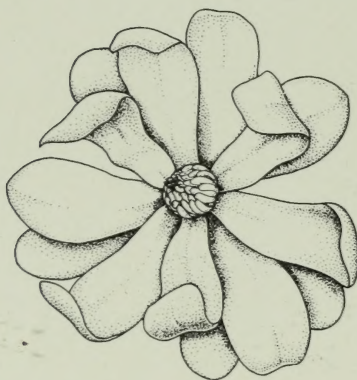




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A New Record of *Dryobalanops beccarii* (Dipterocarpaceae) from Peninsular Malaysia

L.S.L. CHUA AND L.G. SAW

Forest Research Institute Malaysia,
Kepong 52109, Kuala Lumpur, Malaysia

Abstract

Dryobalanops beccarii Dyer, Dipterocarpaceae, first described and recorded from Borneo, has now been documented from Johore, Peninsular Malaysia, where it grows on ridges in several compartments in the Panti Forest Reserve, Kluang Forest Reserve, and the Labis Forest Reserve. It is a large tree frequently reaching 40 m height and more than 1 m diameter.

Introduction

Two species of *Dryobalanops*, *D. aromatica* and *D. oblongifolia*, were recorded for Peninsular Malaysia (Ashton, 1982). The genus *Dryobalanops* is clearly distinguished from other dipterocarp genera by the presence of five wing-shaped, subequal fruit calyx lobes and closely parallel venation on its leaf blade. In Peninsular Malaysia, trees of both species are characterized in the field by scaly bark, peeling in large, irregular, thin flakes. In *D. oblongifolia*, leaves are oblong or oblong-lanceolate and the fruit calyx lobes are shorter than the nut, while in *D. aromatica*, leaves are oval or sub-ovate and the calyx lobes are longer.

During a plant diversity enumeration exercise in the Virgin Jungle Reserves (VJR) network in Peninsular Malaysia, Ang Khoon Cheng and Kamarudin Saleh discovered in Kluang Forest Reserve (FR) and the VJR in Labis FR, Johore, trees that had leaves that closely resembled *D. aromatica* but the bark was distinctly different in that the outer bark was scaly, very shallowly fissured and had a laminate inner bark. It was clear that these populations belonged neither to *D. aromatica* nor *D. oblongifolia* but their identity could not be confirmed in the absence of flowers and fruits.

A dipterocarp mast-fruiting episode occurred in Peninsular Malaysia during the second and third quarters of 2002. Taking advantage of this cyclic event, teams from the Botany and Seed Technology Units, Forest Research Institute Malaysia (FRIM), launched an extensive fruit collection exercise, targeting species that are rare and/or threatened. Fruiting trees in several of these *Dryobalanops* populations

enabled materials for herbarium specimens and fruits for *ex situ* planting to be collected. The identity of the species could be confirmed and proved to be *D. beccarii* Dyer. A full description of the species based on characters from these populations is provided below.

Dryobalanops beccarii Dyer J. Bot. 12 (1874) 100; Ashton, Fl. Malesiana I (9) (1982) 375. Type: Malaysia, Sarawak, Matang, *Beccari PB2944* (K, lecto).

Large tree to 30 m tall, 63.7 cm diam., with small buttress to 1.5 m tall. *Bark* shallowly fissured to scaly, flaky and peeling off in pieces on the lowest part of the trunk immediately above the buttress, greyish-white; inner bark laminate, reddish-brown; sapwood yellowish brown, exuding resin when cut. *Twigs* 3 mm diam., glabrous, drying almost black. *Leaves* thickly coriaceous, glabrous, drying brown above, dark brown below; petiole 10–17 mm long, 1 mm thick, glabrous, drying almost black; blade broadly ovate, 3.5–6.3 x 2.4–3.7 cm, apex tapering to a 7-mm long acumen, base broadly cuneate to rounded, margin thickened, midrib prominently raised below, sunken above, secondary veins numerous, closely parallel, faint on both surfaces, smelling of camphor smell when crushed. *Flowers* not seen. *Fruit* calyx glabrous, shallow cup tapering gradually and cuneate at the pedicel, lobes 5, equal, oblong-spathulate, base to 2 mm, yellowish green when fresh, 4.0–6.5 x 0.6–1.0 cm, veins conspicuously raised on both surfaces, nut ovoid, glabrous, yellowish green when fresh, to 1.4 x 0.9 cm, style remnant 1 mm long, free from calyx except the base.

