branch with female inflorescences with immature and mature fruits; B. Node with male inflorescence (all flowers already fallen off); C. Node with compound female inflorescence with female flower buds and immature fruits. (A & C based on *Siti Munirah et al. FRI 65736*; B based on *Rahim Ismail KEP 100114*. All illustrations drawn by Jan van Os).

base ± rounded or truncate or faintly hastate, margin (sub)entire, apex 1-1.5 cm, acuminate. **Male raceme**: peduncle 2-5 mm long, co-axillary with female inflorescence; raceme spike-like, 10(-15) mm long, 10-20-flowered, flowers ± densely set. Pedicels of **male flowers** 1-1.5 mm long, persistent; bract lacking; mature flower not known. **Female inflorescence**: an axillary or terminal few-branched short-shoot 10-30 mm long, the branches 5-10 mm long, each with 5(-10) flowers of different stages of development in loose clusters; bracts lacking or minute and caducous, subulate, 0.5 mm long. Pedicels of **female flowers** 1–2 mm long; ovary solid, apparently 2-loculed, each with 1 ovule, ovoid-oblong, 5.5 mm long, *ca* 3 mm wide, base rounded, gradually narrowed to the apex in upper half, sparsely hairy, hairs 0.2 mm long of many serial cells; receptacle-tube 2(-2.5) mm across, inside glabrous; sepals (long) triangular, 0.5-1 mm long; petals imbricate, pale yellow, obovate, *ca* 3 by (1.5-)2 mm, apex broadly rounded, both surfaces papillose hairy, hairs 0.1 mm long; style *ca* 3 mm long, stigmas 2, together 2-2.5 mm wide, each ± lacerate, papillose; staminodes minute, fleshy, 0.2-0.3 mm long, inserted near receptacle-throat, two paired and one solitary. **Fruits** ripening glossy orange-red, drying glossy, ovate-oblong, *ca* 15 mm long, 10-12 mm wide, glabrous; fruiting pedicel *ca* 2 mm long. **Seed** 1 per fruit, globose, (pale) brown, *ca* 7 mm across, faintly low-margined, smooth.

Other specimens examined: Malaysia, Pahang, Ulu Krau (Rezab Hidupan Liar Krau), N 3° 51' 33.4"; E 102° 12' 22.6", 27 Nov 2008, *Siti Munirah et al. FRI 65736* (KEP, L).

Distribution: Only known from Peninsular Malaysia, Pahang, Ulu Krau.

Habitat and Ecology: Dense primary lowland forest on hillsides on rich soil, to 214 m altitude; flowering and fruiting in April and November.

Notes. Kedrostis monosperma is similar to *K. bennettii*, the latter with a wider distribution in western Malesia, but not known from Peninsular Malaysia. In *K. bennettii* the disposition of the fruit is different, single or few subaxillary to leaves, the fruits are dull on drying, globose or transversely ellipsoid, 1- or 2-seeded, with a longer fruiting pedicel, 5-10 mm long; the male racemes are much longer, to 15 cm long with longer peduncle, 3-7 cm long; the petioles are generally longer, 2-6 cm long. As far as can be judged from the few female flowering collections of *K. monosperma*, the ovary is hairy, the perianth glabrous inside, in *K. bennettii* the ovary is subglabrous and the perianth hairy in the throat.

In *K. monosperma* the older main stem of the liana is *ca* 0.5 cm thick, the bark has whitish corky patches (see Fig. 1).

The collection, *van Balgooy 7551* of *K. bennettii* from Bali (Lesser Sunda Islands), has in the male raceme caducous bracts, 1-3 mm long, in other specimens bracts are absent.

(2) Three new combinations in African *Neoachmandra* and five new combinations in *Pilogyne* from Malesia and the Pacific.

The genus *Neoachmandra* was one of several new genera proposed by De Wilde and Duyfjes (2006), as an outcome of morphological studies in the flowers of a large group of SE Asian species till then generally referred to a large variable genus *Zehneria*. The validity of these genera on molecular grounds is currently tested (Cross *et al.*, in preparation) with a broad sampling of species, including three *Neoachmandra* species from Africa, newly combined below:

Neoachmandra capillacea (Schumach.) W.J.de Wilde & Duyfjes, *comb. nov.*
-**Basionym**: *Bryonia capillacea* Schumach., Beskr. Guin. Pl. (1827) 430. - *Melothria capillacea* (Schumach.) Cogn. in A. & C. DC., Monogr. Phan. 3 (1881) 600; - *Zehneria capillacea* (Schumach.) C. Jeffrey, Kew Bull. 15 (1962) 366. –**Typus:** Ghana, *Thonning* (holo, LE, not seen).

Neoachmandra cordifolia (Hook.f.) W.J.de Wilde & Duyfjes, *comb. nov.*
- **Basionym**: *Melothria cordifolia* Hook.f., Fl. Trop. Afr. [Oliver et al.] 2 (1871) 563. –**Typus:** Gabon, *Mann* (holo, K, not seen).
- Synonym: *Zehneria gillettii* (De Wild.) C. Jeffrey, Kew Bull. 15 (1962) 366.

Neoachmandra deltoidea (Schumach.) W.J. de Wilde & Duyfjes, *comb. nov.*
- **Basionym**: *Bryonia deltoidea* Schumach. Beskr. Guin. Pl. (1827) 449. - *Melothria deltoidea* (Schumach.) Benth., Niger Flora [W.J. Hooker] (1849) 368; - *Zehneria hallii* C. Jeffrey, J. W. African Sci. Assoc. 9 (1965) 93, *nom. nov.* [*non Zehneria deltoidea* Miq., Fl. Ned. Ind. 1, 1 (1856) 655 = *Neoachmandra leucocarpa* (Blume) W.J.de Wilde & Duyfjes, Blumea 51 (2006) 23, based on *Bryonia leucocarpa* Blume, Bijdr. Fl. Ned. Ind. (1826) 924]. –**Typus:** Ghana, *Thonning* (holo, C, not seen).

The uncertain taxonomic status of the genus *Zehneria* Endl., based on DNA sequencing of *Z. baueriana*, made us to accept *Zehneria* as a monotypic genus restricted to its type, from Norfolk Isl. and New Caledonia in the western Pacific. There are but a few collections of true *Zehneria* from Norfolk Isl. and New Caledonia (see next item in the present publication).

Five deviating species in *Zehneria* were still kept under *Zehneria*. But since the re-instatement of the genus *Pilogyne* (de Wilde and Duyfjes, 2009), the five taxa now appear better included in *Pilogyne* as well, and the new combinations are made below.

Pilogyne erythrobacca (W.J.de Wilde & Duyfjes) W.J.de Wilde & Duyfjes, *comb. nov.*
- **Basionym**: *Zehneria erythrobacca* W.J.de Wilde & Duyfjes, Blumea 51 (2006) 55. – **Typus:** Papua New Guinea, Milne Bay, Menapi, Cape Vogel Peninsula, *Brass 21720* (holo, L; iso, A).

Pilogyne neocaledonica (W.J. de Wilde & Duyfjes) W.J. de Wilde & Duyfjes, *comb. nov.* - **Basionym**: *Zehneria neocaledonica* W.J. de Wilde & Duyfjes, Blumea 51 (2006) 67. – **Typus:** New Caledonia, *Däniker 3139* (holo, L; iso, Z, not seen).

Pilogyne samoensis (A. Gray) W.J. de Wilde & Duyfjes, *comb. nov.*
– **Basionym:** *Karivia samoensis* A. Gray, U.S. Expl. Exped. Phan. (1854) 643.
– **Lectotypus**: Samoa, without further locality, *US exploring expedition s.n.* (US, barcode US00147706 see Fosberg & Sachet, 1981).
- Homotypic synonyms: *Zehneria grayana* (Cogn.) Fosberg & Sachet, Smithsonian Contr. Bot. 47 (1981) 12; W.J. de Wilde & Duyfjes, Blumea 51 (2006) 59. - *Melothria grayana* Cogn. in A. & C. DC., Monogr. Phan. 3 (1881) 591, p.p., excluding specimens from Tahiti.

Notes: The epithet *samoensis* could not be used at the time by Cogniaux (1881) in *Melothria* because the combination was already preoccupied by *Melothria samoensis* A. Gray, a different species, now *Neoachmandra samoensis* (A. Gray) W.J. de Wilde & Duyfjes.

Pilogyne tahitensis (W.J. de Wilde & Duyfjes) W.J. de Wilde & Duyfjes, *comb. nov.*
– **Basionym:** *Zehneria tahitensis* W.J. de Wilde & Duyfjes, Blumea 51 (2006) 76. – **Typus:** Tahiti, *Vesco s.n.*, anno 1847, male (holo, P, barcode P00218593; iso, P, 5 duplicates).

Pilogyne viridifolia (W.J.de Wilde & Duyfjes) W.J.de Wilde & Duyfjes, *comb. nov.*
– **Basionym:** *Zehneria viridifolia* W.J.de Wilde & Duyfjes, Blumea 51 (2006) 77. – **Typus:** Papua New Guinea, Milne Bay, Biniguni Camp, Gwariu River, *Brass 23914* (holo, A; iso, CANB, L).

(3) Assessment on the morphology of the male flower of *Zehneria baueriana* Endl., the type species of the genus *Zehneria* Endl.

The genus *Zehneria* was described by Endlicher (1833), with a single species, *Z. baueriana* from Norfolk Island, but the generic name became commonly used for a large number of small-flowered species of the Old World (Jeffrey, 1962). De Wilde and Duyfjes (2006) recognized within the large genus *Zehneria* some smaller genera for SE Asia, i.e., *Neoachmandra, Scopellaria, Urceodiscus,* and *Zehneria*. Currently, the validity of these genera has been tested molecularly (Cross *et al.*, in preparation), and preliminary results indicate that *Neoachmandra* and *Zehneria* (in the restricted sense, as defined by De Wilde and Duyfjes, 2006) could only be partly held up, because DNA sequencing of *Z. baueriana* (as well as of some related species in the Pacific) revealed two different clones, one clone belonging to *Zehneria* as newly defined, the other to *Neoachmandra*, rendering *Zehneria* paraphyletic, and indicating that *Z. baueriana* could be of hybrid origin.

Zehneria baueriana is a local endemic of Norfolk Island and New Caledonia, represented in herbaria by only few collections. Its original description (Endlicher, 1833, 1838 with good figures) is only in Latin. The only other description of the species, also in Latin, is by Cogniaux (1881), under the name *Melothria baueriana*, but this latter was mixed up with material from two different species: *Zehneria grayana* (Cogn.) Fosberg & Sachet, and *Z. guamensis* (Merr.) Fosberg. Therefore, a more recent good collection of *Z. baueriana* made in 1967 (*Hoogland 11220*) from the type locality, with ample male flowering and fruiting elements, offered the opportunity to present an accurate description, at the same time, assessing some ambiguities in Endlicher's original description. Also, it appeared that the species could not be readily identified with our key (De Wilde and Duyfjes, 2006).

At present the true state of certain characters of *Z. baueriana*, now needed for an understanding of the genus *Zehneria* in the restricted sense, notably characters of the male inflorescence, and the place of insertion of the stamens in the receptacle tube in male flowers, is assessed in order to contrast these to those resembling species from the Malesian area (De Wilde and Duyfjes, 2009).

Zehneria baueriana Endl., Prodr. Fl. Norfolk. (1833) 69; W.J.de Wilde & Duyfjes, Blumea 51 (2006) 51. - *Melothria baueriana* (Endl.) F.Muell., Fragm. (Mueller) (1868) 188; Cogn. in A. & C. DC., Monogr. Phan. 3 (1881) 610; in Engl., Pflanzenr. 66, 4.275.I (1916) 109. – **Lectotypus**: Norfolk Island, *Bauer* in *Herb. Endlicher s.n.*, male (W; iso B†, K, LE see De Wilde & Duyfjes, 2006). **Figs. 3, 4.**

Branched **climber** 5(-10) m long; **stems** 2-4 mm diam; subglabrous, generally drying brown; dioecious. Pobract oblong-linear, 4-5 mm long. Tendrils unbranched. **Leaf** petioles, 1.5-3.5 cm long; blade ovate, sometimes faintly 3-lobed, 5-10 by 4.5-7.5 cm, base deeply cordate, margin remotely minutely (sometimes irregularly) denticulate, apex acute or broadly acuminate, 2-3 mm mucronate; cystoliths minute. **Inflorescences** in male and female a subsessile many-flowered fascicle, in male 10-20, in female 5-12-flowered, outer flowers oldest, in male sometimes divided into several sub-fascicles, suggesting a reduced leafless short-shoot; common peduncle lacking; bracts lacking; flowers outside glabrous, pedicel with few sparse, short hairs. Pedicels of **male flowers** 2.5-3 mm long; receptacle tube *ca* 3 mm long, 3.5 mm wide, densely long-haired in the throat and upper third inside; sepals *ca* 1 by 0.6 mm, acute; petals ovate, 2(-2.5) by 1.8(-2) mm, subacute, minutely papillose-hairy adaxially; stamens inserted halfway in the receptacle tube, filaments *ca* 1 mm long, glabrous; anthers circular in outline, *ca* 1–1.2 mm across, thecae curved, at apex nearly touching, forming nearly a ring, connective not produced, broad in the middle, thickened, hairy along the thecae; disc depressed, bluntly 3-lobed, *ca* 1.5 mm wide. Pedicels of **female flowers** (after Endlicher) 1–2 mm long; ovary narrowly ovoid(-oblong), much narrowed into a neck to the perianth, 15 mm long, 4 mm wide, neck to 5 mm long, all glabrous; perianth as in male flowers; style long-cylindrical, *ca* 3 mm long, style-arms 3, each *ca* 0.5 mm long, stigmas reniform, 2-lobed, papillose; disc consisting of 3 separate lobes at base of style, *ca* 1 mm long; staminodes inserted *ca.* halfway the receptacle tube, subulate, slender, *ca.* 1 mm long with some coarse hairs at base. **Fruits** 5-10 in a cluster, at first greenish with 5 longitudinal lines and densely scale-like paler flecked (netted), ripening (orange-) red, drying with irregular surface, collapsing over the seeds, oblong, 12-20 mm long, 8-10 mm wide, glabrous; fruiting pedicel 5-7 mm long. **Seeds** 15-30, compressed, elliptic, 4 mm long, (2.5-) 3 mm wide, pale, rather broadly but indistinctly margined, edge rounded, faces not ornamented.

Fieldnotes: Petals pale yellow; fruit red (Endlicher); fruit pale green (Hoogland).

Other specimens examined: Norfolk Isl., *Bauer s.n.*, fruit (W); Norfolk Isl., 28-10-1967, *Hoogland 11220*, 2 sheets, flowers & fruit (CANB). New Caledonia, 27-11-1970, *Guillaumin & Baumann-Bodenheim 8604* (L); ibid., 7-02-1951, *Guillaumin & Baumann-Bodenheim 10315* (L).

Distribution: Norfolk Island, New Caledonia.

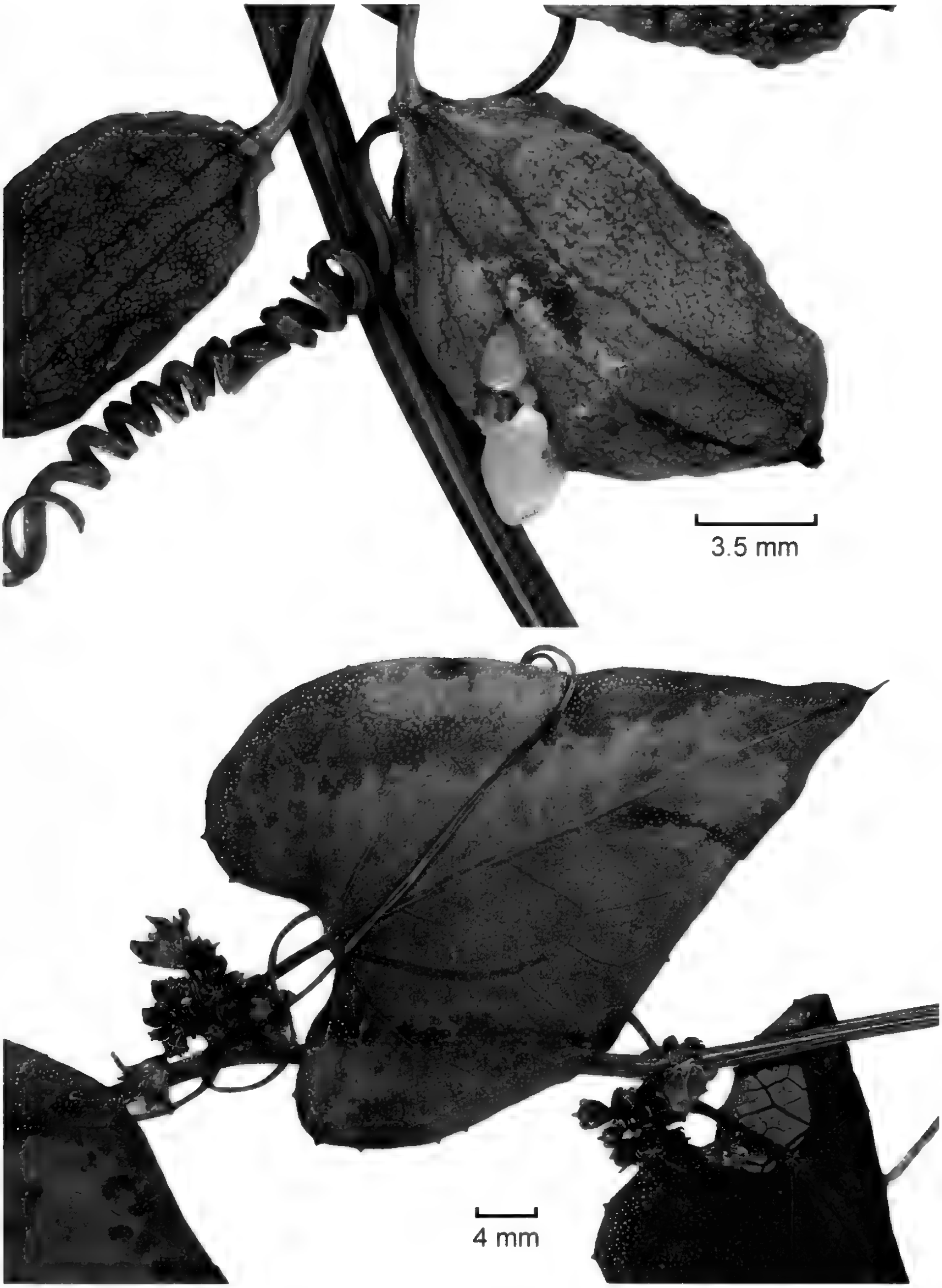

Figure 3. Details of two herbarium sheets of *Zehneria baueriana*: upper details of fruit showing one seed; lower details of female inflorescences (based on *Hoogland 11220*, CANB).

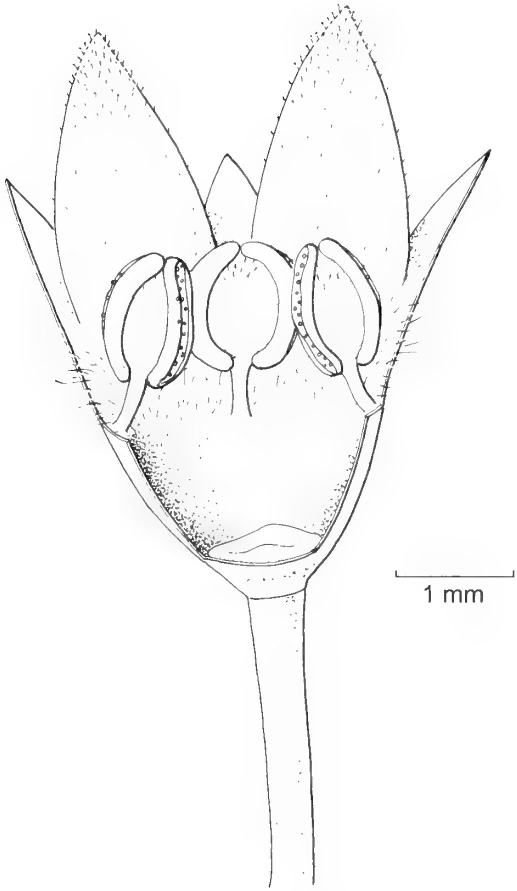

Figure 4. Male flower of *Zehneria baueriana* (based on *Hoogland 11220*; drawn by Jan van Os).

Habitat and Ecology: Forest edges and roadsides, 200-300 m; flowering and fruiting in October.

Notes: The stamens are inserted halfway in the receptacle tube, not towards the apex as written by Endlicher (1833). The filaments are about as long as the anthers, and the stamens are largely included. The anthers are comparatively much larger as depicted by Endlicher (1838). The disc of the male flowers is distinctly 3-lobed, but not consisting of 3 separate globose parts as stated by Endlicher. The disc in the female flower is 3-parted. The corolla was described by Endlicher as fused, but the petals are free.

As described above, the male flowers link up easily with flowers of species of *Zehneria* recognized for SE Asia (De Wilde and Duyfjes, 2006), or later, as *Pilogyne* Schrad. (De Wilde and Duyfjes, 2009). However, for molecular reasons, the type species of the genus *Zehneria*, i.e., *Z. baueriana*, can better be regarded as separate from *Pilogyne*, and the minor differences between these two genera are primarily in the male inflorescence, pedunculate in *Pilogyne*, fasciculate and not pedunculate in *Zehneria*. This latter condition is also found in *Pilogyne neocaledonica* and *P. erythrobacca* p.p. (De Wilde and Duyfjes, 2006, fig. 15), but both these species differ considerably in various other characters from *Zehneria baueriana*.

For *Z. baueriana* the stout habit, the 3-parted disc in the female flowers, the lengthwise 5-lined fruits, the yellow or pale yellow petals are unique. Unfortunately, female flowers of *Pilogyne neocaledonica* are unknown as yet. As remarked by De Wilde and Duyfjes (2006, 2009), most of the then under *Zehneria* recognised species in eastern New Guinea and southern Pacific possess characters blurring the clear distinction between *Neoachmandra* and *Zehneria* in this area, presumably because these species, like *Z. baueriana*, are (partly) of hybrid origin as well.

Acknowledgements

This research was carried out as part of the Flora of Peninsular Malaysia Project (Project no. 01-04-01-0000 Khas) at the Forest Research Institute Malaysia funded by the Ministry of Science, Technology and Innovation (MOSTI). Material from BM, CANB, K, KEP, L, SING, and W was studied. The permission from the curator of CANB to use a herbarium leaf fragment of *Hoogland 11220* for DNA sequencing is gratefully acknowledged. We thank Ruth Kiew (KEP) for facilitating fieldwork, and also our enthusiastic colleagues in the field, Siti Munirah and Hok Lim Kueh (both KEP), without their help, the second collection of *Kedrostis monosperma* would not have been found. As usual, J.F. Veldkamp (L) translated the description of the new species into Latin, Jan van Os (L) prepared the drawings and Ben Kieft (L) scanned the drawings and prepared the photographic plates. This research also received support from the SYNTHESYS Project which is financed by European Community Research Infrastructure Action under the FP6 "Structuring the European Research Area" Programme.

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Studies on Schismatoglottideae (Araceae) of Borneo VIII: A Review of *Piptospatha elongata* in Sarawak

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Abstract

A review of *Piptospatha elongata* (Engl.) N.E. Br. in Sarawak is presented. The species is shown to comprise three morphologically and ecologically distinct taxa, two of which are new to science and herewith described as *Piptospatha impolita* S.Y.Wong, P.C. Boyce & Bogner and *P. viridistigma* S.Y.Wong, P.C. Boyce & Bogner. A new key to *Piptospatha* is presented and all species of the Elongata group are illustrated. Additionally, new observations on the morphologies separating the *Piptospatha elongata* Group and *P. grabowskii* Group *sensu* Bogner and Hay (2000) are presented.

Introduction

Bogner and Hay (2000) provides a comprehensive and excellent revision of the Schismatoglottideae, including *Piptospatha* N.E.Br., for which six species are recognized in Sarawak. Since the publication, the first two authors have had the opportunity to undertake comprehensive field studies, and the first author in detailed molecular analyses of most of the presently recognized Sarawak species and this has produced a number of new observations resulting in the removal of *Piptosptha lucens* (Bogner) Bogner & Hay into a new genus (Boyce and Wong, in press) and compelling evidence that *P. elongata* (Engl.) N.E. Br. *sensu* Bogner and Hay (2000) is heterogeneous.

Piptospatha elongata Group

The distribution and habitat data and a considerable portion of the description given in Bogner and Hay (2000) for *P. elongata* incorporates five or possibly more taxonomic elements. One of these elements is restricted to very hard sandstones in the coastal areas of Lundu (NW Sarawak) and is here described as *Piptospatha impolita* S.Y.Wong, P.C. Boyce & Bogner. Another element is endemic to the Serian & Padawan areas as far NW as the Sungai Tegora (SE flanks of the Bungo range) and the southernmost Bau limestones and is usually (but not exclusively) associated with limestone. This element is also novel and is described as *Piptospatha viridistigma* S.Y.Wong, P.C. Boyce & Bogner.

Key to *Piptospatha* species-

1. Spathe limb caducous; spadix above female flower zone shed directly after male anthesis; peduncle becoming erect and infructescence erect at fruit dispersal; fruits dispersing via 'splash-cup' mechanics .... (***P. elongata*** **group**) 2
1. Spathe limb almost fully persistent until fruit dispersal; spadix axis persistent until well after fruit dispersal; peduncle declinate and infructescence pendent at fruit dispersal; fruit dispersal various (mostly unstudied except for *P. grabowskii*) but not via 'splash-cup' mechanics .... (***P. grabowskii*** **group**) 11

2. Peduncle shorter than spathe; W Kalimantan .... ***P. brevipedunculata***
2. Peduncle much exceeding the spathe 3

3. Sterile interstice well-defined; NW Borneo .... ***P. burbidgei***
3. Sterile interstice absent or not well-defined 4

4. Connective extended into a pronounced elongate beak; Sabah .... ***P. insignis***
4. Connective not raised above the thecae or shortly elevated and obtuse 5

5. Anthers pubescent to papillose 6
5. Anthers glabrous 8

6. Connective swollen; Peninsular Malaysia .... ***P. ridleyi***
6. Connective not swollen 7

7. Anthers in closely appressed regularly arranged pairs; Malay Peninsula and southern peninsular Thailand .... ***P. perakensis***
7. Anthers (seen from above) irregularly arranged; E Kalimantan .... ***P. manduensis***

8. Spadix usually with slightly narrowed sterile appendix (male zone rarely

fertile to apex); petiole with narrow crispate wings distally; Sarawak .... ***P. truncata***
8. Male zone fertile to apex; petiole without crispate wings; Sarawak, Kalimantan 9

9. Spadix bullet-shaped, the male portion tapering towards the apex; lower part of male zone comprised of larger flowers, that may be sterile, intermixed adjacent to the pistils with white staminodes; thecae broadly excavated, the excavations of adjacent anthers forming a butterfly-shaped depression; stigmas bright green; spathe at anthesis shading proximally to distally from deep olive-green through very pale pink to medium pink, the interior of the spathe tip rostrum with 5-7 conspicuous keels; persistent fruiting spathe wide-flared; plants frequently limestone associated .... ***P. viridistigma***
9. Spadix cylindrical; male flowers uniform throughout zone; thecae longitudinally sulcate with the pores ventral and dorsal to the sulcae; stigmas pink or dirty whitish. Spathe at anthesis shading proximally to distally from deep plum purple through medium pink to deep pink, the interior of the spathe tip rostrum with 2-3 conspicuous keels or keels absent. Persistent fruiting spathe narrowly obconic; plants of sandstone or granite 11

10. Stigmas mid-deep pink; anthers with connective flat; spathe tip rostrum almost straight or only weakly reflexed (*ca* 45°) relative to spathe axis at anthesis, inside with 2-3 conspicuous longitudinal keels; plants exclusively of granite .... ***P. elongata***
10. Stigmas dirty whitish; anthers with a short acute-triangular connective on each side, spathe tip rostrum strongly reflexed (*ca* 130°) relative to spathe axis at anthesis, inside without keels or these only very vaguely defined; plants exclusively of sandstone .... ***P. impolita***

11. Female zone free, stigmas as wide as ovary, usually on a distinct style; basal sterile zone partly adnate to spathe; widespread in Borneo .... ***P. grabowskii***
11. Lower part of female zone adnate to the spathe; stigmas narrower than ovary, sessile; NW Borneo .... ***P. kinabaluensis***

Piptospatha elongata (Engl.) N.E. Br.
Curtis's Bot. Mag. 51, *in descr. ad tab.* 7410 (1895); Engl., Pflanzenr. 55 (IV.23Da): 124, fig. 75 (1912); Ridl., J. Bot. 51: 202 (1913); Bogner & Hay, Telopea 9(1): 205 (2000). *Schismatoglottis elongata* Engl., Bull. Soc. Tosc. Ortic. 4: 298 (1879). *Rhynchopyle elongata* (Engl.) Engl., Bot. Jahrb. Syst.

1: 184 (1881) & in Becc. , Malesia 1: 289, pl. 23, figs 3-15 (1882). – **Typus:** Malaysia, Sarawak, Kuching Division, Lundu, Gunung Gading, June 1867, *O. Beccari P.B. 2308* (holo, FI-B). **Plates 1A & 2**.
-*Schismatoglottis marginata* Engl., Bull. Soc. Tosc. Ortic 4: 298 (1879). *Rhynchopyle marginata* (Engl.) Engl., Bot. Jahrb. Syst. 1: 184 (1881) & in Becc. , Malesia 1: 288, pl. 23, figs 1-2 (1882). *Piptospatha marginata* (Engl.) N.E. Br., Curtis's Bot. Mag. 51. *in descr. ad tab.* 7410 (1895); Engl., Pflanzenr. 55 (IV.23Da) (1912) 125. - Type: Malaysia, Sarawak, no further data, *O. Beccari P.B. 3838* (holo, FI-B; iso, B).
-*Gamogyne pulchra* N.E. Br., Kew Bull. (1910) 197 & Curtis's Bot. Mag. 135 t. 8330 (1910). -Type: not designated (see Bogner and Hay, 2000: 205).
-*Piptospatha rigidifolia* Engl., Pflanzenr. 55 (IV.23Da): 127 (1912). - Type: Malaysia, Sarawak, Kuching Division, Lundu, Sept. 1905, *H.N. Ridley s.n.* (lecto, SING, selected by Bogner and Hay, 2000: 205).
?*Piptospatha angustifolia* Engl. ex Alderw., Bull. Jard. Bot. Buitenzorg III, 4: 193 (1922); Bogner, Pl. Syst. Evol. 142: 52 (1983). - Type: Indonesia, Kalimantan, *H. Hallier 614* (holo, BO), *prov. syn.*

Rheophytic **herb** 9-20 cm high. **Stem** condensed, 2–6 cm long, 0.5-1.1 cm diam., with robust pale green to more-or-less reddish-tinged roots 1.5-2 mm diam. **Leaves** several to 20 together; petiole 6-11 cm long, 1.5-2 mm diam., slightly canaliculate adaxially, sheathing only at the extreme base, the remainder of the sheath ligular, the ligules extended into a narrowly triangular, purple to reddish portion 3-5 cm long, this drying dark brown and not long-persisting; blade very narrowly elliptic to narrowly elliptic-oblong to oblanceolate, coriaceous, dark green adaxially, paler abaxially, 15-24 cm long × 1-3.5 cm wide, the base cuneate, the apex acute and tubular-apiculate for 2-3 mm; midrib robust, abaxially prominent, adaxially bluntly raised (fresh), impressed (dry), with (6-)7-10 primary lateral veins on each side, diverging at 35°-45° and more or less regularly alternating with lesser interprimary veins especially in the lower half of the blade; secondary venation adaxially more or less obscure, abaxially fine and dense; tertiary venation obscure. **Inflorescence** solitary to 2-3 together and then often alternating with foliage leaves; peduncle shorter than to equalling, rarely exceeding the length of the whole leaf, 11-22 cm long, 1.8-2.2 mm diam., purple to reddish. **Spathe** nodding at anthesis, subcylindric-obovoid, 3-4 cm long, apically rostrate for 3-4 mm, the rostrum conspicuously 2-3-keeled internally, straight at female anthesis but recurving up to 45° at the onset of male anthesis; spathe at anthesis shading proximally to distally from deep plum purple through medium pink to deep pink, inflating and the distal-most part opening at female anthesis, at the end of male anthesis the opening increasing by the reflexing of the terminal rostrum and then at late male anthesis the upper

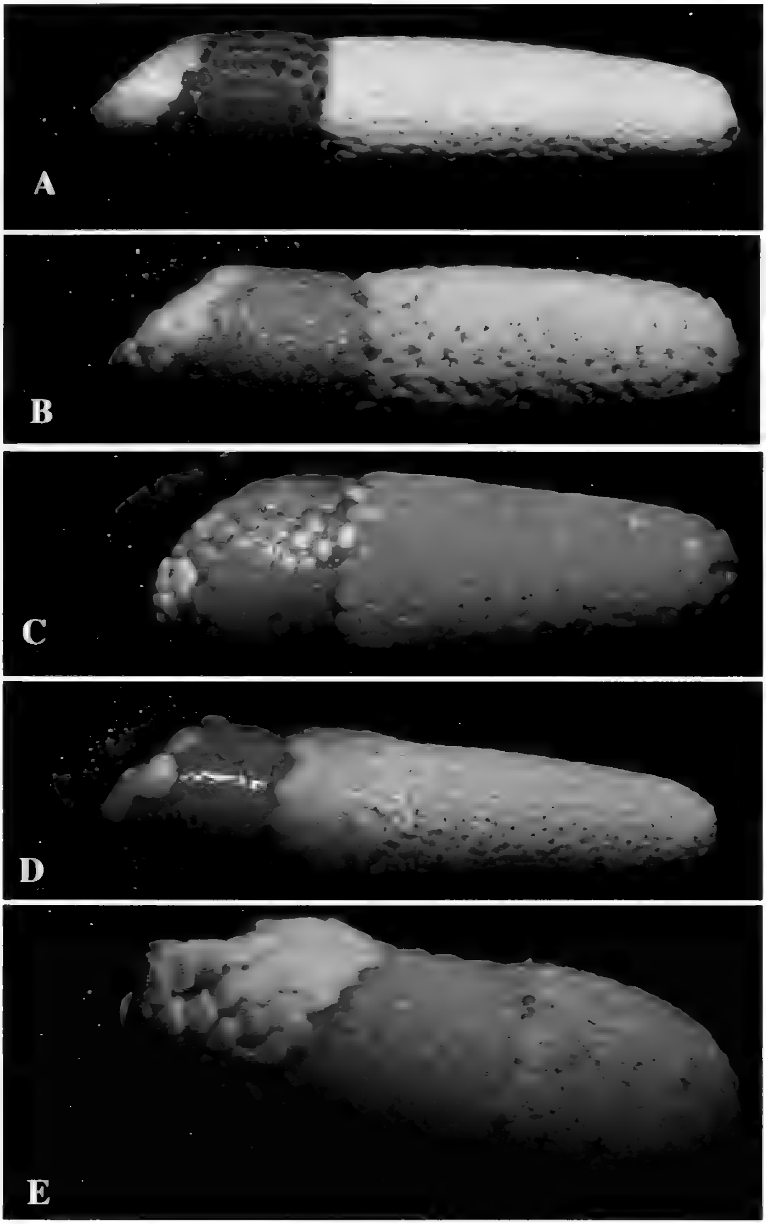

Plate 1. Spadices of five Sarawak *Piptospatha* species. A. *Piptospatha elongata* showing the sinuate arrangement of the stamens and diagnostic pink pistils; B. *P. impolita*, note the carinate connectives and dirty white pistils; C. *P. viridistigma*, showing the butterfly-shaped excavated thecae and diagnostic green pistils. Note the neuter flowers below the fertile female flowers comprise centrally-depressed white pistillodes (positioned ventrally) and yellow staminodes (positioned dorsally); D. *P. burbidgei*, note the distinctive zone of staminodes separating the male and female flower zones; E. *P. grabowskii*, note the conspicuous zone of pistillodes positioned below the female flower zone, and the pubescent stamens.

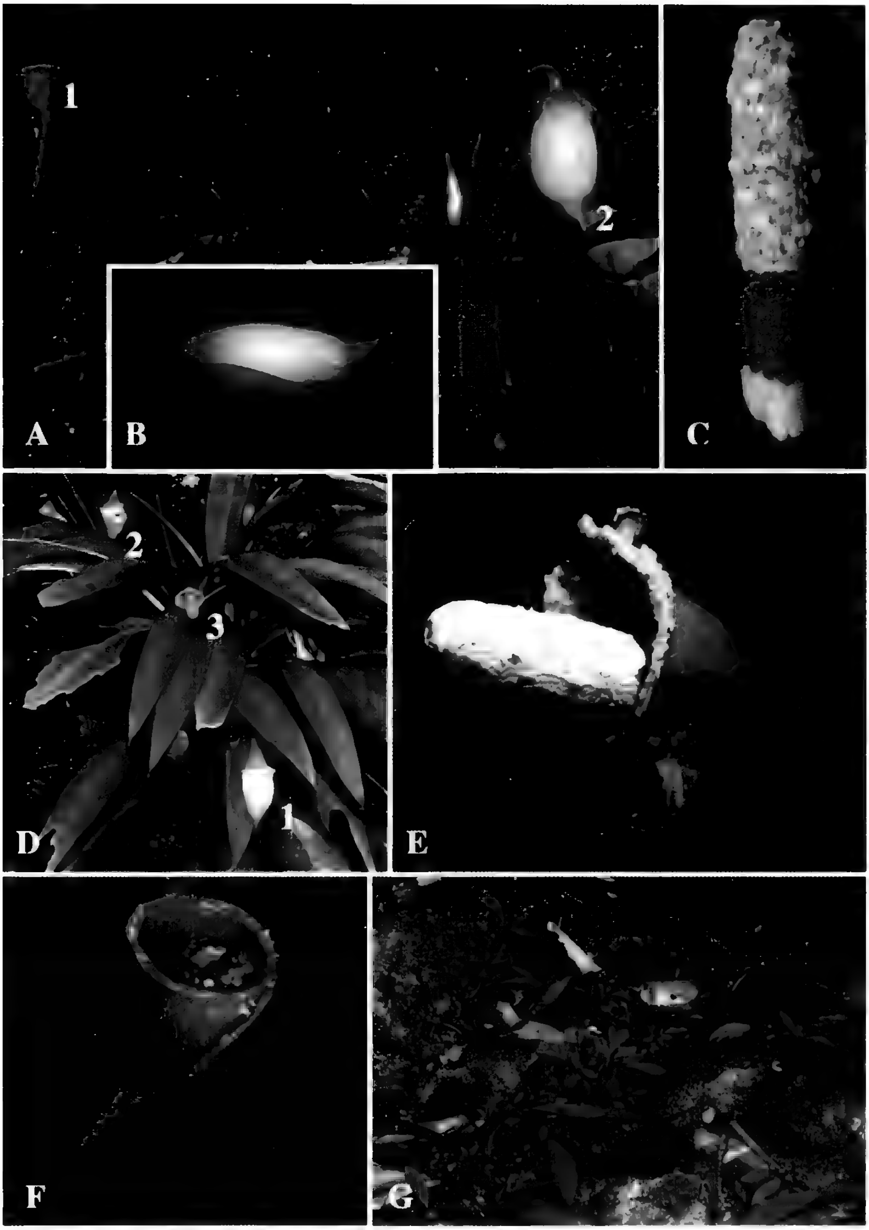

Plate 2. *Piptospatha elongata* (Engl.) N.E.Br. A. Flowering plant in habitat. Of note is the nodding inflorescence with almost straight rostrum (A2) and the erect infructescence (A1); B. Inflorescence at female anthesis. Note the almost straight rostrum; C. Spadix at male anthesis with spathe artificially removed. Note the pollen masses; D. Plant in habitat with inflorescences at a variety of anthetic stages: D1 = inter-anthetic period; D2 = onset of male anthesis; D3 = post anthesis; E. inflorescence during late male anthesis. Note the spathe limb is already shed and pollen has been released; F. Infructescence approaching maturity. Note the narrowly obconic persistent lower spathe; G. Seedlings in habitat.

third opening further before becoming caducous. **Spadix** cylindric, more-or-less sessile, 2-2.5 cm long, 0.4-0.5 cm diam.; female zone cylindric, 5-7 mm long, 5-7 mm diam.; ovary subcylindric to subprismatic, *ca* 0.9 mm diam., mid-deep pink; stigma sessile, as broad as the ovary, thinly discoid, mid- to deep pink; staminodes confined to 1-3 irregular and somewhat oblique rows at the base of the female zone, truncate, more-or-less sessile, 0.7-0.9 mm diam., about as high as the pistils, ivory; male zone cylindric, approximately equalling diam. of female zone, 1.3-1.7 cm long, apically obtuse; stamens crowded, more or less rectangular from above, glabrous, at anthesis longitudinally sulcate with the thecae pores dorsal and ventral to the sulcae, 1.2-1.4 mm across, connective flat, pale cream; pollen extruded in masses. **Fruiting spathe** narrowly funnel-shaped, erect, 1.2-1.5 cm diam.; berry obovoid, *ca* 3.5 mm long × 1.2-2 mm diam.; **seed** cylindric, very slightly ribbed, 1.4-1.6 mm long, brown but outer integument translucent, with a long curved micropylar appendage rotting away in dispersed seeds.

Other specimens seen: BORNEO. **Sarawak**. Kuching Division, Lundu, Sungai Sebako, 14 Apr 1984, *Dayang Awa & Paie S.46973* (K, KEP, L, SAN, SAR); Lundu, Kampung Sebako, Sungai Sebako, 01° 43' 18.9"; 109° 42' 53.8", 3 Feb 2005, *P.C. Boyce & Jeland ak Kisai AR-989* (SAR – spirit); Lundu, Gunung Gading, trail to waterfalls, 01° 41' 28.3"; 109° 50' 43.6", 14 Nov. 2006, *P.C. Boyce & Wong Sin Yeng AR-2052* (SAR – spirit); Lundu, 2 May 1954, *Brooke 8410* (L, SAR); Lundu, Gunung Gading, 19 Jul 1963, *Chai S.18484* (GH, K, L, SING); Lundu, Gunung Gading, Oct 1929, *Clemens & Clemens 21924* (GH, K, SAR); Lundu, Gunung Gading, *Foxworthy 326* (SAR, SING); Lundu, Sebuluh, 21 Jan 1989, *Othman Ismawi et al. S.62244* (K, L, KEP, MO, SAN, SAR); ibid, 15 Aug 1990, (K, KEO, L, SAN, SAR); Lundu, Gunung Pueh, Sungai Batu, 2 Mar 1989, *Othman Ismawi et al. S.56652* (K, KEP, L, SAN, SAR, US); Lundu, Gunung Pueh, Sungai Batu, 2 Oct 1974, *Mamit S.35218* (K, L, SAN, SAR, US); Lundu, Gunung Gading, *Micholitz s.n.* (SING); Lundu, Gunung Gading, 19 Sep 1955, *Purseglove & Shah P.4534* (K, L, SING); Lundu, Gunung Gading, 16 Aug 1960, *Sinclair & bin Tassin 10365* (E, K, L, SAR, SING); Lundu, Sematan, Pueh, close by Pueh mulberry plantation (Silkworm Farm), 7 Feb 1996, *S.Teo & Awg Enjah, S.68066* (K, KEP, SAR); Lundu, Gunung Gading, Sungai Sebuluh, 14 Jun 1991, *Yahud et al. S.61955* (K, KEP, SAR, US); Lundu, Kampung Pasir Ulu, Sungai Pasir Ulu, *Yahud et al. S.61925* (K, SAR); Lundu, Gunung Gading, 26 Mar 1980, *Yii Puan Ching S.42018* (L, SAR, US).

Habitat: Rheophytic on granite rocks in lowland to lower hill forest in light to medium shade. 10-400 m asl.

Distribution: Borneo, Sarawak, Kuching Division, endemic to the Lundu area, centred on Gunung Gading. It is quite likely also present in adjacent Kalimantan but we have not been able to re-examine the Kalimantan Barat specimens cited by Bogner and Hay [*Church et al. 2787* (K); *Nieuwenhuis 432* (B) and *Winkler 798* (HBG)]; by the vague locality data that accompanies these specimens we are unable to place them adjacent to the Sarawak distribution of *P. elongata* or *P. viridistigma*.

Notes: *Piptospatha elongata* as here defined is endemic to the Lundu area centred on Gunung Gading where it is restricted to granite substrates. It is readily separated in flower from the other *elongata* Group *Piptospatha* in west Sarawak (*P. viridistigma* and *P. impolita*) by the combination of a cylindrical spadix, unexcavated thecae, mid- to bright pink stigmas, a spathe tip rostrum conspicuously 2-3-keeled internally, and remaining straight or reflexing by only *ca* 45° during anthesis, flat anther connectives and the spathe at anthesis shading deep plum purple proximally through medium pink to deep pink distally and, in fruit, by the narrowly obconic persistent lower spathe.

From *P. impolita*, *P. elongata* is readily distinguished by the mid- to dark pink stigmas, the spathe tip rostrum conspicuously 2-3-keeled internally and remaining straight or reflexing by only *ca* 45° during anthesis, and the flat anther connectives.

Piptospatha elongata is immediately separated from *P. viridistigma* by a cylindrical (vs. bullet-shaped) spadix, longitudinally sulcate unexcavated thecae, 2-3 (*vs.* 5-7 keels) on the interior of the spathe tip rostrum and a narrowly obconic (*vs.* wide flared) persistent lower spathe. The pollen of *P. elongata* (and *P. impolita*) is released en masses whereas that of *P. viridistigma* is extruded in strings.

Piptospatha elongata is restricted to granite, whereas *P. viridistigma* is mainly, although not exclusively, found on limestones.

Piptospatha impolita S.Y.Wong, P.C. Boyce & Bogner, *sp. nov.*
A Piptospatha elongata *affinis, sed carinae intus spathorum nullis (vs. 2-3), rostrum spathorum valde reflexis (dum 130°) at staminis connectivo acute producto differt.* – **Holotypus:** Malaysia, Kuching, Lundu, Sempadi, Sg. Limau, Bukit Kankar, 25 Aug 2007, *P.C. Boyce, Wong Sin Yeng & Jipom Tisai AR-2141* (SAR, + spirit). **Plates 1B & 3.**

Rheophytic **herb** 9-11 cm high. **Stem** condensed, 1-4 cm long, 0.5-0.9 cm diam., with slender pale green 0.5-1.5 mm diam. **Leaves** several to 10 together; petiole 2-6 cm long, 1-1.5 mm diam., very slightly canaliculate adaxially, sheathing only at the extreme base, the remainder of the sheath

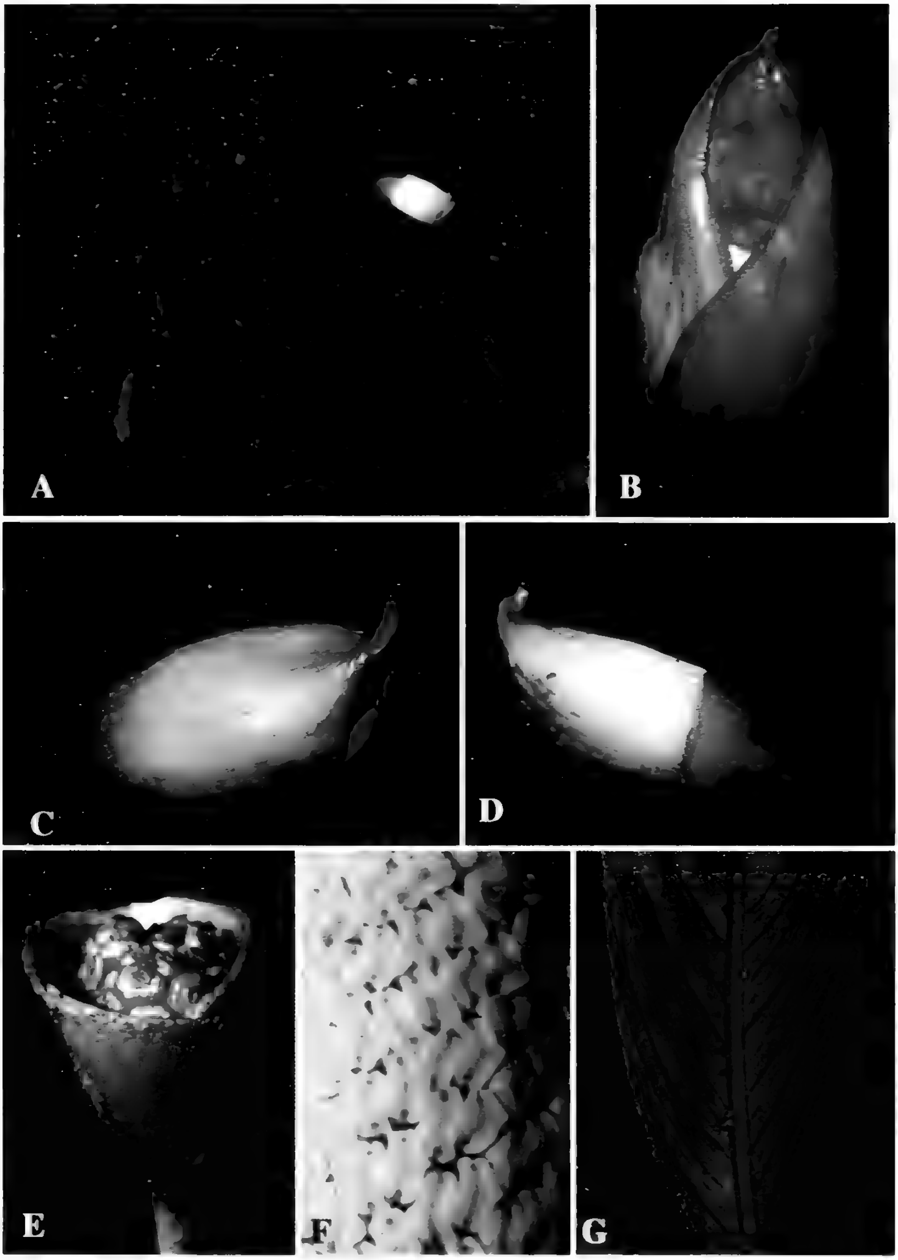

Plate 3. *Piptospatha impolita* S.Y.Wong, P.C. Boyce & Bogner. A. Flowering plant in habitat; B. Inflorescence at late female anthesis. Note that the orifice of the spathe lacks keels; C. Inflorescence at late female anthesis; D. Inflorescence at onset of male anthesis with spathe limb beginning to shed; E. Infructescence at mid-maturity. Note that the persistent lower spathe is broadly narrowly obconic; F. Detail of male flower zone just prior to male anthesis showing the sulcate stamens and lateral, beaked connective; G. Detail of leaf lamina abaxial venation.

ligular, the ligules extended into a narrowly triangular, purple to reddish portion 2-3 cm long, drying dark brown and moderately long-persisting; blade very narrowly elliptic to narrowly elliptic-oblong to oblanceolate, thinly coriaceous, matte medium-green adaxially, paler to slightly dull-pink flushed abaxially with the mid-rib and occasionally main venation markedly reddish, 6-13 cm long × 0.5-1.5 cm wide, base cuneate, apex acute and tubular-apiculate for 2-3 mm; midrib robust, abaxially prominent, adaxially bluntly raised (fresh), impressed (dry), with (6-)7-10 primary lateral veins on each side, diverging at *ca* 35° and more or less regularly alternating with lesser interprimary veins; secondary venation adaxially more or less obscure, abaxially fine and dense; tertiary venation obscure. **Inflorescence** solitary to 2-3 together and then alternating with foliage leaves; peduncle shorter than to equalling, the whole leaf, 9-14 cm long, 1-2 mm diam., purple to reddish. **Spathe** nodding at anthesis, subcylindric-obovoid, 2-3 cm long, apically rostrate for 3-4 mm, the rostrum internally smooth or with *ca* 2 very ill-defined keels, straight at female anthesis but recurving strongly by up to 130° at the onset of male anthesis; spathe at anthesis shading proximally to distally from deep plum purple through medium pink to deep pink, inflating and the distal-most part opening at female anthesis, at the end of male anthesis the opening increasing by the reflexing of the terminal rostrum and then at late male anthesis the upper third opening further before becoming caducous. **Spadix** cylindric to very weakly, 1.5-2 cm long, 0.4-0.5 cm diam.; female zone cylindric, 5-7 mm long, 5-7 mm diam.; ovary subcylindric to subprismatic, *ca* 0.9 mm diam., dirty whitish; stigma sessile, as broad as the ovary, thinly discoid, dirty whitish; staminodes confined to 1-2 irregular and somewhat oblique rows at the base of the female zone, truncate, more or less sessile, 0.7-0.9 mm diam., about as high as the pistils, ivory; male zone weakly fusiform, isodiametric to female zone, 1.3-1.7 cm long, apically obtuse; stamens crowded, more or less rectangular from above, glabrous, at anthesis longitudinally sulcate with the thecae pores dorsal and ventral to the sulcae, 1.2-1.4 mm across, connective short acute-triangular, pale cream; pollen extruded in masses. **Fruiting spathe** narrowly funnel-shaped, erect, 1-1.3 cm diam.; berry obovoid, *ca* 2.5-3 mm long × 1.5-2 mm diam.; **seed** cylindric, 1.4-1.6 mm long, brown but outer integument translucent, with a short curved micropylar appendage rotting away in dispersed seeds.

Other specimen seen: BORNEO. **Sarawak**, Kuching Division, Lundu, Sempadi, Sg. Limau, Bukit Kankar, 01°39' 44.2"; 109°59'56.5", 26 Mar 2004, *P.C. Boyce & Jeland ak Kisai AR-269* (SAR + spirit).

Habitat: Rheophytic on very hard sandstones in seasonally dry, but perhumid, lowland and lower hill forest between 50-150 m asl.

Distribution: Borneo, Sarawak, Kuching Division, endemic to the Lundu area along the coast.

Notes: *Piptospatha impolita* is most similar to *P. elongata*, but readily distinguished by the anthers with a short acute-triangular connectives (one on each side of the stamen and held parallel to the longitudinal sulcae), the spathe tip rostrum without internal keels, or the keels only very weakly defined, and the rostrum becoming strongly reflexed (*ca* 130° *vs.* 45°) relative to spathe axis at anthesis, and the dirty whitish pistils and stigmas.

Etymology: from the Latin (*impolitus* - unpolished) in reference to leaf lamina markedly matte adaxially.

Piptospatha viridistigma S.Y.Wong, P.C. Boyce & Bogner, *sp. nov.*
Ab alli Piptospatha *gregis* elongatae *borneensibus combinatio spadice conoideo, antherae excavates, excavatio papilio similis, spathae intus distalis 5-7 carinae instructa et spathae fructiferorum cyathiformis differt.* – **Holotypus:** Kuching Division, Siburan, Kampung Giam, Air Terjun Giam, 01° 19' 11.2"; 110° 16' 11.4", 7 Feb 2006, *P.C. Boyce, Jeland ak Kisai & Wong Sin Yeng AR-1687* (holo, SAR + spirit). **Plates 1C & 4.**

Rheophytic **herb** 16-40 cm high. **Stem** condensed, 2-6 cm long, 0.8-2 cm diam. with robust more or less reddish-tinged roots 1.5-2.5 mm diam. **Leaves** several to 15 together; petiole 6-15 cm long, 1.5-2.5 mm diam., D-shaped in cross-section, minutely aperous, sheathing only at the extreme base, the wings extended into a narrowly triangular purple to reddish ligular portion 5-8 cm long drying dark brown; blade very narrowly elliptic to narrowly elliptic-oblong to oblanceolate, coriaceous, dark green adaxially, paler abaxially, 10-24 cm long × 1.5-3.5 cm wide, the base cuneate, the apex acute and apiculate for 2-3 mm; midrib robust, abaxially prominent, adaxially impressed, with (6-)7-10 primary lateral veins on each side diverging at 35-45° and more or less regularly alternating with lesser interprimary veins; secondary venation adaxially more-or-less obscure, abaxially fine and dense; tertiary venation obscure. **Inflorescence** solitary; peduncle shorter than to equalling, or rarely exceeding the length of the whole leaf, 11-24 cm long, 1.8-2 mm diam., purple to reddish, minutely asperous. **Spathe** nodding at anthesis, subcylindric-obovoid, 3-4 cm long, apically beaked for 3-4 mm, spathe at anthesis shading proximally to distally from deep olive-green through very pale pink to medium pink, the interior of the spathe tip rostrum with 5-7 conspicuous keels, opening in the upper third, then the upper part caducous. **Spadix** the bullet-shaped, with the male portion tapering towards the apex, anthers with the thecae broadly excavated, and the excavations of

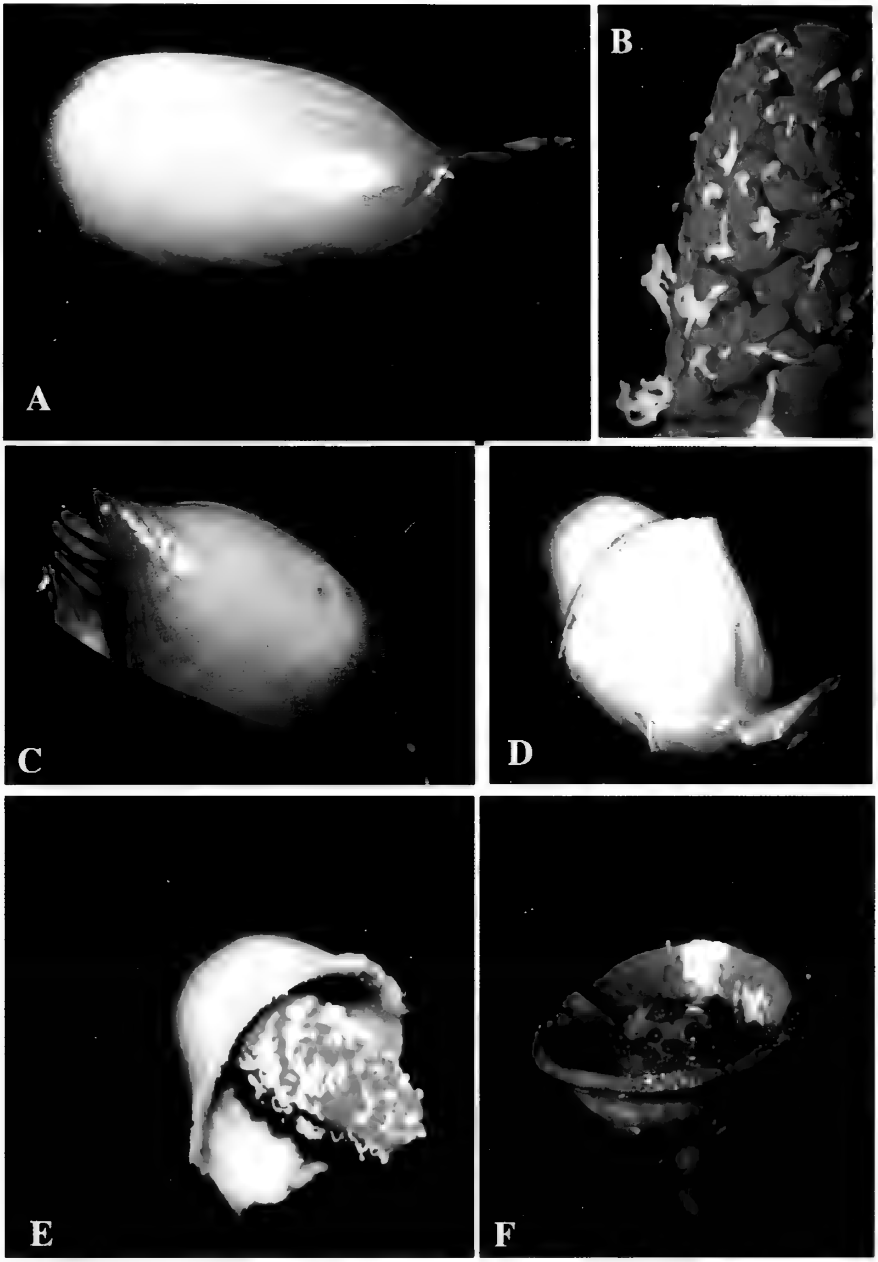

Plate 4. *Piptospatha viridistigma* S.Y.Wong, P.C. Boyce & Bogner. A. Inflorescence at female anthesis; B. Detail of spadix at male anthesis. Note the extruded pollen in strands; C. Inflorescence at late female anthesis. Note the conspicuous keels at the orifice of the spathe; D. Inflorescence at onset of male anthesis with spathe limb beginning to shed; E. Inflorescence at late male anthesis with spathe limb shed. Note the copious pollen strands; F. Infructescence at mid-maturity. Note that the persistent lower spathe is broadly funnel-form.

adjacent anthers forming a butterfly-shaped depression, and the diagnostic bright green stigmas and pistils, 2-2.5 cm long, 0.4-0.5 cm diam.; female zone fusiform, 5-7 mm long, 5-7 mm diam.; ovary subcylindric to subprismatic, *ca* 0.9 mm diam.; stigma sessile, as broad as the ovary, thinly discoid; interpistillar staminodes absent from among the pistils; neuter organs (an admixture of staminodes and pistillodes) confined to 1-2 irregular and somewhat oblique rows at the base of the female zone, staminodes truncate and centrally-depressed positioned ventrally, white, pistillodes truncate or weakly convex, positioned dorsally, yellow, all more or less sessile, 0.7-0.9 mm diam., about as high as the pistils; sterile interstice comprised of on in complete row of white staminodes and 1-2 rows of the lowermost male flowers larger than the fertile flowers and apparently sterile; male zone stoutly fusiform-cylindric, isodiametric with female zone, and often with a distinct ledge at the base that truncately-overhangs the female zone, 1.3-1.7 cm long, apically obtuse; stamens crowded, truncate, the connective not raised, more-or-less rectangular from above, glabrous, 1.2-1.4 mm across, thecae excavated, adjacent thecae excavations forming a butterfly-shaped deporession, deep yellow; pollen extruded in strings. ***Fruiting spathe*** broadly funnel-shaped, erect, 1.2-1.5 cm diam.; berry obovoid, *ca* 3.5 mm long × 1.2-2 mm diam.; **seed** cylindric, very slightly ribbed, 1.4-1.6 mm long, brown but outer integument translucent, with a long curved micropylar appendage which rots away in old seeds.

Other specimens examined: BORNEO. **Sarawak**, Kuching Division, Padawan, Bukit Manok, 01° 12'; 110° 18', 1 Apr 2004, *P.C. Boyce, Jeland ak Kisai & A.Shafreena AR-14* (SAR, + spirit); ibid, 18 Mar 2004, *P.C. Boyce, Jeland ak Kisai & A.Shafreena AR-250* (SAR, + spirit); Siburan, Kampung Giam, Air Terjun Giam, 01° 19' 11.2"; 110° 16' 11.4", 7 Feb 2006, *P.C. Boyce, Jeland ak Kisai & Wong Sin Yeng AR-1687* (SAR, + spirit); Bau, Bongo Range, trail to Tegora Mine, 01° 19' 41.5"; 110° 09' 19.0", 8 Sept. 2007, *P.C. Boyce, Wong Sin Yeng & Alexander Kocyan AR-2185* (SAR, + spirit); Bau, Gunung Lanyang, 11 Apr 2001, *Julia S., et al. SBC 2683* (SAR, SBC); Padawan, Gunung Gayu, 1° 12' 52"; 110° 19' 59", 14 Dec 1995, *Kato et al.* (SAR); Padawan, Stabut, 16 Jan 1970, *Mamit S.29953* (A, BO, E, K, L, MEL, SAR); Padawan, Jalan Kampung Annah Rais, hot springs, 12 Jan 1996, *Mohizah et al. S. 66820* (K, KEP, L, SAN, SAR, US); Padawan, Kampung Sadir ('Sadil'), Mini Hydro Station, *Yii Puan Ching S.51335* (K, SAR); Gunung Siruruh, Sarawak/Kalimantan border, 21 Sep 1987, *Yii Puan Ching S. 55240* (K, KEP, L, SAN, SAR, US). Sarawak, Samarahan Division, Serian, Sungai Ranchan ('Renchang'), Feb 1963, *Ashton S.21298* (K, L, SAR, SING); Tebakang, ('Tabakang'), Bukit Alak, *Awa & Paie S.45730* (K, SAR); Serian, Pichin, Umon Murut, Tiab Belanting, 01° 08' 03.7"; 110° 27' 00.3"S, 22 Jun 2005, *P.C. Boyce, Jeland ak Kisai & A.Shafreena AR-1256* (SAR, + spirit); Serian, Pichin, Bung Biringan, 28 Oct 2004, *P.C. Boyce & Simon Kutuh ak Paru AR-733* (SAR, + spirit); Serian, Mongkos, Kampung Batuh Mawang, Labak Ebang, Utak Samat, 5 Jan 2006, *P.C. Boyce & Simon Kutuh ak Paru AR-1658* (SAR, + spirit); Serian, Gunung Niyat, Ulu Sungai Majat, 27 Feb 2002, *Jemree & Enjah S. 85506* (K, KEP, L, SAN, SAR); Serian, Ranchan Falls, 26 Feb 1993, *Lai Chak Teck, Rantai et al. S. 66046* (K, KEP, SAR); Gunung Sirang, nr Sarawak/Kalimantan border, *Mamit S.35875* (L, SAR).

Habitat: Rheophytic, usually on limestone, occasionally on sandstone (*pers. obs.*) or basalt (fide *Ashton S.21298*) along small forest streams and waterfalls in light to medium shade, 100 – 350 (950) m asl.

Distribution: Borneo, Sarawak, Kuching & Samarahan Divisions, endemic to the Serian & Padawan areas as far NW as the Sungai Tegora (SE flanks of the Bungo range) and the southernmost Bau limestones. As with *P. elongata* it is very likely that *P. viridistigma* extends into adjacent Kalimantan but we have not been able to re-examine the Kalimantan Barat specimens cited by Bogner and Hay (2000).

Notes: *Piptospatha viridistigma* is readily differentiated from *P. elongata* and *P. impolita* by the bullet-shaped spadix, with the male portion deep yellow (*vs.* pale cream) tapering towards the apex, the anthers with the thecae broadly excavated with the excavations of adjacent anthers together forming a butterfly-shaped depression, and the diagnostic bright green pistils (from whence the trivial epithet is derived) and stigmas. Other characters include the minutely puberulent petioles and peduncle, pollen extruded in strings (*vs.* masses) and the spathe at anthesis shading proximally to distally from deep olive-green through very pale pink to medium pink. In fruit the persistent fruiting spathe is wide-flared rather then narrowly conical.

Sterile plants of *P. viridistigma* are very similar to *P. elongata*, although the uniformly minutely asperous petioles (D-shaped in cross-section) and longer persistent petiolar sheath are stable morphologies to differentiate *P. viridistigma* from *P. elongata*. To date *P. elongata* has never been collected away from granite.

Despite the long standing obfuscation with *P. elongata* we believe that the closest morphologically similar species is probably *P. burbidgei* (N.E.Br.) M.Hotta based on the presence of a sterile interstice comprised of the lowermost male flowers being larger than the fertile flowers and apparently sterile and intermixed with an complete row of white staminodes (and thus morphologically similar to the staminodal interstice that is diagnostic of *P. burbidgei*) and also the bullet-shaped spadix. However, it must be noted that vegetatively *P. burbidgei* is quite different in appearance to *P. viridistigma* (indeed different to all other Sarawak *Piptospatha*) and that the apparent similarities in the inflorescences may well be an evolutionary parallel or convergence.

Etymology: from the Latin for green (*viride*) and *stigma* in allusion to the strikingly green coloured stigmas.

Additional elements included in *P. elongata sensu* Bogner and Hay (2000)

Other elements cited by Bogner and Hay (2000) as belonging to *P. elongata*, but which need to be excluded, or for which doubt exists are:

Nicolson 1264 (K-photo, L-photo, SAR-photo, US-photo), Kuching Division, Matang FR, 10 mi W of Kuching, is unequivocally *P. grabowskii* (Engl.) Engl.

Argent et al. 692 (L) from "Miri Division ('4th Divn'), Gunung Mulu NP, Sungai Lansat", is referable to *P. burbidgei*. The first two authors have undertaken extensive fieldwork in the lowlands of Mulu, including the Sungai Lansat, and are confident that *P. elongata* is not present in the area (nor, indeed, anywhere in NE Sarawak), whereas *P. burbidgei* is a common species on the exposed shales throughout the Mulu area, including on the Sungai Lansat.

McDonald & Ismail 3615 (GH) from "Kalimantan Timur, Bulungan ('Pujungan') Distr., Kayan-Mentarang Reserve...." may belong to either *P. burbidgei* or *P. manduensis* Bogner & A.Hay, or be referable to a novel taxon but requires re-examination. We are confident that by the considerable geographical disjunction that it is not referable to any species dealt with in detail in this paper.

The depauperate *Hullett s.n.* (SING) collection from Sri Aman Division, Lingga, Batu Gajah, is interesting in that it may be referable to the very poorly known *P. remiformis* Ridl., the type of which is missing but originates from Lingga. At present Lingga is notably under-collected but, based on the few aroids so far gathered from there, harbours an intriguing mixture of otherwise highly localized west Sarawak endemics including *Aridarum nicolsonii* Bogner & M.Hotta and *A. crassum* S.Y.Wong & P.C. Boyce. However, neither of these species in their main distribution occur in the same locality nor on the same geology as *P. elongata*. The Lingga area needs to be extensively investigated before a confident identification can be made.

Informal Groups

One of the significant contributions in the Bogner and Hay (2000) *Piptospatha* account is the proposal of two groups, the *P. elongata* Group and the *P. grabowskii* Group defined by the persistence or otherwise of the spathe limb into fruiting. We have observed a suite of additional characters that further reinforce the morphological and perhaps phylogenetic validity for these two groups.

Elongata Group

The spathe limb is caducous during anthesis as reported by Bogner and Hay (2000). Based on our observations, spathe limb senescence begins mid-way through the period of male anthesis, when the somewhat soft-textured limb degrades and becomes increasingly fragile, while at the same time abscising from the leathery and persistent funnel-form lower spathe. By the end of male anthesis the inflorescence is comprised of an erect to sub-erect peduncle and a nodding spathe/spadix from which the spathe limb is already shed and the spadix is still intact. With the completion of male anthesis, providing that the female flowers have been successfully fertilized, the spadix above the female zone is shed – if fertilization has not been successful the entire spadix decays and is shed. The shedding of the distal portion of the spadix is accompanied by the peduncle becoming more or less erect and the axis at the attachment of the spathe twisting so as to bring the funnel-form lower spathe orthotropic to the peduncle; in such a posture the lower spathe later functions as a 'splash-cup' dispersal unit. At or shortly after the spathe being bought vertical, the lower spathe perceptibly thickens and turns green.

Grabowskii Group

Bogner and Hay (2000) defined the Grabowskii Group by (in successfully pollinated inflorescences) the spathe limb persistent throughout and after anthesis with only the very distal-most portion decaying. We are able to add to these observations and confirm that the spathe persists, with the very distal-most portion decaying only after anthesis, until during fruit dispersal at which point the spathe abscises at the junction of the peduncle and is lost along with the dispersing fruits. Other notable differences in the Grabowskii Group are that the inflorescence post-anthesis is declinate by deflexing of the lower part of the peduncle and also the spadix is persistent until post-dispersal, the spent male flowers and various neuter structures are shed, but the axis remains even after the fruits and persistent spathe have been shed. Based on on-going research it appears that the shedding of the distal-most part of the spathe serves to enlarge the opening at the end of the now much thickened spathe and is perhaps associated with facilitating the shedding of the spent male flowers and neuter organs. It also appears that the spadix axis is perhaps involved with fruit dispersal mechanics but more observations are needed to confirm this. Whatever the outcome of studies on these morphological interactions, it is clear that fruit/seed dispersal mechanics of the Elongata and Grabowskii groups is fundamentally different.

Pistillodes & Staminodes

Bogner and Hay (2000) noted several instances in *Piptospatha* where it was not possible from dried and alcohol-preserved material to unequivocally assign neuter organs as staminodes or pistillodes, in particular with regard to such neuter organs situated below the female flower zone (i.e., basal-most on the spadix). We have been fortunate to observe a large number of fresh inflorescences of five species that are indigenous to Sarawak; based on these observations we are confident that the lowermost organs in *P. grabowskii* (Plate 1E), *P. elongata* (Plate 1A), *P. impolita* (Plate 1B) and *P. burbidgei* (Plate 1D) are pistillodes, while those present in *P. viridistigma* are comprised of pistillodes and a few staminodes (see Plate 1C).

References

Bogner, J. and A. Hay. 2000. Schismatoglottideae in Malesia II – *Aridarum, Bucephalandra, Phymatarum* and *Piptospatha*. *Telopea* **9(1)**: 183-194.

Boyce, P.C. and S.Y. Wong. 2009. Studies on Schismatoglottideae (Araceae) of Borneo VII: *Schottarum* and *Bakoa*, two new genera from Sarawak, Malaysian Borneo. *Botanical Studies*: in press.

Book Review: J. H. Beaman and P. J. Edwards. 2007. **Ferns of Kinabalu, an Introduction.** Natural History Publications (Borneo). 198 pp. ISBN: 983-812-122-3. Price: Sing $53.

Mt. Kinabalu in Sabah State of Malaysia is a paradise of plant diversity. In recent years, there have been many introductory pictorial guidebooks published for various groups of plants grown on this highest mountain in the Asian tropic. To my knowledge, this seems to be the first one on the fern diversity.

This beautifully executed book with vividly coloured photo plates of the more commonly seen fern species around the Kinabalu Nature Park Headquarter and the several popular trails from 600 to 2,800 m, is very well written by J. H. Beaman and P. J. Edwards, two knowledgeable botanists who have studied the flowering plant and fern floras of Mt. Kinabalu for a number of decades.

The book starts aptly with a succinct introduction describing the life cycle of fern, a discussion of the latest system of classification of ferns based on the molecular phylogeny, and a brief summary of the fern distribution in the region from the point of view of the Mt Kinabalu flora.

More than a hundred pages of coloured photos and illustrative line drawings, with short description for each of the species chosen to represent 29 recognized families arranged in alphabetical order, follow the Introduction. And the book ends with a useful and updated checklist of all known ferns from Mt Kinabalu, a Glossary, the Acknowledgements and an Index to the Scientific Names.

What is new in phylogenetic interpretation published in this guidebook is the inclusion of *Psilotum* and *Equisetum* in the ferns, and not the traditional fern allied plant group. For *Equisetum*, the authors reported that the recent DNA evidence indicated a close relationship to the *Marattia* ferns. Eight endemic Bornean ferns are shown in very nicely reproduced photos, namely *Aglaomorpha brooksii* Copel., *Alsophila ramispina* Hook., *Elaphoglossum heterolepium* Alderw., *Grammitis reinwardtioides* Copel., *Loxogramme ensifrons* Alderw., *Mesophlebion dulitense* Holttum, *Selliguea murudensis* (C. Chr.) Parris, and *Sphaeropteris capitata* (Copel.) R.M. Tryon. Likewise, five Mt. Kinabalu endemic fern, *Dicranopteris clemensiae* Holttum, *Diplazium atrosquamosum* (Copel.) C. Chr., *D. poiense* C. Chr., *Odontosoria veitchii* (Baker) Parris and *Sphaerostephanos lithophyllus* (Copel.) Holttum, are included with well taken closed up photos showing also the fertile fronds.

Other nomenclatural and taxonomical novelties encountered in this book are the use of *Odontosoria* for the genus *Sphenomeris*. The split genera in the family Cyatheaceae, Hymenophyllaceae, Thelypteridaceae and Grammitidaceae are recognized, while the recently proposed new genera of Vittariaceae and the Polypodiaceous genera of *Phymatorus* (= *Microsorum*) and *Crypsinus* (= *Selliguea*) are not accepted. *Diplazium* and *Athyrium* are place in the family Woodsiaceae.

Although the book illustrated only 100 taxa of common ferns seen on Mt. Kinabalu out of the 590 known taxa of the mountain fern flora, the book is a useful guide to have while visiting the mountain either on an excursion at leisure or on a more seriously planned botanical exploration visit. Since the majority of the species are widespread in the region, sure enough, the book can also serve as a good reference, used with monographs and floristic publications, in the identification of the ferns in tropical SE Asia. The authors and the publisher are to be thanked for producing this timely and useful pictorial guide to the Kinabalu ferns.

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Book Review: Hughes, M. 2008. **An Annotated Checklist of Southeast Asian *Begonia*.** Royal Botanic Garden Edinburgh. 164 pp. Price: Sing $60 (£25).

This useful and informative publication aims to stimulate, as stated by the author, the production of much needed local floras of *Begonia* through the provision of a regional checklist with extensive bibliography.

The main body of the publication consists of a short and information-rich Introduction, followed by a lengthy section of Annotated Species List and a Geographic List, and ended with the References and Index of Names.

According to the author, the main annotated list accounts for 521 species of *Begonias* reported from 18 Botanical Countries (see Brummit, 2001) in SE Asia based on some 5,827 specimens housed in various herbaria. The political countries included in this checklist include Myanmar, Thailand, Vietnam, Laos, Kampuchea, Malaysia, Philippines, Indonesia, Brunei, Papua New Guinea, and the Pacific Island groups, Vanuatu and Fiji. Surprisingly, based on current information, Philippines has the highest number of species recorded (104 species) and also the greatest number of endemic species reported (103 species). This is followed by Borneo (95 species) and New Guinea (79 species). The high number of species of *Begonias* in the Philippines probably reflects more on the long historically preference and frequency of collections of this genus in the country.

For every species listed in this publication, sufficient information is provided for the original publication and important taxonomic bibliography, the complete synonymy, the type information, the sectional classification, the enumeration of specimens reported in publications and where deposited today, and most importantly, the author's proposed IUCN status of the species endangerment. According to the author, readers of the publication can also find the digital images of the plant and the protologues of each species by consulting the website of the Royal Botanic Garden Edinburgh.

The species names in the main annotated list are arranged alphabetically for ease of searching. Likewise, the names of the taxa placed under a country in the Geographic List are also alphabetically listed, but with additional listing of excluded taxa from the country/island groups based on the author's many years of taxonomic and nomenclatural researches.

Some nomenclatural novelties published in this checklist include *Begonia cristata* Warb. ex L.B.Sm. & Wassh. (*syn. nov*., p. 7), *Begonia yunnanensis* H. Lév. (*syn. nov*., p. 83), *B. sootepensis* var. *thorelii* Gagnep. (*syn. nov*., p. 83), *B. lushaiensis* C.E.C. Fish. (*syn. nov*., p. 83), *Casparya robusta* var. *glabriuscula* A. DC. (*syn. nov*., p. 86), and *B. modestiflora* var. *sootepensis* (Craib) Z. Badcock ex M. Hughes, *comb. nov*. (p. 84).

Additionally, two species of *Begonia*, *B. kaniensis* Irmsch. and *B.*

demissa Craib, are beautifully illustrated.

What I find most elucidating and informative about this publication is the many comments of the author provided for many species throughout the publication as Notes to explain the confusing history of a name, the past errors made in reporting a species, the author's taxonomic interpretation, the alleged and corrected range information, as well as the justification of revised sectional classification. All these notes show the profound knowledge of the author for the genus, taxonomically, nomenclaturally and bibliographically.

Having been involved in the study of the flora of the Philippine Archipelago for many years, I did find a few small errors in the spelling of locality and the collector names that deal with the Philippine taxa. For examples, the collector name of "Edaño" has been written inaccurately as "Edano", and the town name, "Peñablanca" in Cagayan Province is mis-spelled as "Panablanca". Moreso, the locality name of Mt. Makiling is the same as Mt. Maquiling, and Mt. Banahao is the same as Mt. Banajao. Mt. Susong-Dalaga (female breast) in Rizal Province (see p. 37) is mis-spelled as Mt. Susong-Dalanga. "Baranguay San Jose" on p. 26, the type locality under *B. chloroneura* P. Wilkie & Sands, should be written as "Barangay San Jose". The type locality of *B. longibractea* Merr. (see p. 72) is Siargao Island, and not Siargo Island as printed. Also, the type locality of *Begonia subtruncata* Merr. in Union Province (see p. 125) is today known as "La Union Province". Likewise, the type locality, "Banos" town, of *B. aequata* A. Gray in Laguna Province (p. 4), is to be "Los Baños" town.

I have two nomenclatural points to make. (1) The listing of the accepted name for the homotypic synonymy between *Begonia wenzelii* Merr. (1915) and *B. leytensis* Merr. (1914), in favour of the former (p. 138), is not clearly stated. The latter name is actually a junior homonym of *B. leytensis* Elm. (2) Naked names, like *B. bulusanensis* Elmer ex Merr. and *B. hemicardia* Elmer ex Merr. on p. 15, *B. neopurpurea* L.B.Sm. & Wassh. on p. 89, and *B. sorsogonensis* (Merr.) Elmer on p. 121, lack a type specimen, but have an original specimen.

The workers and students of *Begonia* in SE Asia should be grateful to the author for compiling such a useful publication that builds the bibliographical groundwork for the documentation of the richness of the species of this genus in the region; many of them are local endemic and have high ornamental value. Seen in this light, this publication should be considered essential and a bible to plant growers, landscapers and gardeners who need to check on the correct name of a species of *Begonia* from SE Asia used in horticulture.

Literature Cited: Brummit, R.K. 2001. *World Geographical Scheme for Recording Plant Distributions*. Hunt Institute for Botanical Documentation,

Pittsburgh.

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Singapore Botanic Gardens

The Gardens' Bulletin
Singapore

VOL. 61 (2) 2010 ISSN 0374-7859

A Commemorative Volume of the
150th Anniversary of the Singapore Botanic Gardens

Singapore Botanic Gardens

150 years
Connecting Plants and People

THE GARDENS' BULLETIN SINGAPORE

The Gardens' Bulletin Singapore publishes original papers on plant taxonomy (including revisions), horticulture, phytogeography, floristics, morphology, anatomy and related fields with emphasis on plants in the West Malesian region.

The Gardens' Bulletin is published twice yearly by the National Parks Board, Singapore. Neither the National Parks Board nor the Editorial Board is responsible for the opinions or conclusions expressed by the contributing authors.

The annual subscription for the Gardens' Bulletin is Singapore $100.00 including postage. Overseas subscribers are required to make payment in the form of bank drafts or international money orders in Singapore currency payable to *National Parks Board, Singapore.*

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[Cover photo : *Musa arfakaina* with mature fruit (see p. 245); photo by G. Argent]

The Gardens' Bulletin
Singapore

VOL. 61 (2) 2010 ISSN 0374-7859

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Date of publication: March 2010

Published and copyrighted by

National Parks Board
Singapore Botanic Gardens
1 Cluny Road
Singapore 259569

Printed by **Oxford Graphic Printers Pte Ltd**

Congratulations to the Singapore Botanic Garden Sesquicentennial 2009

Throughout 2009, universities, museums and botanical gardens in countries across the world, have celebrated the bicentenary of the birth of Charles Darwin. Most recently, on November 24th 2009, the 150th anniversary of the publication of Darwin's classic book "The Origin of Species ..." was the opportunity for further reflection on the impact of his work. Through his ideas and experiments Darwin established the foundation for our modern understanding of biological diversity and how it has come to be through the processes of evolution.

But in many celebrations of Darwin's life it is sometimes forgotten that his insights had as much meaning for those interested in the variety of plant life as those concerned with the origin of diversity in the animal kingdom. Indeed, Darwin devoted several books to different aspects of plant evolution, and the mid-nineteenth century scientific milieu in which he worked was a golden age of botanical exploration. This was a time when new plants were being discovered and brought into cultivation from the most remote corners of the globe.

The Singapore Botanic Gardens, founded in 1859 by a group of agriculturalists and horticulturalists in Tanglin, was borne in this era. Its origin lies in an era of fascination with plants and their potential economic importance, and at a time when the value of public parks, for leisure and beauty, was first being realized. Ever since, the Gardens has played a major role in the life of Singapore and the surrounding region. Its luxuriant planted landscapes are echoed throughout the city. Over 150 years, the Singapore Botanical Gardens has evolved into one of the great botanical gardens of the world. Both a major tourist destination and a national icon, it continues to enrich the lives of the people of Singapore. Open every day, free of charge, from early in the morning until late at night, the Singapore Botanic Garden is a well-loved national treasure.

Plants have been important in the history and development of Singapore since Sir Stamford Raffles founded the first "Botanical and Experimental Garden" on Government Hill in 1822 almost at the birth of the colony itself. Since then, and especially since the early scientific work of H. N. Ridley, the Singapore Botanical Gardens has been at the center of botanical research on the plant life of tropical South-east Asia. That leadership continues today, with even more urgency, as the Gardens coordinates with regional and global partners on the conservation and sustainable use of tropical plants.

In 1859, the same year that the Singapore Botanic Gardens was founded, on the other side of the world, Henry Shaw established the Missouri Botanic Garden in St. Louis. A hundred years earlier, in 1759, the Royal Botanic Gardens, Kew began its transition from a Royal estate to a scientific collection of plants. The past year, 2009, has therefore been a time for celebration at all three of these great gardens. A celebration given greater significance by the recognition that all three now work ever more effectively as part of a global network of more than 2,000 botanical gardens - all dedicated to the cultivation and conservation of plant species, and increasing knowledge and public enjoyment of botanical diversity.

We send our congratulations to the Singapore Botanic Gardens on 150 years of remarkable achievements and outstanding accomplishments. We wish it well at its sesquicentennial, and in the coming decades, as it continues its important work of "Connecting People and Plants".

Dr. Cristián Samper
Director, National Museum of Natural History, The Smithsonian Institution

Professor Peter H. Raven
President, Missouri Botanical Garden

Professor Steven Hopper
Director, The Royal Botanic Gardens, Kew

Professor Sir Peter Crane
Carl W. Knobloch, Jr., Dean, School of Forestry and Environmental Sciences
Yale University

A New Species of Wild Banana *Musa arfakiana* (Musaceae) from Papua (Formerly Irian Jaya) of Indonesia

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Abstract

Musa arfakiana is described and illustrated as a new species from Papua, Indonesia.

Introduction

New Guinea is an important centre of diversity for the genus *Musa* (Argent, 1976, 2001). With the addition of this new record, there are 11 wild species recorded, most of which are endemic. The area is also arguably the richest place in the world for indigenous cultivars (Simmonds, 1966), many of which are diploides and potentially important as a gene reservoir.

Terminology and description below follows Simmonds (1962, 1966) and Argent (1976).

Musa arfakiana Argent, *sp.nov.*
Musae johnsii *Argent similis sed fructu minore distaliter acuto haud truncato non schizocarpo, fructuum fasciculo erecto, tepalis compositis cum apicibus viridibus non cremeis et canale petiolari paene clauso haud late aperto differt.* – **Typus:** INDONESIA. Papua, West Papua, Kampung Siobri, Mokwam District, Arfak Mts. Mt. Sembiedip, 01° 07' S. 133° 54' E. 2 Feb 2009, *Argent et al ABEG 106* (holo, BO; iso, E & Manokwari Forestry Herbarium). **Figs. 1, 2 & 3.**

Clump forming **herbaceous plant**, suckers erect and close to the base of the parent plant but mostly only one or two, the clumps small. **Sucker** leaves mostly auriculate at the base. **Pseudostem** to 1.5-2 m, 9-12 cm diameter near the base, predominantly black, otherwise green with some dark brown coloration in the upper parts, no wax; undersheath green, inner sheath white with purple streaks, sap clear. Shoulder brown or green, entire, smooth and appressed, the margin black but not scarious. Fourth last **leaf** *ca* 160 x 45 cm, right handed to *ca* 10 mm, the base auriculate, slightly broader in the lower half. Other leaves often with a truncate or even slightly tapering base,

Figure 1. *Musa arfakiana* with inflorescence showing the male bud.

Figure 2. *Musa arfakaina* with mature fruit.

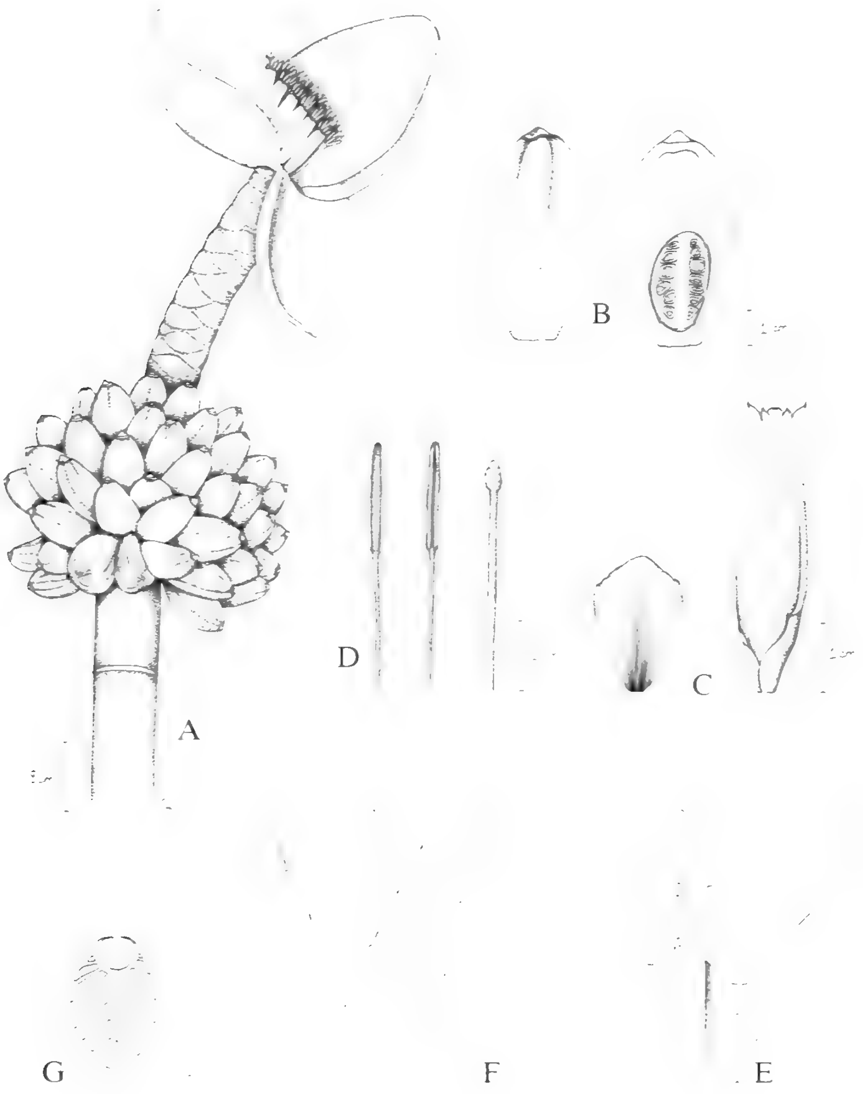

Figure 3. *Musa arfakiana*. A. Habit of fruit bunch, peduncle and male bud; B. Whole fruit and fruit in l.s. showing distal sterile pith chamber; C. Compound and free tepal; D. Stigma with anthers; E. Leaf base; F. Petiole bases showing upper shoulder margins; G. Petiole (t.s.) at the mid-point.

all bright green, hardly different in colour above and below, slightly paler beneath and with the prominent midrib, mostly pale yellow, sometimes with a little brown proximally, without wax. Petiole 76-80 × *ca* 3 cm, green, the adaxial channel green, almost completely closed, the wings black or green distally, TS ration 0.33 (see Argent, 1976). PB ratio 2-3.
Peduncle thick, green, glabrous, smooth. Bunch erect. The female bracts lanceolate, yellow, shiny outside, dull yellow and slightly paler inside, acuminate the apices with the margins strongly inrolled, quickly deciduous or sometimes trapped between the fruit. **Female flowers** hermaphrodite with fully fertile anthers, cream with green tips. Ovary trilocular, each loculus with the ovules in two rows. **Fruit bunch** dense, sub-spherical in shape to *ca* 30 × 30cm. Fruits in two rows, the second hand with *ca* 10 fruits. The fruits irregular, apparently ageotropic, showing no curvature in any part of the bunch, ripening bright orange, up to 8 × 5 cm, very strongly 2 or 3-angled, tapering in the distal half to a broadly acute apex with a prominent scars *ca* 1 cm in diameter, not splitting, sterile in the distal third, the seeds confined to the proximal two-thirds of the fruit, with orange pith and similarly coloured or yellowish flesh around the seeds in the carpel chambers. Pedicel very short *ca* 4-5 mm, the fruits almost sessile. **Seeds** dark brown 5-7 mm in diameter, irregularly angled, and with only an indistinct domed boss opposite the impressed hilum, which is *ca* 2.5-3mm in diameter and smooth.
Male peduncle growing vertically upwards or mostly angled upwards at about 30° to the vertical, rough with a dense covering of bract and flower scars. The male bud up to 15 × 9 cm, pale yellow or green, shiny yellow, convolute or only imbricate for *ca* 1 cm from the tip. Male bracts up to 16 x 9cm, shiny pale yellow outside, shiny yellow inside but becoming dull inside after falling, with broadly rounded, obtuse apices, lifting to a wide angle to *ca* 45° below the horizontal; after falling only recurved at the base not revolute from the apex or margins. **Male flowers**, two-rowed, cream, the free tepal translucent white, with a rounded, but irregular upper margin and no distinct sub-apical wrinkle, about half as long as the compound tepal. Compound tepal cream with green apices.

Musa arfakiana is similar to *Musa johnsii* Argent, in the dense sub-spherical bunch of almost sessile fruits, with sterile distal pith chambers. This new species differs from *M. johnsii* in its smaller stature; in having the petiole canals almost closed with the 'wings' inflexed not broadly open; in having erect, not hanging bunches of fruit; the fruits tapering distally to broad points, not expanding distally to broad truncate apices and the fruit is not schizocarpic as it is in *M. johnsii*.

Vernacular name '*Bulada*' in the local language of Kampung Siobri, where the people did not eat any part of the plant in contrast to the the Amungme Tribe whose people eat *Musa johnsii* as a vegetable (Argent, 2001).

Notes: Named after the mountain range on which it was found.

This very distinctive new species was a very surprising find above the village of Siobri in the Arfak Mountains and may have a very restricted distribution as it was not found around Anggra village which was very close to Siobri, effectively on the other side of a main ridge of mountains. A single population of *Musa arfakiana* was seen on the side of Mt. Sembiedip from *ca* 1500-1800m. It occurred in the upper area of secondary forest, which was regenerating after timber extraction and gardening but also occurred in the relatively undisturbed lower montane forest, sometimes in quite deep shade. The population comprised numerous plants in various stages of flowering and fruiting and like *M. johnsii*, it would appear to be non-seasonal. There was no evidence of anything eating the fruit, which remained very tough and hard even when the seeds were apparently mature, but the seeds brought back to Edinburgh failed to germinate. Nor was there any evidence of the fruit splitting open when ripe and this was confirmed by our local guide from the village, 'Zeth' who had a good knowledge of the local plants and readily confirmed that the fruit of some other species did split open at maturity. Nothing appeared to eat the fruit and thus the dissemination of the seeds remains a mystery.

This species is undoubtedly related to *M. johnsii* having a similar sterile pith chamber in the distal portion of the fruit, which until the discovery of this new species was thought to be a character unique to *M. johnsii*. It is also similar in its waxless foliage and spherical bunch shape. *M. arfakensis* significantly differs from *M. johnsii* in the almost closed petiolar canals, the shorter petiole to blade ratio having relatively longer petioles. *M. arfakensis* also has an erect fruit bunch with semi-erect male axis, unlike the half-hanging bunch with vertically descending the male axis in *M. johnsii*. The fruit, although with a similar sterile distal portion, tapers distally, unlike the truncate distal apices of *M. johnsii* and there was no evidence that the fruit ever naturally splits open. The basal flowers in *M. arfakensis* are functionally hermaphrodite, not female, and the tips of the compound tepals are green and not cream as in *M. johnsii*.