Vegetatively, the leaf morphology of *Dryobalanops aromatica* and *D. beccarii* is very similar and hence it is difficult to differentiate them when sterile. However, the bole character as described above can readily distinguish the two species. In addition, the fruits of *D. beccarii* are different from *D. aromatica* (Table 1).

Table 1: The bark and fruit characters of *Dryobalanops aromatica* and *D. beccarii*

| | <i>D. aromatica</i> | <i>D. beccarii</i> |
|-----------------------|--|-----------------------------|
| Outer bark | long, thin, recurved, irregular scales | shallowly fissured to scaly |
| Inner bark | fibrous | laminate |
| Fruit calyx size (cm) | 4.0–6.0 x 0.8–2 | 4.0–6.5 x 0.6–1.0 |
| Max. nut size (cm) | 3 x 1.5 | 1.4 x 0.9 |

Specimens examined: Johore: Compartment 6B in Panti FR, *Damahuri S. FRI 43567*, 7 August 2002 (KEP), *Ang K.C. FRI 43651*, 13 August 2002 (KEP); Kluang FR, *Ang K.C. FRI 43653*, 14 August 2002 (KEP).

Geographical distribution in Peninsular Malaysia

In Peninsular Malaysia, *Dryobalanops beccarii* is known only from Johore from three localities, namely in compartments 6A, 6B, 7, 8A and 8B, Panti FR; in compartment 132, Kluang FR; and in compartment 841 in VJR, Labis FR.

Prior to this discovery, *D. beccarii* was only known to occur in Borneo on leached sandy soils on coastal hills and inland ridges below 700 m (Ashton, 1982). Like *D. aromatica* and *D. oblongifolia*, it shows the same pattern of geographic distribution in southern Johore and west Borneo. Corner (1958) has drawn attention to the similarity in the floras of these two regions, which he termed the Riouw pocket.

Ecology

In Johore, this species is found in the lowland dipterocarp forest at about 75 m altitude, confined to ridges. They are large trees in the emergent and main canopies. On some ridges, it is co-dominant with *Shorea curtisii* Dyer ex King. In Kluang FR, it grows sympatrically with *D. aromatica* on steep hill slopes. In all the three sites, *D. beccarii* grows gregariously. In Borneo, the species is locally abundant on leached sandy soils on coastal hills and inland ridges below 700 m.

Germination

Three seed batches of mature fruits were collected from five trees in Panti FR and six trees in Kluang FR in August 2002 and germinated with the seed wings removed in the FRIM nursery (Table 2). Germination is deemed to begin when the radicle protrudes through the seed coat. Germination is epigeal. The hypocotyl elongates to c. 1.8 cm. The emergent cotyledons are bilobed, fleshy and unequal. The first two leaves are opposite. In some seedlings, branching may begin at the first node.

Mean percentage germination was 73 ± 12 s.d., the percentage varying from 62 to 86 (Table 1). All three seed batches showed a typical germination sigmoid curve (Fig. 1).

The germination period for *Dryobalanops beccarii* seed batches was longer than that of *D. aromatica* (100% within 20 days, Ng 1991, Siti Asha *et al.* 1995, Tamari 1976) and *D. oblongifolia* (100% within 10 days, Siti Asha *et al.* 1995 and 33 days, Ng 1991). In addition to the longer germination period, the three seed batches of *D. beccarii* achieved a maximum germination percentage of only 86.

Conservation notes

In Panti FR, ground checks in August 2002 indicated that the boundary of compartments 6B, 8A and 8B, which forms part of the forest reserve boundary, is adjacent to land being developed for small-scale agriculture activities. Because agriculture has a propensity for expansion, it is recommended that the forest office regularly monitors this section of the boundary to ensure its integrity and prevent future conflict. Compartments 6B, 8A and 8B had been logged in 1982/83. These

compartments are neither VJR nor are they above 1000 m elevation and hence have no legal protected status and may be licensed out for timber harvesting. Populations in Labis VJR and in Compartment 132, Kluang FR have a much brighter prospect as these forests are virgin and VJR and water catchment areas have protected status. Studies are currently being undertaken to determine the species' population size and genetic structure.