Our local guide at Kampung Siobri claimed to recognise four other different wild bananas, all growing in the vicinity. '*Binput*' was *Musa ingens* Simmonds; '*Bunkan*' was *M. acuminata* Colla subsp. *banksii* but the other two were not seen and could not be identified from the local descriptions. *Musa ingens* was commonly seen on the road at higher elevations, distinctive in its large size, tapering pseudostems and waxy leaves. It was also seen on Yappen island, both these records extend the known distribution of this species away from the main range that forms the spine of mountains east-west along the island of New Guinea. Additionally *Musa schizocarpa* Simmonds was seen on the road to Siobri (Arfak Mts.).

Acknowledgements

I am indebted to Dr Robert Mill for the translation of the Latin diagnosis. Işık Gűner has ably drawn the pen and ink illustration. Zeth our local guide freely shared his local knowledge with our expedition and to the other members of the team who participated in the collection of this plant: Louise Galloway, Sadie Barber and Andrew Ensoll and our Indonesian counterparts: Dr. Charlie Heatubon and Pak Rustandi. Financial assistance was provided by the Royal Botanic Garden Edinburgh, especially 'The Members Committee', The Royal Horticultural Society and the James and Eve Bennet Trust. We are grateful to LIPI the Indonesian Institute of Sciences for their support.

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A Review of the White-flowered *Amorphophallus* (Araceae: Thomsonieae) Species in Sarawak

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Abstract

A review of the white-flowered *Amorphophallus* species in Sarawak is presented. A total of five species are recognized, four of which belong to the Eburneus Group and are restricted to limestone, and moreover, locally endemic: *A. eburneus* Bogner (Padawan and Tebedu areas), *A. brachyphyllus* Hett. (Bau), *A. juliae sp. nov.* (Merirai) and *A. niahensis sp. nov.* (Niah). A fifth species, *Amorphophallus infundibuliformis* Hett., A.Dearden & A.Vogel, of doubtful affinity, is widespread and locally abundant on a variety of substrates excluding limestone. A key to the white-flowered species in Sarawak is presented and all species are illustrated.

Introduction

Fieldwork on forested limestone areas of Sarawak is proving remarkably productive in revealing hitherto undescribed species of *Amorphophallus*. As this paper exemplifies, even supposedly well-botanized areas can be revealed to have new taxa and, thus, it is no great surprise that when remote and not easily accessible limestone areas are scrutinized, these, too, prove to have their complement of novel species.

Batu Niah is a significant limestone formation in Miri Division, northeast Sarawak. Bukit Merirai is a smaller but more remote limestone formation on the border of Kapit and Bintulu Divisons. Both areas are geographically separated from the limestones of Mulu (Miri and Limbang Divisions) and from the isolated Bukit Sarang limestones on the Bintulu/ Kapit Division border, and from areas further east in Sarawak and Sabah, as too from the complex limestone formations in western Sarawak that have received the most attention in recent years. Fieldwork in these areas has shown that while such formations have aroid species in common, there are also for each formation, suites of closely related but morphologically distinct, presumably vicariant, local endemics. In addition to examples in the genus *Schismatoglottis* (see especially Hay and Yuzammi, 2000), and *Alocasia* (see Hay, 1998, 2000), this phenomenon is particularly well exemplified by *Amorphophallus*, in which the species on limestone in western Sarawak [*A. eburneus* Bogner (Bau limestone), *A. brachyphyllus* Hett. (Padawan limestone), and from Serian (*A. ranchanensis* Ipor, Tawan, A.Simon, Meekiong & Faud)] are mirrored in eastern Sarawak by the recently described Mulu-endemic, *A. julaihii* Ipor, Tawan & P.C. Boyce, the two novel species here described, and thence to Sabah where *A. tinekeae* Hett. & A. Vogel is restricted to the limestone at Gua Gomontong.

The two novelties described here take to 17 the number indigenous endemic *Amorphophallus* species recorded for Borneo (see also Mayo and Widjaja, 1982; Bogner *et al.*, 1985; Bogner, 1989; Bogner and Hetterscheid, 1992; Hetterscheid, 1994; Hetterscheid and van der Ham, 2001; Ipor *et al.*, 2004, 2007). Remarkably, 15 of these species have been described within the past 30 years. Additionally, a further four species recorded for Borneo are either introduced or of doubtfully native provenance: *A. konjac* K.Koch, *A.paeoniifolius* (Dennst.) Nicolson, *A. prainii* Hook. *f.* and *A. muelleri* Blume.

Taxonomy

The limestone-obligate white-flowered *Amorphophallus* in Sarawak are seemingly closely related, and are currently referred to as informal Eburneus Group. The common characters, admittedly polythetic, for the Eburneus Group, are: irregularly bulging tubers, presence of corky outer tuber skin, turgid petioles, at least upper male flowers vertically aligned, inflorescence with a fishy smell at anthesis, and large (to 2 cm long) elongate fruits that, except for those of *A. titanum* (Becc.) Becc. (5-6 cm long), are the largest in the genus.

The systematic position of non-limestone *A. infundibuliformis* is unclear. The leaf, especially the intricate morphology of the petiole ornamentation, is quite different to the turgid, smooth, usually unmarked light green, rarely with smooth paler green or reddish circular markings typical of the Eburneus Group. The tuber is also markedly different and striking by the inside flesh deep red.

The use of an informal subordinate grouping is in line with the approach used in other taxonomically intractable groups (e.g., *Alocasia* G.Don., *Schismatoglottis* Zoll. & Moritzi, the Potheae Engl., and *Rhaphidophora* Hassk.), where the establishment of informal groups has become a standard approach until such time as phylogenetic testing *ca*n be undertaken leading to the establishment of evolutionarily robust groups (see Boyce and Wong, 2008 for commentary on this approach). Other species in the Eburneus Group are *A. julaihii* (Mulu), *A. hottae* Bogner & Hett., and *A. palawanensis* Bogner & Hett. in the Philippines (Palawan). All except *A. hottae* are limestone obligates.

Key to the white-flowered *Amorphophallus* species in Sarawak

1. Petioles turgid, smooth, rachises of fully developed leaf spreading. Spadix appendix smooth, rugulose or echinate but never with hooked staminodes. Plants of limestone 2
1. Petioles not turgid, conspicuously white-warty, rachises of fully developed leaf ascending. Spadix appendix with conspicuous hooked staminodes. Plants of a variety of substrates but never on limestone .... 3. ***A. infundibuliformis***

2. Spadix appendix echinate. Male flowers not fused into longitudinal rows. Spathe limb reflexing during anthesis. C and N.E. Sarawak 3
2. Spadix appendix smooth or weakly rugulose. Male flowers fused into longitudinal rows. Spathe limb remaining erect throughout anthesis. S.W. Sarawak 4

3. Petioles dull pale red with strongly demarcated irregular reddish brown spots and elongated streaks. Opening of lower part of spathe strongly recurving to form a conspicuous collar *ca* 1cm wide during anthesis, spathe limb margins recurving markedly. Spadix appendix stongly echinate. Merirai .... 4. ***A. juliae***
3. Petioles pale to medium green, concolorous or very occasionally with obscure paler green circles. Opening lower part of spathe not or only minutely recurved, spathe limb incurved or planate, margins not recurving. Gua Niah .... 5. ***A. niahensis***

4. Petiole to 120 cm, long relative to the lamina diameter; lamina little divided, leaflets to 60 cm long, never petiolulate; cataphylls greyish brown. Ovaries densely congested, dark purple, stigma diameter equalling ovary. Padawan limestones .... 2. ***A. eburneus***
4. Petiole to 50 cm, very short relative to the lamina diameter; lamina much divided, leaflets to 35 cm long, terminal leaflets petiolulate; cataphylls off white. Ovaries distant, pale purple, stigma diameter distinctly smaller than ovary. Bau limestones .... 1. ***A. brachyphyllus***

1. ***Amorphophallus brachyphyllus*** Hett., Blumea 46(2): 258 (2001). – **Type:** Malaysia, Sarawak, Kuching, Division, Bau district, exact locality unknown, (described from plant cultivated in Hortus Botanicus, Leiden); orig. coll. *P. Kessler EVK 246 sub. Hetterscheid H.AM.032C-T* (holo, L, spirit coll.). **Fig. 1.**

Medium-sized, robust aseasonally dormant geophytic **herb** to 90 cm. **Tuber** depressed globose, not offsetting, with irregular raised areas, to 32 cm diam. ×15 cm high, surface with a grey, corky layer. **Leaf** solitary; petiole short, to 50 × 5 cm diam., uniformly green, very turgid; lamina to 188 cm diam., highly dissected, rachises naked; **leaflets** elliptic-lanceolate, to 35 ×11 cm, those on the most proximal parts of the rachises petiolulate, upper surface mid-green, slightly glossy or dull, slightly coriaceous. **Inflorescence** solitary, rarely two together, short pedunculate; cataphylls off-white; peduncle 8-13 ×1- 2.2 cm diam., entirely subterranean, white with a faint greenish flush, smooth, very tightly enveloped by the *ca*taphylls; **spathe** erect, suborbicular, often broader than long, 10-13.5 ×11.5-16 cm diam., limb obliquely spreading at female anthesis, erect at male anthesis, lower part tubular, strongly convolute, largely hidden in cataphylls, spathe exterior off-white, occasionally flushed pale reddish purple on the inside limb margins, interior with base reddish purple, and with scattered small warts, or coarsely grooved, with grooves distinctly verruculate. **Spadix** longer than spathe, stipitate, 13.5-21 cm long; stipe massive, oblique, off-white, 0.6-1 × 1.6 cm diam. (base); **female flower zone** 1.5-2.5 cm ×1.5-2.3 cm diam., slightly conic, flowers in vertically separate sinuous chains; **male flower zone** conic, 3-4.5 × 1.1-2.2 cm diam., flowers arranged as female flowers but chains closer together, or partly or entirely fused vertically, sometimes forming vertical chains; appendix fusiform, 8-14 × 1.2-2.8 cm diam., slightly laterally compressed, subacute, yellowish white, surface rugulose and with narrow, shallow grooves, producing a strong smell of fried fish and oozing out droplets at female anthesis. Pistil (**female flower**) with an ovate or slightly depressed ovary, 2-3 mm diam. × 2.5-3 mm high, base off-white, top dirty reddish brown, unilocular, one basal ovule; style excentrically placed, consisting of three acute branches, two acroscopic small ones and one basiscopic longer one, pale dirty reddish brown, *ca* 1.5 mm diam. × 0.3-0.8 mm long; stigma thin, *ca* 1.5 mm diam. × *ca* 0.5 mm high, irregularly, shallowly lobed-sinusoid, surface very pale dirty brownish, verruculate. **Male flower** consisting of *ca* 3 stamens but pattern often obscured by lateral and vertical fusion of flowers; stamens *ca* 1 mm high, × *ca* 1-2 mm diam., often fused with adjacent stamens; filaments *ca* 0.5 mm long, entirely connate; anthers *ca* 0.5 mm long, truncate, often entirely connate, ivory-white; pores apical, rounded, oval or variously elongate, often confluent with adjacent pores in various ways. **Fruit** a very large, elongate, slightly angulate berry, up to 4 × 2 cm, ripening red, 1-seeded. **Seeds** elongate-

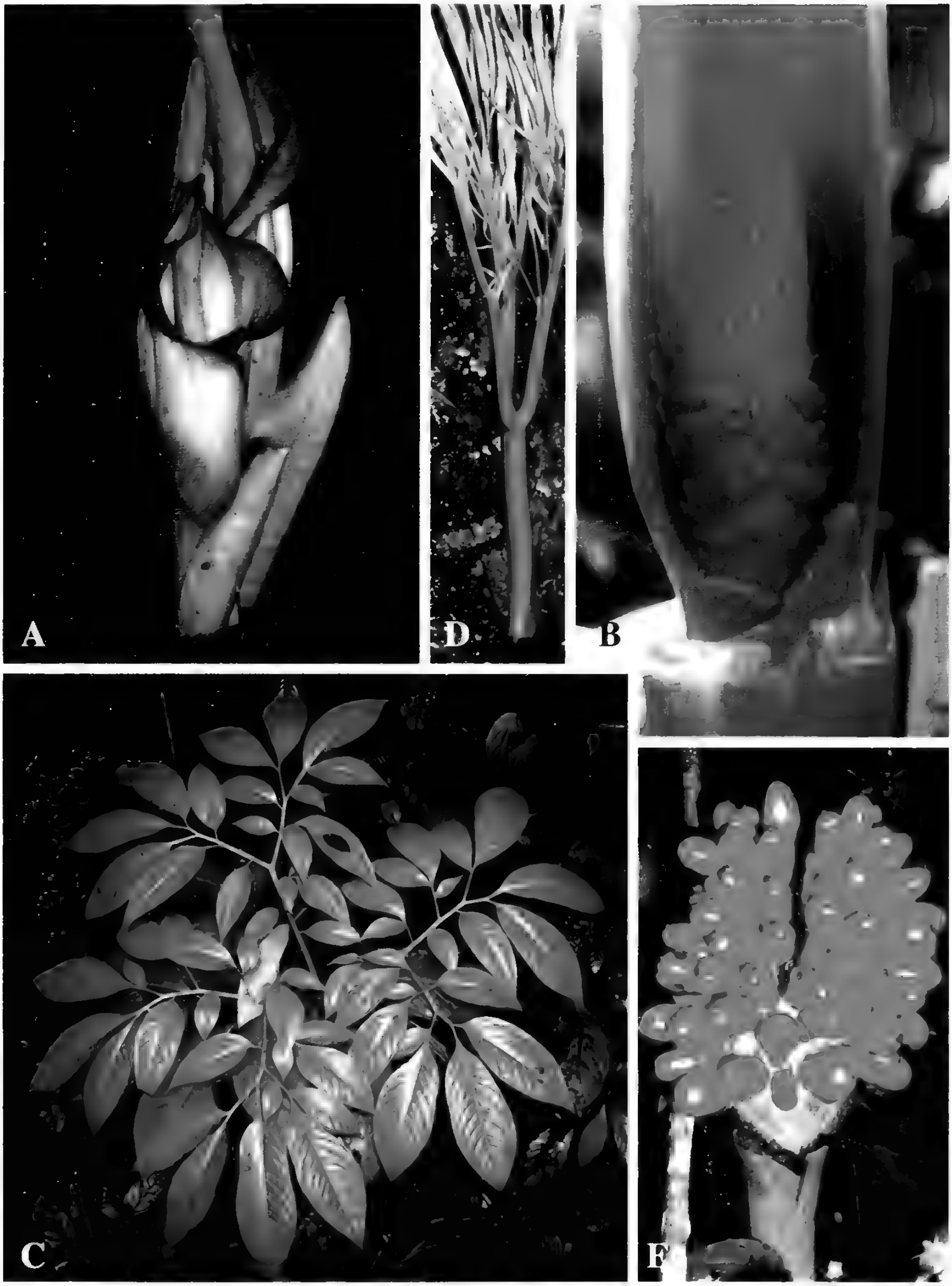

Figure 1. *Amorphophallus brachyphyllus* Hett. A. Flowering plant in habitat, note the erect spathe limb and rugulose spadix appendix; B. Inflorescence with spathe artificially opened. Note the scattered pistils, and the male flowers fused into longitudinal rows; C. Mature leaf. Note the complex lamina division and the distal-most leaflets are petiolate; D. Newly emerging leaf. Note the unmarked, turgid petiole; E. Mature infructescence. [Images: A, C-E © Peter Boyce. Image B © W.L.A. Hetterscheid].

oblongo-conical, *ca* 3 cm × 1.2 cm diam. at the point of germination, 0.7 at the opposite end, skin brownish.

Distribution: East Malaysia, Sarawak, endemic to Karst limestone formations in the Bau area of Kuching Division.

Ecology: On rocky lowland forested limestone slopes under perhumid to everwet evergreen forest, in humus layer or humus-filled pockets, less often in clay at the base of limestone formations, 15-60 m asl.

Notes: *Amorphophallus brachyphyllus* is without doubt closely related to *A. eburneus* and the inflorescences are deceptively similar, although separable by these characters: stigma of *A. brachyphyllus* is half the size of that of *A. eburneus*, while the pistils are much more regularly placed and more congested in *A. eburneus*. In addition to these small but consistent differences there is a marked difference in leaf morphology. In *A. eburneus* the leaf has a long petiole (to 120 cm) relative to the lamina diameter (the reverse in *A. brachyphyllus*). Moreover, the lamina in *A. eburneus* is considerably less strongly divided, with the leaflets distinctly larger (to 60 cm) and never petiolulate. Cataphylls in *A. eburneus* are greyish brown, those in *A. brachyphyllus* off-white. These vegetative differences remain constant, and coupled with geographical separation, and differences in the inflorescence, strongly support the recognition of two discrete but closely related, probably vicariant, taxa. *Amorphophallus niahensis*, described elsewhere in this paper is also in this complex, as too is *A. juliae*.

Etymology: The epithet *brachyphyllus* (Greek: *brachy* - short; *phyllus* - leaf) refers to the very short petiole length relative to the diameter of the lamina.

Other specimens seen: MALAYSIA. Sarawak. **Kuching Division**: Bau, Gua Angin, 5 Jun 1999, *C.C. Lee AM-21.1* (SAR); Bau, Jambusan, 26 May 2004, *P.C. Boyce & Jeland ak Kisai AM-31* (SAR); Bau, Gunung Bidi, 01° 23' 27.0"; 110° 07' 07.6", 7 Dec 2004, *P.C. Boyce & L.Jenkins AM-88* (SAR); Bau, without further locality data: *Hetterscheid H.AM.031A* (L).

2. ***Amorphophallus eburneus*** Bogner, Willdenowia 18: 441 (1989). – **Type:** Malaysia, Sarawak, 'near Padawong, north of Bau' (see notes below), *Bogner* 1772 [described from plant cultivated in Munich Botanical Garden; orig. coll. York Meredith *s.n. sub. Bogner 1772* (holo, M)]. **Fig. 2.**

Medium-sized to large, robust, aseasonally dormant geophytic **herb** to 1.3 m. **Tuber** depressed-globose, not offsetting, to *ca* 35 cm diam. × *ca* 20 cm high,

Figure 2. *Amorphophallus eburneus* Bogner. A. Flowering plant in habitat, note the erect spathe limb and rugulose spadix appendix; B. Inflorescence with spathe artificially opened. Note the scattered pistils, and the male flowers fused into longitudinal rows; C. Mature leaf. Note the simple lamina division and no leaflets are not petiolate; D. Mature leaf, infructescence and seedling. Note the unmarked, turgid petiole; E. Mature infructescence. [Images A-C & E © Peter Boyce. Image D © Art Vogel (used with permission)].

pale greyish brown, skin corky, broken up in numerous, small, angulate fields separated by narrow grooves. **Leaf** solitary; petiole very turgid, to *ca* 120 × *ca* 10 cm diam., smooth, uniformly pale green or occasionally with a few scattered whitish greenish spots; lamina moderately dissected, up to *ca* 240 cm, diam., rhachises winged distally from the basal branches; leaflets elliptic or elliptic-lanceolate, 12-60 cm long, 5.5-21 cm diam., mid or pale green, coriaceous, long acuminate. **Inflorescence** solitary, short pedunculate, largely hidden in cataphylls; cataphylls *ca* 6, lanceolate, pale olive brown to whitish or greenish with pale brownish flushes, largest up to *ca* 35 × 10 cm; peduncle 15-20 × *ca* 2.5 cm diam., pale green, entirely hidden by cataphylls; **spathe** erect, infundibuliform, ovate, base strongly convolute and hidden by cataphylls, separated from limb by a shallow constriction, limb slightly spreading, acute, margins revolute, 20-23 × 19-21 cm, outside creamy white, upper margins sometimes flushed with purple, inside base dark purple and then cream, limb cream with or without a pale purple flush, base within with numerous irregular, shallow warts and some shallow grooves. **Spadix** slightly longer than spathe, shortly stipitate, 21-26 cm long; **female flower zone** slightly conic, 2.5-3 × 2-2.5 cm diam., flowers slightly or variably distant; **male flower zone** cylindric, 4-5 × 1.5-2 cm diam., flowers congested; appendix 14-18 × 1.5-3 cm diam., terete or laterally compressed, acute, cream, turning pale yellowish during male anthesis, surface rugulose and with scattered, short, shallow grooves, producing a smell of fish during female and male anthesis. Pistil (**female flower**) comprised of a depressed pyriform or oblong ovary, 2.5-4 diam.× *ca* 4-5 mm high, uni- or rarely (?) bilocular, top divided in three narrow lobes, base white or pale green, remainder dark purple; stigma thin, strongly sinuous, stellate, ± 2-lobed, partly sunken in between the three lobes emanating from the ovary, surface densely scaberulate, dirty greyish stained with purple, *ca* 1.5-2.5 diam. × *ca* 0.5-1 mm high, ± quadrangular in cross-section. **Male flower** consisting of 4-6 stamens, often elongate parallel to the spadix-axis and connate with upper and/or lower flowers; stamens *ca* 1 mm long × *ca* 1-2 mm diam.; filaments *ca* 0.5 mm long, connate; anthers *ca* 0.5 mm long, free or connate, truncate or subtruncate, pores apical, free or connected within one flower or with other flowers and then irregularly elongate. **Fruit** a berry, very large, elongate, slightly angulate, 4.5 × 2 cm, red, 1-seeded. **Seeds** elongate conical, 3.5 cm long × 1.2 cm diam. at the point of germination, 0.7 at the opposite end, testa brownish.

Distribution: East Malaysia, Sarawak, endemic to Karst limestone formations of Padawan (Kuching Division) and Tebedu (Samarahan Division).

Ecology: Perhumid lowland forested limestone, growing deep in limestone cracks with leaf litter 25- 350 m asl.

Notes: There are two errors in the type locality cited by Bogner (1989). Padawan (Padawong, *sic*) is southeast, not north, of Bau. The limestones of the Padawan area are both geographically and floristically distinct from the Bau limestones and extend down to the Kalimantan border in the direction of Tebedu and Serian (Samarahan Division), with their northern boundary to the east of the Bungo range. *Amorphophallus eburneus* is restricted to these limestones. For differences between *A. eburneus* and *A. brachyphyllus* see under that species.

Etymology: The epithet *eburneus* (Latin: ivory white) is in allusion to the white spathe and spadix.

Other specimens seen: MALAYSIA. Sarawak. **Kuching Division**: Padawan, Gunung Braang, 2 May 2001, *C.C. Lee AM-67.1, AM-67.2* (SAR); Padawan, Bukit Manok, 01° 12'; 110° 18', 18 Mar 2004, *P.C. Boyce AM-67.3* (SAR); Padawan, *Vogel 940011* (L, cult. in Hortus Botanicus, Leiden, *sub. Hetterscheid H.AM.402*); *Vogel 940012* (L, cult. Hortus Botanicus, Leiden, *sub. Hetterscheid H.AM.394*); *Vogel 970618* (L, cult. Hortus Botanicus, Leiden, *sub. Hetterscheid H.AM.893*); Padawan, Gunung Penrissen, *Vogel s.n.* (L, cult. Hortus Botanicus, Leiden, *sub. Hetterscheid H.AM.311*). **Samarahan Division**: Serian, Pichin, Umon Murut, Tiab Belanting, 01° 08' 03.7"; 110° 27' 00.3", 15 Jun 2005, *P.C. Boyce s.n.* (image record SAR); Serian, Mongkos, Kampung Batuh, Gunung Selabur, 00°57' 26.2"; 110° 30' 15.8", 15 Mar 2006, *P.C. Boyce s.n.* (image record SAR);

3. ***Amorphophallus infundibuliformis*** Hett., A.Dearden & A.Vogel, Blumea 39(1-2): 259 (1994). – **Type:** Malaysia, Sarawak, Kuching Division, without further locality, 1990, *Dearden s.n.* (holo, L). **Fig. 3.**

Medium-sized, slender, aseasonally dormant geophytic **herb** to 1.3 m. **Tuber** depressed-globose to subglobose, pinkish externally, internally deep red, without offset development. **Leaf** solitary; petiole, pale grey-green to dark green to dark green-purple, with dirty whitish with numerous, confluent, irregular, green spots and scattered white punctiform dots and patches, these more or less raised; lamina weakly dissected, up to 35 cm diam., thinly coriaceous, adaxial surface deep, sometimes weakly metallic, glossy green, abaxial surface paler, rachises naked, ascending, very shallowly and narrowly canaliculate, greyish-green with irregular dark green patches; leaflets lanceolate, margin with numerous small undulations, main veins impressed, 2-11 × 2-5 cm, shortly petiolulate, petiolule 0.2-1 mm long, very slightly canaliculate adaxially, lowermost pair of leaflets symmetrical, all others asymmetrical and obliquely inserted on petiolule, apex shortly acuminate to

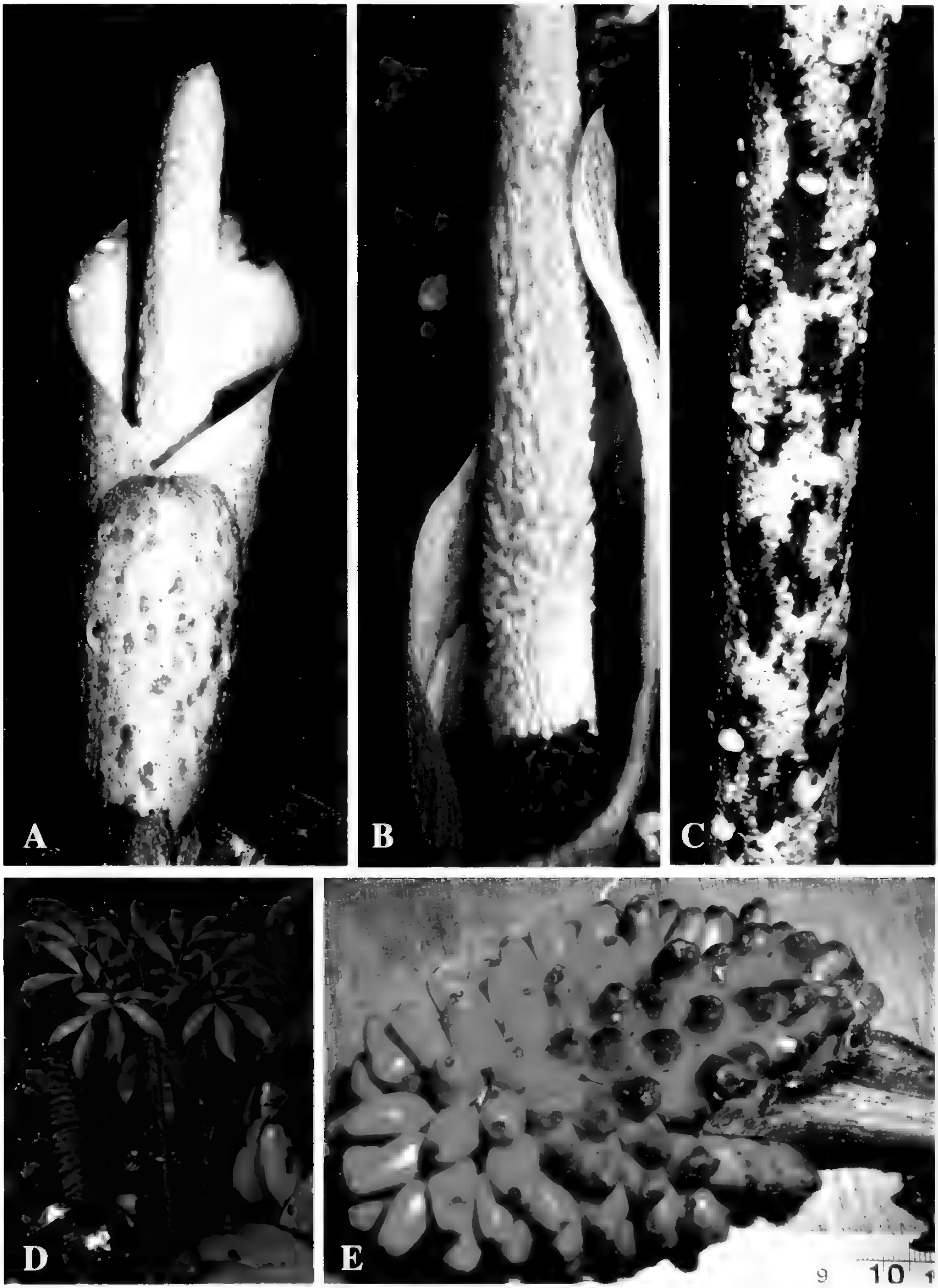

Figure 3. *Amorphophallus infundibuliformis* Hett., A.Dearden & A.Vogel. A. Flowering plant in habitat, note the funnel-form erect spathe; B. Inflorescence with spathe artificially opened. Note hooked staminodes covering much of the spadix appendix; C. Detail of petiole to show the diagnostic raised white warts; D. Mature leaf. Note ascending rachises; E. Mature infructescence. [Images A-E © Peter Boyce].

long acuminate, up to 1.5 long; margins of larger leaflets very slightly sinuate; 5-8 pairs of primary lateral veins, venation forming distinct submarginal veins; interprimary veins much less defined, secondary veins forming a weak reticulum. **Inflorescence** solitary, short pedunculate; cataphylls whitish with numerous small, pinkish dots and many larger, blackish green, irregular spots; peduncle 4 cm × *ca* 0.8 cm diam. (base), lengthening in fruit; **spathe** strongly convolute, funnel-form, obconic in side-view, transversely orbicular-elliptic, 6 × *ca* 8 cm diam., very widely acute, limb and base poorly differentiated, outside dirty whitish with pale brownish venation and scattered, small, angulate, blackish green spots, inside whitish, the lower half dark maroon, base within strongly, longitudinally ridged. **Spadix** sessile, very obliquely inserted, slightly longer than spathe; **female flower zone** oblique, annuliform, 1 mm (dorsal side)-5 mm (ventral side) long × *ca* 1 cm diam., flowers congested; **male flower zone** cylindric, base oblique, 0.8-1.3 cm *ca* 1 cm × diam., flowers congested; appendix cylindric, obtuse, whitish, 6.5 × 1 cm diam., entirely or at least almost entirely, densely covered with hooked staminodes, these in the lower third shortly conical to aristate, sometimes uncinate and with long, narrowly decurrent, ridge-like bases, upwards shorter or reduced to only the base, up to 2 mm long, bases longitudinally confluent. Pistil (**female flower**) with ovaries depressed, irregular or cubic, angulate in cross-section, 0.9-1.5 × 1.2-1.5 mm, reddish brown, near the style insertion maroon, unilocular; style absent or only basiscopically developed; stigma sessile or partly sessile, acroscopically orientated, reniform, a shallow depression in the middle, one conic lobe on the outward facing margin, 0.8-1 mm × 0.3-0.5 mm high, dark greyish brown, surface densely verruculate. **Male flower** upwards fused into longitudinal chains, otherwise consisting of 3-5 stamens, upper flowers confluent with the lowermost staminodial ridges; stamens *ca* 1-1.3 × *ca* 0.7 mm long, rounded, oval or irregular in cross-section, white; filaments absent or nearly so, entirely connate; anthers truncate; pores apical, rounded or elongate (confluent). **Infructescence** with few to rather many berries, irregular; berries elongate, *ca* 2 × 0.75 cm, slightly conic, top truncate, orange-red, one-seeded. **Seed** elongate ellipsoid, *ca* 1.8 × 0.5 cm, testa pale brown.

Distribution: East Malaysia, Sarawak (Kuching, Sri Aman & Kapit Divisions but probably throughout the state and overlooked); Indonesia, Kalimantan Barat.

Ecology: Perhumid to everwet lowland mixed dipterocarp to upper hill forest, mainly on sandstones, occasionally on shale, rarely on raised podzols, 50-875 m asl.

Notes: *Amorphophallus infundibuliformis* cannot be mistaken for any other species in the genus in Sarawak by virtue of the spadix appendix with hooked staminodes. The petiole, with ascending rachices and intricately ornamented with dark patches and conspicuous raised, white warty areas is approached by that of *A. ranchanensis*, in which the raised areas are scutteliform and pale grey-green. The inflorescences of *A. infundibuliformis* and *A. ranchanensis* are profoundly dissimilar.

Etymology: The specific epithet is from the Latin for funnel-shaped, referring to the shape of the spathe.

Other specimens seen: MALAYSIA. Sarawak: **Kuching Division:** Lundu, Gunung Gading, 01° 42'; 109° 50', 3 Mar 2004, *P.C. Boyce & Jeland ak Kisai* AM-3 (SAR); Bau, Segong, Sungai Adis, 11 Mar 2004, *P.C. Boyce & Jeland ak Kisai AM-4.1*(SAR); Bau, Kampung Jugan, 26 Mar 2004, *P.C. Boyce & Jeland ak Kisai AM-4.2* (SAR); 22 May 2004, *P.C. Boyce, Jeland ak Kisai & Jipom ak Tisai AM-33* (SAR); Padawan, Puncak Borneo, trail behind Malesiana Tropicals Nursery to Hornbill Resort golf course maintenance kampong, 01° 07' 35.1"; 110° 13' 28.8", 10 Jun 2004, *P.C. Boyce & Jeland ak Kisai AM-36* (SAR); 01° 07' 35.1"; 110° 13' 28.8", 30 Nov 2004, *P.C. Boyce AM-87* (SAR); Sematan, Teluk Selabang Ulu Sungai, Selabang, 8 Oct 2004, *P.C. Boyce & Jipom ak Tisai AM-81* (SAR); Bau, Gunung Noka, 11 Oct 2004, *P.C. Boyce & Jeland ak Kisai AM-84* (SAR); Lundu, Brungea, 8 Jan 2005, *P.C.Boyce & Jipom ak Tisai AM- 92* (SAR); Bau, Kampung Duyoh, Sungai Duyoh, 01° 20' 45.6"; 110° 02' 36.9", 8 Jun 2005, *P.C. Boyce & Jeland ak Kisai AM- 95* (SAR); Matang, Kubah N.P., Waterfall Trail, 7 Mar 2009, *P.C. Boyce* (SAR, image record). **Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, 01° 12' 02.3"; 112° 03' 09.3", 27 Jul 2004, *P.C.Boyce, Jeland ak Kisai & N.Lembang AM-43* (SAR); Lubok Antu Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 7 Apr 2005, *P.C. Boyce et al.* AM-94 (SAR); Sri Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Wong Ensalai, 01° 11' 51.0"; 112° 03' 39.9", 26 May 2008, *P.C. Boyce, Wong Sin Yeng & Jipom ak Tisai AM-200* (SAR). **Kapit Division:** Kapit, Taman Rekreasi Sebabai, 01° 56' 45.6"; 112° 54' 16.8", 13 Dec 2004, *P.C. Boyce, Jeland ak Kisai & M. Gibernau AM-89* (SAR). INDONESIA. **Kalimantan**: Kalimantan Barat, Semeng, *Sizemore 960031* (L, image record).

4. ***Amorphophallus juliae*** P.C. Boyce & Hett., *sp. nov.*
Ab omnibus speciebus in habitu calcicola lithophytica Borneensibus borealis combinatio appendice spadicis echinatis et petiolorum foliis pallide rubro et valde brunneis maculatis distinguitur; ab A. niahensis *spathae lamina marginem valde revolutis et reflexis et appendice spadicis profunde echinatis differt.* – **Type:** Sarawak, Kapit Division, Belaga District, Bukit Merirai, path

to Gua Tiang & Gua Spring, 2° 46' 07" N; 113° 38' 58" E, 6 Jul 2005, *P. Leong, R. Kiew, S. Julia et al.* PL 135 (Holotypus, SAR; isotypus, SING.). **Fig. 4.**

Medium-sized, moderately robust, aseasonally dormant geophytic **herb** to 1.2 m tall. **Tuber** depressed globose, with irregular slightly raised areas, up to 7 cm diam., 4 cm high, surface pale brown, interior white. **Leaf** solitary, petiole proportionately short compared to the lamina diameter; petiole up to 35 cm long, *ca* 2 cm diameter at base, moderately turgid, cylindrical, smooth, uniform dull pale red with strongly demarcated irregular reddish brown spots and elongated streaks, subtended by 2-3 marcescent cataphylls, these extending *ca* 1/3rd the length of the petiole; lamina moderately dissected, up to 55 cm diam., thinly coriaceous, adaxial surface mid green, abaxial surface paler, rachises naked, narrowly canaliculate, pale pinkish green; leaflets elliptic-lanceolate, 2-13 × 2-5 cm, more-or-less sessile, lowermost pair of leaflets symmetrical, all others asymmetrical and obliquely inserted or rhachis, apex shortly acuminate to 1.5 long; margins of larger leaflets very slightly sinuate; 5-7 pairs of primary lateral veins, these adaxially flush to slightly impressed, abaxially very slightly raised; venation forming distinct submarginal veins; interprimary veins less defined, secondary veins forming a weak reticulum. **Inflorescence** solitary, occasionally two together, flowering before emergence of foliage leaves but in any one colony mature plants at all stages of growth (emerging leaves to ripe infructescences) present simultaneously; peduncle and lower part of spathe encased in sub-fleshy cataphylls; peduncle cylindrical, up to 13 cm long, 5-6 mm diam., pale green, pinkish where exposed to light; cataphylls several per inflorescence; elongate-ovate to linear, 2-15 cm × 1.5 -3.5 cm, pale greenish white, sub fleshy at anthesis, then soon withering and then decaying, drying mid brown. **Spathe** broadly oblong-ovate, funnel-form, up to 9 cm long × 3 cm wide (fresh), pressed material up to 7 cm diam.; spathe limb accounting for *ca* 1/3 or less of the spathe length, margins recurved at anthesis and at first somewhat conspicuously green-veined; interior white, smooth, somewhat glossy, exterior very pale greenish white to white; lower spathe convolute and much inflated at anthesis, 2-7 cm long, interior muricate-verrucate, deep reddish purple, exterior pale greenish white, sometimes slightly pink-tinged, the margins recurving to form a conspicuous collar *ca* 1cm wide, this somewhat glossy and frequently tinged and veined pale green at anthesis. **Spadix** exceeding spathe, 9-12 cm long. Appendix up to 11 cm long, slender elongate-fusiform, *ca* 9 mm diam. (fresh), *ca* 4 mm diam, (dried), white to dull cream, very pronounced-echinate, producing a mild odour of rotten fish during anthesis. Flowers unisexual; **male flower zone** weakly fusiform-cylindrical, up to 3 cm × 6 mm diam., cream; stamens *ca* 1 mm long, *ca* 0.5 mm broad across, pores paired, mostly solitary, the reduction in pore

Figure 4. *Amorphophallus juliae* P.C.Boyce & Hett. A-B. Flowering plants in habitat, note the strongly echinate spadix appendix, the recurved lower spathe margins and recurved spathe limb; C. Mature leaf; D. Emerging leaf. Note the conspicuous petiole markings; E. Mature infructescence. [Images A-C, E © Julia anak Sang (used with permission). Image D © Peter Boyce].

number proceeding upwards towards the appendix, pollen pale yellow. **Female flower zone** cylindrical, contiguous with the maleflower zone, *ca* 4.5-7 × *ca* 7 mm diam.; **male flowers** dense, not arranged in longitudinal rows; pistils (**female flowers**) few, densely arranged, ovaries compressed globose, *ca* 1.5 × 1.5 mm, dark purple, mostly bilocular; stigma sessile, conspicuously three lobed. **Infructescence** with up to 50 berries, peduncle up to 18 cm long, but mostly buries, *ca* 7 mm diam. at base, 9 mm diam. at apex, with a dark brown V-shaped scar from the marcescent spathe. ***Fruit*** an ellipsoid berry 15-21mm × 8-10 mm, apex rounded, with conspicuous impressed blackish stigma remnants, one seeded, deep orange at maturity. **Seeds** ellipsoid, 12-17 mm × 7-8.2 mm wide, testa smooth, thin, yellowish green.

Distribution: Endemic to Sarawak, so far recorded only from Bukit Merirai, Belaga, Kapit Division.

Ecology: Lowland limestone forest, shady areas in humus-filled fissures and holes in limestone, *ca* 60 m asl.

Notes: By the leaf with a proportionately short petiole compared with the leaf lamina diameter, and in bearing numerous small leaflets *Amorphophallus juliae* is vegetatively most similar *A. brachyphyllus* and *A. niahensis*. From both, *A. juliae* differs in the pale reddish petioles with large darker reddish brown spots (*vs* pale to medium green, concolorous or very occasionally with obscure paler green circles in *A.brachyphyllus* and *A. niahensis*).

The male flowers not fused into longitudinal rows, the subentire to weakly bilobed stigma and echinate spadix appendix resemble those of *A. niahensis*, although the echinate texture is markedly more pronounced in *A. juliae*. *Amorphophallus juliae* is readily distinguished from *A. niahensis* by the opening of the lower part of spathe strongly recurving to form a conspicuous collar *ca* 1cm wide during anthesis (margins not or only minutely recurved in *A. niahensis*) and spathe limb margins recurving very markedly.

Amorphophallus juliae is most readily distinguished from *A. brachyphyllus* by the male flowers not fused into longitudinal rows, the densely arranged pistils, the proportionately shorter spathe limb (comprising *ca* 1/3 or less of the entire spathe *vs* ½ or more of entire spathe), and the spathe limb reflexing at male anthesis (vs. spathe limb erect throughout anthesis), and subentire to weakly trilobed stigma (versus deeply bi-trilobed).

Etymology: Named for Julia anak Sang, a forest botanist from the Forestry Research Department, Sarawak Forestry Corporation, Kuching, and co-collector of the type specimen.

Other specimen seen: MALAYSIA. Sarawak, **Bintulu/Kapit Division** border, Belaga District, Bukit Merirai, trail from Sungai Bekuyat to Gua Naga, 11 July 2005, *P. Leong, R. Kiew, S. Julia et al.* PL 270, (SAR, SING).

5. ***Amorphophallus niahensis*** P.C. Boyce & Hett., *sp. nov.*
Ad A. brachyphyllus *spadix appendice echinatis, floribus masculinus nec in serialis longitudinaliter tectis, stigmate sessile subintegris; spathae anthesin feminibus reflexis, non erectis; ab* A. juliae *petiolorum foliis non pallide rubro et maculatis, spathae lamina marginem nec valde revolutis differt.* – **Type:** Sarawak, Miri Division, Niah Suai District, Gunung Subis, Gua Niah N.P., along plank walk to Niah caves, 21 Aug 2002, *Julaihi L et al.* S 89309 (Holotypus, SAR). **Fig. 5.**

Medium-sized, rather robust, aseasonally dormant geophytic **herb** to 1 m tall. **Tuber** depressed globose, with irregular raised areas, up to 12 cm diam., 6 cm high, surface pale brown, interior white. **Leaf** solitary, petiole proportionately short compared to the lamina diameter; petiole up to 60 cm long, *ca* 2.5 cm diameter at base, moderately turgid, cylindrical, smooth, uniform pale-green with a few obscure paler spots present in some individuals, subtended by 2-3 marcescent cataphylls, these extending *ca* $1/10^{th}$ the length of the petiole; lamina moderately dissected, up to 1 m diam., thinly coriaceous, adaxial surface mid-green, abaxial surface paler, rachises naked except for terminal leaftets long-decurrent, narrowly canaliculate, mid-green; *leaflets* elliptic-lanceolate, 2-15 × 1.5-6 cm, terminal-most petiolulate, petiolule 1-2.5 cm long, narrowly canaliculate adaxially, lowermost pair of leaflets symmetrical, all others asymmetrical and obliquely inserted on petiolule, apex shortly acuminate; 3-9 pairs of primary lateral veins, these slightly impressed adaxially, abaxially slightly raised; venation forming distinct submarginal veins; interprimary veins less well-defined, secondary veins forming a weak reticulum. **Inflorescence** solitary, occasionally two or rarely three together, flowering before emergence of foliage leaves but in any one colony mature plants at all stages of growth (emerging leaves to ripe infructescences) present simultaneously; peduncle and lower part of spathe encased in sub-fleshy cataphylls, peduncle cylindrical, up to 17 cm long ×5-6 mm diam., pale green; cataphylls several per inflorescence; elongate-ovate, 3-16 cm × 1-4 cm, pale greenish white, sub fleshy at anthesis, soon withering and decaying, drying mid brown. **Spathe** broadly oblong-ovate, narrowly funnel-form, up to 9 cm long × 3 cm wide (fresh), pressed material up to 5 cm wide; spathe limb accounting for *ca* 1/3 or less of the spathe length, spathe mouth margins hardly recurved at anthesis and spathe limb margins planate; interior white, smooth, somewhat glossy, exterior very pale greenish white to white; lower spathe convolute and much inflated at anthesis, 2-7 cm long, interior muricate-

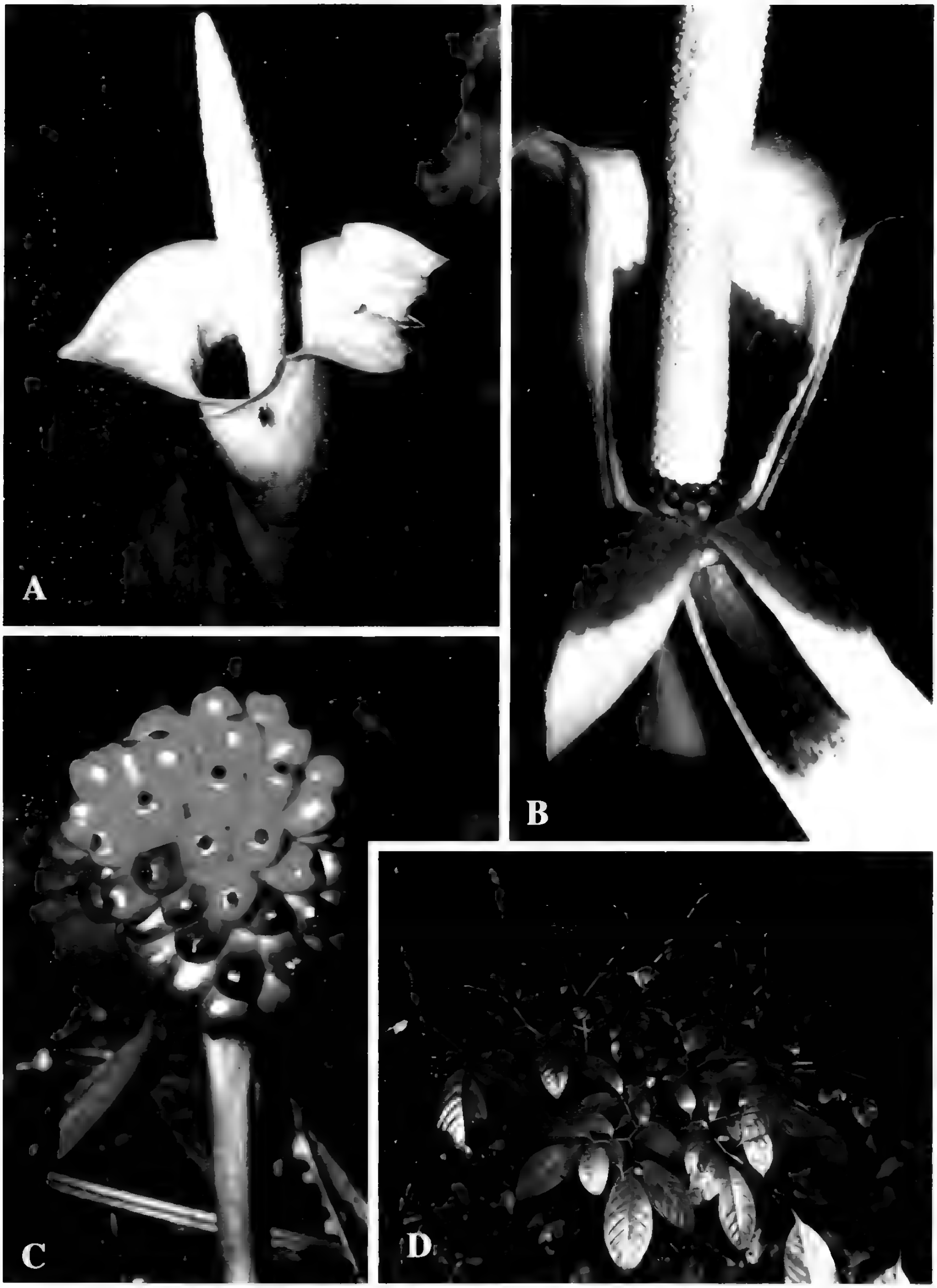

Figure 5. *Amorphophallus mahensis* P.C.Boyce & Hett. A. Flowering plants in habitat, note the echinate spadix appendix and recurved spathe limb; B. Inflorescence with spathe artificially opened. Note the warty lower spathe interior and the male flowers not in fused longitudinal rows; C. Mature infructescence; D. Mature leaf. Note the complex division. [Images A-D © Peter Boyce].

verrucate, deep reddish purple, exterior pale greenish white, sometimes slightly pink-tinged. **Spadix** exceeding spathe, 9-12 cm long. Appendix up to 9 cm long, elongate-fusiform, *ca* 9 mm diam. (fresh), *ca* 4 mm diam, (dried), white, moderately echinate, producing a sharp smell of rotten fish at anthesis. **Flowers** unisexual; **male flower zone** cylindrical, up to 3 cm long, 6 mm diam., cream; stamens *ca* 1 mm long, *ca* 0.5 mm broad across, pores paired, partially fused or solitary, pollen dark yellow. **Female flower zone** shortly cylindrical, contiguous with the male zone, *ca* 4.5-7 mm × *ca* 7 mm diam.; pistils few, densely arranged; ovaries compressed globose, *ca* 1.5 × 1.5 mm, dark purple, mostly bilocular; stigma sessile, three lobed. **Infructescence** with up to 35 berries, pedunculate up to 22 cm long, 6 mm diam. at base, 9 mm diam. at apex, with blackish dark brown V-shaped scar from the marcescent spathe, basally with remains of the *ca*taphylls. **Fruit** ellipsoid 15-16 × 8-10 mm, apex rounded, with blackish stigma remnants, when ripe deep orange, one seeded. **Seeds** ellipsoid, 12-14 mm × 7-8.2 mm wide, testa smooth, thin, yellowish green, seed copiously starchy, embryo small.

Distribution: East Malaysia, Sarawak, so far recorded only from Niah National Park.

Ecology: Limestone forest, growing shady areas in humus-filled fissures and holes in limestone, often on limestone emergent in swampy areas, *ca* 45 m asl.

Notes: *Amorphophallus niahensis is* most similar to *A. brachyphyllus*, especially in the rather short petiole compared to the lamina diameter, but is readily distinguished by the conspicuously echinate spadix appendix, the male flowers not arranged in longitudinal lines, the concolourous deep purple pistils, and the spathe limb reflexing at female anthesis.

Amorphophallus niahensis approaches *A. juliae* in the echinate spadix appendix morphology (although the echinate texture is markedly more pronounced in *A. juliae*), but is readily distinguished by the pale green (not pink) petiole lacking any markings (*vs* reddish-brown spotted) and the spathe limb margins not or only slightly recurving at anthesis.

Curious to note is that in nature the inflorescences very often produce two morphologically normal spathes, set at 180° to one another. Similar observations have been made with *A. eburneus* and *A. brachyphyllus*.

Etymology: The species is named for originating from Gua Niah, to which it is endemic.

Other specimens seen: MALAYSIA. Sarawak, **Miri Division**: Niah Suai District, Niah National Park, Gunung Subis, outside Great cave, 24 Apr 1972, *J.A.R. Anderson* S 31903 (SAR); Niah N.P., trail to Great cave, 03° 49' 09.9"; 113° 46' 52.3", 13 Oct 2005, *P.C. Boyce, Jeland ak Kisai & Jipom ak Tisai* AM-101 (SAR); Niah Suai District, Niah National Park, Madu Trail, 03°48' 57.9"; 113° 46'18.3", 13 Jul 2006, *P.C. Boyce et al. AM-107* (SAR); Subis, Gua Niah N.P., below W mouth of Great cave, 22 Aug 2002, *K. Pearce et al.* S 89487 (SAR); Batu Niah. 113 46 E. 3 49 N, *Vogel 970616* (L, cult. Hortus Botanicus, Leiden, *sub. Hetterscheid H.AM.895*).

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Studies on Homalomeneae (Araceae) of Borneo II: The *Homalomena* of Nanga Sumpa (Batang Ai) – Novel and Pre-existing Taxa, and Notes on Iban Usages

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Abstract

Fieldwork targeting indigenous *Homalomena* at Nanga Sumpa, part of the Batang Ai drainage system (Sri Aman Divison, Sarawak) revealed 14 species of which six are novel and herewith described: *Homalomena atrox* P.C.Boyce, S.Y.Wong & Fasihuddin, *H. clandestina* P.C.Boyce, S.Y.Wong & Fasihuddin, *H. hanneae* P.C.Boyce, S.Y.Wong & Fasihuddin, *H. sengkenyang* P.C.Boyce, S.Y.Wong & Fasihuddin, *H. symplocarpiifolia* P.C.Boyce, S.Y.Wong & Fasihuddin, and *H. vivens* P.C.Boyce, S.Y.Wong & Fasihuddin. Of the six *Homalomena* species present at Batang Ai for which there are pre-existing names, two, *H. borneensis* Ridl. & *H. humilis* (Jack) Hook.f., are species complexes still awaiting a full taxonomic and systematic investigation, and are treated here as morpho-taxa to which we apply the earliest applicable epithet. The remaining four species with available names have only recently been described: *H. geniculata* M.Hotta (1967); *H. vagans* P.C.Boyce (1994), and *H. josefii* P.C.Boyce & S.Y.Wong, and *H. pseudogeniculata* P.C.Boyce & S.Y.Wong (2008). Additionally, two further species located during fieldwork, that while unarguably novel based on their vegetative morphology, were not located as fertile plants and have yet to flower in cultivation; they are here treated as sp. nov. A & B. Of the 14 species present at Batang Ai, five have significance in the ethnobotany of the indigenous Iban people of the Ai drainage, and of these five, four are novel. A key to the *Homalomena* in the Batang Ai drainage area is given, and all species are illustrated.

Introduction

As noted in the first of these papers (Boyce & Wong, 2008), *Homalomena* is the most abundant, speciose and conversely least well understood mesophytic aroid genus in tropical Asia. It is also now becoming the focus for pharmaceutical studies by virtue of the prevalence of uses amongst Malaysian indigenous peoples mainly due to the presence of aromatic compounds in almost all tissues.

That a taxonomic study is urgently required is no better exemplified than by the work of Hanna Christensen (Christensen, 2000) in which five *Homalomena* species are highlighted as having moderate to significant importance as plants utilized by the indigenous Iban community of Nanga Sumpa, Batang Ai, yet four of the five species are scientifically novel. These are among the novelties dealt with here in this preliminary account of *Homalomena* on the Ai drainage system.

Five of the species here newly described, namely, *H. clandestina* P.C.Boyce, S.Y.Wong & Fasihuddin, *H. hanneae* P.C.Boyce, S.Y.Wong & Fasihuddin, *H. sengkenyang* P.C.Boyce, S.Y.Wong & Fasihuddin, *H. symplocarpiifolia* P.C.Boyce, S.Y.Wong & Fasihuddin & *H. vivens* P.C.Boyce, S.Y.Wong & Fasihuddin, belong in the informal Cyrtocladon supergroup, and one, *H. atrox* P.C.Boyce & S.Y.Wong, in the Chamaecladon supergroup (see Boyce & Wong, 2008).

Usage among Iban indigenous people at Nanga Sumpa

Christensen (2000) listed 6 *Homalomena* utilized by the Iban community of Nanga Sumpa, although only one, *H. borneensis* (reported under the synonym *H. ovata* in Christensen, 2000) is identified to species. Four of the *Homalomena* utilized at Nanga Sumpa are known collectively by the Iban as "*kemuyang*"; a fifth (here described as *H. clandestina*) is called "*subung tilan*" , while a sixth species occurs wild with populations near the longhouse artificially managed, here described as *H. sengkenyang*, is called "*sengkenyang bakung*".

The uses of the species known as *kemuyang* are rather generic (see below under each relative species), while *subung tilan* is used soley to flavour dishes such as fish. More interesting is the usages of the semi-managed *Homalomena* known as *sengkenyang bakung*, which is utilized as a protector of rice plants. Plants utilized for *sengkenyang* are enormously important to the Iban as they are believed to protect the rice plants against malevolent spirits and prevent the beneficial rice spirits from leaving the farm. Very few plants have the potential to be appointed to the status of *sengkenyang*.

This species is here described as *Homalomena sengkenyang* (see below).

Key to the *Homalomena* of the Batang Ai drainage

1. Leaf lamina base* truncate, cordate, or sagittate 2
1. Leaf lamina base acute to decurrent 6

2. Leaf base sagittate 3
2. Leaf base truncate or cordate 8

3. Pistils not associated with interpistillar staminodes .... 12. ***H. vivens***
3. Pistils associated with interpistillar staminodes 4

4. Spadix producing copious amber resin droplets at anthesis; pistils apricot .... 5. ***H. hanneae***
4. Spadix not producing resin droplets at anthesis; pistils various colours but never apricot 5

5. Medium plants not exceeding 50 cm tall and often only half this height; pistils bright green; stigma entire .... 9. ***H. sengkenyang***
5. Large plants often exceeding 1 m tall; pistils cream; stigma trisulcate .... 7. ***H. josefii***

6. Leaf lamina oblong, venation deeply impressed adaxially; spathe with a conspicuous dorsal median ridge; female and male flower zones equal in diameter; contiguous .... 10. ***H. symplocarpifolia***
6. Leaf lamina ovate to very weakly ovato-sagittate; venation not impressed; spathe without a ridge; female flower zone exceeding male zone in diameter 7

7. Lamina abaxially glaucous; male flower zone more or less contiguou with the female flower zone, female flower zone stoutly fusiform; pistils densely arranged , not ascending, with stigmas coherent .... 2. ***H. borneensis***
7. Lamina not glaucous abaxially; male flower zone separated from the female flower zone by a brief naked interstice; female flower zone weakly fusiform; pistils somewhat lax, ascending, stigmas not coherent .... 3. ***H. clandestina***

8. Leaves in a strictly distichous arrangement .... 4. ***H. geniculata***
8. Leaves not so arranged 9

9. Diminutive plants, microscopically puberulent, with a velvety or scintillating quality 10
9. Larger plants, without a velvety or scintillating quality 11

10. Leaf lamina oblong-lanceolate to oblanceolate laminae, long-decurrent; spadix sessile, top-most flowers sterile .... 1. ***H. atrox***
10. Leaf lamina oblong-ovato-sagittate, base shallowly cordate; spadix stipitate, fertile to the tip .... 6. ***H. humilis***

11. Facultative rheophytes, lamina l pendent on the petiole, lanceolate-elliptic 11-23.5 × 1.5-6 cm, infructescence with peduncle declinate and spathe ascending .... 11. ***H. vagans***
11. Terrestrial on slopes, lamina spreading, oblongo-lanceolate, sometimes oblongo-elliptic to ovate, 18-33 cm long × 6-15 cm wide .... 8. ***H. pseudogeniculata***

*The leaf shape is based on leaves of mature, preferably flowering, shoots; juvenile *Homalomena* are virtually impossible to identify to species by leaf shape alone.

Taxonomic part

1. ***Homalomena atrox*** P.C.Boyce, S.Y.Wong & Fasihuddin, *sp. nov.*
Ab aliis specibus flumenicolis Borneensibus folliis et petiolis scintillans et spadice sessile cum antheris terminalis sterilis differt. – **Typus:** Malaysia, Sarawak, Sri Aman Division, Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 12' 16.2"; 112° 03' 26.0", 24 May 2008, *P.C.Boyce et al. AR-2375* (holo, SAR, + spirit). **Fig. 1.**

Diminutive, almost odourless evergreen microscopically pubescent **herbs** to *ca* 10 cm tall. **Stem** pleionanthic, erect to decumbent, *ca* 5 mm thick, dull red, internodes to *ca* 3 mm long. **Leaves** up to *ca* 6 together; petiole very shallowly channelled adaxially, rounded abaxially, sub-erect, up to 5 cm long, with a weak articulation *ca* 1/3 way along, microscopically asperate, matte dull reddish, drying dark brown; petiolar sheath to *ca* 3 cm long, over ½ of petiole length, sheath long-persistent, lower clasping part with undulate-bullate margins; lamina oblong-lanceolate to oblanceolate, 8-12 cm long × 2-3 cm wide, thinly and rather softly, glossy mid-green adaxially (fresh), drying pale olive green, abaxially pale and slightly refractive (fresh), drying pale brown, base cuneate-decurrent, posterior lobes absent, lamina tip acute, thence apiculate for *ca* 3.5 mm; midrib prominently rounded-raised abaxially, (fresh and dry), same colour as lamina, adaxially flush with or very slightly sunken into lamina (fresh and dry), *ca* 1.5 mm wide, with *ca* 5 primary lateral veins on each side, diverging at 20°- 30° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), joining a near the margin; interprimary veins *ca* ¾ width of the primary lateral veins, alternating irregularly with primaries, posterior lobes each with 3-4 primary lateral veins; secondary venation rather obscure, striate; tertiary venation not visible, all veins running into a thickened intermarginal vein, this particularly conspicuous at the leaf tip, drying paler than the lamina. **Inflorescences** 1-2 together, erect at anthesis, later declinate; peduncle to *ca* 3 cm long × *ca* 1 mm diam., matte dull red. **Spathe** 1-1.2 cm long, not constricted, matte dull red externally, shiny greenish red internally, with a terminal short mucro (*ca* 0.5 mm long), spathe opening at anthesis by inflation and thence a broad slit; lower spathe and spathe limb not obviously differentiated. **Spadix** 1-1.2 cm long × 0.30-0.35 cm diam., the uppermost portion sterile by the presence of 2-4 sterile male flowers, sessile; **female flower zone** 0.5 mm long; pistils somewhat distant, broadly ovoid, *ca* 1 mm tall × 0.8-0.9 mm diam. greenish whitish, stigma sessile to subsessile, disk-like, 0.3-0.4 mm diam.; each pistil with a single staminode situated on ventral side of the flower relative to the base of the spadix; interpistillar staminodes irregularly clavate, *ca* 0.2 mm long, white; suprapistillar interstice zone very short, less than 0.1 mm, naked, pale pink; **male flower zone** 10-12 mm long, apex acute; **male flowers** broadly dumbbell shaped, each consisting of two stamens, stamens rounded, *ca* 0.5 mm tall, 0.6-0.8 mm long × *ca* 0.4 mm wide, ivory-white, anther thecae opening by a broad terminal slit. **Infructescence** declinate, dull red, peduncle matte dark red. **Fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak, Sri Aman Division – endemic to riverine shales of the Batang Ai drainage system.

Habitat: Riverine forest on red soils overlying shale, plants exclusively on exposed shales, 80-150 m asl.

Notes: *Homalomena atrox* is immediately recognizable by the thinly soft-leathery, oblong-lanceolate to oblanceolate laminae with decurrent bases, and sessile spadix with the terminal portion sterile by the presence of 2-4 sterile flowers. In overall habit is vaguely reminiscent of *H. paucinervia* Ridl. (sandstones, Matang area) but is readily distinguished by the much softer textured leaves not slightly glaucous abaxially.

Homalomena atrox is often sympatric with riverside populations of *H. humilis sensu lat.*, but always grows nearer the water. It appears to be a facultative rheophyte, this view is further supported by the stenophyllous habit.

Uses: No recorded uses among the Iban communities at Batang Ai.

Iban name: None recorded.

Etymology: The specific epithet is from the Latin *atrox* – terrible – in gently chiding allusion to the taxonomic complexity of the Chamaecladon supergroup to which this remarkably distinctive new species belongs.

Other specimens seen: **SARAWAK. Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 11' 40.8"; 112° 04' 04.2", 28 Jul 2004, *P.C.Boyce et al. AR-1115* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2389* (SAR).

2. ***Homalomena borneensis*** Ridl., J. Straits Branch Roy. Asiat. Soc. 44: 173 (1905). – **Typus:** Malaysia, Sarawak, Kuching, *Ridley* s.n. (holo, SING). **Fig. 2.**
Syn: *Homalomena ovata* Engl. *non* (Schott) Hook.f., Fl. Brit. Ind. 6: 536 (1893), *nom. illeg.*, based on Malaysia, Sarawak, Kuching Division, Matang, *Beccari* p.b. 1780.

Medium, rather robust strongly aromatic (mango-resin) evergreen glabrous **herbs** to *ca* 85 cm tall. **Stem** pleionanthic, erect, up to *ca* 3 cm thick, pale green, internodes to *ca* 1.5 cm long. **Leaves** up to *ca* 15 together, *ca* 5 per module; petiole weakly D-shaped in cross section, erect, 15-45 cm long, obscurely pulvinate *ca* ⅔ along length, pulvinus *ca* 2 cm long; petiole bases clasping, pale green, sometimes suffused reddish for the basal ¼, matte, drying medium brown, petiolar sheath *ca* 9-20 cm long, *ca* ⅓ of petiole length, equal, decurrent at apex, margin erect when fresh, margins membranous, pale green, persistent, occasionally slightly scarious on the oldest leaves, these oldest sheathes often red; lamina ovate to very weakly ovato-sagittate, 10-22 cm long × 9-15 cm wide, thinly leathery, pale green adaxially, drying medium olive-brown, abaxially slightly glaucous(fresh), drying glaucous pale brown, base subtruncate to very shallowly cordate, posterior lobes absent or very short, straight, if present the n ovato-triangular, 0.5-3 cm long, tip acute, acuminate for *ca* 1 cm thence tubular-apiculate for *ca* 2-3 mm; midrib raised abaxially (fresh and dry), glaucous green when fresh, adaxially sunken slightly into lamina, *ca* 3 mm wide, with *ca* 7-10 primary lateral veins on each side, diverging at 30°-70° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ¼ width of the primary lateral veins, alternating with primaries; secondary venation very obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein, this often reddish-flushed. **Inflorescences** up to 6 together, erect and smelling of anise at anthesis, thence sinuous-declinate, each subtended by prophyll, to *ca* 10 cm long; peduncle to *ca* 15 cm long × *ca* 3.5 mm diam., pale green. **Spathe** 9-11 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening wide, entire spathe white at anthesis; lower spathe ovoid-ellipsoid, equalling spathe limb, 5-6 cm long, constricted at the junction of the spathe limb, the constriction coinciding with junction of the male and female flower zones; spathe limb ovato-triangular, *ca* 5-6 cm long × ca. 3.5 cm wide (at male anthesis), spathe limb margins recurving at male anthesis, apex mucronate to *ca* 5 mm long. **Spadix** subequalling the spathe, *ca* 9-10.5 cm long, stipitate; stipe *ca* 4 mm long × 3 mm diam., cylindrical, and inserted obliquely on peduncle, white, **female flower zone** *ca* 4.5 cm long × *ca* 1 cm wide, *ca* ½ length of spadix, stoutly fusiform; pistils *ca* 1.3 mm × 0.75 mm, densely arranged, globose-cylindrical, white; stigma globose-capitate, slightly exceeding the ovary and coherent with its neighbours, staining deep brown in alcohol, each pistil associated with one interpistillar staminode; interpistillar staminodes clavate on a stout stipe *ca* 0.4 mm diameter, equalling or slightly overtopping the associated female flower waxy white; suprapistillar interstice zone ± absent; **male flower zone** more-or-less contiguous with female flower zone but markedly narrower, to *ca* 5 cm long, *ca* ½ length of spadix, separated from female zone by the prominently truncate upper part of the latter, with the lowest portion of male flower zone comprised of sterile male flowers intergrading into a single row of staminodes intermixed, this zone separated from the remainder of the male flower zone by a distinct constriction; **male flowers** *ca* 3 mm × 2 mm trapezoid, comprising 3 – 5 truncate stamens, each overtopped by a large, flat connective. **Infructescence** declinate, spathe entirely persistent, pale green, somewhat glaucous, ripening mid-green, less often deep red, peduncle matte medium green. **Fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak, widespread west of the Rejang valley. This species is recorded from scattered localities in Kalimantan Barat, Kalimantan Tengah & west Kalimantan Timur.

Habitat: Ever moist to slightly seasonal evergreen forest on sandstone or shale-derived clays with deep leaf litter. 30-600 m asl.

Notes: The leaf laminae almost always lacking posterior lobes, and pale green, rather matte adaxially and moderately to conspicuously glaucous abaxially are diagnostic throughout Sarawak. The spathe limb shorter than the lower part of the spathe is shared with *H. borneensis*, *H. clandestina*, along with numerous undescribed species.

At Batang Ai *H. borneensis* may be confused with *H. clandestina*, with which it grows intermixed. *Homalomena borneensis* may be distinguished by the male flower zone being contiguous with the female flower zone (not separated by a naked interstice); the female flower zone being far more stoutly fusiform, with much more densely arranged pistils that are not ascending, and with coherent stigmas.

Sterile plants are immediately recognizable by the leaf lamina abaxially glaucous with the primary lateral venation much less pronounced.

Homalomena ovata Engl. non . (Schott) Hook.f., a *nom. illeg.*, based on a specimen from Matang, Kuching, is incontrovertibly the same as *H. borneensis*.

Uses: Used as an antidote to snakebites, scorpion stings, *etc*. The bitten area is kept in the smoke of the burning stems (reported as rhizomes) as long as the patient can stand it. The leaves are used in post-partem *petangas*, a herbal sauna. The rhizomes are also used to treat sick chickens by keeping them in the smoke from burning 'rhizomes' of this and other species. Traditionally burning rhizomes were also used to keep monkeys away from fields. The aromatic rhizome is used in perfume mixtures. The ripe fruit is edible, with a sourish taste.

Iban name: Kemuyang.

Etymology: "*Borneo + ensis*", referring to origins on the Sunda shelf island of Borneo.

Other specimens seen: **SARAWAK. Kuching Division:** Bau, Kampung Segong, Sungai Adis, 11 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-5.4* (SAR); Bau, Kampung Segong, Ulu Sungai Adis, Sungai Bronand, 4 May 2004, *Jeland ak Kisai & Jipom ak Tisai* AR-45 (SAR); Matang, Maha Mariamman Temple, trail to Indian Temple, 2 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-227* (SAR); Bau, Kampung Jugan, 26 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-275* (SAR); Bau, Rieng Opui, 28 May 2004, *Jeland ak Kisai & Jipom ak Tisai AR-406* (SAR); Bau, Kampung Segong, Ulu Sungai Adis, 9 May 2004, *Jeland ak Kisai & Jipom ak Tisai AR-411.1* (SAR); Padawan, Subang, 7 Dec 2004, *M.Gibernau AR-830* (SAR); Krokong, Kampung Tringgus, 01° 15' 40.2"; 110° 05' 35.9", 19 Feb 2005, *P.C.Boyce et al. AR-991* (SAR); Bau, Kampung Segong, 01° 32' 00.9"; 110° 08' 58.8", 10 Aug-05, *P.C.Boyce et al. AR-1330* (SAR); Bau, Gunung Juita, 01° 23' 48.7"; 110° 08' 07.2", 28 Oct 2005, *P.C.Boyce et al. AR-1497* (SAR); Padawan, Kampung Tubih, Labak Payang, 25 Jan 2006, *Simon Kutuh ak Paru AR-1674* (SAR); Matang, Kubah National Park, Waterfall Trail, 01°35' 40.2"; 110° 10'45.9", 28 July 2007, *P.C.Boyce et al. AR-2112* (SAR); Bau, Bongo Range, trail to Tegora Mine, 01° 19' 41.5"; 110° 09' 19.0", 8 Sep 2007, P.*C.Boyce et al.* AR-2190 (SAR). **Samarahan Division:** Serian, Gunung Ampungan, 01° 09' 08.2"; 110° 37' 21.2", 11 Nov 2003, *P.C.Boyce & Jeland ak Kisai AR-5.2* (SAR), *AR-158* (SAR); Serian, Pichin, Umon Murut, Tiab Belanting, 01° 08' 03.7"; 110° 27' 00.3", 20 Aug 2004, *Simon Kutuh ak Paru AR-653* (SAR); *AR-654* (SAR); Serian, Pichin, Bung Biringan, 28 Oct 2004, *Simon Kutuh ak Paru AR-736* (SAR); Serian, Pichin, Gunung Kedadum, Sugun Kerang, 13 Nov 2004, *Simon Kutuh ak Paru AR-743* (SAR); Serian, Pichin, Utak Dibung, 8 Mar 05, *Simon Kutuh ak Paru AR-1022* (SAR); Serian, Pichin, Sungai Abu Sijo, 19 Mar 2005, *Simon Kutuh ak Paru AR-1110* (SAR); Serian, Pichin, Labak Singong, 8 Mar 2005, *Simon Kutuh ak Paru AR-1023* (SAR); Kuap, Pangkalan Kuap, 01° 26' 16.7"; 110° 22' 18.9", 25 Oct 2005, *P.C.Boyce et al. AR-1486* (SAR). **Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, 01° 12' 02.3"; 112° 03' 09.3", 27 Jul 2004, *P.C.Boyce et al. AR-544* (SAR); *AR-546* (SAR); Serian, Pichin, Kampung Bidak, 6 Mar 2006, *Simon Kutuh ak Paru AR-1718* (SAR); Serian, Pichin, Pakan Jilayau, 1 Apr 2006, *Simon Kutuh ak Paru AR-1758* (SAR); *AR-1800* (SAR); Serian, Pichin, Sungai Jarak, 25 Apr 2006, *Simon Kutuh ak Paru AR-1805* (SAR). Sarikei: Pakan, Binatang, Ulu Binatang, 02° 02' 30.1"; 111° 43' 34.4", 6 Dec 2005, *P.C.Boyce et al. AR-1571* (SAR); *AR-1572* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 12' 16.2"; 112° 03' 26.0", 24 May 2008, *P.C.Boyce et al. AR-2361* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2386* (SAR).

3. ***Homalomena clandestina*** P.C.Boyce, S.Y.Wong & Fasihuddin, *sp. nov.* *Ab* H. borneensis *sed foliis foliis subtus non glaucis, venis lateralibus primariis abaxialiter plus prominentis, inflorescentia femina ab inforescentia mascula interstitio neutro separatus, pistillis sublaxis ascendens et stigmate non confluentibus distinguenda.* –**Typus:** Malaysia, Sarawak, Sri Aman Division, Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2385* (holo, SAR, + spirit). **Fig. 3.**

Medium, strongly aromatic (bitter lime (limau-purut) peel) evergreen glabrous **herbs** to *ca* 75 cm tall. **Stem** pleionanthic, erect to ascending, *ca* 2.5 cm thick, medium green, internodes to *ca* 1 cm long. **Leaves** up to *ca* 10 together, *ca* 3-5 per module; petiole terete, erect, 30-32 cm long, obscurely pulvinate *ca* ⅔ along length, pulvinus *ca* 2 cm long; petiole bases clasping, petioles medium green, sometimes suffused reddish for the basal ¼, semi-glossy, drying dark brown; petiolar sheath *ca* 11-13 cm long, *ca* ⅓ of petiole length, equal, decurrent at apex, margin erect when fresh, margins persistent; lamina narrowly weakly ovato-sagittate, 16-20 cm long × 9-11 cm wide, thinly leathery, glossy dark green adaxially (fresh), drying medium olive-brown, abaxially pale green (fresh), drying medium brown, base shallowly cordate, posterior lobes short, straight, ovato-triangular, 1-3 cm long, apex acute, acuminate for *ca* 2 cm, thence tubular-apiculate for *ca* 2-3 mm; midrib raised abaxially (fresh and dry), green when fresh, drying reddish brown, adaxially sunken slightly into lamina, *ca* 2 mm wide, with *ca* 7-11 primary lateral veins on each side, diverging at 30°-80° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating irregularly with primaries; secondary venation very obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences** up to 4 together, erect and smelling of anise at anthesis, thence declinate, each subtended by prophyll, to *ca* 14 cm long that soon degrades into fibres, peduncle to *ca* 18 cm long × *ca* 2.5 mm diam., medium green. ***Spathe*** 9-10 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening wide, entire spathe white at anthesis; lower spathe ovoid-ellipsoid, 5-6 cm long, moderately constricted at the junction of the spathe limb, the constriction coinciding with junction of the male and female flower zones; spathe limb narrowly ovato-triangular, *ca* 5-6.5 cm long × ca. 2 cm wide (at male anthesis), limb margins recurving at male anthesis, apex mucronate to *ca* 5 mm long. **Spadix** subequalling the spathe, *ca* 8.5-9.5 cm long, stipitate; stipe *ca* 3 mm long × 2 mm diam., cylindrical, and inserted obliquely on peduncle, white; **female flower zone** *ca* 4 cm long × *ca* 1 cm wide, *ca* ½ length of spadix, weakly fusiform; pistils *ca* 1.3 mm × 0.75 mm, somewhat laxly arranged, globose-cylindric, directed upwards, white; stigma globose-capitate, slightly exceeding the ovary, dirty grey in nature, staining paler brown than ovary in alcohol, each pistil associated with one interpistillar staminode; interpistillar staminodes clavate on a very slender stipe *ca* 0.4 mm diameter, equalling or slightly overtopping the associated female flower, waxy white, suprapistillar interstice zone to *ca* 2 mm long × 2 mm wide, lower part with scattered pistils, these seemingly sterile (ovary slender cylindrical) and intermixed with a single row, and a few scattered staminodes each comprising a single or rarely 2 anthers, upper part of interstice naked; **male flower zone** to *ca* 5 cm long, *ca* ⅔ length of spadix, separated from naked part of interstice by a prominently truncate lower part, with the lowest portion comprised of fertile male flowers intergrading into a single row of staminodes intermixed with one to several pistils, lowermost flowers fertile male, this lower part separated from the remainder by a weak constriction; **male flowers** *ca* 3 mm × 2 mm trapezoid, comprising 3 – 5 truncate stamens, each overtopped by a large, flat connective. **Infructescence** declinate, reddish, peduncle matte dark green. **Fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak, Sri Aman Division – endemic & known only from the type.

Habitat: Terrestrial on shales in evermoist forest, 80 m asl.

Notes: Sterile plants resemble the widespread and abundant *H. borneensis* but are readily identifiable by the abaxial venation much more prominent, and the leaf laminae not abaxially glaucous. The spadix with a naked interstice, longer (*ca* $^2/_3$ spadix length) male flower zone truncate proximally with the lowermost male flowers intermixed with pistillodes, and the weakly fusiform female flower zone with somewhat laxly arranged pistils are diagnostic.

Uses: The sour-tasting leaves of *Homalomena clandestina* are utilized at as flavouring, especially for fish.

Iban name: Subung tilan (Christensen, 2002: 283)

Etymology: From the Latin, *cladestinus*, hidden, in allusion to the fact that the authors initially overlooked this species due to its overall similarity to sympatric *H. borneensis*.

Other specimen seen: **SARAWAK. Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 7 Apr 2005, *P.C.Boyce et al. AR-1160* (SAR).

4. ***Homalomena geniculata*** M.Hotta, Acta Phytotax. Geobot. 22: 155 (1967). –**Typus:** Malaysia, Sarawak, Bintulu Division, vicinity of Minah camp, *Hotta 15779* (holo, KYO!). **Fig. 4.**

Small, aromatic (mango/resin) evergreen glabrous solitary, rarely weakly clustering **herbs** to *ca* 35 cm tall. **Stem** pleionanthic, initially erect but soon spreading-decumbent with the active shoot tip weakly ascending, *ca* 1.5 cm thick, medium green, internodes to *ca* 1 cm long. **Leaves** up to *ca* 20 together, *ca* 3-5 per module but exact number obscured by the tightly distichous leaf bases; petiole terete, spreading, 5-22 cm long, strongly pulvinate at the lamina insertion, pulvinus *ca* 1-1.5 cm long; petiole bases distichous-clasping, petioles medium green, sometimes suffused brownish-reddish basal, matte, petiolar sheath *ca* 2-12 cm long, *ca* ½ of petiole length, decurrent at apex, margin erect when fresh, persistent; lamina narrowly oblanceolate, 10-30 cm long × 2.5-7 cm wide, chartaceous, matte medium green adaxially (fresh), drying olive-brown, abaxially glaucous (fresh), drying glaucous-brownish, base acute, tip acute, acuminate for *ca* 2 cm thence tubular-apiculate for *ca* 3 mm; midrib raised abaxially (fresh and dry), adaxially sunken slightly into lamina, *ca* 1.5 mm wide, with ca. 5-11 primary lateral veins on each side, diverging at 30°-70° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating regularly with primaries; secondary venation obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences** solitary, erect and smelling powerfully of anise at anthesis, declinate beneath the leaf fan soon after anthesis and there remaining until fruit dispersal, thence decomposing, subtended by a prophyll to *ca* 5 cm long, peduncle to7-12 cm long × *ca* 2 mm diam., medium green. **Spathe** 7-8.5 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening wide, entire spathe white at anthesis; lower spathe ovoid-ellipsoid, 2.5-3 cm long, constricted at the junction of the spathe limb, the constriction coinciding with junction of the male and female flower zones; spathe limb narrowly ovato-triangular, *ca* 2-3 cm long × ca. 2 cm wide (at male anthesis), apex mucronate to *ca* 1.5 cm long. **Spadix** subequalling the spathe, *ca* 6-7 cm long, stipitate; stipe *ca* 3 mm long × 2 mm diam., cylindrical, inserted obliquely on peduncle, pale green; **female flower zone** *ca* 1.5-2.5 cm long × *ca* 0.5 cm wide, *ca* 1/3 length of spadix, fusiform; pistils *ca* 1.3 mm × 0.75 mm, without interpistillar staminodes, very densely arranged, cylindrical-globose; stigma discoid, slightly exceeding the ovary and coherent with adjacent stigmas; suprapistillar interstice zone to *ca* 4 mm long × 1.5 mm wide, entirely clothed with staminodes comprising 2 anthers and these intergrading with fertile stamens; **male flower zone** to *ca* 2.5-2.8 cm long, *ca* ½ length of spadix, the lowest portion comprised of fertile male flowers intergrading into a few rows of staminodes intermixed; **male flowers** *ca* 3 mm × 2 mm trapezoid, comprising 2-4 truncate stamens, each overtopped by a large, flat connective. **Infructescence** erect above the leaf fan, spathe entirely persistent, reddish at fruit maturity, peduncle matte dark green. **Fruits** pale green, exposed by the circumscissile splitting and tearing of the spathe; weakly fruit-smelling. **Seeds** ovoid, *ca* 1.5 mm long, dark-brown, longitudinally sulcate.

Distribution: Borneo. Sarawak, only known with certainty north and east of the Batang Lupar (but see below).

Habitat: Terrestrial on soils overlying shales & sandstones, usually on step to vertical banks with the plants projecting horizontally, 80-430 m asl.

Notes: The tightly distichous leaf arrangement, the habit on vertical or near vertical earth banks and the petioles prominently pulvinate at junction of the lamina make *H. geniculata* immediately recognizable. However, it appears that there are at least two species involved. As defined here true *H. geniculata* has leaf narrowly oblong leaf laminae that are pronouncedly glaucous abaxially occurs east of the Batang Lupar ('Lupar Divide') whereas plants with the leaves broadly oblongo-lanceolate and abaxially pale green and occurring in NW Sarawak (specifically on the Matang Range, Kuching Division) are referable to *H. crassinervia* Ridl. The status of *geniculata*-like plants from Kuching (excluding Matang) and Samarahan Divisions requires clarification. If these plants all prove to be conspecific, the name *H. crassinervia* has priority.

Homalomena geniculata is not utilized at Batang Ai, and no record exists for its utilization elsewhere in Sarawak.

Uses: None recorded.

Iban name: None recorded.

Etymology: Latin, *geniculatus*, 'kneed' in allusion to the conspicuous swelling (geniculum, or more accurately pulvinus) at the junction of the petiole and lamina.

Other specimens seen: **SARAWAK. Sri Aman Division:** Pantu, Gunung Gaharu, 01° 02' 39.5"; 110° 53' 18.3", 8 Aug 2004, *P.C.Boyce et al. AR-644* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Wong Ensalai, 01° 11' 51.0"; 112° 03' 39.9", 26 May 2008, *P.C.Boyce et al. AR-2424* (SAR). **Kapit Division:** Nanga Gaat, Rejang Wood Concession, Sungai Piat, 01° 38' 09.1"; 113° 24' 09.9", 14 Oct. 2003, *P.C.Boyce & Jeland ak Kisai AR-112.1* (SAR); Nanga Gaat, Rejang Wood Concession, stream below Camp Gahada, 01° 41' 49.4"; 113° 26' 16.3", 15 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-112.2* (SAR); Nanga Gaat, Rejang Wood Concession, km 65 road to Camp Gahada, 01° 42' 01.1"; 113° 31' 14.8", 12 May 2004, *P.C.Boyce et al. AR-319, AR-335 & AR-365* (SAR); Rejang Wood Concession, km 3.5 after heli-logging camp on road to Camp Gahada, Sungai Bereng, 01° 45' 36.0"; 113° 27' 54.7", 15 Dec 2004, *P.C.Boyce et al. AR-903* (SAR); Belaga, Belaga road, 02° 43' 45.8"; 113° 45' 37.1", 12 Oct 2005, *P.C.Boyce et al. AR-1424* (SAR). **Bintulu Division:** Bukit Satiam, 02° 58' 47.6"; 112° 56' 37.5", 10 Aug 2004, *P.C.Boyce & Jeland ak Kisai AR-579* (SAR); Bukit Satiam, 02° 59' 10.0"; 112° 55' 42.8", 14 Jul 2006, *P.C.Boyce et al. AR-1905* & 15 Jul 2006, *AR-1907* (SAR); Tatau, Bukit Sarang, Ulu Sungai Sarang, 13 Jul 2006, *Skornickova 144 sub. AR-2028* (SAR). **Limbang Division:** Mulu, Long Lama, Mulu N.P., Sungai Empangau, tributary from Sungai Mendalam, 04° 13' 41.6"; 114° 52' 50.5", 30 Sep 2007, *P.C.Boyce et al. AR-2250* (SAR).

5. ***Homalomena hanneae*** P.C.Boyce, S.Y.Wong & Fasihuddin, *sp. nov.*
Ab aliis speciebus Homalomenae combination pistillis armeniacus et spadice resinfer per anthesin mascula unica est. –**Typus:** Malaysia, Sarawak, Sri Aman Division, Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 12' 16.2"; 112° 03' 26.0", 24 May 2008, *P.C.Boyce et al. AR-2360* (holo, SAR,+ spirit). **Fig. 5.**

Medium, strongly aromatic (mango resin) evergreen glabrous **herbs** to *ca* 50 cm tall. **Stem** pleionanthic, erect to ascending, *ca* 3 cm thick, dull red, internodes to *ca* 1 cm long. **Leaves** up to *ca* 10 together, *ca* 3 per module; petiole sub-terete, erect, 30-35 cm long, obscurely pulvinate *ca* 2/3 along length, pulvinus *ca* 2 cm long; petiole bases clasping, petioles medium green, suffused deep red or red-brown for the basal ¼, semi-glossy, drying dark brown, **petiolar sheath** *ca* 6-10 cm long, *ca* 1/5 of petiole length, equal, decurrent at apex, margin erect when fresh, soon degrading, reddish to scarlet; lamina narrowly to rather broadly ovato-sagittate, 16-22 cm long × 9-16 cm wide, thinly leathery, glossy dark green adaxially (fresh), drying medium brown, abaxially pale green (fresh), drying medium brown, base hastato-cordate to cordate, posterior lobes short, straight, ovate to ovato-triangular, 3-5 cm long, tip acute, acuminate for *ca* 2 cm thence tubular-apiculate for *ca* 2-3 mm; midrib raised abaxially (fresh and dry), green when fresh, drying reddish brown, adaxially sunken slightly into lamina, *ca* 3 mm wide, with *ca* 7-11 primary lateral veins on each side, diverging at 30°-80° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating irregularly with primaries; secondary venation obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences** up to 7 together, with additional synflorescences often arising after the next foliage leaf, thus plants with 20 or more inflorescences at various developmental stages not uncommon, erect and smelling powerfully of anise at anthesis, thence declinate, each subtended by prophyll, to *ca* 11 cm long; peduncle to *ca* 20 cm long × *ca* 4 mm diam., pale creamy green. **Spathe** 10-14 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening wide, entire spathe white at anthesis; closing post anthesis and then turning pink and finally deep red; lower spathe ovoid-ellipsoid, about equalling the spathe limb in length, 5-7 cm long, moderately constricted at the junction of the spathe limb, the constriction coinciding with junction of the male and female flower zones; spathe limb ovato-triangular, *ca* 5-7 cm long × *ca* 2.5 cm wide (at male anthesis), limb margins very slightly recurving at male anthesis, apex mucronate to *ca* 3 mm long. **Spadix** slightly exceeding the spathe, *ca* 8.5-9.5 cm long, briefly stipitate; stipe *ca* 3 mm long × 2 mm diam., gibbose-cylindrical, and inserted slightly obliquely on peduncle, pale yellow, **female flower zone** *ca* 5 cm long × *ca* 1.5 cm wide, slightly less than *ca* ½ length of spadix, stoutly fusiform; pistils *ca* 1.8 mm × 0.9 mm, densely arranged, stoutly cylindrical, very pale apricot, each associated with a large staminode; stigma globose-capitate, slightly exceeding the ovary, very pale apricot, staining paler brown than ovary in alcohol, each pistil associated with one interpistillar staminode; interpistillar staminodes stoutly clavate on a slender stipe *ca* 0.4 mm diameter, equalling or slightly overtopping the associated female flower, waxy white; suprapistillar interstice zone almost absent, at most to *ca* 0.5 mm long, naked; **male flower zone** to *ca* 8 cm long, just exceeding *ca* ½ length of spadix, lowest portion comprised of a few sterile male flowers, producing large numerous amber-coloured resin droplets during late female and at onset of male anthesis; **male flowers** moderately well defined from one another, *ca* 3 mm × 2 mm trapezoid, comprising 3-5 truncate stamens, each overtopped by a large, flat connective, white **Infructescence** declinate to pendent, spathe entirely persistent, matte deep red, peduncle deep green with darker green, short striae, matte. **Fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak, Sri Aman Division – endemic to the Batang Ai drainage system.

Habitat: Terrestrial in deep leaf litter on red soils over shales, often on step banks above the river, 80-200 m asl.

Notes: *Homalomena hanneae* belongs to the large and taxonomically complex Cyrtocladon supergroup. Species have usually cordate leaf laminae and inflorescences with a distinct constriction between the lower spathe and spathe limb. The numerous species separate on subtle combinations of characters in the spathe and spadix that may or may not relate to morphological differences, and *vice versa*, linked to often highly localized distributions.

At Batang Ai *H. hanneae* is immediately identifiable by apricot-coloured pistils and the presence of copious amber-coloured resin droplets on the spadix at the onset of male anthesis. These droplets mix with the pollen to form a sticky paste that adheres readily to visiting insects, notably beetles of Scarabaeidae, and Chrysomelidae (*Dercetina* sp.) and is seemingly linked to pollination strategy. Similar resin-pollen pastes have been observed in Neotropical *Philodendron* (cf. Gottsberger and Amaral, 1984; Grayum, 1990; Mayo, 1991).

Uses: Used as an antidote to snakebites, scorpion stings, etc. The bitten area is kept in the smoke of the burning stems (reported as rhizomes) as long as the patient can stand it. The leaves are used in post-partem *petangas*, a herbal sauna. The rhizomes are also used to treat sick chickens by keeping them in the smoke from burning 'rhizomes' of this and other species. Traditionally burning rhizomes were also used to keep insect pest away from fields. The aromatic rhizome is used in perfume mixtures. The ripe fruit is edible, with a sourish taste.

Iban name: Kemuyang.

Etymology: Named for Hanne Christensen whose meticulous work on the ethnobotany of the indigenous peoples of Sarawak drew attention to the many new species yet to be described.

Other specimens seen: **SARAWAK. Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 11' 58.9"; 112° 03' 27.0", 28 Jul 2004, *P.C.Boyce et al.* AR-560 (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Wong Enseluai, 01° 11' 00.9"; 112° 04' 20.8", 6 Apr 2005, *P.C.Boyce et al. AR-1137* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2382* & *AR-2406* (SAR, + spirit); Lubok Antu, Batang Ai, Nanga Sumpa, Wong Ensalai, 01° 11' 51.0"; 112° 03' 39.9", 26 May 2008, *P.C.Boyce et al.* AR-2408 (SAR, + spirit).

6. ***Homalomena humilis*** (Jack) Hook.f., Fl. Brit. India 6: 533 (1893). – **Typus:** Malaysia, Penang, *Wallich* (holo, K-W). **Fig. 6.**
Syn: *Calla humilis* Jack, Malayan Misc. 1(1): 22 (1820) – *Chamaecladon humile* (Jack) Miq., Fl. Ned. Ind. 3: 213 (1856).

Very small to small, very weakly aromatic (resin-like) peel, clumping, evergreen, microscopically puberulent **herbs** to *ca* 20 cm tall, but usually much less tall. **Stem** pleionanthic, erect to creeping, occasionally pendent under its own weight, *ca* 4 mm thick, medium green to deep maroon, internodes to *ca* 4 mm long. **Leaves** up to *ca* 15 together, *ca* 5-7 per module; petiole sub-terete in cross section, erect to spreading, 5-15 cm long, obscurely pulvinate *ca* ⅔ along length, pulvinus *ca* 1 cm long; petiole bases weakly clasping, petioles bright to dark green, brownish pink, or deep maroon, drying dark brown; petiolar sheath *ca* 2-4 cm long, *ca* ⅓ of petiole length, equal, decurrent at apex, margin erect when fresh, margins persistent; lamina ovato-sagittate, 2-16 cm long × 1-9 cm wide, softly thinly leathery, scintillating bright to dark green, brownish pink or deep maroon adaxially (fresh), drying medium olive-brown, abaxially paler (fresh), drying medium brown, base shallowly cordate, posterior lobes short, straight, ovato-triangular 1-3 cm long, tip acute, acuminate for *ca* 2 mm thence tubular-apiculate for *ca* 2-3 mm; midrib raised abaxially (fresh and dry), same colour as lamina when fresh, drying reddish brown, adaxially sunken slightly into lamina, *ca* 2 mm wide, with *ca* 4-7 primary lateral veins on each side, these diverging at 30°-80° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating irregularly with primaries; secondary venation very obscure, striate; all veins running into a slightly thickened intermarginal vein. **Inflorescences** up to 10 together, erect and smelling slightly sour at anthesis, thence declinate, each subtended by small prophyll, to *ca* 2 cm long; peduncle to *ca* 4 cm long × *ca* 1 mm diam., medium green, brownish pink, or deep maroon. **Spathe** *ca* 1 cm long, tapering-cylindrical, tightly furled prior to anthesis, gaping at female anthesis, then closing, *lower spathe* not differentiated from spathe limb, spathe narrowly ovato-triangular, *ca* 1cm long × ca. 5 mm wide (at male anthesis), margins recurving at male anthesis, apex mucronate to *ca* 1 mm long. **Spadix** exceeding the spathe at anthesis, *ca* 1.2 cm long, stipitate; stipe *ca* 0.5-2 mm long × 0.5 mm diam., cylindrical, and inserted obliquely on peduncle, pale green or pink, **female flower zone** *ca* 4 mm long × *ca* 1 cm wide, *ca* ⅓ length of spadix, cylindrical; pistils *ca* 0.5 mm × 0.4 mm, loosely arranged, cylindrical-globose, pale green, brownish pink m, or pink; stigma globose-capitate, less than ovary diam., each pistil associated with one interpistillar staminode; interpistillar staminodes clavate on a slender stipe *ca* 0.1 mm diameter, shorter the associated female flower, ***suprapistillar interstice zone*** absent; **male flower zone** to *ca* 7 mm long, *ca* ⅔ length of spadix, with the lowest portion comprised of a very few sterile male flowers; **male flowers** *ca* 0.3 mm × 1 mm, dumbbell-shaped, comprising 1-2 truncate stamens, overtopped by a larger rounded connective. **Infructescence** declinate, spathe entirely persistent, reddish, peduncle matte dark green, brownish pink, or deep maroon. **Fruits** oblong-ovoid, pale green or tinged pinkish, *ca* 2 × 1 mm. **Seeds** not observed.

Distribution: As defined here distributed from southern Peninsular Thailand throughout Peninsular Malaysia, and thence into Borneo, but see note below.

Habitat: Lowland to upper hill evergreen perhumid to everwet forest on a variety of substrates including limestone. Sometimes on bare limestone under forest. 10-700 m asl.

Notes: The taxonomy of *H. humilis* is chaotic and thus the full distribution is not clear. The small stature of the plants, their natural variability, and the small and fleeting nature of the inflorescences, coupled with over-dependence on dried specimens, has compounded an extremely unwieldy infraspecific classification, without a key and with labyrinthine synonymy proposed by Furtado [Gard. Bull. Straits Settlem. 10 (1939): 199], and including taxa at the levels of variety, subvariety and forma (some illegitimate). The synonymy given above intentionally omits all synonyms previously cited for *H. humilis* in, e.g., Hay *et al.* (1995), Govaerts & Frodin (2002), and Govaerts *et al.* (2009). The *humilis* complex requires an exhaustive study throughout its range.

Uses: No recorded uses among the Iban communities at Batang Ai.

Iban name: None recorded.

Etymology: Latin, *humilis* - low or low-growing, refers to the growth habit.

Other specimens seen: **SARAWAK. Kuching Division:** Bau, Gunung Juita, 01° 23' 48.7"; 110° 08' 07.2", *C.C.Lee AR-4.1* (SAR); Bau, Krokong, Gua Peri-peri, 01° 22' 51.9"; 110° 07' 09.3", 29 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-4.3*(SAR); Lundu, Gunung Gading, 01° 42'; 109° 50', 3 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-4.4* (SAR); Matang, Maha Mariamman Temple trail to Indian Temple, 2 Mar 2004 *P.C.Boyce & Jeland ak Kisai AR-4.5* (SAR); Padawan, Bukit Manok, 01° 12'; 110° 18', 18 Mar 2004, *P.C.Boyce, Jeland ak Kisai & A.Shafreena AR-4.6* (SAR); *AR-4.7* (SAR); Bau, Gunung Ti-Ton, 01° 23'; 110° 07', 17 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-4.8* (SAR); Bau, Jambusan, Kampung Seromah, 2 Apr 2004, *P.C.Boyce & Jeland ak Kisai AR-4.9* (SAR); Bau, Gunung Singai, 18 Apr 2004, *P.C.Boyce & Jeland ak Kisai AR-4.10* (SAR); Serian, 13th mile Kuching - Serian road, Bukit Quap, 01° 23' 44.6"; 110° 21' 10.6", 1 Sep 2004, *P.C.Boyce & Jeland ak Kisai AR-669* (SAR); Bau, Gunung Juita, 01° 23' 48.7"; 110° 08' 07.2", 18 Jun 2005, *P.C.Boyce & Jeland ak Kisai AR-1238* (SAR); Padawan, Kampung Sadir, 2 Feb 2006, *P.C.Boyce & Simon Kutuh ak Paru AR-1698* (SAR); Bau, Kampung Stenggang, Sungai Topah, 25 Mar 2006, *P.C.Boyce & Jipom ak Tisai AR-1747* (SAR); AR-1748 (SAR); Lundu, Gunung Gadin, trail to Waterfall Trail above Batu Apek, 01° 41' 48.2"; 109° 50' 20.5", 14 Dec 2006, *P.C. Boyce et al. AR-2063* (SAR); Matang, Kubah National Park, Waterfall Trail, 01°35' 40.2"; 110° 10' 45.9", 8 Jul 2007, *P.C.Boyce et al. AR-2109* (SAR). **Samarahan Division:** Serian, Pichin, Enteng Sabung, 28 Feb 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1009* (SAR); *AR-1010* (SAR); *AR-1011* (SAR); Serian, Pichin, Bubung, Sungai Bomo, 23 Apr 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1176* (SAR); 5 May 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1186* (SAR); Serian, Pichin, Jalan Tahang Nodoi, 10 Jul 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1263* (SAR) *AR-1264* (SAR); Serian, Pichin, Sungai Umpu Sabai, 12 Jul 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1265* (SAR); Serian, Pichin, Labu Sungai Tiyab, 26 Jul 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1294* (SAR); *AR-1297* (SAR); Serian, Pichin, Gunung KedadumBubung Darud, 6 Aug 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1312* (SAR); Serian, Pichin, Ampan Balah, Dawu, 6 Aug 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1323* (SAR); Serian, Pichin, Sungai Kerasik, 15 Sep 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1382* (SAR); Serian, Pichin, Darud Tirimun, Tiab Lawak, 20 Oct 2005, *P.C.Boyce & Simon Kutuh ak Paru AR-1493* (SAR). **Sri Aman Divison:** Lubok Antu, Batang Ai, 01° 13' 18.0"; 112° 03' 21.2", 28 Jul 2004, *P.C.Boyce & Jipom ak Tisai AR-538* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 11' 40.8"; 112° 04' 04.2", 28 Jul 2004, *P.C.Boyce et al. AR-563* (SAR); *AR-564* (SAR); 24 May 2008, *P.C.Boyce et al. AR-2372* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0" 25 May 2008, *P.C.Boyce et al. AR-2401*(SAR). **Bintulu Division:** Bukit Merairi, 02° 46' 26.9"; 113° 39' 19.8", *S.Julia & L.Chan-24 AR-1288* (SAR, SING); Bintulu, Bukit Satiam, 02° 59' 13.3"; 112° 55' 57.5", 14 Jul 2006 *P.C.Boyce et al. AR-1891* (SAR); Tatau, Bukit Sarang, Grand Perfect field station, path to Gua Lubang, Batu Rusa L-45, 12 Jul 2006, J. *Leong-Škorničková 106 (AR-2008)* (SAR, SING). **Sarikei Division:** Pakan, Berasok, 01° 54' 30.8"; 111° 38' 59.1", 06 Dec 2005, *P.C.Boyce et al. AR-1567*(SAR). **Miri Divison:** Niah Suai, Niah N.P., Madu Trail, 03°48' 57.9"; 113° 46' 18.3", 13 Jul 2006, *P.C.Boyce et al. AR-1886* (SAR); Marudi, Long Lama, Mulu N.P., trail from Clearwater Cave, 04° 03' 49.2"; 114° 49' 51.7", 8 Aug 2006, *P.C.Boyce et al. AR-1961* (SAR); Marudi, Long Lama, Mulu N.P., trail to Long Lansat, Sungai Licat, 04° 00' 03.5"; 114° 48' 49.8", 9 Aug 2006, *P.C.Boyce et al. AR-1978* (SAR). **Limbang Division:** Limbang, Nanga Medamit, Mulu N.P., Sungai Empangau, tributary from Sungai Mendalam, 04° 13' 41.6"; 114° 52' 50.5", 30 Sep 2007, *P.C.Boyce et al. AR-2245* (SAR); *AR-2246* (SAR); Limbang, Nanga Medamit, Mulu N.P., Sungai Abun Kiri, tributary from Sungai Terikan, from the back of Mentawai Research Station, 04° 14' 07.4"; 114° 52' 27.6", 2 Oct 2007, *P.C.Boyce et al. AR-2295* (SAR); Limbang, Nanga Medamit, Mulu N.P., Melinau Gorge, 3 Oct 2007, *P.C.Boyce et al. AR-2318* (SAR). **INDONESIA. Kalimantan Barat:** Gunung Saran, 22 Nov 1999, *C.C.Lee AR-4.2* (SAR).

7. ***Homalomena josefii*** P.C.Boyce & S.Y.Wong, Gard. Bull. Singapore 60(1): 13 (2008). – **Typus:** Malaysia, Sarawak, Bintulu Division: Bukit Satiam, 02° 59' 10.0"; 112° 55' 42.8", 14 Jul 2006, *P.C.Boyce et al. AR-1894* (holo, SAR, + spirit). **Fig. 7.**

Medium to robust strongly aromatic (ginger/resin) evergreen glabrous **herbs** to *ca* 125 cm tall. **Stem** pleionanthic, erect to ascending, *ca* 5 cm thick, dark red to green, internodes to *ca* 1 cm long. **Leaves** up to *ca* 15 together, *ca* 5-7 per module; petiole terete, erect to decumbent, 50-70 cm long, petiole bases clasping, eventually falling to leave a conspicuous lunate scar, petioles matte dark reddish to matte green, dark reddish forms with longitudinal ridges, green forms always with pinkish red bases, drying dark brown; petiolar sheath *ca* 16-21 cm long, *ca* ¼ to ⅓ of petiole length, equal, sometimes unequal, broader side rounded at apex, narrower side, weakly decurrent at apex, margin always convolute when fresh, sometimes wide open with broader petiolar sheath, sheath initially long-persistent with the marginal 1.5 mm soon drying paler, eventually the whole sheath marcescent; lamina broadly ovato-sagittate, 25-45 cm long × 18-32 cm wide, thinly leathery, glossy dark to pale green adaxially (fresh), drying pale olive green, abaxially matte medium green (fresh), drying pale brown, base cordate, posterior lobes spreading, subtriangular 7-9 cm long, tip obtuse, short-acuminate for *ca* 1 cm thence stiffly apiculate for *ca* 2-7 mm; midrib raised abaxially (fresh and dry), green when fresh, drying reddish brown, adaxially flush with lamina, *ca* 1.5 mm wide, with 6-9 primary lateral veins on each side, diverging at 50°-90° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), curved sharply towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating irregularly with primaries, posterior lobes each with 3-4 primary lateral veins; secondary venation rather obscure, striate; tertiary venation not visible, all veins running into a thickened intermarginal vein, often red when fresh, this particularly conspicuous at the leaf tip and there drying paler than the lamina. **Inflorescences** 1-7 together, erect at anthesis, later declinate, each subtended by prophyll, to *ca* 9 cm long, followed by cataphyll, *ca* 2-8 cm long; peduncle to *ca* 15 cm long × *ca* 5 mm diam., matte deep red. **Spathe** 6.5-15.3 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening wide, lower spathe pale green, stained deep red at insertion of peduncle, flushed pink above, spathe limb white at anthesis, with apex and mucro shading to dark pink during anthesis; lower spathe ovoid-ellipsoid, 2.5-6.5 cm long, moderately constricted at the junction of the spathe limb, the constriction coinciding with the lower-most fertile male flowers; spathe limb narrowly to broadly elliptic, *ca* 3.3-8.5 cm long × 2.3 cm wide (at male anthesis), prominently keeled along the dorsal midline, limb margins with the middle *ca* 2/3 reflexing slightly at male anthesis, apex mucronate to *ca* 3.5 mm long. **Spadix** equalling the spathe, *ca* 6-15.3 cm long, elongate cylindrical-fusiform, narrowing in the lower male zone coinciding with the constriction of the spathe and there intergrading with staminodes, stipitate; stipe *ca* 3.5 mm long × 5 mm diam., shortly fusiform, with a few staminodes present at the insertion of peduncle, similar to interpistillar staminodes; **female flower zone** *ca* 2 cm long × *ca* 1.2 cm wide, *ca* ⅓ length of spadix, weakly fusiform; pistils *ca* 1.3 mm × 0.75 mm, densely arranged, globose-cylindric; ***stigma*** as broad or slightly exceeding the ovary, raised and weakly trisulcate, staining pale brown in alcohol, extending beyond the ovary as a translucent collar, lowermost flowers each mostly associated with two or more interpistillar staminodes, and seemingly sterile; interpistillar staminodes truncate on a very slender stipe *ca* 0.3 mm diameter equalling or slightly overtopping the associated female flower, a few pistillodes at the base of interstice, these of similar size to pistils; suprapistillar interstice zone, to *ca* 1cm long × 5 mm wide, sometimes wider than female zone; suprapistillar staminodes each comprising a single anther; **male flower zone** to *ca* 4 cm long, *ca* ½ length of spadix, separated from interstice by weakly constricted lower part of male zone, clothed with fertile male flowers intergrading into a single row of staminodes., distal- and proximal-most flowers apparently sterile; **male flowers** *ca* 3 mm × 2 mm trapezoid, comprising 3-5 truncate stamens, each overtopped by a large, flat connective, terminal-most flowers sterile and spadix often topped with a vestigial naked appendix. **Infructescence** declinate, spathe entirely persistent, pale green stained reddish pink, sometimes whole reddish pink, peduncle matte dark red, matte. **Fruits** and **seeds** not observed.

Distribution: Borneo. In Sarawak endemic to Bintulu & Sri Aman Divisions.

Habitat: Terrestrial on shales and seasonally inundated alluvium, 7-200 m asl.

Notes: This is a new Division record, hitherto known only from Bintulu Division. *Homalomena josefii* is rare at Batang Ai, with only single small population so far located. It is by far the largest *Homalomena* species present, often exceeding 1m tall and with a stem up to 5 cm thick. The spathe is keeled along the dorsal median line much as in the much smaller

H. symplocarpifolia described elsewhere in this paper, aside from the much greater size and ovato-sagittate leaves, *H. josefii* also differs by the weakly trisulcate stigma.

Uses: No recorded uses among the Iban communities at Batang Ai.

Iban name: None recorded.

Etymology: Named for Dr Josef Bogner (formerly of Botanischer Garten München, Germany), one of the foremost experts on the aroids and perhaps the only person to have seen all currently recognized aroid genera in the field.

Other specimens seen: **SARAWAK. Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 11' 58.9"; 112° 03' 27.0", 28 July 2004, *P.C.Boyce et al. AR-559* (SAR). **Bintulu Divison:** Bukit Satiam, 02° 59' 13.3"; 112° 55' 57.5", 14 Jul. 2006, *P.C.Boyce et al. AR-1900* (SAR, + spirit); Bukit Satiam, 02° 59' 07.4"; 112° 55' 47.0", 15 Jul. 2006, *P.C.Boyce et al. AR-1908* (SAR, + spirit); Bintulu, road to Kampung Jepak, *ca* 3.3 km after bridge over Batang Kemena en route to Sibu from Bintulu, 03° 08' 32.3"; 113° 03' 24.3", 15 Jul. 2006, *P.C.Boyce et al. AR-1911* (SAR, + spirit).

8. ***Homalomena pseudogeniculata*** P.C.Boyce & S.Y.Wong, Gard. Bull. Singapore 60(1): 17 (2008). – **Typus:** Malaysia, Sarawak, Sarikei Division, Ulu Sarikei, 01° 55' 05.4"; 111° 29' 35.8", 7 Dec 2005, *P.C.Boyce et al. AR-1583* (holo, SAR). **Fig. 8.**

Medium to moderately robust, strongly aromatic (pine resin) evergreen glabrous **herbs** to *ca* 50 cm tall. **Stem** pleionanthic, decumbent with apex erect, frequently creeping for several metres and branching laterally while still continuing a physionogmically unbranched primary axis, stem green, internodes to *ca* 1 cm long. **Leaves** *ca* 8-12 together, *ca* 5 per module, each module subtended by prophyll, up to *ca* 12 cm long; petiole terete, erect to decumbent, up to *ca* 30 cm long, pulvinate apically, distance *ca* 3-13 cm from lamina base, roots penetrating petiole bases, petioles matte green when fresh, drying light brown; petiolar sheath to *ca* 14 cm long, *ca* ½ of petiole length, sheath convolute, initially persistent, eventually the whole sheath marcescent; lamina oblongo-lanceolate, sometimes oblongo-elliptic to ovate, 18-33 cm long × 6-15 cm wide, rather thinly coriaceous, matte mid-green adaxially , sometime the mid-rib paler (fresh), drying pale olive green, abaxially matte pale green, sometimes with conspicuous pellucid dots when fresh, very occasionally red (fresh), drying pale brown, base decurrent to truncate, tip obtuse, acuminate for *ca* 2 cm thence apiculate to *ca* 9 mm; midrib raised abaxially (fresh and dry), drying straw-coloured, adaxially flush with lamina, but slightly channelled towards the leaf base, *ca* 2.5 mm wide, with 6-9 primary lateral veins on each side, diverging at 45°-55° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), curved towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating irregularly with primaries, secondary venation rather obscure, striate; tertiary venation not visible, all veins drying in intermittent raised and flush strips especially when near to leaf margin, all veins running into intermarginal vein. **Inflorescences** 1-5 together, erect, each subtended by a prophyll up to *ca* 6.2 cm long; peduncle to *ca* 12-15 cm long × 1.5-1.6 cm diam., yellowish green. **Spathe** *ca* 10.6 cm long, tightly furled prior to anthesis, loosening at female anthesis and yet further at male anthesis, lower spathe yellowish green to white at maturity, spathe limb white prior to and at anthesis, with apex and mucro pale green at anthesis; lower spathe narrowly ellipsoid, *ca* 3.5 cm long, weakly constricted at the junction of the spathe limb, the constriction coinciding with the lower-most fertile male flowers; spathe limb narrowly lanceolate, *ca* 7 cm long, mucronate to *ca* 7 mm long. **Spadix** shorter than the spathe, *ca* 8.3 cm long, stipitate; stipe *ca* 4.5 mm long, weakly dorso-ventrally flattened, obliquely inserted on peduncle; **female flower zone** *ca* 2.2 cm long × 6.5 mm wide, *ca* ¼ length of spadix, weakly fusiform; pistils densely arranged, *ca* 1.3 mm diam. × 1 mm tall, round-cylindrical, lower-most pistils *ca* twice the size of fertile females, stigma exceeding the ovary, coherent to adjacent stigma, slightly raised, staminodes absent at the base of insertion, pistils with no associated interpistillar staminode, suprapistillar interstice zone wider than the other zones; staminodes truncate, *ca* 1.5 mm wide, slightly overtopping the pistils. **male flower zone** *ca* 4.8 cm long × 5.2 mm wide, *ca* ½ length of spadix, cylindrical, tapering to a sharp end, narrowing in the lower part coinciding with the constriction of the spathe, distal- and proximal-most flowers apparently sterile; **male flowers** *ca* 3 mm × 1.6 mm trapezoid comprising (3) 4-7 truncate stamens overtopped by a large connective, seemingly fertile to the tip. **Infructescence** declinate, spathe entirely persistent, lower spathe dark red, limb green, peduncle green. **Fruits** and **seeds** not observed.

Distribution: A Bornean endemic: Sarawak, Kuching, Sarikei, Sri Aman, Kapit and Miri Divisions; and Brunei.

Habitat: Terrestrial mostly under full shade in deep soil on various substrates, frequently on shales, rarely on granite, 62-600 m asl.

Notes: *Homalomena pseudogeniculata* is distinctive by its pulvinate petioles and remarkable decumbent-creeping stem giving rise to short leafy side shoots while maintaining a primary axis. Plants frequently occur growing down steep forested slopes giving the impression of several individual plants in a row but on investigation revealing a single creeping stem/rhizome with numerous short lateral branches.

The other currently recognized species with geniculate (pulvinate) petioles is the Sumateran endemic *H. elegantula* A.Hay, which differs from *H. pseudogeniculata*, among other characters, by hapaxanthic shoots, overall much smaller and less robust habit, and smaller (1 cm long) spathes with only a very weak constriction between the limb and lower part.

Uses: No recorded uses among the Iban communities at Batang Ai.

Iban name: None recorded.

Etymology: The specific epithet is coined from the superficial similarity of the leaves of this species to *H. geniculata* – hence *pseudo* – false.

Other specimens seen: **SARAWAK. Kuching Division:** Lundu, Gunung Gading, trail to Waterfall, trail above Batu Apek, 01° 41' 48.2"; 109° 50' 20.5", 14 Dec 2006, *P.C. Boyce et al. AR-2064* (SAR). **Kapit Division:** Nanga Gaat, Rejang Wood Concession, stream below Camp Gahada, 01° 41' 49.4"; 113° 26' 16.3", 15 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-141.1* (SAR); Nanga Gaat, Rejang Wood Concession, km 65 road to Camp Gahada, 01° 42' 01.1"; 113° 31' 14.8", 12 May 2004, *P.C.Boyce et al. AR-363* (SAR); Nanga Gaat, Rejang Wood Concession, km 55 road to Camp Gahada, 01° 44' 44.5"; 113° 28' 32.3", 13 May 2004, *P.C.Boyce et al. AR-385* (SAR); Nanga Gaat, Rejang Wood Concession, trail to water catchment behind main camp, 01° 53' 00.2"; 113° 26' 53.9", 14 Dec 2004, *P.C.Boyce et al. AR-882* (SAR); Nanga Gaat, Rejang Wood Concession, km 65 road to Camp Gahada, 01° 41' 59.7"; 113° 31' 13.7", 16 Dec 2004, *P.C.Boyce et al. AR-907* (SAR); Pelagus, Pelagus Rapids, Woodpecker Trail, 02° 11' 15.1"; 113° 03' 29.01", 14 Mar. 2005, *P.C.Boyce et al. AR-1034* (SAR); Belaga, Belaga road, 02° 43' 45.8"; 113° 45' 37.1", 12 Oct 2005, *P.C.Boyce et al. AR-1455* (SAR); Belaga, Belaga road, 02° 42' 55.9"; 113° 45' 29.3", 12 Oct 2005, *P.C.Boyce et al. AR-1457* (SAR); Belaga, Belaga road, 02° 42' 55.9"; 113° 45' 29.3", 12 Oct 2005, *P.C.Boyce et al. AR-1461* (SAR + spirit); Belaga, km 10 Bakun, Bintulu-Miri road junction, 02° 50' 51.7"; 114° 01' 57.6", 11 Oct 2005, *P.C.Boyce et al. AR-1481* (SAR, + spirit). **Miri Division:** Mulu, Long Lama, Mulu National Park, trail to Gunung Mulu Summit, 04° 02' 18.7"; 114° 49' 44.2", 7 Aug 2006, *P.C.Boyce et al. AR-1955* (SAR); Mulu National Park, trail to Long Lansat, Sungai Licat, 04° 00' 03.5";

114° 48' 49.8", 9 Aug 2006, *P.C.Boyce et al. AR-1985* (SAR); Miri, Marudi, Sungai Silat Basin, Sungai Palutan, 02° 49.59'; 115° 00.30', 25 Mar 2003, *Lim S.P. S.90424* (SAR). **Limbang Division:** Limbang, Nanga Medamit, Mulu National Park, trail from Camp 5 to Kuala Terikan, 04° 12' 58.0"; 114° 53' 20.1", 29 Sep 2007, *P.C.Boyce et al.* AR-2237 (SAR). **BRUNEI. Temburong District:** Sungai Temburong at Kuala Belalong, banks of Sungai Belalong. 4° 32', 225° 9', 24 Jun 1989, *P.C. Boyce 431* (BRUN, K, L).

9. ***Homalomena sengkenyang*** P.C.Boyce, S.Y.Wong & Fasihuddin, *sp. nov.*
Per pistillis viride clarus Homalomena sengkenyang *mirabilis est.* – **Typus:** Malaysia. Sarawak, Sri Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, 01° 12' 16.2"; 112° 03' 26.0", 24 May 2008, *P.C.Boyce et al. AR-2362* (holo, SAR + spirit). **Fig. 9.**

Medium, strongly aromatic (juniperus/mango resin) evergreen glabrous weakly clumping **herbs** to *ca* 50 cm tall. **Stem** pleionanthic, erect to ascending, *ca* 2.5 cm thick, pale green, internodes to *ca* 2 cm long. **Leaves** up to *ca* 7 together, *ca* 3-4 per module; petiole terete, erect, 25-30 cm long, obscurely pulvinate *ca* ⅔ along length, pulvinus *ca* 2.5 cm long, petiole bases clasping, petioles medium matte green, suffused reddish from the pulvinus to the lamina insertion in moist plants, slightlyglossy, drying brown; petiolar sheath *ca* 19-13 cm long, *ca* ⅓ of petiole length, slightly unequal, decurrent at apex, margin erect when fresh, margins soon scarious, brown, remainder of the sheathremaining medium green; lamina narrowly ovato-sagittate, 10-22 cm long × 5-13 cm wide, thinly leathery, glossy dark green adaxially (fresh) with scattered darker glands (extrafloral nectaries?), drying medium olive-brown, abaxially pale green (fresh), drying medium brown, base shallowly and narrowly, cordate, posterior lobes short, straight, ovato-triangular 1-3 cm long, tip acute, acuminate for *ca* 2 cm thence tubular-apiculate for *ca* 3-5 mm; midrib raised abaxially (fresh and dry), green when fresh, drying reddish brown, adaxially sunken slightly into lamina, *ca* 2 mm wide, with *ca* 7-9 primary lateral veins on each side, diverging at 30°-80° from the midrib, adaxially deeply impressed, giving a weakly quilted effect (fresh), almost flush with lamina when dry, abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating irregularly with primaries; secondary venation very obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences** up to 3 together, erect and smelling powerfully of anise at anthesis, thence declinate, each subtended by prophyll, to *ca* 14 cm long soon marcescent, peduncle to *ca* 13 cm long × *ca* 3 mm diam., matte pinkish brown. **Spathe** 9-10 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening wide, entire spathe white at anthesis; lower spathe ovoid-ellipsoid, 3-3.5 cm long, constricted at the junction of the spathe limb, the constriction coinciding with junction of the male and female flower zones; spathe limb narrowly ovato-triangular, *ca* 7-6.5 cm long × ca. 2.5 cm wide (at male anthesis), apex mucronate to *ca* 4 mm long. **Spadix** subequalling the spathe, *ca* 9-9.5 cm long, stipitate; stipe *ca* 3 mm long × 2 mm diam., weakly obconical, glossy pale green; **female flower zone** *ca* 3 cm long × *ca* 1 cm wide, *ca* 1/3 length of spadix, fusiform; pistils *ca* 1.5 mm × 0.75 mm, densely arranged, globose, bright green; stigma capitate, slightly exceeding the ovary, pale green, staining brown and darker than ovary in alcohol, each pistil associated with one interpistillar staminode; interpistillar staminodes clavate on a slender stipe *ca* 1 mm diameter, overtopping the associated female flower, waxy white, suprapistillar interstice zone to *ca* 1 cm long × 1 cm wide, contiguous with and equalling diam. of female flower zone, covered with large scattered staminodes, these intergrading to the lowermost fertile flowers of the male flower zone; **male flower zone** to *ca* 5 cm long, *ca* 1/3 length of spadix; **male flowers** *ca* 3 mm × 3 mm trapezoid, comprising 3-5 truncate stamens, each overtopped by a large, flat connective. **Infructescence** declinate, spathe entirely persistent, pinkish to reddish, peduncle matte dark green flushed and stained dull red and with paler conspicuous longitudinal striate, these particularly prominent on the distal-most portion. **Fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak: Sri Aman Division – endemic to the Batang Ai drainage system.

Habitat: Terrestrial in deep leaf litter on red soils over shales, often on step banks above the river, 80-165 m asl.

Notes: A common species at Batang Ai with extensive colonies in the forest and also in areas close to the longhouses, in which areas the plants are maintained artificially.

Homalomena sengkenyang is immediately identifiable by the bright green pistils, a character hitherto never reported for *Homalonena*.

Uses: This is by far the most important aroid utilized at Batang Ai, with the status of *sengkenyang bakung*, plants of which are utilized as a protector of rice plants. Plants utilized for *sengkenyang* are enormously important to the Iban, as they are believed to protect the rice plants against malevolent spirits and prevent the beneficial rice spirits from leaving the farm. Very few plants have the potential to be appointed to the status of *sengkenyang*.

Iban name: Sengkenyang bakung.

Etymology: The species epithet is derived from the Iban *sengkenyang*.

Other specimens seen: **SARAWAK. Sri Aman Divison:** Lubok Antu, Batang Ai, Nanga Sumpa, 01° 12' 02.3"; 112° 03' 09.3", 27 Jul 2004, *P.C.Boyce et al. AR-547* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, 01° 12' 07.6"; 112° 02' 51.2", 27 Jul 2004, *P.C.Boyce et al. AR-548* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2381, AR-2387, AR-2388 & AR-2403* (SAR,+ spirit).

10. ***Homalomena symplocarpiifolia*** P.C.Boyce, S.Y.Wong & Fasihuddin, *sp. nov.*

Species notabilis ab combinatio foliis oblongo et spathe exterior cum carina longitidinalis dorsalis. Ab spathe inferior cum lamina spathae equalis H. borneensis *simillima est sed folis oblongo et infloresentiae mascula et feminae eadem diametero differt.* – **Typus:** Malaysia. Sarawak, Sri Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Wong Ensalai, 01° 11' 51.0"; 112° 03' 39.9", 26 May 2008, *P.C.Boyce et al. AR-2411* (holo, SAR, + spirit). **Fig. 10.**

Robust, very strongly aromatic (pinene) evergreen glabrous **herbs** to *ca* 50 cm tall. **Stem** pleionanthic, erect, *ca* 3 cm thick, glossy medium green, internodes to *ca* 1 cm long. **Leaves** up to *ca* 5 together, *ca* 3-5 per module; petiole weakly D-shaped in cross section, spreading, 20-30 cm long, stoutly pulvinate *ca* 2/3 along length, pulvinus *ca* 1.5 cm long; petiole bases loosely clasping, medium green, semi-glossy, drying almost black; petiolar sheath *ca* 8-10 cm long, less than 1/3 of petiole length, equal, weakly auriculate at apex, margin strongly incurved, persistent, open; lamina oblong, 10-20 cm long × 9-12 cm wide, leathery, glossy medium green adaxially (fresh), drying medium olive-brown, abaxially pale (fresh), drying medium brown, base very shallowly cordate, posterior lobes almost absent, , tip blunt, very briefly tubular-apiculate for *ca* 2-3 mm; midrib raised abaxially (fresh and dry), green when fresh, drying reddish brown, adaxially sunken slightly into lamina, *ca* 4 mm wide, with *ca* 8-10 primary lateral veins on each side, these diverging at 30°-80° from the midrib, adaxially impressed (fresh), abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating with primaries; secondary venation very obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences** up to 4 together, erect and smelling of overripe banana/ anise at anthesis, thence declinate, each subtended by somewhat persistent prophyll, to *ca* 10 cm long, peduncle to *ca* 10 cm long × *ca* 3 mm diam., glossy green. **Spathe** 7-9 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening moderately wide, entire spathe white at anthesis; lower spathe narrowly ovoid-ellipsoid, 4-5 cm long, the dorsal side often with a pronounced ridge, moderately constricted at the junction of the spathe limb, the constriction coinciding with junction of the male and female flower zones; spathe limb narrowly ovato-triangular, *ca* 3-4 cm long × *ca* 2 cm wide (at male anthesis), limb margins incurved at male anthesis, apex mucronate to *ca* 3 mm long. **Spadix** subequalling the spathe, *ca* 8.5-9 cm long, stipitate; stipe *ca* 5 mm long × 4 mm diam., cylindrical, and inserted obliquely on peduncle and spadix, **female flower zone** *ca* 2.4 cm long × *ca* 1 cm wide, somewhat isodiametric, *ca* 1/3 length of spadix, weakly conical cylindrical, basally oblique; pistils *ca* 1 mm × 0.75 mm, densely arranged, globose-cylindrical; stigma globose-capitate, slightly exceeding the ovary, greyish at anthesis, staining deep brown in alcohol, most pistils associated with one interpistillar staminode; interpistillar staminodes stoutly clavate on a slender stipe *ca* 0.6 mm diameter, equalling the associated female flower; suprapistillar interstice zone contiguous with female and male flower zones and almost indistinguishable from male flower zone, to *ca* 5 mm long × 1 cm wide, covered with scattered staminodes each comprising a single or rarely 3anthers; **male flower zone** to *ca* 5 cm long, *ca* 2/3 length of spadix, the lowest portion comprised of sterile male flowers intergrading with staminodes; **male flowers** *ca* 3 × 2 mm regularly trapezoid, comprising 3-4 truncate stamens, each overtopped by a large, flat connective. **Infructescence** declinate, pale pinkish red, peduncle glossy medium green. **Fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak: Sri Aman Division – endemic to the Batang Ai drainage system.

Habitat: Terrestrial in deep litter on red soils on seasonally inundated alluvium and shale mud banks mostly in riverine forest. 100 m asl.

Notes: A highly distinctive species by virtue of the almost oblong leaves and conspicuously longitudinally dorsally ridged lower spathe. The lower spathe exceeding the spathe limb is a character shared with *H. borneensis*, from which *H. symplocarpifolia* is readily distinguished by leaf shape.

Uses: Same as in *Homalomena hanneae* as an antidote to snakebites, scorpion stings, etc.

Iban name: Kemuyang.

Etymology: The trivial epithet is based on the lamina shape which in outline and general, but not detailed, venation much resembles that of *Symplocarpus foetida* Salisb. (Araceae: Orontoideae).

11. ***Homalomena vagans*** P.C.Boyce, Kew Bull. 49(4): 799 (1994). – **Typus:** Brunei, Temburong: Batu Apoi Forest Reserve, Sungai Belalong, steep bank near river, 4° 33' N, 115° 9' E, 14 Mar 1992, *Poulsen & Motte 273* (holo, AAU; iso, BRUN, K). **Fig. 11.**

Relatively small, creeping, strongly aromatic (pinene) facultatively rheophytic **herbs,** 20-45 cm tall. **Stem** pleionanthic, epigeal-creeping, 10-20 cm × 6-8 mm, lower part leafless with age, upper part obscured by densely overlapping leaf bases, rooting along length and attaching strongly to substrate, roots emerging through the splitting leaf sheath. **Leaves** many together, *ca* 5 per module; petiole slender, subterete, canaliculate basally, 11-19 cm × 2-6 mm, base moderately expanded, pulvinate *ca* 2/3 along length, pulvinus marked, *ca* 2 cm long ; petiolar sheath 4.5-7 cm long, persistent, open, the margins incurved; lamina 11-23.5 × 1.5-6 cm, pendent on the petiole, lanceolate-elliptic, leathery, base decurrent, apex long acuminate, lamina (living) dark green adaxially, yellow green abaxially, lamina (dry) dull grey-green adaxially, pale brownish green abaxially; midrib prominent abaxially, rounded, flush to somewhat impressed adaxially; primary lateral venation slightly impressed adaxially, prominent abaxially, all other venation ± obscure. **Inflorescences** several together, each sympodium subtended by a persistent linear-lanceolate prophyll 2-4 cm × 2-5 mm, inflorescences smelling sickly-sweet at anthesis; peduncle 7-8 cm × *ca* 1.5 mm; spathe *ca* 6 cm × 9 mm; lower spathe *ca* 2 cm , then constricted and distally tapering, yellow-green, later pure white; **spadix** 3-5 cm × *ca* 5 mm (lower part) to 3 mm (upper part), stipitate; stipe 3 × 1.5 mm, terete, white; **female flower zone** 1-2 × *ca* 5 mm, cylindric, usually with a few stamens interspersed with the first few pistils, and with each pistil with an associated staminode; pistils 1 × *ca* 0.75 mm, ovary obpyriform, pale green; stigma circular, *ca* half ovary diam., *ca* 0.5 mm diam., stigma surface slightly papillate and wet at anthesis; interpistillar staminodes clavate, truncate, slightly shorter than the pistil, 0.75-1 × *ca* 0.5 mm; suprapistillar interstice zone narrower than female flower zone, clothed with a few rows of sterile male flowers, white; **male flower zone** 2-3 cm × *ca* long, narrowly cylindric; **male flowers** *ca* 0.75 × 0.75 mm, polygonal, densely arranged, white. **Infructescence** peduncle declinate with the spathe erect at maturity, 8-11 cm x *ca* 2 mm. **Fruit** ± globose, 1.5-3

× *ca* 1.5 mm, slightly truncate apically, pale to mid-green, stigma remaining darker. **Seed** ellipsoid, *ca* 0.75 × 0.5 mm, mid-brown.

Distribution: Malaysia (Sarawak) & Brunei.

Habitat: Facultative rheophyte on sandstones and shales in lowland evergreen perhumid or everwet forest, 60-450 m asl.

Notes: *Homalomena vagans* forms extensive colonies along river bank just above the high-water mark and is readily identifiable by the long-creeping rhizome-like stem and dull-green, rather coriaceous, lanceolate leaves pendent on the petioles.

Boyce (1997) reported the species to be rheophytic but further observations seem to show that this is in error, and that *H. vagans* is at most only facultatively rheophytic.

There are several facultatively rheophytic, lanceolate-leaved riverside *Homlaomena* in Sarawak, including *H. lancea* Ridl. (Matang), and a number of undescribed species.

Uses: No recorded uses among the Iban communities at Batang Ai.

Iban name: None recorded.

Etymology: Named from Latin *vagans*, wandering, in allusion to the long-creeping rhizome-like stem, a feature that at the time of publication was considered unusual in the genus.

Other specimens seen: **SARAWAK. Kuching Division:** Bau, Kampung Jugan, Sungai Merah, 27 Apr 2004, *P.C.Boyce & Jeland ak Kisai AR-33* (SAR); Bako, trail to N.P., *ca* 3 hours by foot from park boundary, 13 Feb 2004, *P.C.Boyce & Jeland ak Kisai AR*-219 (SAR); Bau, Kampung Apar, 17 Mar 2006, *P.C.Boyce & Jipom ak Tisai AR-1735* (SAR). **Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 11' 40.8"; 112° 04' 04.2", 28 Jul 2004, *P.C.Boyce et al. AR-553* (SAR); Pantu, Gunung Gaharu, 01° 02' 39.5"; 110° 53' 18.3", 8 Aug 2004, *P.C.Boyce et al. AR-645* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2390* (SAR). **Sarikei Division:** Sarikei, Sungai Lepong, 01° 57' 12.9"; 111° 30' 34.9", 8 Dec 2005, *P.C.Boyce et al. AR-1602* (SAR); Maradong, Sungai Matob, 01° 52' 06.1"; 111° 55' 30.7", 8 Dec 2005 *P.C.Boyce et al. AR-1616* (SAR). **Limbang Division:** Limbang, Nanga Medamit, Mulu N.P., Sungai Abun Kanan, tributary from Sungai Terikan, from the back of Mentawai Research

Station, 04° 14' 08.7"; 114° 52' 17.3", 1 Oct 2007, *P.C.Boyce et al. AR-2272* (SAR); Limbang, Nanga Medamit, Mulu N.P., Sungai Abun Kiri, tributary from Sungai Terikan, from the back of Mentawai Research Station, 04° 14' 07.4"; 114° 52' 27.6", 2 Oct 2007 *P.C.Boyce et al. AR-2297* (SAR). BRUNEI. **Temburong:** along the Sungai Temburong and Sungai Belalong, near their junction, 4° 30', 115° 10', 2 Oct 1958, *Jacobs 5615* (BRUN, G, L!, K!, US); Batu Apoi Forest Reserve, Sungai Belalong, steep bank near river, 4° 33', 115° 9', 14 Mar 1992, *Poulsen & Motte 47* (AAU! BRUN! K, spirit!).

12. ***Homalomena vivens*** P.C.Boyce, S.Y.Wong & Fasihuddin, *sp. nov.*
Ab allii Homalomenae foliis sagittato Batang Aiensis similis H. hanneae *praesertium, sed ab allii staminodiis inter pistilla nullis distinguida. Folii laminorum produnde viride, nervis lateralibus primariis impressus et petioli vagina long persistens uniqa est.* – **Typus:** Malaysia, Sarawak, Sri Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2402* (holo SAR – spirit). **Fig. 12.**

Medium, aromatic (camphor) evergreen glabrous **herbs** to *ca* 45 cm tall. **Stem** pleionanthic, erect, *ca* 2 cm thick, dark green, internodes to *ca* 1.5 cm long. **Leaves** up to *ca* 8 together, *ca* 3-5 per module; petioles dark green, suffused reddish for the apical ¼, semi-glossy, drying dark brown, terete, erect, 25-35 cm long, obscurely pulvinate *ca* ⅘ along length, pulvinus *ca* 2 cm long, petiole bases clasping; petiolar sheath *ca* 12-15 cm long, *ca* ½ of petiole length, equal, decurrent at apex, margin erect when fresh, margins persistent and remaining bright green; lamina narrowly sagittate, 16-20 cm long × 9-11 cm wide, thinly and rather softly leathery, semi-glossy dark green adaxially (fresh), drying olive-brown, abaxially paler green (fresh), drying medium brown, base cordate-sagitatte, posterior lobes, straight, ovato-triangular 3-5 cm long, tip acute, acuminate for *ca* 1 cm thence tubular-apiculate for *ca* 24 mm; midrib raised abaxially (fresh and dry), green when fresh, drying reddish brown, adaxially sunken slightly into lamina, *ca* 2 mm wide, with *ca* 7-11 primary lateral veins on each side, diverging at 30°-80° from the midrib, adaxially impressed (fresh), flush with lamina when dry, abaxially slightly raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins *ca* ½ width of the primary lateral veins, alternating irregularly with primaries; secondary venation very obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences** up to 6 together, erect and smelling powerfully of anise at anthesis, thence declinate, each subtended by prophyll, to *ca* 5 cm long; **peduncle** to *ca* 16 cm long × *ca* 3.5 mm diam., semi-glossy pale pink to somewhat reddish. **Spathe** 10-13 cm long, tightly furled prior to anthesis, lower spathe inflating at female anthesis, spathe limb loosening at female anthesis, thence inflating and then opening wide, entire spathe white at anthesis; lower spathe ovoid-ellipsoid, 3-5 cm long, constricted at the junction of the spathe limb, the constriction coinciding with junction of the male and female flower zones; spathe limb ovato-triangular, *ca* 5-8.5 cm long × ca. 3 cm wide (at male anthesis), limb margins recurving at male anthesis, apex mucronate to *ca* 5 mm long. **Spadix** exceeding the spathe at anthesis, *ca* 10-14 cm long, stipitate; stipe *ca* 5 mm long × 2 mm diam., gibbose-cylindrical, glossy white; **female flower zone** *ca* 5 cm long × *ca* 1 cm wide, just over ⅔ length of spadix, weakly fusiform; pistils *ca* 1.3 × 0.75 mm, very densely arranged, cylindric-globose; stigma capitate, slightly exceeding the ovary, coherent with its neighbours, staining paler brown than ovary in alcohol, interpistillar staminodes absent; suprapistillar interstice zone to *ca* 6 mm long × 9 mm wide, completely covered with sterile male flowers, lower part with coherent with female flower zone, upper part of interstice contiguous with male flower zone; **male flower zone** to *ca* 7 cm long, over ½ length of spadix, separated interstice by a weak constriction; **male flowers** *ca* 3 mm × 3 mm trapezoid, comprising 4-5 truncate stamens, each overtopped by a large, very slightly convex connective, white. **Infructescence** declinate, deep scarlet, peduncle matte dark green or slightly reddish. **Fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak: Sri Aman Division – endemic to the Batang Ai drainage system.

Habitat: Terrestrial in deep litter over red on shale mud banks in riverine forest. 80-200 m asl.

Notes: *Homalomena vivens* resembles several of the sagittate-leaved *Homalomena* at Batang Ai, particularly *H. hanneae*, but is readily identifiable from all by lacking interpistillar staminodes. The narrowly sagittate glossy deep green leaf lamina, with the primary veins adaxially impressed, and the petiolar sheaths bright green and long-persistent are diagnostic.

Etymology: From the Latin for living (*vivens*) to highlight the bright green, long persistent petiolar sheathes that are a distinctive feature of this plant.

Other specimens seen: **SARAWAK. Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 11' 58.9"; 112° 03' 27.0", 28 Jul 2004, *P.C.Boyce et al. AR-555* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Wong Enseluai, 01° 11' 00.9"; 112° 04' 20.8", 6 Apr 2005, *P.C.Boyce et al. AR-1145* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 12' 16.2"; 112° 03' 26.0", 24 May 2008, *P.C.Boyce et al. AR-2363* (SAR,+ spirit); Sri Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01° 11' 58.9"; 112° 03' 27.0", 25 May 2008, *P.C.Boyce et al. AR-2384* (SAR, + spirit).

Inadequately known species

13. ***Homalomena*** **sp. A. Fig. 13A.**

Medium, very strongly aromatic (mango peel resin) evergreen glabrous **herbs** to *ca* 30 cm tall. **Stem** pleionanthic, erect to decumbent-ascending, *ca* 2 cm thick, very dark green, internodes to *ca* 2.5 cm long. **Leaves** up to *ca* 8 together, *ca* 3-4 per module; petiole terete, erect, 20-30 cm long, very obscurely pulvinate *ca* ⅔ along length, pulvinus *ca* 2 cm long, petiole bases clasping; petioles dark green, glossy, drying dark brown; petiolar sheath *ca* 10-15 cm long, *ca* ½ petiole length, equal, decurrent at apex, margin erect when fresh, margins persistent, later degrading into papery wings and then shedding; lamina spreading, elliptic, 10-15 cm long × 6-11 cm wide, stiffly chartaceous, semi-glossy dark green adaxially (fresh), drying olive-brown, abaxially much paler green (fresh), drying medium brown, base broadly cuneate, tip acute, acuminate for *ca* 1 cm thence tubular-apiculate for *ca* 2 mm; midrib raised strongly abaxially (fresh and dry), green when fresh, adaxially sunken slightly into lamina, *ca* 3 mm wide, with *ca* 9-14 primary lateral veins on each side, these diverging at 70°-80° from the midrib, adaxially impressed (fresh), abaxially prominently raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins almost the same width as primary lateral veins, alternating with primaries and occasionally arching to meet them; secondary venation semi-obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences**, **infructescences**, **fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak: Sri Aman Division, Batang Ai drainage.

Habitat: Terrestrial on shales in evermoist gallery forest, 100 m asl.

Notes: Although as yet found only sterile and as yet to flower in cultivation the leaf morphology of this species is so distinctive we have no hesitation is assigning this to an undescribed species.

Specimen seen. **SARAWAK. Sri Aman Division:** Lubok Antu, Batang Ai, Lubok Antu, Batang Ai, Nanga Sumpa, Wong Ensulai, 01° 11' 51"; 112° 03' 39.9", 26 May 2008, *P.C.Boyce et al. AR-2414* (SAR).

14. ***Homalomena* sp. B. Fig. 13B.**

Small, strongly aromatic (citrus peel) evergreen glabrous **herbs** to *ca* 25 cm tall. **Stem** pleionanthic, decumbent-ascending, *ca* 1.5 cm thick, medium green, internodes to *ca* 2.5 cm long. **Leaves** up to *ca* 7together, *ca* 3-4 per module; petioles pale purple, glossy, drying medium brown, terete, erect, 10-15 cm long, obscurely pulvinate *ca* ⅔ along length, pulvinus *ca* 1.5 cm long, petiole bases weakly clasping; petiolar sheath *ca* 5-10 cm long, *ca* ½ petiole length, equal, decurrent at apex, margin erect when fresh, margins persistent, open; lamina spreading, oblong, 12-18 cm long × 7-110 cm wide, thinly leathery, glossy deep green adaxially (fresh), drying olive-brown, abaxially glossy maroon (fresh), drying medium brown, base broadly cuneate, tip obtuse, acuminate for *ca* 1 cm thence tubular-apiculate for *ca* 2 mm; midrib raised abaxially (fresh and dry), adaxially slightly sunken slightly into lamina, *ca* 3 mm wide, with *ca* 7-10 primary lateral veins on each side, these diverging at 50°-70° from the midrib, adaxially impressed (fresh), abaxially raised (fresh and dry), distal-most veins curved slightly towards the apex when near the margin, interprimary veins much less prominent than primary lateral veins, alternating with primaries; secondary venation semi-obscure, striate; tertiary venation not visible, all veins running into a slightly thickened intermarginal vein. **Inflorescences**, **infructescence**s, **fruits** and **seeds** not observed.

Distribution: Borneo. Sarawak: Sri Aman Division, Batang Ai drainage.

Habitat: Terrestrial on sandstone-derived clays in evermoist gallery forest, 100 m asl.

Notes: This species resembles the widespread *H. insignis* N.E.Br. from west of the Lupar, but differs by the leaf lamina adaxially glossy and abaxially shiny deep maroon (vs. leaf lamina semi-glossy and abaxially glaucous).

Specimens seen. **SARAWAK. Sri Aman Division:** Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01° 11' 40.8"; 112° 04' 04.2", 28 Jul 2004, *P.C.Boyce et al. AR-562* (SAR); Lubok Antu, Batang Ai, Nanga Sumpa, Wong Enseluai, 01° 11' 51.0"; 112° 03' 39.9", 26 May 2008, *P.C.Boyce et al. AR-2407* (SAR).

Figure 1. *Homalomena atrox* P.C.Boyce, S.Y.Wong & Fasihuddin. A. Flowering shoot, note the scintillating quality of the petioles and abaxial surface of the lamina; B. Inflorescence at female anthesis with spathe partially artificially removed. All photos from *P.C.Boyce et al. AR-2375* (SAR).

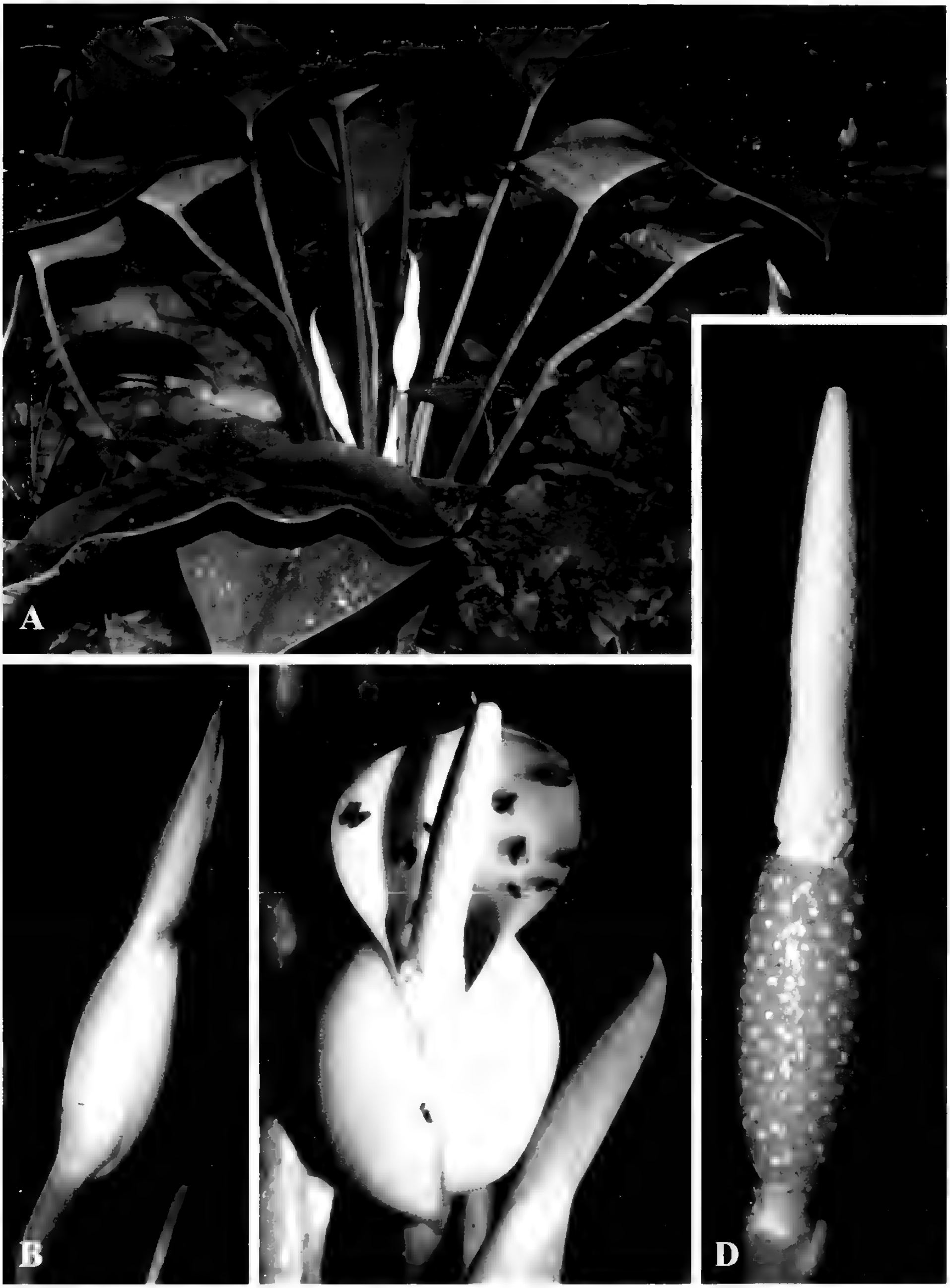

Figure 2. *Homalomena borneensis* Ridl. A. Flowering plant; B. Inflorescence just prior to female anthesis, note the entire spathe still tightly furled; C. Inflorescence at late female anthesis, note the inflated lower spathe and fully expanded spathe limb; the insects are *Colocasiomyia* (Diptera: Drosophilidae); D. Spadix at female anthesis (spathe artificially removed), note the dense pistils and coherent stigmas. A-B photos from *P.C.Boyce et al. AR-544* (SAR); C-D photos from *P.C.Boyce et al. AR-546* (SAR).

Figure 3. *Homalomena clandestina* P.C.Boyce, S.Y.Wong & Fasihuddin. A & B. Inflorescence at early male anthesis, note the damage to the male flower zone resulting from beetles chewing the spadix; C. Spadix at female anthesis (spathe artificially removed), note naked interstice between the male and female flower zones, the lax, ascending pistils, and separate stigmas; D. Details of the female flower zone and lowermost part of the male flower zone; E. Post-anthesis spadix, note the beetle-damaged male flower zone, and that the interpistillar staminodes are now missing, having been eaten. All photos from *P.C.Boyce et al. AR-2385* (SAR).

Figure 4. *Homalomena geniculata* M.Hotta. A. Plant in habitat; B. Inflorescence at female anthesis; C. Spadix at female anthesis, spathe artificially removed; note that there are no interpistillar staminodes; D. Detail of distichous leaf arrangement. All photos from *P.C.Boyce et al. AR-2424* (SAR).

Figure 5. *Homalomena hanneae* P.C.Boyce, S.Y.Wong & Fasihuddin. A. Flowering plant; B. Inflorescence at early anthesis, note amber-coloured resin droplets on the spadix; C. Detail of post-anthesis female flower zone and lowermost part of the male flower zone; the black lines are fly larvae; D. Spadix at female anthesis, spathe artificially opened; note the resin droplets of the spadix and also the resin exuded from the cut spathe; E-F. Post antheis spadix showing extensive beetle damage. All photos from *P.C.Boyce et al. AR-2360* (SAR).

Figure 6. *Homalomena humilis* (Jack) Hook.f. A. Flowering plant, red expression; B. Plant with inflorescences at various stages of development, the sequence running from right (youngest) to left (oldest); C. Detail of inflorescence at female anthesis; note that spadix is fertile to the tip. A photo from *P.C.Boyce & Jipom ak Tisai AR-538* (SAR); B photo from *P.C.Boyce et al. AR-563* (SAR), and C photo from *P.C.Boyce et al. AR-2401* (SAR).

Figure 7. *Homalomena josefii* P.C.Boyce & S.Y.Wong. A. Plant; B. Petioles of green form with inflorescences and infructescences; C. Emerging inflorescence bud, with declinate infructescences behind; D. Inflorescence at late anthesis. All photos from *P.C.Boyce et al. AR-1894* (SAR).

Figure 8. *Homalomena pseudogeniculata* P.C.Boyce & S.Y.Wong. A. Plant in habitat; B. Emerging inflorescence showing the distinctive mucro; C. Two infructescences. All photos from *P.C.Boyce et al. AR-1583* (SAR).

Figure 9. *Homalomena sengkenyang* P.C.Boyce, S.Y.Wong & Fasihuddin. A. Plant in habitat; B. Detail of petioles showing scarious petiolar sheath margins; C. Spadix, spathe artificially removed to show the diagnostic green pistils; D. Developing infructescences. All photos from *P.C.Boyce et al. AR-2362* (SAR).

Figure 10. *Homalomena symplocarpifolia* P.C.Boyce, S.Y.Wong & Fasihuddin. A. Plant in habitat, note the oblong leaves; B. Inflorescence at late male anthesis; C. Spadix, spathe artificially removed to show the contiguous male and female flower zones; the lowermost flowers of the male zone are sterile; D. Detail of female flower zone. All photos from *P.C.Boyce et al. AR-2411* (SAR).

Figure 11. *Homalomena vagans* P.C.Boyce. A. Plant in habitat; B. Detail of the older part of the creeping stems; C. Spadix, spathe artificially removed; D. Detail of female flower zone, note the proportionately small stigmas; E. Infructescences with the diagnostic declinate peduncle and erect spathe. All photos from *P.C.Boyce et al. AR-2380* (SAR).

Figure 12. *Homalomena vivens* P.C.Boyce, S.Y.Wong & Fasihuddin. A. Flowering plant in habitat; B-C. Inflorescence at male anthesis; C. Spadix, spathe artificially removed, note the female flower zone lacks interpistillar staminodes. All photos from *P.C.Boyce et al. AR-2402* (SAR).

Figure 13. *Homalomena* sp. A & B. A. Plant of *H.* sp. A in habitat, note the pronounced abaxial venation and somewhat ascending stem; B-C. Plants of *H.* sp. B in habitat. A photo from *P.C.Boyce et al. AR-2414* (SAR); B & C from *P.C.Boyce et al. AR-2407*

Acknowledgements

The collaboration and support of the Sarawak Forestry Department, notably Dr Mohd. Shahbudin Sabki, Dr Azahari Bin Omar, L.C.J. Julaihi, and Lucy Chong, and the Sarawak Biodiversity Centre, in particular Dr Rita Manurong, & Dr Charlie Yeo Tiong Chia, is gratefully acknowledged. This study is funded by MOSTI E-Science: 05-01-09-SF0006, under Sarawak Forestry Department Research Permit No. NPW.907.4.2(I)-101 & Park Permit No. 58/20076.

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Lost for a Century: Rediscovery of the Endemic Ridley's Jewel Orchid, *Zeuxine exilis* Ridl., on Christmas Island, Indian Ocean

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Abstract

In a botanical expedition to Christmas Island in 1904, Sir Henry Ridley, the first director of the Singapore Botanic Garden, discovered and thereafter described an endemic ground orchid, *Zeuxine exilis* Ridl. Botanical expeditions and surveys over the century since the original discovery failed to relocate *Z. exilis*. We report here the rediscovery of *Z. exilis* in rainforest in the western section of the island, and in Ridley's honour, propose "Ridley's jewel orchid" as its common name. The distribution and conservation status of *Z. exilis* remains to be determined. Despite a century of ecological insults to this unique oceanic island, primarily through phosphate mining and the introduction of invasive species, the rediscovery of this endemic orchid renews hope that the imperiled biodiversity on this island is resilient and can be conserved.

Introduction

More than a century ago, Sir Henry N. Ridley, founding director of the Singapore Botanic Gardens, visited Christmas Island on two occasions, first for just 10 hours in 1890 (Ridley, 1891) and again in 1904, for about five weeks (Ridley, 1905a). This oceanic island, 360 km south of Java in the northeastern Indian Ocean (10°29′ S, 105°38′ E) is covered in tall tropical rainforest where it has not been cleared for phosphate mining. Ridley's expeditions yielded important collections that served as the basis for his comprehensive treatment of the island's flora (Ridley, 1905b). He described several new species as endemic to the island, and one of these, *Zeuxine exilis* Ridl. (Orchidaceae), has not been collected since, and was presumed extinct. Here we report on the rediscovery of this endemic orchid, 105 years after its first and only collection.

The rediscovery and identification of *Zeuxine exilis*

Specimens of an unidentified ground orchid were collected on 17 Nov 2009 from rainforest in the western area of the island. An initial identification as *Z. exilis* was made by reference to Du Puy *et al.* (1993) and by comparison with digital images of herbarium specimens from the Singapore Botanic Gardens (Fig. 1A) and the Royal Botanic Gardens, Kew. An authoritative determination was provided by Dr. M. Clements, orchid specialist at the Centre for Plant Biodiversity Research, Australian National Herbarium (CANB) Canberra, Australia. Given the undetermined conservation status of *Z. exilis*, we do not report specific localities. Specimens are currently being lodged with the Australian National Herbarium.

Although most individuals of *Z. exilis* observed in the field were senescing (see below), we located several fresh plants (Fig. 1B-F). The attributes observed are consistent with Ridley's initial description (Ridley, 1905b, p. 236, presented below with SI units):

> "Whole plant 30-45 cm tall, succulent, rhizome shortly creeping, roots fleshy. Leaves lanceolate, acute, light green, 2.5-7.5 cm long, 1.2-2 cm wide, glabrous, shortly petioled; sheaths papery, 1.2 cm long. Stem white-hairy, peduncle 7.5-15 cm long, raceme many-flowered, 2.5-7.5 cm long. Bracts lanceolate, acuminate, hairy. Sepals reddish, hairy, lanceolate, acute, 3 mm long. Petals thin, white, adnate to the upper sepal. Lip base saccate with broad wings, then narrowed, limb broadly bilobed, lobes broad oblong, divaricate edges crenulate, processes in the base of the lip slender, subulate, curled, whole lip white with a central yellow bar. Column short, anther lanceolate, beak up-curved, dull red, pollinia elongate, pyriform, disc large, oblong. Rostellum lobes linear, acuminate. No accessory processes. Capsule pubescent, elliptic, 6 mm long. Centre of the island, among ferns, not rare. Endemic."

Given its all too brief history, *Z. exilis* has never enjoyed a common name. We name this species as "Ridley's jewel orchid" in honour of his important contributions to botany on Christmas Island, and his discovery and description of *Z. exilis* in particular.

Natural history of *Zeuxine exilis*

The genus *Zeuxine* comprises approximately 70 species, mostly distributed in the tropics from Africa through southern and southeast Asia to Australia and the Pacific (Ormerod *et al.*, 2003). Species in the genus vary in their life histories from annual to perennial. On Christmas Island, Ridley collected

Z. exilis in full flower in Oct 1904, whereas we found mostly senescent plants in Nov 2009. This suggests that *Z. exilis* appears aboveground for relatively brief periods. It is unclear whether plants die off completely or just back to rhizomes. Reproductive systems in *Zeuxine* vary from outcrossing in *Z. gracilis* to apomixis in *Z. strateumatica* (Sun and Wong, 2001). *Zeuxine exilis* may be apomictic given that all flowers appear to set fruit. We found individuals in both heavily shaded rainforest understorey and in disturbed, higher-light environments next to roads. Clearly, more information on the life history, breeding system, and population biology of *Z. exilis* is needed. Furthermore, *Z. exilis* is morphologically similar *Z. gracilis* and their taxonomical differences need clarification.

Discussion

Rugged terrain and limited time forced the earliest naturalists visiting Christmas Island, J. J. Lister in 1887 (Lister, 1888) and H. N. Ridley in 1890 (Ridley, 1891), to confine their activities to the area immediately surrounding Flying Fish Cove, the only safe anchorage. The upper plateau was not surveyed by a naturalist until C.W. Andrews stayed on the island for 10 months in 1897/98 (Andrews, 1900). Although he collected several orchid species, he did not find *Z. exilis*. Ridley made his second collecting trip to the island in October 1904, this time for about five weeks. He made several collecting forays in the northeast of the island (Ridley, 1905a), but also made an expedition of several days duration in which he traversed the island across the upper plateau from northeast to southwest (Fig. 2). It was on this trip that Ridley collected a species of *Zeuxine*, and later formally described it as an endemic species, *Z. exilis*, in a major work, *The Botany of Christmas Island* (1905b).

Ridley's specimens from that day were eventually sent to the Singapore Botanic Gardens (SING 0046902, see Fig. 1A), the Royal Botanic Gardens at Kew (K00079379), and the Natural History Museum, London (BM00007629). Both the SING and BM specimens are labeled holotypes, while the Kew specimens are labeled lectotypes. Apparently, there is a need to lectotypify the species to resolve the designation of the type status. The specimen collection labels on both the Singapore Botanic Gardens and Kew Gardens' sheets have the collection date and location simply stated as "Murray Hill Track, Oct 1904". In 1904, this track extended a considerable distance, some 15 km, from Flying Fish Cove in the northeast, to Murray Hill and beyond in the west.

We can now pin down the exact collection date and narrow considerably the area in which Ridley discovered *Zeuxine exilis*. In addition to the formal description of his collections (Ridley, 1905b), he gave an almost daily description of his collecting activities (Ridley, 1905a), including the day he discovered *Z. exilis*. He describes finding this plant on 18 Oct, 1904, close to where he and the party spent the night of 18/19 October, southwest of Ross' 'old encampment'. Ridley did not provide a map to show even approximately where this location may have been, and since then, formal descriptions of the orchids of Christmas Island (Wood, 1982; Du Puy *et al.*, 1993) have been forced to report Ridley's original, imprecise locality. However, many years after the 1904 expedition, Ridley's fellow expeditioner, Dr Karl Hanitsch, the first curator of the Raffles Museum, prepared handwritten notes for a lecture he gave to the Ashmolean Natural History Society of Oxfordshire on 15 May, 1923 (Hanitsch, 1923). This unpublished manuscript contains a map of Christmas Island marked with the exploring party's route and campsites (Fig. 2). The coastline and contours in this map have obviously been copied from the foldout map in Andrews' (1900) monograph, and we presume that Hanitsch drew on his original field notes from 1904 to plot the route. Knowing the exact date that Ridley collected *Z. exilis*, and where the party was on that day from Hanitsch's map, we can now narrow the type locality to somewhere in the vicinity of present-day Aldrich Hill, or perhaps to its west.

Zeuxine exilis has not been collected since, even though the island has been re-surveyed several times. Comprehensive collections were made by D.A. Powell and H'ng Kim Chey in the 1980s and by B.A. Mitchell in 1984 (Mitchell, 1985). These collections have been lodged at Kew and the Australian National Herbarium in Canberra, respectively. D.J. Du Puy visited the island twice in 1987 in preparation for his treatment of the flora of Christmas Island (Du Puy, 1993). Here Du Puy listed *Z. exilis* as 'apparently extinct' (p. 13), and 'possibly endangered' (p. 521). Previously, in an unpublished report that focused on native and endemic plants with limited distributions, he had listed *Z. exilis* as 'extinct' (Du Puy, 1988). Since then two other attempts have been made to locate this orchid, both without success (Holmes and Holmes, 2002; R. de Kok, Royal Botanic Gardens Kew, pers. comm., 2009). Even though *Z. exilis* has been considered extinct by botanists, it has no official status as such under the Environment Protection and Biodiversity Conservation Act (1999) in Australia.

Ridley's original account of *Z. exilis* described it as 'not rare.' Why then has it taken more than a century for it to be seen again? We believe that Ridley's jewel orchid was not present in the western area of the island where it was rediscovered until the last few years. We conducted intensive seedling surveys across this area over 10 years from the late 1980s (Green *et al.*, 1997, 2008) and never encountered it. These surveys included the transition from dry to wet season (Oct-Dec) when *Z. exilis* should be evident. Similarly, inappropriately timed surveys cannot explain the failure of Du

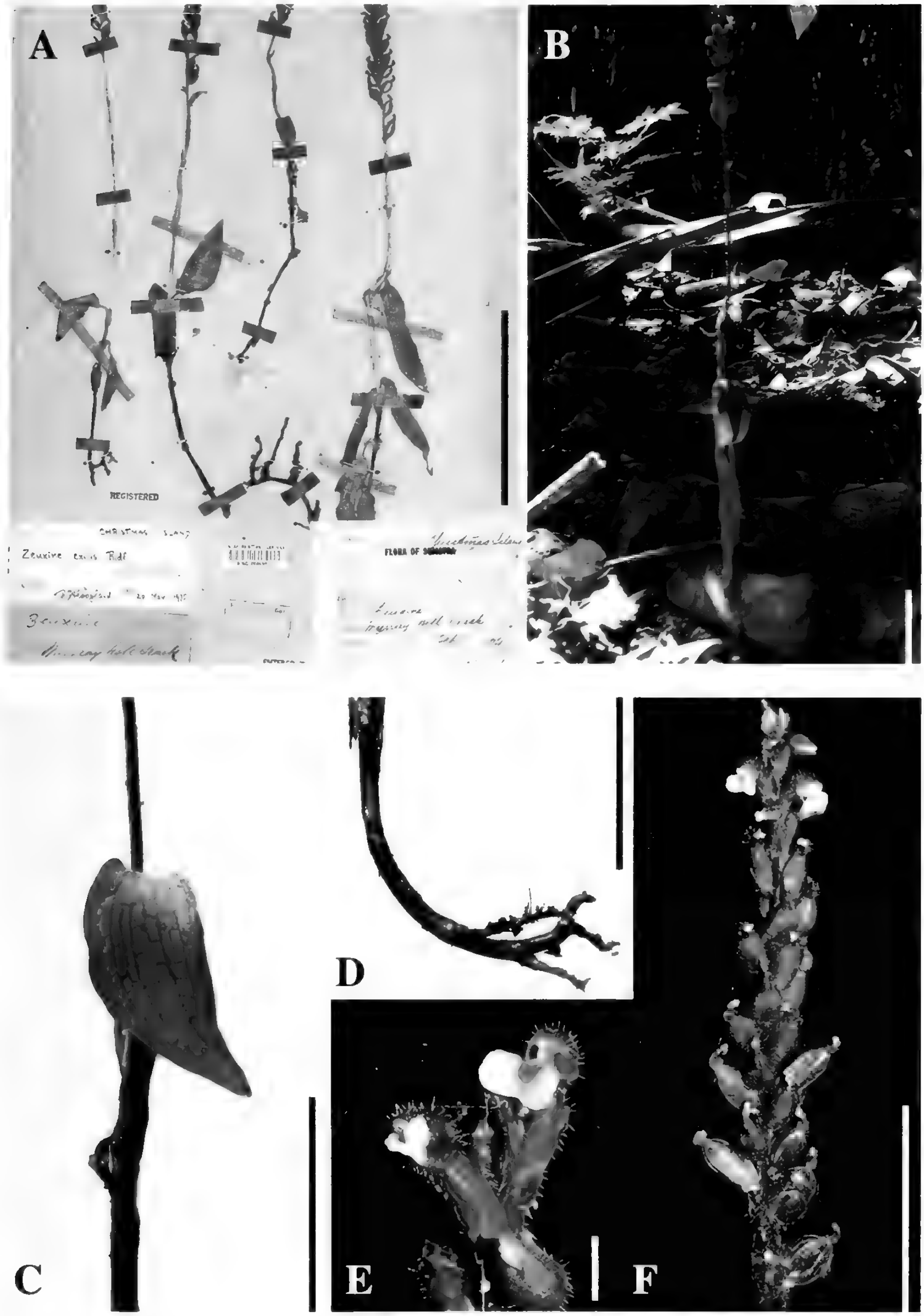

Figure 1. *Zeuxine exilis* Ridl. A. Holotype of *Zeuxine exilis* Ridl. (SING 0046902; scale bar is 10 cm); B. *Z. exilis* in situ in rainforest, 17 Nov. 2009 (bar is 5 cm); C. Lanceolate leaf (bar is 4 cm); D. Creeping rhizome (bar is 3 cm); E. Flowers (bar is 3 mm); F. A raceme showing flowers, with developing and dehiscent capsules (bar is 3 cm).

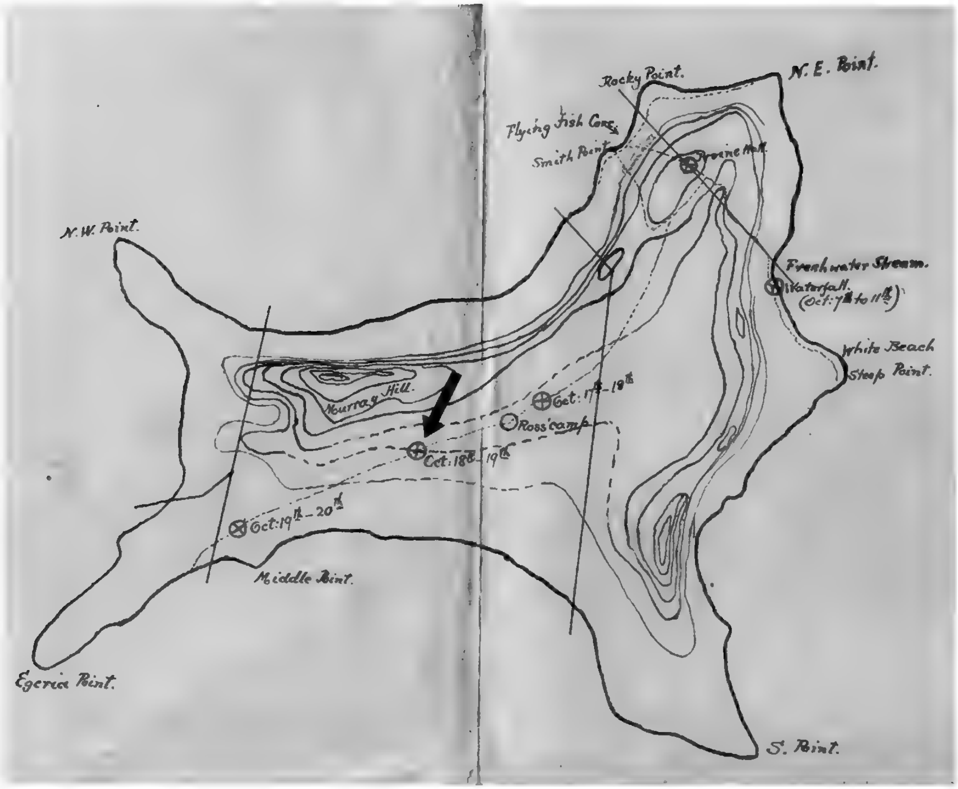

Figure 2. Hanitsch's original hand-drawn map of the 1904 expedition to Christmas Island (see Hanitsch, 1923). Expedition route is a red dashed line; camping locations with dates indicated by red crossed circles. Arrow indicates campsite on 18/19 Oct 1904 near the site where Ridley collected *Zeuxine exilis*.

Puy (1988), Holmes and Holmes (2002), or the team from Kew in 2005 (R. de Kok, pers. comm.) to relocate the orchid. We can only note that the reappearance of the orchid coincides with major changes in rainforest understory structure as a result of widespread invasion by the yellow crazy ant (*Anoplolepis gracilipes*) and its impacts (O'Dowd *et al.*, 2003). Until the distribution and abundance of Ridley's jewel orchid is determined across the island, the reasons for its unexpected but welcome reappearance, 105 years after Ridley's discovery, remain enigmatic.

Acknowledgements

We thank S. Brecknell and D. Rogers of Oxford University Museum for the map from Hanitsch's unpublished report, and the Singapore Botanic Gardens for permission to use the image of holotype specimen of *Z. exilis* kept at SING herbarium. R. Barnes provided one of the photographs in Figure 1.

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New Species of *Hoya* (Apocynaceae) from Brunei and the Philippines

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Abstract

Two new species of *Hoya* collected from Brunei and the Philippines are described and illustrated with coloured photographs of the flower details.

Introduction

Wild and cultivated species of *Hoya* in Borneo and the Philippines have been documented and studied in recent years (Kloppenburg, 1991; Kloppenburg and Wayman, 1993; Kloppenburg and Siar, 2009; Wennstrom and Stenman, 2008). Several species of Philippine and Bornean *Hoya* have also been used in molecular study to shed light on their phylogenetic position in the genus (Wanntorp et al. 2006). A recent examination of live plants grown in private gardens and nurseries has revealed two new species of *Hoya* taken into cultivation from the wild. They are described and illustrated below.

1. ***Hoya yapianum*** Kloppenburg, *sp. nov*. Section Otostemma
A Hoya sipitangensis *Kloppenburg & Wiberg similes, sed hic sp. nova sepalorae apex obtusam non acutam; pedecilli glabras non puberulas; coronae apex interiora acutum non spathulatum; folia magnior; pollinaria ca 1/3 breves, differt.* – **Holotypus:** BRUNEI. Tutong District, Kuala Belait, 21 Jan 2008, *Wang Luan-Keng BN090122* (SING). **Figs. 1 & 2.**

A twining **herb. Stem** long slender, glabrous. **Leaves** lanceolate, variable in size, 4.4-8.5 cm long and 1.5-3 cm at the widest part near the middle, apiculate, nerves not conspicuous, pinnately veined, majour veins extending from base to near apex. Petiole terete, 1-1.8 cm long. **Inflorescence** umbelliform, consisting of 15-30 flowers. Pedicels variable in length, curved, glabrous with crystalline surface, longest *ca* 1.5 cm and 0.10 cm in diameter, slight enlarged at the calyx. **Calyx** small, whitish, and calyx lobes (sepals) do not reach the corolla sinuses. Outer surface of calyx lobes granulose, thickened centrally slightly, edges membranous, 0.08 x 0.08 cm, glabrous inside, apex obtuse,

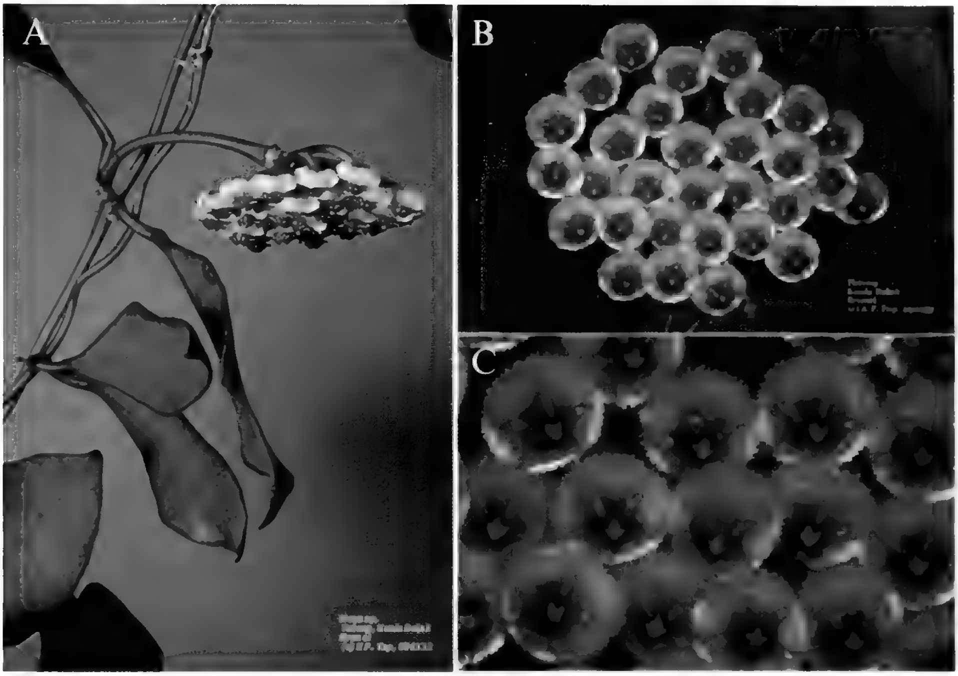

Figure 1. *Hoya yapianum* Kloppenburg. A. Plant habit (×1); B & C. Inflorescences (B: ×1.5; C: ×2).

narrow ligules present. Sepals very little overlapped at base. **Corolla** whitish, thick, tightly revolute and outer surface villous-pubescent except for the area under the corona. Outer surface of corolla glabrous, about 0.51 cm long and 0.21 cm wide. The **corona** reddish in color, corona crown has the center raised with outer lobes long and narrow, with very thin translucent edges. The inner lobe is raised with an acute apex that does not cover the membranous anthers. Central column pronounced, 0.07 cm long with a 0.10 cm opening, surface glabrous but finely crystalline. Skirt lobes rounded with a central groove leading to the anther winged outer apex. The outer scale membranous, dorsally keeled from apex to apex. The keel about mid way has a hump as it extends to the outer apical area. Scale edges are sharp. Stylar crown short, ovaries 2, cone shaped, glabrous, *ca* 0.11 cm long and the base pair *ca* 0.06 cm broad. **Anthers** membranous, triangular; **pollinia** two in pollinarium, oblong, 0.25 mm long and 0.12 mm wide; translator 0.10 mm long and 0.04 mm wide. Caudicles clearly distinct, cone shaped. Retinaculum 0.06 mm long with extensions 0.04 mm. **Fruit** not seen.

This new species is similar to *Hoya sipitangensis* but different as the apex of the sepals are obtuse not acute and the pedicels are glabrous not puberulent; inner apex of the corona is acute not spathulate, the foliage is

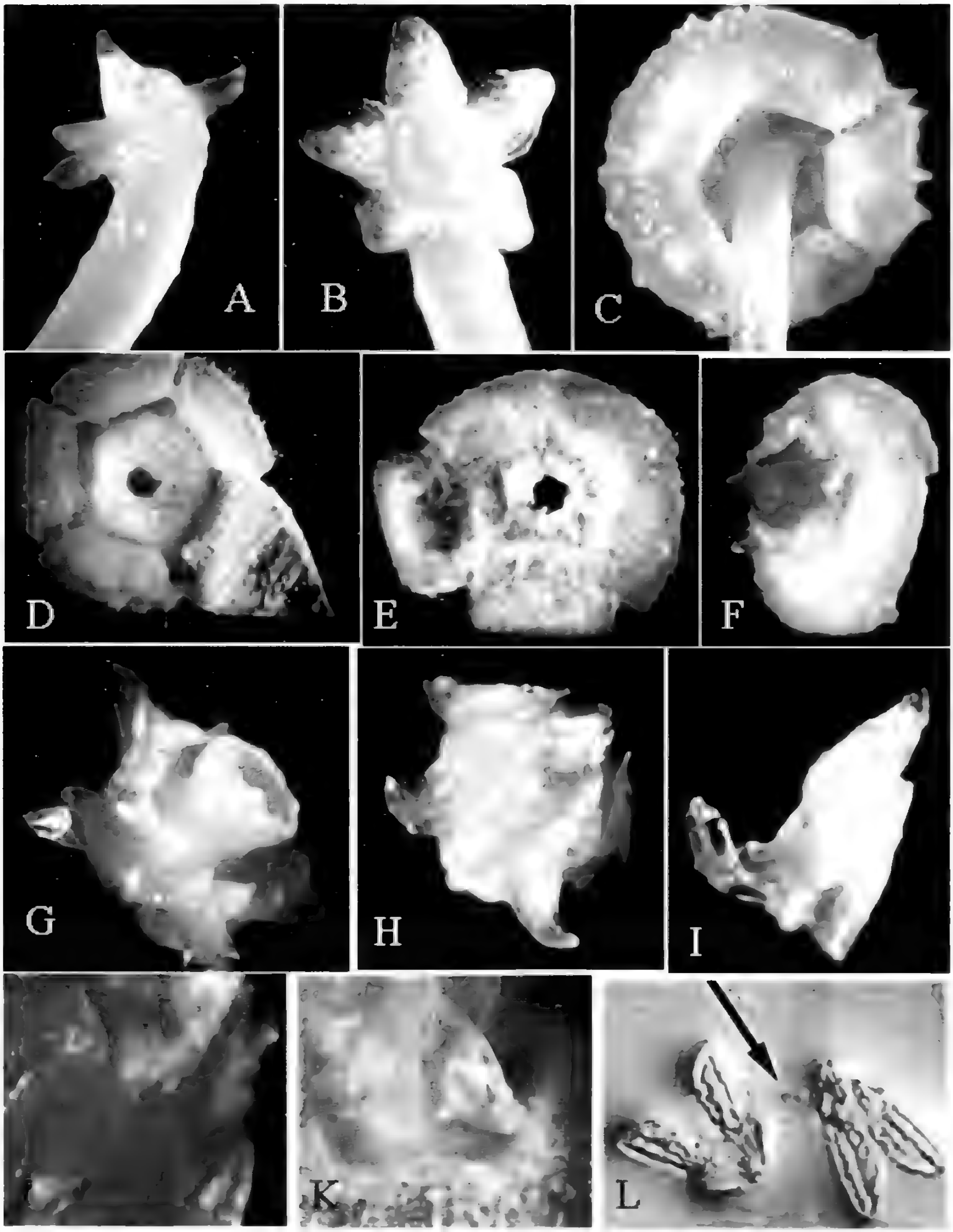

Figure 2. *Hoya yapianum* Kloppenburg, details of inflorescence. A. Pedicel enlarged (×15), showing also calyx and ovary of pistil; B. Top inside view of the calyx enlarged (×15). The sepals are very little overlapped at the base; C. View of ventral side of a flower showing corolla enlarged (×8). Corolla is tightly revolute and outer surface is villous-pubescent except for the area under the corona; D. Outer surface of the corolla enlarged (×8) with one lobe extended, note this surface is glabrous; E. Dorsal surface of corolla (×8). There is a slight pentagonal dip in the corolla center under the corona that is glabrous; F. View of the

flower with corona attached (×8). The corona is reddish in color and the corolla is off white. Crown has center raised with outer lobes long and narrow, with very thin translucent edges. The inner lobe is raised with an acute apex that does not cover the membranous anthers; G. Corona enlarged (×16). The species of Otostemma Section has a very pronounced central column, surface is glabrous but finely crystalline. Note the thin translucent outer coronal lobe at the left extreme; H. Corona dorsal view enlarged (×16). The inner lobes are thin and acute, not covering nor exceeding the inner anther apices; I. Individual scale side view (×16), note the membranous outer scale lobe; J. Flower center showing the inner apex of two lobes (×32). The retinaculum of a pollinarium is visible in the central lower left; K. Area between two adjacent coronal outer lobes (×32). In the center is the anther wing not clearly in focus. Note the thinness of the outer coronal lobes and the central keel. All coronal surfaces are glabrous; L. Above two pollinaria the arrow on scale pointer is 0.1 mm. long (×60).

larger and the pollinia are about 1/3 shorter.

The new species was collected from Brunei by Ms.Wang Luan-Keng and grown to flower by Mr. K. F. Yap on 22 January 2009 in Singapore. Microphotographs and species data taken from materials sent by K. F. Yap.

Note: In size the pollinarium of the new species is close to *Hoya revoluta* Wight, but the outer lobe of the corona of the new species is not divaricate

2. ***Hoya benitotanii*** Kloppenburg, *sp nov.* Section Acanthostemma
A Hoya gigantanganensis *Kloppenburg similes, sed folia ovata-lanceolata apiculatis, basi obtusis vs. linear-elliptic et basi acuminata; 9 × 4 cm vs. 11-16 × 2.4-6.2 cm; calycis lobus rotundatis 0.15 × 0.18 cm longis vs triangularis et 0.21 × 0.17 cm longis; corolla aliquantump parvum differt.* – **Holotypus:** *Kloppenburg 2010-6* (UC) *hic designatus, ex hort.* by Ted Green, Kaaawa, Hawaii. **Figs. 3 & 4**.

A long twining **herb**. **Stem** slender, long, glabrous. **Leaves** ovate lanceolate with an obtuse base, variable in size, 9 × 14 cm long, nerves 3-5, pinnately branched, majour veins extending from base to near apex. Petiole terete. **Inflorescence** umbelliform, consisting of 12-15 flowers. Pedicels pale violet or rose in color, terete, curved, 2 cm long, 0.10 cm in diameter, extremely glabrous and shiny. **Calyx** small, sepals very rounded, ciliate, finely reticulate-veined, 0.15 cm long and 0.18 cm wide with nearly 1/2 overlap; ligules at base white, small. **Corolla** revolute, outer surface glabrous, inside surface finely pubescent with whitish shiny stellate hairs; lobes cut more than half way and the apex acute. **Corona** glabrous, inner lobes spatulate, not long, leaving much more of the anthers exposed. The bilobes with flattened upper surfaces, which are longitudinally sulcate, extending beyond outer lobe apices, and the outer lobe apex drops off sharply as in the other species of *Hoya*. **Anthers** 5, membranous, triangular, covering staminal crown, and exceeding inner lobes. Below the lobes are channeled, but only a short distance toward the

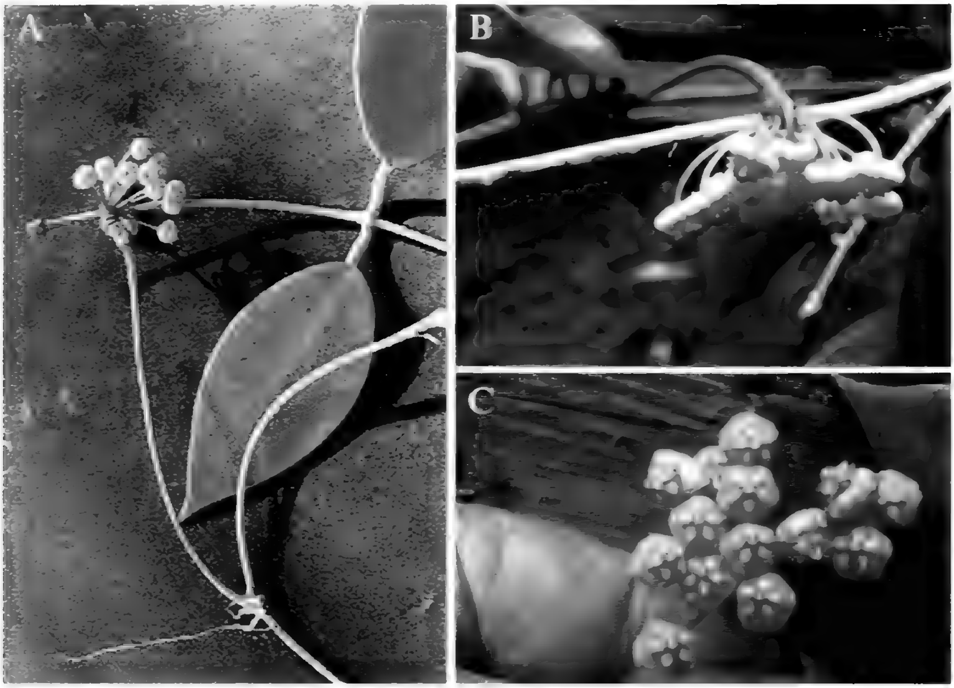

Figure 3. *Hoya benitotanii* Kloppenburg. A. Plant habit (×0.5); B & C. Inflorescence (B: ×1.5; C: ×2.25).

center where there is a prominent thickened column 0.12 cm in diam (inside) and 0.13 cm (outside) and 0.12 cm tall. Central collar is 0.03 cm in diameter (opening) thickened to 0.02 cm and slightly raised. Pollinarium with two long **pollinia**, 0.57 mm long and 0.14 mm wide; translators prominent, 0.10 mm long and 0.02 mm wide; caudicles prominent; the retinaculum has a broad head and body with long well developed extensions. **Fruit** not seen.

Similar to *Hoya gigantanganensis* Kloppenburg but the leaves are ovate lanceolate with an obtuse base versus linear-elliptic with a cuneate leaf base; the calyx lobes are round not triangular, the corolla is slightly smaller. In addition the pollinium are also shorter in this new species.

The garden clone originated from a 1997 collection of David Bicknell taken from the wild in Matutinao in Badian, Cebu, The Philippines, and grown to flower by Ted Green in Hawaii in the Spring of 2003. The original plant was collected from forest at about 50 ft elevation in a coastal mountain a few meters from the seashore. With the report of this new species, the Philippine *Hoya* has now 69 species, many of which are local endemics.

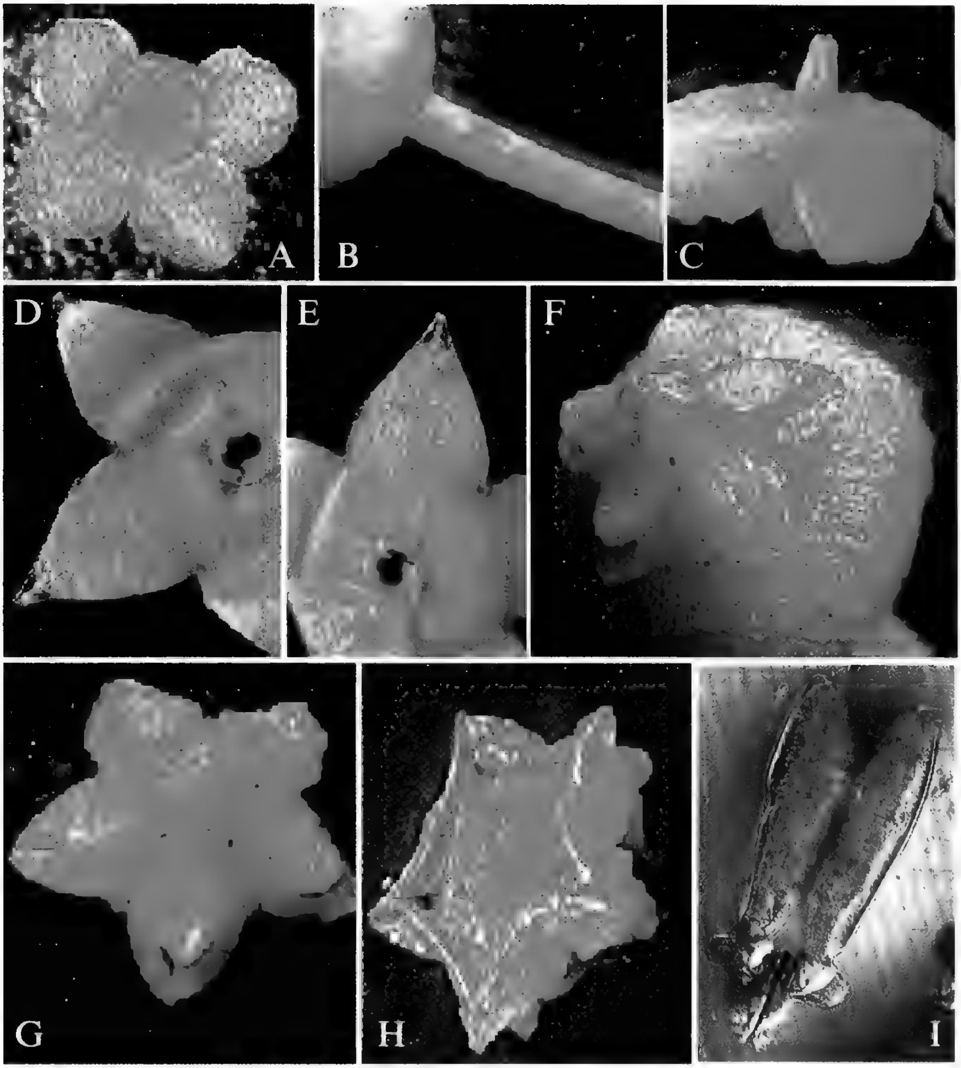

Figure 4. *Hoya benitotanii* Kloppenburg, details of inflorescence: A. Top view of the calyx (×8). These sepals are very rounded as opposed to the triangular sepals found on *H. gigantanganensis*; B. Side view of the pedicel (×8), which is actually pale violet or rose in color; C. Side view of flower with the corona removed showing the revolute corolla and the ovaries (×8); D. & E. Inner (D) and outer (E) surfaces of the corolla (×8). Inner surface is pubescent (D), outer surface is glabrous (E); F. View of the flower (×8). The crown is very similar to that of *Hoya gigantanganensis*, except that the inner lobes are not as long, leaving much more of the anthers exposed; G. & H. Upper (G) and lower (F) views of the corona (×8). Note the inner lobes flare out toward the apex and do not exceed much from the anthers in the center; I. Pollinarium enlarged (×150). The pollinia are very long, translators and caudicles prominent; the retinaculum has a broad head and body with long well developed extensions.

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Pecteilis rawatii (Orchidaceae), a New Species from India

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Abstract

Pecteilis rawatii, sp. nov. (Orchidaceae) is described and compared to its nearest ally, *P. triflora*.

Introduction

The genus *Pecteilis* Rafin. (Orchidaceae) is represented by 5 to 12 species distributed from India to South China and Malesia. In India there are 4 species (Misra, 2007; Govaerts *et al.*, 2008). It is similar to *Habenaria* Willd. and *Peristylus* Blume on the basis of the separate stigmatic lobes, but not freely extending from the column as in *Habenaria*, nor adnate to the hypochile as in *Peristylus*. The rostellum is characteristic in forming a broad band above the stigmatic lobes.