In view of the above scenario, *Dryobalanops beccarii* in Peninsular Malaysia is given the 2001 IUCN category of Endangered EN A3dB1. *D. beccarii* falls within the A3 category (there will be a projected or suspected population size reduction of $\geq 50\%$ within the next 10 years or three generations, whichever is the longer); 'd' (the reduction can be based on actual or potential levels of exploitation); and B1 (its geographic range, in the form of the extent of occurrence, is estimated to be less than 5000 km²).

Table 2. Percentage germination and survival in three seed batches of *Dryobalanops beccarii*

| Batch No. | 2002-0502 (FRI 43567) | 2002-0545 (FRI 43653) | FRI 43651 |
|--------------------------------------|--------------------------|-----------------------|--------------------------|
| Locality | Panti FR, Compartment 6B | Kluang FR | Panti FR, Compartment 6B |
| Collector | Damahuri S | Ang KC | Ang KC |
| Date planted | 12 August 2002 | 16 August 2002 | 16 August 2002 |
| No. sown | 41 | 617 | 78 |
| Max. germination (%) | 71 | 86 | 62 |
| Germination period (days) | 4-32 | 4-31 | 2-31 |
| No. days to achieve 50 % germination | 6 | 9 | 23 |
| % seedling survival after 1 month | 22.8 | 72.8 | 100 |

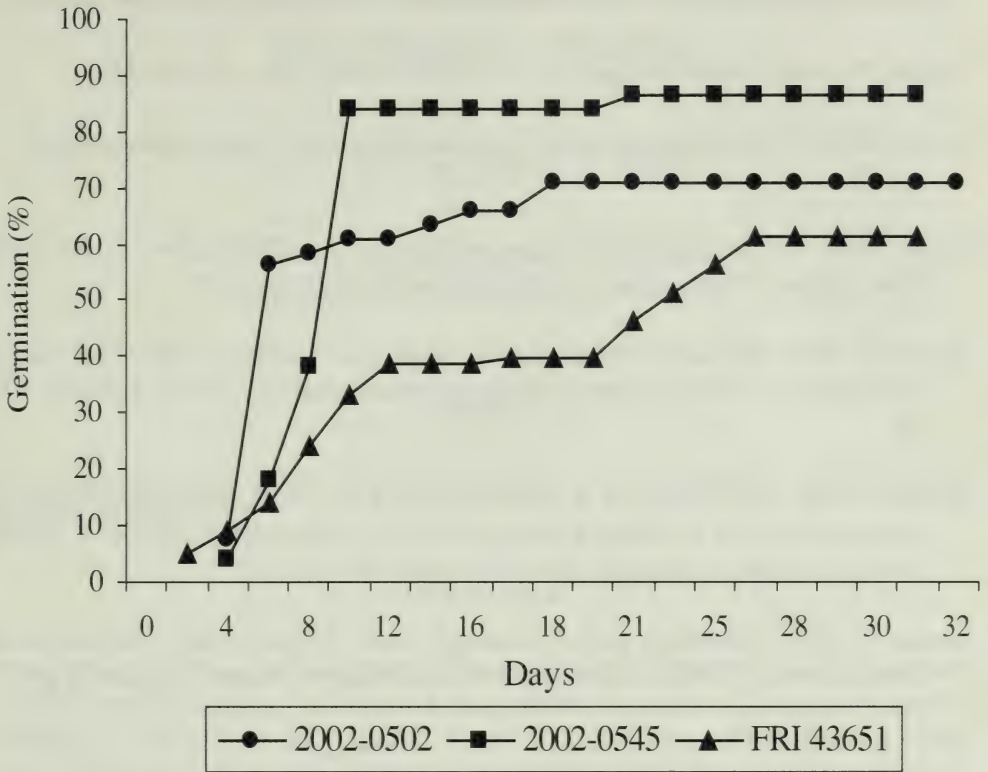


Figure 1: Germination curve for three different seed batches of *Dryobalanops beccarii*

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Conservation Notes on *Vatica yeechongii* (Dipterocarpaceae) from Peninsular Malaysia

L.S.L. CHUA AND L.G. SAW

Forest Research Institute Malaysia
Kepong 52109, Kuala Lumpur, Malaysia

Abstract

The conservation status of *Vatica yeechongii* L.G. Saw, recently discovered from Peninsular Malaysia, is described.