While studying the orchids of Chotanagpur (Kumar *et al.*, 2007), a species that turned out to be *Pecteilis triflora* (D. Don) T. Tang & F.T. Wang was collected (*P. Kumar 051062*, WII). *Pecteilis triflora* was originally described based on a Wallich's collection from Nepal (Original material: *Wallich 7035*, A, K! IDC microfiche 7394; *CAL, L!), but is known to be distributed also in India (Chotanagpur plateau and Uttarakhand) and Bangladesh (Govaerts *et al.*, 2009).

During our research we came across a publication by Hooker f. (1895), who, based on an illustration by Mr. G.C. Dass, described what he thought was an aberrant form of *Habenaria triflora* D. Don (the basionym of *P. triflora*). He noted that it was a plant of unknown origin, "presumably flowered in the Calcutta Botanic Garden" (Fig. 1) and remarked that it represented a many-flowered, gigantic state of *H. triflora*, mentioning some other differences as well. He did not describe it as new as he thought that the best course would be to refer it doubtfully to *H. triflora*.

This publication was largely overlooked until Pradhan (1976, 1979) described *Platanthera triflora* (D. Don.) Pradhan var. *multiflora* Pradhan based on the report. Unfortunately this trinomial was invalidly published as the diagnosis was in English, and not in Latin as is required after 1 January 1935. We now agree that it is a taxon different from *Pecteilis triflora*, and after having seen living material of *P. triflora*, it became clear that this is not a mere variety, but a quite distinct species (Table 1).

Pecteilis rawatii P. Kumar & Veldk., *sp. nov.*
Syn. *Platanthera triflora* (D. Don.) Pradhan var. *multiflora* Pradhan, Indian Orchids: Guide Identif. & Cult. 1:57 (1976), *inval., anglice; ibid.* 2:680 (1976), *sine descr.*

Pecteilis triflorae *(D. Don) T. Tang & F.T. Wang similis, foliis bracteatisque fasciculatis, floribus plus quam 3, labii lobis lateralibus apice rotundato, margine integra, lobo medio lobis lateralibus longiore, columna latiore differt. Pecteilis triflora folia breacteaeque distantiter dispersae, flores haud plus quam 3, labii lobi laterales apice acuto, margine crenulata, lobo medio lobis lateralibus multo breviore, columna quadrata gaudet.* – **Typus:** *Hooker f., Ann. Roy. Bot. Gard. (Calcutta)* 5: t. 99. 1895. **Figs. 1 & 3.**

Plant terrestrial, herbaceous, erect with stout **stem**. **Leaves** many, green, glabrous, single veined, densely placed in the lower half on the plant, base sheathing, blade ovate, acute, margins entire. Leaves smaller and narrower upwards, gradually decreasing in size, becoming bract-like. Inflorescence terminal, short and dense, erect. Floral bracts green, glabrous, many, single veined, base slightly sheathing the ovary, ovate, acute, margins entire, longer than ovary. **Flowers** 9, pure white, densely placed. Sepals subequal in size, midvein longitudinally ridged on the outer side, with two veins on either side. Dorsal sepal ovate, apex obtuse, slightly notched. Lateral sepals broadly ovate, apex obtuse. **Petals** linear, 1-veined, slightly constricted in the lower half. Labellum trilobed, partition of lobes extending till the centre of the lower half of labellum; lateral lobes broadly ovate, gradually constricting towards the base, with a transverse basal callus, entire, apex rounded; midlobe linear, distinctly longer than the lateral lobes, 1-veined, apex acute; spur with a wide opening in the hypochile, gradually tapering and then again broadening towards the apex, much longer than ovary. **Column** concave; rostellum forming a broad transverse band above the broad, slightly concave stigmatic lobes. **Anther** locules obpyriform, diverging towards the apex of the column. **Pollinia** oblong, apex acute, caudicle thin, viscidium present (Fig. 1).

Distribution. India, possibly once cultivated in Calcutta, original provenance unknown.

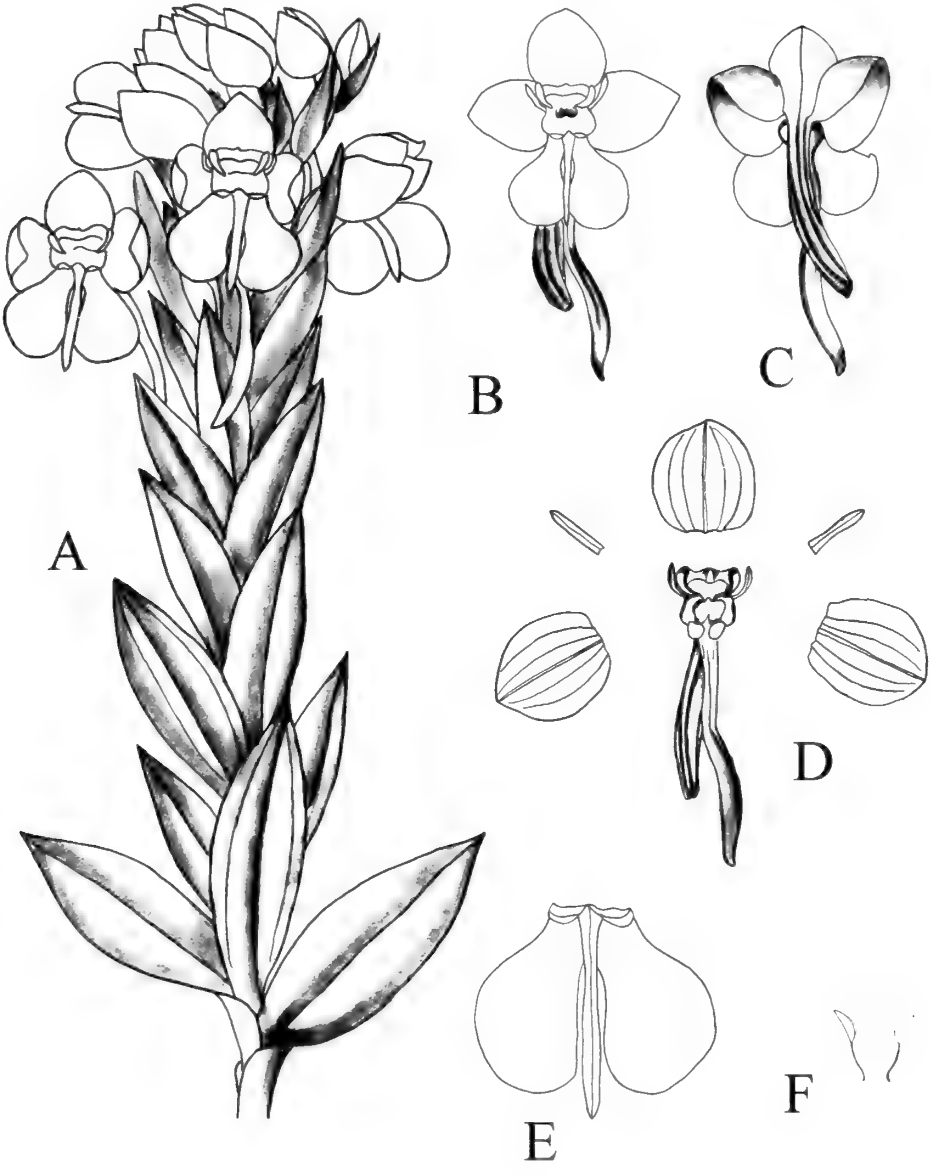

Figure 1. *Pecteilis rawatii* P. Kumar & Veldk. A. Plant; B. Flower (front view); C. Flower (dorsal view); D. Dissected flower and column; E. Labellum; F. Pollinia; (illustration redrawn from Hooker f., 1895 by P. Kumar).

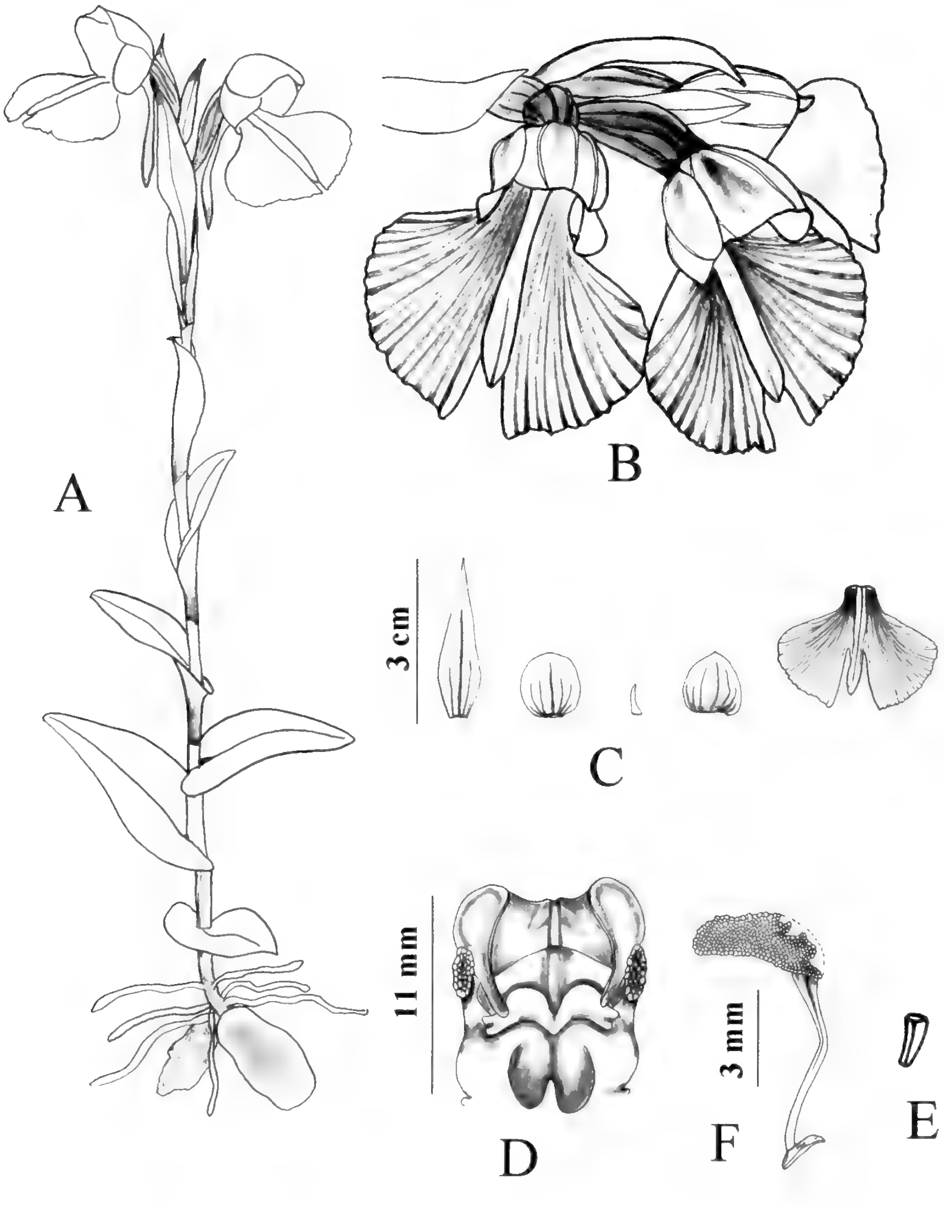

Figure 2. *Pecteilis triflora* (D. Don) T. Tang & F.T. Wang. A. Plant; B. Flower; C. Dissected flower (floral bract, dorsal sepal, lateral petal, lateral sepal and labellum); D. Column; E. Pollinia; F. Single pollen (based on *P. Kumar 051062*, WII). (Drawn by P. Kumar).

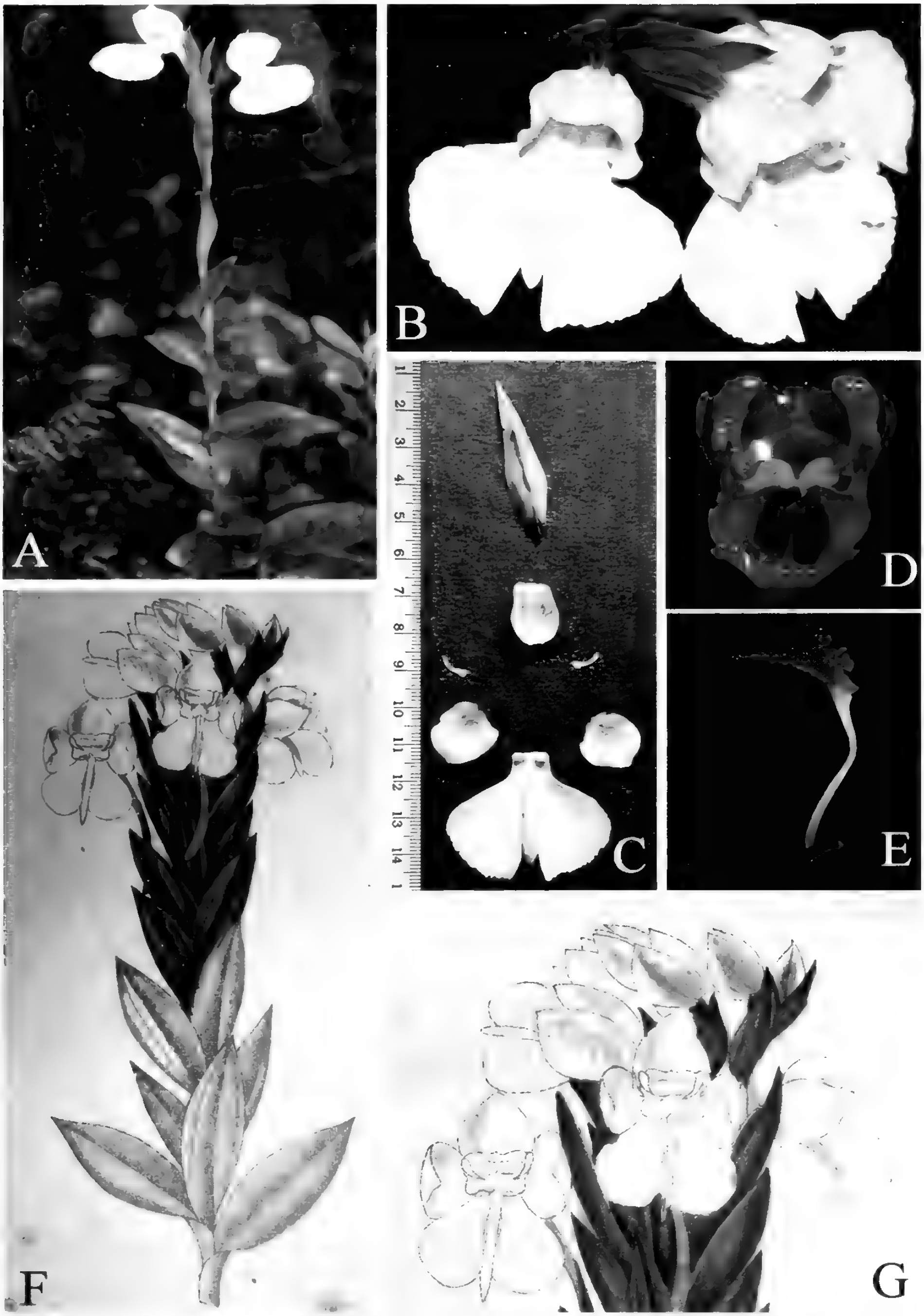

Figure 3. *Pecteilis triflora* (D. Don) T. Tang & F.T. Wang (A-E). A. Habit; B. Close up of flower; C. Dissected flower; D. Column; E. Pollinia. *Pecteilis rawatii* P. Kumar & Veldk. (F-G). F. Habit; G. Close-up of flower [A-E: based on *P. Kumar 051062*, WII, photos by P. Kumar; F & G, courtesy of Singapore Botanic Gardens].

Etymology. Named after Prof. Dr. Gopal Singh Rawat, Wildlife Institute of India (WII), who is one of the leading phytotaxonomists and ecologists of India and a source of inspiration for his students including the first author and colleagues.

Table 1. Differences between *P. rawatii* (Fig. 1) and. *P. triflora* (Fig. 2).

Character states	*Pecteilis rawatii*	*Pecteilis triflora*
Leaves	Densely placed, 5 or 6, apex acute but not sharply pointed.	Scattered on the stem, many, apex sharply pointed_acute.
Inflorescence	*ca* 9 flowered	1-3 flowered
Flower	Sepals and petals widely spread, each with two lateral veins on each side of the midrib. Base of lateral sepals oblique.	Sepals and petals forming a hood, each with three lateral veins on each side of the midrib. Base of lateral sepals truncate.
Labellum	Midlobe much longer than the side lobes. Margins of lateral lobes entire and apex rounded. Base of midlobe broadly cuneate.	Midlobe (much) shorter than the lateral lobes. Margins of lateral lobes crenulate and apex acute. Base of midlobe elongated and shortly attenuate.
Column	Column broader towards the upper side.	Column more or less square

Acknowledgements

The authors wish to thank the Mr. P.R. Sinha, Director (WII); Dr. G.S. Rawat (WII); Dr. C. Sathish Kumar, Coordinator, All India coordinated research project on the Taxonomy of Orchids; Dr. J.R. Bhatt, Director, GOI-MOEF; Dr. D. Scherberich (LYJB); Mr. P. Boyce, Kuching, Sarawak, Malaysia; Dr. P. Cribb, Dr. J.J. Wood and Renata Borosova (K) for translations from the Latin, provision of digital images of type materials and valuable suggestions. The authors are also thankful to Dr. Jana Leong-Škorničková, Singapore Botanic Gardens (SING), for her valuable suggestions and also for providing the images of colour plates from Hooker (1895).

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Land Use, Land Cover Change and Conservation in the Dipterocarp Rain Forest Area of Southern Yunnan, China

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Abstract

Based on Landsat TM/ETM images from 1988, 2003 and field data of 2006, land uses and land cover changes were researched over 18 years in the dipterocarp rain forest area in Southern Yunnan of China. The expansion of rubber plantations has resulted in a dramatic decrease in natural forest cover, especially the tropical seasonal rain forest at lower elevation. In 1988, rubber plantations covered 765.06 ha which increased to 2,294.07 ha in 2003, with an annual rate of change at 13.32%. The pace of change increased after 2003, with a change of 213.69 ha per annum. The tropical seasonal rain forest has decreased by 111.35 ha per annum since 1988 in the study area. Arable lands increased during 1988 and 2003 but declined rapidly from 2003 to 2006 due to expansion of rubber plantations and the construction of reservoirs. There was an increase in water bodies from 2003 to 2006 as well as construction areas. Market prices, policies, increasing population, and the unregulated pursuit of commerce and trade, at times at the cost of the environment were the main driving forces of change. We suggest that local government takes strong action to regulate further expansion of rubber plantations and creates conditions for sustainable and harmonious development of economy, society and natural resources in biodiversity rich region of Southern Yunnan.

Introduction

With the increasing concern about global climate change and biodiversity conservation, study of land uses and land cover changes (LUCC) has become an extremely important and hot topic (Li, 1996). LUCC is one of the most important human alterations affecting the surface of the earth (Lambin *et al.*, 2001). It directly impacts biodiversity (Sala *et al.*, 2000), contributing to local extinction and regional climate changes (Chase *et al.*, 1999), and causing land degradation by altering ecosystem services and livelihood support systems (Vitousek *et al.*, 1997).

There have been dramatic land uses and land cover changes in some places in China in recent years. By using remote sensing (RS) and geographic information system (GIS), Chinese scholars have carried out many studies on land use and land cover change detections and their impacts on the environments (Gao *et al.*, 2002; Li *et al.*, 2003, 2007; Liu *et al.*, 2006).

Southern Yunnan bordering Laos and Myanmar, is in a biogeographical transition zone between tropical SE Asia and temperate East Asia, and is one of the most biodiversity-rich regions in China (Zhu, 1997). The dipterocarp rain forest is the most species-rich plant community in southern Yunnan (Zhu, 2000). It is dominated by the species *Parashorea chinensis* (Dipterocarpaceae), a first grade protected plant species at national level. However, during the last few decades, forest cover has dramatically decreased from 60% to 27% (Zhang and Cao, 1995; Liu *et al.*, 2005). Currently, forests remain primarily in nature reserves and state forests, and land areas outside nature reserves, which were previously forested, have largely been converted into rubber plantations. There is an essential and urgent research need to survey the land uses and land cover changes in tropical region in China in order to collect and update scientific data and to provide suggestions on how to improve the land use policy in a way that balances economic needs with biodiversity conservation. Our work here focuses on a dipterocarp rain forest area in Southern Yunnan and presents findings for a discussion on the land uses and land cover changes. It also shows the underlying driving forces in the local tropical rain forest and, thereby, provides a scientific basis for biodiversity conservation and management of the forest *in situ*.

The Study Area

The study area is located in the administrative region of Xishuangbanna, which includes three counties (Menghai, Jinghong and Mengla), and borders on Laos to the South and Myanmar to the Southwest (Fig. 1). The topography of Xishuangbanna consists of alternating hills and valleys, with elevations ranging from 2,430 m above sea level (asl) in the North and 480 m asl in the South. About 95% of the region is mountainous and hilly. The Mekong River cuts through Xishuangbanna, and the region contributes more than 20 important tributaries, resulting in many river valleys and small basins (Cao and Zhang, 1997). This region has basically a tropical monsoon climate. In the lower hills and valleys, the annual mean temperature is about 20° C, and frost has never been recorded. The annual precipitation is about 1,500 mm, of which more than 80% falls during the rainy season, which starts in May and lasts until the end of October. The dry season from November to April is characterized by little rain, but there is always heavy fog and dew, which can compensate for lack of rain. Thus the tropical rain forest in the region occurs only at lower elevations. It was also revealed that the occurrence of the tropical rain forest in southern Yunnan is more influenced by local habitats and microclimates than the regional climate (Zhu, 2004, 2008)

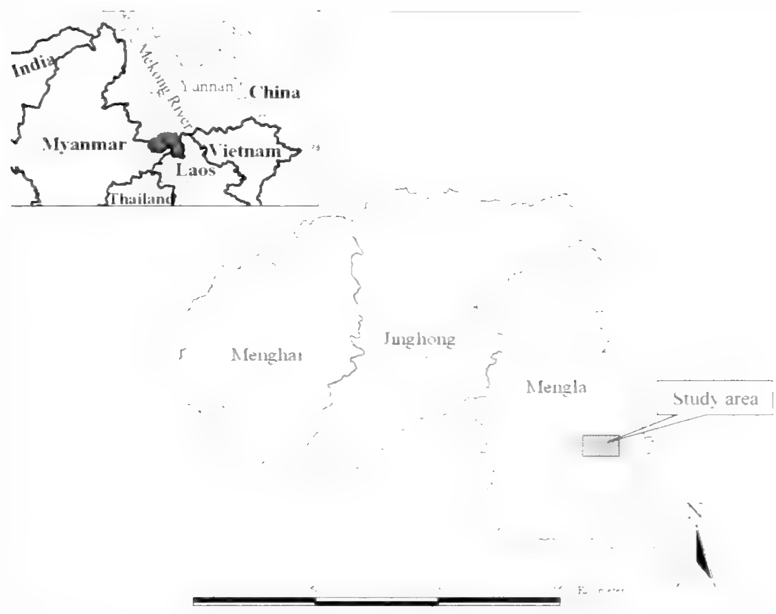


Figure 1. Xishuangbanna region and the location of study site.

The dipterocarp rain forest in Xishuangbanna is located mainly in the South of Mengla County (Zhu, 2000). Our study site (21°33'~21°38' N, 101°32'~101°41'E) covers the whole distribution of dipterocarp rain forests encompassing an area of 125 km^2. The altitude varies from 650 m to 1,600 m asl. The dipterocarp rain forest occurs in the area mainly below at 900 m asl, and other vegetation types such as tropical montane evergreen broad-leaf forest occurs in the mountains (Zhu *et al.*, 2005).

Materials and Methods

Data Sources

We obtained a Landsat Thematic Mapper (TM) image (2 February 1988-#130/45) and a Landsat Enhanced Thematic Mapper (ETM) image (7 March 2003-#130/45) of the study area. Both images were acquired during the dry season. Four land use maps (scale = 1:25000) developed by the Xishuangbanna Department of Land and Resource Management (Xishuangbanna Land Use Status Map, 1991) were used as references for the classification of the TM image. Four topographic maps (scale = 1:25,000) published by the China State Bureau of Surveying and Mapping were used to correct the images of 1988 and 2003 and to draw the land use map of 2006.

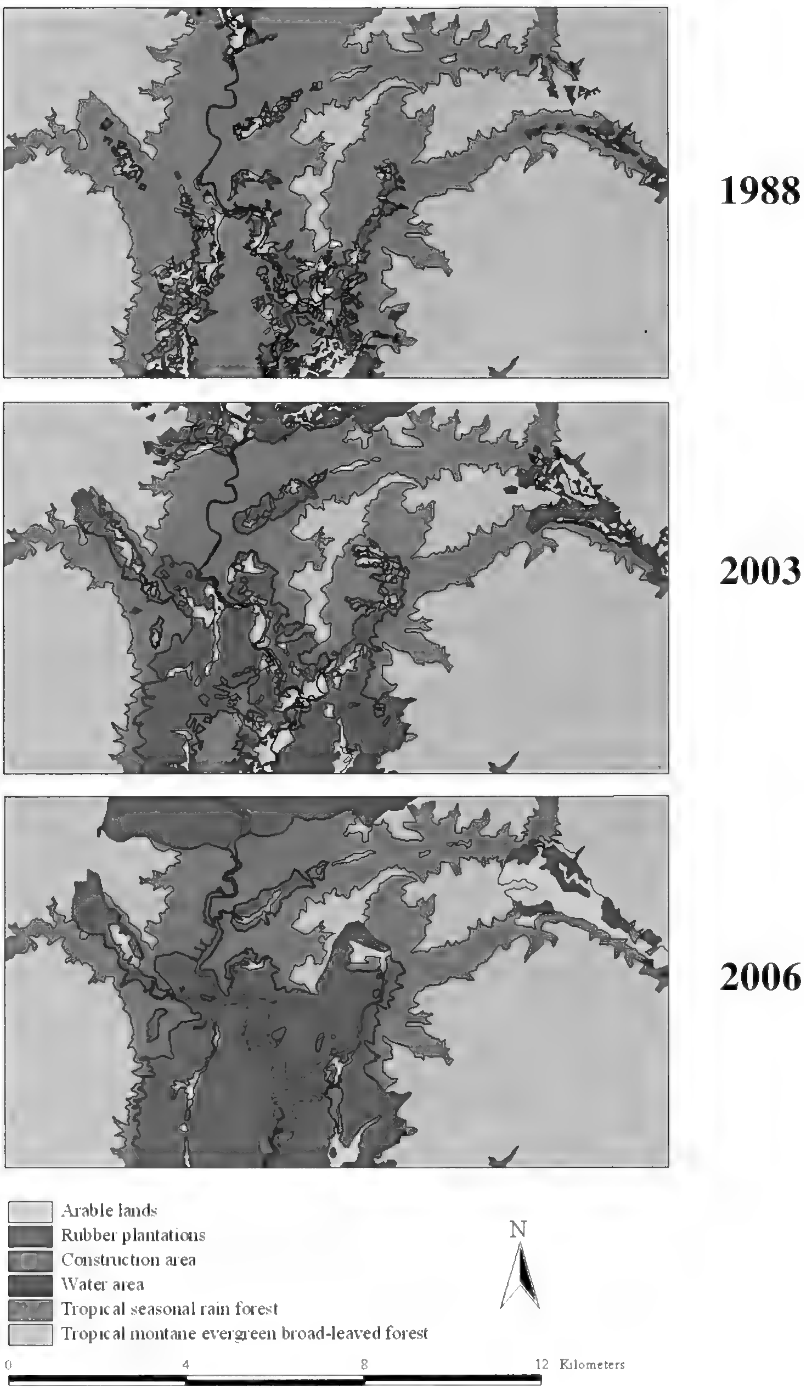


Figure 2. Land use in the distribution area of dipterocarp rain forest in Xishuangbanna, SW China in 1988, 2003 and 2006.

Data processing

Based on the land use classes developed by the National Agricultural Zoning Committee (1984), as well as characteristics of the images of study area, land uses were categorized into 5 classes (Table 1): arable lands, rubber plantations, forests, developed/constructed areas and water bodies. Due to low resolution of images, it was difficult to classify the land use types in detail; hence, the forest was simply divided into tropical seasonal rain forest and tropical montane evergreen broad-leaf forest based on elevation. Shrublands were incorporated into forests, grasslands and sugar cane fields were incorporated into arable lands.

The TM and ETM images had already undergone radiant correction, so we only had to do the geometric correction. Both images were rectified to the topographic maps and the rectification errors were <0.5 pixels.

After the correction, the images were classified using the supervised maximum likelihood classification method. For each land use type, at least 10 training areas were used to reflect the variation within a land use due to topography and slope effects.

The classified images were then transformed by using clump, elimination and filter options in Erdas Imagine (Version 8.7, Leica Geosystems). Then with the ArcView GIS (Version 3.3, Environmental Systems Research Institute, Redlands, USA) and ArcGIS (Version 8.3, Environmental Systems Research Institute, Redlands, USA), the transformed images were converted to land use maps for analysis.

The paper topographic map was firstly magnified and used in the field to draw the outline of the land use map of 2006 by using contour, topography and other information from the topographic map. The current land use cover was determined at the field site and the locations were determined by using a global positioning system (GPS). The GPS points were also used to prepare the land use map of 2006 and to assess the accuracy of the land use maps of 1988 and 2003. The field works lasted two weeks and covered the whole study area. The working map was scanned and digitized, and finally was made into a land use map of 2006 using ArcGIS.

The accuracy of the classification of both images of 1988 and 2003 was verified by the points obtained in the field in 2006. All land use maps (1988, 2003, 2006) were rectified to Albers Conical Equal Area projection system, with Beijing 54 datum and Krosovsky ellipsoid. By using ArcView GIS, the database of the land uses and land cover changes of 1988, 2003 and 2006 was determined, which was used to analyze land use and land cover changes during the research period.

Table 1. Land use classes used in our image classification.

Land use class	General description
Arable lands (AL)	Shifting cultivation or permanent agriculture (e.g. paddy rice, dry lands, fallow lands, slash and burn)
Rubber plantations (RP)	Forested areas with rubber trees clearly planted in rows and deciduous during the dry season, having a homogeneous canopy
Tropical seasonal rain forest (TSRF)	Forested areas with a canopy cover more than 30% and below 900 m above sea level.
Tropical montane evergreen broad-leaf forest (TMEBF)	Forested areas with a canopy cover more than 30% and above 900 m above sea level.
Construction areas (CA)	Land covered by constructions, including urban areas, residential areas, factory and traffic areas
Water areas (WA)	Natural terrestrial water, including river, pool, lake and reservoir

Notes: The construction areas in the study site are dispersed and too small to be distinguished from the images, so we just made a simple estimate of the increased area from 2003 to 2006. There are many rivers in the study area, but most of them are also too small to be distinguished from the images, so we only considered the charge of Nanla River, the biggest river in the study area.

Data analysis

The annual change rate index was used to reflect the rate of land use and land cover change (Wang *et al.*, 1999), and it may be expressed by the following equation:

$$K = \frac{U_b - U_a}{U_a} \times \frac{1}{T} \times 100\%$$

In this expression, K was the annual rate of change of one land use class, U_a and U_b were the initial and the final area values of the research period respectively, and T was the time (year) of the period.

The contribution rate of LUCC was used to reflect the source of existing land use class, and it could be expressed as follows:

$$B_{dij} = \frac{U_{bij}}{U_{bj}} \times 100\%$$

In this expression, B_{dij} was the contribution rate of land use type i to j from the initial time a to the ending time b of the research period. U_{bij} was the area that land use type i turned to j, and U_{bj} was the area of land use type j in time b.

In order to analyze the change of the major land use type (Zhu *et al.*, 2003), there is another index—the intensity index of LUCC.

$$K = \frac{U_{bj} - U_{aj}}{U} \times \frac{1}{T} \times 1000‰$$

In this expression, K is the change intensity index of the land use class j, U is the area of the whole study site, U_{aj}, U_{bj} is the initial and the final area of j of the research period respectively, and T is the duration time (year) of the period.

Results

Area changes in land cover

Changes in land cover in the study area from 1988 to 2006 are shown in Fig. 2 and summarized in Table 2. The most obvious change was the decrease in forest cover and an increase in rubber plantations. In 1988, the area of rubber plantations was 765.06 ha, which increased to 2,294.07 ha in 2003, with an annual rate of change at 13.32%. However, the expansion of rubber plantation has further accelerated since 2003, increasing 213.69 ha per annum. The forested area declined rapidly from 1988 to 2006, especially the tropical seasonal rain forest at lower elevation, at a decreasing rate of 111.35 ha per annum. The forest at higher elevation also declined rapidly during 2003 and 2006. The arable lands increased during 1988 and 2003 but declined rapidly from 2003 to 2006. Water body in the study site did not change before 2003, but abruptly increased after 2003 due to the building of a big reservoir-Dashaba Reservior on Nanla River. The open-up area for settlement also increased with the building of the reservoir.

Transitions in land cover

Table 3 and Table 4 are contribution matrixes showing resources of existing

Table 2. Area changes of land use classes of the study area in different time period.

	AL	RP	TSRF	TMEBF	WA
Area (ha)					
1988	389.51	765.05	4653.50	6709.90	40.16
2003	509.59	2294.07	3202.47	6511.83	40.16
2006	403.68	2935.13	2649.23	6236.41	333.67
% of area coverage					
1988	3.10	6.09	37.06	53.43	0.32
2003	4.06	18.27	25.50	51.85	0.32
2006	3.21	23.37	21.10	49.66	2.66
Change area (ha)					
1988—2003	120.08	1529.02	-1451.03	-198.07	0.00
2003—2006	-105.91	641.06	-553.24	-275.42	293.51
Annual change area (ha)					
1988-2003	8.01	101.93	-96.74	-13.20	0.00
2003-2006	-35.30	213.69	-184.41	-91.81	-
Annual change rate (%)					
1988-2003	2.06	13.32	-2.08	-0.20	0.00
2003-2006	-6.93	9.31	-5.76	-1.41	-

Notes: The increase of water area is due to the construction of the reservoir and it is a once-off activity, so we don't calculate its annual change area and annual change rate. [AL: arable lands; RP: rubber plantations; TSRF: tropical seasonal rain forest; TMEBF: tropical montane evergreen broad-leaf forest; WA: water area.]

Table 3. Contribution matrix of land-cover categories in the study area between 1988 and 2003 (%).

1988	2003				
	Arable lands	Rubber plantations	Water area	TSRF	TMEBF
Arable lands	28.49	9.66	0.00	0.71	0.00
Rubber plantations	31.23	24.78	0.00	1.10	0.08
Water area	0.00	0.00	100.00	0.00	0.00
TSRF	35.17	58.00	0.00	98.19	0.01
TMEBF	5.11	7.56	0.00	0.00	99.91

Table 4. Contribution matrix of land-cover categories of study area between 2003 and 2006 (%).

2003	2006					
	Arable lands	Rubber plantations	Water area	CA	TSRF	TMEBF
Arable lands	24.23	8.71	34.19	71.13	0.71	0.08
Rubber plantations	47.23	60.75	39.40	24.23	5.88	0.66
Water area	0.00	0.01	12.22	0.52	0.00	0.00
TSRF	11.52	21.78	14.19	4.12	93.41	0.00
TMEBF	17.02	8.75	0.00	0.00	0.00	99.26

land cover classes of 2003 and 2006. Except for the water area, all other land use categories contributed to increasing rubber plantations. Increase in rubber plantations took place in the tropical seasonal rain forest. The water body area increased between 2003 and 2006 at the expense of arable lands as well as rubber plantations. The cleared settlement area also increased with the completion of the reservoir, mainly at the expense of arable lands and rubber plantations. A large part of tropical mountain evergreen broad-leaf forest converted to agricultural use between 2003 and 2006 was the result of sugar cane planting.

Change intensity in land cover

Fig. 3 shows the change intensity index of land use categories from 1988 to 2006. The intensity of change between 2003 and 2006 is much higher than that between 1988 and 2003. Analyzing the change intensity of these two periods respectively, we found that rubber plantation was the major land cover category of LUCC between 1988 and 2003, with a change intensity index of 8.12‰, followed by the tropical seasonal rain forest, with a change intensity index of -7.70‰. Rubber plantation was still the major land-cover category of LUCC after 2003, with a change intensity index of 17.02‰, followed by tropical seasonal rain forest, water bodies, tropical montane evergreen broad-leaf forest, and arable lands.

Discussion

This study investigated the changes in land use and land cover of dipterocarp rain forest area in Xishuangbanna from 1988 to 2006. The results showed a dramatic change in land use and land cover in the study area. The most obvious change was a decrease in forest cover and an increase in rubber plantations. From 1988 to 2003, rubber plantations increased at a rate of

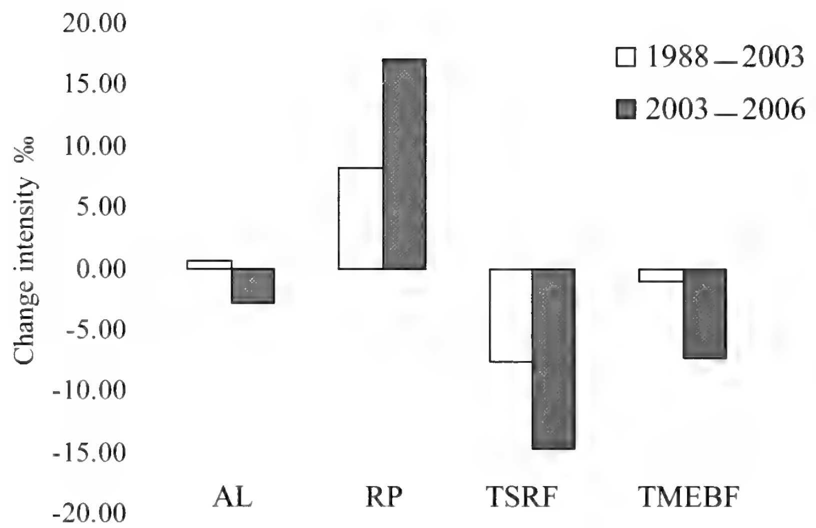
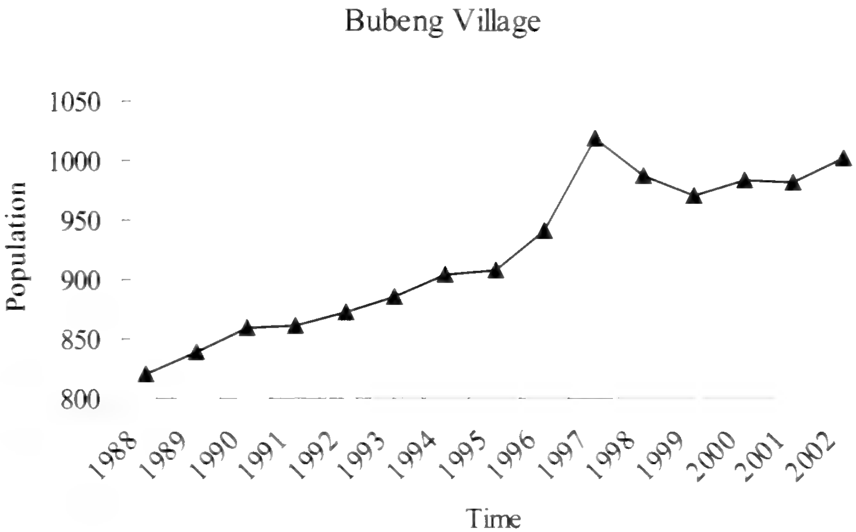


Figure 3. Comparison of land use intensity (using the permillage to describe) of study area from 1988 to 2006. [*AL*: arable lands; *RP*: rubber plantations; *TSRF*: tropical seasonal rain forest; *TMEBF*: tropical montane evergreen broad-leaf forest; *WA*: water area.]

101.93 ha per annum, between 2003 and 2006 this rate increased to 213.69 ha per annum. In contrary, the area of tropical seasonal rain forest and tropical mountain evergreen broad-leaf forest declined continually over time, especially the tropical seasonal rain forest at a rate of 111.35 ha per annum. In recent years, tropical mountain evergreen broad-leaf forest has declined faster as a result of rubber plantations expanding also to higher elevations in the region. Arable lands also decreased rapidly between 2003 and 2006 from the expansion of rubber plantations and the building of Dashaba Reservoir on Nanla River. The normal water level of the reservoir was about 680 m asl. After the construction of reservoir, some arable lands were submerged and others were replaced by buildings of hydropower station, house, hotel, parking sites, recreation ground, etc., which resulted in an increase of constructed area from 2003 to 2006.

The research also showed that almost all land use categories, in particular the tropical seasonal rain forest at low elevation, contributed to the increase of the rubber plantations. The change intensity of LUCC also became larger than before and the remaining forests, including the dipterocarp rain forest, are threatened by the expanding rubber plantations.

Increasing population is the basic driving force at LUCC, with the increasing demand for food, housing and public facilities, which resulted in the expansion of rubber plantations, arable lands and construction areas.



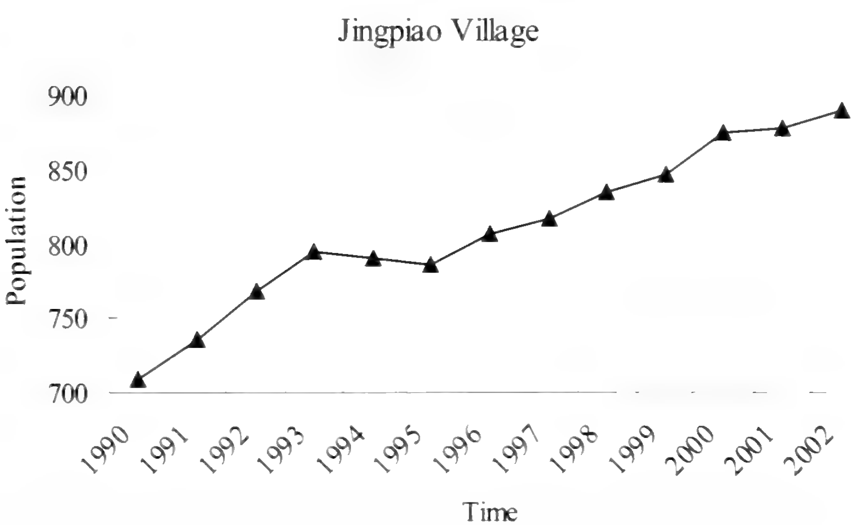


Figure 4. The changes of population of Bubeng and Jingpiao Village in recent years.

The population of the study area increased rapidly during the past 18 years. Figure 4 shows the populations of Bubeng and Jingpiao Village of the study area from 1988 to 2002.

The Household Responsibility Policy provided land to individual households and the local people have the rights to manage their own lands. With the development of the market economy in China, the increasing market price has a profound effect on land use. The price of natural rubber is constantly rising, which increases people's enthusiasm for rubber planting. As a result, rubber plantations became the major income source for local people in the study region.

The dipterocarp rain forest is the most species-rich community in southern Yunnan and is dominated by the species *Parashorea chinensis* (Dipterocarpaceae), a first grade protected plant species at national level. Similar tropical rain forests occur also at ca 27° 31' N in northeastern India (Proctor *et al.*, 1998) and Burma (Kingdon-Ward, 1945), but these places still have basically tropical wet climates due to their geographical location and lower elevations.

The tropical rain forest in southern Yunnan occurs really at the northern climatic limits of tropical rain forest and is unique in biogeography and biodiversity conservation. The forest is at present strongly protected by the government policy. However, over the past 18 years, there has been a dramatic land uses and land cover changes in its area of distribution. In our research, we found that almost all forests and shrubs outside the nature reserves were converted to rubber plantations. In some places, even the nature reserves were nibbled away by rubber plantations. The dipterocarp rain forests have become quite fragmented and exposed to other external impacting factors. These include changes in the micro-climate of the habitat and the physicochemical property of the soil, which would consequently change the characteristics of the plant communities and their inherent biodiversity (Liu *et al.*, 2001, Sophia *et al.*, 2000, Zhu *et al.*, 2004).

We suggest that local government takes strong action to control further expansion of rubber plantation and creates a sustainable and harmonious development of the local economy, the society and natural resources in the region of biodiversity rich dipterocarp forest area in southern Yunnan.

Acknowledgements

This project was funded by the National Natural Science Foundation of China (30570128, 30770158), also by the grant 2007 OFA 91660-5. We thank M. Ma who provided invaluable assistance with data collection and H. Wang, S.-S. Zhou who assisted with fieldwork. We also offer thanks to H.-M. Li, W.-J. Liu, Y.-J. Zhang and L.-P. Yang for their helpful comments on the manuscript. We are very grateful to Mr. Hasan Moinuddin from GMS Environment Operations Center for his help in English improvements on the manuscript.

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Siliquamomum oreodoxa (Zingiberaceae): a New Species from Southern Vietnam

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Abstract

The second species of *Siliquamomum* (Zingiberaceae), *S. oreodoxa* N.S.Ly & Škorničk., is described as new and illustrated. The two species in the genus are compared and a key is provided for their identification.

Introduction

The genus *Siliquamomum* was described by Baillon (1895) based on a collection made by Benedict Balansa in Lankok valley of Ba Vi Mountain, Tonkin (North Vietnam). The only representative of the genus known till date, *S. tonkinense* Baill., has also been reported from SE Yunnan, China (Wu and Larsen, 2000; Gao *et al.*, 2005) where it is found in dense forests in mountain valleys at 600-800 m elevation.

During an expedition in southern Vietnam in June 2008, the first author found a *Siliquamomum* species growing quite abundantly at *ca* 1500 m in a moist and shady area of Bidoup Nui Ba National Park. The type material of *S. tonkinense* (*Balansa 4218*, Nov 1887, 4 sheets, P) was located and examined and the original description by Gagnepain (1908) studied. The material collected by us is different in several significant characters and a new species is therefore described below including a colour plate. In addition, a key to the two species of *Siliquamomum* is provided.

Siliquamomum oreodoxa N.S. Ly & Škorničk., *sp. nov.*
Siliquamomo tonkinensi *similis, surculo foliaceo multifolio (foliis 9-13 contra 3), petiolo breviore (ad 2 cm contra 2.5-9 cm longum), laminis minoribus (12-18 × 3-4.5 cm contra 25-42 × 7-12 cm), inflorescentia breviore sed densiore (ad 9 cm longa floribus 8-25 contra 13-15 cm longum floribus ca 12) differt.* – **Typus:** Vietnam, Lam Dong Province, Lac Duong District, Bidoup Nui

Ba National Park, Cong Troi station, along the road between Yang Ly and Hon Giao station, alt. 1449 m asl., 12° 10' 41.9" N, 108° 43' 26.4" E, 14 Jun 2008 (flowering), *Hul & Ly Ngoc Sam 3583* (holo, VNM; iso, E, P, SING with flowers in alcohol). **Figs. 1 & 2.**

Terrestrial **herb** forming loose clumps. **Rhizome** subterranean, branched, *ca* 0.8-1.2 cm in diam., creamy white externally and internally, slightly aromatic; scales papery, brown, triangular scales, *ca* 1-2 cm long. **Leafy shoots** *ca* 3–5 cm apart, 0.9 m long, leafless for about 15-30 cm from the base, with 9-13 leaves per shoot. Leafless sheaths 3-5, yellowish green when young, turning dark brown-green with age, glabrous with dark brown margins. Ligule *ca* 2-3 mm long, bilobed, dark brown, becoming papery and brittle with age, glabrous. Petiole 1-2 cm long, green, glabrous. Lamina elliptic to narrowly ovate, (9.5-) 12-18 × (2.5-) 3-4.5 cm, dark green and glossy above, slightly lighter beneath, apex acuminate, base cuneate, margin entire. **Inflorescence** terminal, peduncle enclosed by leaf sheaths of the pseudostem, terminated by a lax pendulous thyrse with 8-25 flowers, first (lowermost) and second bract at the base of thyrse boat-shaped, 4.5-7 × 1.8-2.5 cm, light green, glabrous, sometimes with a small lamina at the apex, enclosing the budding inflorescence, soon caducous, leaving semicircular scars on the axis, fertile bracts narrowly ovate to elliptic, the bract subtending the lowermost cincinnus the biggest, *ca* 25-30 × 6-8 mm, those subtending upper cincinni usually minute, bluntly triangular *ca* 1-8 × 1-1.5 mm, whitish green, turning papery brown, soon dehiscent (best seen in young inflorescences with unopened buds), axis of thyrse to 9 cm long (measured from the lowermost caducous bract to the top of the axis), to 2 mm diam., light green, glabrous, cincinni 1-3 flowered at the base of the axis, single flowered at the top, bracteoles absent. Pedicel 3-6 mm, *ca* 1 mm diam., light green, glabrous. **Flower** *ca* 5.5 cm long, calyx tubular 18-25 mm long, 6-7 mm diam. at broadest, unilaterally slit *ca* 9-11 mm, translucent white sometimes with a slight pink tinge near margin, glabrous, 3-toothed at apex, teeth 3-5 mm long, 4 mm wide at base, becoming brownish and papery with age. Floral tube 19-21 mm long, white, glabrous at base, sparsely hairy at apex, dorsal corolla lobe elliptic-oblong, concave, 22-27 × 8-10 mm, translucent white, glabrous, lateral corolla lobes oblong to obovate-oblong, concave, 20-24 × 6-8 mm, translucent white, glabrous. **Lateral staminodes** connate to labellum in basal third, oblong-obovate, apex rounded, 19-21 × 11-13 mm, white, glabrous, margin slightly undulate. Labellum obovate, 22-26 mm long, 18-20 mm wide at broadest, apex obtuse to retuse, white at periphery with dark green patch with yellow margins in the centre, adaxially hairy along the midline and green patch, hairs *ca* 1 mm long, white, glabrous abaxially. **Stamen** 15-20 mm long, filament 6-8 × 2-2.5 mm, white, sparsely hairy at base. Anther 9-12 × 3-3.5 mm, attached to filament at 160°, white

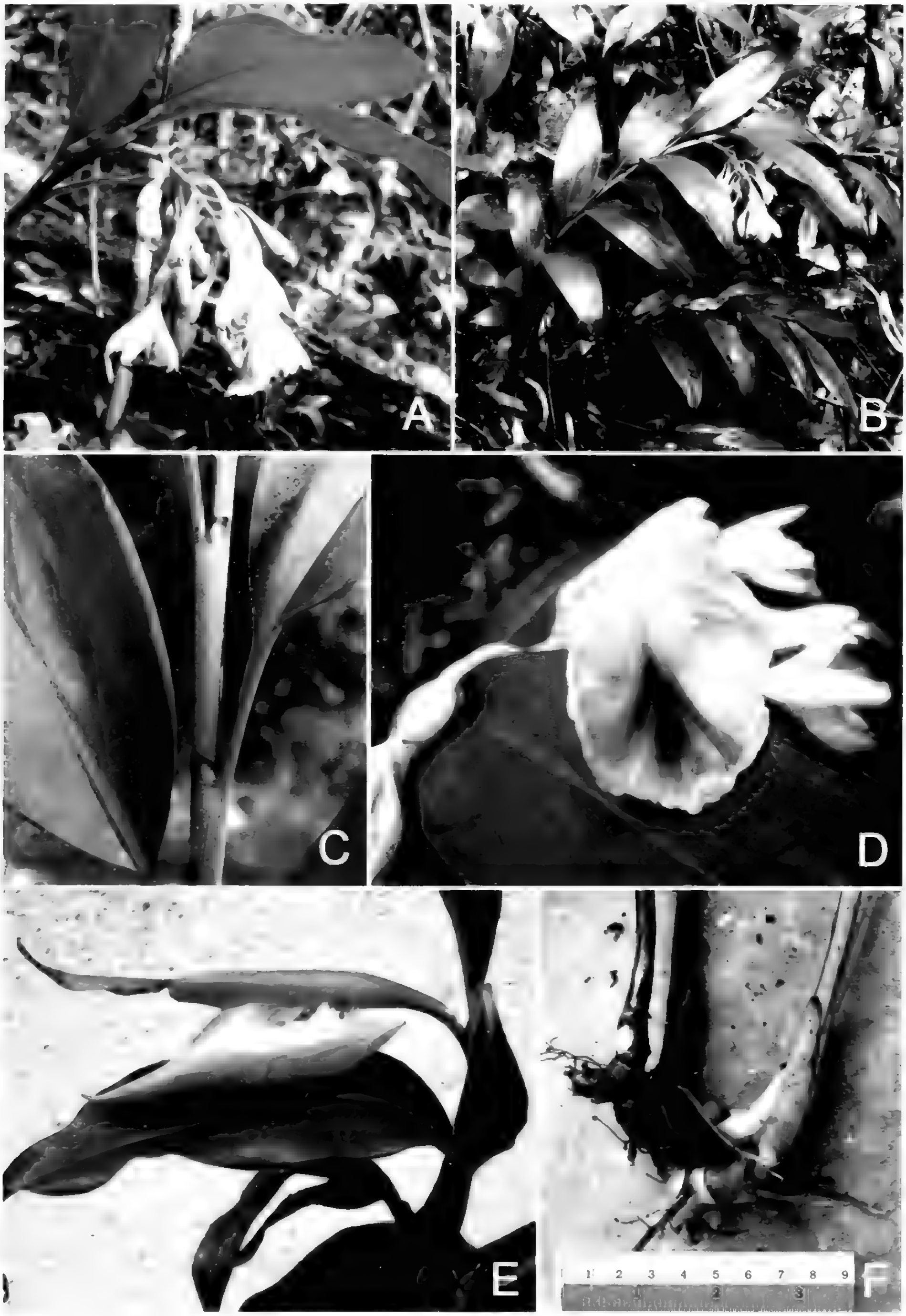

Figure 1. *Siliquamomum oreodoxa*. A. Inflorescence; B. Plant habit; C. Ligules; D. Close-up of flower; E. Sterile caducous bracts enclosing budding inflorescence; F. Rhizome. (Based on *Hul & Ly Ngoc Sam 3583*; Photo by N. S. Ly)

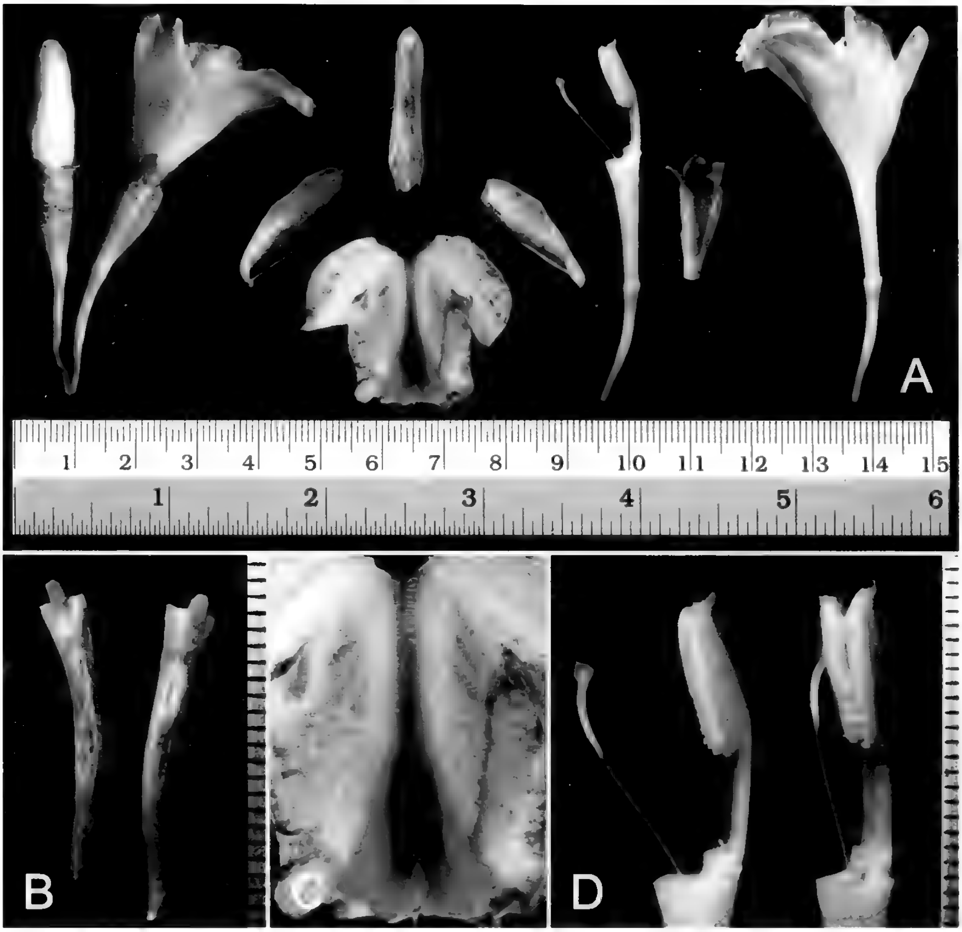

Figure 2. *Siliquamomum oreodoxa*. A. Flower detail and dissection; B. Close-up of ovary dissection; C. Close-up of central part of labellum with hairs along the midline; D. Close-up of anther. (Based on *Hul & Ly Ngoc Sam 3583*; Photo by N. S. Ly).

or light cream, with glandular hairs on connective, apex emarginate, anther thecae 9-11 mm long, white or light cream, dehiscing longitudinally for its entire length, glabrous, each with a minute, tooth-shaped, *ca* 1 mm long crest. **Ovary** narrowly cylindrical, 12-14 mm long, *ca* 1.2 mm diam. at base, up to 2 mm at apex, light yellow-green, glabrous, trilocular, placentation axile. Style 33-36 mm long, white, glabrous, stigma *ca* 1.2 mm diam., club-shaped, top of club ciliate, ostiole ciliate, sub-apical, transverse elliptic, *ca* 1 mm wide, facing forwards to upwards. Epigynous glands two, 2-3 mm long, *ca* 1 mm diam, with blunt apex, cream to very light brown. **Fruit** not seen. All measurements based on living and spirit material of the type.

Phenology: Flowering June to July.

Habitat and ecology: Growing in moist and shady understorey of coniferous and broadleaved mixed forest in Bidoup Nui Ba National Park at 1500-1800 m. This forest type covers most of the Langbiang Plateau (or Lam Vien Plateau) of Lam Dong Province. The prevailing climate in this area is tropical montane with an annual rainfall of 1775 mm and an average temperature of 18°C.

Etymology: Greek *oreo*, "pertaining to mountains" and *doxa*, "glory". We chose the epithet *oreodoxa* because this beautiful species thrives in the mountains. The word *oreodoxus* (*-a, -um*) has often been regarded in botany as an adjective, but in classical Greek it was regarded to be a noun, which, when used as an epithet, cannot be declined.

IUCN assessment: In spite of several surveys of Bidoup Nui Ba National Park and adjacent areas, *Siliquamomum oreodoxa* is only known from the type locality situated immediately adjacent to a camp occupied by members of a minorities ethnic group who have established agricultural fields and built numerous roads to facilitate access to the area. These conditions present a clear threat to the single known population of *S. oreodoxa*. Based on the IUCN Red List criteria (IUCN 2001), we propose a provisional conservation status of Critically Endangered (CR B1ab(iii)+2ab(iii)); D).

Notes: The characteristic features of the genus *Siliquamomum*, based on its previously sole species *S. tonkinense*, include a leafy shoot with few leaves, lax terminal raceme with flowers borne singly, minute bracts, bracteoles absent, petaloid lateral staminodes, each anther theca with an apical linear-acuminate crest and a trilocular ovary developing into narrowly fusiform capsule (e.g., Larsen et al., 1998). *Hul & Ly Ngoc Sam 3583* conforms with all these characters except the higher number of leaves and the fact that the flowers are produced in cincinni of 1–3 flowers. Even though we have not seen ripe fruits, the ovary is conspicuously narrowly cylindrical and identical-looking with ovary of *S. tonkinense*. It is therefore justified to describe the new taxon in *Siliquamomum* and update some of the circumscriptive characters of the genus, i.e., the higher number of leaves and the presence of cincinni.

Siliquamomum oreodoxa differs from *S. tonkinense* by several characters (Table 1), the most important by its leafy shoot with many leaves (9-13 vs. 3), a shorter petiole (to 2 cm vs. 2.5-9 cm), a smaller lamina (12-18 × 3-4.5 cm vs. 25-42 × 7-12 cm), and a shorter and denser inflorescence (up to 9 cm long with 8-25 flowers vs. 13-15 cm long with *ca* 12 flowers).

The flowers of *Siliquamomum oreodoxa* are mostly white, but the labellum has a dark green patch with a yellow border in the centre. The midline and the green–yellow coloured patch are shortly hairy. The original description of *S. tonkinense* states merely that the flower is yellowish white without any further details but from Gagnepain's drawing attached to the type, it appears that the labellum is glabrous. Based on this comparison, a key to the two species was constructed and is provided below.

Colour pictures of *S. tonkinense* from Yunnan (Gao *et al.*, 2005) show yellowish white flowers, and a labellum with a yellow patch in the centre ornamented with dark green lines. Some of the measurements of *S. tonkinense* from Yunnan differ from those made from type material of Vietnamese origin. Only a comparison of living material re-collected from type locality in Vietnam can shed light on the question, whether the Chinese material is indeed conspecific.

The genus *Siliquamomum* has been traditionally placed in the former tribe Hedychieae (Burtt and Smith, 1972; Smith, 1981; Larsen *et al.*, 1998; now Zingibereae *sensu* Kress *et al.*, 2002) on the account of its petaloid lateral staminodes. The plane of the distichy as observed by us on *S. oreodoxa* is transverse and the pseudostems are evergreen. Both of these features are typical for Alpinioideae, while genera in Zingiberoideae have parallel plane of distichy and most of the species have capacity of going into dormancy during the dry season in monsoonal climates (Kress *et al.*, 2002). The presence of few caducous sterile bracts enclosing the budding inflorescence, is yet another character common in some genera of Alpinioideae. The most recent comprehensive study that dealt with the phylogeny of the whole family Zingiberaceae (Kress *et al.*, 2002) was unable to place *Siliquamomum* in any of the two tribes, Riedelieae or Alpinieae, of Alpinioideae. The study noted that the long silique-like fruits of *Siliquamomum* are similar to those found in the Riedelieae but it differs by the presence of a well developed labellum and lateral staminodes, as well as the absence of the extrafloral nectaries on the leaf midribs. *Siliquamomum* was therefore left as an uncertainly placed genus in Alpinioideae. A later study focusing on molecular phylogeny of *Alpinia* (Kress *et al.*, 2005) placed *Siliquamomum* as sister to the rest of the Alpinieae.

With a second species of *Siliquamomum* collected and described, future sequences may assist in confirming where the genus should be placed and what morphological characters are important for the generic delimitation.

Key to *Siliquamomum*

1. Pseudostem with *ca* 3 leaves; petiole to 9 cm long; lamina 25-42 × 7-12 cm .... ***Siliquamomum tonkinense***
1. Pseudostem with 9-13 leaves; petiole to 2 cm long, lamina 9.5-18 × 2.5-4.5 cm .... ***Siliquamomum oreodoxa***

Table 1. A comparison of characters of *S. oreodoxa* and *S. tonkinense* (based on Baillon, 1895; Gagnepain, 1908; our measurements of type herbarium material marked by *. Characters of *S. tonkinense* from Chinese material stated in Wu & Larsen, 2000, and Gao *et al.*, 2005 are not included).

Characters	***S. oreodoxa***	***S. tonkinense***
Leafy shoot	to 0.9 m long, 9-13 leaves per shoot	at least 0.6 m high, 3 leaves per shoot
Petiole	1-2 cm long	2.5-9 cm long
Lamina	elliptic to narrowly ovate, (9.5-) 12-18 × (2.5-) 3-4.5 cm	ovate-lanceolate, 25-42* × 7-12* cm
Inflorescence	to 9 cm long, with 8-25 flowers	13-15 cm long, with *ca* 12 flowers
Pedicel	3-6 mm long	5-9 mm long
Calyx	18-25 mm long	*ca* 25 mm long *
Lateral staminodes	*ca* 19-21 mm long	*ca* 8-9 mm long
Labellum	obovate, 22-26 mm long, 18-20 mm at broadest point, adaxially hairy along the midline with green and yellow patch, hairs *ca* 1 mm long, white, abaxially glabrous	orbicular, *ca* 12 mm in diam., flowers yellowish white
Anther	*ca* 9-12 mm long	*ca* 11-12 mm long
Stigma	club-shaped	funnel shaped
Ovary	cylindric, trilocular	elliptic, unilocular at apex, 3 locular at base

Acknowledgements

We thank the management of the Institute of Tropical Biology and specifically Dr. Luu Hong Truong, the curator of VNM, for providing research facilities. The French Government Project, Sud-Expert-Plantes (SEP n°228: Improving Services and Capacity of the National Herbarium of the Institute of Tropical Biology) is acknowledged for sponsorship of the field trip, and the director and staff of Bidoup Nui Ba National Park for granting permits to conduct it. We thank the curators of P and SING for letting us examine specimens in their care and the Asian Zingiberaceae Information Centre (AZIC) at Singapore Botanic Gardens for providing protologues, related references and images of type specimens. The first author thanks Dr. M. Newman (E) for introducing him to Zingiberaceae taxonomy, to Mr. Truong Quang Tam and Mr. Nguyen Tran Vy for helpful discussions and overall support. The Russell E. Train Education for Nature (EFN) Program of World Wildlife Fund supported the first author's training on Zingiberaceae at Singapore Botanic Gardens. We are grateful to Dr. J.F. Veldkamp (L) for translating the diagnosis into Latin and helpful discussion on Greek etymology, Dr. A. Poulsen (E) and Dr. M. Newman (E) for helpful comments on the manuscript.

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Three New Species of *Wrightia* (Apocynaceae: Apocynoideae) from Thailand

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Abstract

Three new species of *Wrightia* from Thailand are described: *Wrightia karaketii* D.J.Middleton, *Wrightia tokiae* D.J.Middleton and *Wrightia poomae* D.J.Middleton.

Introduction

The genus *Wrightia* R.Br. is reasonably well known due to a revision of the entire genus by Ngan (1965), coupled with more recent regional revisions for China (Li *et al.*, 1996), Thailand (Middleton, 1999), Malesia (Middleton, 2007a), Peninsular Malaysia (Middleton, 2010), and Cambodia, Laos and Vietnam (Middleton, in press). This literature has meant that undescribed species have been relatively easy to discern and several have been published in recent years (Middleton and Santisuk, 2001; Middleton 2005a, 2007b). The pattern that has emerged is of a number of widespread species, mostly not growing on limestone, along with several local endemic species, mostly on limestone. Many of the more recent discoveries are these limestone endemics as collecting efforts in a number of countries, particularly in Thailand, have intensified. A similar pattern of widespread non-limestone species and fairly narrowly endemic limestone species can be seen in *Alstonia* R.Br. (Sidiyasa, 1998; Middleton, 2005b). Recent collecting in northern Thailand has brought to light three undescribed species of *Wrightia*, two of them from limestone, the other from dry evergreen forest.

Ngan suggested that *Wrightia* could be divided into four sections. Livshultz *et al.* (2007) sampled six species of the genus in their molecular phylogeny of Apocynaceae subfamily Apocynoideae. The two species of *Wrightia* sect. *Scleranthera* (Pichon) Ngan which were sampled, namely *W. dubia* (Sims) Spreng. and *W. coccinea* (Roxb. ex Hornem.) Sims, are nested within *Wrightia* sect. *Wrightia*. *Wrightia sirikitiae* D.J.Middleton & Santisuk, which was not included in Ngan's system (Ngan, 1965), but would key out to *Wrightia* sect. *Wallida* A.DC., is also nested within *Wrightia* sect. *Wrightia*. No species from *Wrightia* sect. *Balfouria* (R.Br.) Ngan were included. This section, confined to Africa and Australia, was defined on the basis of the corona lobes being coherent, only attached to the corolla at the very base and forming a ring around the stamens. Of the three new species described here, *Wrightia tokiae* would key out in *Wrightia* sect. *Balfouria* in Ngan (1965), but, given the findings of Livshultz *et al.* (2007), the sectional arrangement should be abandoned until further research is done.

Conservation assessments have been applied to each taxon using the IUCN guidelines (IUCN, 2001; IUCN Standards and Petitions Working Group, 2008).

Wrightia karaketii D.J.Middleton, *sp. nov.*
Corolla rotata. Corona annulum continuum ad corollam praeter fimbrias marginales adnata. Ovaria apocarpa. Fructus bini. – **Typus:** Thailand, Chiang Mai, Chiang Dao, Ban Arunothai, Kio Phawok, 13 May 2007, *Pooma, Karaket, Pattharahirantricin & Sirimongkol 6732* (holotype, BKF; isotype, E). **Figs. 1-3.**

Tree 5-10 m tall, 15 cm dbh; bark pale brown, lenticellate; twigs puberulent when young with short hooked hairs, soon glabrescent. **Leaves** opposite; petiole 9-10 mm long, densly puberulent with short hooked hairs; blade elliptic, 9-21 × 5.6-11.8 cm, 1.2-1.9 times as long as wide, apex emarginate-apiculate to rounded-apiculate or shortly acuminate, base cuneate, mid green above, slightly paler beneath, densely puberulent beneath, sparsely so above but more densely so on venation, venation weakly brochidodromous, 15-19 pairs of secondary veins, these occasionally forking, tertiary venation alternate percurrent. **Inflorescence** a short terminal cyme, few-flowered, puberulent; peduncle 8-23 mm long; pedicels *ca* 4.5 mm long. **Sepals** ovate, 3.7-5.5 × 2.5-2.8 mm, apex obtuse, puberulent outside, greenish, with two broad colleters per sepal at base inside, these bifid at the apex. **Corolla** bright red, greenish at base outside, rotate; tube *ca* 2 mm long, minutely puberulent outside; lobes overlapping to the left in bud, obovate, 17-20 × 12-15 mm, apex rounded, papillose inside and outside, minutely puberulent at base outside. Corona bright red, a continuous ring likely to be composed of antepetalous and alternipetalous lobes, adnate to the corolla thereby joining the bases of the corolla lobes together, 4-5 mm long opposite the corolla lobes, slightly shorter between the corolla lobes where it is 2.2-3.2 mm long, glabrous, margin shortly fimbriate, the fimbriae free from the corolla, fimbriae 1.2-1.5 mm long. **Stamens** 5, attached in a ring to the style head, inserted at the mouth of the corolla; filaments *ca* 1.5 mm long, puberulent; anthers yellow, narrowly triangular, base sagittate, *ca* 6.5 × 2 mm, shortly puberulent dorsally. **Gynoecium** of two apocarpous ovaries united into a common style; ovaries *ca* 2.5 mm high, glabrous; style + style head *ca* 6 mm long. **Fruit** of paired

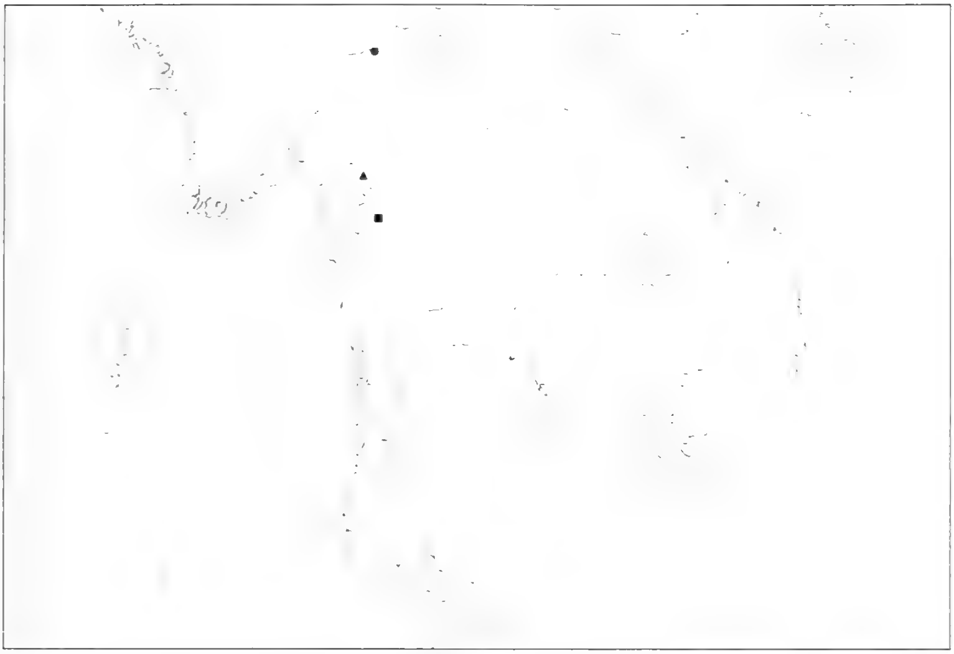

Figure 1. Distribution of *Wrightia karaketii* D.J.Middleton (●), *Wrightia tokiae* D.J.Middleton (▲) and *Wrightia poomae* D.J.Middleton (■).

Figure 2. *Wrightia karaketii* D.J.Middleton - flower (×1.5). Photo of *Pooma et al.* 6732 by Rachun Pooma.

follicles, these pendulous and slighly diverging or occasionally twisting around each other but still free, often rejoining at the tips, 29.5-40 cm long, 7-9 mm wide, brown, densely cream lenticellate, glabrous. **Seeds** linear, *ca* 17.5 x 2.2 mm, coma pointing towards base of fruit, *ca* 31 mm long.

Additional collection studied: THAILAND. Chiang Mai, Chiang Dao District, Kio Phawok border checkpoint, 750 m altitude, 21 Sep 2008, *Middleton, Karaket, Triboun, Kawatkul & Meeboonya 4541* (BK, BKF, E, K).

Distribution: Only known from Kio Phawok in Thailand, very close to the border so is also likely to occur in Burma.

Habitat: On karst limestone rocks in mixed deciduous forest at 750 m altitude.

IUCN conservation assessment: DD. Under IUCN guidelines, as this species is only known from the type locality and there is no information on possible threats, the category of Data Deficient should be given (IUCN Standards and Petitions Working Group, 2008).

Etymology: This species is named after Mr Preecha Karaket, one of the collectors of both known specimens and an excellent photographer.

Notes: This species is highly distinctive with its corona in a ring almost entirely adnate to the corolla and its apocarpous ovaries which give rise to paired fruits. Its affinities are probably with *Wrightia lanceolata* Kerr and *W. siamensis* D.J.Middleton. It differs from both species in its larger leaves, the shorter corolla tube, the slightly longer corolla lobes and the more fimbriate corona.

Wrightia tokiae D.J.Middleton, *sp. nov.*
Corolla rotata. Corona annulum continuum e corolla ad basin exceptum libera. Ovaria apocarpa. Fructus bini. – **Typus:** Thailand, Tak, Maesot, Phawo spirit house on the Tak-Maesot road, 700 m altitude, 24 May 2008, *Pooma, Karaket, Pattharahirantricin & Saengrit 6906* (holotype, BKF; isotypes, A, AAU, BKF, E, K, L, SING). **Figs. 1, 4, 5.**

Tree 15 m tall; bark pale brown, with fine lenticels; twigs densely short puberulent with short hooked hairs, eventually glabrescent. **Leaves** opposite; petiole 4-6 mm long, puberulent; blade ovate to elliptic, 5.3-21 x 3.4-8 cm, 1.4-2.6 times as long as wide, apex acuminate, base rounded to

Figure 3. *Wrightia karaketii* D.J.Middleton - fruit (×0.25). Photo of *Middleton et al.* 4541 by Preecha Karaket.

Figure 4. *Wrightia tokiae* D.J.Middleton - flower (×0.15). Photo of *Pooma et al.* 6906 by Preecha Karaket.

acute, densely puberulent beneath, papillose above, sparsely puberulent on midrib, venation brochidodromous, 13-18 pairs of secondary veins, tertiary venation alternate percurrent. **Inflorescence** a terminal cyme, few-flowered, densely puberulent; peduncle 6-10.5 mm long; pedicels 3-5 mm long; flowers slightly fragrant. **Sepals** pale green, ovate, 3.5-4.2 × 2.4-4.8 mm, apex obtuse to rounded, puberulent; colleters absent. **Corolla** yellowish green inside, paler outside, fallen corolla reddish, rotate; tube 2.5 mm long, minutely papillose outside; lobes overlapping to the left in bud, elliptic, *ca* 13 x 11 mm, apex rounded, margins reflexed, papillose inside, minutely so outside. Corona yellow, a continuous cup-like ring, slightly narrower at the top than in the middle, adnate to corolla only at very base, *ca* 5 mm long, glabrous inside, minutely papillose outside, margin dentate. **Stamens** 5, attached in a ring to the style head, inserted at the mouth of the corolla; filaments 1 mm long, puberulent; anthers yellow, narrowly triangular, base sagittate, *ca* 7 x 1.8 mm, shortly puberulent dorsally. **Gynoecium** of two apocarpous ovaries united into a common style; ovaries *ca* 1.5 mm high, glabrous; style + style head *ca* 5.5 mm long. **Fruit** of two closely associated but not fused parallel follicles joined at the apex, *ca* 13.5 cm long, each follicle *ca* 1.3 cm wide, dark brown, pale brown lenticellate except on inner surfaces. **Seed** not seen.

Additional collection studied: THAILAND. Tak, Maesot, behind Phawo spirit house, 24 August 2008, *Karaket 3* (BKF, E).

Distribution: Only known from the type locality.

Habitat: In dry evergreen forest on limestone hills.

IUCN conservation assessment: DD. Under IUCN guidelines, as this species is only known from the type locality and there is no information on possible threats, the category of Data Deficient should be given (IUCN Standards and Petitions Working Group, 2008).

Etymology: This species is named after Ms Nannapat Pattharahirantricin, more commonly known as Tok, one of the collectors of the type.

Note: This species would appear to fall into *Wrightia* sect. *Balfouria* in the sectional system proposed by Ngan (1965). This section is otherwise only known from Africa and Australia. However, as noted above, the sectional arrangement in the genus is in need of revision. In flower it is perhaps most similar to *Wrightia coccinea*, but that species does not have its corona in a ring and the ovaries are syncarpous. There does not appear to be any sepaline colleters in *Wrightia tokiae*, which, although similar in

Figure 5. *Wrightia tokiae* D.J.Middleton - fruit (×0.6). Photo of *Karaket* 3 by Preecha Karaket.

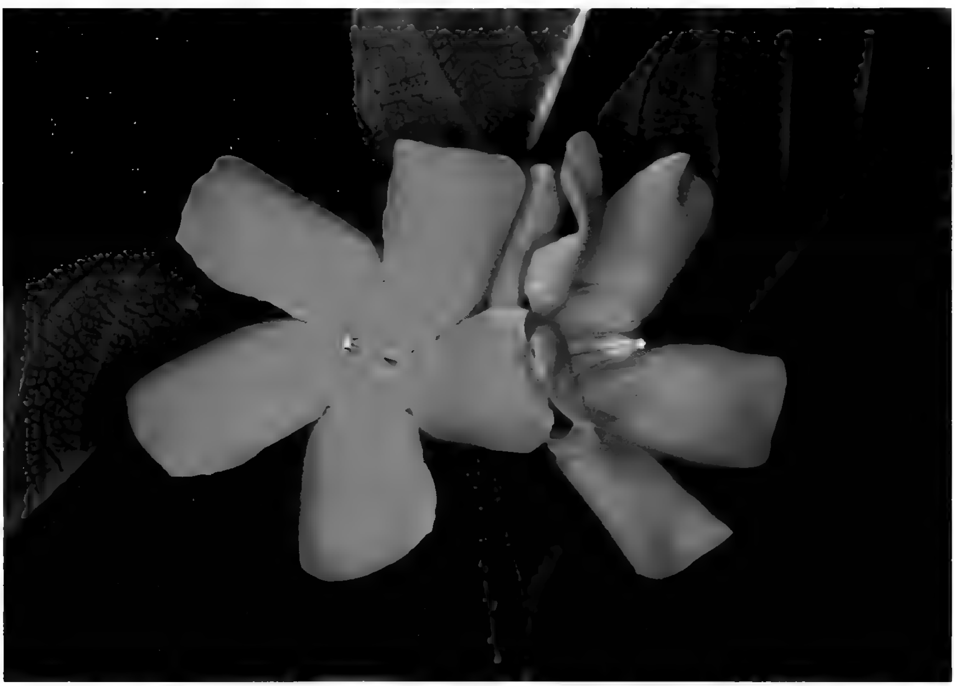

Figure 6. *Wrightia poomae* D.J.Middleton - flower (×1.5). Photo of *Pooma* 6973 by Preecha Karaket.

Wrightia poomae, is highly unusual in the genus. The fruit of this species appears to be syncarpous as in *Wrightia coccinea*, but the follicles, although very closely associated (see Fig. 5) are not fused together.

Wrightia poomae D.J.Middleton, *sp. nov.*
Corolla rotata. Corona e lobis antepetalis alternipetalis et alternantibus glabris composita. Ovaria apocarpa. Fructus ignoti. – **Typus:** Thailand, Tak, Umphang, roadside from Huai Nam Khao Forest Protection Unit to summit of Mae Chan Tha Forest Protection Unit, 700 m altitude, *Pooma, Karaket, Pattharahirantricin & Saengrit* 6973 (holotype BKF; isotype A, AAU, BKF, E, K, L, SING). **Figs. 1, 6.**

Tree *ca* 4 m tall; bark greyish-green; twigs sparsely puberulent when young, soon glabrescent. **Leaves** opposite; petiole 2-5 mm long, sparsely puberulent; blade ovate to elliptic, 2.3-12 × 1.5-5.6 cm, 1.8-2.1 times as long as wide, apex acuminate to subcaudate, base obtuse to acute, dull green above, pale green beneath, minutely papillose and very sparsely puberulent on venation above and beneath, venation weakly brochidodromous, 8-12 pairs of secondary veins, tertiary venation alternate percurrent. **Inflorescence** a terminal cyme, few-flowered, sparsely puberulent; peduncle 4-10 mm long; pedicels 2.5-7 mm long; flowers fragrant. **Sepals** pale green, ovate, 4.2-4.5 × 5.8-6.4 mm, apex rounded, sparsely puberulent, ciliate; colleters absent. **Corolla** pale yellowish-orange, turning pale red with age, rotate; tube *ca* 2.7 mm long, minutely papillose outside; lobes overlapping to the left in bud, elliptic, *ca* 19 × 13 mm, apex truncate, margins somewhat reflexed, minutely papillose inside, barely so outside. Corona pale orange, of three distinct parts: antepetalous, alternipetalous and alternating lobes, the antepetalous and alternipetalous lobes glabrous inside, minutely papillose outside, the alternating lobes glabrous; antepetalous lobes *ca* 6.5 mm long, *ca* 1/3 width of and adnate to corolla lobes for approximately half their length, fimbriate to 1/3 of their length; alternipetalous lobes in same plane as antepetalous, adnate to antepetalous lobes at base, *ca* 5 mm long, bifid; alternating lobes between the antepetalous and alternipetalous at the very base (but somewhat irregular in number up to 10), simple, *ca* 1.7 mm long. **Stamens** 5, attached in a ring to the style head, inserted at the mouth of the corolla; filaments *ca* 1.5 mm long, puberulent; anthers yellow, narrowly triangular, base sagittate, *ca* 9 × 2.5 mm, shortly puberulent dorsally. **Gynoecium** of two apocarpous ovaries united into a common style; ovaries *ca* 2.2 mm high, glabrous; style + style head *ca* 7 mm long. **Fruit** and **seed** not known.

Distribution: Only known from the type collection.

Habitat: In dry evergreen forest at 700 m altitude.

IUCN conservation assessment: DD. Under IUCN guidelines, as this species is only known from the type locality and there is no information on possible threats, the category of Data Deficient should be given (IUCN Standards and Petitions Working Group, 2008).

Etymology: This species is named after Dr Rachun Pooma, one of the collectors of the type.

Note: This species appears superficially similar to *Wrightia pubescens* R.Br., which is common in Thailand, but that species normally has only two whorls of corona lobes, the corona is pubescent inside and the ovaries are syncarpous. It is most similar to *Wrightia kwantungensis* Tsiang from China and northern Vietnam, which also has three whorls of corona, but that species has smaller sepals with an acute apex and colleters at the base inside, and a much longer corolla tube. There does not appear to be any sepaline colleters in *Wrightia poomae*, which, although similar in *Wrightia tokiae*, is highly unusual in the genus.

Acknowledgements

My most grateful thanks go to Rachun Pooma, Nannapat Pattharahirantricin and Preecha Karaket for bringing these plants to my attention, and, along with them, to U. Kawatkul, R. Meeboonya S. Sirimongkol, S. Saengrit and P. Triboun for collecting the material of these new taxa. In addition, Rachun Pooma provided valuable advice on the manuscript. I should also like to thank R. Mill for the Latin descriptions.

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Two Basidiomycetes New to Indonesia, *Pterygellus armeniacus* and *Rimbachia leucobryi*

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Abstract

Rimbachia leucobryi, a small pleurotoid agaric, is described as new to science. The species grew on living stems of *Leucobryum sanctum* in lowland rainforest. It is characterised by lamellate hymenophore, hymenial cystidia and small, ellipsoid spores. *Pterygellus armeniacus*, a bright-coloured stipitate stereoid species, is reported as new to Indonesia. The two species are illustrated.

Introduction

Tropical Southeast Asian mycota is one of the most poorly known globally. Only a few mycologists work in the area while deforestation rates in the mycologically most diverse rainforest areas hit all time high. To answer the call to catalogue the vanishing mycological diversity, Herbarium of Andalas University (ANDA, Padang, Indonesia) and Botanical Museum, University of Helsinki (H, Finland) have established cooperation, during which basidiomycete diversity in Sumatra is recorded and described. From the collections made so far, two minute species new to Indonesia are described and reported below.

Materials and methods

The basic mounting medium used in microscopic studies was Cotton Blue (CB), but also Melzer's reagent (IKI) and 5% KOH. Spore and other measurements were made and illustrations were drawn in CB. Entry CB+ means cyanophily, CB(+) weak but distinct cyanophilous reaction, CB– acyanophily; IKI– means neither amyloid nor dextrinoid reaction; KOH– means that hyphae were left almost unchanged. Measurements were done using ×1000 magnification and phase contrast illumination; eyepiece scale bar with 1-μm-grid was used, and dimensions were estimated subjectively with an accuracy of 0.1 μm (see Miettinen et al., 2006 for further detail).

The following symbols are used for spore measurements: L = mean length, W = mean width, Q = L/W, i.e. average length divided by average width, Q' = length/width ratio of individual spores, n = number of spores measured from given number of specimens, for instance 90/3 means 90 spores measured from 3 specimens. In presenting the variation of spore size and Q', the whole range is given in parentheses. The 90% range excluding the extreme 5% of values from both ends is given without parentheses. In case the 5% limit falls between two values, the one further from the median was chosen to represent the 5% tail. Whenever the figures within and outside parentheses are identical, parentheses are omitted.

Species descriptions

Pterygellus armeniacus Corner
A monograph of Cantharelloid fungi (1966) 168.

Basidiocarp centrally to more rarely laterally stipitate, **cap** irregular, venose, upwards directed, often divided from the base to several separate spathulate lobes, particularly when young, stipe 10-15 mm long, cap 5 mm in diameter, 0.2 mm thick. **Stipe** and upper surface covered with rough, upward-pointing tufts, brownish orange, hymenium paler than rest of the basidiocarp, consistently tough but brittle when dry. Hymenial surface consists of branching, blunt veins. Cap margin irregularly sharp with saw-like pattern, following vein patterns of the cap. **Hyphal system** monomitic. Hyphae homogenous throughout the basidiocarp, slightly thick-walled, clamps absent, CB– but inclusion stained in CB, IKI– but cells with golden yellow content, (2.8-) 3.2-4.3 (-6) μm in cap trama, (3.2-) 4-5.4(-7) μm in stipe context. Hyphal tufts of the upper and stipe surface formed by parallel, tightly arranged hyphae, similar to normal generative hyphae albeit narrower, (2.8-) 3-4.3 (-4.7) μm (measured from the stipe). Hyphae forming the cap surface not different from the tramal hyphae, but slightly projecting, blunt, occasionally slightly swollen hyphal ends present. **Cystidia** absent. **Hymenium.** Basidia with a tapering base, narrowly clavate, occasionally sinuous, often with visible, granular inclusion, 25-65 × 6.5-8.6 μm, with (2-)3-5 sterigmata, length 4-7 μm. **Basidiospores** broadly ellipsoid to subglobose, CB–, IKI–, slightly thick-walled, smooth, 7.5-9.2 (-9.8) × (5.9-) 6.2-7.8 (-7.9) μm, L=8.50 μm, W=6.92 μm, Q'=1.1-1.3(-1.5), Q=1.23, n=40, apiculus prominent, about 0.8 × 0.8 μm. Inclusion granular, without guttules. In some slightly dehydrated spores the spore wall seems to have minute ornamentation in the form of small granules, not unlike the inclusion. **Figs. 1-3**.

Specimens studied: INDONESIA. Sumatera Barat, Padang, Limau Manis, Andalas University Biology research forest, S 0° 54.61', E 100° 28.36', alt. 430 m, on the ground in a steep slope of natural forest dominated by Dipterocarpaceae and Fagaceae, 13.VII.2008, *O. Miettinen 13004*, field no NOM292 (ANDA, H).

Habitat and ecology: The species grew on the ground without any evident connection to decomposing substrate. It is probably ectomycorrhizal, although a root-rotting habit can not be ruled out. Ectomycorrhizal fungi are not uncommon in this forest type dominated with two well-known ectomycorrhizal tree families, Dipterocarpaceae and Fagaceae. *Pterygellus* is traditionally included in Cantharellales, which includes numerous ectomycorrhizal fungi. Verbeken and Walleyn (1999) report *Pterygellus polymorphus* to be ectomycorrhizal with Euphorbiaceae.

Distribution: The type locality of this species is in Singapore, and the new find extends the distribution to Sumatra.

Notes: Our specimen fits well with Corner's (1966) description with the exception of the number of sterigmata in each basidium, (3-) 4-6 according to Corner. We studied over 60 basidia, and could not spot any 6-steritmate (Fig. 3). Peculiarly 5-sterigmate basidia were almost as common as 4-sterigmate, and 3-sterigmate were not rare either.

Rimbachia leucobryi Miettinen, *sp. nov.*
Basidioma pileatum, lamellatum, estipitatum, 2-5 mm latum, muscicola. Systema hypharum monomiticum, hyphis fibulatis, inflatis, cystidiis hymenialibus subulatis, basidiosporae ellipsoideae, 5-6 × 3.8-4.8 µm. – **Typus:** INDONESIA, Riau, Kabupaten Kampar, Balung, Teratak Baru, N 0° 8.6', E 100° 49.4', alt. 170-250 m, on living stems of *Leucobryum sanctum* (Brid.) Hampe growing on a large, fallen log in a logged-over primary rain forest, 24.XII.2006, *O. Miettinen 11267* (holotype, ANDA; isotypes, H, SING). **Figs. 4-5.**

Basidiocarp pileate, laterally attached or slightly pendant, without stipe, pure white when fresh, drying cream-coloured, 2-5 mm wide when fresh, 1-2 mm when dry, often curving inwards upon drying. Consistency rather fragile. Hymenophore consists of forked lamellae or folds, same colour as the upper surface. **Hyphal system** monomitic. Hyphae thin- to slightly thick-walled, clamps present in nearly all septa, CB–, IKI–. Tramal (and contextual) tissue relatively dense, hyphae inflated, subparallel, (3-)3.8-6.5(-15) µm in diameter. Hyphae at upper surface not differentiated. Sparse, loose, inconspicuous hyaline, shiny granules or encrustation present in all parts of the basidiocarp in CB; in IKI scanty golden encrustation seen along hyphae. **Cystidia** thin-walled, projecting above hymenium, subulate, occasionally branched, arising from subhymenium just as other hymenial cells, 20-44 × 4.4-5.8µm. **Hymenium.** Basidia cylindrical to clavate, with (2-) 4 sterigmata, 18-23.5 × 5-6.8 µm, sterigmata up to 3.5 µm long. **Basidiospores** ellipsoid to subglobose, often pip-shaped, thin- to very slightly thick-walled, smooth, CB–, IKI–, (4.8-) 5-6(-6.1) × 3.8-4.8(-5.0), L=5.36, W=4.28, Q'=1.1-1.4, Q=1.25, n=50, with a prominent apiculus, typically 1.5 × 1.5 µm.

Habitat and ecology: Evidently the species has a close connection to its bryophyte host. Whether the relationship is parasitic, saprobic or symbiotic, we can not judge at present. All the host stems and the moss colony in general seem to be in good condition.

Distribution: The only find comes from lowland rainforest in central Sumatra. The host species, *L. sanctum,* has a wide distribution in tropical Asia from India and China to Papua New Guinea and is found throughout this area in natural forests, being common in at least insular Southeast Asia (Enroth, 1990; Yamaguchi, 1993). Other similar moss-inhabiting fungi are not species specific. Thus the species could potentially be found anywhere in tropical Asia.

Etymology: Named after the host plant species, *Leucobryum sanctum*

Notes: In search of the name for the present species, all species validly combined in the genera *Arrhenia, Cheimonophyllum, Cyphallostereum, Leptoglossum, Mniopetalum, Pleuromycenula, Pseudocratarellus, Pterygellus, Rhodoarrhenia,* and *Rimbachia* were compared using Mycobank (2009) and literature. The most suitable genus according to the key of Singer (1986) seems to be either *Pleuromycenula* or *Mniopetalum*, both included by Redhead (1984) in *Rimbachia.*

The current species fits best in *Mniopetalum* or *Rimbachia* being astipitate, pleurally attached, small, pale-coloured, moss-inhabiting and gilled, with clamped, inflated tramal hyphae, inamyloid, hyaline spores and lacking differentiated pileipellis. The hymenial hyphoid cystidia are the only deviating character.

DNA-based analysis would be needed to sort out relationships between the minute-sized agarics that lack clear spore and cystidial characters. No DNA sequence data exist currently in Genbank for the type - or any other - species of *Rimbachia, Flabellimycena, Mniopetalum,* or *Pleuromycenula*. Redhead *et al.* (2002a, b) did not include any members of these genera in their DNA-based phylogenetic analysis. For these reasons we follow Redhead's (1984) broad concept of *Rimbachia* here, inclusive of *Mniopetalum.*

The genus *Cheimonophyllum* includes small pleurotoid species with cheilocystidia warranting generic comparison. The three species currently included in the genus are all lignicolous. The type species, *Cheimonophyllum candidissimum* (Berk. & M.A. Curtis) Singer, has non-inflated hyphae of rather small diameter in contrast to inflated hyphae in *Rimbachia* (based on literature and studied Finnish material in H). The cystidia in the type species are long, branching and restricted to the gill edge, and not simple and hymenial (pleurocystidia) as in *R. leucobryi.* Considering the ecology, hyphal structure and even cystidial characters, *Rimbachia* seems a more natural placement for the new species.

At the species level, *Rimbachia bryophila* (Pers.) Redhead is externally and ecologically very similar to *R. leucobryi.* However, according to Kuyper (1995) and Senn-Irlet and Moreau (2003) based on European material, its spores are clearly larger, 6-8.5 × 5-6.5 μm. Redhead (1984:878) reported slightly smaller spores for American material, 5-7 × 4.5-7 μm, but these are still larger than those of *R. leucobryi.* Same applies to *Leptoglossum subbryophilum* Singer (spores 6.5-8.5 × 5.5-8 μm, Singer, 1931: 521), *Mniopetalum flabelliforme* M. Zang and *Mniopetalum miniatum* M. Zang (spores 7-10 × 5-6 μm for both, see Zang, 1986).

Rimbachia furfuracea (Petch) Redhead and *Mniopetalum distinctum* Horak (considered a synonym of the first-mentioned by Redhead, 1984) are also quite similar. We rely on the detailed descriptions of Corner (1966: 76), Horak (1980: 100), and Pegler (1986: 95). Basidiocarps of *Rimbachia furfuracea* are spathulate and bear a short lateral stipe; the basidiocarps are terrestrial or growing on mosses, 5-25 mm in size, the gills are thick, blunt, shallow and frequently anastomosing. The spore size is 5-6.5 × 3.2-4, L=6, W=3.5 (Pegler, 1986), or 4.5-6 × 3-4 (Horak, 1980, for *Mniopetalum distinctum*), hyphae 3-15 μm wide and inflated. The microscopic characters agree with *R. leucobryi*, except that no cystidia are mentioned. The ecology and macroscopic characters (shallow gills and larger basidiocarps, stipe) are clearly different from *R. leucobryi.*

Rimbachia cyphelloides Lloyd (=*Rhodoarrhenia cyphelloides* (Lloyd) Singer) from Brazil has a reticulate hymenium and a short stipe. Its spores are also larger, 8 × 6 μm (Lloyd 1918: 802) or 5.5 - 7-4 × 3.5-5.4 μm (Singer, 1963: 143). *Rimbachia ellipsoidea* (Singer) Redhead from Mexico produces small, white basidiocarps with a venose hymenium, growing on mosses. The original description (Singer, 1973: 27) states that the spores measure 6.2-7.5 × 3.5-4.5 μm, clearly longer than in *R. leucobryi.* Redhead (1984) reports that the type is in bad condition. None of the above-mentioned species is reported to bear hymenial cystidia as does *R. leucobryi.*

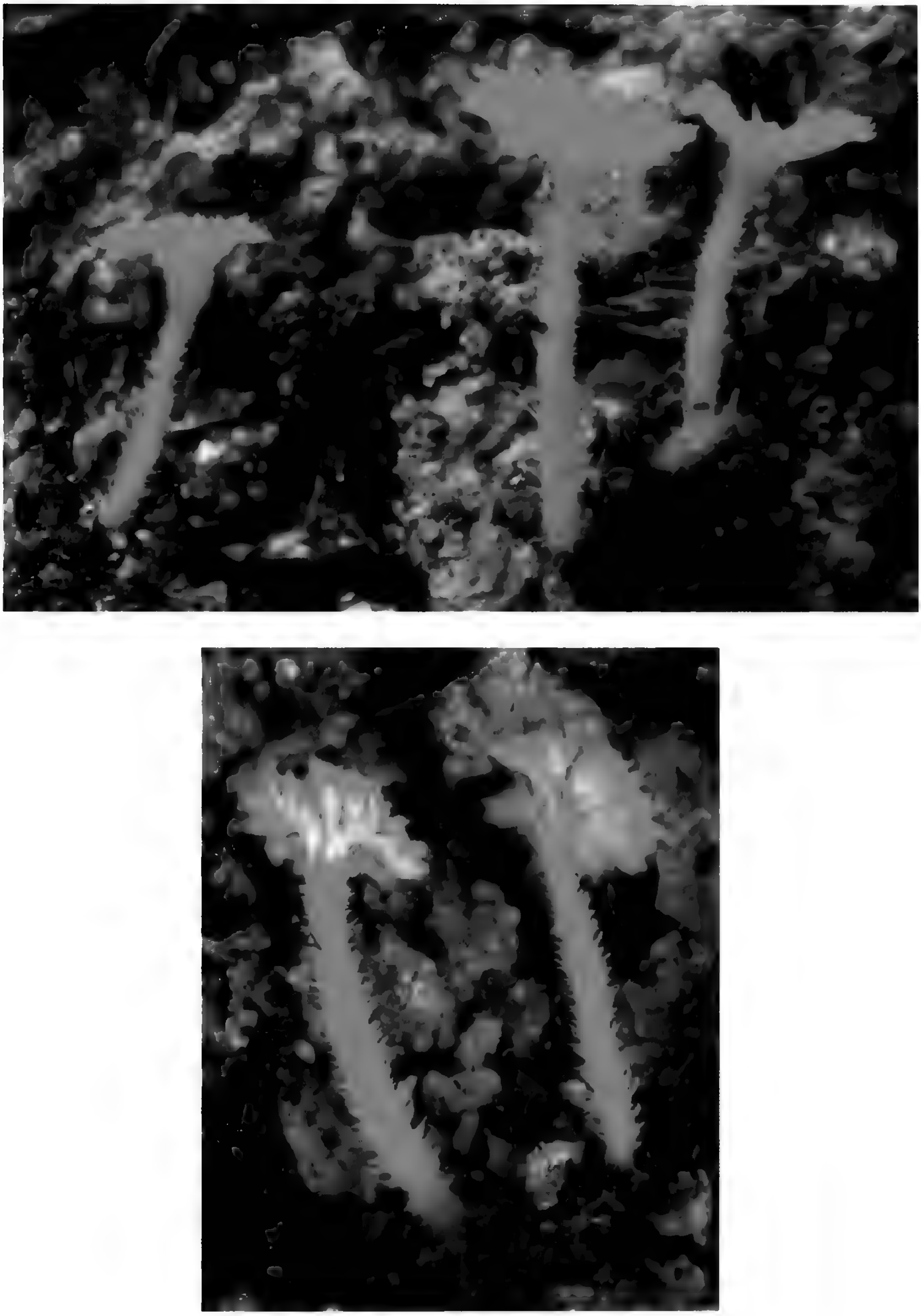

Figure 1. *Pterygellus armeniacus* (*Miettinen 13004*), photographed when fresh.

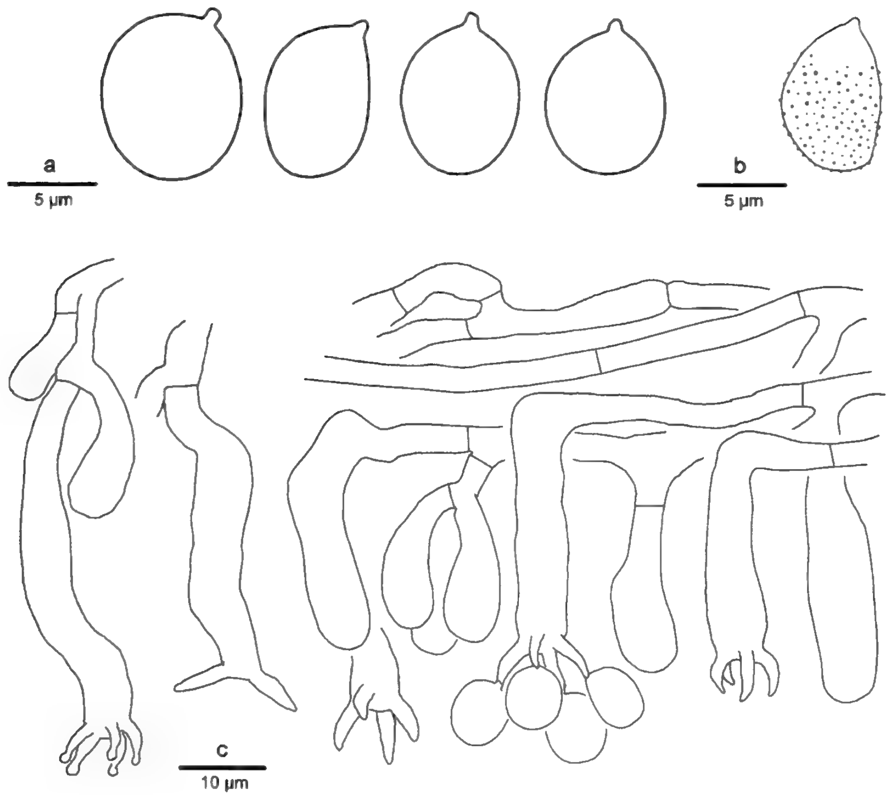

Figure 2. *Pterygellus armeniacus* (*Miettinen 13004*). Normal spores (a), a dehydrated, "ornamented" spore (b), and hymenium (c).

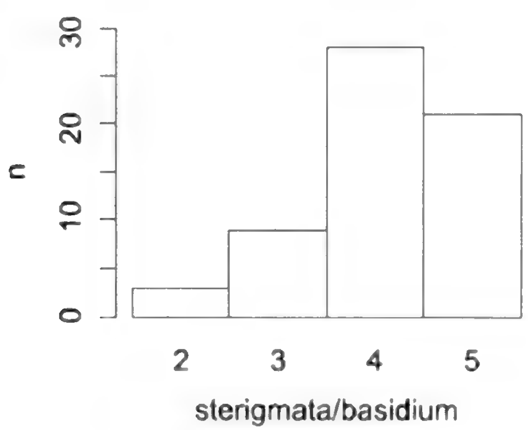

Figure 3. Number of stergimata per basidium in *Pterygellus armeniacus* (based on *Miettinen 13004*). Total number of basidia included is 61.

Figure 4. *Rimbachia leucobryi*, based on fresh type material.

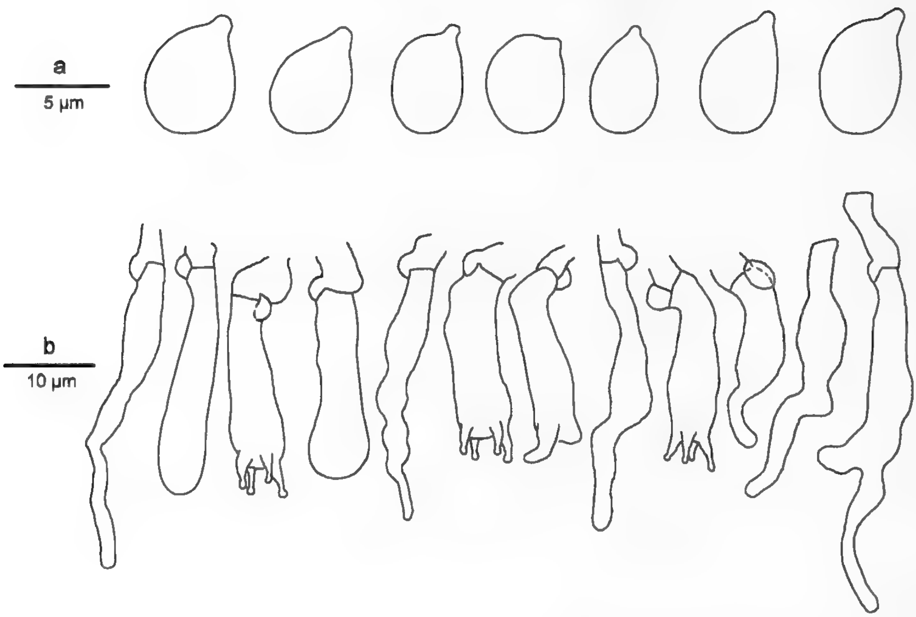

Figure 5. *Rimbachia leucobryi,* holotype: spores (a) and hymenial cells (b).

Acknowledgements

We express our gratitude to Dr. Arbinis Arbain, Prof. Dr. Syamsurdi, Dr. Rusdji Tamin, all our friends at the Herbarium of Andalas University, and Prof. P. Uotila (H) for providing generous assistance to this project. We also thank Dr. J. Enroth (H) for identifying the bryophytes, Prof. T. Ahti (H) for revising the Latin description, and Dr. T. Niemelä (H) for his comments on the manuscript.

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Ten New Records of Mosses from Doi Inthanon National Park in Thailand

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Abstract

Ten species of mosses collected from Doi Inthanon National Park are reported newly for the flora of Thailand. Of these, *Rhizomnium* and *Oligotrichum* are two new moss generic records for the country. The report includes notes on ecology, morphology, taxonomy, and distribution of the new species records.

Introduction

Thailand is located centrally in continental SE Asia. The country encompasses a total land area of 513,115 km^2. The elevation ranges from sea level to 2,565 m (Doi Inthanon). Because of its geographical position, the flora is rich in temperate Himalayan and Chinese elements in the north, and in tropical Malesian moss taxa to the south.

The moss flora of Thailand has been studied intermittently since the first westerner, J. Schmidt, collected moss specimens from Koh Chang in 1899 and 1900 (see Brotherus, 1901). Dixon (1932) published the first moss checklist for Thailand based on the large collections of A.F.G. Kerr. When Tixier (1971) published a summary of moss taxa for Thailand, the flora consisted of 500 species. In his paper, Tixier analyzed the floristic affinity of the moss flora of Thailand, which showed nearly an equal percentage of species sharing with the Indian subcontinent, Indochina and Malesia.

From 1950 on, bryological activities in Thailand have intensified with the participation and publication of bryologists from The Netherlands (see Touw, 1968), France (Tixier, 1971, 1972), Japan (Horikawa and Ando, 1964), Singapore (Tan and Iwatsuki, 1993, Tan and Tran Ninh, 1998; Tan *et al.*, 2006), USA (He, 1998), and Denmark (Larsen, 1979, 1992). A recent listing of the bryoflora prepared by Sornsamran and Thaithong (1995) reported 644 species of mosses based on publications from 1900-1979 (see Tan, 1998).

More recent researches on Thai mosses include a number of local workers, such as, Chantanaorrapint *et al.* (2004), Koronochalert (2006), Manachit (2006), and Wongkuna *et al.* (2009). Finally, an updated checklist of Thai mosses prepared electronically and housed at Missouri Botanical Garden (see http://www.mobot.org/MOBOT/moss/Thailand/welcome.shtml) listed 620 species and 31 subspecific taxa in 190 genera and 52 families.

In this paper, we report 10 new moss records for the Thai flora collected from Doi Inthanon National Park, Chiang Mai Province. All the new records are collected from montane evergreen forests at an elevation above 2000 m. Of these, *Rhizomnium* and *Oligotrichum* are two new generic records for the country's moss flora. The voucher specimens are deposited, as indicated separately under each species entry, at the Herbarium of Chualongkorn University (BCU) and the Herbarium at Singapore Botanic Gardens (SING).

New Records of Thai Moss Flora

Family Fissidentaceae

1. ***Fissidens obscurus*** Mitt. **Fig. 1.**

This is a medium sized plant that is dark green in color. It was collected on wet rock and sandy soil. *Fissidens obscurus* is similar to *Fissidens polypodioides* Hedw., but easily recognize by having abundant tomentose rhizoids on the underside of stems. The lack of hyaline nodule on the stem, the smooth leaf cells, the absence of leaf limbidium and the obtuse to obtusely acute leaf apex, in combination, identify this species.

Fissidens obscurus has a widely scattered distribution in China, Japan, Nepal, India, and now in northern Thailand.

Specimens studied: *Y. Nathi 914, 1015, 1024* (BCU).

Family Hypnaceae

2. ***Glossadelphus prostratus*** (Dozy & Molk.) M.Flesich.

Syn. *Taxiphyllum prostratum* (Dozy & Molk.) W.R.Buck

The plants were collected from Kew Mae Pan on Doi Inthanon, forming a mat of intertwined, fine and elongate branches. Leaves are small, about 0.25-0.4 mm long, varying from ovate with obtuse apex on branchlets and near the distal ends of branches, to ovate with short acuminate apex on primary and secondary branches. Leaf margins are serrate and the elongate laminal cells are often prorulose.

Glossadelphus prostratus is known already from China, Laos, Vietnam, Indonesia (Java, Lombok, Irian Jaya), Papua New Guinea and several Pacific Islands. It is not surprising to find it in Thailand.

Specimen studied: *Y. Nathi 945* (BCU, SING).

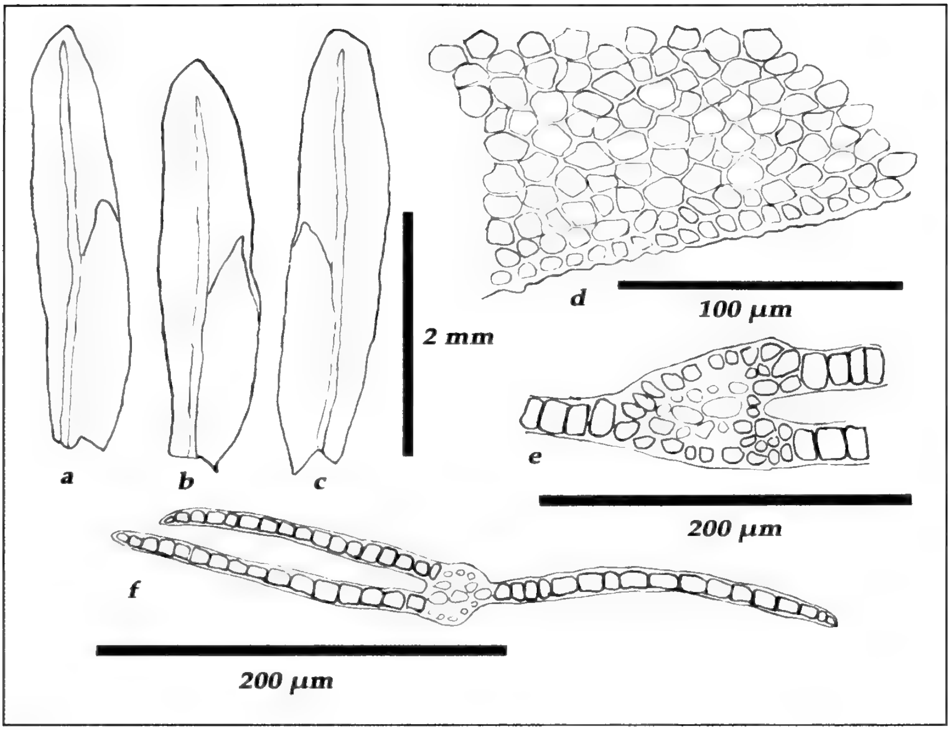

Figure 1. *Fissidens obscurus*. a-c. Leaves; d. Cells at leaf margin; e- f. Cross section of leaf.

Family Meteoriaceae

3. ***Meteorium subpolytrichum*** (Besch.) Broth.

This epiphytic moss species is large, dark-green and densely branched. Leaves are imbricate to appressed on branches, but the overall morphology of the branch foliation is not as strongly julaceous as in *Meteorium buchananii* (Brid.) Broth. The ovate-oblong to ligulate leaves have rounded to truncate apices, auriculate and undulate bases, and crenulate leaf margins; costae reach *ca* 2/3 of the leaf length.

Meteorium subpolytrichum is distributed in the Himalayas, China, Japan, the Philippines and is here reported from northern Thailand.

Specimens studied: *Y. Nathi 137, 262* (BCU).

Family Mniaceae

4. ***Rhizomnium striatulum*** (Mitt.) T.J.Kop. **Fig. 2.**

The two specimens of *Rhizomnium striatulum* were found along a shaded stream, growing on rocks on Doi Inthanon. The plants are small and their stems are dark to reddish, 0.8-1.0 cm long. Leaves are elliptic to obovate in outline, slightly contorted when dry and widely spreading when moist. Leaf borders are entire, strong and dark brown in color, comprising of 2-3 rows of linear and elongate-rectangular cells. The leaf tip ends in an apiculus and the costa ends near the leaf apex.

Rhizomnium striatulum is a new species record and also a new generic record for the flora of Thailand. Distribution of this species is from Eastern Russia, Korea, Japan, China, Taiwan, Himalayas to northern Thailand.

Specimens studied: *Y. Nathi 1016, 1051* (BCU).

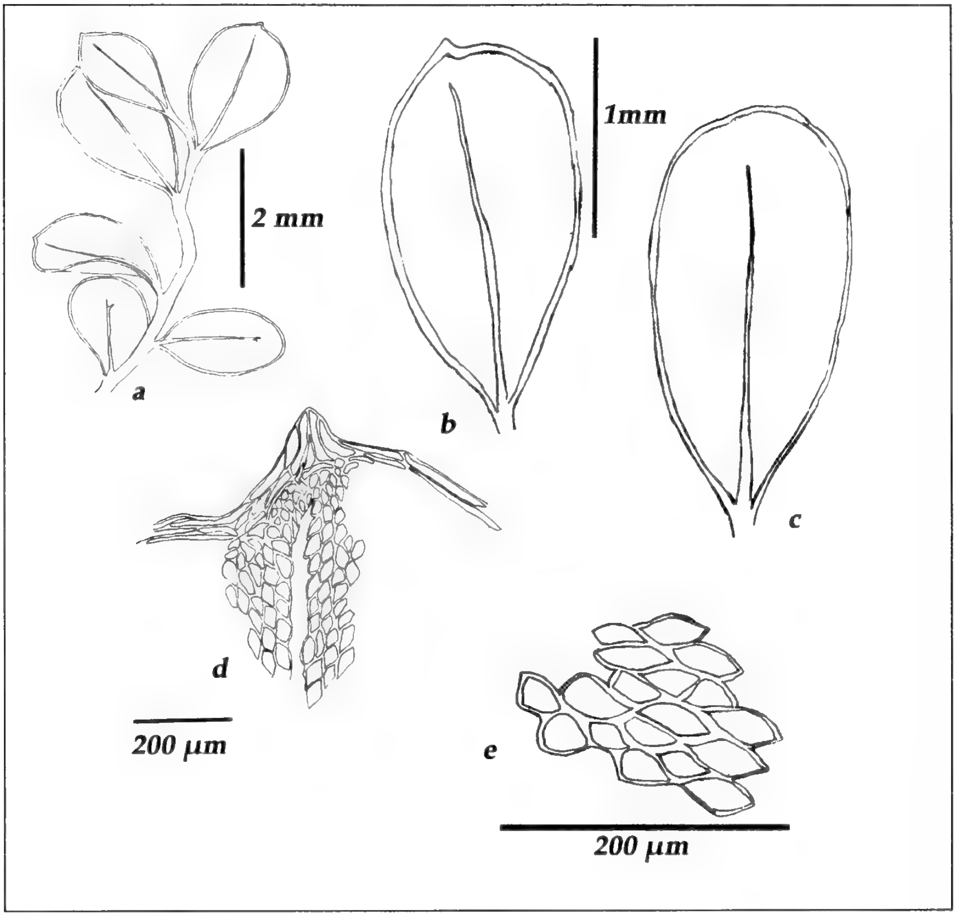

Figure 2. *Rhizomnium striatulum*. a. Plant habit; b -c. Leaves; d. Leaf tip; e. Leaf cells.

Family Polytrichaceae

5. ***Oligotrichum aligerum*** Mitt. **Fig. 3.**

This is a moss collected from the roadside on way to the summit of Doi Inthanon. The specimens were found growing mixed with species of *Pogonatum*. The plants are small and the stems are rigid and short, about 0.5-0.8 cm high. The leaves are oblong to oval in shape, covered with slightly wavy rows of ventral and dorsal lamellae, each lamella is 4-8 cells high. The broadly acute to acute leaf apices and the presence of several low dorsal lamellae identify this species from the other members of the genus in continental SE Asia. *Oligotrichum aligerum* is a new generic and species record for Thailand.

Distribution of *Oligotrichum aligerum* ranges from North and Central Americas, Russian Siberia, Japan, Korea, China, Taiwan, northern Philippines, Nepal, India to northern Thailand.

Specimens studied: *Y. Nathi 29, 196, 955* (BCU).

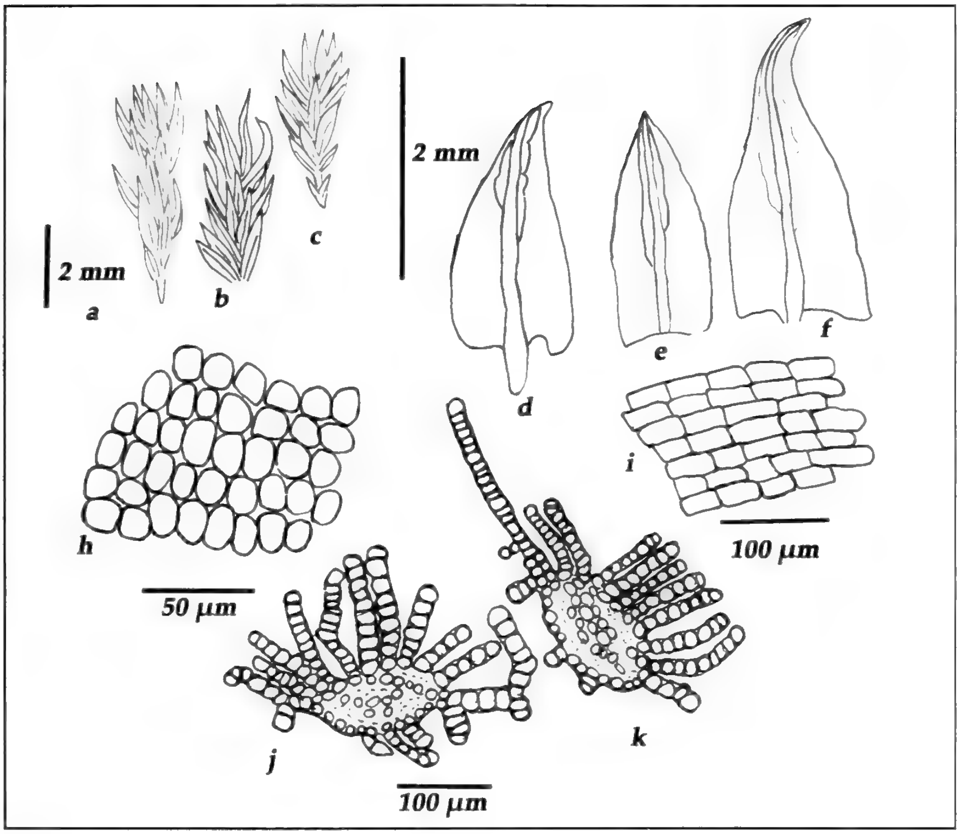

Figure 3. *Oligotrichum aligerum*. a-c. Plant habits; d-f. Leaves; h. Leaf cells; i. Leaf cell at base; j-k. Cross section of leaves.

Family Pottiaceae

6. ***Didymodon maschalogena*** (Renauld & Cardot) Broth. **Fig. 4.**

Syn. *Didymodon michiganensis* (Steere) K.Saito

Didymodon maschalogena grows along the roadside on Doi Inthanon and is easy to recognize because of the presence of abundant, uniquely dark and round gemmae in leaf axils. The plants are small, about 1-1.5 cm high.

Leaves are dense and close to stem when dry, but spread out when wet. Leaf shape is characteristically ovate and abruptly acuminate at apex. Its leaf margins are narrowly recurved in the lower part. Laminal cells are mostly round to hexagonal, slightly bulging and smooth, and arranged in observable longitudinal rows.

Didymodon maschalogena is known in North America as *D. michiganensis*. (Frahm *et al*., 1996; Jiménez *et al*., 2004). It is also known from Africa, Mexico, Japan, India, Sri Lanka, Himalayas, China and the Philippines. Its presence in Thailand represents a local range extension. A worldwide distribution map of this species was presented by Jiménez *et al.* (2004).

Specimens studied: *Y. Nathi 49, 411, 577, 986* (BCU).

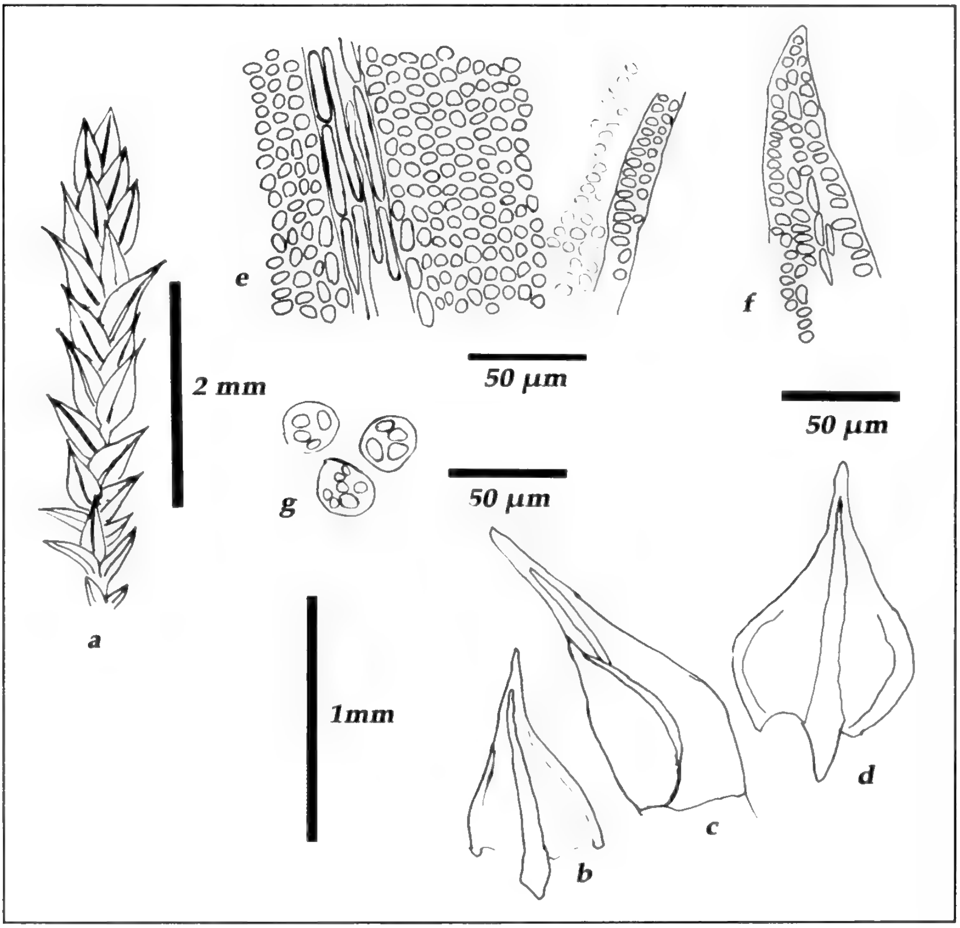

Figure 4. *Didymodon maschalogena*. a. Plant habit; b-d. Leaves; e. Leaf cells; f. Leaf tip; g. Gemmae

Family Sematophyllaceae

7. ***Clastobryopsis brevinervis*** M.Fleisch.

This is an epiphyte on branches in montane mossy forest near summit of Doi Inthanon. The plant is small, about 1 cm long. It is recognized by its single costa-like leaf appearance. Actually one of the two costae is short. As a typical member of the genus, the leaf base is decurrent and the alar cells are made up of a mixture of quadrate and rectangular, more or less thick-walled cells. Leaves of this species are lanceolate, acuminate, plicate, and the leaf margins are somewhat revolute.

Clastobryopsis brevinervis is distributed in China, Japan, Indonesia (Java, lesser Sunda), Malaysia (Sabah), the Philippines and Papua New Guinea. It is new to Thailand.

Specimens studied: *Y. Nathi 150, 627, 1071* (BCU).

8a. ***Clastobryopsis planula*** (Mitt.) M.Fleisch. var. ***planula*** **Fig. 5.**

This mat-forming species is commonly found in open sites of forest near the summit of Doi Inthanon. It grows on trunk and branches of trees. Stems are densely branched and produce an enlarged and complanate terminal with many propaguliferous gemmae found inside the leaf axil. Leaves are broadly ovate and ovate-lanceolate, double-costate, with acuminate tip, and the leaf margins are slightly reflexed. Leaf bases are decurrent and the alar cells are quadrate to rectangular in shape, often colored.

Clastobryopsis planula is known from China, Japan, India (Sikkim), Nepal, Indonesia, the Philippines, and is new to Thailand.

Specimens studied: *Y. Nathi 258, 328, 486, 838, 924, 959* (BCU).

8b. ***Clastobryopsis planula*** var. ***delicata*** (M.Fleisch.) B.C.Tan & Y.Jia

Although treated as a synonym of *Clastobryopsis planula* by many workers (cf. Tan and Jia, 1999), in Doi Inthanon National Park, this variety is distinctly small and more delicate in appearance. Its leaf outline is also narrower than the typical variety. It is also an epiphyte found on branches in upper montane forest.

Specimens studied: *Y. Nathi 55, 349, 525, 653, 664* (BCU).

9. ***Clastobryopsis robusta*** (Broth.) M.Fleisch.

This rather widespread tropical Malesian species grown on branches of a tree at Doi Inthanon and appears to be rare in occurrence locally. The two specimens represent undoubtedly juvenile plants. Stems are creeping and irregularly branched. Stem leaves are ovate-lanceolate to oblong-lanceolate in shape. The broadly ovate and somewhat plicate branch leaves, coupled with acuminate apex, broadly decurrent leaf bases, and narrowly recurved margins with teeth above, identify this species from its congeners.

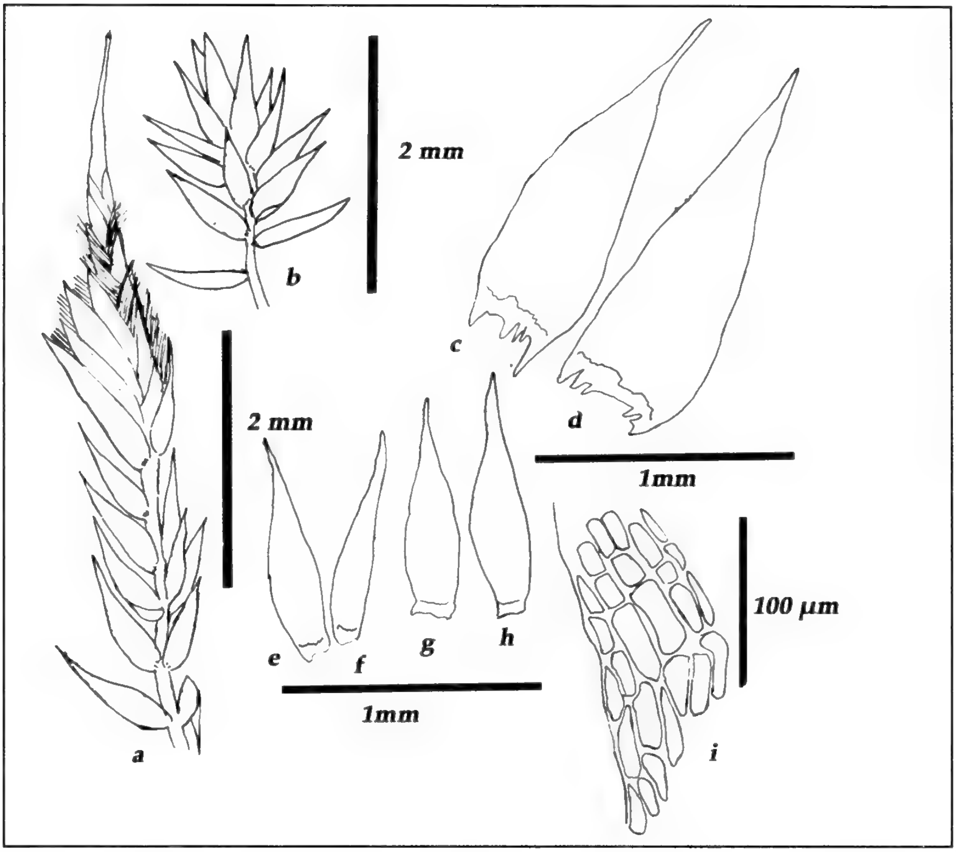

Figure 5. *Clastobryopsis planula*. a. Propaguliferus branch; b. Branch; c-d. Propaguliferus leaves; e-h. Branch leaves; i. Alar cells.

The leaf alar cells, like all members of the genus, are typically numerous, brownish, rectangular to quadrate in shape, and not inflated.

Clastobryopsis robusta is distributed in Japan, China (Taiwan), Philippines, Borneo, Java and Papua New Guinea. It is newly found in Thailand.

Specimens studied: *Y. Nathi 627, 1072* (BCU).

10. ***Warburgiella bistrumosa*** (Müll.Hal.) M.Fleisch. **Fig. 6.**

The spcimens were collect from Kew Mae Pan Nature Trail at Doi Inthanon National Park. The small and slender plants are about 0.5 cm long, and irregularly branched. Leaves are narrowly lanceolate, gradually long acuminate, concave and mostly falcate. Leaf cells are smooth at base and develop a papilla on lumen of many cells in upper half of the leaf. Occasionally one or two leaf cells can be observed to have two papillae. Alar cells are big, thin-walled and inflated.

This species was treated as *Trichosteleum bistrumosum* (Müll. Hal.) A.Jaeger (see Bartram, 1939) because of its unipapillose leaf cell character. Since no species of *Trichosteleum* in the region have such strongly falcate leaves, we preferred to follow Fleischer (1904-1923) in placing it in *Warburgiella*. We also think that the leaf morphology of the species indicates a possible link to *Radulina*.

Warburgiella bistrumosa, an endemic species in the Philippine, is now found in Thailand.

Specimens studied: *Y. Nathi 109, 207, 683, 1037* (BCU).

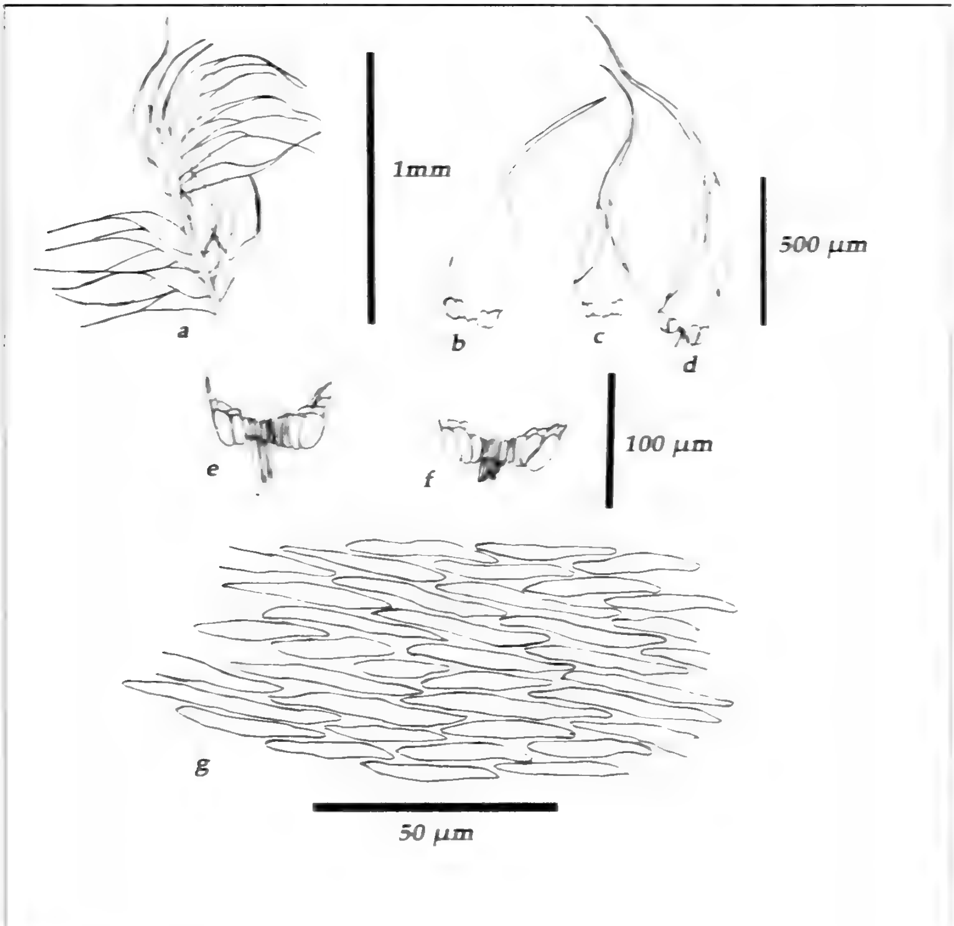

Figure 6. *Warburgiella bistrumosa*. a. Branch; b.-d. Leaves; e-f. Alar cells; g. Leaf cells.

Acknowledgments

The first author thanked the SING Herbarium at the Singapore Botanic Gardens for the warm reception given her during the visit in 2008, and to the Head of Doi Inthanon National Park and park rangers for their generous helps during the field works. This project was supported by the Thai government budget 2006 under the Research Program on Conservation and Utilization of Biodiversity and the Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University (CEB_M_34_2007), the Graduate School of Chulalongkorn University, and Chulalongkorn University Centenary Academic Development Project given to the first and the last authors.

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Epifoliar Fungi of Singapore

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Abstract

This article is a discussion of the known epifoliar fungi from Singapore found in several worldwide Herbaria, and those collected by the author. Fifty species in 15 genera are reviewed and annotated. An additional twenty new combinations in *Setameliola* are proposed to contain *Meliola* species with an ascocarp bearing straight setae. Critical attention is given to the species concepts in *Meliola* and *Polychaeton*.

Introduction

Ecologically, the epifoliar fungi are stratified in the tropical canopy (Reynolds, 1972; Gilbert *et al.*, 2007) with a prevalence in the understory where abundant hosts support a greater number and diversity of fungi. Environmental conditions affecting spatial distributions are sites in the dark canopy and openness.

Epifoliar fungi are specialized as nutritional guilds found only on the surface of living plants, particularly the leaves (Gilbert *et al.*, 2007). Several, principally, Ascomycete lineages that together comprise a polyphyletic group, have evolved into this habitat as four nutritional guilds: saprobes, plant parasites, fungal parasites, and lichenized species. With the exception of lichenized species, all share common adaptive morphological traits including a dark, melanoid pigmentation and reproduction by ascospores and mitospores. For the non-lichenized taxa, the habits and morphological traits are convergent plesiosynapsies that distinguish groups of fungi at lower clade levels. In contrast, lichenized fungi have acquired the epifoliar habit at higher clade levels equivalent to genus or species (Lücking, 2002). The Singapore lichenized species have been reviewed by Sipman (2003a, 2003b, 2007).

Thaung (2006) observed that one distribution pattern of epifoliar fungi is comparable with the phytogeography of the Indo-Malayan Biogeograhic Realm with tropical rainforests, (mongabay.com/0102.htm). He suggested that the radiation pattern indicates an Indo-Himalayan origin with dispersal southward into SEAsia, including Singapore.

The information on currently known epifoliar fungi from Singapore is obtained from several worldwide Herbaria, and those collected by the author in Singapore in 2007. The epifoliar fungi from Singapore are historically known from the Fungi Malayana exsiccatum assembled by C.F. Baker from 1916-1920. Numbers 401- 500 of Century V were collected in Singapore out of the total 600 specimens. Twenty-two Singapore species of epifoliar ascomycetes were identified; 12 of them were described as new by Saccardo (1918). The exsiccatum specimens are currently known to be curated in Herbaria BPI, CUP, FH, PC, S and UC (Pfister, 1985; Holmgren & Holmgren, 1998). Lim (1975) published a list of 13 epifoliar species from Singapore; the cited collections are currently unavailable for reexamination.

The list of taxa is as follows –

1. ***Asteridiella*** McAlpine, Proc. Linn. Soc. New South Wales 187 (1897) 38.
Ascospores 4 septate, brown; asci evanescent; ascocarp superficial, globose, glabrous; mycelium superficial, brown, septate, branched, asetose, hyphopodia alternate.

1.1. ***Asteridiella umirayensis*** (Yates) Hansford, Sydowia 10 (1957) 51.
-*Meliola umirayensis* Yates, Philipp. Jour. Sci. Bot. 13 (1918) 370;
-*Irenia umirayensis* (Yates) Hansford, Proc. Linn. Soc. London 157 (1946) 170.
-*Irenia bakeriana* Hansford, Proce. Linn. Soc. London 157 (1946) 169.
Ascospores 4 septate, oblong to ellipsoid, 36-45 x 14-16 µm. Ascocarp scattered, to 180µm diameter, surface cells conoid projecting to 15µm. Mycelium to 3mm diameter, hyphopodia alternate, ampulliform.

Specimen reported: *C.F. Baker Fungi Malayana 455*, determined as *Meliola reticulate* Karsten & Roumeguère; *BPI 696686-87*, *Flora of Singapore 5796*, Coll. *J.J. Chupp*, 2 Jul 1920.

Illustration: Hansford, 1963.

Distribution: Java, Philippines, Singapore.

2. ***Asterina*** Léveillé, Ann. École Natl. Agric. Montpellier (1845) 59.
Ascospores brown, 1 septate, ellipsoid-oblong; Asci fissitunicate, aparaphysate; Ascocarp dimidiate, circular, radiate, astomate; Mycelium brown, with hyphopodia or node cells.

2.1. ***Asterina erebia*** Sydow, Ann. Mycol. 25 (1927) 59, *sensu* Stevens & Ryan, Ill. Biol.

Monogr. (1939) 70. **Fig. A.**
Ascospores 26-32 x 12-16 μm. Ascus 55-65 μm. Ascocarp 150-300 μm; hyphopodia alternate, 2-celled.

Specimens reported: Singapore, Bukit Timah Nature Reserve, Oct 2007, *DRR 15, 16, 17, 18.*

Distribution: Singapore.

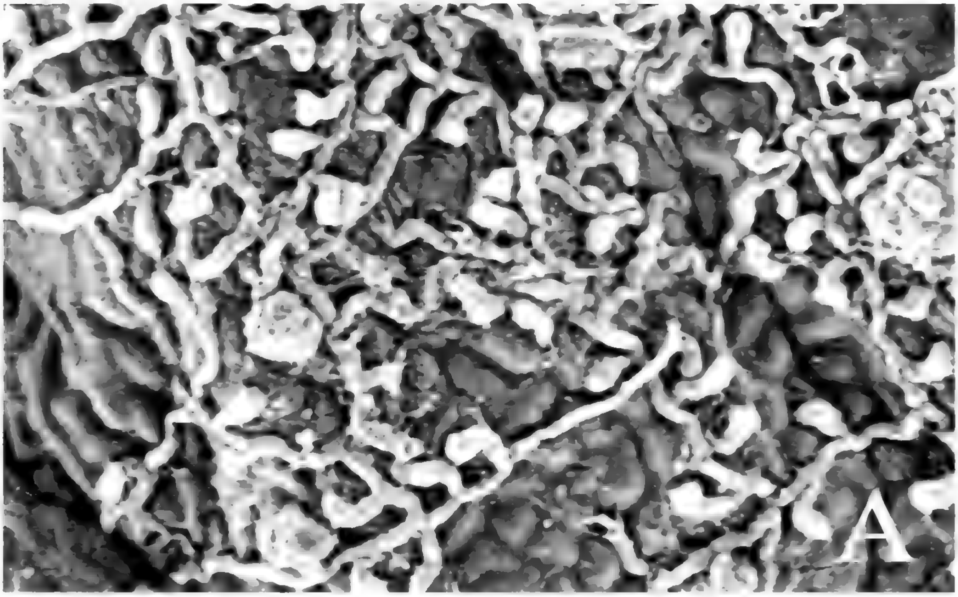

Figure A. *Asterina erebia* Sydow. Mycelium with hyphopodia and ascocarps [from *DRR Singapore 16*; line = 20 μm].

2.2. ***Asterina singaporensis*** Sydow, Ann. Mycol. 18 (1920) 159. **Fig. B.**
Ascospores 16-20 x 6-8 μm. Asci 30-40 μm. Ascocarp 80-110 μm diameter. Colonies epiphyllous, 2-5 mm diameter, hyphopodia dispersed rarely opposite, 10-15 μm long.

Specimen reported: *C.F. Baker Fungi Malayana 401*. Holotype at UC. Sydow and Sydow (1917) noted that this specimen was distributed as *Asterina trachycarpa* Sydow (see also Saccardo, 1918).

Distribution: Singapore.

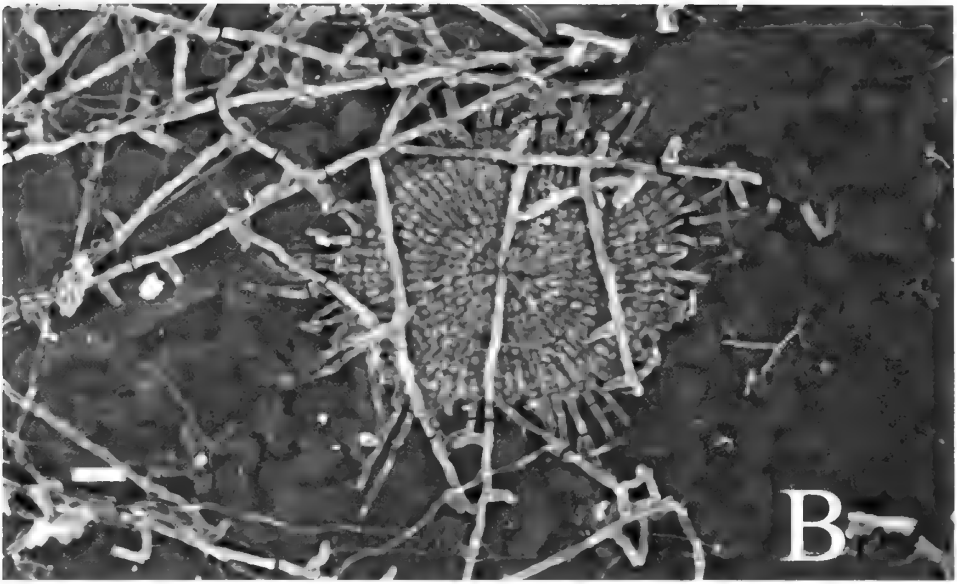

Figure B. *Asterina singaporensis* Sydow. The dimidiate ascocarp is formed beneath hyphopodate hyphae [from *C.F. Baker Fungi Malayana 301*; line = 10 µm].

3. ***Ciferriusia*** Batista in Batista & Ciferri, Sydowia Beih. 3 (1962) 17.
Ascospore 3 transseptate. Asci fissitunicate, paraphysate. Ascocarp developed beneath a mycelia pellicle, without setae. Mycelium hyaline to subhyaline, septate.

3.1. ***Ciferriusia orientalis*** Batista & Costa *in* Batista & Ciferri, Sydowia Beih. 3 (1962) 17.
Ascocarp globose-depressed, with a mycelical shield, 90-180 µm diameter, ostiolate. Asci 40-60
µm. Ascospores clavate, 3-transversely septate, hyaline, 15-20 x 4-5 µm.

Specimen collected: Singapore Botanical Garden, Oct 2007, *DRR 4*.

Illustration: Batista & Ciferri, 1962: Fig. 11.

Distribution: Philippines, Singapore.

Note: Arx and Müller (1975) considered *Ciferriusia* to be a synomym of *Yatesula* H. Sydow & P. Sydow, which has muriform ascospores.

4. ***Ellisiodothis*** Theissen, Ann. Mycol. 12 (1914) 73.
Ascospores hyaline, unicellular. Ascus fissitunicate, pseudoparaphysate, 45-50 x 16 µm; Ascocarp hypostomatic, superficial, dimidiate, nonradiate, dark.

This genus is closely related to *Microdothella* Sydow and *Myiocopron* Spegazzini. It was suggested as a synonym of the latter taxon by A. Sivanesan (see Kirk, 2008).

4.1. ***Ellisiodothis grammatophylli*** (Saccardo) Sydow & Sydow, Ann. Mycol. 18 (1920) 185.
-*Microthyrium grammatophylii* Saccardo, Bull. Orto Bot. Regia Univ. Napoli 6 (1918) 49.
-*Ellisiodothis grammatophylli* Sydow, Ann. Mycol. 18 (1920) 134.
Ascospores 22 x 6 µm. Ascus 45-50 x 16 µm. Ascocarp 325-450 µm.

Specimen reported: *C.F. Baker Fungi Malayana 467*. Holotype at PAD and isotype, UC.

Distribution: Singapore.

5. ***Lembosia*** Léveillé, Ann. Sci. Nat. 3 (1845) 58.
Ascospores 1 septate, brown. Asci spherical, fissitunicate, paraphysate. Ascocarp long or linear forming, X or Y forming, with a longitudinal slit. Mycelium superficial, hyphae with lateral or intercalary hyphopodia, hypostroma or innate hyphae absent

5.1. ***Lembosia hormosiana Saccardo***, Bull. Orto Bot. Regis Univ. Napoli 6 (1918) 52. Ascospores 17-16 x 15-6.5 µm. Ascus 35-40 x 18-20 µm. Ascocarp 235-400 x 90 µm.

Specimen reported: *C.F. Baker Fungi Malayana 443*. Holotype at PAD and isotype, UC.

Distribution: Singapore.

5.2. ***Lembosia pandani*** (Rostafinski) Theissen, Ann. Mycol. 11 (1913) 457.
-*Asterina pandani* Rostafinski, Bot. Tidsskr. 24 (1902) 361.
Ascospores 28-38 x 24-26 µm. Ascus 28-30 x 24-26µm. Ascocarp 350-850 µm.

Specimen reported: *C.F. Baker Fungi Malayana 444*. Holotype at FH and isotype, SING. *Distribution*: Philippines, Singapore.

6. ***Lembosina*** Theissen, Ann. Mycol. 11 (1913) 437.
Ascospores brown, 1-septate. Asci fissitunicate, paraphysate. Ascocarp superficial, elongated or linear, *textura radiate*, opening by a longitudinal slit.

Mycelium subcuticular or intraepidermal, crustose stroma present. Hyphae, septate, without hyphopodia, forming hypostroma between the epidermis and cuticle.

6.1. ***Lembosina heptapleuri*** (Saccardo) v. Arx in Arx & Müller, Studies in Mycol. 9 (1962) 123.
-*Lembosia heptapleuri* Saccardo, Bull. Orto Bot. Regis Univ. Napoli 6 (1918) 52;
-*Echidnodes heptapleuri* (Saccardo) H. Sydow & P. Sydow, Ann. Mycol. 18 (1921) 185.
Ascospores 16 x 5 µm. Ascus 40 x 12 µm. Ascocarp 300-1000 x 100-120 µm.

Specimen reported: *C.F. Baker Fungi Malayana 442*, as *Lembosia heptapleuri*. Holotype at PAD and isotype, UC.

Distribution: Singapore.

7. ***Meliola*** Fries emend. Mibey & Hawksworth, Mycol. Pap. 174 (1997) 23.
- *Amphitrichum* Nees ex Sprenger, Pl. Crypt. Trop. (1820) 46 *pro parte sensu* Hansford (1961).
- *Asteridium* Saccardo, Syll. Fung. 1 (1882) 49.
- *Courturea* Castagne In Fries, Summ. Veg. Scandl. (1846) 407.
- *Meliola* Fries emend. Bornet, Ann. Sci. Nat III: 16 (1851) 267.
- *Meliola* Fries, Syst. Orb. Veg. (1825) 111.
- *Mycothecium* Kunze ex Fries, Syst. Mycol. 3 (1829) 232.
- *Sphaeria* Fries, Syst. Orb. Veg. (1823) 513, *pro parte sensu* Hansford (1961).
Ascospores darkly pigmented, 3-4 transseptate; Ascus unitunicate, uniformly thin-walled; Ascocarp globose, glabrous. Mycelium superficial, comprised of darkly pigmented, septate, setose hyphae; capitate hyphopodia alternate or unilateral, opposite or mixed opposite and alternate. Asexual reproduction, when present, by single phialides producing unicellular, hyaline mitospores.

Meliola was first described by Fries (1825) with a single species and currently includes 2957 taxa (Kirk, 2008). The genus was one of five genera recognized in the Meliolineae by Hansford (1961). This lineage was recognized as the Meliolaceae by Dennis (1968, 1970), Stevens (1927, 1928), and Stevenson (1975), and Meliolales by Alexopoulos *et al*. (1996) and Müller and Arx (1973). Luttrell (1989) placed *Meliola* in the Meliolales of the Pyrenomycetes, which was sustained in a phylogeny discovered by Saenz and Taylor (1999).

A careful and detailed monographic study of 1814 taxa in the genus was undertaken by Hansford (1961). Nonetheless, a more than double proliferation of names has been inadvertently manifested with Hansford's unaccountable arrangement of the species according to the families of the host plants on which they occurred. Subsequent new taxa have been described because of the compartmentalization introduced with the associated vascular plant family as a plesiomorphic character. A comparison of species descriptions that disregards this character demonstrates the taxonomic redundancy. This artificial classification is underscored in the Hansford (1961) monograph by some species listed as occurring on members of more than one vascular plant family and by the recognition of species in which the host is unknown. The Hansford (1961) approach also implies a co-evolution of *Meliola* with angiosperms at the family level, which is not supported by distribution patterns on a phylogenetic clade for the latter.

The consequence of Hansford's *Meliola* species concept is a high potential for a redescription of the same fungus several times. An example is the excessive number of proliferation of uncritically described species by subsequent workers (Hosagoudar 1994, 1996, 2000; Hosagoudar *et al.*, 1997; Hosagoudar and Agarwal, 2008; Hu, 1996, 1999; and Mibey and Hawksworth 1997; Rodriguez 2006). This report does not recognize the associated vascular plant host as a plesiomorphic character.

The species concept of *Meliola* recognized here does not recognize the associated vascular plant host as a plesiomorphic character, although the host range appears to be limited for some clades (Stevens, 1926; Ciferri, 1954; Rodriguez, 2001). The consequence is a description of the same fungus several times because of the host affiliation.

A useful device for an assessment of a *Meliola* species was introduced by Beeli (1920). A numerical code was derived from a set of eight character states with from 3 to 6 variables. The Beeli Formula was revised by Stevens (1927, 1928), Hansford (1961) and Farr (1971). Some authors (Mibey and Hawksworth, 1977) criticize the Beeli Formula as not representing all features and thus was said to be diagnostically lacking. The occurrence of the same Beeli Formula for a group of species was dismissed as insignificant because of the supposed value of other features that would purportedly separate species. These include finite distinctions such as small variations in ascospore size and hyphal or hyphopodial cell size. Most of the features they (Mibey and Hawksworth, 1977) would utilize in the species concept for critical separation of taxa are highly variable and thus unreliable in species recognition, except as a promulgation.

I believe that Beeli recognized the core characters that comprise a species concept for *Meliola*. The continuous character delimitations reflect natural size ranges. Furthermore I regard all putative taxa with a similar Beeli Formula to represent the same or a group of closely related species. Phylogenetically, a large number of overlapping names have been proposed for the termini of a monophyletic lineage with morphological expression better represented by the Beeli Fomula than the minutial variations of these same characters as exemplified by Mibey and Hawksworth (1997).

This predominately tropical genus first appeared in the fossil record in the Eocene (Dilcher, 1965), at a time in the Cretaceous when associated angiosperm hosts were diversifying from a Triassic origin (Taylor *et al.*, 2009). The fossilized, melanoid ascocarp walls of this taxon and other foliicolous ascomycetes are well preserved on compressed leaf cuticles. A lineage older than the Eocene is suggested by the remarkable similarity of specimens to extant species, although the centrum was rarely preserved.

7.1. ***Meliola aethiops*** Saccardo, Bull. Orto Bot. Regis Univ. Napoli 6 (1918) 41.
-*Meliola aglaina* Hansford, Sydowia 9, (1955) 59.
-*Meliola ekebergiae* Hansford, J. Linn. Soc. Bot. 51 (1937) 274.
-*Meliola kauaiensis* Stevens, Bernice P. Bishop Mus. Bull. 19 (1925) 39.
-*Meliola mataybae* Stevens, Ann. Mycol. 26 (1928) 228;
-*Meliola capensis* (Klatchbrenner & Curtis) Theissen var *mataybae* (Stevens) Hansford,
Sydowia Beih. 2 (1961) 447.
-*Meliola nicaraguensis* Spegazzini, Bol. Acad. Nac. Cien. Córdoba 26 (1926) 378.
-*Meliola opposite* Sydow var *africana* Hansford, Sydowia Beih. 2 (1961) 411.
Ascospore 32-45 × 11μm. Ascocarp to 180 μm diameter. Mycelium to 3 mm diameter;
capitate hyphodia opposite or alternate, ampulliform; mycelial setae grouped around ascocarp, straight, simple, 280 μm.

Beeli Formula: 31123221

Specimen reported: *C.F. Baker Fungi Malayana 449*, determined as *Meliola aethiops*. Holotype at SING (#33777). A Singapore specimen was cited as *Meliola aethiops* by Lim (1975).

Illustration: Hansford, 1963.

Distribution: Philippines, Singapore.

7.2. ***Meliola citricola*** Sydow, Ann. Mycol. 15 (1917) 183.
[IMI Descriptions of Fungi and Bacteria 2006, 168, Sheet 1672].

-*Meliola bussei* Mibey in Mibey & Hawksworth, Mycol. Pap. 174 (1997) 32.
-*Meliola khayae* Hansford var *minor* Hansford & Deighton Mycol. Pap. 23 (1948) 43.
-*Meliola ostryodemidis* Hansford & Deighton. Mycol. 3 (1948) 34.
-*Meliola ostryodemidis* Hansford & Deighton var *leptoderridis* Hansford & Deighton 1948. Mycol. Pap. 23 (1948) 35.
-*Meliola stizolobii* Hansford & Deighton var *desmodii-salicifolii* Hansford & Deighton, Mycol. Pap. CMI 23 (1948) 31.
Ascospores 30-48 μm × 9-19 μm. Ascocarp to 140-170 μm diameter. Mycelium to 5 mm diameter; capitate hyphopodia alternate, opposite, straight to antrorse. Mycelial setae scattered or grouped around ascocarp, 160-800 μm. *Briania* phialides (Reynolds, 1989b) sometimes present.

Beeli Formula: 31334223

Specimens reported: Hansford (1961) cites a Singapore collection, *Chupp 5949*, which is curated in SING as *#38557* and *#96896*; they are determined as *Meliola*. An addition specimen, *Baker 1627*, is also cited (Type: Herb. PBS 23747).

Illustrations: Stevens, 1928; Hansford, 1963; Lim, 1975; Hosgoudar & Agarwal, 2008.

Distribution: Borneo, Philippines, Singapore, Sumatra, Taiwan.

7.3. ***Meliola cylindropoda*** Doidge, Trans. Roy. Soc. South Africa 8 (1920) 138.
-*Irenina mangostana* (Saccardo) Stevens, Ann. Mycol. 25 (1927) 457.
-*Meliola araliicola* Yamamoto, Trans. Nat. Hist. Soc. Formosa 31 (1941) 224.
-*Meliola euc*hrestiae Yamamoto, Trans. Nat. Hist. Soc. Formosa 31 (1941) 226.
-*Meliola eugeniae-jamboloidis* Hansford var *paulensis* Hansford, Sydowia 9 (1955) 62.
-*Meliola garcinae* Yates var *mangostana* (Saccardo) Hansford, Proc. Linn. Soc. London 160 (1948) 120.
-*Meliola littoralis* Sydow, Bothalia 2 (1928) 462.
-*Meliola mangostana* Saccardo, Bull. Ort. Bot. Napoli 6 (1921) 42.
-*Meliola plumbaginis* Hansford & Stevens, J. Linnean Soc. London 51 (1937) 280.
-*Meliola tecleae* Hansford var *toddaliae-asiaticae* Hansford, Proc. Linn. Soc. London 153 (1941) 11.

Ascospores 38-44 µm × 15-17 µm. Ascocarp to 240 µm diameter. Mycelium to 6 mm diameter, capitate hyphopodia alternate, straight or bent. Mycelial setae scattered, to 1110 µm.

Beeli Formula: 31114233

Specimen reported: *C.F. Baker Fungi Malayana 453*. This is the type specimen for *M. mangostana* (Herb. SING 33779).

Illustration: Hansford, 1963.

Distribution: Philippines, Singapore, Taiwan.

7.4. ***Meliola fagraeae*** Sydow & P. Sydow, Ann. Mycol. 12 (1914) 549.
- *Meliola mannavanensis* Hosagoudar, C.K. Biju, Baram & Crane. Mycotaxon 76 (2000) 302.
-*Meliola rajamalaensis* Hosagoudar, C. K. Biju & Abraham. Nova Hedwigia 80 (2005) 493.
Ascospores 41-55 µm × 15-19 µm. Ascocarp to 225 µm diameter. Mycelium to 3mm diameter, capitate hyphopodia alternate, straight. Mycelial setae numerous, scattered, straight or flexuous, to 360 µm.

Beeli Formula: 31215232

Specimen reported: BO 5354, reported in Hansford 1961:525.

Illustration: Hansford, 1963.

Distribution: Philippines, Singapore, Sumatra

7.5. ***Meliola garciniae*** Yates, Philipp. Journ. Sci. Bot. 13 (1918) 369.
-*Meliola dognyensis* Huguenin, Rev. Mycol. 34 (1969) 52.
-*Meliola kisubiensis* Hansford, var. *peleicola* Hansford, Sydowia 9 (1955) 43.
-*Meliola kydia* Saccardo Bull. Orto Bot. Regis Univ. Napoli 6 (1918) 13.
-*Meliola mauritiana* Hansford, Sydowia 9 (1955) 20.
-*Meliola megalochaeta* Sydow, Philipp. Journ. Sci. 21 (1932) 135.
-*Meliola teke* Hansford, Proc. Linnean Soc. Lond. 157 (1946) 180.
Ascospores 41-59 x 15-25 µm. Ascocarp 180-360 µm diameter. Mycelium (3) 5-10 mm diameter; capitate hyphopodia opposite or alternate; mycelia setae simple, entire, acute to obtuse or dentate, 325-1600 µm.

Beeli Formula: 31115334

Specimen reported: *C.F. Baker Fungi Malayana 450*, determined as *Meliola kydia*. Holotype at PAD and isotype, UC.

Illustration: Hansford, 1963.

Distribution: Amboina, Borneo, Java, Philippines, Singapore, Vietnam.

7.6. ***Meliola heterodonta*** Sydow, Ann. Mycol. 14 (1916) 357.
-*Meliola columbiensis* Hansford, Sydowia 9 (1955) 61.
-*Meliola justiciae* Hansford, Journ. Linn. Soc. Lond. 31 (1938) 541.
-*Meliola micropoda* Hansford, Proc.Linn. Soc. Lond. 121 (1946) 121.
-*Meliola millettiae-chrosyphillae* Deighton, Sydowia 7 (1951) 7.
-*Meliola nephelii* Saccardo, Bull. Orto Bot. Regis Univ. Napoli 6 (1918) 42.
-*Meliola newbouldiae* Hansford & Deighton, Mycol. Pap. 23 (1948) 66.
-*Meliola oncinotidis* Doidge, Bothalia 4 (1948) 851.
-*Meliola securidacae* Hansford, Sydowia 10 (1957) 88.
-*Meliola securidacicola* Hansford, The Meliolineae, a monograph. Sydowia Beih. 2 (1961) 82.
-*Meliola stizolobii* Hansford & Deighton, Mycol. Pap. 23 (1948) 31.
-*Meliola tounatae* Stevens, Ann. Mycol. 26 (1948) 204.
Ascospores 28-40 x 11-24 µm. Ascocarp to 190 µm; Mycelium 8 mm diameter; mycelia setae simple, entire, acute to obtuse, or dentate, scattered or grouped around perithecium, to 960 µm; capitate hyphopodia opposite or alternate, subanthrose to straight. *Hughesia* phialides sometimes present.

Beeli Formula: 31133223.

Specimens reported: *Baker Fungi Malayana 252* (holotype, PBS 4031); also *Baker Fungi Malayana 454* (holotype of *Meliola nephelii*, SING 33781).

Illustrations: Hansford, 1963; Hosagoudar & Agarwal, 2008.

Distribution: Java, Philippines, Singapore.

7.7. ***Meliola inocarpi*** Stevens, Ann. Mycol. 26 (1928) 232.
Ascospore 43-52 × 17-20 µm. Ascocarp 190 µm diameter. Mycelium 2-8 mm diameter, setae to 900 µm; capitate hyphopodia opposite to alternate, straight or bent.

Beeli Formula: 31124323

Specimen reported: *C.F. Baker Fungi Malayana 459*, determined as *Meliola* sp. Holotype at ILL, and isotype, UC.

Illustration: Hansford, 1963. *Distribution*: Singapore

7.8. ***Meliola litseae*** Sydow, Ann. Mycol. 15 (1917) 366.
-*Meliola golaensis* Deighton, Sydowia 11 (1958) 105.
-*Meliola litseae* Yates, Philip. Journal Sci. C. Botany 12 (1918) 366.
-*Meliola micheliae* Hansford, Proc. Linn. Soc. London 158 (1947) 34.
-*Meliola singaporensis* Hansford, Proceedings of the Linnean Society, London 157 (1946) 17.
Ascospores 4 septate, 42-60 × 16-25 μm. Ascocarp to 225 μm. Mycelium amphigenous, thin to velvety, 1 to 7 mm diam. Hyphae substraight to undulate or flexuous, capitate hyphopodia alternate, antrorse to ampulliform, mycelia setae scattered or grouped around ascocarp, entire, obtuse or dentate, 600-1000 μm.

Beeli Formula: 31114323

Specimens reported: *C.F. Baker Fungi Malayana 457*, determined as *Meliola sp. C.F. Baker Fungi Malayana 480*, type of *M. singaporensis* (holotype, SING).

Illustrations: Hansford, 1963; Hosagoudar & Agarwal, 2008.

Distribution: Philippines, Singapore, Taiwan.

7.9. ***Meliola mangiferae*** Earle, Bull. New York Bot. Gard. 3 (1905) 307.
-*Meliola helicae* Yamamoto, Trans. Nat. Hist. Soc. Formosa 31 (1941) 54.
-*Meliola naisophyllae* Hansford & Deighton, Mycol. Paper IMI 23 (1948) 13.
-*Meliola palmicola* Winter var *coperniciae* Spegazzini, Anal. Mus. Nac. Bueos Aires 32 (1924) 384.
-*Meliola subdentata* Patouillard, Journal de Bot. (1897) 347.
-*Meliola subdentata* Patouillard var *microspora* Hansford & Deighton, Mycol. Paper IMI 23 (1948) 72.
-*Meliola taityuensis* Yamamoto, Trans.Nat. Hist. Soc. Formosa 31 (1941) 131.
-*Meliola trichoscyphae* Hansford & Deighton, Sydowia 10 (1957) 94.
Ascospores 4 septate, 40-59 x 12-25 μm. Ascocarp 180-350 μm. Mycelium 3 to 10mm diameter, hyphopodia alternate or opposite, ampulliform to antrorse, mycelia setae scattered or grouped around ascocarp, simple, entire, acute to obtuse or dentate 810 μm. *Hughesia* phialides sometimes present.

Beeli Formula: 31315333

Specimen reported: *C.F. Baker Fungi Malayana 452*, determined as *Meliola mangiferae*. Holotype, NY; SING
33779, annotated as "type".

Illustrations: Hansford, 1963; Hosagoudar & Agarwal, 2008.

Distribution: Sierra Leone, Australia, Singapore, Taiwan, Philippines, Indonesia, Jamaica, Porto Rico, Venezuela.

7.10. ***Meliola panici*** Earle, Muehlenbergia 1 (1901) 12.
-*Meliola africana* Hansford, Sydowia 10 (1957) 62.
-*Meliola allophylorum* Mibey in Mibey & Hawksworth, Mycol. Pap. 174 (1977) 29.
-*Meliola alyxiae* Stevens, Bernice P. Bishop Mus. Bull. 19 (1925) 30.
-*Meliola ambigua* Patouillard & Guillard var *caseariaecola* Ciferri, Mycopath. Mycol. Appl. 7 (1954) 93.
-*Meliola aristolochiae* Stevens & Tehon, Mycologia 18 (1926) 4.
-*Meliola banarae* Stevens, Ann. Mycol. 26 (1928) 249.
-*Meliola beilschmiediae* Yomomoto, Trans. Nat. Hist. Soc. Taiwan 31 (1941) 52.
-*Meliola berliniae* Hansford & Deighton, Mycol. Pap. (1948) 23.
-*Meliola camellicola* Yamamoto, Trans. Nat. Hist. Soc. Taiwan 31 (1941) 53.
-*Meliola canarii* Sydow, Ann. Mycol. 12 (1914) 550.
-*Meliola caseariae-arboreae* Hansford var. *guatemalensis* Hansford, Sydowia Beih. 1 (1957) 103.
-*Meliola caseariae-guanensis* Hansford, Sydowia 9 (1955) 11.
-*Meliola castaneifoliae* Mibey in Mibey & Hawksworth, Mycol. Pap. 174 (1977) 37.
-*Meliola castanha* Theissen, Broteria 12 (1914) 24.
-*Meliola chasaliae* Mibey in Mibey & Hawksworth, Mycol. Pap. 174 (1977) 38.
-*Meliola cumbrensis* Hansford, Sydowia 10 (1957) 69.
-*Meliola cunoniae* Hansford, Sydowia 9 (1955) 13.
-*Meliola dactylipoda* Sydow, Bothalia 2 (1928) 460.
-*Meliola dasiana* Mibey in Mibey & Hawksworth, Mycol. Pap.174 (1977) 41.
-*Meliola daviesii* Hansford var *longiseta* Hosagoudar, Mycopath. Mycol. Appl. 44 (2006) 44.
-*Meliola desmodii-laxiflori* Deighton var *crotalariae* Deighton, Sydowia 11 (1958) 41.

-*Meliola eryeibes* Hansford, Reinwardtia 3 (1954) 81.
-*Meliola erythrinae* Sydow, Ann. Mycol. 15 (1917) 185.
-*Meliola erythrinae* Sydow var. *psophocarpi* Hansford, Sydowia 10 (1957) 70.
-*Meliola excoecariae* Doidge, Trans. Roy. Soc. South Africa 8 (1920) 139.
-*Meliola ficium* Yates var *ugandensis* Hansford, Sydowia 10 (1957) 72.
-*Meliola forsteroniae* (Stevens) Hansford, Proc. Linn. Soc. Lond. 160 (1948) 1920.
-*Meliola garryae* Hansford, Sydowia 9 (1955) 17.
-*Meliola gnetii* Hansford, Reinwardtia 3 (1954) 85.
-*Meliola gregoriana* Stevens, Bernice P. Bishop Mus. Bull. 19 (1925) 39.
-*Meliola grewiicola* Hansford, Sydowia 11 (1958) 56.
-*Meliola ichnocarpii* Hansford & Thirumalachar., Farlowia 3 (1948) 295.
-*Meliola ichnocarpicola* Hansford, Sydowia Beih. 2 (1961) 559
-*Meliola knowltoniae* Doidge, Bothalia 1 (1924) 308.
-*Meliola landolphiae-floridae* Hansford, Jour. Linn. Soc. Bot. 51 (1938) 542.
-*Meliola landolphiicola* Hansford, Proc. Linn. Soc. Lond. 157 (1945) 23.
-*Meliola leptochaeta* Sydow, Ann. Mycol. 15 (1917) 187.
-*Meliola lianchangensis* Jiang, Acta Mycol. Sin. 14 (1995) 2.
-*Meliola litseae* Graff, Mem. Torrey Bot. Club 17 (1917) 61.
-*Meliola litseae* Sydow var. *rotundipodia* Hansford, Reinwardtia 3 (1954) 88.
-*Meliola logiseta* Höhnel, Akad.Wiss. Wien, Sitzungsber. Math.-Naturwiss. Kl. Abt. 1:116 (1907) 100
-*Meliola lucumae* Stevens, Illinois Biol. Monogr. 2 (1916) 49.
-*Meliola mombasana* Mibey in Mibey & Hawksworth, Mycol. Pap.174 (1977) 55.
-*Meliola ochrocarpii* Thite & Patil, Geophytology 13 (1983) 125.
-*Meliola pachystellae* Mibey in Mibey & Hawksworth, Mycol. Pap.174 (1977) 62
-*Meliola palaquiicola* Hansford, Sydowia 11 (1958) 58.
-*Meliola pandanii* Sydow, Ann. Mycol. 26 (1928) 89.
-*Meliola panici* Earle var. *vetiveriae* Hansford & Deighton in Hansford, Sydowia 10 (1958) 82.
-*Meliola pinnatae* Miber in Mibey & Hawksworth, Mycol. Pap.174 (1977) 66.
-*Meliola plectroniae* Hansford, Sydowia 9 (1955) 72.
-*Meliola pseudocapensis* Hansford, Sydowia 9 (1955) 23.
-*Meliola ruiacearum* Mibey in Mibey & Hawksworth, Mycol. Pap. 174 (1977) 70.
-*Meliola sauropicola* Yates, Philipp. Journ. Sci. Bot. 12 (1917) 368.
-*Meliola semecarpii* Sydow, Ann. Mycol. 21 (1923) 95.
-*Meliola semecarpicola* Hansford, Sydowia 11 (1958) 58.
-*Meliola serjaniae* Stevens, Illinois Biol. Monogr. 2 (1916) 44
-*Meliola tabernaemontanae* Spegazzini var *forsteroniae* Stevens, Illinois Biol.

Monogr. 2 (1916) 50.
-*Meliola terecitensis* Hansford. Sydowia Beih. 1 (1957) 117.
-*Meliola tijucensis* Hansford. Sydowia 9 (1955) 77.
-*Meliola torricelliae* Kar & Maity. Nytt Mag. Bot. 17 (1970) 81.
-*Meliola trichiliicola* Spegazzini. Anal. Mus. Nac. Buenos Aires 32 (1924) 366.
-*Meliola uncariicola* Deighton. Sydowia 11 (1958) 42.
-*Meliola venezuelana* Orejuela. Mycologia 36 (1944) 437.
-*Meliola vicina* Sydow. Ann. Mycol. 21 (1923) 95.
Ascospores 4-septate. 17-66 × 11-28 µm. Ascocarp to 250 µm diameter. Colony diameter to 20 mm. thin to dense. velvety: Mycelium with setae. scattered or grouped around ascocarp. simple. acute. to 1000 µm: capitate hyphopodia alternate to unilateral or opposite. antrorse.

Beeli Formula: 31114223

Specimen reported: *C.F. Baker Flora Malayana 456*. determined as *Meliola* sp. Listed as *M. panici* by Hansford (1961): 745. Holotype at NY: isotype. UC.

Illustrations: Hansford. 1963: Hosagoudar & Agarwal. 2008.

Distribution: Borneo. Java. Malaya. Philippines. Singapore. Taiwan.

7.11. ***Meliola psidii*** Fries. Linneae 5 (1830) 549.
-*Amazonia gniomae* Doidge. Bothalia 1 (1924) 204.
-*Meliola aethiops* Saccardo var *cassia* Rao. Mycopath. Mycol. Appl. 33 (1967) 163.
-*Meliola alchorneae* Stevens & Tehon. Mycologia 12 (1926) 21.
-*Meliola allyphyli* Doidge var *pervillei* Mibey & Hawksworth. Mycol. Pap. 174 (1997) 28.
-*Meliola amadelpha* Sydow. Leafl. Philipp. Bot. 9 (1925) 3114.
-*Meliola anodendri* K. Sawada & Yamamoto. Spec. Publ. Coll. Agri. Nat. Taiwan Univ. 8 (1959) 28.
-*Meliola asclepiadacearum* Hansford var *brasiliensis* Hansford. Sydowia 11 (1958) 52.
-*Meliola banarae* Stevens var *aculeatae* Ciferri. Mycopathologia 7 (1954) 99.
-*Meliola bicornis* var *galactiae* Stevens. Ill. Biol. Monogr. 2 (1916) 65.
-*Meliola biparasitica* Ciferri. Ann. Mycol. 36 (1938) 205.
-*Meliola borbonicae* Mibey in Mibey & Hawksworth. Mycol. Pap. 174 (1997) 31.
-*Meliola bridiicola* Hansford. Proc. Linn. Soc. Lond. 157 (1946) 175

-*Meliola bryae* Hansford, Sydowia 10 (1957) 65
-*Meliola bwaniana* Mibey in Mibey & Hawksworth, Mycol. Pap. 174 (1997) 33.
-*Meliola canthii* Hansford var *leonensis* Hansford & Deighton, Mycol. Pap. 23 (1948) 59.
-*Meliola clavulata* Winter var *jamaicensis* Hansford, Sydowia 11 (1957) 54.
-*Meliola cnestidis* Doidge, Bothalia 2 (1928) 453.
-*Meliola cochlospermifolii* Batista apud Batista, Atlas Inst. Micol. Univ. Recife 1 (1960) 34.
-*Meliola corazoyensis* Hansford, Sydowia Beih. 2 (1961) 375.
-*Meliola dactylipoda* Sydow var. *jamaicensis* Hansford, Sydowia 10 (1957) 68.
-*Meliola daviesii* Hansford, Proc. Linn. Soc. Lond. 157 (1946) 176.
-*Meliola dipholidis* Stevens , Ill. Biol. Monogr. 2 (1916) 44.
-*Meliola erioglossi* Hansford, Sydowia Beih. 1 (1957) 107.
-*Meliola feretiae* Hansford, Sydowia 10 (1957) 71.
-*Meliola ferruginiae* Mibey in Mibey & Hawksworth, Mycol. Pap. 174 (1997) 45.
-*Meliola funtumiae* Beeli, Bull. Jard. Bot. État. 7 (1920) 95.
-*Meliola galactiae* (Stevens) Hansford, Sydowia Beih. (1961) 287.
-*Meliola gardneriae* Hansford & Thirumalachar, Farlowia 3 (1948) 293.
-*Meliola goianensis* Batista & Maia apud Batista, Atlas Inst. Micol. Univ. Recife 2 (1965) 265.
-*Meliola goniomae* Doidge, Bothalia 2 (1928) 461.
-*Meliola guareae* Spegazzini, Ann. Mus. Nac. Buenos Aires 23 (1913) 42.
-*Meliola hendrickxiana* Hansford, Proc. Linn. Soc. Lond. 159 (1947) 25.
-*Meliola henyri* Hosagoudar var oldenlandiae Hosagoudar, Biju & Abraham, Nova Hedw. 80 (2005) 486.
-*Meliola heyneae* Hansford & Thirumalachar, Farlowia 3 (1948) 294.
-*Meliola hippomaneae* Stevens, Ann. Mycol. 28 (1928) 284.
-*Meliola horrida* Ellis & Everhart *in* Smith, Bull. Univ. Iowa 2 (1893) 396.
-*Meliola hoyae* Saccardo, Atti Accad. Sci. Ven. 10 (1917) 60.
-*Meliola hughesiana* Hansford, Sydowia 10 (1957) 76.
-*Meliola hypselodelphidis* Hughes, Myco. Pap. 48 (1952) 51.
-*Meliola jasmine* Hansford & Stevens *in* Hansford, Journ. Linn. Soc. Bot. (1937) 273.
-*Meliola lasiacidis* Toro in Chardon & Toro, Monograph Univ. Porto Rico B 2 (1934) 121.
-*Meliola lictorea* Ciferri, Ann. Mycol. 36 (1938) 214.
-*Meliola lobellicola* Farr, Canad. J. Bot. 47 (1969) 372.
-*Meliola longispora (Gaillard)* Stevens, Ann. Mycol. 26 (1928) 244.
-*Meliola malacotricha* Spegazzini var. *longispora* Gaillard, Le Genre *Meliola* (1892) 82.

-*Meliola microthea* Sydow, Ann. Mycol. 37 (1939) 331.
-*Meliola mitragynicola* Deighton var *leonensis* (Hansford & Deighton) Deighton, Sydowia 11 (1958) 111.
-*Meliola mitragynicola* Deighton, Sydowia 11 (1958) 110.
-*Meliola ocoteicola* Stevens, Ill. Biol. Monogr. 2 (1916) 45.
-*Meliola oldenlandiae* Hansford & Stevens var *indica* Hosagoudar, Biju & Abraham, Nova Hedw. 80 (2005)
492.
-*Meliola oligopoda* Sydow, Ann. Mycol. 21 (1923) 89.
-*Meliola opuntiae* Hansford, Sydowia 10 (1957) 81.
-*Meliola ormocarpi* Hansford & Deighton, Mycol. Pap. 23 (1948) 30.
-*Meliola osmanthi* Sydow var. *hawaiiensis* Hansford, Sydowia 9 (1955) 44.
-*Meliola panici* Earle var *lasiacidis* (Toro) Hansford, Sydowia Beih. (1961) 747.
-*Meliola panici* Earle var. *olyrae* Hansford, Sydowia 10 (1957) 82.
-*Meliola parenchymatica* Gaillard, Le Genre *Meliola* (1892) 180
-*Meliola pentaphylacis* Song & Hu in Song & Hugh, Journ. Trop. Subtrop. Bot. 5 (1997) 37.
-*Meliola petrospermicola* Stevens & Roldan, Philipp. Journ. Sci. 56 (1935) 69.
-*Meliola phoebes* Hansford, Proc. Linn. Soc. London 160 (1948) 136.
-*Meliola physostigmatis* Hansford & Deighton, Mycol. Pap. 23 (1948) 33.
-*Meliola psychotriae* Hansford, Sydowia Beih. 2 (1961) 375.
-*Meliola psychotriae* Earle var *moreliae* Hansford & Deighton, Sydowia Beih. 2 (1961) 597.
-*Meliola randiae-aculeate* Hansford, Sydowia 9 (1955)74.
-*Meliola ranganathii* Hansford, Proc. Linn. Soc. London 157 (1946) 185.
-*Meliola samydae* Ciferri, Ann. Mycol. 29 (1931) 285.
-*Meliola saurAuiae* Sydow, Ann. Mycol. 37 (1939) 232.
-*Meliola scabriseta* Hansford & Deighton var. *brasiliensis* Hansford, Sydowia 9 (1955) 47.
-*Meliola scaevolae* Sydow, Ann. Mycol. 12 (1914) 551.
-*Meliola secamonis* Hansford, Proc. Linn. Soc. Lond. 156 (1944) 39.
-*Meliola silventvalleyensis* Hosagoudar, Journ. Mycopath. Mycol. Appl. Research 45 (2006) 3.
-*Meliola straussiae* Hansford, Sydowia Beih. 1 (1957) 117.
-*Meliola strophanthi* Hansford non Doidge, Journ. Linn. Soc. Bot. 51 (1937) 282
-*Meliola strophanthicola* Hansford, Sydowia Beih. 61 (1961) 551.
-*Meliola taitensis* Mabey & Cannon, Crypto. Mycol. 20 (1999) 277.
-*Meliola thungergiicola* Hansford & Deighton, Mycol. Pap. 23 (1948) 68.
-*Meliola trichostroma* (Kunze) Toro, Journ. Depart. Agric. Univ. Porto Rico 36 (1952) 62.

-*Meliola yuanjiangensis* Jiang, Acta Mycol. Sinica 8 (1989) 177.
-*Meliola zamboangensis* Hansford, Sydowia Beih. 1 (1957) 119.
-*Sphaeria trichostroma* Kunze *in* Weigelt's Exsiccatum (1827). (see Pfister, Mycotaxon 23: (1985) 1-139.
Ascospores 33-48 × 11-21 μm. Ascocarp 140-200 μm diameter. Mycelium to 15 mm; mycelial setae scattered or grouped around ascocarp, simple, sometimes dentate, 270-600 μm; capitate hyphodia alternate.

Beeli Formula: 31114222

Specimen reported: A specimen of *A. Chupp 5948* (SING 38558) at K is cited by Hansford
(1961) from Singapore. Holotype at S.

Illustrations: Hansford, 1963; Housgoudar & Agarwal, 2008.

Distribution: Borneo, Burma, Malaya, Philippines, Singapore, Taiwan.

7.12. ***Meliola* sp.**

Specimen reported: C.F. Baker Fungi Malayana 458. UC, BPI 692188-89.

Distribution: Singapore

Note: The Baker collection is not a *Meliola*; the material appears to be sterile.

8. ***Meliolina*** H. Sydow & P. Sydow, Ann. Mycol.12 (1914) 553.
Ascospores 3-septate, constricted, darkly pigmented, often with thin-walled pale bands. Ascus extenditunicate, paraphyses evanescent. Ascocarp superficial on external mycelium, globose, glabrous, astomatic, often setose. Mycelium brown, superficial, exhyphopodiate, forming stomopodia, setose, furcated.

8.1. ***Meliolina malacensis*** (Saccardo) Trotter *in* Saccardo, Sylloge Fungorum 24 (1926) 360.
-*Meliola malacensis* Saccardo, Bull. Orto Bot. Regia Univ. Napoli 6 (1918) 43.
Ascospores with midconstriction, 35-45 × 12-15 μm. Ascus oblong-clavate, 80-90 μm. Ascocarp 250-300 μm; setae simple, acute, 300-350 × 5-5.5 μm. The associated mitosporic state, *Briania* (Reynolds, 1989), was not found.

Specimen reported: *C.F. Baker Fungi Malayana 451*, determined as *Meliola malacensis* Saccardo.

Distribution: Singapore

Note: This taxon was recognized by Hansford (1961) as a *Meliolina* and excluded from *Meliola*. This species was not accepted in the treatment of *Meliolina* by Hughes (1993). *Meliola* and *Meliolina* are morphologically different as well as distant in phylogeny. These two members of the Pezizomycotina were phylogenetically inferred by Saenz and Taylor (1999) to be on separate clades. *Meliola* is a taxon in the Sordariomycetes, Meliomycetidae, Meliolales with a unitunicate ascus, as predicted by Luttrell (1989), and *Meliolina* is in the Dothidiomycetes, Dothidomycetidae, with an extenditunicate modification of the fissitunicate ascus (Reynolds, 1989a).

8.2. ***Meliolina cladotricha*** (Léveillé) H. Sydow & P. Sydow, Ann. Mycol. 17 (1914) 553h.
-*Meliola octospora* Cooke, Grevillea 11 (1882) 71.
-*Meliolina octospora* (Cooke) Höhnel, Akad.Wiss. Wien, Sitzungsber., Math.-Naturwiss. Kl. Abt. 118 (1909) 813.
-*Meliolina octospora* Höhnel, Akad.Wiss. Wien Sitzungsber. Math.-Naturwiss. Kl. Abt 1. 128 (1919) 557.
Ascospores with hyaline band in terminal cells near septum, 45-57 × 17-20 μm. Ascus with abundant paraphyses, 100-120 μm. Ascocarp spherical, 400μm diameter, setae 145-186 μm.

Specimen reported: A Flora of Singapore collection (SING 96897) made by an unknown collector in 1899 was labeled as *Meliola octospora* Cooke. There are no spores.

Note: Hughes (1993) argues for the acceptance of *M. octospora* Höhnel based on his interpretation of Höhnel's (1909, 1919) observations and supposed prior misuse by Stevens (1927), Hansford (1954), Yamamoto (1957) and Sivanesan (1984). We find Hughes' argument to be suspicious in that the attempt to affirm the observations of von Höhnel was based on his inadequate material now curated in Herbarium FH and assumptions made from the observations of Yamamoto (1957) from Taiwan, but without surviving specimens.

9. ***Micropeltella*** Montagne, Ann. Sci. Nat. Bot., sér 2, 17 (1842) 325.
Ascospores hyaline, 2-8 septate, clavate. Asci clavate, cylindrical, fissitunicate, aparaphysate. Ascocarp orbicular, dimidiate-scutulate, margin pelluculoae, blue to green-black, textura meandriforme, plechymatous; ostiole distinct, round. Mycelium absent at ascocarp maturity.

Batista (1959) noted that the species of this taxon were removed from *Micropeltis* because of a lack of paraphyses, based on the examination of Singapore specimens cited here. The type specimen is Montagne 1134, Herb. P.

9.1 *Micropeltella marginata* (Montagne) Batista, Inst. Micol. Univ. Recife Publicação 56 (1959) 160.
-*Micropeltella albo-marginata* (Spegazzini) Batista, Inst. Micol. Univ. Recife Publicação 56 (1959) 153; -*Micropeltis albo-marginata* Spegazzini, Bol. Acad. Nac. Ci. Argent. 11 (1889) 572.
-*Micropeltella orchidearum* (P. Hennings) Batista, Inst. Micol. Univ. Recife Publicação 56 (1959) 163.
-*Micropeltis albo-ostiolata* P. Hennings, Hedwigia 47 (1908) 268.
-*Micropeltis ekmanii* Petrak & Ciferri, Ann. Mycol. 30 (1930) 205.
-*Micropeltis marginata* Montagne, Ann. Sci. Nat. (Paris) 4, 3 (1855) 133.
-*Micropeltis orchidearum* P. Hennings In: A. Engler & K. Prantl, Die naturlichen Pflanzenfamilien 23 (1897) 286.
Ascospore 87-125 × 12-15 µm. Ascus fissitunicate. Ascocarp dimidiate, plectenchymatic, blue- black, ostiolate, orbicular, 535-700 µm diameter.

Specimens reported: *C.F. Baker Fungi Malayana 460*; see also SING 36128, 36129. *C.F. Baker*
Malayana #460 is determined as *Micropeltis marginata* Montagne

Illustration: Batista, 1959: 88, Fig. 18.

Distribution: Singapore.

10. ***Micropeltis*** Montagne Ann. Sci. Nat. Bot. sér 2, 17 (1842) 122.
Ascus paraphysate, fissitunicate. Ascospores hyaline, 2-many septate, clavate, oblong to cylindrical. Ascocarp dimidiate-scutate, parenchymatic, circular, ostiolate, green-black. Mycelium absent.

10.1. ***Micropeltis trimera*** Saccardo, Bull. Orto Bot. Regis Univ. Napoli 6 (1918) 51.

Ascospores fusoid, 2-3 septate, 35 × 8µm. Ascocarp margin pelliculose, black, 510-610 µm diameter.

Specimen reported: *C.F. Baker Fungi Malayana 461*, holotype in BP and isotype, UC. The UC specimen has an ascocarp measuring 350-421 µm in diameter; the immature asci measured 100 µm in length; the ascospores are immature.

Illustration: Batista 1959: 146. Fig. 60.

Distribution: Singapore.

11. ***Polychaeton*** (Persoon) Léveillé
-*Fumago* [subgenus] *Polychaeton* Persoon. Mycologica europea. Sectio prima. Erlangae (1822)
-*Morfea* Roze Bull. Soc. Bot. France 14: (1868) 15.
-*Morfea* (G. Arnaud) Ciferri & Batista (1963) 140.
-Subgenus *Morfea* G. Arnaud (1913) 280.
Lectotype: *Polychaeton quercinum* (Persoon) O. Kuntze (1891) =*Fumago quercina* Persoon. Mycologica europea. Sectio prima. Erlangae (1822). Type: Herb. L.

Mitospores formed in an expanded basal or midway centrum within a wide stalk. Stalk single, or branched with a columnate extension with a fringed ostiole. Mitospores unicellular, hyaline.

11.1. ***Polychaeton artocarpi*** (Batista, Nascimento & Ciferri) Khodap. Rostaniha 7 (2006) 79.
-*Microxiphium artocarpi* Batista, Nascimento & Ciferri in Batista & Ciferri. Quaderno 31 (1963)114.
-*Microxiphium footi* (Berkeley & Desmazières) Spegazzini 1918.
-*Microxiphium jafarnizamie* Manocharachar (1979) Nova Hedwigia 63:185.
-*Microxiphium jambosae* Batista apud Batista & Ciferri. Quaderno 31 (1963) 132.
-*Microxiphium leptospermi* Fisher. Proc. Royal Soc. Victoria. N.S.W. 45 (1963) 191.
-*Microxiphium obtusulum* Saccardo Phil. J. Sci. (1921) 19: 602.
-*Microxiphium secundum* Batista & Ciferri. Quaderno 31 (1963) 136.
Mitospores measuring 2 x 5 µm.

Note: Lim (1975) listed three Singapore collections of *Microxiphium artocarpi*, *M. leptospermi*, and *M. secundum*.

11.2. ***Polychaeton brasiliense*** (Batista in Batista & Ciferri), *comb. nov.*
Basionym: *Microxiphium brasiliense* Batista in Batista & Ciferri. Quaderno 31 (1963) 119.
-*Microxiphium alanqii* Agarwal & Sharma. J. Indian Bot. Soc. 53(1-2) (1974) 77.
-*Microxiphium ciliolatum* (Saccardo) Ciferri & Batista apud Batista &

Ciferri, Quaderno 31 (1963) 121.
-*Microxiphium coffeanum* Batista & Matta, Quaderno 31 (1963) 122.
-*Microxiphium inspersum* Batista & Ciferri, Quaderno 31 (1963) 132.
-*Microxiphium spathodeae* Batista & Matta apud Batista & Ciferri, Quaderno 31 (1963) 137.
-*Microxiphium unedonis* (Marie & Saccardo) Batista & Ciferri, Quaderno 31 (1963) 139.
-*Polychaeton bassiae* Manocharachary, Kunwar, Sarath & Nagamani in Manocharachary, Kunwar, Babu & Nagamani. 2003.
Mitospores measuring 2 x 3.5 µm.