Introduction

Vatica yeechongii was discovered along Sungai Tekala in Sungai Tekala Recreational Forest, which is located in Sungai Lalang Forest Reserve, Selangor, Peninsular Malaysia, 3° 03.485' N, 101° 52.373' E, alt. 79 m asl (Saw, 2002). Several weeks after its discovery in the type locality, a population was found in Compartment 4, Setul Forest Reserve, along the upper stream of Setul River, Negeri Sembilan (2°46.937' N, 101° 55.069' E). The population was located in the forest margin of a logged-over forest adjacent to the trunk road from Mantin to Seremban town at an altitude of c. 192 m.

Vatica yeechongii is very distinct in leaf characters and nut shape (Saw, 2002). The leaf blade is oblanceolate, 44–84 x 10–6.5 cm, thickly coriaceous, bullate above with 28–30 pairs of veins. The nut is ovoid.

Ecology

A medium-sized tree 8–15 m tall and 9–13 cm diameter, *V. yeechongii* occupies the dense understorey of lowland dipterocarp forest. In the type locality, nine trees were found on gentle earth banks of a free flowing stream near the public campsite. There were no trees further upstream. Details of its growth pattern are described in Saw (2002). Large dipterocarps such as *Shorea leprosula* Miq., *S. parvifolia* Dyer, *S. macroptera* Dyer, *S. acuminata* Dyer, *S. pauciflora* King, *S. ovalis* (Korth.) Blume, *S. bracteolata* Dyer, *S. dasyphylla* Foxw., *Dipterocarpus crinitus* Dyer and *D. cornutus* Dyer dominated the forest. Non-dipterocarps included *Intsia palembanica*

Miq. (Leguminosae), *Saraca cauliflora* Baker (Leguminosae), *Terminalia subspathulata* King (Combretaceae), *Pometia pinnata* J.R. Forst. & G. Forst. (Sapindaceae), *Canarium patentinervium* Miq. (Burseraceae), *Elateriospermum tapos* Blume (Euphorbiaceae), *Palaquium gutta* (Hook.f.) Baill. (Sapotaceae), *Pimelodendron griffithianum* (Müll.Arg.) Benth. (Euphorbiaceae), *Endospermum diadenum* (Miq.) Airy Shaw (Euphorbiaceae), *Dyera costulata* (Miq.) Hook.f. (Apocynaceae), *Artocarpus lanceifolius* Roxb. (Moraceae), *A. scortechinii* King, *Girroniera subaequalis* Planch. (Ulmaceae), *G. nervosa* Planch., *Payena lucida* A. DC. (Sapotaceae), *Streblus elongatus* (Miq.) Corner (Moraceae), *Litsea costalis* (Nees) Kosterm. (Lauraceae), *Gynotroches axillaris* Blume (Rhizophoraceae), *Cratoxylum formosum* (Jack) Dyer (Guttiferae), *Scaphium macropodum* (Miq.) Beumée ex Heyne (Sterculiaceae) and *Pternandra echinata* Jack (Melastomataceae).

At Setul, the forest margin vegetation gradually gave way to a forest having a main canopy to c. 20 m tall, dominated by *Shorea leprosula*, *S. macroptera*, *S. multiflora* (Burck) Symington, *S. acuminata*, *S. parvifolia*, *Parkia speciosa* Hassk. (Leguminosae), *Pometia pinnata*, *Camptosperma auriculatum* (Blume) Hook.f. (Anacardiaceae), *Artocarpus scortechinii*, *Pterocymbium tinctorium* (Blanco) Merr. (Sterculiaceae) and *Alstonia angustiloba* Miq. (Apocynaceae). The understory lacked palms and climbing rattans and the forest floor was covered with abundant dipterocarp seedlings. Herbs such as *Tacca integrifolia* Ker Gawl. (Taccaceae) and *Costus speciosus* (J. König) Sm. (Costaceae) were present in scattered numbers. At least 70 *V. yeechongii* trees were found on steep slopes of riverbanks and on slopes away from the riverbanks. Trees here averaged 9.8 m tall (range 2–21 m), had a diameter at breast height c. 8.2 cm (range 1.6–18.8 cm) with a spreading crown. Its bark was whitish and smooth with horizontal rings. Those growing along the riverbanks had poor bole form and multiple branching was common while those further away had a better bole form.

Germination

Mature fruits were available from at least six trees in Sungai Tekala and one tree in Setul Forest Reserve from June to August 2002. Three seed batches, collected from two localities at different dates, were germinated with the seed wings removed and observed in the Forest Research Institute Malaysia, FRIM (Table 1). Germination is deemed to begin when the radicle protrudes through the seed coat. Germination of *Vatica yeechongii* is epigeal. The emergent cotyledons are bilobed, fleshy and equal. The hypocotyl elongates to c. 4.8 cm tall and the first two leaves are opposite.

Mean percentage germination was 63.011 ± 31.207 s.d., the percentage varying from 42.1 to 98.9. All three seed batches showed a typical sigmoidal germination curve. Germination percentage on the first day of germination, i.e. day 5, was 38% for seed batch 2002–0510 and 18.7% for seed batch 2002–0503. Despite this promising

Table 1. Percentage germination and survival of three seed batches of *Vatica yeechongii*

| Batch No. | 2002-0503 (FRI 46613) | 2002-0510 | 2002-0542 (FRI 46668) |
|-------------------------------------|---|---|---------------------------------------|
| Locality | Sungai Tekala, Sungai Lalang Forest Reserve, Selangor | Sungai Tekala, Sungai Lalang Forest Reserve | Setul Forest Reserve, Negeri Sembilan |
| Collector | Chung R | Saw LG | Chan YC & Ayau K |
| Date planted | 14 July 2002 | 28 July 2002 | 20 August 2002 |
| No. sown | 107 | 79 | 89 |
| Max. germination (%) | 42.1 | 48.1 | 98.9 |
| Germination period (days) | 5–37 | 5–25 | 2–25 |
| No. days to achieve 40% germination | 45 | 32 | 5 |
| % seedling survival after 1 month | 95.5 | 97.3 | 40 |

beginning, however, these two seed batches took a longer time to achieve the 40% germination mark compared to seed batch 2002–0542 (Fig. 1). Preliminary germination results suggest that seed viability is higher in the population at Setul Forest Reserve but this could be due to a variety of factors e.g., fruit maturity, seed vigour, timing of fruit collection, tree health, pest infestation on fruits, etc. In addition, population sizes could also affect gene flow; a larger population is probably more genetically diverse.

In situ Conservation

Vatica yeechongii is so far known only from these two localities. Preliminary observations on population size suggest that this species is a rare endemic. The population at Sungai Tekala lies in recreational forest. Under the National Forestry

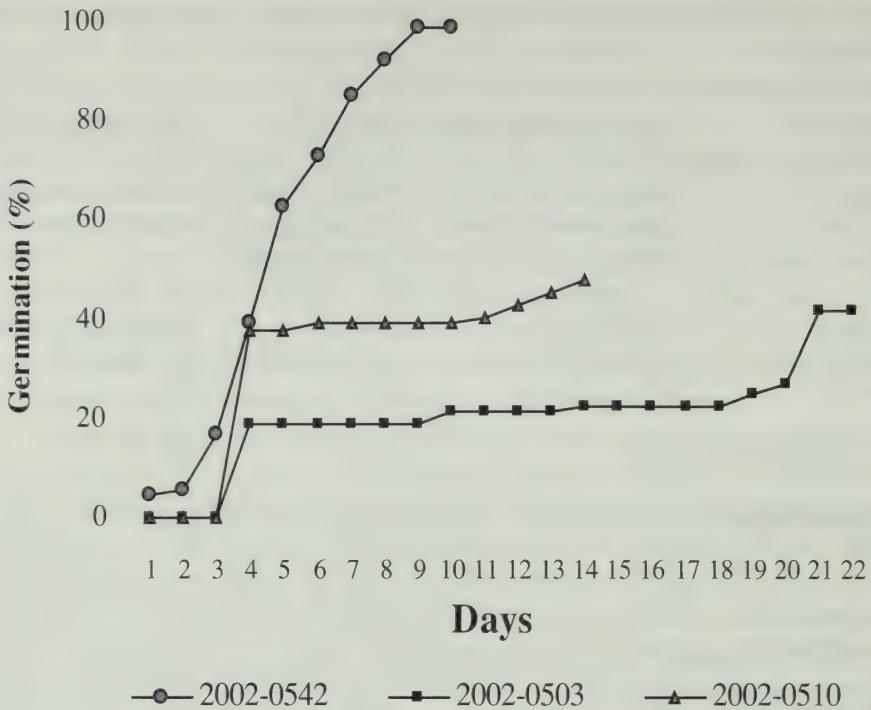


Figure 1: Cumulative germination percentage for different seed batches of *Vatica yeechongii*