Note: Lim (1975) listed two Singapore collections of *Microxiphium coffeanum* and *M. spathodeae.*

11.3. ***Polychaeton tenellum*** (Saccardo), *comb. nov.*
Basionym: *Microxiphium tenellum* Saccardo, Bull. dell'orto Bot. della R. Univ. Napoli 24 (1918) 5.
-*Microxiphium aciculiforme* Ciferri, Batista & Nascimento in Batista & Ciferri, Quaderno 31 (1963) 110.
-*Microxiphium atmosphaericum* Batista, Bezerra & Garnier in Batista & Ciferri, Quaderno 31 (1963) 117.
-*Microxiphium columnatum* Batista, Ciferri & Nascomento in Batista & Ciferri, Quaderno 31 (1963) 123.
-*Microxiphium cylindricum* Batista & Ciferri, Quaderno 31 (1963) 127.
-*Microxiphium dubium* Saccardo, Ann. Mycol. 13 (1915)127.
-*Microxiphium philippinensis* Ciferri & Batista in Batista & Ciferri, Quaderno 31 (1963) 135.
-*Microxiphium virde* Batista & Ciferri, Quaderno 31 (1963) 141.
-*Polychaeton pinicola* Batista, Nascimento & Ciferri apud Batista & Ciferri, Quaderno 31 (1963) 135.
-*Polychaeton purpuraefaciens* (J.F.H. Beyma) Reynolds & Gilbert, Aust. Syst. Bot. 18(3) (2005) 275.
Mitospores measuring 1.5 x 5 µm.

Specimens reported: *C.F. Baker Fungi Malayana 468*, holotype at BP; isotype, UC; Singapore, Bukit Timah Reserve, Oct 2007, *DRR Singapore 20* (SING, UC). Lim (1975) also listed two Singapore collections of this species as *Microxiphium aciculiforme*, *M. columnatum.*

Illustrations: Beyma, 1931; Batista & Ciferri, 1963; Ciferri *et al.*, 1956.

Distribution: Indonesia, Philippines, Singapore, Taiwan, Thailand, Vietnam.

Note: Forty six species have been described as *Microxiphium* (=*Microxyphium*) (Harvey) ex Berkeley & Desmazières in Thümen (1879). Most of these are synonyms of *Polychaeton*.

Yamamoto (1955) noted a "*Microxyphium* (*Certatopycnidium*) type" in the "imperfect stage," described as, "A peridium is semispherical..." Reynolds and Gilbert (2005) found that *Microxiphium* is based on two mitosporic forms. The mycelium forms a setose pellicle and mitosporic reproduction is twofold: 1. a rosette of hialidic cells found in the mycelium or as a cortex of hyphae surrounding the mycelia setae (*Microxiphium*); 2. subpellicular areas producing triradiate, septate mitospores (*Bisbyopeltis phoebesii*)."

The pycnidium of *Microxiphium sensu* Batista & Ciferri (1963b) is the source of a few characters that are used to distinguish 28 taxa. It is described as cylindric. A fimbriated appearance is given to the apex by hyaline hyphal extensions beyond the darkly pigmented cells forming the apical dispersal column. The taxa recognized range in a continuous progression from an attenuated form to one with a somewhat attenuated lower area that continues as an extended neck formed around a canal through which the mitospores are dispersed from the basal conidiogenous centrum. A continuum of character variability can be found in an examination of the types and other collections of *Microxiphium* spp. in Herbarium URM and in pure culture isolates derived from a single mitospore (unpublished research).

Polychaeton forms a mitosporic centrum within a wide stalk, located from the central to the upper part. *Conidioxyphium* Batista and Ciferri was found to be indistinguishable microscopically (Singh *et al.*, 2006) with cluster analysis, principal components analysis, and discriminate analysis (Faull *et al.*, 2002). Arnaud (1913) considered these structures to be spermagonia. Beyma (1931) gives details of development in culture. The conidiogenous hyphae of the centrum are sympodially branched, forming phialides with collarettes. The stalks may be single or branched; the branching often arises from mitospores germinating directly on the stalk. A columnate extension beyond the centrum often has a fringed ostiole. The mitospores are unicellular and hyaline. Observations (Reynolds, 1978) made on the mitosporic structures of *Scorias spongiosa* and collections from tropical climates indicate that the pycnidia of *Polychaeton* are variable in length and branching patterns. The fruit body stalk that subtends the mitosporic centrum is characteristically as wide as the centrum. The mitospore morphology is stable and produced within an internal pycnidial centrum. The hyaline, unicellular spore is exuded from the centrum along a canal in a columnate neck. A droplet of water soluble matrix contain multiple conidia forms under humid conditions. The mitospores flow down the fruit body onto a substrate; dilution of the spore containing drop initiates germination. Typically the mitospore divides to form a hyphal initial and the melanoid pigmentation accumulates in the cell walls. Measurements of the mitospores as they are exuded from the apex of the fruit body comprise primary taxonomic characters.

The name *Morfea* has been utilized for both a concept of mitosporic and ascosporic monomorphic and pleomorphic species by Roze (1868) and Batista and Ciferri, (1963a). The name was clarified as a mitosporic nomen and affirmed as *Polychaeton* (Hughes, 1976; Punithalingam, 1981; Reynolds, 1998).

12. ***Schizothyrium*** Desmazières, Ann. Sci. Nat. Bot. sér 3, Bot. 11 (1840) 360.
Ascospores 1-septate, hyaline; Ascus extenditunicate; ascocarp dimidiate, dark, with radial margin; Mycelium inconspicuous.

12.1. ***Schizothyrium longispora*** (Patouillard) Arx, in Müller & Arx, Die Gattungen der didymosporen Pyrenomycetes (1962) 202.
-*Dictyopeltis lucumae* Batista, Anais IV. Congresso Nac. Soc. Bot. Brazil (1953) 117.
-*Eremotheca philippensis* Sydow, Ann. Mycol.15 (1917) 235,
-*Microthyriella enaequalis* Batista, Mycopath. Mycol. Appl. 5 (1951) 171.
-*Microthyriella guianensis* Stevens & Manter, Bot. Gaz. 79 (1925) 290.
-*Microthyriella macrospora* Höhnel, Akad.Wiss. Wien, Sitzungsber. Math.-Naturwiss. Kl. Abt. I, Biologie 127 (1918) 630.
-*Microthyrium browneanum* Saccardo, Bull. Orto Bot. Regis Univ. Napoli 6 (1918) 50.
-*Microthyrium lomgisporum* Patouillard, Bull. Soc. Mycol. France 20 (1888) 118.
Ascospores 35-60 × 12-17 µm. Asci 60-75 × 40-50 µm. Ascocarp superficial, roundish, 400-1200 µm diameter, dark brown.

Specimen reported: *C.F. Baker Fungi Malayana 465*. Holotype at UC.

Distribution: Singapore.

13. ***Setameliola,*** *gen. nov*
=*Meliola sensu* Mibey & Hawksworth (1997)
Sporidia 3-4, septata, fusca. Asci con 2-4 spori, aparaphysati. Ascocarp in

mycelio maculiformi superficiali, globosa, astoma, setosus. Mycelium ex hyphis brunneis, septatis vel hyphis formans catillus, cum hyphopodia, setosus. - Typus species: *Setameliola argentina* (Spegazzini) D.R.Reynolds

Diagnosis: This taxon is distinguished by the presence of setae on the perithecium as well as the mycelium. *Meliola* Fries emended Bornet (1851) *sensu* Hansford (1961) includes species that have glaborous as well as setose ascocarp. The Mibey and Hawksworth (1997) *Meliola* emendment provides for a perithecium "devoid of setae or appendages." Accordingly, *Setameliola* includes the 23 species of *Meliola sensu lato* with setose ascocarp. The mycelial setum is the character distinction of *Meliola* and *Setameliola* from *Irenopsis* (setose ascocarp), *Appendiculella* (laviform ascocarp appendages) and *Asteridiella* (glabrous ascocarp). Two of the 24 species of *Setameliola* (*S. araucariae and S. agathidis*) form unusual thalloid plates (Ellis, 1974; Hansford, 1961; Katumoto & Hosagoudar, 1989).

13.1 ***Setameliola argentina*** (Spegazzini), *comb. nov.*
Basionym: *Meliola argentina* Spegazzini, Ann. Soc. Cient. Argentina 9 (1880) 177. [Holotype: *Speggazini 510*, S].
-*Ireniopsis martiniana* (Gaillard) Stevens, Ann. Mycol. 25 (1927) 437
-*Meliola argentina* Spegazzini var *hawaiiensis* Hansford, Sydowia 11 (1958) 51.
-*Meliola argentina* Spegazzini var *africana* Hansford, Sydowia 9 (1955) 9.
-*Meliola argentina* Spegazzini var *leeuwenii* Hansford, Sydowia 10 (1957) 63. Type: BO 5607.
-*Meliola circinans* Earle, Bull. New York Bot. Gard. 3 (1905) 304.
-*Meliola circinans* Earle var *rhynchosporae* Hansford (1904) 304.
-*Meliola intricata* Sydow, Philipp. Journ. Sci. Bot. (1913) 268. Type: PBS 7152
-*Meliola juddiana* Stevens, Bernice B. Bishop Mus. Bull. 19 (1925) 32.
-*Meliola martiniana* Gaillard, Le Genre *Meliola* (1892) 68.
-*Meliola setulifera* (Spegazzini) Stevens, Ann. Mycol. 25 (1927) 285. Type: Rabenhorst and Winter. *Fungi Europaei et Extraeruopaei 3852* (Herb. F).
Ascospores oblong, obtuse, 4-septate, 37-47 x 15-18 µm. Ascocarp to 190 µm diameter, with setae straight to acute, 90 x 8 µm. Mycelium epiphyllous, dense, velvety; hyphae sub-straight to undulate, branching opposite; capitate hyphopodia alternate to opposite, head cell straight or bent, stalk cell cuneate; mycelial setae, simple with acute apex, entire, 400 µm length.

Illustrations: Hansford, 1963; Stevens, 1928: 381, Plate IV-40.

Distribution: Borneo, Philippines, Singapore, Taiwan

The following recombinations are made on the basis of the setose ascocarp:

13.2. ***Setameliola agathidis*** (Ellis), *comb. nov.*
Basionym: *Meliola agathidis* Ellis, Trans. Brit. Mycol. Soc. 63 (1974) 96. Type: IMI 73853.

13.3. ***Setameliola apiculata*** (Hansford), *comb. nov.*
Basionym: *Meliola apiculata* Hansford, Proc. Linn. Soc. London 160 (1948) 137. Type: Herb. ILL.

13.4. ***Setameliola araucariae*** (Ellis), *comb. nov.*
Basionym: *Meliola araucariae* Ellis, Trans. Brit. Mycol. Soc. (1974) 93. Type: IMI 170578.

13.5. ***Setameliola artocarpiicola*** (Stevens ex Hansford), *comb. nov.*
Basionym: *Meliola artocarpiicola* Stevens ex Hansford, Sydowia Beih. 11 (1958) 52. Type: PBS 36433.

13.6. ***Setameliola bayamonensis*** Tehon var *guettardae* (Ciferri), *comb. nov*.
Basionym: *Meliola bayamonensis* Tehon var *guettardae* Ciferri, Mycopath. Mycol. Appl. 7(1954) 98. Type: Herb. S.

13.7. ***Setameliola brinkii*** (Hansford), *comb. nov.*
Basionym: *Meliola brinkii* Hansford, Reinwardtia 3 (1954) 96. Type: BO 12315.

13.8. ***Setameliola canariicola*** (Stevens ex Hansford), *comb. nov.*
Basionym: *Meliola canariicola* Stevens ex Hansford, Sydowia Beih. 1 (1957) 102. Type: PBS 34009.

13.9. ***Setameliola canthii*** Hansford var *aristata* (Hansford), *comb. nov.*
Basionym: *Meliola canthii* Hansford var *aristata* Hansford, Proc. Linn. Soc. Lond. 51 (1945) 22. Type: Herb. IMI.
-*Meliola woodiana* Saccardo var *aristata* Hansford, Journ. Linn. Soc. Bot.51 (1937) 284.

13.10. ***Setameliola circinans*** (Earle), *comb. nov*.
Basionym: *Meliola circinans* Earle, Bull. New York Bot. Gard. 3 (1905) 304. Type: *Heller 6347*, NY.

13.11. ***Setameliola circinans*** Earle var ***rhynchosporae*** (Hansford) *comb. nov.*
Basionym: *Meliola circinans* Carle var *rhychosporae* Hansford, Sydowia 9

(1955) 13. Type: *Nash 1803*, FLS.

13.12. ***Setameliola coriae*** (Hueguenin), *comb. nov.*
Basionym: *Meliola coriae* Hueguenin, Rev. Mycol. (Paris) 34 (1969) 30. Type: Herb. P.

13.13. ***Setameliola cyperi*** (Patouillard in Gaillard), *comb. nov.*
Basionym: *Meliola cyperi* Patouillard in Gaillard, Le Genre *Meliola* (1892) 70. Type: Herb. FH.

13.14. ***Setameliola fusispora*** (Yamamoto), *comb. nov.*
Basionym: *Meliola fusispora* Yamamoto, Trans. Nat. Hist. Mus. Taiwan 31 (1941) 219. Type: Herb. TNS.

13.15. ***Setameliola kaduae*** (Stevens), *comb. nov.*
Basionym: *Meliola kaduae* Stevens, Bernice B. Bishop Mus. Bull. 19 (1925) 30. Type: Herb. ILL.

13.16. ***Setameliola martiniana*** (Gaillard), *comb. nov.*
Basionym: *Meliola martiniana* Gaillard, Le Genre Meliola (1892) 68. Type: *Rabenhorst's Fungi Europea 3852* (Herb. F).
-*Irenopsis martiniana* (Gaillard) Stevens, Ann. Mycol. 25 (1927) 437.
-*Meliola perseae* Stevens forma *setulifera* Spegazzini. Bol. Acad. Nac. Cien. Cordoba 26 (1923) 380.
-*Meliola setulifera* Stevens, Ann. Mycol. 26 (1928) 285.

13.17. ***Setameliola microtricha*** (Sydow in Sydow & Sydow), *comb. nov.*
Basionym: *Meliola microtricha* Sydow in Sydow & Sydow, Ann. Mycol. 18 (1920) 157. Type: Herb. UC.

The Singapore record for this taxon is *C.F. Baker Fungi Malayana 490* determined as *Tetrachia singularis* Saccardo (1918). The taxon is cited by Hansford (1961) as the type under *Meliola microtricha* H. Sydow & P. Sydow [see Annales Mycologia 18 (1920) 157]. The Saccardo description is of a sporodochial fungus and only conidia are described. Sydow & Sydow (1920) regarded *Tetrachia singularis* as a synonym of *Spegazzinia meliolae* Zimmerman. Damon (1953) considered that *Spegazzinia tessartha* (B & C) Saccardo comprised a monotypic genus and cited *T. singularis* as a synomym of *Isthmospora trichophila* (Atkinson) Damon. Hughes (1953) considered *T. singularis* to be a synonym of *Trichothrium*.

The UC specimens *490* and *491* (determined as *T. singularis, n. gen. et n. sp.*) from the C.F. Baker *Fungi Malayana exsiccatum* exhibit two epifoliar fungi. The isthmospores of *T. singularis* or *T. asterophorum sensu* Hughes (1953) similar to those of *Spegazzinia*, are found in both specimens. *Tetrachia singularis* is a hyperparasite of a second fungus present that agrees with the Hansford (1961) description of *Setameliola (=Meliola) microtricha*. No thyriothecia of *T. singularis* were seen.

13.18. ***Setameliola paratrophidis*** (Hansford), *comb. nov.*
Basionym: *Meliola paratrophidis* Hansford, Reinwardtia 3 (1954) 96. Type: Herb. BO.

13.19. ***Setameliola pradosiae*** (Batista in Batista, Nascimento & Maia), *comb. nov.*
Basionym: *Meliola pradosiae* Batista in Batista, Nascimento & Maia, Inst. Micol. Publicaçao 25 (1956) 8. Type: Herb. URM.

13.20. ***Setameliola pseudomori*** (Hansford), *comb. nov.*
Basionym: *Meliola pseudomori* Hansford, Proc. Linn. Soc. New South Wales (1954) 65. Type Herb. IMI.

13.21. ***Setameliola sakahensis*** (Yamamoto), *comb. nov.*
Basionym: *Meliola sakahensis* Yamamoto, Trans. Nat. Hist. Soc. Taiwan 30 (1940) 421. Type: Herb. BPI.

14. ***Trichomerium*** Spegazzini emend. Reynolds, Mycotaxon 14 (1982) 190.
-*Capnobatista* Ciferri & Leal *in* Batista, A.C. & R. Ciferri, Saccardoa 2 (1963) 75.
-*Chaetopotius* Batista, Mycopath. Mycol. Mycol. Appl. 5 (1951) 151. *Pro parte*
-*Triposporiopsis* Yamamoto, Special Publ. Kasai Shuppan Institute Minato-ku Tokyo (1955) 55.
Ascospores hyaline, fusiform, 18-32 x 5-10 µm. Hymenium periphysate. Asci fissitunicate, obclavate.
Ascocarp dark brown, setose, ostiolate 80-230 µm. Mycelium of superficial, branching, septate hyphae, not setose nor hyphopodiate

14.1 ***Trichomerium grandisporum*** (Ellis & Martin in Ellis & Everhart) Batista & Ciferri, Saccardoa 2 (1963) 210 (see Reynolds, 1982, for synonyms).
Ascospores hyaline, fusoid, granulate, 4-6 septate, 18-38 x 5-10 µm. Asci aparaphysate, fissitunicate. Ascocarp ostiolate, 100-170 x 88-170 µm; Setae 62.5-170 µm in length. Mycelium of superficial, branching, septate hyphae, brown to blackish, not setose nor hyphopodiate.

Specimens reported: Singapore, Bukit Timah Reserve. Oct 2007. *DRR 1, 5, 6, 14, 20, 22*. (SING, UC).

Illustration: Batista & Ciferri 1963a: figs 75-96.

Distribution: Pantropical

Note: A specimen identified by F. von Höhnel as *Aithaloderma setosum* is represented by a microscope slide preparation (*IMI 63263*, F). The sparse data indicate that the collections were made in Singapore in 1956. An unclear understanding of *Aithaloderma* species is manifested by different interpretations of the ascocarp. In one type, the setose ascocarp is globose similar to that of *Trichomerium*. Other species have been attributed with a shield over the ascocarp that is characteristic of *Chaetothyrium*. We find that the *Aithaloderma* examined by von Höhnel should be assigned to *Trichomerum grandisporum*.

Acknowledgements

I thank the Singapore Botanical Garden for a Research Fellowship in October of 2007; Dr. M.M. Thang, Dr. D. Pfister and Dr. Paul Kirk made helpful suggestions.

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A Conspectus of the Lichens (Lichenized Fungi) of Singapore

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Abstract

A total of 296 species of lichenized fungi are reported from Singapore and presented in an annotated list with local distributional information. It is based on herbarium and literature study and the fieldwork done in the year 2000. Unidentified samples suggest the figure to be an underestimation, while some of the listed species may have become extinct. Lists of synonyms and collectors are added.

Introduction

Tropical conurbations, the world's most fast-growing habitat, have turned out to harbour significant numbers of lichenized fungi. Aptroot and Seaward (1999) and Aptroot and Sipman (2001) report no less than 308 species for the city of Hongkong. Singapore seems particularly suitable for a study of lichens in an urbanized tropical area because it has received regular attention from botanists during its development from primary lowland forest with small settlements *ca* 1800 to extensive plantations a century later and to the present urbanized area with large built-up high rise areas interspersed by parks and secondary forest. During 1800-1964 scattered lichen collections were made by visiting and resident general botanists, e.g., E. Almquist, O. Beccari, T.R. Chipp, Kiah, A.M. Lemaitre, A.C. Maingay, H. Möller. Their collections have been investigated and published by, e.g., Krempelhuber (1875, 1877), Nylander and Crombie (1884) and Müller Argoviensis (1893). From 1964-1992 three lichen experts visited the area and made herbarium vouchers, Aptroot, Degelius, and Tibell (see list of collectors below). In November 2000 the author made a lichen inventory in collaboration with Dr. B.C. Tan (NUS/SING) and Prof. D.H. Murphy (Singapore), and took samples from 18 study sites spread over Singapore Island and on some of the smaller off shore islands. Presented below is an evaluation of the present day lichen flora of Singapore. A comparison with temperate urban areas and a discussion of probable changes in the island's lichen flora through the centuries are presented in another paper (Sipman, in press).

Material and methods

The evaluated records originated mainly from fieldwork conducted in 2000 by the author in collaboration with Dr. B.C. Tan, Prof. D.H. Murphy and Ms Farida then at the National University of Singapore. This yielded 962 specimens of lichenized fungi and 1,126 records when taking into account mixed specimens and field observations. Where possible the names of the phorophytes of lichens collected were noted, and in the Botanical Garden also the tree ID number. The specimens are deposited in the herbaria of B and SING and the data of the B set are available in the web database - http://www.bgbm.org/scripts/ASP/lichcol/query.asp. For a list of the visited localities and habitats see Table 1. In addition, the lichenological literature was searched for lichen records from Singapore, and relevant specimens were also borrowed from the herbaria SING and UPS, and the private collections of A. Aptroot, P. Diederich and F. Schumm. Additional collections were found notably via the herbarium database of UPS (http://www-hotel2.uu.se:8888/cgi-bin/wwwdrive.fytotek/beginner). All indicated specimens were examined by the author, unless otherwise stated. The specimens were investigated in the usual way by stereomicroscope and photomicroscope, and selected specimens were analysed by TLC (Orange *et al.*, 2001).

Table 1. List of localities of the fieldwork by the author in 2000 with codes used in the species list (in bold), collection numbers and habitat information.

1 - Sungei Buloh Nature Park, on N-coast, opposite Johor Baru. At E-margin of reserve. Mangrove forest *ca* 10 m tall. Elev. *ca* 1 m. Coord. 1° 27' N, 103° 44' E, 4 Nov 2000 - *H. Sipman & D.H. Murphy 45441-45514.*

1. Away from the coast. On *Allophylus cobbe* branchlet. **1a.** On *Rhizophora apiculata* trunk/Foliicolous in undergrowth, on *Brownlowia tersa* leaves/on *Xylocarpus granatum* leaves/on *Asplenium nidus* leaves/On *Rhizophora apiculata* trunk. **1b.** On *Xylocarpus granatum* trunk. **1c.** Away from the coast. On *Excoecaria agallocha* trunk. **1d.** Away from the coast. On *Hibiscus tiliaceus* branches. **1e.** At the coast. On *Sonneratia alba* trunk. **1f.** On *Avicennia officinalis* trunk (Nr. 45477 on *A. alba* in splash zone). **1g.** On *Bruguiera cylindrica* trunk. **1h.** On *Avicennia alba* trunk. **1i.** On *Excoecaria agallocha* trunk. **1j.** Land-side. On *Excoecaria agallocha* trunk.

2 - Campus of National University of Singapore, around Kent Ridge, parkland with scattered buildings and roads. Elev. *ca* 50 m Coord. 1° 18' N, 103° 45.5' E, 5 Nov 2000 - *H. Sipman 45515-45637.*

2. On thin palm stem (*Ptychosperma macarthurii*)/On trunk of leguminose tree/Kent Ridge Road. On weathered siliceous stone/On low concrete ridge along road, shady, on top/On soil of steep bank of path, open, over weathered stone/Kent Ridge Road. On branches of *Erythrina crista-galli* shrub. **2a.** On small tree of *Bauhinia purpurea*, on trunk *ca* 20 cm diam. **2b.** On *ca* 20-30 cm diam. trunk of small *Cassia fistula* tree. **2c.** On *ca* 10-30 cm diam. *Acacia auriculiformis* trunk. **2d.** On *ca* 50-100 cm diam. *Samanea saman* trunk. **2e.** Kent Ridge Road. On *Peltophorum pterocarpum* trunk. **2f.** Kent Ridge Road. On *Khaya* sp.(Meliaceae) trunk *ca* 40 cm diam. **2g.** Kent Ridge Road. On branches of *Callistemon* sp. treelet/On *Roystonea regia* trunk/On *Cassia*? trunk/On trunk.

3 - Singapore Botanic Gardens, parkland with scattered trees and shrubs. Elev. *ca* 50 m Coord. 1° 18' N, 103° 48' E, 7-9 Nov and 10 Nov 2000 - *H. Sipman 45638-45814, 45836-45855.*

3. On trunk./(45814) On lava stone in half shade of shrub in succulent garden./Epiphyte./On concrete roadside/On soil on ant heap in lawn. **3a.** On 50 cm diam. *Peltophyllum pterocarpum* (nr. 5500) trunk. **3b.** On 25 cm diam. *Archontophoenix alexandrae* (nr. 10151) trunk. **3c.** On 15 cm diam. *Phoenix rupicola* (nr. 5315) trunk. **3d.** On 15 cm diam. *Atalantia monophylla* (nr. 5322) trunk. **3e.** On 50 cm diam. *Tectona grandis* (nr. 5325) trunk. **3f.** On 150 cm diam. short *Calophyllum inophyllum* (nr. 5323) trunk. **3g.** On *ca* 25 cm diam. *Lepisanthes rubiginosa* (nr. 5301) trunk. **3h.** On *ca* 20 cm diam. *Azadirachta indica* (nr. 5313) trunk. **3i.** On *ca* 60 cm diam. *Hevea brasiliensis* (nr. 5305) trunk. **3j.** On *ca* 30 cm diam. *Jacaranda obtusifolia* ssp. *rhombifolia* (nr. 5498, planted 1968) trunk. **3k.** On *ca* 30 cm diam. *Podocarpus falcatus* (nr. 5503) trunk. **3l.** On *ca* 40 cm diam. *Podocarpus neriifolius* (nr. 5513) trunk. **3m.** On *ca* 20-40 cm diam. tree trunks and branches of *Juniperus chinensis* (nr. 5488, 5489, 5379). **3n.** On *ca* 35 cm diam. *Podocarpus rumphii* trunk (nr. 5286 planted 1942, 5287). **3o.** On *ca* 30 cm diam. slanting *Majidea zanguebarica* (nr. 5497, planted 1955) trunk. **3p.** On *ca* 30 cm diam. *Libocedrus macrolepis* var. *formosana* (nr. 5385) trunk. **3q.** On *ca* 30 cm diam. *Podocarpus gracilior* (nr. 5389, planted 1932) trunk. **3r.** On *ca* 30 cm diam. *Swietenia macrophylla* (nr. 5983) trunk. **3s.** On *ca* 20 cm diam. 10 m tall palm stem of *Scheelea insignis* (nr. 5054). **3t.** On *ca* 40 cm diam. *Mangifera caesia* (nr. 5062) trunk. **3u.** On *ca* 40 cm diam. *Podocarpus neriifolius* trunk. **3v.** On *ca* 25 cm diam. branchy trunk of small *Pithecellobium dulce* (Nr. B-72). **3w.** On *ca* 100 cm diam. *Fagraea fragrans* trunk. **3x.** On *ca* 100 cm diam. *Tetrapleura thonningii*? (near Nr. 6002) trunk. **3y.** On *ca* 100 cm diam. *Michelia alba* (Nr. 6516) trunk. On *ca* 100 cm diam. *Michelia alba* (Nr. 6516) trunk. **3z.** On *ca* 40 cm diam. *Cassia fistulosa* (Nr. 09354A) trunk. **3aa.** On *ca* 70 cm diam. *Peltophorum pterocarpum* trunk. **3ab.** On trunks and branches of *Plumeria*. **3ac.** On *ca* 100 cm diam. *Carapa guianensis* (Nr. 6007) trunk, between the butresses. **3ad.** On *ca* 20 cm diam. *Podocarpus* sp. trunk. **3ae.** On *ca* 80 cm diam. *Samanea saman* (Nr. 5968) trunk. **3af.** On *ca* 35 cm diam. *Quercus bambusaefolia* (Nr. B/136/36/6, planted 1935) trunk. **3ag.** On *ca* 30 cm diam. *Artocarpus altilis* (Nr. j/184/93/897) trunk. **3ah.** On ca. 100 cm diam. trunk, between buttresses. **3ai.** On *ca.* 20-30 cm diam. *Maniltoa browneoides* trunk. **3aj.** On *ca* 70 cm diam. 15 m tall palm stem of *Roystonea oleracea* near herbarium entrance. **3ak.** On *ca* 40 cm diam. *Heritiera alata* (Nr. 09332G) trunk, on buttresses. **3al.** On *ca*. 30 cm diam. trunk. **3am.** On *ca* 25 cm diam. palm stem of *Phoenix sylvestris* (Nr. K/00/7094). **3an.** On *ca* 20 cm diam. stem of tall palm. **3ao.** On *ca* 15 cm diam. young *Shorea curtisii* (Nr. K99/95/4990A) trunk. **3ap.** On base of palm stem of *Phoenix loureirii*. **3ar.** On *ca* 60 cm diam. *Tamarindus indicus* (Nr. XH 26) trunk. **3as.** On *ca* 80 cm diam. trunk. **3at.** On *ca* 25 cm diam. *Shorea* fa. *apueiiana* (Nr. XH 64) trunk. **3au.** On *ca* 20 cm diam. branch of *Eugenia brasiliensis* shrub (Nr. 19970843 A 2). **3av.** On *Plumeria* dwarf trees. **3ax.** On *ca* 80 cm diam. *Fagraea fragrans* (Nr. XH-11) trunk./On *ca* 80 cm diam. *Fagraea fragrans* (Nr. XH-11) trunk. **3ay.** On *ca* 60 cm diam. *Myristica lowiana* (Nr. XH-79) trunk. **3az.** On *ca* 100 cm diam. *Pterocarpus indicus* (Nr. XH-26) trunk. **3ba.** On *ca* 80 cm diam. trunk.

4 - Singapore Botanic Gardens, Rainforest Reserve. Elev. *ca* 50 m Coord. 1° 18' N, 103° 48' E - 7-9 Nov 2000 - *H. Sipman 45815-45835*.
On lower part of *Castilla elastica* trunk 50 cm diam./On lower part of *Dyera costulata* trunk 100 cm diam./On lower part of small tree trunk./Foliicolous in undergrowth.

5 - SE side of MacRitchie Reservoir. Elev. *ca* 50 m Coord. 1° 21' N, 103° 50' E - 12 Nov 2000 - *H. Sipman & B.C. Tan 45856-45944*.
5a. Parkland with scattered trees and shrubs. On *ca* 120 cm diam. *Peltophorum pterocarpum* trunk. **5b.** Parkland with scattered trees and shrubs. On *ca* 100 cm diam. *Mangifera* trunk. **5c.** Parkland with scattered trees and shrubs. On *ca* 40 cm diam. tree trunk of leguminose. **5d.** Parkland with scattered trees and shrubs. On *ca* 70 cm diam. *Calophyllum inophyllum* trunk. **5e.** Secondary forest with primary forest remnants. On 10 cm diam. *Calophyllum* trunk at forest margin, within reach from the soil/On 10 cm diam. tree trunk at forest margin, within reach from the soil/On tree trunk, within reach from the soil/On loamy bank of path at forest margin on lake shore/Secondary forest with primary forest remnants. On *Pandanus* leaves in undergrowth/On leaves in undergrowth. **5f.** Secondary forest with primary forest remnants. On tree trunk in gap (*Macaranga macrophylla* 10-15 cm diam.), within reach from the soil.

6 - Bukit Timah Nature Reserve, slightly disturbed primary forest. Elev. *ca* 50-80 m Coord. 1° 21' N, 103° 41' E - 13, 15, 24 Nov 2000 - *H. Sipman & D.H. Murphy 45945-45985, H. Sipman & Farida 46076-46114, H. Sipman & B.C. Tan 46379-46383*.
6. SE-side, Taban valley. On trunks within reach from the ground/On leaves in undergrowth/On *Pandanus* leaves in undergrowth/On *Streblus elongatus* leaves in undergrowth/E-side, along Cave Path and Rock Path. On 20 cm diam. *Adinandra dumosa* trunk within reach from the ground/On *Macaranga triloba* trunk within reach from the ground/On tree trunk within reach from the ground/E-side, Rock Path. Slightly disturbed primary forest. On *ca* 50 cm diam. trunk of fallen tree. **6a.** E-side, along Cave Path and Rock Path. On leaves in undergrowth.

7 - Southern islands: Lazaro Island. Secondary scrub and beach forest of *Terminalia*

and *Casuarina*. Elev. *ca* 1 m Coord. 1° 13' N, 103° 51.5' E - 14 Nov 2000 - *H. Sipman & B.C. Tan 45986-46048.*
7. On trunk in secondary scrub/On siliceous stone on clearing in beach forest/ On loamy soil of termite heap in road bank/On loamy soil of road bank/On rusty iron in clearing/On humid, shady concrete. **7a.** On *Terminalia catappa* trunk, among buttresses./On *Terminalia catappa* trunk. **7b.** On *Casuarina equisetiolia* trunk.

8 - Southern islands: Kusu Island. Cleared beach forest with scattered *Casuarina*, *Terminalia* and planted trees. Elev. *ca* 1 m Coord. 1° 13' N, 103° 52' E - 14 Nov 2000 - *H. Sipman & B.C. Tan 46049-46075.*
On *Casuarina equisetifolia* trunk within reach from the ground/On trunk within reach from the ground/On trunk within reach from the ground, in fissure/On *Terminalia catappa* trunk within reach from the ground.

10 - Nee Soon, SE of Upper Selatar Reservoir. Freshwater swamp forest. Elev. *ca* 20 m Coord. 1° 23.5' N, 103° 48.5' E - 16 Nov 2000 - *H. Sipman, D.H. Murphy & B.C. Tan 46115-46201.*
10. On trunks within reach from the ground/On twig within reach from the ground. **10a.** On trunk and canopy of fallen tree. **10b.** On leaves in undergrowth.

11 - Nature trail N of Lower Peirce Reservoir. Low secondary forest with *Nepenthes*. Elev. *ca* 20 m Coord. 1° 23' N, 103° 49' E - 16 Nov. 2000 - *H. Sipman, D.H. Murphy & B.C. Tan 46202-46217.*
On trunks within reach from the ground.

12 - Lower Peirce Reservoir Park. Elev. *ca* 20 m Coord. 1° 23' N, 103° 49' E - 16 Nov 2000 - *H. Sipman, D.H. Murphy & B.C. Tan 46218-46219.* On *Roystonea* palm stem along road.

13 - Fort Canning Park, in town center. Elev. *ca* 30 m Coord. 1° 17.5' N, 103° 51' E - 18 Nov 2000 - *H. Sipman 46220-46262.*
13. On trunks in park on hilltop. **13a.** On *Plumeria* trunks in park on hilltop.

14 - Pulau Ubin Island, from ferry to Kampong Melayu. Abandoned gardens. Elev. *ca* 5 m Coord. 1° 24' N, 103° 58' E - 19 Nov 2000 - *H. Sipman & B.C. Tan 46263-46361.*
14. On granite cliff at border of garden/On loamy bank of road/On trunk of fruit tree (*Nephelium rambutan*)/On trunk/On termite heap/On roots of betelnut palm/On trunk. **14a.** On durian (*Durio* sp.) trunk. **14b.** On trunk of fruit tree (*Lansium domesticum*). **14c.** On coconut stem in plantation. **14d.** On trunk of fruit tree (*Psidium guava*). **14e.** On trunk of rubber tree (*Hevea brasiliensis*) in abandoned plantation. **14f.** On leaves of lower branches of fruit trees.

15 - Labrador Park, at coast SW of city center. Elev. *ca* 10 m Coord. 1° 16' N, 103° 48' E - 23 Nov 2000 - *H. Sipman & D.H. Murphy 46362-46378.* Secondary forest on hilltop at the coast. On *Eugenia grandis* trunk within reach from the ground/On leaves in undergrowth/On trunk within reach from the ground/On *Milletia atropurpurea* trunk within reach from the ground/On liana near the ground/On *Barringtonia indica* trunk/On *Tabebuia* trunk/On *Casuarina* trunk./Scattered trees on lawns at the coast. On tree trunk./On coastal conglomerate rock, sheltered, about 1 m above highwater level./On underside of overhanging, *ca* 10 cm diam. *Hibiscus tiliaceus* trunk at sheltered coast, about 2 m above highwater level.

16 - Bukit Timah Nature Reserve, N-side, abandoned quarry. Elev. *ca* 100 m Coord. 1° 21' N, 103° 41' E - 24 Nov 2000 - *H. Sipman & B.C. Tan 46384-46397.* Shaded, humid rockface at base of cliff.

17 - Bukit Brown Chinese Cemetery, S of MacRitchie Reservoir. Grassy vegetation with scattered trees and grave tombs. Elev. *ca* 30 m Coord. 1° 21' N, 103° 49' E - 25 Nov 2000 - *H. Sipman & B.C. Tan 46388a-46391.*
On tree stump in secondary forest/On leaves of undergrowth in secondary forest/On brick of tomb/On granite of tomb/On fallen, dry branch.

18 - Sembawan Park, on N-coast. Elev. *ca* 2 m Coord. 1° 28' N, 103° 51' E - 25 Nov 2000 - *H. Sipman & B.C. Tan 46392-46412.* Grassland with scattered trees and shrubs. On trunk within reach from the ground.

Results

The accepted lichen taxa are presented in the following list. In addition lists are given of synonyms used in past publications relating to Singapore lichens, rejected records, and the collectors.

Alphabetical list of the lichen species reported from Singapore with comments

For each species herbarium vouchers and literature references are given. Abbreviations: *S = Sipman*; *SF = Sipman & Farida*; *SM = Sipman & Murphy*; *SMT = Sipman, Murphy & Tan*; *ST = Sipman & Tan*; *obs.*: field observation by the author, without voucher; accompanying species in herbarium specimens deposited under another name are indicated as "in [collector + number] [Herbarium abbreviations] (= [name or taxon under which it is deposited])". Locality codes are given in brackets; they correspond to table 1. Pictures of many species are available in the website http://www.bgbm.fu-berlin.de/sipman/Zschackia/Singa/genuslist.htm

Amandinea diorista (Nyl.) Marbach – (13) *S 46228* [B, SING].

Amandinea efflorescens (Müll.Arg.) Marbach – (2b) *S 45523* [SING]; (2d) *S 45557* [B]; (2f) *S 45615* [B]; (2g) *S 45626* [B], *45631* [B], *45636* [SING] c. apoth.; (3) *obs.*; (7b) *ST 46005* [SING; (8) *ST 46052* [B, SING]; (13) *obs.*; (14) *obs.*; (15) *obs.*; corticola prope Singapore, *ca* 1890, *Maingay 158* [Müller Arg., 1893: 129, type description; Marbach, 2000: 61]; Fort Canning Park, on tree in park, 1989, *Aptroot 25954* [B, Hb. Aptroot; Kalb and Elix, 1998: 468 as *Buellia*; Marbach 2000: 63]; crossing Oxley Road/Oxley Rise, roadside trees, 1994, *Diederich 12223* [Hb. Diederich].

Anisomeridium biforme (Borrer) R.C.Harris – Kusu Island, 1989, *Aptroot 25972* [Hb. Aptroot].
Anisomeridium foliicola R.Sant. & Tibell – (10b) *SMT 46172* [SING].
Anisomeridium subprostans (Nyl.) R.C.Harris – (3i) *S 45663* [SING]; (3ae) *S 45778* [B, SING]; (3ba) *S 45854* [B, SING]; Botanic Gardens, forest area, 1989, *Aptroot 25962* [B, Hb. Aptroot].
Anisomeridium terminatum (Nyl.) R.C.Harris – (3ab) *S 45745* [B, SING].
Anisomeridium throwerae R.C.Harris – (1j) *SM 45509* [SING], in *SM 45514* [B, SING] (= *Pyxine cocoes*); (2a) *S 45516* [B, SING]; (2c) *S 45546* [B, SING]; (2d) *S 45576* [B, SING]; (5e) *ST 45942* [SING]; (6a) *SF 46100* [B]; (7) *ST 46039* [SING]; (13) *S 46245* [SING]; (14d) *ST 46299* [B, SING]; (14f) *ST 46353* [SING]; (18) *ST 46411* [B, SING].

Here all *Anisomeridium* specimens are included with long-beaked, seta-like pycnidia. The conidia are of two types, suggesting that more than one species may be on hand: 9-12 x 4-5 µm with rounded ends, 1-septate (*45516, 46411*) and 8 x 4 µm, cubic, simple (*45942, 46299*). The conidia are lacking in many specimens.

Arthonia catenatula Nyl. – (1a) *SM 45444* [B, SING]; (1b) *SM 45446* [B, SING], in *SM 45452* [B, SING] (= *Graphis caesiella*); (1c) *SM 45457* [SING]; (1e) *SM 45474* [B, SING]; (1f) *SM 45483* [B, SING]; (1g) *obs.*, in *SM 45489* [SING] (= *Graphis caesiella*); (1h) *SM 45494* [SING]; (1i) *SM 45498* [SING]; (1j) *SM 45511* [B, SING]; (2) *S 45520* [SING]; (2b) in *S 45526* [SING] (= *Cryptothecia* cf. *subnidulans*); (2c) *S 45542* [B, SING]; (2d) *S 45559* [B, SING], *S 45575* [B, SING]; (2e) *S 45589* [SING]; (2f) *S 45604* [SING]; (2g) in *S 45631* [B] (= *Amandinea efflorescens*), in *S 45635* [SING] (parasite), in *S 45637* [B, SING] (= *Lecanora helva*); (3k) *obs.*, in *S 45668* [B, SING] (= *Enterographa pallidella*); (3v) *S 45723* [SING]; (3y) *obs.*, in *S 45732* [SING] (= *Graphis cf. caesiella*); (3ab) *obs.*, in *S 45750* [B, SING] (= *Arthonia cinnabarina*); (3ac) *obs.*, in *S 45773* [B] (= *Porina tetracerae*); (3ad) *obs.*, in *S 45775* [B, SING] (= *Phaeographis* sp.); (3at) *S 45839* [SING]; (3av) *obs.*, in *S 45842* [SING] (= *Trypethelium tropicum*); (5a) *ST 45863* [SING]; (7) *obs.*; (7a) *ST 45999* [SING]; (7b) *ST 46006* [B, SING]; (8) *obs.*; (13) *obs.*, *S 46246* [SING]; (14) *obs.*; (14c) *ST 46285* [SING], *ST 46285a* [B, SING]; (15) *SM 46375* [SING]; (18) in *ST 46409* [B, SING] (= *Arthonia* sp. E); crossing Oxley Road/Oxley Rise, roadside trees, 1994, *Diederich 12230* [Hb. Diederich].

The ascocarps are usually stellate with narrow radii, but conspicuously rounded ascocarps occur occasionally (*45575, 45723, 46246, 46285a*). Deviating ascospores (attenuated towards both ends, resembling *A.* sp. A, but larger) were observed in *46409*. TLC: tr. atranorin, confluentic acid (*45511, 45522, 45559, 45575*). The ascospore size (usually about 30 x 12 µm) deviates from the protologue and the identification is provisional.

Arthonia cinnabarina (DC.) Wallr. – (1b) *SM 45447* [SING]; (2a) *S 45518*

[B, SING]; (3ab) *S 45750* [B, SING]; (18) *ST 46412* [B, SING].

Arthonia complanata Fée – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 22].

Arthonia subbessalis Nyl. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 23, type description].

Arthonia trilocularis Müll.Arg. – (6a) *SF 46107* [SING]; (10b) *SMT 46169* [SING], *SMT 46170* [B, SING] cf.; (14f) *ST 46358* [B, SING] cf.

The material is often in poor condition and the identification provisional.

***Arthonia* sp. A** – (2b) *S 45528* [B, SING], *S 45537* [B, SING]; (2e) *S 45598* [B, SING]; (7a) *ST 45999a* [B, SING]; (18) *ST 46410* [B, SING].

Superficially like *A. catenatula*, but apothecia pale brownish and ascospores attenuated at both ends, 20-26 x 6-7 µm, 5-7-septate.

***Arthonia* sp. B** – (3d) *S 45648* [B, SING]; (3ac) *S 45771* [B, SING]? (no spores); (3ah) *S 45790* [B, SING]? (no spores); (5a) *ST 45860* [SING]? (no spores); (14c) *ST 46285b* [B, SING]; (18) *ST 46408* [B, SING].

Ascocarps brown to black, rounded or shallowly lobed, often slightly brownish-pruinose; ascospores 12-15 x 4.5-6 µm, 1-2-septate, one terminal cell swollen.

***Arthonia* sp. C** – (2d) *S 45576a* [SING], *S 45580* [B, SING]; (3l) *S 45673* [B, SING]; (3w) *S 45726* [B, SING]; (5f) *ST 45931* [SING]; (14) *ST 46321* [B, SING]; (14e) *ST 46314* [B, SING]; (15) *SM 46366* [B, SING].

Ascocarps black, rounded, small; ascospores 6-11 x 3 µm, 1-septate, with one swollen terminal cell.

***Arthonia* sp. D** – (1c) *SM 45458* [B, SING]?; (3a) *S 45641* [SING]? (no spores); (3v) *S 45722* [SING]? (no spores); (3y) *S 45730* [SING]; (3aa) *S 45740* [SING]? (no spores); (3az) *S 45850* [B, SING]; (3ba) *S 45853* [B, SING]; (5a) *ST 45858* [B, SING]; (18) *ST 46407* [B, SING].

Ascocarps black, rounded, immersed when on soft, large-celled bark; ascospores 10-16 x 3 µm, 2-septate, with one swollen terminal cell; epithecium dark-brown.

***Arthonia* sp. E** – (18) *ST 46409* [B, SING].

Similar to *A. catenatula*, but ascocarps with prominent white margin.

***Arthothelium* sp.** – (3i) *S 45662* [SING]; (3ab) *S 45748* [B]; (5d) *ST 45878* [SING].

Ascocarps small, lobed, blackish; ascospores regularly muriform, 40 x 16 µm, *ca* 10 x 4 locules.

Astrothelium ochrothelizum (Nyl.) Müll.Arg. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 26 as *Trypethelium*].

Astrothelium subfuscum Kremp. – Ad cortices, *Beccari 256* [Krempelhuber, 1875: 64, type description].

Bacidia rubellovirens (Nyl.) Zahlbr. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 21 as *Lecidea*, type description].

***Bacidia* sp.** – (5e) *ST 45922* [B, SING].

Apothecia pale brown; ascospores unripe, becoming acicular?

Bacidina* aff. *arnoldiana (Körb.) V.Wirth & Vězda – (2g) *S 45627* [B, SING].

Pycnidia present only; conidia *ca* 60 x 0.5 µm, curved.

***Bacidina* sp.**? – (18) *ST 46397* [SING].

A poor specimen probably belonging to this genus, but not conspecific with the preceding species.

Bactrospora metabola (Nyl.) Egea & Torrente – (5c) *ST 45867* [B, SING].

Bactrospora myriadea (Fée) Egea & Torrente – (1b) *obs.*, in *SM 45447* [SING] (= *Arthonia cinnabarina*); (1c) in *SM 45456* [SING] (= *Chrysothrix xanthina*); (1f) *SM 45485* [B, SING]; (1i) *SM 45496* [B, SING]; (2b) *S 45536* [SING]; (2f) *S 45601* [B, SING]; (3) *S 45657* [SING]; (7) *ST 46046* [B].

***Badimia* sp.?** – (17a) *ST 46388b* [SING].

The material is very scarce and was not examined microscopically.

***Biatora* (s.l.) sp.** – (2) *S 45585* [B, SING]; (3) *obs.*

Material with biatorine apothecia and simple, hyaline ascospores, of unclear affinity.

***Biatorella* (s.l.) sp.** – (2) *S 45581* [B, SING].

Material with biatorine apothecia, polysporous asci and simple, hyaline ascospores, of unclear affinity.

***Buellia* sp. A** – (17) *ST 46389* [SING].

Single thallus, on brick.

***Buellia* sp. B** -- (7) *ST 46013* [SING].

Single thallus, on granitic boulder.

Byssoloma leucoblepharum (Nyl.) Vain. – (10b) *SMT 46191* [B, SING]; 1882, on *Cantley 48* (*Memecylon cantleyi*) [K, not seen; Santesson, 1952: 487].

Byssoloma tricholomum (Mont.) Zahlbr. – Ad folia coriacea, *Beccari 269a* [Krempelhuber, 1875: 60 as *Lecanora epiphylla*; Santesson, 1952: 483].

Calenia aspidota (Vain.) Vězda – (14f) *ST 46355* [B, SING].

Calicium hyperelloides Nyl. – (3s) *S 45715* [SING]; (14c) *ST 46288* [B, SING]; (15) *SM 46368* [B, SING]; Sentosa, along the southern shore, outskirts of forest along the beach, on trunk, 1980, *Tibell 8865* [UPS L-057807].

Calopadia subcoerulescens (Vain.) Vězda – (10b) *SMT 46186* [SING].

Calopadia* cf. *vermiculifera (Vain.) Sérus.? – (10b) *SMT 46173* [B, SING].

Poor specimen, identification uncertain.

***Calopadia* sp.** – (14f) *ST 46354* [B, SING].

Poor specimen with muriform ascospores 1-2/ascus.

***Caloplaca* sp. A** – (14) *ST 46266* [SING].

Single, saxicolous thallus.

***Caloplaca* sp. B** – Kusu Island, 1989, *Aptroot 25969* [Hb. Aptroot].

The apothecia have a grey thalloid margin and orange disc.

Carbacanthographis candidata (Nyl.) Staiger & Kalb – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 23 and Redinger, 1936: 50 as *Graphis singaporina*, type description; Staiger and Kalb, 1999: 124].

Carbacanthographis marcescens (Fée) Staiger & Kalb – (6) *SM 45963* [B, SING].

Catarraphia dictyoplaca (Mont. & v.d. Bosch) A.Massal. – (10) *SMT 46124* [B, SING].

***Catillaria* (s.l.) sp.** – (11) *SMT 46202* [B, SING].

Specimen with biatorine apothecia and hyaline, uniseptate ascospores, of uncertain affinity.

Chapsa indica A.Massal. – (13) *S 46258* [B, SING].

TLC: none.

Chapsa platycarpella (Vain.) A.Frisch – (5e) *ST 45899* [B, SING]; (10) *SMT 46133* [B, SING]; (11) *SMT 46208* [SING].

Chiodecton leptospermum Müll.Arg. – (3ab) *S 45770* [B, SING]; (3an) *S 45810* [SING].

Chiodecton natalense Nyl. – (3v) *S 45721* [B, SING]; (3af) *S 45781* [SING]; (5a) *ST 45862* [SING]; (5c) *ST 45869* [SING].

Chroodiscus australiensis Vězda et Lumbsch – (10b) *SMT 46193* [B, SING].

Chroodiscus mirificus (Kremp.) R.Sant. – (10b) *SMT 46199* [B, SING]; Nee Soon Forest Reserve, tropical forest remnant, on leaves of *Aglaea trinervis*, 1980, *Tibell 8813* [UPS L-057770]; ibidem, on leaves of *Calamus scipionum*, 1980, *Tibell 8815* [UPS L-057772].

Chroodiscus* cf. *mirificus (Kremp.) R.Sant. – (6a) *SF 46103* [B, SING]; (10b) *SMT 46199a* [B, SING].

The material deviates from *SMT 46199* because the rounded schizidia develop on the thallus, not at the margin, and are thickened in the centre. In the absence of ascocarps the classification is provisional.

Chrysothrix xanthina (Vain.) Kalb – (1c) *SM 45456* [SING]; (1g) in *SM 45490* [SING] (= *Herpothallon granulare*); (2b) *S 45525* [SING]; (2d) *S 45574* [B, SING]; (2e) in *S 45598* [B, SING] (= *Arthonia* sp. A); (2f) *S 45603* [B, SING]; (2g) in *S 45630* [SING] (= *Lecanora helva*), in *S 45635* [SING] (= parasite), in *S 45624* [SING] (= *Pyrrhospora quernea*); (7) *obs.*; (8) *obs.*; (13) *obs.*; (14) *obs.*; (15) *obs.*; (18) *obs.*; on mango tree along road, Pulau Tekong, 2000, *B. C. Tan* [Hb. Tan]; crossing Oxley Road/Oxley Rise, roadside trees, 1994, *Diederich 12222* [Hb. Diederich].

Cladonia subradiata (Vain.) Sandst. – (3w) *S 45725* [B, SING].

TLC: fumarprotocetraric acid.

Coccocarpia erythroxyli (Sprengel) Swinsc. & Krog – *sine loc.* [BM, L, not seen; Arvidsson 1982: 62]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 18 as *Coccocarpia ciliolata*].

Coccocarpia palmicola (Spreng.) L.Arvidss. & D.J.Gallow. – (14) *ST 46351*

[B, SING]; *sine loc.* [US, not seen; Arvidsson, 1982: 76]; St. John's Island, 1989, *Aptroot 26000* [Hb. Aptroot]; Botanical Garden, on *Cupressus* sp., 1980, *Tibell 8889b* [UPS L-057820, not seen].

Coccocarpia pellita (Ach.) Müll.Arg. – (3a) *S 45645* [B, SING]; (14c) *ST 46291* [B, SING]; sine loc. [W, not seen; Arvidsson, 1982: 79].

Coccocarpia rottleri (Ach.) L. Arvidss. – (14e) ST 46301 [B, SING].

Coenogonium confervoides Nyl. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 20].

Coenogonium dilucidum (Kremp.) Kalb & Lücking – (6a) *SF 46102* [B, SING]; (10b) *SMT 46184* [B, SING]; (14f) *ST 46359* [B, SING].

Coenogonium epiphyllum Vain. – (2d) *S 45572* [B, SING] cf.; (6a) *SF 46106* [B, SING], *46108* [B, SING].

Coenogonium luteum (Dicks.) Kalb & Lücking – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 21 as *Gyalecta lutea*].

Coenogonium subluteum (Rehm) Kalb & Lücking – (10b) *SMT 46182* [B, SING].

Collema actinoptychum Nyl. – 1897, *Möller* [S, TUR, not seen; Degelius, 1974: 125].

Collema leptaleum Tuck. var. ***biliosum*** (Mont.) Degel. – University area, roadside trees, often abundant, 1964, *Degelius As-533, 535, 559* [UPS-Hb. Degelius, not seen; Degelius, 1974: 108].

Collema rugosum Kremp. – Singapore Botanic Gardens, 189?, *Ridley A. 54* [SING]; Economic Gardens, *Bombax*, 1919, *unknown collector, 5416, pp.* [K, UPS not seen; Degelius, 1974: 153]; Singapore Botanical Garden, on *Cupressus* sp., 1980, *Tibell 8887* [UPS L-057817, not seen]; university area, roadside trees, locally abundant, 1964, *Degelius As-489, 495* [UPS-Hb. Degelius; Degelius, 1974: 153].

Cratiria lauricassiae (Fée) Marbach – Singapore Botanic Gardens, 1959, *Burkill 2178* [SING].

Cresponea flava (Vain.) Egea & Torrente – (2d) *S 45549* [B, SING]; (2g) *S 45632* [B, SING], in *S 45630* [SING] (= *Lecanora helva*), in *S 45635* [SING] (= parasite); (3r) *S 45713* [SING]; (3z) *S 45736* [B, SING]; (3aa) *S 45741* [B]; (5b) *obs.*, in *ST 45864* [B, SING] (= *Graphis insulana*); (7a) *obs.*, in *ST 45999* [SING] (= *Arthonia catenatula*); (8) *ST 46055* [B, SING]; (13) *S 46243* [SING]; (13a) *S 46224* [SING]; Fort Canning Park, on tree in park, 1989, *Aptroot* [Hb. Aptroot]; Kusu Island off the coast, on tree along the coast, 1989, *Aptroot* [Herb. Aptroot]; St. John's Island, 1989, *Aptroot 25995* [Herb. Aptroot, det. Egea 1992]; Singapore Botanical Garden, on *Cedrela toana*, 1983, *Tibell* [UPS; Egea and Torrente, 1993: 316]; crossing Oxley Road/Oxley Rise, roadside trees, 1994, *Diederich 12229* [Hb. Diederich].

Cresponea proximata (Nyl.) Egea & Torrente – (14) *ST 46325* [B, SING], *46348* [SING].

Crocynia pyxinoides Nyl. – (3m) *S 45682* [B, SING], in *S 45678* [SING] (= *Porina tetracerae*).

TLC: atranorin, stictic acid, pannarin?, indet. substances (*45682*).

Cryptothecia aleurella (Nyl.) Makhija & Patwardhan – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 22 as *Arthonia*, type description].

Cryptothecia candida (Kremp.) R.Sant. – (10) *SMT 46143* [B, SING], *46145* [B, SING]; (10b) *SMT 46197* [B, SING]; Nee Soon Forest Reserve, tropical forest remnant, on leaves of *Aglaea trinervis*, 1980, *Tibell 8814* [UPS L-057771, not seen].

TLC: 2'-0-methylanziaic acid or similar spot (*46143, 46145, 46197*).

Cryptothecia irregularis Lücking *et al*. – (10b) *SMT 46196* [B, SING].

Cryptothecia lunulata (Zahlbr.) Makhija & Patwardhan -- (1j) *SM 45507* [B, SING]; (2a) *S 45515* [SING]; (2c) *S 45540* [B, SING]; (3q) in *S 45709* [B] (= *Enterographa pallidella*); (5e) *ST 45886* [B, SING], *45917* [B, SING], *45927* [B, SING]; (5f) *ST 45934* [B, SING]; *Benjamin Lee n.c.* [SING].

TLC: confluentic and/or barbatic? acid (*45540, 45886, 45917, 45934*).

Cryptothecia obtecta Makhija & Patwardh. – (5f) *ST 45935* [B, SING]; (6) *SF 46090* [SING]; (10) *SMT 46128* [B, SING], *46130* [B, SING], *46144* [B, SING]; (14) *ST 46331* [SING].

TLC:confluentic,gyrophoric? acids (*45935, 46128, 46130, 46144, 46425*).

Cryptothecia scripta Thor – (1d) *SM 45468* [SING]; (3a) *S 45643* [B, SING]; (3i) *S 45664* [SING]; (3m) *S 45683* [B, SING]; (3ab) *S 45763* [B, SING]; (3ar) *S 45836* [B, SING]; (5a) *ST 45859* [SING]; (5c) *ST 45868* [B, SING]; (13) in *S 46240* [B] (= *Diorygma rufopruinosum*); (14) *ST 46318* [SING]; (14e) *ST 46310* [B, SING]; (17) *ST 46391* [SING]; Singapore Botanic Gardens, 1959, in *Burkill 2177* [SING] (= *Dirinaria picta*) vs., I+ blue, C+ red; juv. asci.

TLC: gyrophoric/hiascic acid complex (*45643, 45683, 45763, 45836, 45868, 46310*).

Cryptothecia cf. ***subnidulans*** Stirt. – (2b) *S 45526* [SING]; (6) *SM 45971* [B, SING], *SF 46091* [B, SING]; (14) *ST 46323* [SING]; *Benjamin Lee* [B, SING].

TLC: gyrophoric acid agg. (*45971, 46091, Lee s.n.*).

***Cryptothecia* sp. A** – (13) *S 46238* [B, SING]; (14) *ST 46319* [B, SING]; (18) *ST 46394* [SING].

TLC: barbatic acid (*46319*). Thick, sorediate thalli of unclear affinity.

***Cryptothecia* sp. B** – (1f) *SM 45484* [B, SING]; (3a) in *S 45643* [B, SING] (= *Cryptothecia scripta*); (3o) *S 45692* [SING]; (5d) *ST 45877* [SING]; (5f) *ST 45936* [B, SING]; (7) *ST 46009* [SING]; (13) *S 46230* [SING]; (14a) *ST 46273* [B, SING]; (14d) *ST 46300* [B, SING]; (15) *obs.*

The material is chemically variable and probably includes more than one species. It is sorediate and lacks ascocarps and is therefore of unclear affinity.

***Cryptothelium* sp.** – (10a) *SMT 46159* [B. SING], *46164* [B. SING].

Ascospores 4/ascus, muriform, 60-80 x 20 µm.

Dichosporidium boschianum (Mont.) Thor – (6) *SM 45949* [SING], *45962* [B. SING]: Bukit Timah, 1959, *Burkill 2139* [SING]: Botanical Garden, Jungle, on *Castillea elastica*, *Tibell 8872*, 1980 [UPS]: Bukit Timah, 1950, *Lemaitre* [H, not seen; Thor, 1990: 67].

Diorygma hieroglyphicum (Pers.) Staiger & Kalb – (1f) *SM 45478* [SING]: (3ab) *S 45757* [B].

TLC: stictic, cryptostictic acids (*45478*).

Diorygma pruinosum (Eschw.) Kalb, Staiger & Elix – (3ag) *S 45786* [SING]: (13) *S 46236* [B]: (14a) *ST 46270* [B]: (14d) *ST 46298* [SING].

TLC: protocetraric acid (*45789, 46298*).

Diorygma reniforme (Fée) Kalb, Staiger & Elix – (3m) *S 45685* [B, SING]: (13) *S 46257* [B, SING].

TLC: salazinic acid (*45685, 46257*). Ascocarps absent.

Diorygma rufopruinosum (A.W.Archer) Kalb, Staiger & Elix – (2d) *S 45554* [B, SING], *45577* [B, SING]: (2f) *S 45612* [SING]: (3m) *S 45681* [B]: (3p) *S 45705* [B, SING]: (3ai) *S 45793* [SING], *45794* [SING]: (3au) *S 45840* [B, SING]: (7) *ST 46007* [SING], *46026* [B, SING]: (13) *S 46240* [B]: (15) *SM 46372* [B, SING], *46373* [B, SING] (c. apoth.).

TLC: norstictic, connorstictic, protocetraric acids (*45554, 45577, 45840, 46240, 46372, 46373*). The Singapore material of this species deviates by the thallus, which is densely covered by very irregular warts turning into pustules, which burst and become sorediate. It is a common "sterile crust" in Singapore and ascocarps are rare.

Dirinaria applanata (Fée) Awasthi – University area, on trees, 19464, *Degelius As-491* [Degelius in UPS]: Awasthi, 1975:82: 1879, *Almquist* [S, not seen], *Harmand* [M, not seen: Awasthi, 1975:82]: Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 18 as *Physcia picta* f. *sorediata*]: university area, roadside trees, 1964, *Degelius As-491* [UPS L-099232, not seen].

The reports may be erroneous, see note under *D. picta*.

Dirinaria caesiopicta (Nyl.) Awasthi – On bark, 1879, *Almquist* [H-Nyl 31822, not seen: Awasthi, 1975: 96].

Dirinaria confluens (Fr.) Awasthi – Botanical Garden, ad corticem palmae, 1949, *Lemaitre* [SING 031008: det. Awasthi 1966].

Dirinaria consimilis (Stirton) Awasthi – On stones, 1949, *Lemaitre* [H, not seen: Awasthi, 1975: 93].

Dirinaria naggarana (Kremp.) Awasthi – Botanical Garden, 1949, *Lemaitre* [H, SING, not seen: Awasthi, 1975: 62].

Dirinaria picta (Sw.) Clem. & Shear – (1c) *SM 45454* [B, SING], *45455* [B, SING]: (1d) *SM 45464* [B, SING]: (1e) in *SM 45476* [SING] (= *Pyrenula ochraceoflava*): (1i) in *SM 45499* [B] (= *Pyrenula ochraceoflava*): (1j) *SM*

45503 [B, SING], *45513* [SING]; (2a) in *S 45519* [B] (= *Graphis caesiella*); (2b) *S 45535* [B, SING]; (2d) *S 45551* [B, SING], *45555* [B, SING], *45579* [SING]; (2f) *S 45616* [B], *45617* [B, SING]; (2g) *S 45628* [B, SING], *45629* [SING], *45633* [B, SING], *45634* [SING], in *45624* [SING] (= *Pyrrhospora quernea*); (3) *obs.*; (3a) in *S 45643* [B, SING] (= *Cryptothecia scripta*); (3m) in *S 45679* [B] (= *Graphis insulana*); (3aa) *S 45737* [SING]; (3aj) *S 45802* [B], *45802a* [B]; (5d) *ST 45871* [SING]; (7) *ST 46021* [SING]; (7a) *ST 45993* [SING], *45994* [B]; (8) *ST 46064* [B, SING], *46065* [SING], *46066* [B, SING], *46067* [B, SING], *46069* [SING], *obs.*; (12) *SMT 46219* [B, SING] c. ap.; (13) *S 46260* [SING], *46261* [B, SING]; (14) *ST 46322* [SING]; (14c) *ST 46287* [B, SING]; (15) *obs.* (2x); (18) *obs.*; Botanic Gardens, 1959, *Burkill 2177* [SING]; Pulau Terkukor, 1960, in *Lemaitre* [SING] (= *Pyxine farinosa*); Singapore Botanical Garden, on palm trunk, 1949, *Lemaitre* [SING 031010; Awasthi, 1975: 75]; Singapore Botanical Garden, 1991, *Gams* [Hb. Aptroot]; on trees, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 52 as *Physcia*]; Pulau Tekong, on rubber tree, 2000, *B.C. Tan* [Hb. Tan]; Pulau Tekong, on *Acacia* tree at seashore, 2000, *B.C. Tan* [Hb. Tan]; Pulau Tekong, on mango tree along road, 2000, *B. C. Tan* [Hb. Tan]; crossing Oxley Road/Oxley Rise, roadside trees, 1994, *Diederich 12228* [Hb. Diederich]; Sentosa, close to the ferry, on trunk of tree, 1980, *Tibell 8853* [UPS L-057795, not seen]; Fort Canning Park, 1989, *Aptroot 25952* [Hb. Aptroot]; Botanical Garden, ad ramas arborum, 1949, *Lemaitre* [SING 500374; Awasthi, 1975: 82 as *D. applanata*].

This sorediate species tends to form clones. Thus, it is not uncommon to find two separate populations differing in lobe size on a single trunk. These may give the impression of separate species, in particular *D. picta* together with *D. applanata* (Fée) D.D.Awasthi. However, populations from adjacent trunks are often intermediate and the large material available did not allow a clear subdivision in two species. TLC: atranorin, sekikaic acid, terpenoids (*45455, 45503, 45551, 45616, 45628, 45633, 45802, 46261, 46287, 46219*); atranorin, divaricatic acid, terpenoids (*45464, 45535, 4555, 45617, 45802a, 45994, 46064, 46066, 46067*). No morphological differences seem to exist between the two chemotypes.

Dyplolabia afzelii (Ach.) A.Massal. – (3o) *S 45697* [SING]; (3ai) *S 45795* [B]; (5e) *ST 45900* [B, SING]; (10a) *SMT 46161* [SING]; Mandai Road, 1920, *Chipp 5801* [SING]; Botanic Gardens, 1920, in *Kiah 5846* [SING] (= *Phaeographina*?); Botanic Gardens, 1920, in *Noor 5663* [SING] (= *Trypethelium* sp.); 0n bark of trees, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 57 as *Graphis*]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 23]; *Beccari 240* [M, not seen; Redinger, 1936: 54; Krempelhuber, 1875: 61]; *Beccari 244* [M, not seen; Redinger, 1936: 55 and Krempelhuber, 1875: 61 as *Graphis atro-alba*].

According to Redinger (1936) *Graphis atro-alba* is a damaged stage of *D. afzelii*.

Echinoplaca pellicula (Müll.Arg.) R.Sant. – (4) *S 45855* [B. SING]; (6a) *SF 46099* [B. SING], *46112* [B. SING]; (10b) *SMT 46177* [B. SING], *46178* [B. SING]; (17a) *ST 46388a* [B. SING].

***Echinoplaca* sp.** – (5e) *ST 45943* [B. SING], (10b) *SMT 46166* [SING]; Bot. Gardens, 1919, *Chipp 4915* [SING].

The material lacks apothecia but contains hyphophores. More than one species may be involved.

Endocarpon pallidum Ach. – (2) *S 45583* [B. SING], *45584* [SING]; (7) *obs.*

Enterographa anguinella (Nyl.) Redinger – (1e) *SM 45475* [B. SING; Sparrius, 2004: 27].

Enterographa angustissima (Vain.) R.Sant. – (5e) *ST 45438* [B. SING]; (10b) *SMT 46176* [SING].

Enterographa divergens (Müll.Arg.) Redinger – (7a) *ST 45989* [B. SING; Sparrius, 2004: 37].

Enterographa pallidella (Nyl.) Redinger – (1a) *SM 45445* [SING]; (1b) *SM 45451* [B]; (1h) *SM 45495* [B. SING]; (3k) *S 45668* [B. SING]; (3d) *S 45779* [B; Sparrius, 2004: 50]; (14b) *ST 46278* [B. SING]; (15) *SM 46378* [SING].

Enterographa subserialis (Nyl.) Redinger – (3a) *S 45638* [B; Sparrius, 2004: 61].

Enterographa tropica Sparrius – (3) *S 45641* [B; Sparrius, 2004: 62]; (4) *S 45829* [B; Sparrius, 2004: 62]; (6) *ST 46383* [B holotype, SING isotype; Sparrius, 2004: 61, 62]; (11) *SMT 46203* [SING].

***Enterographa* sp.** – (15) *SM 46374* [B. SING].

This material has lecanoroid apothecia and reminds *E. anguinella*, in particular the morph named *E. leucolyta* R.C.Harris. However, it lacks psoromic acid and contains an unidentified depsid staying low in the standard solvent systems.

Eremothecella palmulacea (Müll.Arg.) Sérusiaux – (10b) *SMT 46168* [B. SING].

***Eschatogonia*? sp. A** – (4) *S 45817* [B. SING], (14e) *ST 46315* [B. SING], c. ap.

The genus identification is provisional and based on the squamules with a glossy, corticate lower side.

***Eschatogonia*? sp. B** – (5e) *ST 45898* [B. SING].

The genus identification is provisional and based on the squamules with a glossy, corticate lower side.

Eugeniella micrommata (Kremp.) Lücking, Sérus. & Kalb – (6a) *SF 46101* [B. SING]; (10b) *SMT 46184* [B. SING]; Nee Soon Forest Reserve, tropical forest remnant, on leaves of *Calamus* sp., 1984, *Tibell 5616* [UPS L-057773].

Fellhanera bouteillei (Desm.) Vězda – (6) *SM 45984* [SING]; (14f) *ST 46356* [B, SING].

***Fellhanera* sp. A** – (2d) *S 45578* [SING]; (3m) *S 45676* [B, SING]; (3al) *S 45807* [B, SING]; (3am) *S 45808* [B, SING].

This species has conspicuous, dark-brown, beaked pycnidia and brown apothecia with three-septate ascospores *ca* 10-12 × 2.5-4 µm. Conidia 3 × 1.5 µm.

***Fellhanera* sp. B** – (1a) *SM 45441c* [SING].

Foliicolous, grey, granular thallus with pale yellow-brown, small apothecia; ascospores uniseptate, 14 × 5 µm.

***Fellhanera* sp. C** – (2d) *S 45571* [B, SING]; (3g) *S 45658* [B, SING] (c. pycn.); (6) *SM 45957* [B, SING]; (7) *ST 46012* [B, SING], *46030* [B, SING]; (4) *S 45818* [B, SING].

Apothecia pale brown with an often prominent, whitish margin; ascospores 3-septate, 10-12 × 3 µm. Pycnidia like small, young apothecia; conidia 3-4 × 1.5 µm.

***Fellhanera* sp. D** – (10b) *SMT 46171* [B, SING].

Apothecia tiny, dark-brown, dense; ascospores 3-septate, 10 x 3 µm.

***Fellhanera* sp. E** – (3) *S 45855* [B, SING]; (7) *ST 46015* [B, SING], *46016* [B, SING]; (7a) *ST 45986* [B, SING]; (13) *S 46256* [SING]?; (14) *ST 46336* [B, SING], *46337* [B, SING]; (14c) *ST 46292* [B, SING]; (14e) *ST 46312* [SING]; (16) *ST 46387* [SING]; 1989, *Aptroot* [Hb. Aptroot].

Apothecia pale brown to brown; ascospores 3-septate, 13-20(-24) × 4 µm.

***Fellhanera* sp. F** – (14) *ST 46317* [B, SING].

Muscicolous; apothecia black, soon convex; ascospores 3-septate, 16 × 5 µm.

Fissurina* cf. *dumastii Fée – (5e) *ST 45907* [B, SING]; (6) *SF 46077* [B, SING] (no spores), *46098* [B, SING] (no spores); (7) *ST 46041* [B, SING] (thin septa); (11) *SMT 46205* [B, SING] (no spores), *46206* [B, SING] (thin septa); (14) *ST 46339* [B] (thin septa).

TLC: none (*45907, 46041, 46077, 46098, 46205, 46206*). The identifications in this genus are provisional.

Fissurina* cf. *incrustans Fée – (3m) *S 45677* [B, SING]; (3o) *S 45696* [SING]; (4) *S 45820* [B, SING], *45828* [B, SING]; (6) *SF 46093* [B, SING], *46095* [B, SING], *46096* [SING]; (14e) *ST 46305* [B, SING], *46309* [B, SING].

TLC: stictic acid (*45677, 45820, 45828, 46096, 46305, 46309*).

Fissurina* cf. *radiata Mont. – (6) *SM 45973* [B, SING]; (6) *SF 46089* [B, SING] (no spores); (10) *SMT 46122* [B, SING].

TLC: none (*45973, 46122*).

***Fissurina* sp. A** – (1d) *SM 45472* [B, SING].

TLC: none; ascospores muriform, *ca* 4/ascus, 18 x 7 µm.

Glyphis cicatricosa Ach. – (2b) in *S 45525* [SING] (= *Chrysothrix xanthina*); (3ag) *S 45785* [SING]; on Cocos palms, 1861-1865, *Maingay* [Nylander and

Crombie, 1884: 59]: corticola, *Maingay* [Nylander, 1891: 25]; *Beccari 239* [M, not seen; Redinger, 1936: 98; Krempelhuber, 1875: 62].

Glyphis scyphulifera (Ach.) Staiger – (13a) *S 46220* [B, SING].

Graphis assimilis Nyl. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 23].

Graphis caesiella Vain. – (1) in SM 45473 [SING] (= *Phaeographis* sp. C); (1b) *SM 45452* [B, SING]; (1d) *SM 45466* [B, SING]; (1f) *obs.*, in *SM 45485* [B, SING] (= *Bactrospora myriadea*); (1g) *SM 45489* [SING]; (2a) *S 45519* [B]; (2b) *S 45527* [SING]; (2c) in *S 45539* [B, SING] (= ster. crust.); (2e) *obs.*, in *S 45587* [B, SING] (= *Phaeographis intricans*); (2f) *S 45609* [B, SING]; (2g) *S 45625* [B, SING], in *S 45635* [SING] (= parasite); (3o) *S 45689* [SING]; (3y) *S 45732* [SING] cf. (large ascospores); (3ab) *obs.*, *45758* [B]; (7) *obs.*, *ST 46027* [B, SING]; (7a) *ST 45995* [B, SING]; (8) *ST 46074* [B, SING]; (13) *obs.*, *S 46233* [SING]; (13a) *obs.*, in *S 46227* [SING] (= *Pyxine cocoes*); (14) in *ST 46352* [B] (= *Graphis insulana*); (14a) *ST 46275* [B, SING] (small); (14c) *ST 46286* [B, SING]; (15) *obs.*; (18) *ST 46395* [B, SING].

TLC: norstictic, tr. connorstictic acids (*45625, 46286, 46395*); (tr.) norstictic, salazinic acids (*45466, 45519, 45609* (with galbinic acid), *46074*); salazinic acid (*46027, 46275*); none (*45995*). Salazinic acid-containing specimens would fit *Graphis bakeri* Vain. (Lücking *et al.*, 2008). However, the salazinic acid is usually accompanied by traces of norstictic acid not mentioned by Lücking *et al.* (2008), the chemical variation is not correlated with any morphological differences and an intermediate specimen containing about equal amounts of norstictic and salazinic acids was observed. Therefore all material is considered to be a single species. Only a specimen containing stictic acid but otherwise rather similar in morphology is treated here as a separate species, *G. dendrogramma*. Its ascocarps seem less pruinose and more radiately branched.

Graphis cf. ***cleistoblephara*** Nyl. – (7) *ST 46023* [B, SING].

TLC: norstictic acid. The specimen deviates by the smaller ascospores, *ca* 35 x 12 µm, *ca* 4 /ascus.

Graphis confluens (Mont.) Nyl. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 24.

This record may need reinvestigation to establish its current taxonomic position.

Graphis dendrogramma Nyl. – (2d) *S 45564* [B, SING].

TLC: stictic acid with traces of cryptostictic and ?constictic acid. See comment under *G. caesiella*.

Graphis glaucescens Fée – (2d) *S 45562* [B, SING], *45563* [B, SING]; (3m) *S 45686* [B, SING]; (3ab) *S 45761* [SING]; (5d) *ST 45872* [B] (large ascospores); (5e) *ST 45908* [SING]; (6) *SM 45975* [B, SING]; *SF 46087* [B, SING].

TLC: indet. terpenoid? (*45562, 45563, 45686, 45761, 45908, 45975,* *46087*).

Graphis insulana (Müll.Arg.) Lücking & Sipman – (1b) *SM 45448* [B, SING]; (1c) *SM 45459* [SING]; (1i) *SM 45497* [B, SING]; (2d) *S 45560* [B, SING], *45565* [B, SING]; (2g) in *S 45631* [B] (= *Amandinea efflorescens*); (3a) *S 45642* [SING]; (3i) *S 45665* [B, SING]; (3m) *S 45679* [B]; (3y) in *S 45732* [SING] (= *Graphis caesiella*) (degenerated); (3ae) *S 45777* [SING]; (5b) *ST 45864* [B, SING]; (7) *ST 46042* [SING]; (8) *ST 46071* [SING]; (13) *S 46237* [SING]; (14) *ST 46352* [B]; (14e) *ST 46307* [B, SING]; (15) *obs.*; (18) *obs.*; Jungis Banactas, 1920, *Ridout 5657* [SING]; Sentosa, along the southern shore, on trunk, 1980, *Tibell 8858* [UPS L-057800]; nahe der Philippinischen Botschaft, 1999, *Schumm & Schwarz* [Hb. Schumm 5849].

TLC: norstictic acid with or without traces of connorstictic and galbinic? acid (*45448, 45497, 45665, 45777, 45864, 46352*); indet. high spot (*45560, 45565*); none (*45679, 46042, 46071, 46307*). The species is easily recognizable by the thick thalline margin of the lirellae and the finely inspersed hymenium with large, muriform, single ascospores. Its chemistry is somewhat variable because norstictic acid is sometimes accompanied by other substances, and occasionally it is not observed on the TLC plates. The excipulum is usually only laterally carbonized, but may be thinly carbonized below. It has been confused with *G. hiascens* (Fée) A.W.Archer.

Graphis librata C.Knight – (1d) *SM 45462* [SING]; (11) *SMT 46215* [B, SING] (thin lirellae).

TLC: norstictic acid (*45462, 46215*).

Graphis rustica Krempelh. – Ad cortices, *Beccari 258* [M, not seen; Redinger, 1936: 49; Krempelhuber, 1875: 61, type description].

Graphis scripta Ach. – On bark of trees, atypical, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 57]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 23]; species dubia vel excludenda [Redinger, 1936: 118].

These records may need reinvestigation to establish their current taxonomic position.

Graphis scripta Ach. var. ***serpentina*** Ach. – On cocos-nut and palms, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 57].

This record may need reinvestigation to establish its current taxonomic position.

Graphis striatula Ach. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 23].

Graphis tenella Ach. – (10a) *SMT 46156* [B, SING]; (18) *ST 46392* [B, SING].

TLC: none (*46156*).

Graphis vestitoides (Fink) Staiger – (2d) *S 45561* [B, SING].

TLC: none.

Gyalideopsis vainioi Kalb & Vězda – (13) *S 46251* [B, SING].

***Gyalideopsis* sp.** – (3ab) *S 45752* [B]; (4) *S 45834* [SING]; (14e) *ST 46302* [B, SING].

The material is insufficiently developed for certain identification. More than one species may be involved.

Haematomma rufidulum (Fée) A.Massal. – on trees, 1861-1865, *Maingay 67* [BM, not seen; Staiger and Kalb, 1995: 162]; on trees, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 53 as *Lecanora punicea*]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 19 as *Lecanora punicea*].

It is unclear if the Maingay specimen investigated by Staiger is the same as that investigated by Nylander and thus belongs to *H. rufidulum*. For the time being all literature reports are considered to belong to the same species. However, many *Haematomma* species look very similar and occur in similar habitats, so that the presence of more than one species in Singapore is not unlikely.

Herpothallon granulare (Sipman) Aptroot & Lücking – (1g) *SM 45490* [SING]; (2d) *S 45566* [SING]; (3f) *S 45654* [SING]; (3l) *S 45671* [B, SING]; (3as) *S 45838* [B holotype, SING isotype); (3az) *S 45851* [B, SING]; (7) *ST 46031* [B, SING], *46036* [SING].

See also Sipman (2003).

Jamesiella perlucida (Vězda & Hafellner) Lücking, Sérusiaux & Vězda – (3aj) *S 45799* [B, SING].

Laurera phaeomelodes (Müll.Arg.) Zahlbr. – (3o) *S 45694* [B, SING]; (14) *ST 46340* [B, SING].

Lecanora helva Stizenb. – (2b) *S 45521* [B], *45529* [SING]; (2c) *S 45541* [B, SING]; (2f) *S 45619* [SING]; (2g) *S 45630* [SING], *45637* [B, SING]; (7a) *ST 45992* [SING]; (13) *S 46255* [B]; (15) *SM 46370* [B, SING], *46371* [B]; (17) *ST 46390* [SING] cf.; (18) *ST 46396* [B, SING].

TLC: atranorin, 2'-0-methylperlatolic acid (*45521, 45541, 45630, 45637, 46370, 46371, 46396*). The material looks somewhat heterogeneous, as some individuals have more appressed, slightly white-pruinose apothecia and others more raised, non-pruinose and darker-coloured apothecia. Both types may occur mixed and appear to have the same chemistry. Nr. *46390* grew on granitic rock.

***Lecanora* sp.** – (8) *ST 46062* [B, SING].

TLC: atranorin, fatty acid; ascospores notably elongated, 18 × 5 µm.

Lecidopyrenopsis corticola Vain. – University area, roadside trees, 1964, *Degelius As-492* [UPS L-104123 det. P.M. Jörgensen 1999].

Lepraria usnica Sipman – (2) *S 45547* [B, SING]; (2c) in *S 45540* [B, SING] (= *Cryptothecia lunulata*); (2d) *S 45548* [B, SING], *45553* [B, SING]; (3d) *S 45651* [SING]; (8) *ST 46053* [B, SING]; (13) *S 46253* [B, SING], *46254* [B]; (14) *ST 46263* [SING], *46335* [SING], *46349* [SING]; (16) *ST 46385* [B, SING]; (18) *ST 46399* [B holotype, SING isotype]; crossing Oxley Road/

Oxley Rise, roadside trees, 1994, *Diederich 12225* [Hb. Diederich].

See also Sipman (2003).

***Lepraria*? sp. A** (thin yellowish) – (2f) *S 45600* [B, SING]; (7a) *ST 45988* [B, SING]; (13) *obs.*; (14c) *ST 46280* [B, SING]; (18) *obs.*; crossing Oxley Road/ Oxley Rise, roadside trees, 1994, *Diederich 12226* [Hb. Diederich].

TLC: usnic acid, zeorin (*45600, 45988, 46280*). Thallus finely sorediate, therefore generic affinity uncertain.

***Lepraria* sp. B** – (3w) *S 45727* [B, SING].

TLC: indet. substances.

Leptogium cyanescens (Rabenh.) Körb. – (17) *ST 46388* [B, SING]; Botanical Garden, on *Cupressus* sp., 1980, *Tibell 8888* [UPS L-057818].

The species is understood here in a wide sense, to accommodate thin-lobed *Leptogium* species with phyllidia.

Leptogium cochleatum (Dicks.) P.M.Jørg. & P.James – New Tiew, Ama Kong, 1949, *Lemaitre* [SING].

Leptogium marginellum (Sw.) S.F.Gray – Botanical Garden, root of *Swietenia macrophylla*, 1964, *Degelius As-486* [UPS L-102634].

Leptogium phyllocarpum (Pers.) Nyl. – Botanical Garden, root of *Swietenia macrophylla*, 1964, *Degelius As-485* [UPS L-102652].

Leucodecton occultum (Eschw.) A.Frisch – (1j) *SM 45504* [B, SING]; (3ab) *S 45754* [B, SING].

TLC: norstictic, stictic, tr. cryptostictic acids (*45504, 45754*).

Lithothelium illotum (Nyl.) Aptroot – (1d) *SM 45471* [B, SING].

Lopadium sophodinum (Nyl.) Zahlbr. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 21 as *Lecidea*, type description].

This record needs reinvestigation to establish its current taxonomic position.

Malcolmiella* cf. *olivaceolurida (Vain.) INED. – (4) *S 45815* [SING]; (10) *SMT 46126* [B, SING], *46141* [B, SING].

Ascospores 7-10 × 4-5 µm. The description of *Lecidea olivaceorufa* Vain. fits, but an investigation of type material is desirable for certainty. Therefore no formal new combination is made.

Malcolmiella sp. A – (10) *SMT 46126a* [B, SING].

***Malcolmiella* sp. B** – (6) *SF 46097* [B, SING].

Material sorediate, without ascocarps, therefore identification provisional.

***Malcolmiella* sp. C** – (6) *SF 46086* [B, SING]; (14) *ST 46329* [B, SING]; on treefork in disturbed forest, 2000, *B. C. Tan* [SING].

Mazosia phyllosema (Nyl.) Zahlbr. – (5e) *ST 45937* [SING] vs.; (6a) *SF 46105* [SING]; (10b) *SMT 46185* [B, SING]; (14f) *ST 46361* [B, SING].

Melanotrema* aff. *meiospermum (Hale) A.Frisch – (14a) *ST 46276* [B, SING].

TLC: none. The material deviates from the description by Frisch and Kalb (2006) by the convex columella.

Micarea* cf. *leprosula (Th.Fr.) Coppins & A.Fletcher – (3ax) in *S 45844* [B, SING] (in *Micarea* sp.), *S 45845* [B, SING] (ster.).

Micarea* cf. *prasina Fr. – (2c) *S 45545* [B, SING] c. apoth.

***Micarea* sp. A** – (2c) *S 45544* [B, SING]; (3n) *S 45688* [B, SING]; (3w) *S 45724* [B, SING].

Thallus granular, apothecia black.

***Micarea* sp. B** – (3ax) *S 45844* [B, SING].

Apothecia brown, without spores.

***Micarea* sp. C** – (8) *ST 46051* [B, SING]; (15) *SM 46367* [B, SING].

Thallus finely granular, green and apothecia black.

Microtheliopsis uleana Müll.Arg. – (10b) *SMT 46187* [B, SING].

Monoblastia pellucida Aptroot – (13) *S 46249* [B, SING]; (14) *ST 46326* [B, SING].

Mycoporum eschweileri (Müll.Arg.) R.C.Harris – (2f) *S 45614* [B, SING]?; (3w) *S 45728* [B, SING]?; (3ah) *S 45788* [B, SING]?; (3an) *S 45809* [B, SING]?; (3az) *S 45852* [B, SING]; (5e) *ST 45925* [B, SING]?; (6) *SM 45979* [SING]?; (7a) *ST 46002* [SING]?; (8) *ST 46063* [B, SING]; (15) *SM 46369* [B, SING]?; Kusu Island, 1989, *Aptroot 25977, 25978* [Hb. Aptroot]; St. John's Island, 1989, *Aptroot 25998* [Hb. Aptroot].

The material is often poorly developed and the identification provisional. Ascospores uniseptate, 15-18(-22) × 3-4 μm. Nr. 46369 is pycnidiate; conidia 3 x 1 μm, curved.

***Mycoporum* sp.?** – (5e) *ST 45879* [B, SING].

Myeloconis erumpens P.M.McCarthy & Elix – (6) *SM 45948* [B, SING]; (10) *SMT 46123* [B, SING].

Myriotrema albocinctum Hale – Bukit Timah Nature Reserve, 1989, *Aptroot 25988* [Hb. Aptroot].

Myriotrema glaucophaenum (Kremp.) Hale – (5e) *ST 45897* [B, SING], *45910* [SING], *45926* [B]; (6) *SM 45945* [B, SING].

TLC: psoromic acid (*45910*).

Myriotrema microporellum (Nyl.) Hale – (5e) *ST 45913* [B, SING].

TLC: hypoprotocetraric acid.

Myriotrema subconforme (Nyl.) Hale – (3b) *S 45646* [SING]; (3c) *S 45647* [SING]; (3m) *S 45680* [B, SING]; (3p) *S 45703* [B]; (3t) *S 45716* [B, SING]; (3ah) *S 45789* [SING]; (3ay) *S 45849* [B, SING]; (4) *S 45824* [SING]; Bukit Timah nature reserve, 1989, *Aptroot 25989* [Hb. Aptroot !].

TLC: none (*45646, 45647, 45789, 45824, 45913*).

Ocellularia cavata (Ach.) Müll.Arg. – on the trunks of dead trees, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 53 as *Thelotrema*]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 19 as *Thelotrema*].

These records need reinvestigation to establish their current taxonomic position.

Ocellularia crocea (Kremp.) Overeem & D.Overeem – (3n) *S 45687* [B, SING]; (3u) *S 45718* [B, SING]; (3an) *obs.*, in *S 45810* [SING] (= *Chiodecton leptospermum*); (3ay) *S 45847* [SING]; (4) *obs.*; (5a) *ST 45857* [B, SING]; (5d) *ST 45875* [B, SING]; (5e) *ST 45882* [B, SING], *45894* [SING], *45901* [SING], *45905* [B], *45918* [B, SING]; (6) *ST 46382* [B, SING], *SM 45953* [B], *45966* [SING], *45980* [SING], *SF 46083* [B, SING]; (10) *SMT 46118* [SING], *46127* [B], *46142* [B], *46146* [SING]; (10a) *SMT 46163* [B, SING], *46165* [B, SING]; (11) *SMT 46214* [SING]; (14) *ST 46330* [B]; (14e) *ST 46313* [SING]; (15) *SM 46363* [SING]; ad cortices, *Beccari 261* [Krempelhuber, 1875: 60 as *Ascidium*]; Sentosa, along the southern shore, on trunk, 1980, *Tibell 8859* [UPS L-057801]; Bukit Timah nature reserve, 1989, *Aptroot 25991* [Hb. Aptroot].

Morphologically very similar to *O. papillata*, and hard to separate when the characteristic, yellow pigment is scarce. TLC: traces (pigment) (*45687, 45718, 45857, 45918, 46083, 46127, 46165*).

Ocellularia dolichotata (Nyl.) Zahlbr. – (6) *SM 45972* [SING]; (10a) *SMT 46152* [B, SING]; Vega expedition, corticola, 1879, *Almquist* [H-Nyl. 22748 lectotype, S isolectotype, not seen; Nylander, 1891: 19 as *Thelotrema*; Hale, 1981: 303].

TLC: none (45972).

Ocellularia feigei Sipman – (6) *SM 45964* [B holotype, SING isotype]; (10) *SMT 46121* [B].

For details see Sipman (2003).

Ocellularia interponenda (Nyl.) Hale – (6) *ST 46379* [SING]; (10) *SMT 46129* [B, SING], *46140* [B, SING]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 20 as *Ascidium*, type description]; Nu Soon Forest Reserve, in tropical forest remnant, on trunk, 1980, *Tibell 8834* [UPS L-057782].

Ocellularia nylanderiana Hale – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 20 as *Ascidium majorinum* var. *longius*, type description].

Ocellularia orthomastia (Kremp.) Zahlbr. – (5e) *ST 45912* [B, SING]; ad corticem, *Beccari 247* [Krempelhuber, 1875: 60 as *Ascidium*, type description].

TLC: none (45912).

Ocellularia papillata (Leight.) Zahlbr. – (3m) *S 45675* [SING] (vs., poor material); (4) *S 45821* [SING], *45827* [B, SING]; (5e) *ST 45903* [B, SING], *45915a* [B, SING]; (5f) *ST 45928* [B, SING]; (6) *ST 46381* [B, SING], *SM 45951* [SING], *45955* [SING], *45958* [B, SING], *45969* [B], *45974* [SING], *SF 46085* [B, SING], *46094* [SING]; (10) *SMT 46132* [SING], *46137* [B], *46139* [SING]; (10a) *SMT 46158* [B, SING], *46160* [B, SING] cf.; (11) *SMT 46209* [SING]; (14) *ST 46346* [B, SING]; (15) *SM 46365* [SING]; Nu Soon Forest

Reserve, in tropical forest remnant, on trunk of *Lithocarpon*, 1980, *Tibell 8810* [UPS L-057767]; ibidem, on bark of *Macaranga*, 1980, *Tibell 8827* [UPS L-057777].

Very similar to *O. crocea*, and differring by the absence of pigment. Since the pigment concentration seems variable, the delimitation between the two species is not always clear. TLC: none (*45827, 45915a, 45928, 45969, 46085, 46137, 46346*).

Ocellularia tanii Sipman – (5e) *ST 45923* [B, SING]; (6) *SF 46081* [B, SING], *46084* [B, SING]; (10a) *SMT 46151* [B holotypus, SING isotypus].

For details see Sipman (2003).

Ocellularia terebrata (Ach.) Müll.Arg. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 19 as *Thelotrema terebratum typicum*]; ad corticem, *Beccari 255* [Krempelhuber, 1875: 60 as *Thelotrema olivaceum*].

Ocellularia terebrata (Ach.) Müll.Arg. f. ***subeminescens*** (Nyl.) Zahlbr. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 19 as *Thelotrema terebratum* f. *subeminescens*].

This record needs reinvestigation to establish its current taxonomic position.

Ocellularia triglyphica (Kremp.) Zahlbr. – Ad cortices, *Beccari 256* [Krempelhuber, 1875: 60 as *Ascidium*].

Ocellularia xanthostromiza (Nyl.) Zahlbr. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 20 as *Ascidium*, type description].

This record needs reinvestigation to establish its current taxonomic position, it may be conspecific with *O. crocea*.

***Ocellularia* sp. A** – (3p) *S 45706* [B, SING].

Ascospores muriform, 1/ascus. TLC: none.

***Ocellularia* sp. B** – (5e) *ST 45890* [B, SING].

Like *O. papillata*, but without columella. TLC: none.

Opegrapha graphidiza Nyl. – (8) *ST 46072* [B, SING].

Identification kindly provided by D. Ertz (Meise), for more details see his forthcoming publication in Bibliotheca Lichenologica.

Opegrapha irosina Vain. – (4) *S 45832* [B].

Identification kindly provided by D. Ertz (Meise), for more details see his forthcoming publication in Bibliotheca Lichenologica.

Opegrapha medusulina Nyl. – (15) *SM 46376* [B, SING].

Identification kindly provided by D. Ertz (Meise), for more details see his forthcoming publication in Bibliotheca Lichenologica.

Opegrapha subrimulosa Nyl. – (2a) *S 45517* [B, SING]; (2d) *S 45568* [B].

Identification kindly provided by D. Ertz (Meise), for more details see his forthcoming publication in Bibliotheca Lichenologica.

Opegrapha subvulgata Nyl. – (1d) *SM 45463* [B].

Identification kindly provided by D. Ertz (Meise), for more details see his forthcoming publication in Bibliotheca Lichenologica.

Opegrapha varia Pers. – (11) *SMT 46217* [B, SING].

Identification kindly provided by D. Ertz (Meise), for more details see his forthcoming publication in Bibliotheca Lichenologica.

Opegrapha vegae R.Sant. – (5e) *ST 45941* [SING]; (6) *SM 45982* [B, SING], *45983* [B, SING], *45985* [B, SING]; (6a) *SF 46104* [B, SING]; (10b) *SMT 46174* [B, SING]; Vega expedition, foliicola, 1879, *Almquist 37a* [S, UPS, not seen; Nylander, 1891: 22 as *O. phyllobia*; Santesson, 1952: 100]; 1879, *Almquist* [UPS L-025868 isotypus, not seen].

Nr. *46174* deviates by the presence of 7-septate ascospores.

Pallidogramme chrysenteron (Mont.) Staiger, Kalb & Lücking – (14a) *ST 46274* [B, SING]; on bark of old trees, without ascospores, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 58 as *Graphis chrysentera*?].

TLC: stictic acid (*46274*).