Act, no harvesting of resources is permitted in such forests as they are strictly meant for recreation. Population loss will only take place if the Forest Reserve or parts of the reserve, through de-gazettement, are converted to non-forestry land use. For Sungai Tekala, such action is, however, highly unlikely as the area is in the vicinity of the water catchment for the Semenyih Dam, a principal dam providing water supply to Kuala Lumpur. In terms of man-made threats to the reduction in population size and area of occupancy, there are no immediate foreseeable pressures either from habitat loss or degradation or timber harvesting. We note that the practice of clearing undergrowth in areas designated for recreational use may affect regeneration and survival of populations. Careful observations on the individuals here suggest that the species has no potential commercial value, as trees do not attain significant harvestable size at maturity and has a poor bole form. The Forest Department of Central Selangor District has been alerted to the presence of the new species and steps are being taken to conserve the population.

The population at Setul faces a different scenario. Although it lies in the forest reserve, it is adjacent to the main road. It has some form of protection by virtue of it being in Forest Reserve, but the fact that it lies very close to the road could pose

future conservation conflicts when road expansion is required. It is therefore recommended that more stringent protection measures be provided for this population. In view of the above scenario, *Vatica yeechongii* should be given the 2001 IUCN category of Critically Endangered CR A2cB1. It falls within the A2 category (inferred or suspected population size reduction of $\geq 80\%$ over the last 10 years or three generations, whichever is longer); 'c' (a decline in area of occupancy, extent of occurrence and/or quality of habitat) and B1 (its geographic range, in the form of the extent of occurrence and area of occupancy, is estimated to be less than 100 km²). An attempt to estimate the population size of the species in each locality is currently being undertaken.

From the viewpoint of conservation, the discovery of a new dipterocarp species in Selangor and Negeri Sembilan is remarkable because in comparison to other states, these two states encounter higher conflict between socio-economic development and conservation. Both populations face an acute need for non-forestry related land development and hence there exist tremendous pressures leading to habitat loss and degradation. The fact that a new species was discovered in this current era of diminishing forest areas merely shows that we do not know enough about our plant diversity and that long-term field observations are necessary. This can only take place with concerted botanical research programmes having full national, financial and personnel support.

Ex situ Conservation

One month after potting, 215 seedlings from the three batches survived, each bearing at least two pairs of leaves. Distribution to other gardens and arboreta is envisaged in the near future.

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Studies in Malesian Piperaceae 3¹

WEE-LEK CHEW

12 Robinson Street
Chatswood NSW Australia

Abstract

Thirteen species, mostly from New Guinea, are dealt with in this paper, of which 12 other species previously considered distinct are reduced to synonymy. No new taxon is proposed.

Introduction

This is part of a series of papers, albeit variously titled, resulting from continuing work initiated some 35 years ago. As mentioned previously (*vide* Chew, *Journal Arnold Arboretum* **53** (1972) 1–25), the work began by way of an undertaking to identify the collection of *Piper* made by the Royal Society Expedition to the Solomon Islands in 1965. This necessitated reference to the New Guinea species of *Piper* which then extended to an assessment of the taxonomic status of the more than 150 species described by Casimir de Candolle from that region and surrounding islands.

I was encouraged to this much larger task by the fact that the type materials from the former German New Guinea held in the Berlin Herbarium are still extant, having been removed to safety prior to the destruction of the Herbarium, and assisted further by the availability of a vast collection of high quality specimens made since about 1945.

Thus, I was enabled to determine (at the least to assess, in a few cases) the taxonomic status of some 108 of de Candolle's species and to identify over 1,000 collections from New Guinea and the surrounding region. This resulted in the reduction of 75 Candollean names to synonyms. The assignment to synonymy of this large number of de Candolle's species should not detract from the otherwise excellent work accomplished by this great taxonomist: he did not have the advantage of the availability of the vast range of contemporary collections that I have.