Parmeliella pannosa (Sw.) Müll.Arg. – Botanical Garden, on *Cupressus*, 1980, *Tibell 8889a* [UPS L-057819]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 19 as *Pannaria*]; ad lignum (vel corticem) putridum, *Beccari 234a* [Krempelhuber, 1875: 60 as *Pannaria*].

Parmotrema gardneri (C.W.Dodge) Sérus. – (3o) *S 45701* [B, SING]; (14c) *ST 46282* [B, SING]; Botanic Gardens, 1949, *Lemaitre* [SING]; Botanical Garden, on *Peltophorum ferrugineum*, 1980, *Tibell 8879* [UPS L-057814]; ibidem, on *Cupressus* sp., 1980, *Tibell 8891* [UPS L-057822].

TLC: atranorin, protocetraric acid (*45701, 46282*).

Parmotrema praesorediosum (Nyl.) Hale – (3ab) in *S 45766* [SING] (= *Parmotrema tinctorum*); (3aj) *S 45804* [B, SING]; (12) *SMT 46218* [SING]; (13) *S 46262* [SING]; (14) *ST 46324* [B]; (18) *ST 46401* [B, SING]; Vega expedition, corticola, 1879, *Almquist* [H-Nyl 35547 holotype, S isotype, not seen; Nylander, 1891: 18 as *Parmelia*]; Government House Domain, on telephone line insulator, 1959, *Burkill 2130* [SING 500253].

TLC: atranorin, 3 fatty acids (*45804, 46218, 46262, 46324, 46401*).

Parmotrema saccatilobum (Tayl.) Hale – (3m) *S 45684* [SING]; (3aj) *S 45801* [B, SING]; (13) in *S 46242* [SING] (= *Trypethelium subeluteriae*); (14c) *ST 46290* [B, SING]; Elix, 1994: 156; Louwhoff and Elix, 1999: 111; on trunk in rubber plantation, 2000, *B.C. Tan* [SING].

TLC: atranorin, protocetraric acid (*45684, 45801, 46290*).

Parmotrema tinctorum (Despr. ex Nyl.) Hale – (3o) *S 45702* [B, SING]; (3ab) *obs., S 45766* [SING]; (3aj) *S 45803* [B, SING]; (14) *obs.*; Singapore Botanic Gardens, 1949, *Lemaitre* [SING]; Singapore Botanic Gardens, 1959, *Burkill 2171* [SING]; on rocks, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 51 as *Parmelia*; Nylander, 1891: 18 as *Parmelia*]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 18 as *Parmelia*]; Singapore Botanical Garden, on *Cedrela glaziovii* (Nr. D6), 1959, *Burkill 2176* [SING 500375]; ibidem, on *Araucaria cunninghamii*, 1980, *Tibell 8874* [UPS L-057809]; ibidem, on *Peltophorum ferrugineum*, 1980, *Tibell 8876* [UPS L-057811]; ibidem, on *Harpullia zanguebarica*, 1980, *Tibell 8882* [UPS L-057815]; ibidem, Jungle, on *Sterculia rubiginosa*, 1980, *Tibell 8870* [UPS L-058096].

TLC: atranorin, lecanoric acid (*45702, 45766, 45803*).

Phaeographina alutacea Zahlbr. – In horto botanico, *Schiffner 3053* [W, not seen; Redinger, 1936: 94].

This record needs reinvestigation to establish its current taxonomic position.

Phaeographina flexans (Nyl.) INED. –Vega expedition, corticola, 1879, *Almquist* [H-Nyl. 7975, not seen; Nylander, 1891: 24 as *Lecanactis*, type description; Egea and Torrente, 1994: 183 as Graphidaceae].

This record needs reinvestigation to establish its current taxonomic position. The species is poorly known and no formal recombination is presented here without an investigation of the type.

Phaeographina prosiliens (Mont. & v.d.Bosch) Müll.Arg. – (10a) *SMT 46155* [B, SING].

TLC: none.

Phaeographina subrigida (Nyl.) Zahlbr. – On Jack-fruit trees, 1861-1865, *Maingay* [H, not seen; Nylander and Crombie, 1884: 58 as *Graphis*, type description; Redinger, 1936: 98]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 24 as *Lecanactis*].

These records need reinvestigation to establish their current taxonomic position.

Phaeographis caesioradians (Leight.) A.W.Archer – (2) *S 45621a* [SING]; (2e) *S 45597* [B, SING]; (3o) *S 45700* [SING]; (3ag) *S 45784* [SING]; (3ai) *S 45797* [B]; (5e) *ST 45881* [SING]; (7) *ST 46029* [B, SING], *46038* [B, SING], in *ST 46007* [SING] (= *Diorygma rufopruinosum*)? (no spores); (7a) *ST 45998* [SING]; (8) *ST 46075* [B, SING]; (13) *S 46235* [SING]; (14a) *ST 46268* [B, SING], *46269* [B, SING]; (14c) in *ST 46283* [B, SING] (= *Phaeographis intricans*); (15) in *SM 46370* [B, SING] (= *Lecanora helva*).

TLC: none (*45597, 45621a, 45700, 45797, 45881, 46029, 46075, 46269*). Externally similar to *Phaeographis* sp. C, but with muriform ascospores.

Phaeographis circumscripta (Kremp.) Zahlbr. – Pulo Pusang, ad cortices, *Beccari 243b* [M, not seen; Krempelhuber, 1875: 62 as *Graphis (Fissurina)*; Redinger, 1936: 78].

This record needs reinvestigation to establish its current taxonomic position.

Phaeographis dendroides (Leight.) Müll.Arg. – (3ab) S 45759 [B, SING].

TLC: stictic acid.

Phaeographis diversula (Nyl.) Zahlbr. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 24 as *Lecanactis diversa*].

Lecanactis diversa is not synonymized here with *Graphina obtrita* (Fée) Müll.Arg. as indicated by Zahlbruckner (1923: 416), because its ascospores seem in conflict with this. Instead the synonymisation of "*Graphis diversa* Kremp." in Redinger (1936: 89) is followed. The record needs reinvestigation to establish its current taxonomic position.

Phaeographis intricans (Nyl.) Staiger – (1) in *SM 45473* [SING] (= *Phaeographis* sp. C); (1g) *SM 45487* [B, SING]; (1j) *SM 45508* [SING]; (2) *S 45622* [SING], *S 45623* [B, SING]; (2b) *obs.*, in *S 45531* [B, SING] (= *Trypethelium eluteriae*); (2d) *obs.*, in *S 45556* [SING] (= *Pyxine cocoes*); (2e) *S 45587* [B, SING], *45594* [B, SING]; (2f) *S 45602* [B, SING], *45607* [B, SING]; (2g) in *S 45630* [SING] (= *Lecanora helva*); (3o) *obs.*, *S 45698* [SING]; (3p) *S 45704* [SING]; (3ab) *S 45756* [SING]; (3ao) *S 45812* [B]; (5e) *ST 45880* [B, SING]; (6) *SM 45967* [SING]; (7) *obs.*, *ST 46011* [B, SING], *46019* [SING], *46032* [B, SING], *46034* [B], *46037* [B, SING]; (7a) *ST 45996* [B, SING]; (8) *ST 46073* [B, SING]; (13) in *S 46260* [SING] (= *Dirinaria picta*); (14) *obs.*; (14a) *ST 46271* [B, SING]; (14c) *ST 46283* [B, SING]; (15) *obs.*; (18) *obs.*; Sentosa, along the southern shore, on trunk,1980, *Tibell 8857* [UPS L-057799]; Kusu Island, 1989, *Aptroot 25980, 25982* [Hb. Aptroot].

TLC: none (*45487, 45587, 45602, 46073*). The material is very variable and the identification provisional. Noteworthy is the presence of specimens with guttulate hymenium: in *45473, 45508, 45623, 45704, 45996*.

Phaeographis maeandrata (Kremp.) Zahlbr. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 24 as *Lecanactis serpentosa*].

This record needs reinvestigation to establish its current taxonomic position.

Phaeographis punctiformis* var. *nylanderi (Vain.) Redgr.? – (2e) *S 45593* [B, SING], *45599* [B, SING]; (2g) in *S 45630* [SING] (= *Lecanora helva*); (8) *ST 46050* [B, SING]; (13) *S 46234* [SING]; (13a) *S 46225* [SING]; Sentosa, along the southern shore, on trunk, 1980, *Tibell 8858 pp* [UPS L-057800, *Graphis insulana*].

TLC: norstictic acid (*45593, 46050, 46234*). The material deviates clearly from *P. punctiformis* s. str. and the identification is provisional.

Phaeographis ramigera Redgr. – *Beccari 268* [M, not seen; Redinger, 1936: 71].

This record needs reinvestigation to establish its current taxonomic position.

Phaeographis scalpturata (Ach.) Staiger – (3ag) *S 45783* [SING]; (3ai) *S 45791* [B, SING]; (5e) *ST 45887* [B, SING]; (10a) *SMT 46157* [B, SING]; Sentosa, along the southern shore, on trunk, 1980, *Tibell 8856* [UPS L-057798].

TLC: none (*45791, 45887, 46157*). The identification of *45783* is uncertain in the absence of ascospores.

***Phaeographis* sp. A** – (3ak) *S 45805* [B, SING].

Ascospores submuriform, *ca* 25 × 10 µm; TLC, norstictic acid.

***Phaeographis* sp. B** – *Benjamin Lee* [SING].

***Phaeographis* sp. C** – (1) *SM 45473* [SING]; (2) *S 45621* [B, SING]; (2f) *S 45608* [B, SING]; (3ad) *S 45775* [B, SING].

Externally similar to *Phaeographis caesioradians*, but with transversely septate ascospores. TLC: none (*45608, 45621, 45775*).

***Phaeographis* sp. D** – (14e) *ST 46306* [B, SING].

Ascospores bacillar, *ca* 4/ ascus, 30-50 × 10-12 µm; TLC: none.

Phyllopsora parvifolia (Pers.) Müll.Arg. – ad lignum putridum, *Beccari 233, 234* [Krempelhuber, 1875: 60 as *Lecidea parvifolia* var. *fibrillifera*].

***Phyllopsora*? sp.** – (14) *ST 46328* [B, SING].

TLC: stictic acid. A squamulose lichen deviating from *Phyllopsora* by the absence of prothallus and from *Eschatogonia* by the absence of a lower cortex; in the absence of apothecia its affinities are unclear.

Physcia* cf. *tribacioides Nyl. – (3ab) *S 45768* [B, SING]; (3aj) *S 45800* [B, SING].

***Physcia* sp.** – (3d) *S 45653* [B, SING]; (3x) *S 45729* [B, SING]; (14) *ST 46264* [B, SING], *46320* [B, SING], *46332* [B, SING]; (18) *ST 46400* [B, SING]; Nu Soon forest reserve, in tropical forest remnant, on trunk, 1980, *Tibell 8845* [UPS L-057788]; St. John's Island, 1989, *Aptroot 26003* [Hb. Aptroot].

A small-lobed species with marginal soralia and without lower cortex. It is apparently widespread and common in cultivated areas in the Malesian area and specimens are available in B from Indonesia and the Philippines.

Physma byrsaeum (Ach.) Tuck. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 18 as *Dichodium byrsinum*]; Singapore Botanical Garden, treestem, 1920, *Kiah 6038* [SING].

Platygramme flexuosa (Nyl.) INED. – (7) *ST 46045* [SING]; (7a) *ST 45997* [B, SING]; (8) *ST 46070* [B, SING]; Sentosa, along the southern shore, on tree trunk, 1980, *Tibell 8855* [UPS]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 25 as *Lecanactis*; Redinger, 1936: 98 as *Phaeographina*].

TLC: none (*45997, 46070*). No formal combination is presented without investigation of the type.

***Platythecium* sp.?** – *Beccari 235* [M, not seen; Krempelhuber, 1875: 61 as *Graphis grammitis* var. *seductilis*, type description; Redinger, 1936: 62] as *Graphis grammitis* var. *seductilis*.

This record needs reinvestigation to establish its current taxonomic position.

***Platythecium* sp.** – (6) *SM 45968* [B, SING].

TLC: stictic acid.

Pocsia mucronata P.M.McCarthy – (1a) *SM 45441b* [B, SING], *45441e* [B, SING].

Polyblastiopsis augescens (Nyl.) Zahlbr. – On bark of trees, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 60-61 as *Verrucaria*, type description; Nylander, 1891: 25 as *Verrucaria*].

Porina atropunctata Lücking & Vězda – (10b) *SMT 46190a* [B, SING], *46190b* [B, SING].

Porina* cf. *canthicarpa P.M.McCarthy – (10b) *SMT 46180* [B, SING].

Algal cells rectangular, in closed, radiating plates; ascospores 3-septate, 20 x 2.5 µm.

Porina chlorotica (Ach.) Müll.Arg. – (16) *ST 46386* [B, SING].

On granitic rock.

Porina epiphylla (Fée) Fée – (10b) *SMT 46190* [B, SING], *46190c* [B, SING].

Porina internigrans (Nyl.) Müll.Arg. – (5e) *ST 45920* [B, SING]; (6) *SM 45960* [B, SING]; (10) *SMT 46134* [B, SING]; (10a) *SMT 46148* [B, SING].

Porina mirabilis Lücking & Vězda – (10b) *SMT 46167* [SING] cf., *46195* [SING].

Porina monocarpa (Kremp.) Schilling – ad folia coriacea, *Beccari 269e* [Krempelhuber, 1875: 63 as *Verrucaria*,]; *Beccari 269b* [M, holotype, G, not seen; Krempelhuber, 1875: 63 as *Verrucaria*; Santesson, 1952: 256].

Porina semecarpi Vain. – (10b) *SMT 46181* [B, SING].

Porina tetracerae (Malme) R.Sant. – (1d) in *SM 45460* [SING] (= *Pyrenula* sp.), *SM 45467* [B, SING]; (1j) *SM 45512* [B, SING]; (3m) *S 45678* [SING]; (3ac) in *S 45773* [B] (= *Porina* cf. *tetracerae*); (4) *S 45816* [SING], in *S 45822* [B, SING] (= *Thelotrema* sp. B), *S 45830* [B, SING]; (5e) *ST 45919* [B, SING]; (6) *SM 45961* [B, SING]; (6a) *SF 46113* [SING]; (10) *SMT 46138* [B, SING]; (10b) *SMT 46179* [B, SING].

While most specimens are isidiate and without ascocarps, the frequency of ascocarps and isidia is very variable and there seemed no reason to separate isidiate from non-isidiate specimens as proposed by some other authors.

Porina* cf. *tetracerae (Malme) R.Sant. – (3m) in *S 45678* [SING] (= *Porina tetracerae*); (3ac) *S 45773* [B]; (4) *S 45825* [B, SING]; (13) *S 46252* [B, SING]; (14) *ST 46334* [B, SING].

These specimens deviate by the absence of cortex on the propagules, which remain usually short and granular. No specimen with ascocarps was seen, so that the classification is tentative and based on superficial resemblance.

Porina tetramera Vain. – (17a) *ST 46388c* [B, SING].

Porina virescens (Kremp.) Müll.Arg. – (10b) *SMT 46192* [B, SING].

***Porocyphus* sp.?** – (2) *S 45582* [B, SING].

A gelatinous algal cover on concrete, which may be lichenized because a few ascocarps seem present.

***Psorotichia* sp.?** – (2) in *S 45584* [SING] (= *Endocarpon pallidum*).

Pyrenula anomala (Ach.) Vain. – on trunks of trees, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 61 as *Trypethelium platystomum*]; ad cortices, *Beccari 236b* [Krempelhuber, 1875: 63 as *Trypethelium platystomum*]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 25 as *Verrucaria aggregata*].

Pyrenula aspistea (Ach.) Ach. – (5e) *ST 45904* [B, SING]; (5f) *ST 45930* [B, SING]; (6) *SM 45978* [SING], *SF 46092* [B, SING]; (11) in *SMT 46210* [B, SING] (= *Pyrenula santensis*) (no spores), *SMT 46212* [B, SING]; Bukit Timah nature reserve, 1989, *Aptroot 25992* [Hb. Aptroot].

Pyrenula concatervans (Nyl.) R.C.Harris – (1a) *SM 45443* [B, SING]; (1i) *SM 45502* [B, SING]; (3a) *S 45640* [B, SING]; (8) *ST 46059* [SING]; (13a) *S 46222* [B].

The ascospores are variable, from 4-loculate and 6-loculate to submuriform, 6 x 1-2 locules, and muriform, 8 x 2-3 locules, and range in size from 18 x 8 to 25 x 10 µm. However, they are much smaller than the related species with muriform ascospores, *P. macularis* (Zahlbr.) R.C.Harris.

Pyrenula mamillana (Ach.) Trev. – (14) *ST 46341* [B, SING].

Pyrenula nitidula (Bres.) R.C.Harris – (2f) *S 45610* [B, SING].

Pyrenula ochraceoflava (Nyl.) R.C.Harris – (1a) *SM 45442* [B, SING]; (1c) in *SM 45456* [SING] (= *Chrysothrix xanthina*); (1e) *SM 45476* [SING]; (1g) *SM 45492* [SING]; (1i) *SM 45499* [B]; (1j) *SM 45506* [SING], *45510* [B, SING]; (2a) in *S 45519* [B] (= *Graphis caesiella*); (2d) *S 45570* [B, SING]; (2g) in *S 45624* [SING] (*Pyrrhospora quernea*), in *S 45631* [B] (*Amandinea efflorescens*), in *S 45635* [SING] (parasite); (3) *obs.*; (3a) in *S 45642* [SING] (= *Graphis insulana*); (3ab) *S 45742* [B], *45743* [SING]; (3ag) *S 45782* [SING]; (3av) *S 45841* [SING]; (5c) *ST 45870* [SING]; (7) *obs.*, *ST 46044* [B], *46047* [SING]; (7a) *ST 46000* [B]; (8) *ST 46056* [SING], *46057* [B]; (13) *obs.*; (13a) *S 46221* [SING]; (14) *obs.*, *ST 46342* [B], *46343* [SING]; (14c) *ST 46295* [SING]; (15) *obs.*, *SM 46377* [B, SING]; Fort Canning Park, 1989, *Aptroot 25958* [Hb. Aptroot]; Sentosa, along the southern shore, outskirts of forest along the beach, on trunk, 1980, *Tibell 8862* [UPS L-057804]; Fort Canning Park, 1989, *Aptroot 25960* [Hb. Aptroot].

This species is conspicuous by the presence of yellow to red anthraquinone pigments. However, their concentration is very variable, perhaps depending on vitality of the thallus and shading. Some specimens seem to lack pigments completely, while in others it is restricted to a reddish pigment on the ascocarps. Both look very different from the modal form with yellowish thallus and perithecia but agree in anatomical characters. TLC: 2 anthraquinones (*45499*, *46000*); 4 anthraquinones (*45570*).

Pyrenula santensis (Nyl.) Müll.Arg.? – (11) *SMT 46210* [B, SING].

The specimen lacks ascospores.

Pyrenula santensis* var. *murina INED. – ad cortices, *Beccari 257, 265* [Krempelhuber, 1875: 63 as *Verrucaria santensis* Tuck. var. *murina*].

This record needs reinvestigation to establish its current taxonomic position.

Pyrrhospora quernea (Dicks.) Körb. – (2f) *S 45618* [B, SING]; (2g) *S 45624* [SING], in *S 45637* [B, SING] (= *Lecanora helva*); (7a) *ST 45987* [B, SING]; (7b) *ST 46004* [B, SING]; (8) *ST 46049* [B, SING]; (13) *S 46248* [B, SING]; (14) *obs.*; (15) *obs.*; (18) *ST obs.*

TLC: thiophanic acid, tr. arthothelin (*45618, 45987, 46004, 46049, 46248*). Surprisingly this material is morphologically and chemically identical with a species known until recently only from temperate and mediterranean climate areas, where it is not uncommon. Apothecia, desirable for confirmation of the taxonomic position, were not found. It is also reported from Hong Kong by Aptroot and Seaward (1999).

Pyxine cocoes (Sw.) Nyl. – (1j) *SM 45514* [B, SING]; (2d) *S 45556* [SING]; (13) *S 46259* [B, SING]; (13a) *S 46227* [SING]; (15) *obs.*; Fort Canning Park, 1989, *Aptroot 25950* [Hb. Aptroot]; Sentosa, close to the ferry, on trunk of broad-leved tree, 1980, *Tibell 8846, 8847* [UPS L-057789, L-057790]; ibidem, on trunk of *Tamarindum indica*, 1980, *Tibell 8849* [UPS L-057792].

Pyxine farinosa Kashiw. – (3a) in *S 45643* [B, SING] (= *Cryptothecia scripta*), *S 45644* [B]: (3aj) *S 45798* [SING]; (8) *ST 46068* [B, SING]; (14c) *ST 46281* [SING]; Pulau Terkukor, 1960, *Burkill 2566* [SING]; 1949, *Lemaitre* [SING]; St. John's Island, 1989, *Aptroot 26001* [Hb. Aptroot]; Kusu Island, 1989, *Aptroot 25965* [Hb. Aptroot].

Ramonia microspora Vězda – (14) *ST 46350* [SING].

Rinodina cinereovirescens (Harm.) Zahlbr. – (14) *ST 46265* [B, SING].

Rinodina oxidata (A.Massal.) A.Massal. – (14) *ST 46267* [B, SING].

TLC: atranorin, gyrophoric acid.

Sarcographa concisa (Kremp.) Zahlbr. – ad cortices, *Beccari 262* [M, not seen; Redinger, 1936:108; Krempelhuber, 1875: 31, 61 as *Graphis concisa*].

This record needs reinvestigation to establish its current taxonomic position.

Sarcographa heteroclita (Mont.) Zahlbr. – (3q) *S 45712* [B, SING]; (3af) *S 45780* [SING]; (5e) *ST 45892* [SING]; (10) *SMT 46115* [B, SING]; (11) *SMT 46213* [B, SING].

Two specimens have pycnidia and lack ascocarps, *45780* and *45712*; conidia 5-6 x 0.5 μm, slightly curved. TLC: stictic, tr. hypostictic acid (*45892, 46115*); stictic acid (*46213*).

Sarcographa labyrinthica (Ach.) Müll.Arg. – (5e) *ST 45896* [SING], *45911* [B]; (10) *SMT 46117* [B, SING]; (14e) *ST 46304* [SING]; Bukit Timah, 1959, *Burkill 2172* [SING]; on Betel-palms, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 59 as *Glyphis*]; Vega expedition, corticola, 1879, *Almquist*

[Nylander, 1891: 25 as *Glyphis*; Redinger, 1936: 107]; Pulau Pinang, ad corticem, *Beccari 241* [Krempelhuber, 1875: 62 as *Glyphis labyrinthica* var. *insulata*]; Nee Soon forest reserve, tropical forest remnant, on bark of *Macaranga*, 1980, *Tibell 8826* [UPS L-057776].

TLC: stictic, tr. cryptostictic acids (*45896, 46304*).

Sarcographa lactea Müll.Arg. – *Beccari 241* [M, not seen; Redinger 1936: 109].

This record needs reinvestigation to establish its current taxonomic position.

Sarcographa protracta (Kremp.) Zahlbr. – Pulo Pinang, ad cortices, *Beccari 242* [M, not seen; Redinger, 1936: 110; Krempelhuber, 1875: 63 as *Acanthoglyphis*, type description].

This record needs reinvestigation to establish its current taxonomic position. Probably this is not a Singapore record.

Sarcographa ramificans (Kremp.) Staiger – (5e) *ST 45914* [B, SING]; (10a) *SMT 46162* [B, SING]; ad cortices, *Beccari 268* [Krempelhuber, 1875: 61 as *Graphis*]; Nu Soon Forest Reserve, tropical forest remnant, on trunk of *Macaranga*, 1980, *Tibell 8807, 8825* [UPS L-057765, L-057775]; Vega expedition, corticola, 1879, *Almquist* [H, not seen; Nylander, 1891: 25 as *Glyphis duodenaria*, type description; Redinger, 1936: 112, as *S. heteroclita* var. *duodenaria*].

TLC: stictic acid (*46162*).

Sarcographa tricosa (Ach.) Müll.Arg. – on Betel-palms, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 58 as *Medusula*]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 25 as *Medusula*].

Sarcographina glyphiza (Nyl.) K.Singh & Awasthi – (3o) *S 45695* [B, SING]; (3v) *S 45720* [SING]; (3y) *S 45734* [B]; (3ab) *S 45760* [B, SING]; (3ai) *S 45796* [SING]; (4) *S 45831* [B]; (6) *SF 46088* [SING]; (14c) *ST 46284* [B]; (14e) *ST 46303* [SING]; Singapore Botanical Garden, on *Harpullia zanguebarica*, 1980, *Tibell 8883* [UPS L-057816]; ad corticem *Arecae*, *Maingay* [H, not seen; Redinger, 1936: 113 as *Sarcographina gyrizans*]; on Betel-palms, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 59 as *Glyphis circumplexa*, type description; Nylander, 1891: 25 as *Glyphis circumflexa*].

TLC: stictic, tr. cryptostictic acids (*45695, 45760, 46088*). This species is not treated by Staiger (2002), and its generic position in the new systematic arrangement of Graphidaceae seems unsettled.

Sclerophyton dendrizans (Nyl.) Zahlbr. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 23 as *Chiodecton*, type description; Redinger, 1936: 117].

This record needs reinvestigation to establish its current taxonomic position. Sparrius (2004) suggests its affinity to *Phaeographis* but did not investigate the type.

Septotrapelia triseptata (Hepp) Aptroot – Economic Gardens, 1920, *Hippance 5935* [SING]; Reformatory Road, 1920, *Chipp 6191* [SING].
***Sporopodium* sp.** – (10b) *SMT 46198* [B, SING]; (14f) *ST 46360* [B, SING]; (17a) *ST 46388d* [B, SING]; Nee Soon forest reserve, tropical forest remnant, on leaves of *Nephelium lappaceum*, 1980, *Tibell 8803* [UPS L-057764].

The specimens have campylidia and no apothecia, and cannot be identified with certainty at species level. The may belong to more than one species.

Stegobolus berkeleyanus Mont. – (6) *SM 45947* [B, SING].
Stegobolus croceoporus (Hale) A.Frisch – (10) *SMT 46131* [SING].
Strigula concreta (Fée) R.Sant. – (5e) *ST 45944* [B, SING]; (6a) *SF 46111* [SING]; (14f) *ST 46357* [B, SING].
Strigula* vs. *nemathora Mont. – (6a) *SF 46109* [B]; (10b) *SMT 46201* [SING].

The identification is tentative because the specimens are in poor condition.

Strigula nitidula Mont. – (1a) *SM 45441f* [B, SING]; (6a) *SF 46110* [B, SING]; (10b) *SMT 46200* [B, SING].

The identification of *46110* is tentative because it contains only pycnidia.

Strigula orbicularis Fr. – (1a) in *SM 45441f* [B, SING] (= *Strigula nitidula*); (15) *SM 46364* [B, SING].
Strigula smaragdula Fr. – (1a) *SM 45441d* [B, SING]; 1879, *Almquist 38* [S, not seen; Santesson, 1952: 169 as *S. elegans*].
***Strigula* sp.?** – Vega expedition, foliicola, 1879, *Almquist* [Nylander, 1891: 26 as *Strigula actinoplaca*].

This record needs reinvestigation to establish its current taxonomic position.

Syncesia* cf. *glyphisoides (Fée) Tehler – (14) *ST 46345* [B, SING].

TLC: lichexanthone, traces.

***Thalloloma* sp. A** – (6) *SM 45959* [B, SING].

TLC: indet. substance.

Thelidium quinqueseptatum (Nyl.) Arnold – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 26 as *Verrucaria*, type description.
Thelotrema aggregatum (Hale) Hale – Nee Soon Forest Reserve, tropical forest remnant, on bark of *Gonystylis*, 1980, *Tibell 8820* [UPS L-057774].
Thelotrema diplotrema Nyl. – (5e) *ST 45902* [B, SING].

TLC: none.

Thelotrema isidiophorum (Kremp.) Zahlbr. – ad cortices, *Beccari 264* [Krempelhuber, 1875: 43, 60 as *Ascidium*; Krempelhuber, 1877: 134 as *Ascidium*].
Thelotrema santessonii Hale – (10) *SMT 46120* [B, SING].

TLC: stictic acid.

***Thelotrema* sp. A** – Nee Soon Forest Reserve, tropical forest remnant, on bark of *Garcinia*, 1980, *Tibell 8809* [UPS L-057766].

***Thelotrema* sp. B** – (4) *S 45822* [B, SING].

Ascospores muriform, hyaline, 8/ascus, ca. 60 x 20 µm, I-negative.

Thysanothecium scutellatum (Fr.) D.J. Gallow. – (3p) *S 45707* [B, SING]; (3ap) *S 45813* [B, SING]; (14c) *ST 46293* [B, SING].

TLC: divaricatic acid (*45813, 45707*).

Trapelia* cf. *involuta (Tayl.) Hertel – (3) *S 45814* [SING].

***Tricharia* sp.** – (5e) in *ST 45942* [SING] (= *Anisomeridium throwerae*); (10b) *SMT 46188* [SING]; ad folia coriacea, *Beccari 232a, 269d* [Krempelhuber, 1875: 64 as *T. orbicularis*, type description; Santesson, 1952: 379].

The new collections lack apothecia.

Trypethelium deformis Makhija & Patwardhan – 1861-1865, *Maingay 165* [BM holotype, not seen; Makhija and Patwardhan, 1992: 240].

Trypethelium eluteriae Spreng. – (2b) *S 45531* [B, SING]; (2e) *S 45588* [SING]; (2f) *S 45606* [B, SING]; (2g) in *S 45630* [SING] (= *Lecanora helva*); (3) *obs.*; (7) *ST 46020* [SING], *46022* [SING]; (14) *ST 46338* [SING]; (14a) *ST 46272* [B]; (18) in *ST 46405* [SING] (= *Trypethelium subeluteriae*); Fort Canning Park, 1989, *Aptroot 25957* [Hb. Aptroot]; nahe der Philippinischen Botschaft, 1999, *Schumm & Schwarz* [Hb. Schumm 5850].

The colour of *46272* suggests that it has a deviating pigment composition.

Trypethelium epileucodes Nyl. – (3) *S 45655* [SING]; (3g) *S 45659* [B]; (3o) *S 45693* [B]; (3aa) *S 45739* [SING]; (5e) *ST 45885* [B, SING], *45924* [SING]; (8) *ST 46061* [SING]; (10) *SMT 46116* [SING]; (10a) *SMT 46150* [B, SING], *46154* [SING]; Bukit Timah nature reserve, 1989, *Aptroot 25993* [Hb. Aptroot].

Trypethelium* cf. *platystomum Mont. – (2b) *S 45533* [B, SING]; (2e) *S 45595* [SING]; (2f) *S 45605* [B]; (8) *ST 46060* [SING]; (13) *S 46242* [SING]; (14) *ST 46344* [B]; (14e) *ST 46311* [B]; (18) *ST 46405* [SING].

Trypethelium stramineum Kremp. – ad corticem, *Beccari 246* [Krempelhuber, 1875: 63].

This record needs reinvestigation to establish its current taxonomic position.

Trypethelium straminicolor Nyl. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 26].

This record needs reinvestigation to establish its current taxonomic position.

Trypethelium tropicum (Ach.) Müll.Arg. – (1b) in *SM 45452* [B, SING] (= *Graphis caesiella*); (1g) *SM 45488* [B, SING]; (2b) *S 45522* [B, SING]; (2e) in *S 45595* [SING] (= *Trypethelium subeluteriae*) (no spores); (3k) in *S 45668*

[B, SING] (= *Enterographa pallidella*); (3q) *S 45711* [B, SING]; (3av) *S 45842* [SING]; (5e) in *ST 45904* [B, SING] (*Pyrenula aspistea*) (no spores); (8) in *ST 46060* [SING] (= *Trypethelium subeluteriae*) (no spores); (13) *obs.*; (13a) *S 46223* [SING]; (18) *ST 46406* [B, SING]; Fort Canning Park, 1989, *Aptroot 25956* [Hb. Aptroot]; on wild Lime-trees, 1861-1865, *Maingay* [Nylander and Crombie, 1884: 60 as *Verrucaria*; Nylander, 1891: 25 as *Verrucaria*]; nahe der Philippinischen Botschaft, 1999, *Schumm & Schwarz* (Hb. Schumm 6689); Botanical Garden, on trunk of *Pangium edule*, 1964, *Degelius As-497* [UPS L-056602]; crossing Oxley Road/Oxley Rise, roadside trees, 1994, *Diederich 12224* [Hb. Aptroot].

Trypethelium variolosum Ach. – (2b) *S 45532* [B, SING], *45538* [B, SING]; (3) *S 45656* [B]? (no spores; c. pycn.); (3q) *S 45710* [B, SING]; (3ab) *S 45746* [SING], *45747* [B]; (3ad) *S 45774* [SING]; (3ah) *S 45787* [SING]; (5e) *ST 45888* [B]; (13) *S 46241* [B]; (14c) *ST 46294* [SING]; (18) *ST 46403* [B], *46404* [B, SING]; Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 26 as *T. ochroleucum*].

***Trypethelium* sp. A** – Sentosa, along the southern shore, on trunk, 1980, *Tibell 8860* [UPS L-057802].

***Tylophoron* sp.** – (1h) *SM 45493* [B, SING].

The specimen lacks ascocarps and contains thalloconidia.

Verrucaria mundula P.M.McCarthy – (1i) *SM 45500* [B, SING].

***Vezdaea* sp.?** – (2) *S 45586* [B, SING].

The specimen has immature ascocarps without spores and the identification is therefore uncertain.

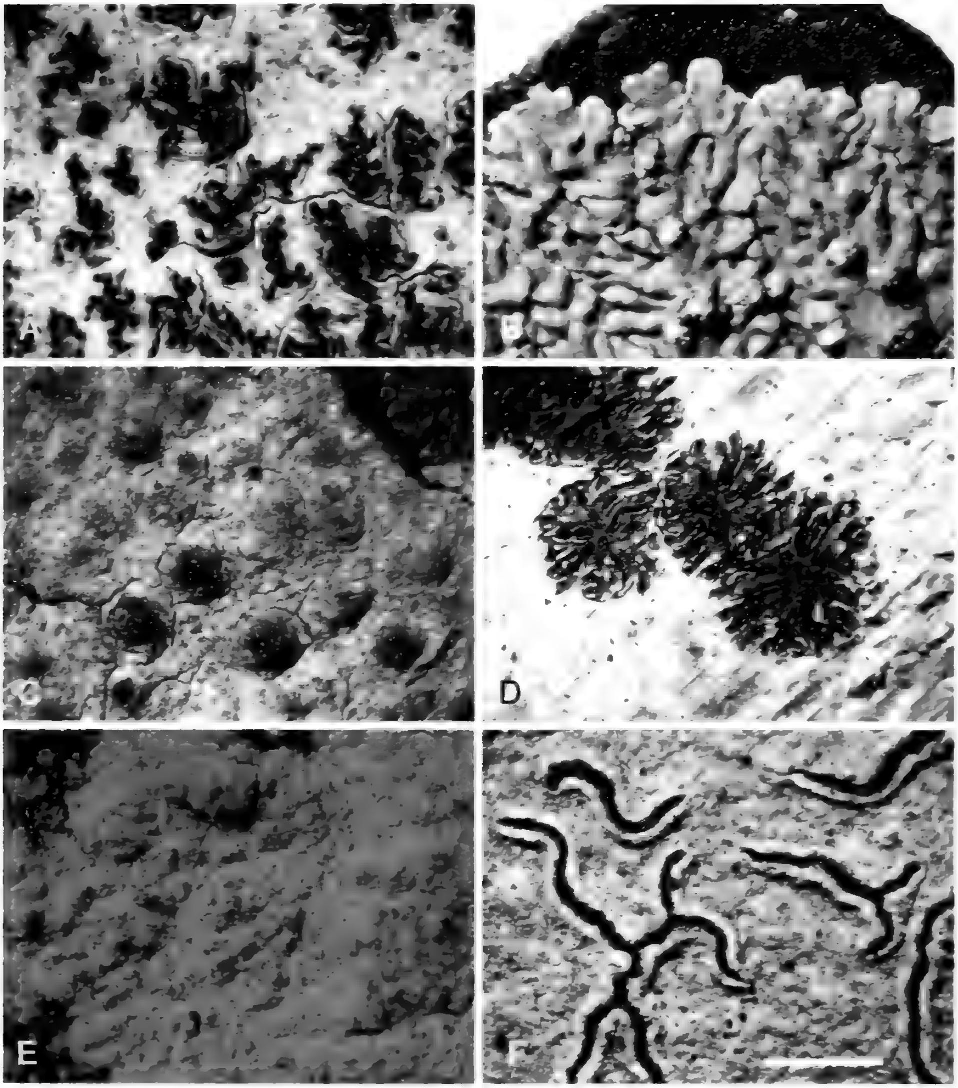

Figure 1. Some of the commonest lichens in Singapore. A. *Arthonia catenatula* (*SM 45498*); B. *Dirinaria picta* (*SM 45454*); C. *Pyrenula ochraceoflava* (*S 45499*); D. *Phaeographis intricans* (*ST 46283*); E. *Chrysothrix xanthina* (*S 45603*); F. *Graphis insulana* (*S 45679*). Scale for all: bar = 1 mm.

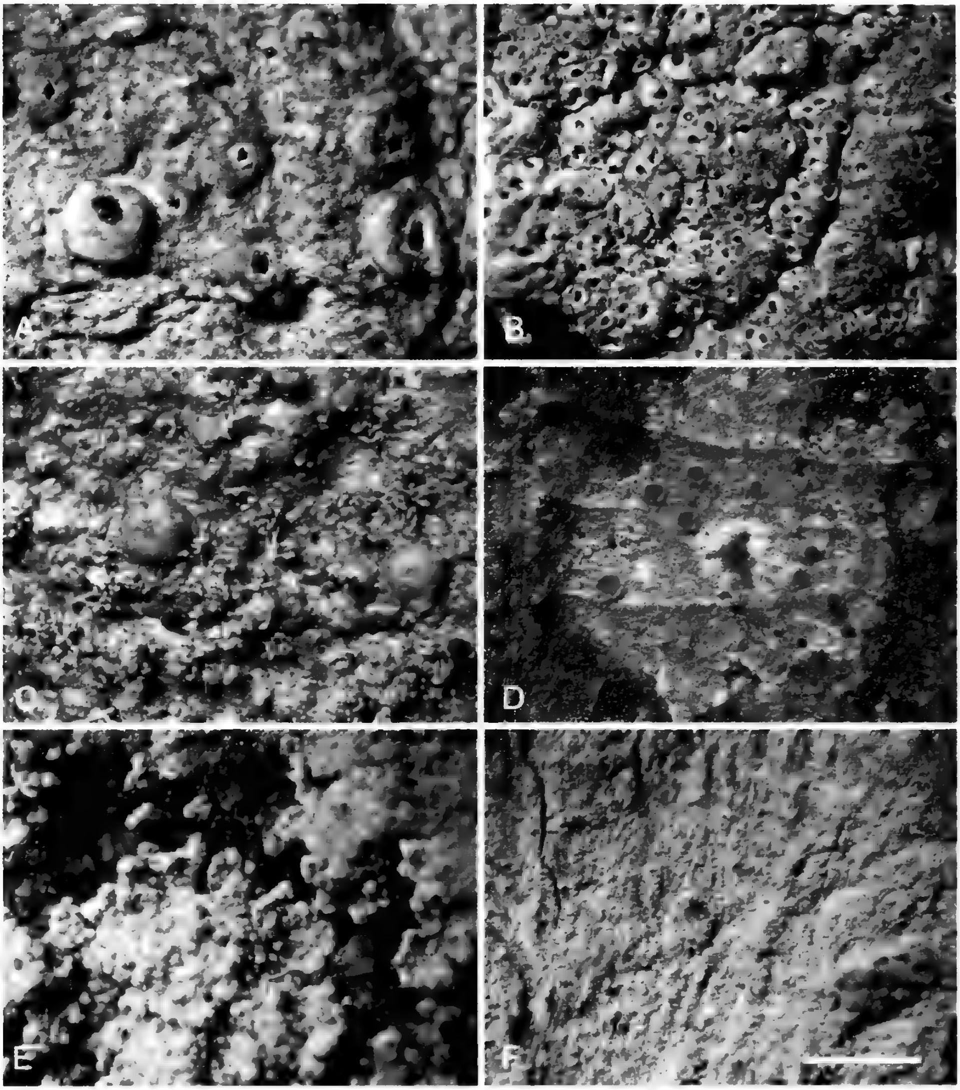

Figure 2. A-C. Forest-inhabiting lichens. A. *Ocellularia crocea* (*ST 45905*); B. *Myriotrema subconforme* (*S 45646*); C. *Porina tetracerae* (*ST 45919*). D. *Chroodiscus australiensis*, a foliicolous lichen (*SMT 46193*). E-F. Two lichen species recently described from Singapore. E. *Lepraria usnica* (*S 45651*); F. *Herpothallon granulare* (*SM 45490*). Scale for all: bar = 1 mm.

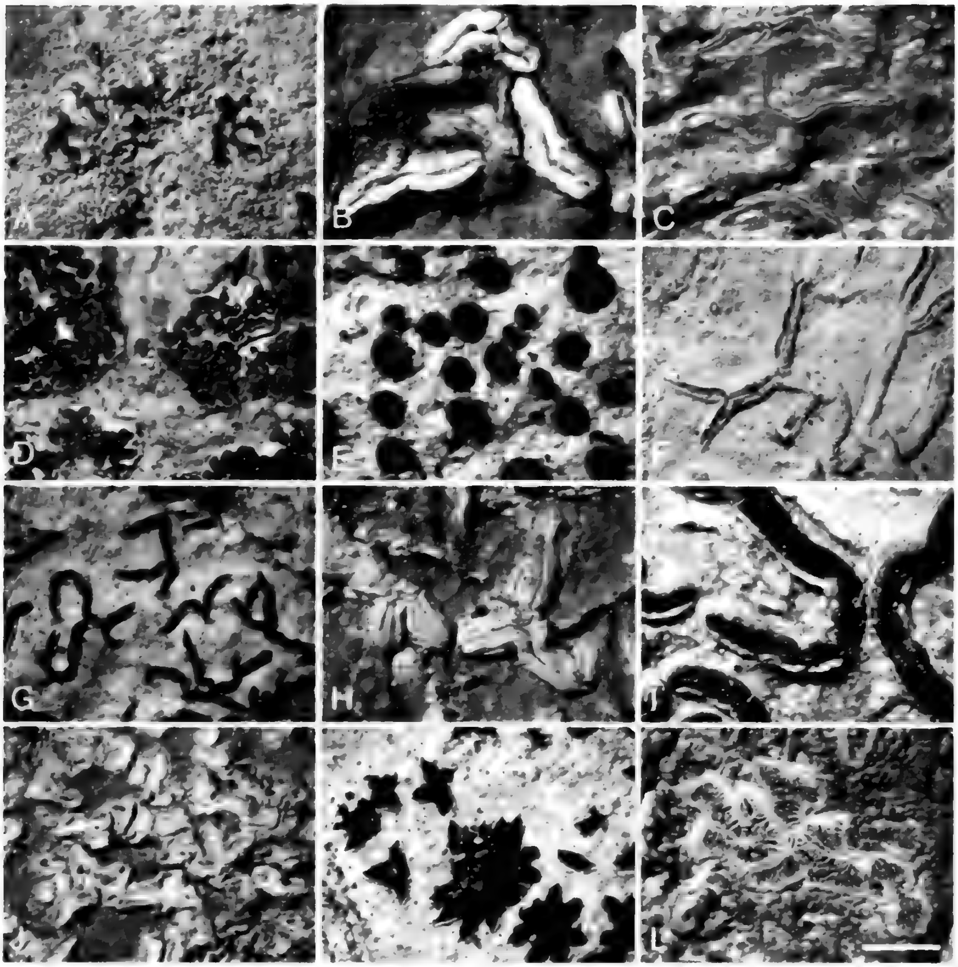

Figure 3. Diversity of Graphidaceae in Singapore. A. *Diorygma rufopruinosum* (*SM 46373*); B. *Dyplolabia afzelii* (*S 45697*); C. *Fissurina* cf. *dumastii* (*S 46456*); D. *Glyphis cicatricosa* (*S 45785*); E. *Glyphis scyphulifera* (*S 46220*); F. *Graphis glaucescens* (*S 45562*); G. *Graphis librata* (*SM 45462*); H. *Pallidogramme chrysenteron* (*ST 46274*); I. *Phaeographina prosiliens* (*SM 46155*); J. *Phaeographis caesioradians* (*ST 46029*); K. *Phaeographis punctiformis* var. *nylanderi* (*S 46234*); L. *Sarcographa heteroclita* (*SMT 46115*). Scale for all pictures: bar = 1 mm.

Synonyms used in published records

Acanthoglyphis protracta Kremp. = *Sarcographa protracta.*
Arthonia aleurella Nyl. = *Cryptothecia aleurella.*
Arthothelium aleurellum (Nyl.) Zahlbr. = *Cryptothecia aleurella.*
Ascidium croceum Kremp. = *Ocellularia crocea.*
Ascidium interponendum Nyl. = *Ocellularia interponenda.*
Ascidium isidiophorum Kremp. = *Thelotrema isidiophorum.*
Ascidium majorinum Nyl. var. *longius* Nyl. = *Ocellularia nylanderiana.*
Ascidium orthomastium Kremp. = *Ocellularia orthomastia.*
Ascidium triglyphicum Kremp. = *Ocellularia triglyphica.*
Ascidium xanthostromizum Nyl. = *Ocellularia xanthostromiza.*
Buellia efflorescens Müll.Arg. = *Amandinea efflorescens.*
Chiodecton dendrizans Nyl. = *Sclerophyton dendrizans.*
Coccocarpia ciliolata Mont. = *Coccocarpia erythroxyli.*
Cryptothecia granularis Sipman = *Herpothallon granulare.*
Dichodium byrsinum (Ach.) Nyl. = *Physma byrsaeum.*
Graphis afzelii Ach. = *Dyplolabia afzelii.*
Glyphis circumflexa Nyl. (misspelling for "*circumplexa*") = *Sarcographina glyphiza.*
Glyphis circumplexa Nyl. = *Sarcographina glyphiza.*
Glyphis duodenaria Nyl. = *Sarcographa ramificans.*
Glyphis labyrinthica Ach. = *Sarcographa labyrinthica.*
Glyphis labyrinthica var. *insulata* Kremp. = *Sarcographa labyrinthica.*
Graphis atroalba Kremp. = *Dyplolabia afzelii.*
Graphis chrysentera Mont. = *Pallidogramme chrysentera.*
Graphis circumscripta Kremp. = *Phaeographis circumscripta.*
Graphis concisa Kremp. = *Sarcographa concisa.*
Graphis ramificans Kremp. = *Sarcographa ramificans.*
Graphis singaporina Nyl. = *Carbacanthographis candidata.*
Graphis subrigida Nyl. = *Phaeographina subrigida.*
Gyalecta lutea Dicks. = *Coenogonium luteum.*
Lecanactis diversa Nyl. = *Phaeographis diversula.*
Lecanactis flexans Nyl. = *Phaeographina flexans.*
Lecanactis flexuosa Nyl. = *Platygramme flexuosa.*
Lecanactis serpentosa Nyl. = *Phaeographis maeandrata.*
Lecanactis subrigida (Nyl.) Nyl. = *Phaeographina subrigida.*
Lecanora epiphylla Auct., non Fée = *Byssoloma tricholomum.*
Lecanora punicea Ach. = *Haematomma* sp.
Lecidea parvifolia Pers. var. *fibrillifera* Nyl. = *Phyllopsora parvifolia*?
Lecidea rubello-virens Nyl. = *Bacidia rubellovirens.*
Lecidea sophodina Nyl. = *Lopadium sophodinum.*

Medusula tricosa (Ach.) = *Sarcographa tricosa.*
Opegrapha phyllobia auct., non Nyl. = *Opegrapha vegae.*
Pannaria pannosa (Sw.) Nyl. = *Parmeliella pannosa.*
Parmelia praesorediosa Nyl. = *Parmotrema praesorediosum.*
Parmelia tinctorum Despr. = *Parmotrema tinctorum.*
Phaeographina flexuosa (Nyl.) Müll.Arg. = *Platygramme flexuosa.*
Physcia picta (Sw.) Nyl. = *Dirinaria picta.*
Physcia picta (Sw.) f. *sorediata* (Hepp) = *Dirinaria applanata.*
Sarcographa heteroclita (Mont.) Zahlbr. var. *duodenaria* (Nyl.) Redgr. = *Sarcographa ramificans.*
Sarcographina gyrizans (Leight.) Müll.Arg. = *Sarcographina glyphiza.*
Strigula actinoplaca Nyl. = *Strigula* sp.?
Strigula elegans (Fée) Müll.Arg. = *Strigula smaragdula.*
Thelotrema cavatum Ach. = *Ocellularia cavata.*
Thelotrema dolichotatum Nyl. = *Ocellularia dolichotata.*
Thelotrema olivaceum Mont. = *Ocellularia terebrata.*
Thelotrema terebratum Ach. = *Ocellularia terebrata.*
Thelotrema terebratum Ach. f. *subeminescens* Nyl. = *Ocellularia terebrata* f. *subeminescens.*
Tricharia orbicularis Kremp. = *T.* sp.
Trypethelium ochroleucum Eschw. = *Trypethelium variolosum.*
Trypethelium ochrothelizum Nyl. = *Astrothelium ochrothelizum.*
Trypethelium platystomum Mont. = *Pyrenula anomala.*
Verrucaria aggregata Fée = *Pyrenula anomala.*
Verrucaria augescens Nyl. = *Polyblastiopsis augescens.*
Verrucaria monocarpa Kremp. = *Porina monocarpa.*
Verrucaria quinque-septata Nyl. = *Thelidium quinqueseptatum.*
Verrucaria santensis Tuck. var. *murina* Kremp. = *Pyrenula* sp.
Verrucaria tropica Ach. = *Trypethelium tropicum.*

Rejected records

Collema flaccidum Ach. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 17]. Erroneous record (Degelius, 1974), perhaps mistake for *C. leptaleum.*

Parmelia dilatata Vain. – *Johnson A-109* [US, not seen; Hale, 1965: 247]. This record needs reinvestigation, it was given in a study (Hale, 1965) where the similar *Parmotrema gardneri* was not recognized and most probably it represents that species.

Parmelia perforata Ach. – Vega expedition, corticola, 1879, *Almquist* [Nylander, 1891: 18]. This record needs reinvestigation to establish its current taxonomic position, the species name has been much misapplied.

List of collectors of Singapore lichens

Ernst ALMQUIST: Vega expedition; 1879; collections in S, H-Nyl.
André & Mariette APTROOT: Nrs. 25950-26005?, 21-31 June 1989; collections in Herb. Aptroot.
O. BECCARI: collections in M.
H. M. BURKILL: Nrs. 2139, 2171-2180?, 2566; dd. 1959, 1960; collections in SING.
T. R. CHIPP: Nr. 4915, 5801, 6191; dd. 1919-1920; collections in SING.
Gunnar DEGELIUS: Nrs. As 485-497?; 25-26 Mar. 1964; collections in UPS.
Paul DIEDERICH: 1994; in Hb. Diederich.
FARIDA: NUS student collaborator with H. Sipman.
HARMAND (?): collections in M.
JOHNSON: Nr. A-109; collection in US.
KIAH: Nr. 5846, 6038; 1920; collection in SING.
Aino M. LEMAITRE ("Lamaitre"): 1949; collections in H, SING.
Benjamin LEE: 2000; collections in SING.
A. C. MAINGAY: 1861-1865; collections purchased by Sir Joseph Hooker, now in BM?, pp. in H-Nyl.?
H. MÖLLER: collections in S, TUR.
D. H. MURPHY: collaborator with H. Sipman.
M. NOOR: Nr. 5663; 1920; collection in SING.
H. N. RIDLEY: Nr. A 54; 189x; collections in SING.
G. RIDORET: Nr. 5657; 1920; collection in SING.
Felix SCHUMM: 199; Hb. Schumm
Uwe SCHWARZ: collaborator with F. Schumm.
Harrie J. M. SIPMAN: Nr. 45661-46412; 4-25 Nov. 2000; collections in B, SING.
Benito C. TAN: 2000; collections in SING; collaborator with H. Sipman.
Leif TIBELL: Nrs. 8800-8872?, 13925; 16-18 Sept. 1980, 5 Oct. 1983; collections in UPS.

Discussion

The list of lichen species reported for Singapore contains 296 taxa. A discussion of the significance of this biodiversity is given in Sipman (2009). However, the figure is only preliminary. On one hand it contains some old reports, which need verification and may turn out to be synonyms of other listed species. On the other hand there are several dozens of samples are left unidentified and may well represent another 25 species. Many are vegetatively reproducing thalli without ascocarps to help establish their affinity. Some very characteristic and frequent types have recently been described as new species (Sipman, 2003): *Lepraria usnica*, *Cryptothecia granularis* (cf. Table 3), but many less frequent forms without clear affinities are still awaiting treatment. Also some of the better sites in Singapore could be rewarding for additional investigation, e.g., the Nee Soon swamp. Moreover, at least 84 species are identified with certainty to genus level only. This suggests that the currently documented lichen diversity of Singapore amounts to over 300 species, perhaps even 325. Remarkably 68 taxa were found only before 1985. In view of the much more intense sampling during the author's field work in Singapore, it is unlikely that so many species have been overlooked. This leaves the suggestion that many may have become extinct in the meantime (for discussion see Sipman in prep.), so that the currently present figure may be only 250 species.

For an impression of the distribution of the lichens within Singapore, the species numbers per locality are compared in Table 5. It shows that the Botanical Garden is the most important habitat for lichens in Singapore. The importance of botanic gardens for lichen diversity is a common feature in urbanized areas, and was observed also in, e.g., Berlin (Sipman and Aptroot, 2008). Also the ecologically rather stable and varied landscape of Pulau Ubin appears favorable for lichens. Among the areas with primary forest relics, the Nee Soon swamp is clearly better than Bukit Timah. Notably poor in lichens are the rainforest remnant in the Botanical Garden, the Bukit Brown Cemetery, and the abandoned quarry at Bukit Timah. Cemeteries and abandoned quarries are often sites with high lichen diversity, but apparently not in Singapore.

When looking at the numbers of species found only once (Table 5, third column), the sequence changes slightly. Nee Soon Swamp comes on the first place. This depends mainly on the many foliicolous lichens (specialized for growing on leaves) that have been found only here. Also the NUS campus ranks higher, probably because more time was involved in the study of its lichen flora than elsewhere, so that more rare or inconspicuous species were found.

Table 5. Number of lichen species and of unique finds per locality.

Singapore Botanical Garden	81	10
Pulau Ubin (island E of Singapore)	74	12
Nee Soon (nature reserve with swamp forest)	61	17
MacRitchie Reservoir (secondary forest)	57	7
Bukit Timah (primary forest relic)	51	4
NUS university campus	48	9
Sungei Buloh (nature reserve)	41	5
Fort Canning Park (city park)	41	4

Lazaro Island (small island S of Singapore)	33	3
Labrador Park (at the coast, W-side)	27	2
Sembawan Park (near the coast, E-side)	25	2
Kusu Island (small island S of Singapore)	24	2
Lower Peirce Reservoir (secondary forest)	16	1
Botanical Garden - Rainforest (primary forest relic)	15	2
Bukit Brown Chinese Cemetery	8	3
Bukit Timah quarry	3	1

Most lichens were observed on free standing trees, mostly in parks. Foliicolous lichens were observed mostly in Nee Soon, and less commonly in other forest remnants. Saxicolous lichens, so common in the cold climatic zones of the world, are very uncommon in Singapore. Only occasionally a few thalli were found on hard, crystalline stone, on anthropogenic occurrences. Concrete, now so common as constructing material, is usually devoid of lichens; these were found only occasionally in half-shade situations, perhaps depending on a certain degree of weathering. It could be speculated that increased weathering and arrival of new immigrant species will cause an increase in the number of saxicolous species.

Special attention was paid to the relation with phorophytes (supporting trees). However, the high number of different tree species involved makes any correlation insignificant. Nevertheless the information is presented in the species list to make it available for monitoring of future changes in the lichen growth. With this purpose also the tree numbers in the Singapore Botanical Garden have been added. The observations confirm the great significance of SBG for the maintenance of biological diversity in Singapore. Not only it houses a higher number of species than any other site, for many interesting species it appears to be the only site, like *Chiodecton leptospermum*, *Crocynia pyxinoides*, *Enterographa subserialis*, and *Jamesiella perlucida*.

Acknowledgements

The generous support provided by Dr. B.C. Tan (at NUS then) is to be mentioned first here. He suggested the project, kindly arranged many details of the study visit, including the required financial resources, and provided research facilities. P.-M. Jörgensen kindly allowed publishing his identification of *Lecidopyrenopsis*, D. Ertz his *Opegrapha* identifications (all except *O. vegae*). For loan of specimens, A. Aptroot, P. Diederich, F. Schumm and the curators of SING and UPS are gratefully acknowledged. Prof. C.H. Murphy and Ms Farida kindly provided fieldwork support and pleasant company. The National Parks Board and Singapore Botanic Gardens helpfully provided the necessary permits for the fieldwork and the

Raffles Museum for Biodiversity Research (RMBR) enabled the project by giving the financial support.

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A Checklist of *Merremia* (Convolvulaceae) in Australasia and the Pacific

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Abstract

A checklist of *Merremia* species is presented for Australasia and the Pacific. In total, 49 species are enumerated here. Total numbers of species are estimated by region and for the genus as a whole. Comments on the systematics and taxonomy of the genus are reported and several problematic species complexes are identified. An index of numbered specimens examined is included to facilitate curation and identification of herbarium specimens.

Introduction

The generic name *Merremia* was published as a *nomen nudum* by Dennstedt (1818: 12, 23, 34) and several modern floras attribute the valid publication of the name to Hallier (1893). Validation was provided substantially earlier, however, by Endlicher (1841) and both *Index Nominum Genericorum* and the current International Code of Botanical Nomenclature note this fact, as well as the status of *nomen conservandum* for *Merremia*. The genus has been recognized at times, and merged into *Ipomoea* at other times, ever since the concept was first established. Following the publication of Hallier's (1893) classification for the family, in which he noted a pollen difference between *Ipomoea* (spinulose pollen grains) and *Merremia* (non-spinulose grains) that was given considerable importance in recognizing subfamilial and tribal groupings, the genus *Merremia* gradually gained wider acceptance and by the mid-twentieth century was almost universally accepted in floras world-wide.

Recent molecular analysis (Stefanovic *et al.*, 2002, 2003) strongly indicates that *Merremia* is a polyphyletic genus, a fact that was already suggested by a comprehensive survey of pollen morphology (Ferguson *et al.*, 1977). In a family where one, or at most two, pollen types are typical for a genus, the five pollen types documented for *Merremia* are indicative that the genus is a mixed assemblage of species.

Merremia has long proven to be difficult to characterize as a genus, with no single morphological character that can be used to recognize it. O'Donell (1941) proposed infrageneric groupings based on his revision of the American species; these sections were adopted by Van Ooststroom and Hoogland (1953) for Malesia, with the addition of one new section, *Wavula*. Later, two species with non-spinose, pantoporate pollen grains were segregated from *Merremia* as the new genus *Xenostegia* (Austin & Staples, 1980); although this genus has not been universally accepted, particularly in African floras, the molecular data supports the segregation and indicates that *Xenostegia* is sister group to the genus *Hewittia* (Stefanovic *et al.*, 2002). A thorough revisionary study is needed to elucidate just how many genera ought to be recognized from the polyphyletic *Merremia* and its closest allies (*Operculina, Hewittia, Remirema, Decalobanthus*) once their relationships are better understood. Until that is possible, an enumeration of the Asian species heretofore included in *Merremia* will provide a useful reference as well as a starting point for further study. And to put the Asian species in context, the species recognized elsewhere in the world must be considered.

The number of species of *Merremia* has been variously estimated in the botanical literature at *ca* 70 (Mabberley, 1997; Staples and Brummitt, 2007) or *ca* 80 (Van Ooststroom and Hoogland, 1953; Verdcourt, 1963; Airy Shaw, 1980; Fang and Staples, 1995; Deroin, 2001; Meeuse and Welman, 2000; *inter alia*). However, these estimates have always seemed too low and it was decided to tabulate the species world-wide to see how many are currently recognized. Tabulation of the accepted names used in recent literature (see Appendix for list of literature consulted) via an Excel® spreadsheet allowed for geographic distribution to be compared and synonyms to be reconciled. Once redundancy in the list was eliminated, there are 27 unique species in the Americas, 31 species in Africa (including Madagascar), just 3 species in Australia, and 40 species in Asia/Malesia/Pacific. This brings the actual number of species to just over 100, which reveals there has been a sizable underestimate (by at least 20%) of the species richness in *Merremia*.

Checklist of Asian *Merremia* Species

The Asian and Pacific species are enumerated here – 49 in total – in alphabetical order by species name. Only selected synonyms relevant for the Asia/Malesia/Pacific regions are included. Excluded names and selected synonyms are listed at the end, to assist in cross-referencing to accepted names.

It has not been possible to produce a key for identification of all Asian species at the present level of knowledge, largely because several species are known only from the type gathering, or from few collections, that are not available for study. Problem groups have been discussed in the Notes sections; two principal complexes of intergrading taxa bear mentioning.

1. The Bornean endemics comprising *M. crassifolia/elmeri/gracilis/korthalsiana*

Van Ooststroom (1939), and later Van Ooststroom and Hoogland (1953), were able to clearly distinguish several species endemic to Borneo, based on the small number of collections available for study at that time. In the intervening decades, many more collections have been made, and the distinctions between species do not seem nearly so clear cut now. Certainly there are specimens in herbaria that are intermediate in their characters, and hence can't be identified precisely, though they do seem close to one or another of the species in this complex. Revisionary study is needed to elucidate the true relationships in this group.

2. The *M. bambusetorum/kingii/tonkinensis/umbellata* group

O'Donell (1941), in tropical America, and Van Ooststroom (1939), in Malesia, were able to sharply delineate *M. umbellata* from all other species of the genus that they studied; based on several characters they assigned *M. umbellata* to sect. Xanthips. However, on the continental Asian mainland, there are a number of additional species, all clearly referable to sect. Xanthips, and some of these named entities intergrade with *M. umbellata*. To date, attempts to resolve the intergradation at the floristic level have met with mixed success (Songkhla and Khunwasi, 1993); what is needed is a regional study of the entire complex, with careful comparison of all type specimens. For now, some observations and comments have been made in the Notes section to guide development of such a revisionary study.

Merremia Dennst. ex Endl., Gen. Pl. 1: 1403. 1841, *nom. cons.*

1. ***Merremia aegyptia*** (L.) Urban, Symb. Antillanae 4: 505. 1910.
Ipomoea aegyptia L., Sp. Pl. 162. 1753. – Type: *Herb. Linn. 218.35* (LINN); lectotype chosen by D.F. Austin, Fl. Ecuador 15: 84. 1982.
Syn.: *Convolvulus pentaphyllus* L., *nom. illeg.*; *I. pentaphylla* Jacq.; *Spiranthera pentaphylla* (Jacq.) Bojer; *Batatas pentaphylla* (Jacq.) Choisy; *Merremia pentaphylla* (Jacq.) Hallier f.; *C. nemorosus* Roem. & Schultes; *C. hirsutus* Roxb., *nom. illeg.*; *C. munitus* Wall. ex Wight.

Distribution: Pakistan, India, Vietnam, Australia, Hawaiian Islands (Kaua'i, O'ahu, Moloka'i, Lana'i, Maui, Kaho'olawe, Hawai'i). Native to tropical America and now widespread around the world as a weed.

Because *Convolvulus pentaphyllus* L. is an illegitimate name the first time the epithet *pentaphyllus* is taken up in another genus, in this case by Jacquin (1788), provides the first valid publication for it and all subsequent combinations of the epithet *pentaphyllus* are to be based on *Ipomea pentaphylla* Jacq.

Notes: Fosberg & Sachet (1977) reported this species from Micronesia based on a single collection, *D. Anderson 227*, with duplicates in several herbaria. However, the BISH duplicate of *Anderson 227* is *Ipomoea pes-tigridis* L. I have seen no authentic material of *M. aegyptia* from the Pacific Basin aside from the Hawaiian Islands, where it is well established (Wagner *et al.*, 1999).

2. ***Merremia aniseiifolia*** Ooststr., Blumea 12: 363. 1964.
Type: Indonesia, Irian Jaya, Kebar Valley, Andjai, *V.W. Moll BW9511* (holotype, L!; iso LAE, *n.v.*).

Distribution: New Guinea.

Notes: Known only from the type collection until quite recently, when a single additional collection was made. When Van Ooststroom described this species he commented that it resembles *M. tridentata*, a species now removed to the genus *Xenostegia* (see Excluded Species). It would be worthwhile examining the pollen of *M. aniseiifolia* to determine whether the resemblance is purely superficial, or whether this might be a third species of *Xenostegia*. It is a pity that most of the duplicates of the following collection have no flowers; only the Kew sheet had a single flower

Specimen examined: INDONESIA. Irian Jaya: NE Kepala Burung, between Sungai Apriri and Sungai Aremi, 11 May 1994, *M.J. Sands et al. 6544* (BISH!, K!, KEP!, SING!).

3. ***Merremia bambusetorum*** Kerr, Bull. Misc. Inform. 1941: 18. 1941.
Type: Thailand [SE], Trat, Khao Kuap, *Kerr 17704* (holotype, K!; isotype, BK!).

Distribution: Myanmar, Thailand, Vietnam.

Notes: Distinguishing *M. bambusetorum* from *M. kingii* and some forms of *M. umbellata* is quite difficult. It is possible that the holotype of *M. bambusetorum* is conspecific with one or more of the syntypes for *M. kingii*, which may be a mixed concept. Only careful comparison of all type specimens concerned will resolve the ambiguity in species concepts. It is possible that *M. caloxantha* belongs with this complex as well.

That said, this complex of three intergrading entities can immediately be recognized among Asian *Merremia* by the presence at the petiole base of tiny paired auricles that look very much like stipules. These can be hidden in the typically dense hair-cloth of *M. umbellata*, but are usually quite evident for *M. bambusetorum* and *M. kingii*.

4. ***Merremia bimbim*** (Gagnep.) Ooststr., Blumea 3: 343. 1939.
Ipomoea bimbim Gagnep., Not. Syst. (Paris) 3: 140. 1915. – Type: Vietnam, Hanoi Prov., near Vo-xa, *Bon 2700* (holotype, P, n.v.).

Distribution: Vietnam.

Notes: I have not seen the type specimen for this name nor any other collections of it. The species appears to be distinct and remains enigmatic.

5. ***Merremia boisiana*** (Gagnep.) Ooststr., Blumea 3: 343. 1939.
Ipomoea boisiana Gagnep., Notul. Syst. (Paris) 3: 141. 1915. – Types: Vietnam, montagnes de Cai-kinh, *Bois 138* (syntype, P!); mont Cha-pa, *Lecomte & Finet s.n.* (syntype, P!). Laos, vers Ken-trap, *Spire 1049* (syntype, P!); du Mékong à Hue, *Harmand 1827* (syntype, P!). See notes.
Syn.: *I. boisiana* var. *fulvopilosa* Gagnep., *I. boisiana* var. *rufopilosa* Gagnep., *Merremia boisiana* (Gagnep.) Ooststr. var. *rufopilosa* (Gagnep.) C.Y. Wu.

Distribution: China, Laos, Vietnam, Indonesia (Sumatra).

Notes. Floras for Malesia recognize two varieties: var. *boisiana* and var. *sumatrana* Ooststr., and floras for China and SE Asia recognize var. *boisiana* and var. *fulvopilosa* (Gagnep.) Ooststr. See Van Ooststroom and Hoogland (1953: 450) for a key to the Malesian varieties and Fang and Staples (1995: 299) for a key to the Chinese varieties.

In transferring the epithet to *Merremia*, Van Ooststroom (1939b: 344) excluded a fifth syntype cited by Gagnepain in the protologue, *Beccari 3594* from Borneo, and referred it to his new species *Merremia crassinervia* Ooststr. Chinese specimens differ from Malesian ones in several characters and it is possible that they are a different species. No taxonomic changes are initiated here until revisionary study clarifies relationships.

6. ***Merremia borneensis*** Merr., Univ. Calif. Publ. Bot. 15: 260. 1929.
Type: Malaysia, Sabah, Elphinstone province, Tawao, *A.D.E. Elmer 20990* (isotypes, A!, BO, F!, G!, GH!, K, MO(× 2)!, P, NY!, SING!, U).

Distribution: Malaysia (Peninsula, Sabah, Sarawak), Brunei, Indonesia (Kalimantan).

Notes: In herbaria, several other Bornean species are often confused with, and misidentified as, *M. borneensis*. The basal petiole attachment, medium-large flowers, and puckered, rugose leaf surface in dried material makes it distinctive.

7. ***Merremia bracteata*** P.S. Bacon, Bot. J. Linn. Soc. 84: 259. 1982.
Type: Solomon Islands, Kolombangara, near Poitete forestry camp, *P.S. Bacon 2* (holotype, K!; isotypes, BSIP, L!).

Distribution: Solomon Islands. Known from only two collections; apparently endemic.

Note: The general facies of this species comes very near to *Operculina ventricosa*, known from the Micronesian islands and the Caribbean (Staples, 2007). The similarity may be only superficial but requires investigation. A few South Pacific insular collections seen (New Caledonia, Vanuatu [Santo, Vaté]) appear intermediate between these two species bearing large, foliose, persistent inflorescence bracts.

Specimens examined: SOLOMON ISLANDS (Santa Cruz group). Vanikoro: secondary forest near Government House, Peou, 27 Mar 1963, *T.S. Whitmore BSIP 1613* (L!).

8. ***Merremia caloxantha*** (Diels) Staples & R.C. Fang, Novon 5: 109. 1995.
Ipomoea caloxantha Diels, Notes Roy. Bot. Gard. Edinburgh 5: 203. 1912. – Type: China, Yunnan: in valley of Mekong River, at crossing of Teng Yueh-Talifu road, *G. Forrest 1111* (holotype, E!).

Distribution: China, Laos, Vietnam.

Notes: An enigmatic species known, for most of the twentieth century, only from the type collection. A recent specimen from Laos has been tentatively identified as conspecific. Although the corollas on these SE Asian specimens are smaller than those on the holotype sheet, in all other characters (leaf shape and indumentum, calyx characters, corolla pubescence), they are a good match with the type specimen. The following collections document the distribution for *M. caloxantha*.

Specimens examined: CHINA. Yunnan: Nujiang Lisu Auton. Prefect., Lushui Xian, road from Man Hui village to Shanjiang, 3 Oct 1997, *Gaoli Gongshan Exped. 1997–9928* (E!); Szemao [=Simao], *A. Henry 13441* (E!, K!); valley of Mekong at the crossing of Teng Yueh–Dalifu road, Sep 1905, *G. Forrest 7111* (E!). PDR LAO. Khammouan Province: along tracks S of Ban Mak Phueang, 31 Oct 2005, *M.F. Newman et al. LAO-659* (E!). VIETNAM. Ho Yung Shan and vicinity, Tien-yen, 13 Oct-22 Nov 1940, *W.-T. Tsang 30645* (B!, BO!, C!, E!, L!).

9. ***Merremia calyculata*** Ooststr., Blumea 3: 265. 1939.
Type: Fiji, Puna, Jun 1860, *Seemann 324* (holotype, K!; isotype, BM!).

Distribution: Fiji, apparently endemic.

Notes: As suggested previously (Staples, 2009) *M. calyculata* may prove to be no more than a variant of the widespread and variable *M. pacifica*. One sterile specimen, for which the vernacular name, "wabula", was recorded by the collector, may belong here. Van Ooststroom (1939a: 265) recorded *wavula* as the vernacular name for *M. calyculata* and *veliyawa* for *M. pacifica*. It remains to be seen whether the difference in vernacular names reflects a genuine taxonomic distinction. Further collecting and field study of Fijian plants is needed to resolve whether one species or two is present.

Specimen examined: FIJI. Bequ: Rukua village, 21 July 1972, *M. Weiner MW-72-F-124* (BISH!).

10. ***Merremia cissoides*** (Lam.) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
Convolvulus cissoides Lam., Tab. Ency. 1: 462. 1793. – *Ipomoea cissoides* (Lam.) Griseb. – Type: French Guiana, Cayenne, *Leblond s.n.* (holotype, P-LA, n.v.; IDC microfiche 6207, 462: II. 4!).

Distribution: India (West Bengal), Sri Lanka, Papua New Guinea, and Thailand.
Note: Native to tropical America and increasingly naturalized in the Old World tropics.

11. ***Merremia clemensiana*** Ooststr., Blumea 3: 350. 1939.
Type: Malaysia, Sarawak, Kapit, upper Rejang River, *J. & M.S. Clemens 21133* (holotype, BO!; isotypes, A!, B!, BISH!, MO!, NY (×2)!, P!, SAR!).

Distribution: Malaysia (Sarawak, Sabah?).

Note: *Merremia clemensiana* is expected to be more widespread on Borneo than the few available collections would indicate. See the comments under *M. gracilis*.

12. ***Merremia cordata*** C.Y. Wu & R.C. Fang, Fl. Reipubl. Popularis Sin. 64(1): 163. 1979.
Type: China, Yunnan: Likiang, Cheli, *R.C. Ching 21660* (holotype, KUN, *n.v.; iso* A!).

Distribution: China (Sichuan, Yunnan).

Notes: The following collections have been examined and agree well with the description for the species.

Specimens examined: China. Yunnan: Ta-pin-tze, 2 Sep 1887, *J.M. Delavay 3073* (P(×3)!); Yung Ning, May 1933, *McLaren's collector 204* (K); sine loco or date, *G. Forrest 11121* (K!).

13. ***Merremia crassinervia*** Ooststr., Blumea 3: 350. 1939.
Type: Malaysia, Sarawak, Saribas, Paku, *Haviland & Hose 3523E* (holotype, L!), *3523K* (isotype, K!), *3523A* (isotype, SAR!).

Distribution: Malaysia (Sarawak), Indonesia (Kalimantan).

Notes: Van Ooststroom described this species from material that lacked mature flowers, thus the shape of the corolla remains imperfectly known. The inflorescence architecture and leaf venation characters he noted seem distinct but further comparative study is needed to correctly associate all stages in the life history.

14. ***Merremia davenportii*** (F. Muell.) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
Ipomoea davenportii F. Muell., Fragm. Phytogr. Austral. 6. 1868. – Type: Australia, [Northern Territory] hills of Davenport's Range, *J.M. Stuart s.n.* (holotype, MEL?, *n.v.*).

Distribution: Australia (Western Australia, Northern Territory).

Specimen examined: AUSTRALIA. Western Australia: near Hedland, Pippingarra Station, 20 Jun 1962, *R.D. Royce* 7492 (PERTH!).

15. ***Merremia dichotoma*** Ooststr., Blumea 3: 311. 1939.
Type: Indonesia, south middle Timor, Kolbano, S coast, *M.E. Walsh 375* (holotype, BO!; isotype, BO (×2)!, L!).

Distribution: Malesia (Timor).

Notes: Apparently rather rare; just two recent collections have come to light since the type gathering was made. The species bears an uncanny similarity to *M. hainanensis* (q.v.).

Specimens examined: INDONESIA. Timor: Berg Sanbet, 21 Apr 1971, *C.W. Kooy 794* (L!), Luid Belu, 28 Jun 1970, *C.W. Kooy 832* (L!).

16a. ***Merremia dissecta*** (Jacq.) Hallier f. var. ***dissecta***, Bot. Jahrb. Syst. 16: 552. 1893.
Convolvulus dissectus Jacq., Obs. Bot. 2: 4. tab. 28. 1767; *Ipomoea dissecta* (Jacq.) Pers.; *Operculina dissecta* (Jacq.) House. – Type: Jacquin plate #28 in protologue (lectotype, designated by Austin, Florida Scientist 42: 219. 1979).
Syn. *I. sinuata* Ortega

Distribution: Pakistan, India, Sri Lanka, Myanmar (reported), China, Indonesia (cultivated Java, Sumatra), Philippines (Mindanao), Australia (Northern Territory, Queensland, Western Australia), French Polynesia (Tahiti), Papua New Guinea, Solomon Islands (Guadalcanal), Samoa (Upolu), Tonga (Niuafo'ou), Seychelles (Praslin); native in tropical and subtropical America and now virtually ubiquitous as a tropical weed.

16b. ***Merremia dissecta*** var. ***edentata*** (Meisn.) O'Donell, Lilloa 6: 502. 1941.
Ipomoea sinuata Ortega var. *edentata* Meisn. in Martius, Fl. Brasil. 7: 285. 1869. – Type: Brazil. Bahia: prope Ilheos, *Riedel 131* (isosyntype NY!); Rio de Janeiro: prope Copacabana, *Riedel s.n.* (*n.v.*).
Syn. *M. fulva* (Bertol.) Manitz

Distribution: Brazil, Bolivia, Paraguay, Argentina; naturalized in French Polynesia (Society Islands: Mo'orea).

Notes: There is no consensus about the rank at which this taxon should be recognized. Manitz (1983: 180) has raised it to specific rank and taken up the name *M. fulva* for it but without description or discussion of the characters used to justify this action. Austin & Staples (unpublished data) consider it to be a variety of the widespread and variable *M. dissecta*, and that rank is accepted here. It has been treated this way in a recent checklist for the Argentine flora (Zuloaga and Morrone 1999: 564).

How this temperate South American variety of a widespread species came to be naturalized on a small Pacific island is unknown (Staples, 2009). The earliest Polynesian collection dates from 1931 (*M.L. Grant 5359*). Plants have been collected at various sites around Mo'orea ever since, the most recent dating from 1999 (*Murdoch M014*).

17. ***Merremia eberhardtii*** (Gagnep.) T.N. Nguyen in Averyanov *et al.*, Mater. Fl. Rast. Ostrov. V'etnama 43. 1988.
Ipomoea eberhardtii Gagnep., Not. Syst. (Paris) 3: 145. 1915. – Type: Vietnam, Thua-thien province, near Long-co, *Eberhardt 1708* (isotypes P, *n.v.*, photos!)

Distribution: Vietnam. Endemic and very seldom collected, apparently. Only one collection seen aside from the type.

Specimen examined: Vietnam. Hue and vicinity, 1927, *J. & M.S. Clemens 4091* (A!, BM!, G!, K!, P!, NY!).

18. ***Merremia elmeri*** Merr., Univ. Calif. Publ. Bot. 15: 261. 1929.
Type: Malaysia, Sabah: Elphinstone province, Tawao, *A.D.E. Elmer 20396* (isotypes, B!, BO!, G!, L!, MO!, NY!, SING!).

Distribution: Malaysia (Sabah), Indonesia (Kalimantan).

Notes: Two varieties are recognized – var. *elmeri* and var. *glaberrima* Ooststr., both found on Borneo. See Van Ooststroom and Hoogland (1953: 453) for distinguishing features of the varieties.

19. ***Merremia emarginata*** (Burm. f.) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
Evolvulus emarginatus Burm. f., Fl. Ind. 77. 1768. – Type: Indonesia, Java, *Kleinhof 85* (lectotype, G-Burman!, chosen by Staples and Jacquemoud, Candollea 60: 449. 2005).
Syn.: *Convolvulus excisus* Zipp.; *C. reniformis* Roxb.; *Ipomoea reniformis* (Roxb.) Choisy; *Lepistemon reniformis* (Roxb.) Hassk.

Distribution: Nepal, India, Sri Lanka, Bangladesh, Myanmar, China, Thailand, Malaysia, Indonesia (Java), Philippines; also in Africa.

20. ***Merremia gemella*** (Burm. f.) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
Convolvulus gemellus Burm. f., Fl. Ind. 46. 1768. – *I. gemella* (Burm. f.) Roth. – Type: Indonesia, Java, *collector unknown* (lectotype, G-Burman!, chosen by Staples and Jacquemoud, Candollea 60: 448. 2005).
Syn.: *Ipomoea cymosa* var. *radicans* (Blume) Miq.; *I. polyantha* Miq.; *I. radicans* Bume non Choisy.

Distribution: India, Sri Lanka, Myanmar, Thailand, Vietnam, Taiwan, Malaysia, Indonesia (Java, Seram, Irian Jaya), Philippines, Papua New Guinea, Australia, Micronesia (Mariana Islands: Guam).

Notes: Malesian floras recognize two varieties – var. *gemella* is widespread throughout Malesia, Asia, and the Pacific; and var. *splendens* Ooststr. is confined to a small area in Papua New Guinea. See Van Ooststroom and Hoogland (1953: 441) for a key to the Malesian varieties. An earlier lectotypification for this species (Van Ooststroom, 1939) had to be set aside because the specimen chosen was not part of the original material available to Burman: see Staples and Jacquemoud (2005) for details.

21. ***Merremia gracilis*** Campbell & Argent, Notes Roy. Bot. Gard. Edinburgh 45(2): 345–348. 1988.
Type: Malaysia, Sabah: Lahad Datu distr., Ulu Segama, Danum Valley Field Centre, *Argent & Campbell 411854* (holotype, SAN!; isotypes, A!, E!, K!, L!)

Distribution: Malaysia (Sabah), Indonesia (Kalimantan).

Notes: *Merremia gracilis* was described and compared by its authors with the species assigned to sect. Wavula (e.g., *M. similis, M. pacifica, M. calyculata*); on that basis it seemed distinctive. However, my own examination of the type gathering revealed it is much more similar to species of sect. Hailale (e.g., *M. clemensiana, M. crassinervia, M. korthalsiana*). It appears that the name *M. gracilis* has been applied to plants from Sabah, where they are widespread and abundant, whereas plants from Sarawak and Brunei have been otherwise named. Revisionary study may show that these names refer to one, or more, variable species distributed across the whole of Borneo.

22. ***Merremia hainanensis*** H. S. Kiu, Fl. Hainan 3: 587. 1974.
Type. China. Hainan Province: Wanning County, *H.F. How 71693* (holotype, where?, n.v.; iso A!).

Distribution: China (Hainan), Vietnam.

Notes: The protologue does not state where the holotype specimen is deposited and I have failed to locate it. Kiu Hua-shing compared this new species from Hainan to *M. dichotoma* and the excellent figure accompanying the protologue demonstrates that the two are uncannily similar. When I saw a duplicate of *How* 71693 in A, I first called it *M. dichotoma* without hesitation, not knowing that it was an isotype for Kiu's species. Ultimately, these two species may prove to be conspecific, though their type localities are far apart. A single specimen was discovered in the Paris herbarium that indicates *M. hainanensis* also occurs in nearby Vietnam.

Specimen examined: Vietnam. Cân Tho, route de Cân Tho a Long xuyên, 2 Nov 1967, *Vu Van Cuong 690* (P!).

23. ***Merremia hederacea*** (Burm. f.) Hallier f., Bot. Jahrb. Syst. 18: 118. 1893.
Evolvulus hederaceus Burm. f., Fl. Ind. 77. 1768. – Type: Indonesia, Java, *Pryon s.n.* (lectotype, G-Burman!, chosen by Van Ooststroom, Blumea 3: 306. 1939).
Syn.: *Convolvulus acetosellifolius* Desr.; *C. chryseides* (Ker Gawl.) Spreng.; *C. dentatus* Vahl; *C. flavus* Willd.; *C. lapathifolius* Spreng.; *Ipomoea acetosellifolia* (Desr.) Choisy; *I. chryseides* Ker Gawl.; *I. dentata* (Vahl) Roem. & Schultes; *I. subtriflora* Zoll. & Moritzi; *Lepistemon glaber* Hand.-Mazz.; *L. muricatum* Spanoghe; *Merremia chryseides* (Ker Gawl.) Hallier f.; *M. convolvulacea* Dennst. ex Hallier f.

Distribution: Pakistan, Nepal, India, Sri Lanka, Bangladesh, Myanmar, Thailand, China, Taiwan, Japan (Ryukyu, Ogasawara), Laos, Cambodia, Vietnam, Malaysia (Sarawak, Sabah), Singapore, Indonesia (Sumatra, Kalimantan), Philippines, Australia (Northern Territory, Queensland, Western Australia), Papua New Guinea, Micronesia (Caroline Islands: Yap; Mariana Islands: Guam), French Polynesia (Society Islands: Tahiti); and widespread in tropical Africa, Madagascar, Indian Ocean islands (Réunion, Mauritius); introduced in the Americas and naturalized around the Caribbean (Cuba, Lesser Antilles, Colombia, Trinidad and Tobago).

24. ***Merremia hirta*** (L.) Merr., Philipp. J. Sci. 7: 244. 1912.
Convolvulus hirtus L., Sp. Pl. 1: 159. 1753. – Type: India, *Osbeck 11* in Herb. Linn. 218.56 (lectotype, LINN!, chosen by Merrill, Philipp. J. Sci., sect. C, 7: 245. 1912).
Syn.: *C. caespitosus* Roxb.; *C. reptans* L., p.p.; *? Ipomoea hepaticaefolia* Blanco; *I. linifolia* Bl.; *I. philippinensis* Choisy; *Lepistemon decurrens* Hand.-

Mazz.; *Merremia caespitosa* (Roxb.) Hallier f.; *M. decurrens* (Hand.-Mazz.) H. S. Kiu; *Skinneria caespitosa* (Roxb.) Choisy.

Distribution: India, Bangladesh, Myanmar, Thailand, China, Taiwan, Laos, Vietnam, Malaysia, Singapore, Indonesia (Sumatra, Irian Jaya), Philippines, Australia (Queensland), Papua New Guinea, Solomon Islands (Guadalcanal).

Notes: Two varieties are recognized – var. *hirta* is widespread; var. *retusa* Ooststr. is found in the Philippines (Luzon). See Van Ooststroom and Hoogland (1953: 442) for a key to the Malesian varieties.

25. ***Merremia hungaiensis*** (Lingelsh. & Borza) R.C. Fang, Fl. Reipubl. Popularis Sin. 64(1): 76. 1979.
Ipomoea hungaiensis Lingelsh. & Borza, Repert Spec. Nov. Regni Veg. 13: 389. 1914. – Type: China, Yunnan: Talifu [Tali town], bei Tschian-t'ou-shao vor Hun-gai, 19 Aug 1913, *H.W. Limpricht 928* (holotype, WRSL, n.v.).
Syn. *Ipomoea wilsonii* Gagnep. (1915), *nom. illeg.*, non House (1907); *Merremia wilsonii* Verdc.; *I. hungaiensis* var. *linifolia* C.C. Huang.

Distribution: China (Guizhou, Yunnan).

Notes: Chinese floras recognize two varieties – var. *hungaiensis* and var. *linifolia* (C.C. Huang) R.C. Fang. See Fang and Staples (1995: 297) for a key to the varieties.

26. ***Merremia incisa*** (R. Br.) Hallier f., Meded. Rijks Herb. Leiden 1: 21. 1923 [t.p. 1910].
Ipomoea incisa R. Br., Prodr. 486. 1810. – Type: Australia, locality not stated, *R. Brown s.n.* (holotype, BM, *n.v.*).

Distribution: Australia. Endemic.

Notes. A presumed new species of *Merremia* reported from the Northern Territory of Australia (Elliot and Jones 1993: 389) is actually *M. incisa* (B. Johnson, pers. comm., 4 Feb 2009).

27. ***Merremia kingii*** (Prain) Kerr, Fl. Siam. En. 3(2): 5. 1954.
Ipomoea kingii Prain, J. As. Soc. Bengal 1, 13, pt. 2: 110. 1894. – Types: specimens from India, Bhutan, and Burma were cited (all CAL, *n.v.*).
Syn.: *Ipomoea cymosa* Roem. & Schultes var. *macra* C.B. Clarke; *M. umbellata* subsp. *macra* (C.B. Clarke) P.J. Parmar.

Distribution: Bhutan, India [West Bengal (Sikkim), Assam, Arunachal Pradesh, Nagaland, Meghalaya], Myanmar, Thailand.

Notes: This is one of the most difficult species to define among all Asian *Merremia*. Prain based his new species *I. kingii* on at least 14 collections, all in CAL, which would be syntypes under today's rules of nomenclature. He sent duplicates for some of these collections to Kew, where O. Stapf compared them with specimens cited by Clarke in the *Flora of British India* Convolvulaceae account. Based on Stapf's findings, Prain subsumed Clarke's variety, *I. cymosa* var. *macra*, and included Clarke's syntypes for that name in his list of collections cited under *I. kingii,* making these collections types for both names.

The lack of a clear-cut type specimen for this name makes it impossible to establish a species concept. Specimens called *M. kingii* in herbaria intergrade with both *M. bambusetorum* and *M. umbellata*, among others. Careful study of the full series of Prain's material in Calcutta, and choice of a lectotype from the many specimens he included, will determine how this name should be applied. A mini revision of the species complex including *kingii/bambusetorum/umbellata* and others is much needed.

28. ***Merremia korthalsiana*** Ooststr., Kew Bull. 1938: 175. 1938.
Type: Indonesia. Borneo: [Kalimantan], Doesoen, *Korthals 237* (holotype L!, 2 sheets).

Distribution: Malaysia (Sarawak, Sabah), Indonesia (Kalimantan), Brunei.

29. ***Merremia mammosa*** (Lour.) Hallier f., Teysmannia 7: 164. 1897.
Convolvulus mammosus Lour., Fl. Cochin. 108. 1790; *I. mammosa* (Lour.) Choisy. –Type: No specimen traced.
Syn.: *Ipomoea gomezii* C.B. Clarke, in part, as to flowers.

Distribution: India (West Bengal, Assam, Andaman Islands), Myanmar, Thailand, Vietnam, Indonesia (cultivated and escaped – Java, Bali, Moluccas).

Notes: The application of this name has stabilised since Van Ooststroom (1939b, and in Van Ooststroom & Hoogland 1953) explicated the species concept and applied it to a distinctive Malesian species with large flowers, perhaps the biggest in the genus, and fascicled, swollen roots used as food and medicine. Previously, Merrill (1935) pointed out that there is no type specimen extant for this Loureiro name and the Rumphius plate (Herbar. Amboin. 5: 370, pl. 131. 1750) – cited by Loureiro as a synonym – may be a mixed concept. Merrill initially (1917: 442) stated that this plate depicts the roots of a *Dioscorea* with the above-ground parts of some convolvulaceous plant and later (Merrill 1935: 325) decided that the above-ground parts referred to the sweet potato. Merrill accordingly reduced *C. mammosa* Lour. to synonymy with *Ipomoea batatas*. However, it seems that the Rumphius plate agrees very well with the plant from SE Asia that has latterly been called *Merremia mammosa*.

Clarke (1883: 211) created a mixed concept when he named *I. gomezii*: the flowers, based on a Burmese collection, *W. Gomez s.n.* (K!, 2 sheets), are *M. mammosa*; the fruits, based on Kurz specimens from the Andaman Islands, appear to belong to *Operculina riedeliana*.

30. ***Merremia pacifica*** Ooststr., Blumea 3: 263. 1939.
Type: Fiji. Vanua Levu: Mbua, *A.C. Smith 1690* (holotype, L!; isotypes, BISH!, K!, NY!, P!).

Distribution: Fiji (Naitasiri, Ovalau, Vanua Levu), Papua New Guinea (Bougainville, New Britain, Rossel), Solomon Islands (Guadalcanal, Vanikoro, Kolombangara, New Georgia, Buka, Faro, Savo, San Cristoval), Vanuatu (Maewo), Micronesia (Caroline Islands – Ponape).

Notes: A full description, illustration, and greatly expanded Pacific distribution for this species appears in Staples (2009).

31. ***Merremia palmata*** Hallier f., Bot. Jahrb. Syst. 18: 112. 1893.
Type: Namibia. Ameib, *Belck 52* (lectotype, BRA, *n.v.*; iso, JE, *n.v.*).

Distribution: Pakistan; otherwise known from tropical and southern Africa.

Notes: Austin & Ghazanfar (1979: 56) tentatively took up this name for two collections from Pakistan that B. Verdcourt identified as *M. palmata*. I have seen no material.

32. ***Merremia peltata*** (L.) Merr., Interpr. Rumphius Herb. Amboin. 441. 1917.
Convolvulus peltatus L., Sp. Pl. 2: 1194. 1753; *I. peltata* (L.) Choisy; *Operculina peltata* (L.) Hallier f. – Type: Icon in: Rumphius, Herb. Amboin. 6: pl. 159. 1750 [lectotype, chosen by Merrill, *op. cit.* 31, 441. 1917].
Syn.: *?Chironia capsularis* Blanco; *?C. lanosanthera* Blanco; *?Ipomoea menispermacea* Domin; *I. nymphaeifolia* Blume; *Merremia nymphaeifolia* (Blume) Hallier f., *nom. illeg.*

Distribution: India (Andaman Islands), Thailand, Malaysia (Peninsula, Sarawak, Sabah), Singapore, Brunei, Indonesia (Aru arch., Java, Kalimantan, Key Islands, Selebes, Sulawesi), Philippines (Mindanao, Sulu arch.), Papua New Guinea, Australia (Queensland), Solomon Islands (Guadalcanal, San Cristobal), Vanuatu (Banks group, Efate, Erromanga, Santo), Fiji (Bua, Kandavu, Naitasiri, Vanua Balavu, Vanua Levu, Viti Levu), Wallis & Futuna, New Caledonia, Cook Islands (Rarotonga), French Polynesia (Austral Islands – Raivavae, Rurutu; Society Islands – Huahine, Maupiti, Moorea, Raiatea, Tahaa, Tahiti), Niue, Samoa (Sava'i, Tutuila, Upolu), Tonga (Eua, Tafahi, Vavau), Federated States of Micronesia (Kosrae, Ponape), Belau (=Palau); also in tropical east Africa, Madagascar, and throughout the Indian Ocean islands.

Notes: *Merremia peltata* is immediately recognizable for several features: the lianoid habit with large flowers; broadly campanulate corollas either bright golden yellow or white; the peltate leaf attachment (though small leaves just below an inflorescence may be basally attached); and the anthers with large tufts of hairs. The vines are rampant growers that quickly take advantage of any disturbance such as forest cutting or land clearing for agriculture; the species is now considered invasive on several Pacific islands, despite being native in Oceania. The only specimen seen from Belau states that it is an introduced plant, grown at the Aimireek Experiment Station.

33. ***Merremia poranoides*** (C.B. Clarke) Hallier f., Bull. Herb. Boiss. 5: 375. 1897.
Ipomoea poranoides C.B. Clarke in Hook., Fl. Brit. India 4: 208. 1883. – Type: India. Sikkim: Darjeeling, *C.B. Clarke 9189A* (lectotype, K!, designated by Staples, Edinb. J. Bot. 60: 91. 2006).
Syn.: *Ipomoea courchetii* Gagnep.; *I. longipedunculata* C.Y. Wu (1965), non Hemsl. (1882); *Merremia longipedunculata* R.C. Fang.

Distribution: ?Bhutan, India (West Bengal, Nagaland), China (Guizhou, Yunnan), Thailand, Vietnam.

Notes. The synonymy and typification for *M. poranoides* were clarified by Staples (2006); soon thereafter it was documented in Thailand (Staples and Traiperm, 2008). The species enjoys a wide geographic range but is evidently not common anywhere.

34. ***Merremia pulchra*** Ooststr., Blumea 3: 348. 1939.
Type: Brunei Darussalam. Brunei Muara District: Muara, Brunei Bay, Apr 1896, *G. K. Gns 14* (holotype SING!).]

Distribution: Brunei, Malaysia (Sarawak), ?Philippines.

Notes: Evidently Van Ooststroom erred in stating the type collection came from Sarawak, because the locality given on the label – "Muara, Brunei bay" – corresponds to modern Brunei. The name of the collector is ambiguous: it appears to be G.K. Gns, just as Van Ooststroom rendered it, but this name is not identifiable with anyone known to have collected in the Malesian region (Van Steenis-Kruseman, 1950, 1958, 1974). Although *M. pulchra* is reported to occur in the Philippines (Coode *et al.*, 1996: 61), and this is quite possible, I have seen no authentic material from there. The large flowers of a vivid yellow color make this species worthy of introduction to horticulture.