Apart from the floristic account of the alpine species by van Royen in *The Alpine Flora of New Guinea* **3** (1982) 1267–1287, I am not aware of any major study having been undertaken on the New Guinea species since commencement of my work.

¹Following: *Blumea* **20** (1972) 145–149 and *Blumea* **37** (1992) 159–164.

There still remains quite a number of Candollean species requiring determination of their taxonomic status. Additionally, large quantities of unnamed materials in many herbaria await identification, some of which may represent undescribed species. As this is a large undertaking, it may need the assistance of future botanists to continue the work.

Unless otherwise stated, all collections cited in this paper have been seen and studied by me personally.

1. **Piper abbreviatum** Opiz in Presl., Rel. Haenk. 1 (1828) 157; Quisumbing, Philip. J. Sci. 43.1 (1930) 58, fig. 24 & 25; Chew, J. Arn. Arb. 53 (1972) 1. **Type:** Philippines, Luzon: *Haenke s.n.* (holotype PR).

Synonyms: *Piper minus* K. Schum. & Lauterb., Fl. Schutzgeb., (1900) 258, *syn. nov.* **Type:** New Guinea, Ramufluss, *Lauterbach 2611* (holotype B).

Piper subnudilimum C.DC., Bot. Jahrb. 55 (1918) 205, *syn. nov.* **Type:** New Guinea, Djamu, *Schlechter 17347* (holotype B, iso K).

Piper quintuplinervium C.DC., Candollea, 1 (1923) 203, 204; Candollea, 2 (1925) 224 *syn. nov.* **Type:** New Guinea, *sine loc.*, *Lauterbach 605* (isotype WRS�).

Dioecious glabrous climber. *Lamina* shortly petiolate, elliptic, ovate to broadly ovate, c. 10 x 5 cm, length:breadth ratio c. 2:1, glabrous on both surfaces, apex acute to acuminate, base cuneate to rounded, symmetrical; lateral veins 4 pairs, the lowermost pair very short, arising from the base, the 2nd and 3rd usually long, arising from the midrib a little above the base, the distal 4th pair very short, often absent, arising from the midrib near the apex. *Stipules* to 1.5 cm long, often 1 cm long, usually as long as petioles. *Inflorescences* shorter than leaves, peduncle c. 1.5 cm long, usually as long as petioles; males thin, to 6 cm long, bracts orbicular, peltate, subsessile; females shorter and thicker, c. 2 x 0.8 cm, bracts orbicular, peltate, sessile. *Male flowers* 2-staminate; pedicel very short stout, hirsute; stamens c. 1 mm long, anthers reniform to subglobose, 2-valved, slightly shorter than filaments. *Female flowers* sessile; stigmas 3- or 4-fid, sessile. *Fruits* sessile, entirely conrescent at maturity.

Distribution: Philippines, Java, Sulawesi, Maluku, New Guinea, Bismark Archipelago and Solomon Islands.

Notes: *Piper minus* is a smaller-leafed version of *P. abbreviatum* and there are no essential differences that can justify their being kept apart. *Kajewski 2047* has leaves that vary greatly from the narrowly ovate c. 4 x 1.5 cm to broadly ovate c. 6 x 4 cm.

In *Piper subnudilimum*, the type materials contain immature inflorescences. The leaves are large, much like those of the Philippine populations of *P. abbreviatum*, but the leaf bases are like the typical New Guinea plants with three pairs of lateral

veins. This difference is, however, not significant and cannot be relied on to distinguish *P. subnudilimbum* from *P. abbreviatum*.

As for *Piper quintuplinervium*, the isotype shows two leaf forms: the narrowly ovate, small ones borne on end of free branches and the large pentagonal leaves borne at the nodes of the climbing parts of the plant. Other than small differences between *P. quintuplinervium* and *P. abbreviatum*, there is nothing significant to keep the two species apart.

Specimens examined: NEW GUINEA: Djamu Distr., *Schlechter 17347*; Ramufluss, *Lauterbach 2611*; sine loc., *Lauterbach 605*. SOLOMON ISLANDS: *Kajewski 2047* (A).