35. ***Merremia quinata*** (R. Br.) Ooststr., J. Arnold Arbor. 29: 417. 1948.
Ipomoea quinata R. Br., Prodr. 486. 1810; *Convolvulus quinatus* (R. Br.) Spreng. – Type: Australia. Northern Territory: Arnhem Bay, Mallinson's Island, *R. Brown sub J.J. Bennett 2755* (holotype, BM!; probable isotypes, E!, K!).
Syn.: *I. hirsuta* R. Br.; *I. pentadactylis* Choisy.

Distribution: Myanmar, Thailand, Vietnam, China (Hainan), Taiwan, Philippines, Papua New Guinea, Australia (Queensland, Northern Territory). Surely more widespread in Malesia than the collections seen to date would indicate.

Notes: Van Ooststroom (1953: 447) commented that continental Asian specimens might not be conspecific with the specimens he examined from Australia, Papua New Guinea, and the offshore islets between. There is great variation in indumentum density, from glabrous to copiously hirsute with stiff yellowish hairs, but otherwise, the morphology is remarkably consistent. The peculiar crest on the seed apex is noteworthy and suggests seed characters might be taxonomically informative if studied comprehensively. Like some other Asian species (e.g., *M. subsessilis, M. verruculosa*) the corolla tube has a slight curve in life that gives the flower a weakly zygomorphic aspect.

36. ***Merremia quinquefolia*** (L.) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
Ipomoea quinquefolia L., Sp. Pl. 162. 1753; *Convolvulus quinquefolius* (L.) L. – Type: Icon in: Plukenet, Phytographia plate 167, fig. 6. 1692 (lectotype designated by D.F. Austin, Ann. Missouri Bot. Gard. 62: 182. 1975).

Distribution: Indonesia (Java), Australia (Queensland), Papua New Guinea, French Polynesia (Society Islands: Tahiti), Nauru, Fiji (Labasa, Lautoka, Vanua Levu), Tonga (Foa); native in tropical America, where it is widespread and abundant, and also naturalized in Africa (Lebrun and Stork 1997, and references cited therein).

Notes. I have seen a single old specimen (*Talmy s.n.*) from Indochina, without locality or date. Gagnepain and Courchet (1915: 239) listed this specimen under their mixed concept "*Ipomoea pentaphylla*", and gave the provenance as "Cochin-chine", which is now Vietnam. The distributional record for Vietnam is based on this Talmy collection.

37. ***Merremia rajasthanensis*** Bhandari, J. Bombay Nat. Hist. Soc. 84: 645. 1988.
Type: India. Rajasthan: Jodhpur District, Sardarsamand, 28 Aug 1975, *Bhandari 1976* (holotype, K, *n.v.*; isotype, JAC, *n.v.*).

Distribution: India; endemic to Rajasthan.

Notes: The author, when naming this species, stated that it "is closely allied to *Merremia quinquefolia* (Linn.) Hall. f. ... However, it appears to be related to the African *M. palmata* Hall. f. and *M. verecunda* Rendle." and went on to note, "The stem of this species is typically winged like that of African *M. pterygocaulos* (Choisy) Hall. f." The similarity with these African species has already been pointed out by Austin (1979: 56–57), citing B. Verdcourt, who examined a duplicate in Kew of *Bhandari 1971* (from the type locality) and considered it to be *M. palmata*, though perhaps differing sufficiently from the African populations of that species to be worthy of subspecific rank.

I have not examined the type collection nor the other material cited in the protologue but based on the detailed plate included there this species appears to me to be conspecific with one of these lobed-leaved African species; it is not remotely similar to the neotropical *M. quinquefolia*, which presents an entirely different facies. Given the well-known biogeographic affinity between eastern tropical Africa and the western Indian subcontinent, it would be entirely possible for *M. rajasthanensis* to be no more than a disjunct population of one of the widespread, variable African species.

38. ***Merremia rhynchorrhiza*** (Dalzell) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
Ipomoea rhynchorrhiza Dalzell, J. Bot. 3: 179. 1851. – Type: India. "in montibus Syhadree, prope Tulkut-ghat, fl. Aug. et Sept." *Dalzell s.n.* (holotype, K, *n.v.*).

Distribution: India, western peninsula.

Notes: Writing more than a century ago Cooke (1905: 239) remarked concerning *M. rhynchorrhiza* "The tubers are eaten and greedily sought for by the natives, which accounts for the rarity of the plant. The leaves are also used as a vegetable." Perhaps this is why not a single recent collection has been seen; the species should certainly be investigated in terms of IUCN conservation status and threats to its survival.

Specimen examined: India, "Malabar, Concan, etc., regio trop." *Stocks, Law & Co. s.n.* (F!, UPS!, S!).

39. ***Merremia semisagittata*** (Griseb. ex Peter) Dandy in Andrews, Flw. Pl. Sudan 3: 123. 1956.
Ipomoea semisagittata Griseb. ex Peter in Engl. & Prantl, Pflanzenfam. 4 (3a): 31. 1891. – Type: "Mesopotamia", no specimen cited.

Distribution: Saudi Arabia (Alfarhan and Thomas, 2001), otherwise known from dryland African above the tropical belt (Sebsebe, 2001).

Notes. The nomenclatural status of several *Ipomoea* names published by Peter (1891) is unsatisfactory because he did not cite specimens that could be considered types under the ICBN. A thorough and comprehensive study of the Peter names is needed to sort out the taxonomic concepts involved and to neotypify the names, if it can be proven that there are no specimens extant that could be eligible as original material for them.

I have seen no Asian material of this species.

40. ***Merremia sibirica*** (L.) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
Convolvulus sibiricus L., Mant. Pl. Alt. 203. 1771; *Ipomoea sibirica* (L.) Pers. – Type: without locality, *Herb. Linn. 218.5* (LINN!, lectotype, designated by Staples in Taxon 55: 1022. 2006).

Distribution: India (Himalayas), China, Mongolia, NE Russia.

Notes: Chinese floras recognize 5 varieties: var. *sibirica*, var. *macrosperma* C.C. Huang, var. *vesiculosa* C.Y. Wu, var. *trichosperma* C.C. Huang, and var. *jiuhuaensis* B.A. Shen & X.L. Liu. See Fang and Staples (1995: 295) for a key to the varieties. As pointed out years ago by Ferguson *et al.* (1977: 768) the pollen of *M. sibirica* is unique in the genus *Merremia*. While the true affinities of the species await disclosure, the pollen discordance is suggestive that *M. sibirica* does not belong with any of the other species groups lumped under *Merremia*.

Merremia sibirica was introduced to horticulture in Britain and Europe in the nineteenth century but apparently does not survive in cultivation. The flowers are small but borne in masses they are attractive; the repeatedly monochasial cymes result in a distinctive candelabrum-shaped inflorescence when well developed.

41. ***Merremia similis*** Elmer, Leafl. Philip. Bot. 1: 335. 1908.
Type: Philippines. Leyte, Palo, *Elmer 7341* (isotypes, BO, *n.v.*, E!, G!, K!, NY!)
Syn.: ? *Convolvulus distillatorius* Blanco, ?*Merremia distillatoria* (Blanco) Merr., *p.p.*

Distribution: Taiwan (Hengchun Peninsula), Philippines (Leyte, Luzon, Mindanao, Panay, Samar, Sibuyan).

Notes: The reports of pinkish to red corollas in *M. similis* require confirmation; this would be most unusual in a genus where white or yellow corollas are the norm.

42. ***Merremia steenisii*** Ooststr., Blumea 20: 127. 1972.
Type: Papua New Guinea, Sepik District, Wewak-Angoram area, road from Yangoru to Kworo, in grassland, 1 Sep 1959, *Robbins 2316* (holotype, CANB, *n.v.*, photo!).

Distribution: New Guinea.

Notes: Based on a single unicate specimen; *M. steenisii* has not been recollected since the type gathering was made in 1959. In describing it, Van Ooststroom (1972) stated that *M. steenisii* is closely allied to *M. aniseiifolia*. If that is the case, then the pollen of *M. steenisii* should also be examined, to see whether the similarity it bears to *Xenostegia* spp. is superficial or whether it should be transferred to that genus.

43. ***Merremia subsessilis*** (Courchet & Gagnep.) T.N. Nguyen, Vasc. Plts. Syn. Vietnam. Flora 1: 183. 1990. – *Ipomoea subsessilis* Courchet & Gagnep., Not. Syst. (Paris) 3: 148. 1915. – Types: Vietnam. Lam, *Mouret 189* (syntype, P!); Ouonbi, *Balansa 811* (syntype P!), same loc., *Balansa 812* (syntype, P!); baie de Fi-tsi-long dans l'ile Verte, *Balansa s.n.* (syntype, P, n.v.); Quang-yen, *d'Alleizette 187* (syntype, P!).
Misapplied: *M. collina* sensu Songkhla & Khunwasi (1993).

Distribution: Thailand, Vietnam, Laos.

Notes: Although the protologue lists a third Balansa collection without number that would be a syntype, I did not find this in Paris. There is, however, a specimen with identical locality data numbered 813 and this may be the third Balansa collection cited.

The foliose bract clasping the peduncle is distinctive in this species, as is the slightly curved corolla tube, which gives the living flower a weakly zygomorphic appearance.

44. ***Merremia thorelii*** (Gagnep.) Staples, Thai Forest Bull. (Bot.) 36: 98. 2008.
– *Ipomoea thorelii* Gagnep., Not. Syst. 3: 148. 1915. – Type: Vietnam, Ti-tinh, *Thorel s.n.* [syntype, P (×2)!]; Laos, Khong, *Thorel s.n.* (syntype, P, *n.v.*).
Syn. *M. collina* S.Y. Liu, Guihaia 4: 199. 1984.

Distribution: China (Guangxi), Thailand, Laos, Vietnam.

45. ***Merremia tuberosa*** (L.) Rendle, Fl. Trop. Africa 4(2): 104. 1905.
– *Ipomoea tuberosa* L., Sp. Pl. 160. 1753; *Operculina tuberosa* (L.) Meissn. – Type: Jamaica, *Herb. Linn. 219.4* (LINN!, lectotype designated by D.F. Austin, Ann. Missouri Bot. Garden 62: 182. 1975).
Syn.: *?Convolvulus paniculatus* Blanco; *Ipomoea tuberosa* var. *oligantha* Hassk.

Distribution: Pakistan, Sri Lanka, Myanmar, Thailand, Malaysia (Kuala Lumpur, Sabah), Taiwan, Australia, French Polynesia (Society Islands: Tahiti), Hawaiian Islands (Kaua'i, O'ahu, Maui, Hawai'i), Micronesia (Guam), Easter Island. Native in tropical America and widely dispersed through cultivation.

Notes: *Merremia tuberosa* has been introduced throughout the tropics as an ornamental. The vines are grown for the large, golden yellow flowers as well as the papery, indehiscent fruits (wood rose), which are used in a variety of handicrafts. It is surely more widespread in tropical Asia than the distribution above would indicate. *Merremia tuberosa* frequently naturalizes where it is introduced, especially in damp to wet sites with plenty of sun and the rampant vines soon blanket roofs, trees, and powerlines.

46. ***Merremia umbellata*** (L.) Hallier f., Bot. Jahrb. Syst. 16: 552. 1893.
– *Convolvulus umbellatus* L., Sp. Pl. 1: 155. 1753; *I. umbellata* (L.) G. Meyer, *non* L. (1759). – Type: Icon in Plukenet, Phytographia plate 167, fig. 1. 1692 (lectotype, designated by D.F. Austin, Florida Sci. 42: 221. 1979).
Syn.: *C. cymosus* Desr., *Ipomoea cymosa* (Desr.) Roem. & Schultes, *I.*

modesta Choisy; *I. pilosa* Houtt.; *I. sepiaria* Zoll. & Moritzi, non Koenig; *I. tonkinensis* Gagnep., *Merremia tonkinensis* (Gagnep.) T.N. Nguyen.

Distribution: Nepal, India, Sri Lanka, Bangladesh, China, Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, Singapore, Indonesia, Philippines, Papua New Guinea, Australia, New Caledonia, Hawaiian Islands (O'ahu), French Polynesia (Society Islands: Raiatea, Tahiti); also widespread in tropical Africa (but absent from Madagascar), the Indian Ocean islands, the Americas.

Notes: Van Ooststroom (1939b, in Van Ooststroom and Hoogland, 1953) recognized two subspecies of *M. umbellata* in the Malesian material he studied: subsp. *orientalis* (Hallier f.) Ooststr., comprised plants native in the Old World, whereas subsp. *umbellata* comprised plants native in the neotropics and introduced in Malesia (see 1953 reference for characters used to distinguish the two subspecies). For many years I followed this taxonomy implicitly, but as more material became available, both from Malesia and continental Asia, the distinctions have blurred and many specimens could not be satisfactorily placed in either taxon. Latterly I have abandoned all attempts to recognize subspecies.

The difficulty is compounded because the small-flowered plants typically called *M. umbellata* intergrade with larger flowered Asian plants that have been named as *M. bambusetorum* and *M. kingii*. Indochinese material called *M. tonkinensis* also belongs in this complex and while these specimens seemed distinctive on first appraisal, they were later found to be virtually identic with Bornean material that agrees almost exactly in terms of small, oblong-lanceolate leaves, dense whitish indumentum, and small flowers with white corollas. Clearly, this whole complex requires intensive study to sort out the taxonomy. The most distinctive feature of all plants in this complex is the presence of paired stipule-like appendages at the petiole-stem junction; this feature was first pointed out by Songkhla and Khunwasi (1993) and I have since found these appendages consistently in all specimens checked; that they have never previously been reported is remarkable. On densely hairy specimens the tiny appendages may be hidden among the trichomes, but careful examination reveals that they are present.

47. ***Merremia verruculosa*** S.Y. Liu, Bull. Bot. Res., Harbin 7(2): 133. 1987. Type: China. Guangxi: Yongning Xian, *S.Y. Liu & S.J. Wei 1355* (holotype, GXCM, *n.v.*; iso, KUN, *n.v.*).

Distribution: China, Thailand, Laos.

Notes: The excellent figure accompanying the protologue (p. 136) provides a clear visual image for this species: the curious warty outgrowths on the abaxial side of the outer sepals are distinctive and this species is not easily mistaken for anything else. As in *M. subsessilis*, the corolla tube in life has a slight curvature, giving the flowers of *M. verruculosa* a weakly zygomorphic appearance.

48. ***Merremia vitifolia*** (Burm. f.) Hallier f., Bot. Jahrb. Syst.16: 552. 1893. – *Convolvulus vitifolius* Burm. f., Fl. Ind. 45. t. 18. f. 1. 1768; *Ipomoea vitifolia* (Burm. f.) Blume – Type: Indonesia. Java. *Garzin s.n.* (G-Burman!, lectotype designated by Staples and Jacquemoud, Candollea 60: 449. 2005).
Syn.: *C. angularis* Burm. f.; *I. vitifolia* var. *angularis* (Burm. f.) Choisy.

Distribution: Nepal, Bhutan, India, Sri Lanka, Bangladesh, Myanmar, Thailand, Laos, Vietnam, China (Hainan, Yunnan), Taiwan, Malaysia (Sabah), Indonesia (Java, Maluku, Selebes, Sumatra, Timor), Philippines (Balabac, Luzon, Palawan, Paragua).

Notes: A species easily recognized; corolla color varies from pure bright yellow, to yellow with a wine-red base of the throat, through paler shades of yellow to almost white.

49. ***Merremia yunnanensis*** (Courchet & Gagnep.) R. C. Fang, Fl. Reipubl. Popularis Sin. 64(1): 74. 1979. – *Ipomoea yunnanensis* Courchet & Gagnep., Notul. Syst. (Paris) 3: 151. 1915. – Types: China. Yunnan: Ta-pin-siou, *Ducloux 4454* (syntype, P!), Lou-pou, près Tong-tchouan, *Ducloux 6398* (syntype, P!), col de Piou-sé, *Delavay 3184* (syntype, P!), près de Ta-pin-tzé, *Delavay 3931* (syntype, P!); Western China, without province or locality: *Wilson 4183* (syntype, P!, iso, A!).
Syn.: *I. yunnanensis* var. *uniflora* C.Y. Wu.

Distribution: China (Guizhou, Sichuan, Yunnan). Endemic.

Notes: Chinese floras recognize three varieties: var. *yunnanensis*, var. *glabrescens* (C.Y. Wu) R.C. Fang, and var. *pallescens* (C.Y. Wu) R.C. Fang. See Fang and Staples (1995: 296) for a key to the varieties.

Undescribed species

There are published reports of undescribed species of *Merremia*, for example from Brunei (Coode *et al.*, 1996: 61), as well as new species yet to be described for Australia (R. Johnson, pers. comm. 4 Feb 2009). I have seen no specimens for either of these, but the reports indicate there are still novelties awaiting discovery. Indeed, given the vast tracts of continental tropical and subtropical Asia that remain severely under-collected – Laos, Cambodia, Myanmar, and eastern Tibet among them, a region here shown to be a center of species richness for *Merremia* – it is quite likely that the number of species will increase in future.

Excluded Species & Synonyms

Merremia angustifolia (Jacq.) Hallier f. = *Xenostegia tridentata* (L.) D.F. Austin & Staples

Merremia boisiana var. *rufopilosa* (Gagnep.) C.Y. Wu = *Merremia boisiana* var. *fulvopilosa*

Merremia caespitosa (Roxb.) Hallier f. = *M. hirta*

Merremia chryseides (Ker-Gawl.) Hallier f. = *M. hederacea*

Merremia collina S.Y. Liu = *M. thorelii*

Merremia convolvulacea Dennst. ex Hallier f. = *M. hederacea*

Merremia crispatula Prain = *Operculina petaloidea* (Choisy) Ooststr.

Merremia decurrens (Hand.-Mazz.) H.S. Kiu = *M. hirta*

Merremia distillatoria (Blanco) Merr. = *M. similis*

Merremia gangetica (L.) Cufod. = *Cocculus hirsutus* (L.) Diels; vide Van Ooststroom (1934: 245).

Merremia hastata Hallier f. = *Xenostegia tridentata* (L.) D.F. Austin & Staples; vide Van Ooststroom (1972b: 939) for nomenclatural notes on the *Merremia* name.

Merremia longipedunculata R.C. Fang = *M. poranoides*

Merremia medium (L.) Hallier f. = *Xenostegia medium* (L.) D.F. Austin & Staples

Merremia nymphaeifolia (Blume) Hallier f. = *M. peltata*

Merremia pentaphylla (Jacq.) Hallier f. = *M. aegyptia*

Merremia petaloidea (Choisy) Burkill = *Operculina petaloidea* (Choisy) Ooststr.

Merremia platypeltis Prain = *Operculina riedeliana* (Oliv.) Ooststr.

Merremia riedeliana (Oliv.) Hallier f. = *Operculina riedeliana* (Oliv.) Ooststr.

Merremia tridentata (L.) Hallier f. = *Xenostegia tridentata* (L.) D.F. Austin & Staples

Merremia tridentata subsp. *genuina* Ooststr. = *Xenostegia tridentata* (L.) D.F. Austin & Staples

Merremia tridentata subsp. *hastata* Ooststr. = *Xenostegia tridentata* (L.) D.F. Austin & Staples

Merremia triquetra (Vahl) Roberty = *Operculina turpethum* (L.) S. Manso

Merremia turpethum (L.) Rendle = *Operculina turpethum* (L.) S. Manso
Merremia wilsonii Verdc. = *M. hungaiensis*

Table 1. Number of total species by region, unique species and infraspecific taxa of *Merremia* in different regions of the world.

Region	total # species in region	# unique species	# infraspecific taxa
Americas	29	27	6
Africa & Madagascar	39	31	9
Australia	13	3	—
Asia & Pacific	48	40	20
TOTAL	—	101	—

Appendix: data sources for Table 1, grouped by region:

Americas (North, Middle, South, and West Indies)
The primary source used is an unpublished manuscript prepared for Flora Neotropica (Austin and Staples, circa 1979), which expands on and updates the revision by O'Donell (1941). A number of new neotropical species have been described in recent years (McDonald, 1987, 2008; Valencia and Martinez, 1995) that have been incorporated into the working list.

Africa (including Madagascar)
The primary source for the African tropics is the Convolvulaceae listing from Lebrun and Storck (1997) with additional recent floras consulted for South Africa (Meeuse and Welman, 2001), Madagascar (Deroin, 2001), Ethiopia (Sebsebe, 2006), and Somalia (Thulin, 2006).

Australia
Names were compiled from diverse historical literature for Australia, and updated against two floras that cite Australia as part of the distribution (Van Ooststroom and Hoogland, 1953; Fang and Staples, 1995). Additional names were found in Elliot and Jones (1993). Bob Johnson (pers. comm., June 2007) kindly reviewed the working list of names that resulted and provided the current taxonomy to be adopted for the forthcoming *Flora of Australia* account.

Asia and Pacific
For Asia the primary flora used as the foundation of the species list was

Malesia (Van Ooststroom and Hoogland, 1953, and subsequent addenda and corrigenda) with updates and additions from the floras for Saudi Arabia (Alfarhan and Thomas, 2001), Pakistan (Austin and Ghazanfar, 1979), Sri Lanka (Austin, 1980), India (Clarke, 1883; Cooke, 1905; Gamble, 1923; Saldanha and Nicolson, 1976; Babu, 1977; Bhandari, 1988; Panigrahi and Murti, 1989), Bhutan (Mill, 1999), Bangladesh (Khan, 1985), Myanmar (Kress *et al.*, 2003), Thailand (Songkhla and Khunwasi, 1993; Staples *et al.*, 2005; Staples and Traiperm, 2008), China (Fang and Staples, 1995), Taiwan (Staples and Yang, 1998), Vietnam (Nguyen, 1990), Brunei (Coode *et al.*, 1996), Peninsular Malaysia and Singapore (Turner, 1995).

For the Pacific region additional references consulted included floras for Micronesia (Fosberg and Sachet, 1977), the Marquesas (Sachet, 1975), New Caledonia (Heine, 1984), and Staples (2009). Specimens I have examined in the past two decades have been used to correct and expand the distributions compiled from the literature.

Index of numbered collections examined

The following alphabetical list includes numbered herbarium specimens I have examined from Asia and the Pacific. Numbers correspond to the list below, which is identical with the numbering used in the text. Type specimens have been indicated with (T).

1. *Merremia aegyptia*
2. *Merremia aniseiifolia*
3. *Merremia bambusetorum*
4. *Merremia bimbim*
5. *Merremia boisiana*
— var. *boisiana*
— var. *fulvopilosa*
— var. *sumatrana*
6. *Merremia borneensis*
7. *Merremia bracteata*
8. *Merremia caloxantha*
9. *Merremia calyculata*
10. *Merremia cissoides*
11. *Merremia clemensiana*
12. *Merremia cordata*
13. *Merremia crassinervia*
14. *Merremia davenportii*
15. *Merremia dichotoma*
16a. *Merremia dissecta* var. ***dissecta***
16b. *Merremia dissecta* var. ***edentata***
17. *Merremia eberhardtii*
18. *Merremia elmeri*
— var. *elmeri*
— var. *glaberrima*
19. *Merremia emarginata*
20. *Merremia gemella*
— var. *gemella*
— var. *splendens*
21. *Merremia gracilis*
22. *Merremia hainanensis*
23. *Merremia hederacea*
24. *Merremia hirta*
25. *Merremia hungaiensis*
— var. *hungaiensis*
— var. *linifolia*
26. *Merremia incisa*
27. *Merremia kingii*
28. *Merremia korthalsiana*

29. ***Merremia mammosa***
30. ***Merremia pacifica***
31. ***Merremia palmata***
32. ***Merremia peltata***
33. ***Merremia poranoides***
34. ***Merremia pulchra***
35. ***Merremia quinata***
36. ***Merremia quinquefolia***
37. ***Merremia rajasthanensis***
38. ***Merremia rhynchorrhiza***
39. ***Merremia semisagittata***
40. ***Merremia sibirica***
— var. *sibirica*
— var. *macrosperma*
— var. *vesiculosa*
— var. *trichosperma*
— var. *jiuhuaensis*
41. ***Merremia similis***
42. ***Merremia steenisii***
43. ***Merremia subsessilis***
44. ***Merremia thorelii***
45. ***Merremia tuberosa***
46. ***Merremia umbellata***
— subsp. *orientalis*
— subsp. *umbellata*
47. ***Merremia verruculosa***
48. ***Merremia vitifolia***
49. ***Merremia yunnanensis***

1984 Sino-American Botanical Expedition 1323 (25).

Aban Gibot SAN 76999 (46); SAN 90220 (21); SAN 95362 (32); SAN 96805 (21); SAN 96627 (46). – Abang Mohtar S. 56140 (46). – Abang Mohtar *et al.* S. 56133 (6). – Abbe, L.B. 9373 (48); 9374 (46). – Aldén, B. *et al.* 1798 (25). – Alston, A.H.G. 14781 (5). – Ambol, A. AA-45 (32). – Ambriansyah & Arifin AA-190 (32). – Amdjiah 918 (18). – Amin *et al.* SAN 121515 (32); SAN 117823 (32). – Amin, G. *et al.* SAN 67448 (21); SAN 117823 (32); SAN 121515 (32); SAN 121576 (18); SAN 96557 (21); SAN 96729 (21). – Amor, E.A. 48 (32); 66 (30); 92 (30). – Amphon 68 (48). – Anderson, E.F. 4285 *et al.* (6). – Anderson, J.A.R. & I. Paie S. 28489 (34); S. 16009 (46). – Anthony, Y.T. A-699 (46); A-775 (32). – Arbainsyah *et al.* AA-3135 (23). – Argent, G. & Iqbar 9964 (48); 9965 (46); 9980 (32); 9986 (5). – Argent, G. & E. Campbell 411854 (T) (21). – Argent, G. *et al.* 93119 (32); 108280 (32); 1987171 (21). – Arifin, Z. BRF-1812 (21). – Arishah FM-09583 (46). – Arnott, D. 2288 (23). – Ashton, P.S. S. 19005 (34); S. 19795 (18). – Asik Mantor SAN 120221 (46); SAN 136121 (21). – Austin A-1212 (46). – Australian National University ANU 1715 (16). – Averyanov, L. *et al.* VH 1380 (5); VH 1063 (5); VH 830 (3); VH 1012 (46). – Awang Yakup S. 8280 (34).

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Bodenheim, M. 11317 (32). – Beauvais, J. 704 (T) (25); 1205 (T)(25). – Beccari, O. 665 (32); 3954 (T)(13). – Bermejos, J. BS-265 (32). – Bernardi, L. 14636 (16a). – Beusekom, C.F. van 12535 (24). – Beusekom, C.F. van & C. Charoenphol 1687 (46); 2017 (24). – Beusekom, C.F. van & C. Phengklai 2649 (24). – Beusekom, C.F. van *et al.* 3825 (35); 3953 (19); 4002 (23); 4287 (43); 4473 (48); 4474 (46); 4705 (46). – Bhargava, N. 3375 (32). – Blake, S.T. 16701 (16); 23196 (16); 23286 (23). – Blewett, J.B.J. B-19 (21); B-20 (21). – Bloembergen, S. 4612 (32). – Bodinier, E. & Ducloux 272 (T)(25); Bodinier, E. & L. Martin 1806(T), in part (49); in part (25). – Boeea, Rahmat Si 1330 (32); 1532 (23); 1645 (32); 2268 (46); 3778 (23). – Bois, D. 138 (T)(5). – Bon, l'abbé 2425 (T)(46); 2813 (46); 4801 (5); 5216 (T)(46). – Boom, B.K. 25770 (40). – Bor, N.L. 6294 (27); 6689 (33); 6774 (27); 16699 (29). – Borden, T.E. FB-2714 (20). –Bourdy, G. 675 (30). – Boyland, D.E. & J.G. Gilliett 367 (16). – Bragg, K. 22 (48); 217 (48). – Brass, L.J. 545 (46); 2712 (32); 7578 (T)(20); 7646 (20); 7778 (20); 27240 (24); 27264 (32); 28540 (30); 29365 (20). – Brass, L.J. & C.T. White 145 (32). – Bray, P.S. FRI 11786 (46). – Brook, Miss W.M.A. 8281 (18); 8828 (23). – Brooke, W. 10802 (23). – Brown, R. [Bennett catalogue no.] 2755 (T)(35); 2756 (35). – Bryan Jr., E.H. 584 (32). – Bunchuai, K. 4 (46). – Bünnemeyer, W. 12477 (48). – Bureau of Science BS 483 (48). – Burgess, P.F. FRI 9222 (32); FRI 9253, in part (32), in part (6); FRI 10161 (6); SAN 25166 (18). – Burkill, I.H. Mo-2829 (16). – Burley, J.S. NGS-651 (32); NGS-666 (46). – Bush, W. 32725 (46); 32727 (46). – Byrnes, N. 2469 (20).

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Acknowledgments

This material is based upon work supported by the US National Science Foundation under Grant No. 0212762. I began the research at Herbarium Pacificum (BISH); all the staff there are gratefully acknowledged. The project was brought to a conclusion at Singapore Botanic Garden; I am grateful to the SBG administration and the National Parks Board for support. I thank Robert Johnson (BRI) for generously sharing information about the Australian taxa. Reviews of the manuscript by R. Johnson and D. F. Austin (ARIZ) are gratefully acknowledged.

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Syzygium subscandens (Myrtaceae), a New Species from Sumatra

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Abstract

A new species of *Syzygium* Gaertn. from Sumatra is described and illustrated: *Syzygium subscandens* Widodo. Morphologically the new species is similar to *S. garciniifolium*, but differs in being a small tree and in having longer terminal and axillary panicles.

Introduction

Sumatra is one of the largest islands in Indonesia and is one of the richest in biodiversity (Whitten, 1999), however, it is also one of the least known flora in the country. Land conversions, the development of industry, illegal logging, and forest fires have created severe pressure on the biodiversity of Sumatra.

Species of *Syzygium* are key components of Southeast Asian and Sumatran lowland forests. They provide nectar, pollen, and fruits as food for a wide range of insects, birds and mammals (Parnell *et al.*, 2007). They are also of economic importance to humans as sources of fruits, timber, tannin and medicine (Heywood *et al.*, 2007).

The genus *Syzygium* is largest in the family Myrtaceae, comprising *ca* 1200 species (Craven *et al.*, 2006), or approximately 1040 species (Govaerts *et al.*, 2008). The current concept of *Syzygium* includes species with and without an intercotyledonary inclusion; the inflorescences are either solitary or in clusters, either on old trunk, axillary, or terminal; and the calyx may be either calyptrate or free (Craven *et al.* 2006).

The new species was identified during preparation of a revision of *Syzygium* in Sumatra. To make sure that the new species has not been named and reported anywhere else outside of Sumatra, we compared it with specimens of morphologically similar species from the surrounding islands kept in BO, L and K.

The new species of *Syzygium* is an important discovery for Sumatra because it creates awareness and appreciation of the island's tree biodiversity. The new information can be used for the development of an effective conservation strategy.

Syzygium subscandens Widodo, *sp. nov.*
Frutices subscandentes. Ramuli teretes, luteo-brunnei pallidi. Folia coriacea, obovata, basi et apice obtusa. Inflorescentiae terminales et laterales, paniculatae; floribus cruciformibus stellatis, hypanthio obconico-urceolati; corollis albo-roseis. –**Typus:** Indonesia. Sumatra WC, west side of Mt. Merapi, 2,300 m alt., 22 Jun 1953, *JV Brossum W 2201* (holotype, BO!; iso, L.). **Fig. 1.**

Treelets, climbing on tree. Twigs terete, smooth, yellowish. **Leaves** obovate, 14-18 x 7.5-10.6 cm, drying yellowish brown, lower surface paler; base obtuse, apex obtuse; petiole thick, not swollen, 1-1.2 cm long; midrib narrowly furrowed on the upper surface, rounded, raised below; lateral veins 5-8 pairs, straight or curved, 2-2.8 cm apart, at an angle of 45°-70°; oil dots none or few; intramarginal vein looped, faint, 5-10 mm from margin. **Inflorescence** a panicle, up to 9 cm long, to 9 cm wide, terminal and axillary; peduncle 2-9 mm; ultimate inflorescence axis *ca* 5 mm long. **Flower** buds turbinate, white; pseudostipe sometimes none, hypanthium smooth, obconic to urceolate. Sepals 4, free, triangular, margin hyaline, 5-8 mm long and wide, pink. Petals 4, free, whitish pink, 4-8 mm long and wide, orbicular or slightly triangular, a few gland dots per petal. Stamens deciduous, not seen. Style not seen. **Fruits** globose ca 5 mm (immature). **Seeds** solitary, globose, ca 3 mm diameter.

Habitat: Primary forest, climbing on trees.

Distribution: Known only from Mt. Merapi in Sumatra.

Notes: S. subscandens looks like *S. garciniifolium.* It differs in its habit, being a small tree or shrub climbing on trees, and in its longer terminal and axillary panicles. It is characterised also by the thick leathery leaves with very faint looped intramarginal veins.

Acknowledgements

We would like to thank Dr. Eko B. Walujo (BO), Prof. E. F. Simets (L) ad Dr. D. Mabberley (K), Herbarium Bogoriense for the permission to examine the collections and for the use of facilities. Prof. Dr. Mien A. Rifai, Herbarium Bogoriense, and Mr. Lyn Craven, CSIRO, Canberra, Australia are thanked for advice, references, and discussion. Prof. Dr. John Parnell, Trinity College,

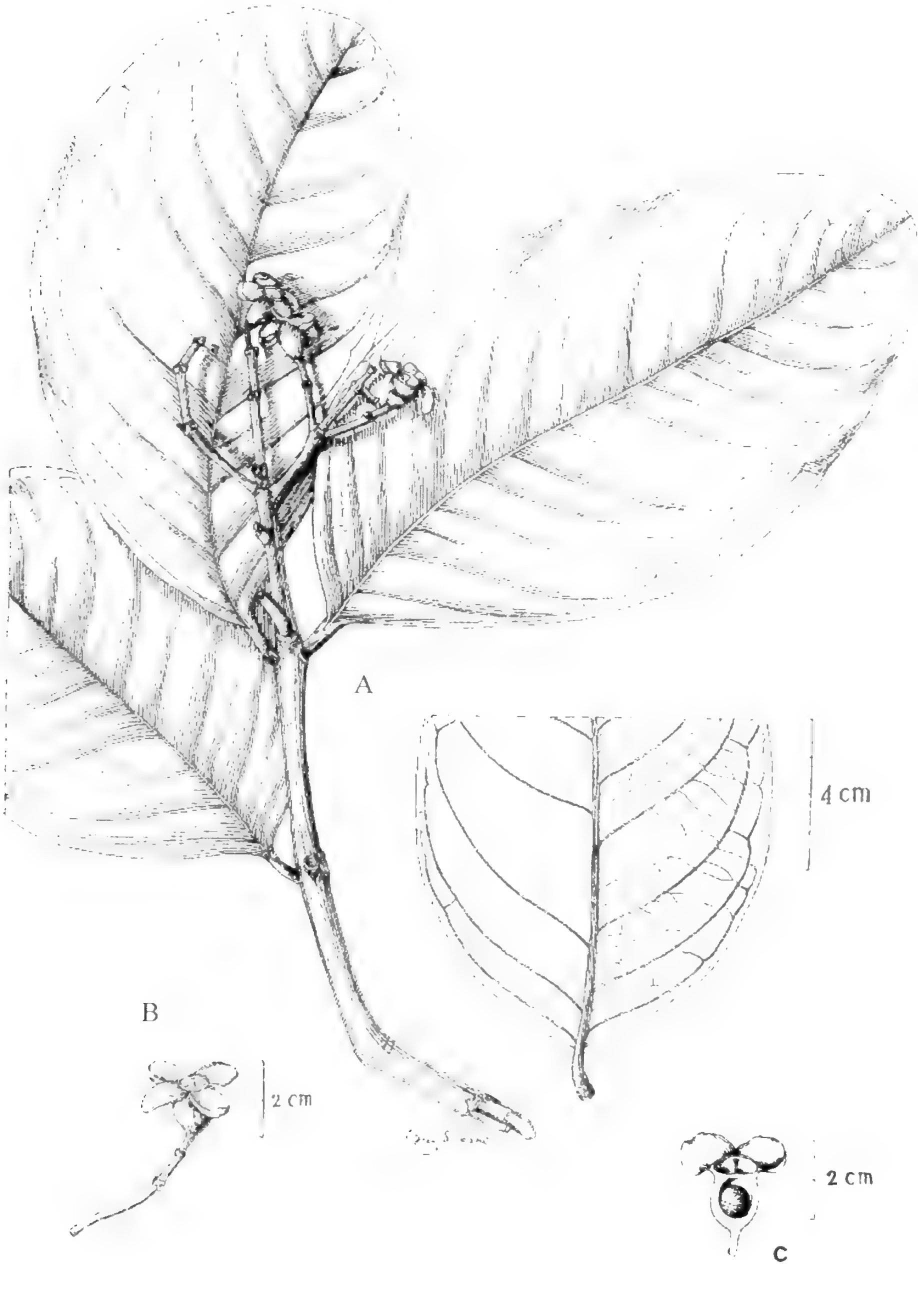

Figure 1. *Syzygium subscandens*. A. Leafy twig with inflorescence; B. Flower; C. Young Fruit. A, B and C from *JV Brossum W No. 2201* (BO). Drawn by Subari.

Dublin, Ireland, is appreciated for references. Subari is also thanked for drawing the figures. The Directorate General of Higher Education of the Republic of Indonesia is acknowledged for providing scholarships via IPB (Bogor Agricultural University).

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Studies on Schismatoglottideae (Araceae) of Borneo XII: Three New Species of *Schismatoglottis* in the Multiflora Group

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Abstract

Fieldwork since 2002 has revealed three novel taxa of *Schismatoglottis* in Sarawak, Malaysian Borneo. Based on the presence of a free ligular portion to the petiolar sheath, these new taxa belong to the Multiflora Group *sensu* Hay and Yuxammi (2000). Here, these species, *Schismatoglottis clausula* S.Y.Wong, *S. dulosa* S.Y.Wong, and *S. jitinae* S.Y.Wong are described, and illustrated, and a key to the Multiflora Group in Sarawak is presented.

Introduction

The last revision of *Schismatoglottis* was that of Hay & Yuzammi (2000), at which time *Schismatoglottis* in Malesia stood at 94 species, of which 63 occurred in Borneo. Since then, a further 7 taxa have been published: *Schismatoglottis hayana* Bogner & P.C.Boyce, *S. jelandii* P.C.Boyce & S.Y.Wong, *S. jipomii* P.C.Boyce & S.Y.Wong, *S. maelii* P.C.Boyce & S.Y.Wong, *S. ardenii* A.Hay, *S. tahubangensis* A.Hay & Herscovitch, and *S. bulbifera* H.Okada, H.Tyukaya & Y.Mori (see Bogner and Boyce, 2009; Boyce and Wong, 2006; Hay, 2002; Hay and Herscovitch, 2003; Okada *et al.*, 1999, and Wong and Boyce, 2008). These taxa are all endemic to Borneo. Here, a further three novel Bornean endemic taxa, *Schismatoglottis clausula* S.Y.Wong, *S. dulosa* S.Y.Wong, and *S. jitinae* S.Y.Wong are described. These taxa belong to the Multiflora Group *sensu* Hay and Yuzammi (2000).

Multiflora Group

Based on fieldwork observations, and of plants in cultivation in the Botanical Research Centre, Semenggoh (BRC), *Schismatoglottis pudenda* A.Hay does not belongs to the Multiflora Group. The foliage leaves of *S. pudenda* alternate with cataphylls, and have the petiolar sheath very much reduced, with the role of protecting the emerging leaf/shoot/inflorescence taken over by the subtending cataphyll, therefore, this species belongs to the Tecturata Group. A separate paper (Boyce and Wong, in prep.) will address this and other changes in the Tecturata Group. Based on molecular work on two plastid regions on the Schisamatoglottid Alliance (Tribe Schismatoglottideae + Cryptocoryneae + Philonotieae) (Wong, *et al.*, in press), *Schismatoglottis josefii* A.Hay and *S. sarikeensis* (Bogner & Hotta) Bogner & Hay do not belong in *Schismatoglottis*, but rather in one of the 'satellite' genera, possibly in a redefined *Hottarum* Bogner & Nicolson. Therefore, *S. josefii* and *S. sarikeensis* are here excluded, These changes mean that currently there are thirteen species in the Multiflora Group in Sarawak.

Key to *Schismatoglottis* Multiflora Group in Sarawak

1. Petiolar sheath fully attached to the petiole, either long or extremely abbreviated (sometimes with a short apical ligulate portion) .... ***Schismatoglottis* excl. Multiflora Group**
1. Petiolar sheath attached to the petiole only at the base, the remainder free-ligulate and comprising at least half of the entire sheath .... 2. ***Schismatoglottis* Multiflora Group**

2. Stem elongated, erect, sometimes ascending 3
2. Stem condensed, sometimes more-or-less creeping but never erect 4

3. Plant medium; petiolar sheath marcescent; petiole asperulate ; lamina softly leathery, matte at least adaxially; peduncle stout and short, not elongated; lower spathe succulent; female zone almost as wide as long; appendix present. Never rheophytic .... ***S. jitinae***
3. Plant small; petiolar sheath persistent; petiole glabrous; lamina thinly leathery, glossy at least adaxially; peduncle slender, elongated during anthesis; lower spathe softly coriaceous; female zone longer than wide; appendix absent. Always rheophytic .... ***S. erecta***

4. Lamina corrugated adaxially; primary and interprimary veins prominently raised adaxially; spathe limb green at anthesis; inflorescence strongly fruity-smelling at anthesis .... ***S. maelii***
4. Lamina never corrugated; primary and interprimary veins smooth adaxially; spathe limb always white at anthesis; inflorescences usually smelling powerfully esteric at anthesis 5

5. Appendix absent or very reduced (comprising just a few terminal staminodes) 6
5. Appendix present 10

6. Plants not rheophytic 7
6. Plants rheophytic 8

7. Lamina abaxially not glaucous, base obtuse to slightly decurrent, secondary and tertiary venation obscure; pore at edge of stamen, punctiform (c. 0.15 mm) with protruding tissue from innermost surface, connective elevated, male zone remained white basally and stained brown distally in alcohol. Lithophytic on limestones, Bau, Kuching Division .... ***S. bauensis***
7. Lamina abaxially glaucous, leaf base always decurrent, secondary venation prominent, tertiary venation sometimes pronouncedly tessellate; pore at inner surface of stamen, oblong (*ca* 0.3 mm), connective flat, male zone completely stained brown in alcohol. Terrestrial in deep soil on limestones and sandstones, Padawan, Kuching Division and Serian, Samarahan Division .... ***S. confinis***

8. Spathe inflated at anthesis; spadix with a blunt end 9
8. Spathe unrolling slightly at anthesis but not inflated; spadix with a tapering end .... ***S. multiflora***

9. Leaf adaxially very glossy; primary lateral veins are flush adaxially; spathe caducous, pink at anthesis. Rejang Valley .... ***S. roseospatha***
9. Leaf adaxially slightly glossy; primary lateral veins are sunken adaxially; spathe Marcescent, white at anthesis. Sematan .... ***S. hayana***

10. Plant large, up to *ca* 1 m tall; lamina to *ca* 40 cm long; placenta 1 per ovary; Mulu Limestones .... ***S. monoplacenta***
10. Plant medium, less than 60 cm tall, lamina less than 30 cm long; placenta more than 1 per ovary; West Sarawak, never on limestone 11

11. Spathe limb marcescent 12
11. Spathe limb caducous 13

12. Spathe limb disarticulating into numerous circumferential rings along the length, and then collapses downwards; appendix thicker than the male zone; sterile interstice wider than the distal portion of female zone, and the male zone .... ***S. clausula***
12. Spathe limb remaining erect marcescent in one piece; appendix contiguous from the male zone; sterile interstice contiguous with the distal portion

pf female zone, and the proximal portion of the male zone .... ***S. dulosa***

13. Spadix usually *ca* 8 cm long, with a short sterile interstice of sterile stamens between the fertile zones; stamens and appendical staminodes large, *ca* 1 mm across; Matang .... ***S. mayoana***
13. Spadix usually *ca* 4.5 cm long, with the fertile zones contiguous; stamens and appendical staminodes small, *ca* 0.3 mm across; Bako .... ***S. nicolsonii***

Schismatoglottis clausula S.Y.Wong, *sp. nov.*
Ab Schismatoglottis mayoana *(in sylvis mons Matangae restrictus) spathae laminorum tempore anthesis clausus, lamina senescens per disarticulatis circumferentialis numerosis, mox collabens inde marcescens remanens postanthesin; staminis parva (0.2-0.3 mm), cum margini thecae elevates connectivo antherae superantis, fovea latus profunde cingens differt* – **Typus:** Malaysia, Sarawak, Sarikei, Ulu Sarikei, 01° 55' 05.4"; 111° 29' 35.8", 7 Dec 2005, *P.C.Boyce et al. AR-1582* (holo, SAR). **Fig. 1.**

Herbs to *ca* 30 cm tall. **Stem** pleionanthic, condensed, more or less creeping, *ca* 2 cm diam., green. **Leaves** *ca* 5-7 together; petiole terete, 18-26 cm long, densely scabrid, green, sheathing only at the extreme base, the sheath extended into a bicarinate narrowly lanceolate free ligular portion to *ca* 10 cm long, drying red-brown; laminae lanceolate to oblongo-ovate, *ca* 15-25 cm long × 4-9 cm wide, matte dark green adaxially, abaxially paler, drying brown, base obtuse, sometimes slightly decurrent, tip acute and acuminate for up to *ca* 2 cm and with a cylindric mucro to 2 cm long; midrib grooved adaxially and abaxially very prominent (dry) with 14-16 primary lateral veins on each side alternating with fine interprimaries and diverging at *ca* 60°; secondary venation fine and very dense, adaxially obscure, mostly arising from the midrib; tertiary venation obscure. **Inflorescences** up to 2 together, pendent, *ca* 8-10 cm long, subtended by cataphylls resembling the ligular leaf sheaths; peduncle less than the length of the free ligules. **Spathe** 8-10 cm long; lower spathe obliquely inserted from peduncle, *ca* 2.4 cm long, thickly coriaceous, green, differentiated from the limb by a weak constriction corresponding to the distal portion of the female zone; spathe limb 5-6 cm long, white, oblongo-lanceolate, apiculate for 3 mm, barely open during anthesis, senesce by disarticulating into numerous circumferential rings along the length, and this then collapsing downwards, and remaining marcescent post anthesis. **Spadix** sessile, 5.5-6.0 cm long, subcylindric; female zone 2.2-2.4 cm long × 0.5 cm proximally (0.4 cm distally) diam., adnate to the spathe in the lower ½, somewhat conic in the free part; pistils many and crowded, more or less

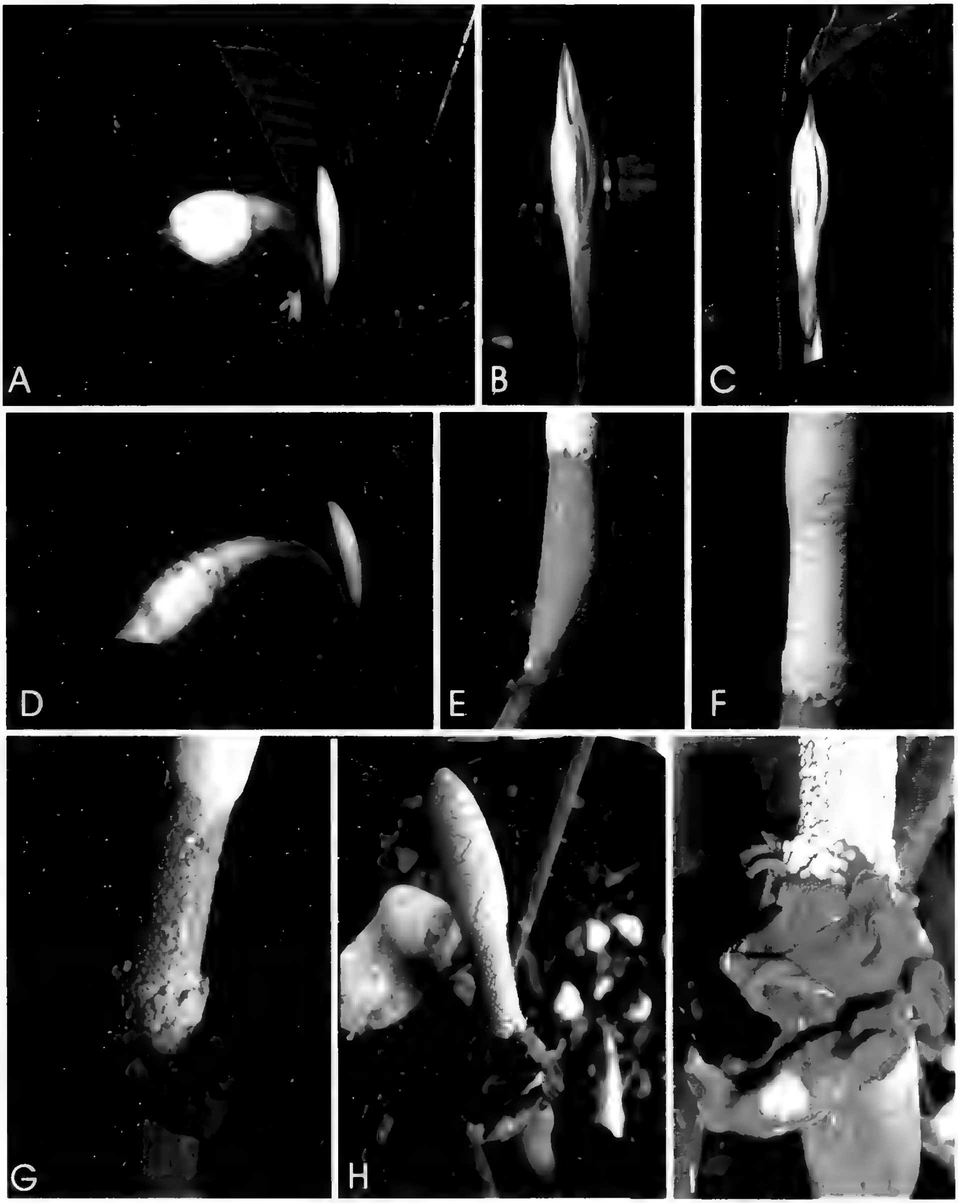

Figure 1. *Schismatoglottis clausula* S.Y.Wong. A. A pair of inflorescences. B & C. Inflorescence at female anthesis. D. Spathe limb senescense by disarticulating into numerous circumferential rings along the length; E. female zone (spathe removed artificially); F. Sterile interstice, male zone and appendix at female anthesis; G. Spadix at the end of male anthesis; H & I. Spathe limb marcescent.

globose, *ca* 0.4 mm diam., green when fresh; stigma sessile, button-like, *ca* 0.3 mm diam., turn orange post female anthesis; interpistillar staminodes confined to a basal row along the spathe/spadix adnation, shortly stalked, clavate, round-topped, *ca* 0.5 mm wide; sterile interstice present, above the spathe constriction, *ca* 0.3-0.5 cm long × 0.6 cm diam., wider than the distal portion of the female zone and the male zone, crowded, irregularly polygonal, flat-topped, 0.5 – 0.6 mm diam., white prior to anthesis, greyish orange post anthesis; male zone cylindrical, 1.1 cm long × 0.5 cm diam.; stamens crowded, small, *ca* 0.2-0.3 mm diam., truncate, dumbbell-shaped, white when fresh, turn orange post male anthesis, connective narrow; thecae with slightly elevated rims (overtopping the connective) surrounding a deep broad pit-like pore; appendix *ca* 2 cm long, slightly wider than the top of the male zone, in the distal half tapering to an acute point; staminodes of appendix flat-topped, irregularly polygonal, small, *ca* 0.3 mm diam., white when fresh, turn yellow post male anthesis. **Infructescence** unknown.

Distribution: Malaysia, endemic to Sarawak, known only from the type locality.

Habitat: Lithophytic in shade of primary lowland dipterocarp forest on shales, 60 m asl.

Etymology: The specific epithet is derived from the Latin *clausus* meaning closed, referring to the spathe limb barely opening at anthesis.

Notes: *Schismatoglottis clausula* is most similar to *Schismatoglottis mayoana* Bogner & M.Hotta but is readily distinguished by the senescence mechanics of the spathe limb. The spathe limb senesces by disarticulating into numerous circumferential rings along the length, and then collapses downwards, while remaining marcescent post anthesis. The stamen is small (0.2-0.3 mm), with thecae rims slightly elevated and overtopping the connective, these rims each surrounding a deep, broad, pit-like pore. The interstice staminodes become markedly elevated prior to male anthesis. This latter character has so far only been observed in *S. mayoana*.

Schismatoglottis dulosa S.Y.Wong, *sp. nov.*
Ab Schismatoglottis multiflora *similis, combinatio appendice spadicis, inflorescentis erectis et spathae laminorum marcescenti remanens, non reflexis postanthesis, distinguitur* – **Typus:** Malaysia, Sarawak, Kuching, Bau, Kampung Jugan, 01° 28' 46.4"; 110° 05' 08.5", 26 Mar 2004, *P.C. Boyce & Jeland ak Kisai AR-279* (holo, SAR). **Fig. 2.**

Herbs to *ca* 35 cm tall. **Stem** pleionanthic, condensed, more or less creeping, *ca* 2 cm diam. **Leaves** *ca* 8-12 together; petiole terete, 20-30 cm long, always tinged reddish towards the base, glabrous, sheathing only at the extreme base, the sheath extended into a bicarinate narrowly lanceolate free ligular portion to *ca* 12 cm long, drying red–brown; laminae broadly lanceolate, softly coriaceous, *ca* 15-25 cm long x 4-9 cm wide, dull dark green adaxially, abaxially paler and glaucous when fresh, drying brown, base always obtuse, tip acute and acuminate for 2 cm and with a cylindric mucro to 2 cm long; midrib adaxially grooved and abaxially very prominent (dry) with 14-16 primary lateral veins on each side alternating with fine interprimaries and diverging at *ca* 60°; secondary venation fine and very dense, adaxially obscure, mostly arising from the midrib; tertiary venation tessellate but obscure. **Inflorescences** up to 3 together, up to *ca* 13 cm long, emerging and remaining erect throughout anthesis, subtended by cataphylls resembling the ligular sheath extensions; peduncle less than the length of the free ligules. **Spathe** *ca* 13 cm long, lower spathe obliquely inserted from peduncle, *ca* 4 cm long, thickly coriaceous, pale green at base, whitish towards the distal portion, differentiated from the limb by a weak constriction corresponding with the top portion of the female zone; spathe limb *ca* 9 cm long, white, oblongo-lanceolate, apiculate for 5 mm, forming a hook, remaining marcescent, not reflexing, turning brownish red. **Spadix** sessile, *ca* 10 cm long, subcylindric; female zone *ca* 4 cm long × 1 cm proximally (0.6 cm distally) diam., adnate to the spathe in the lower ½, somewhat conic in the free part; pistils crowded, more or less globose, *ca* 0.5 mm diam., yellowish green when fresh; stigma sessile, overtopping the ovary, pappilate, *ca* 0.6 mm diam.; interpistillar staminodes present, scattering, shortly stalked, clavate, round–topped, *ca* 0.4 mm wide, white when fresh; sterile interstice present, monometric with female and male zone, cylindrical, *ca* 0.5 cm long × 0.6 cm diam., white when fresh; male zone cylindric, *ca* 2.3 cm long x 0.6 cm diam.; stamens laxly arranged, truncate, more or less rectangular, *ca* 0.7 mm long × 0.5 mm wide, pale orange when fresh, with the connective wide and about the height of the thecae, the thecae at the short ends, each with one pore; appendix contiguous from the male zone, *ca* 4 cm long, in the distal half tapering to an acute point; staminodes of appendix flat-topped, cylindrical, white when fresh, turn yellow post male anthesis, *ca* 1.0 mm diam. **Infructescence** unknown.

Distribution: Malaysia, endemic to Sarawak, known only from the type locality.

Habitat: Lithophytic in shade of lowland forest on limestone, 50 m asl.

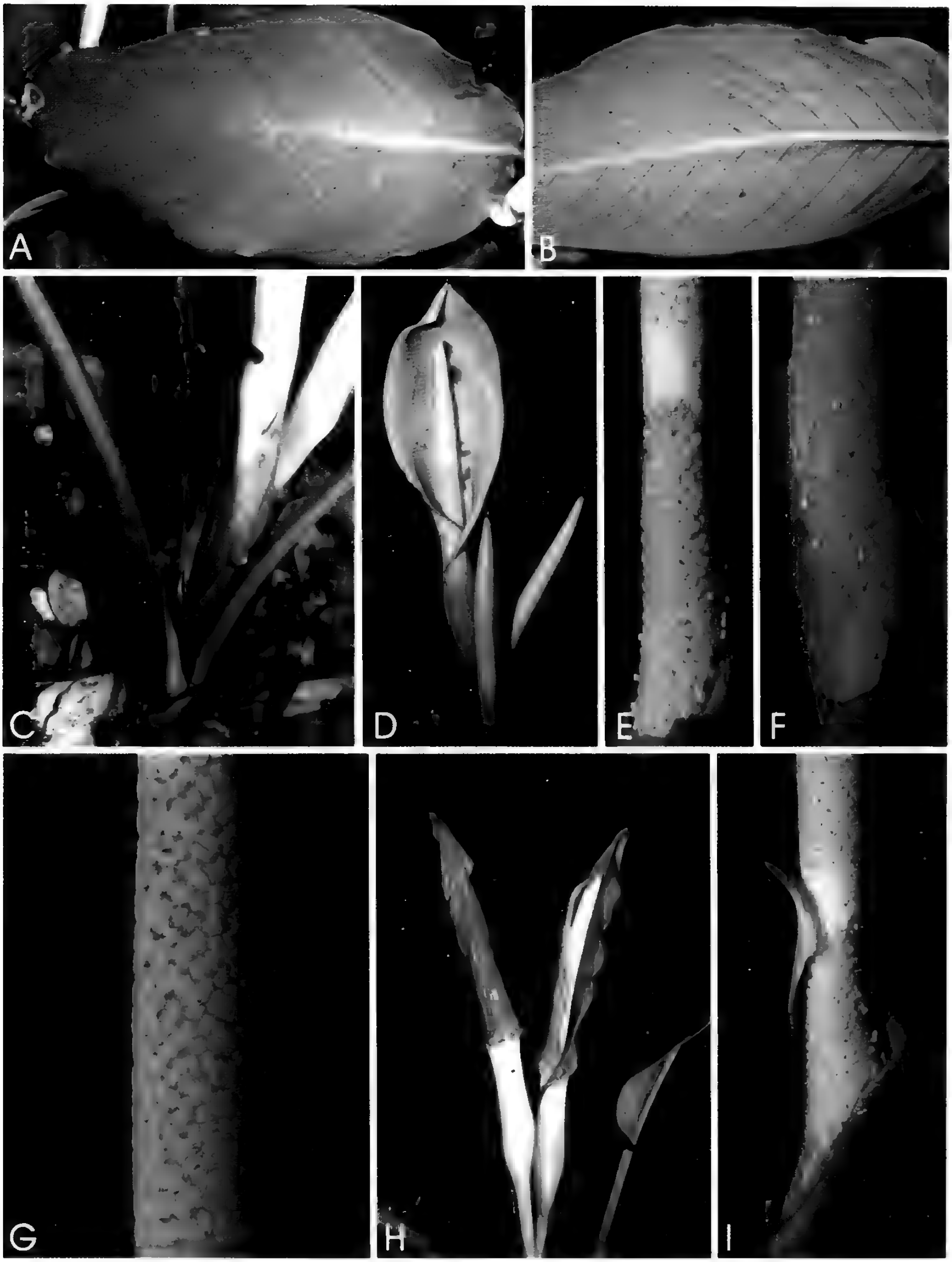

Figure 2. *Schismatoglottis dulosa* S.Y.Wong. Adaxial (A) and abaxial (B) side of lamina; C. Petiole with marcescent free petiolar sheath; D. An inflorescence at male anthesis with two emerging inflorescences; E & F. Female zone at female anthesis; G. Male zone; H. Spathe limb marcescent; I. Spadix at male anthesis.

Etymology: The specific epithet is derived from the Latin *dulon* meaning enslaving, referring to the spathe limb remaining marcescent and enclosing the spadix post anthesis.

Notes: *Schismatoglottis dulosa* is vegetatively most similar to *Schismatoglottis multiflora* Ridl. except an appendix is present in *S. dulosa* (absent in *S. multiflora*), and the inflorescence remains erect in *S. dulosa* (declinate by flexing of the peduncle in *S. multiflora*). *Schismatoglottis dulosa* is further distinguished by the spathe limb marcescent, not reflexing and falling caducous post anthesis as occurs in *S. multiflora*.

Schismatoglottis jitinae S.Y.Wong, *sp. nov.*
Inter alii specibus Schismatoglottidorum grex Multiflorae per combinatio caulis elongatis, erectis ascendentis, cum inflorescentia femina et inforescentia mascula in partem conubialiter intra spatham inferiorem contentis cum constricta spathae supra media Schismatoglottis jitinae *proprius. Ab* S. erectus *ligulis vaginae petiolaris marcescentis et laminis foliorum lenis coriacea, impolitus, abaxaliter pro totam longitidinem, et basali (adaxaliter) roseus, pedunculo valde brevis et crassus, erectus, differ; spathae fructiferorum succulentus differt.* – **Typus:** Malaysia, Sarawak, Kapit, Pelagus Rapids, 02° 11' 15.1"; 113° 03' 29.01", 14 Mar 2005, *P.C.Boyce et al. AR-1038* (holo, SAR). **Fig. 3.**

Herbs to *ca* 40 cm tall. *Stem* pleionanthic, elongated, erect, sometimes ascending, *ca* 2-2.5 cm diam.. **Leaves** *ca* 12-15 together; petiole short, 10-15 cm long, terete, always D-shaped towards the base, asperulate, pink in new leaf, sometimes remain dark red at base, puberulent, sheathing only at the extreme base, the sheath extended into a bicarinate narrowly lanceolate free ligular portion to *ca* 12 cm long, drying red–brown; laminae lanceolate to obovate, *ca* 18-25 cm long × 4-9 cm wide, softly leathery, matte green adaxially, paler and glaucous abaxially, base decurrent, always unequal, the tip acute then acuminate for 2 cm and with a cylindric mucro to 2 cm long; midrib adaxially grooved, always pink during innovation at the base (adaxially) and at the whole length (abaxially), primary lateral veins very prominent abaxially, 14-16 on each side alternating with fine interprimaries and diverging at *ca* 60°; secondary venation fine and very dense, adaxially obscure, mostly arising from the midrib; tertiary venation obscure. **Inflorescences** solitary, up to *ca* 8 cm long, emerging erect, remains throughout anthesis, peduncle short, *ca* 2.5 cm, stout, subtended by cataphylls resembling the ligular sheath extensions, always pink. **Spathe** *ca* 5.0 cm long; lower spathe, obliquely inserted from peduncle, *ca* 2.3 cm long, succulent, pale green at base, whitish towards the distal, differentiated from the limb by a weak constriction coinciding with the male zone; spathe limb *ca* 2.7 cm long, oblongo-lanceolate, white,

Figure 3. *Schismatoglottis jitinae* S.Y.Wong. A. Whole plant; B. Emerging inflorescence; C. Inflorescence at female anthesis; D. Spathe limb caducous in small pieces; E. Female zone (spathe removed artificially); F. Spadix (spathe removed artificially).

apiculate for 1 mm, caducous, fragmenting into small pieces. **Spadix** sessile, *ca* 4.5 cm long, subcylindric; female zone *ca* 1.3 cm long × 1.2 cm proximally (0.7 cm distally) diam., adnate to the spathe in the lower $^{2}/_{3}$, somewhat conic in the free part; pistils crowded, more or less globose, yellowish green when fresh, *ca* 0.5-0.7 mm diam.; stigma sessile, button-like, pappilate, overtopping ovary; interpistillar staminodes confined to the basal of female zone, a few, shortly stalked, clavate, round-topped, *ca* 0.5 mm wide, white when fresh; sterile interstice present, *ca* 0.4 mm long × 0.7 cm wide, monometric with the female and male zone, white when fresh; male zone cylindric, *ca* 1.4 cm long × 0.6 cm diam.; stamens packed, truncate, dumbbell shaped, *ca* 0.5 mm long × 0.3 mm wide, white when fresh, with the connective wide and taller than the thecae, the thecae at the short ends, each with one pore; appendix contiguous from the male zone, *ca* 1.7 cm long, in the distal half tapering to a blunt point; staminodes of appendix flat-topped, irregularly polygonal, small, white when fresh, *ca* 0.3 mm diam. **Infructescence** unknown.

Distribution: Malaysia, endemic to Sarawak, Kapit Division.

Habitat: Mesophytic in steep gallery forest on shales, 50-430 m asl.

Etymology: The specific epithet is for Madam Jitin ak. Ojek, one of the nursery staff at Malesiana Tropicals Sdn. Bhd., and who formerly assisted with the maintenance of the Araceae research collection.

Notes: *Schismatoglottis jitinae* is distinctive by its elongated and erect aerial stem, the leaf laminae basally attenuate and usually unequal, and softly leathery, with the midribs of the innovations longitudinally bright pink abaxially and basally adaxially. Cataphylles are also always pink.
In having erect, elongated stems, *S. jitinae* approaches *S. erects* M.Hotta, from which it differs by the short and stout peduncle not elongating during anthesis, the succulent lower spathe and the spathe constriction coinciding with the middle part of the male zone.

Other specimens seen: MALAYSIA. Sarawak: Kapit Division, Nanga Gaat, Rejang Wood Concession, Sungai Bereng, 01° 45' 36.0"; 113° 27' 54.7", 15 Dec 2004, *P.C. Boyce et al. AR-891* (SAR); Pelagus, Pelagus rapids, 02° 11' 15.1"; 113° 03' 29.01", 14 Mar 2005, *P.C. Boyce et al. AR-1039* (SAR); Kapit, Taman Rekreasi Sebabai, 01° 56' 45.6"; 112° 54' 16.8", 19 Apr 2006, *P.C. Boyce et al. AR-1785* (SAR).

Acknowledgements

This study is funded by the Ministry of Higher Education, Malaysia Fundamental Research Grant Scheme No. FRGS/01(04)/609/2006(42) under Sarawak Forestry Department Research Permit Nos. NPW.907.4.2(I)-101 & NCCD.907.4(IV)-41 & Park Permit Nos. 58/2007 & 37/2009. The collaboration and support of the Sarawak Forestry Department, the Forest Research Centre (Kuching), The Semenggoh Botanical Research Centre, and the Sarawak Biodiversity Centre are gratefully acknowledged. Thanks are due to Peter Boyce for translating the Latin diagnoses.

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Studies on Schismatoglottideae (Araceae) of Borneo X. *Pichinia*, a New Genus from Sarawak, Malaysian Borneo

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Abstract

Pichinia S.Y. Wong & P.C. Boyce is described as a new genus from Sarawak, Malaysian Borneo with one species, *Pichinia disticha* S.Y. Wong & P.C. Boyce. This genus is, so far, known only from the type locality, Pichin, Serian, Bahagian Kuching, Sarawak. The genus is illustated and a key to the Schismatoglottideae is presented.

Introduction

Tribe Schismatoglottideae comprises *Schismatoglottis* Zoll. & Moritzi (with probably in excess of 150 species), and six mono- to oligospecific 'satellite' genera: *Aridarum* Ridl., *Bakoa* P.C. Boyce & S.Y. Wong, *Bucephalandra* Schott, *Phymatarum* M.Hotta, *Piptospatha* N.E. Br. and *Schottarum* P.C. Boyce & S.Y. Wong (Bogner and Hay, 2000; Boyce and Wong, 2008). The overwhelming majority of Schismatoglottis species, and all the satellite genera except *Piptospatha*, are endemic to Borneo. Initially, the new species described here was tentatively placed as a *sp. nov.* in *Schismatoglottis*, although the unique shoot architecture and basal placentation are anomalous. However, subsequently molecular analyses based on two plastid markers by the first author (Wong *et al.*, in review) revealed that the species to be well-supported as a taxon distinct from to *Schismatoglottis sensu* Hay & Yuzammi, the latter being a grossly polyphyletic assemblage. We are here describing this taxon as a new genus, *Pichinia* S.Y. Wong & P.C. Boyce, basal to *Schismatoglottis*, plus the satellite genera with the exception of *Schottarum* P.C. Boyce & S.Y. Wong.

Key to genera of Schismatoglottideae and their principle subgeneric divisions in Borneo, Jawa and Nusa Tenggara

1. Wings of petiolar sheath fully or almost fully attached to the petiole; seeds never with a micropylar appendage 2
1. Wings of petiolar sheath extended into a free ligular portion; seeds sometimes with micropylar appendage 3

2. Inflorescences on very slender peduncles, nodding at anthesis, peduncle at spathe insertion flexing 180° from vertical axis. Infructescences narrowly campanulate, nodding. Plants of podsols .... ***Hestia***
2. Inflorescences erect to nodding at anthesis, if nodding, then either peduncle massive, and peduncle at spathe insertion at most 45° from vertical axis. Infructescences fusiform with a constricted orifice, if campanulate, then thick-walled and erect, never nodding. Plants of various substrates but never on podsols 4

3. Modules monoeuphyllous, congested in a distichous arrangement; ligular sheath persistent .... ***Pichinia***
3. Modules polyeuphyllous and leaves never distichous; ligular sheath when present marcescent 5

4. Spathe limb persistent into fruiting. Petiolar sheath usually fully deciduous; spadix interstice always present, invariably at least partly naked .... ***Apoballis***
4. Spathe limb deciduous during anthesis, or marcescent. Petiolar sheath persistent or marcescent; interstice where present always fully clothed with sterile flowers .... 12 ***Schismatoglottis***

5. Spathe not constricted 6
5. Spathe constricted 11

6. Thecae of anther never with horn- or needle-like projections 7
6. Thecae of anther each with a horn- or needle-like projection, although these sometimes visible only after female anthesis 8

7. Spadix almost completely adnate to spathe; male flowers mostly sterile with a narrow zone of fertile flowers exposed by the spathe opening; peduncle declinate during fruit maturation but twisting to become semi-erect at fruit maturity; spathe persistent into fruiting, and then at fruit maturity swiftly drying, reflexing and opening basally by tearing at

peduncle insertion to expose fruits but remaining distally convolute and while in this situation clasping the spadix. Seeds with blunt micropyle .... ***Bakoa***

7. Spadix either entirely free or only part of the female flower zone which is adnate to spathe; male flowers all fertile; peduncle erect (and then spathe limb caducous) or declinate (and spathe persistent) throughout the fruit dispersal; spathe limb either caducous early in anthesis or persistent until fruit maturity and then falling, still fresh to reveal entire spadix and ripe fruits. Seeds with a pronounced, hooked, micropylar appendage .... ***Piptospatha***

8. Thecae with needle-like projection extending only after female anthesis; projection tipped with a weakly peltate ovate-triangular flap. Appendix composed of pistillodes .... ***Schottarum***
8. Thecae with a horn- or needle-like projection present prior to female anthesis; with the projection pointed and never associated with a terminal flap. Appendix, where present, composed of staminodes 9

9. Sterile interstice of spadix with flattened scale-like staminodes; anthers not excavated .... ***Bucephalandra***
9. Sterile interstice absent or with truncate staminodes; anthers nearly always with the top excavated (except *A. incavatum*) 10

10. Thecae at each end of the anther (seen from above) .... ***Aridarum*** Sect. ***Aridarum***
10. Thecae adjacent on one side of the anther (seen from above) .... ***Aridarum*** Sect. ***Caulescentia***

11. Thecae of anther without horn- or needle-like projections; ovules on parietal placenta; seeds without a micropylar appendage .... ***Schismatoglottis* Multiflora Group**
11. Thecae of anther, each with horn- or needle-like projections; ovules on basal placanta; seeds with a long, hooked micropylar appendage .... ***Phymatarum***

12. Stem pleionanthic 13
12. Stem hapaxanthic .... ***Schismatoglottis* Calyptrata Group**

13. Petiole sheathing only at extreme base; each foliage leaf alternating with a cataphyll .... ***Schismatoglottis* Tecturata Group**
13. Petiole usually sheathing for at least a third of its length (rarely less); foliage leaves not alternating with cataphylls 14

14. Inflorescence erect; spathe limb irregularly crumbling and breaking away at or after male anthesis; small to medium plants .... ***Schismatoglottis* Asperata Group**
14. Inflorescence nodding; spathe limb clasping the spadix and more or less marcescent after anthesis, finally falling with spent parts of spadix; massive pachycauls .... ***Schismatoglottis* Corneri Group**

Pichinia S.Y. Wong & P.C. Boyce, *gen. nov.*
Herba lithophytica, caulis porrecto vel decumbens. Folii plura, in modulis monophyllorum distichus congestis, petioli vagina long persistens. Inflorescentia 1, erecta sub anthesis; pedunculus quam petiolo valde brevior; spatha erecta leniter constricta ad medium; spadix ad spatham basaliter adnatus, parte femina densiflora, parte mascula densiflora, staminodia ad basim et apicem habens, baccae carnosae densiter dispositae in spathae fructiferorum anguste-campanulatum persistens; flores masculi 2-andricis; flores feminei ovarium ovoideum, 2-loculare, ovulum plura ad basim loculi insertum. – **Typus:** *Pichinia disticha* S.Y. Wong & P.C. Boyce, *sp. nov.*

Lithophytic mesophytes. **Stem** creeping to erect. **Leaves** many together, distichously arranged, each module with prophyll, cataphyll (both long persistent, as long as petiolar sheath) and single foliage leaf; petiole D-shaped, puberulent, petiolar sheath with a long- persistent free ligular portion; lamina oblonceolate, orthotropic to petiole, basally cuneate, apex acuminate with tubular mucro, this short, and soon marcescent and brown, softly chartaceous, adaxially matter pale olive-green, abaxially glaucous; primary lateral veins prominent, pinnate, adaxially sunken, abaxially prominent, secondary venation pinnate, running parallel to primary veins, tertiary venation obscure. **Inflorescence** solitary, erect; peduncle terete, shorter than petiole; **spathe** up to 8 cm long; lower spathe ellipsoid, strongly oblique at insertion of spadix/ peduncle, sometimes with a ventral triangular gap formed during female anthesis and then closed prior to male anthesis, inflating at female anthesis but remaining constricted at top, lower spathe orifice gaping slightly at male anthesis once spathe limb shed; constriction between upper and lower spathe weakly defined; spathe limb caducous in a single piece; **spadix** often slightly exceeding spathe at anthesis, or at least equalling, conico-cylindric; **female flower zone** cylindrical, attenuate distally; pistils ellipsoid-cylindrical, white; stigma overtopping ovary, translucent white; ovary incompletely 2-locular, placenta basal, ovules several, micropylar appendage absent; interpistillar staminodes absent; interstice present, wider than female flower zone, with pistillodes proximally, these smaller than pistil, and staminodes distally, these very similar to stamens; **male flower zone** short; stamens irregular, crowded, whitish yellow; anthers 2 per flower, oblong to somewhat irregular in shape; pores apical, pollen extruded in strings; *appendix* present, conic, distally, staminodes crowded, irregular. **Infructescence** with lower spathe, narrowly campanulate, persistent; **fruits** berry, crowded, oblongo-globose; **seeds** ellipsoid, weakly longitudinally striate.

Distribution: Malaysia, Sarawak, Samarahan, Serian, Pichin.

Habitat: Perhumid evergreen forest on limestone, 100-250 m asl.

Notes: The shoot architecture of *P. disticha* is unique in the Schismatoglottideae. Although plants are polyphyllous, the individual modules are monoeuphyllous, comprising a prophyll, a cataphyll, both long-persistent, and a foliage leaf (euphyll). This basic model is similar to the module architecture of *Schimatoglottis tecturata* (*Schismatoglottis* Tecturata Group). However, unlike the Tecturata Group, the petiolar sheath in *Pichinia* is elongated in the form of a greatly lengthened persistent ligule, which would seem to have some protective role associated with the emerging shoots (as compared with the Tecturata Group where the petiolar sheath is greatly reduced to a minute ridge at the petiole base and the protective role of the sheath is homeotically taken by the cataphylls.

The distichous arrangement appears to favour litter-trapping ability, the plants growing horizontally out from vertical or near-vertical rock surfaces. The leaf posture is typically with the lamina orthotropic to the petiole in nature. Similar gross morphology and associated ecology is found in some *Homalomena* species, notably *H. geniculata* M. Hotta and *H. crassinervia* Ridl.

Occasionally the spathe has a triangular-shaped opening ventrally during female anthesis and which closes prior to the onset of male anthesis; it is not observed elsewhere in the tribe. Nothing is currently known about the pollination ecology of *Pichinia*.

Etymology: This genus is named after the type location, Pichin, Serian, Samarahan, Sarawak, Malaysia. This place is remarkable for the forested limestones that have been well preserved by the local community.

Pichinia disticha S.Y. Wong & P.C. Boyce, *sp. nov.*

Ab alii Schismatoglottidorum folii plura in modulis monophyllii distichus congestis et petioli vagina long persistens differt. Ad generis certeris Schismatogottideae (speciebus Schismatoglottii *et* Hestii *excludens) spatha erecta leniter constricta ad medium baccae carnosae densiter dispositae in spathe erecta anguste-campanulatus persistens, seminae sine appendice* *microphylorum et ovulum plura ad basim loculi distinguitur.* – **Typus:** Malaysia, Sarawak, Samarahan, Serian, Pichin, Gunung Kedadum, Sugun Karang, 01° 06' 17.6"; 110° 29' 04.5", 29 Jun 2006. *P.C. Boyce, Simon Kutuh ak Paru & Wong Sin Yeng AR-1860* (holotypus, SAR, + spirit). **Fig. 1.**

Mesophytic lithophyte up to 40 cm tall. **Stem** creeping to erect, up to 10 × 2 cm diam. **Leaves** many, distichously arranged, each module with prophyll, a cataphyll (both long persistent), up to 7 cm long, and a single foliage leaf; petiole D-shaped, puberulent, up to 12 × 1 cm diam., petiolar sheath with a long persistent free ligular portion up to 7 cm long; lamina oblonceolate, up to 25 × 9 cm, softly chartaceous, base ovate to cuneate, apex acuminate, with a short tubular mucro, up to 2 mm long, this soon marcescent, brown; lamina matte pale olive-green , abaxially greyish glaucous; primary lateral venation pinnate, up to 11 per side, prominent abaxially, sunken adaxially, interprimary venation barely distinguished from primaries; secondary venation pinnate, running parallel with primary veins, tertiary venation obscure. **Inflorescence** solitary, erect, smelling weakly esteric at anthesis; peduncle terete, pale green, up to 8 cm long; **spathe** up to 8 cm long; lower spathe mid green with darker longitudinal veins, *ca* 3 cm long, strongly oblique at insertion, with a ventral triangular gap sometimes forming during female anthesis and closing prior to male anthesis, barely constricted in between upper and lower spathe, spathe limb broadly triangular, *ca* 5 × 3 cm, white, caducous in a single piece, in interior surface at first shiny, then degrading into raised scales prior to falling; spadix exceeding or at least equalling spathe, *ca* 7 cm × 8 mm, conoid-cylindrical; **female flower zone** cylindrical, attenuate distally, *ca* 3 cm long; ovary ellipsoid-cylindrical, pale green; stigma overtopping ovary, translucent white; interpistillodes absent; *interstice* present, wider than female flower zone, with pistillodes proximally, these smaller than pistil, light orange, and staminodes distally, these similar to stamens, whitish yellow; **male flower zone** short, *ca* 1 cm long; stamens irregular, crowded, whitish yellow, *ca* 2 mm diam., pores apical, pollen extruded in strings; appendix *ca* 1.5 cm long, tapering-conic, appendiccal staminodes crowded, irregular, pale whitish yellow.

Distribution: Known only from the type locality and nearby forested limestone hills.

Habitat: Lithophytic mesophytes on exposed limestone or earth banks in perhumid limestone forest, 100-250 m alt.

Etymology: The specific epithet is for the distichous arrangement of the leaf.

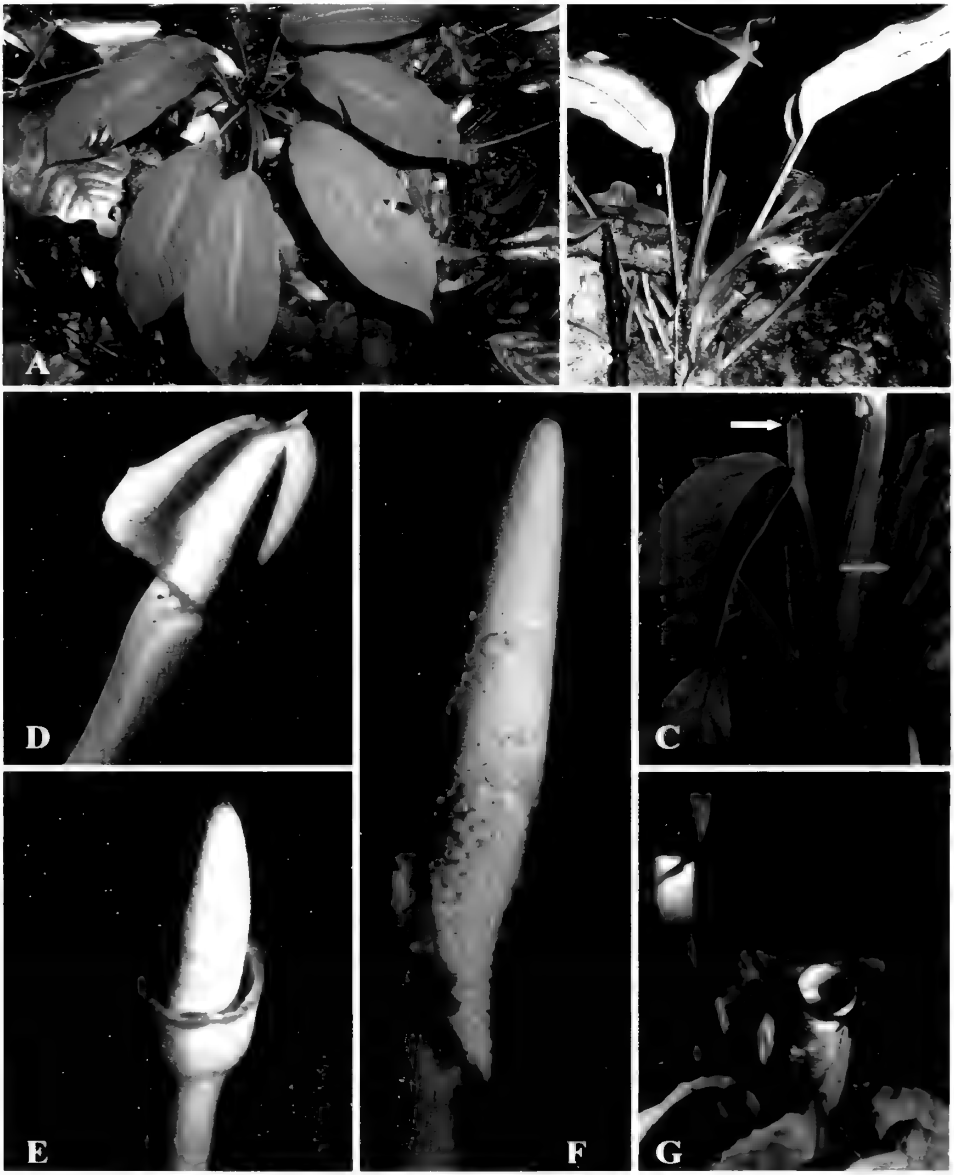

Figure 1. *Pichinia disticha* S.Y.Wong & P.C.Boyce. A. Plant in habitat, note the distichous leaf arrangement; B. Plant in habitat showing the leaf lamina glaucous abaxially and persistent free-ligular petiolar sheaths; C. Cultivated plant showing detail of the leaf arrangement. The white arrow indicates a petiolar sheath; the red arrow indicates a prophyll; D. Inflorescence at onset of male anthesis, note the spathe limb caducous in a single piece and the pollen extruding in strings; E. Inflorescence very late female anthesis, note gaping orifice to the lower spathe; F. Spadix at early male anthesis with spathe artificially removed; G. Young infructescences showing the open orifice to the persistent lower spathe; the spathes limbs in both examples have failed to fall after being shed due to dry air. All photos based on *P.C.Boyce et al. AR-1860* (SAR).

Other specimens seen: MALAYSIA. Sarawak, Samarahan Divison: Serian, Pichin, Tubih, Tahang Sipukam, 01° 07' 16.6"; 110° 26' 51.2", 26 Jul 2005, *P.C. Boyce et al. AR-1402* (SAR); Pichin, Sugun Serabu, 10 Oct 2005, *P.C. Boyce & Simon Kutuh ak Paru AR 1476*, (SAR); Pichin, Gunung Kedadum, Sugun Karang, 01° 06' 17.6"; 110° 29' 04.5", 7 Apr 2006, *P.C. Boyce, Simon Kutuh ak Paru & Wong Sin Yeng AR-1761* (SAR).

Acknowledgements

This study is funded by the Ministry of Higher Education, Malaysia by fundamental research grant scheme No. FRGS/01(04)/609/2006(42) under Sarawak Forestry Department Research Permit No. NPW.907.4.2(I)-101 & Park Permit No. 58/20076. The collaboration and support of the Sarawak Forestry Department, the Forest Research Centre (Kuching), and the Sarawak Biodiversity Centre, are gratefully acknowledged.

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Boyce, P.C. and S.Y. Wong. 2008. Studies on Schismatoglottideae (Araceae) of Borneo VII: *Schottarum* and *Bakoa*, two new genera from Sarawak, Malaysian Borneo. *Botanical Studies* **49**: 393-404.

Book Review: Tan, Benito C. and Ho Boon-Chuan. 2008. **A Guide to the Mosses of Singapore.** Photographs by Lim Yao-Hui. Science Centre Singapore. 149 pp. Price: SGD$ 5.50.

Finally it is here! After many months of waiting, I have received my copy of the book pent by post from a good friend in Singapore. It arrived yesterday and I have not stopped until I read it all. It is a great complement to my other bryology books and the first to cover tropical mosses. Co-authored by the world renown bryologist Dr. B.C. Tan, it expertly covers the species of mosses found in Singapore. And yet it is written in simple flowing English and accompanied by a wealth of clear colour photographs which will be enjoyed by both newcomers to moss biology and more seasoned bryologists alike. The first few pages are in fact dedicated to newcomers in moss biology with a description on morphology, life cycles and general information about these tiny green plants.

Over 150 species of indigenous mosses have been recorded in Singapore of which two are endemic to the island at present. The book contains a checklist of all these species with useful comments on habitat, distribution and survival status. As can be expected of a small book, not all of these mosses are described in detail. However over 56% of the book is dedicated to portraits of selected species. In this section the more common species are described in detail, accompanied by photographs of habit and morphology, which would allow the amateur bryologist to make an identification even in the field. Selected rare and unusual species are also described here in detail to make this a good cross section of the species to be found in the region. To make this chapter even more enjoyable the descriptions include the various uses of these mosses. This means that enthusiasts from the aquarium hobby, the bonsai hobby, and traditional medicine have been offered a good fodder for their interests.

The habitat and locations in Singapore have been also been listed for each species, which will help amateur bryologists find them easily. They will also find the keys to the families and genera of Singapore mosses in the book useful. If needed, there is a short description on how to collect and preserve mosses for later identification or study by specialists working at the herbarium and plant museum overseas. Finally the glossary complements the other sections by serving as a quick reference to the technical terms used in the book.

The Guide to the Mosses of Singapore serves as both a wonderful armchair read as well as a practical field guide. My only problem with it is that it has aggravated my desire to come over to do moss "hunting" in the island country called Singapore.

Stephan Mifsud
Malta, Europe

Book Review: Heide-Jørgensen. H S. 2008. **Parasitic Flowering Plants**. Brill NV, Leiden. 438 pp., numerous color photographs. ISBN 978 90 04 16750 6. Price: € 99/ US $147.

It is a pleasure to review such a beautiful book as this. The author has clearly crafted a labor of love, based on decades of study and research, followed by years of effort to write, design, and illustrate it. The book brings together an enormous amount of information about the biology, physiology, taxonomy, life history, and systematics (classification) of all flowering plants that are wholly or partly parasitic by nature. Their global distribution is mapped by family, which is a very handy feature.

In total, the author estimates that there are approximately 4,490 species of parasitic plants known, of which *ca* 4,100 species are *hemiparasites* (partly self-sustaining through photosynthesis) and only 390 species are *holoparasites* (entirely dependent on a host plant for survival). This total represents less than 1% of the estimated number of flowering plant species on earth. While the book does not present any figures for how many species are covered, an impressive diversity of them has been described and illustrated.

Virtually every page of text is enlivened by color photographs, most are of good to high quality, photomicrographs, schematic diagrams, and line art. The list of photo acknowledgments extends to 4 full pages; the amount of effort the author must have expended to track down and obtain permission to use the hundreds of color images in the book can scarcely be imagined. Only someone passionate about parasitic plants could have seen through to the end the task of searching for, and obtaining permission to use, so many fine color images, with such admirable results. Readers interested to know more about a particular image will find the full contact details provided for the photographers, a welcome touch. I note, in passing, that among the photographers is Singaporean Joseph T. K. Lai, and readers can expect to find photos in the book that were taken in Singapore.

Quibbles: there are a few. The running head on every one of the 438 pages states the title of the book, *Parasitic Flowering Plants*, but the reader has no idea in which of the 8 chapters or 43 subchapters he/she is in on any of those pages. In an information-dense and copiously illustrated tome such as this, finding one's way around within the book can be tricky, especially given the number of cases where illustrations cited in the text appear elsewhere in the book. It would have been far more user-friendly to use the running heads to indicate the chapters and subchapters to ease internal navigation.

Like many books that are edited by the author, there are some quirks and oddities of a very minor nature that creep into the text. Another pair of eyes is always beneficial in catching these little gremlins and removing them.

For example, the state of New Jersey (in the USA) has consistently been rendered as "New Yersey" everywhere it occurs in text and photo captions. On the whole, however, typos are remarkably few and the text reads very well.

The price is off-putting: like most books published by scientific and technical publishers, the price tag will deter many people from buying this magnificent book. It is to be hoped that Brill will produce a soft cover edition at a more economical price. Libraries, scientific institutes, and the serious student of parasitic plants will buy the hardcover edition, but the general public probably will not, purely for cost consideration. And that is a pity, because there is so much information contained in the book that will fascinate, educate, and delight anyone with an interest in the natural world. It is to be hoped that Singaporeans, and others in Southeast Asia generally, will splurge and indulge themselves by buying this book — it has much to offer. And all of the parasitic flowering plants native in our part of the world — *Rafflesia, Striga, Balanophora,* even a species of *Lepionurus* — are to be found within its covers, which brings the information in this book very close to home.

I can wholeheartedly offer my sincere congratulations to the author and publisher for bringing this comprehensive and beautiful work into existence; I believe it will be the standard of excellence on the subject of parasitic plants for decades to come.

George Staples
Senior Researcher
The Herbarium
Singapore Botanic Gardens

Book review: Fernando E.S., Min Hwan Suh, Jaeho Lee and Don Koo Lee. 2008. **Forest Formations of the Philippines.** ASEAN-Korea Environmental Cooperation Unit (AKECU), Korea, 232 pp. ISBN 978-89-92239-40-0 93530.

This is a beautiful pictorial guidebook produced under the joint research program of ASEAN-Korea Environmental Cooperation project (AKECOP). The book illustrates the various types of forest formations found in the Philippines today with minimal text but heavily elucidated with hundreds of colour images of the forest structures and representative plant species. According to the book, the aim is, "to help increase awareness, understanding, and appreciation of the rich biodiversity of the Philippine forests, and promote their conservation and sustainable use." Indeed, considering that the country today has less than 10% of the original forest cover, the publication is a timely reminder and serves to educate the young generation of Filipinos and people from the region what the country looked like once upon a time with its extensive and diverse forest formations.

The book starts with a short and succinct introduction that includes a terse description of the physical geography, geological origin and vegetation history of the island groups. It shows in a tabulated form the 12 types of natural primary forest vegetation still found in the country and their differences in soil water requirement, location, soil type, and elevation range. The 12 forest types described and illustrated in the book follow the forest classification proposed by Whitmore in 1984 in his book entitled, "Tropical Rain Forests of the Far East" (Oxford Press). They are: (1) Tropical lowland evergreen rain forest, (2) Tropical lower montane rain forest, (3) Tropical upper montane rain forest, (4) Tropical subalpine forest, (5) Forest over limestone, (6) Forest over ultramafic rocks, (7) Beach forest, (8) Mangrove forest, (9) Peat swamp forest, (10) Fresh water swamp forest, (11) Tropical semi-evergreen rain forest, and (12) Tropical moist deciduous forest. The book concludes with a short glossary of technical terms, the Literature Cited, an Acknowledgements and an Index.

Separate illustrative maps showing the limited range and disjunctive location of the limestone forest formation, the ultramafic forest formation, peat swamp forest formation and the fresh water swamp forest formation in the Philippines are provided. It would be more useful and educational had the authors of the book also provided up-to-date distribution maps for all other forest formations today.

No doubt, this pictorial book, with its many colourful photos, has made the reading and understanding of the usually dry subject matter of forest vegetation types easy and enjoyable.

What struck me most are the three chapters reporting on the ultramafic forest, peat swamp forest and fresh water swamp forest formations in the Philippines. My own knowledge about them in the Philippines has been enriched after reading the book. To my knowledge, this book is the first to document in writing and show with photos the existence of peat swamp forest in the Philippine archipelago! I can see from the photos presented that the peat swamp forest discovered recently in southern Philippines does have a similar plant community structure and harbors the same dominant plant species found in the peat swamp forest in Borneo. As these last mentioned three types of forest formations are also not well known to many in the neighboring countries, the book will be useful for any library in the region to possess.

My main "complaint" about the book is the uneven quality of sharpness of the colored photos printed in the book ranging from good to excellent. A cursory read of the book will reveal some photos that appear dull in color separation and not very clear in image outline, while others are printed in brilliant, colourful texture to show details in good contrast. Some of the well composed and reproduced photos of individual plant species seen in the book that merit a special mention are *Monophyllaea merrilliana* on p. 93, *Xanthostemon fruticosus* on p. 102, *Bruguiera gymnorhiza* on p. 143, *B. sexangula* on p. 144, *Nypa fruticans* on p. 160, *Medinilla teysmanii* on p. 179 and *Symphorema luzonicum* on p. 210. As several of the plant species photographed and shown in the book are the uncommon, rare and endemic plant taxa in Philippines, the book has an added value in providing a pictorial aid to the identification of these little known species.

My other criticism against the book is the very small print of the photo credits of the photographers in the acknowledgement.

I like to recommend this pictorial book to everyone who has an interest in knowing and learning about the different types of forest formation in the region, not just in the Philippines. It is a great pleasure and deep intellectual satisfaction to read this book and appreciate the beauty of the plant world, as well as to imbibe the rich information of the types of forest formation conveyed by the book. In fact, I will recommend the book to every school and university, research institutions and government offices across the country, and in the region too, as an important reference.

The authors are to be congratulated for a pictorial book well prepared to create public awareness on an important topic of conservation today – the tropical rainforest vegetation.

B.C. Tan
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INSTRUCTIONS TO AUTHORS

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Ridley, H.N. 1930. *The Dispersal of Plants Throughout the World.* L. Reeve, Ashford, U.K.

For literature citations in taxonomic papers, the main standards are Stafleu & Cowan, Taxonomic Literature, ed. 2, Regnum Vegetabile, Utrecht, for abbreviated names of books, and Botanico-Periodicum-Huntianum (B-P-H), Pittsburgh for abbreviated names of periodicals. The following style is required:

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Sterculia acuminatissima Merr., Philipp. J. Sci. 21 (1922) 524.

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