2. *Piper arfakianum* C.DC. in Gibbs, Phyt. Fl. New Guinea. (1917) 127. **Type**: New Guinea, Irian Jaya: Arfak Mts., Angi Lake, *L.S. Gibbs 5525* (isotypes K, L).

Synonym: *Piper pilosulinodum* C. DC. in Gibbs, Phyt. Fl. New Guinea. (1917) 128, *syn. nov.* **Type**: New Guinea, Arfak Mts., Koebre Ridge. *L.S. Gibbs 5624* (holotype BM; isotype K).

Climber, usually glabrous, rarely hairy. *Leaves* with 1–2 cm-long petioles. *Lamina* symmetrically ovate, c. 9 x 4 cm; lateral veins 3 pairs, arising from the base; apex long acuminate; base rounded, not auriculate. *Inflorescence* longer than leaves; peduncle longer than petiole. *Bracts* peltate, circular. *Flowers* sessile, crowded. *Stigma* 3-fid, reflexed, subsessile.

Distribution: New Guinea.

Notes: *Piper pilosulinodum*, also from the Arfak Mountains, is conspecific with *P. arfakianum*. Having compared the type materials of these two species and with other recent collections, I am unable to keep the species apart. Of the collections cited above, *Kanehira & Hatusima 13708* is the closest match to the type material of *P. arfakianum* and *van Royen & Sleumer 7456* is a good match to the type material of *P. pilosulinodum*.

Piper arfakianum is closely related to *P. macropiper* Pennant from which it can be distinguished by the above enumerated combination of characters, especially the petiole being much longer than in the latter species and the lamina base not auriculate.

Specimens examined: IRIAN JAYA: Arfak Mt., alt. 2200 m, *Kanehira & Hatusima 13708*, April (A, BO); alt. 2400 m, *L.S. Gibbs 5525* (BM, K); Koebre Ridge, *L.S. Gibbs 5624* (BM, K); Mt. Nettoti, alt. 1920 m, *van Royen & Sleumer 7456*, Nov (A,

BRI, CANB, L, LAE). PAPUA NEW GUINEA: Central Division, Mt. Tafa, alt. 2300 m, *Brass* 4047 (BRI), 5029 (BRI), 5116 (BRI); Chimbu Distr., Mt. Wilhelm, alt. 2600 m, *Borgmann* 292, Aug. (LAE); Milne Bay Distr., Mt. Dayman, alt. 2200 m., *Brass* 22534, May (A, CANB, LAE); Morobe Distr., Edie Creek, *Ridsdale* NGF 30266, Nov (LAE); alt. 2000 m, *Womersley & Thorne* NGF 12837, Jun. (BRI, CANB, LAE); Mt. Kaindi, alt. 2200 m, *Brass* 29732, May (LAE); alt. 2438 m: *Coode & Katik* NGF 32863, Jun. (BRI, CANB, LAE); alt. 2300 m, *Millar* NGF 23627, Aug. (BRI, CANB, LAE); alt. 2100 m, *Streimann* NGF 30867, Aug (BRI, LAE, NSW); Southern Highland Distr., Anga, alt. 2000 m, *Schodde* 1556, Jul. (A, CANB, LAE); Spreader Divide, alt. 2255 m, *Streimann & Kairo* NGF 45446, Nov (CANB, NSW).

3. ***Piper austro-caledonicum*** C.DC. in DC. Prodr. 16.1 (1869) 346; Schlechter, Bot. Jahrb. 39 (1906) 92; Moore, J. Linn. Soc. Bot. 45 (1921) 381; Guillaumin, *Flore analytique et synoptique de la Nouvelle-Caledonie, Phanerogames.* (1948) 90. **Type:** sine loc., *Forster s.n.* (syntype: BM). sine loc., *Vieillard* 1227 (syntype: P).

Synonyms: *Piper paitense* Schltr., Bot. Jahrb. 39 (1906) 92, *syn. nov.* **Type:** New Caledonia, Mt Paita. *Schlechter* 14964 (isotypes L, P, WRSL).

Piper comptonii S.Moore, J. Linn. Soc. Bot. 45 (1921) 381, *syn. nov.* **Type:** New Caledonia, Mt Panie. *Compton* 1805 (isotype BM).

Piper peekelii C.DC., Bot. Jahrb. 57 (1922) 354, *syn. nov.* **Type:** Neu-Mecklenburg, Namatanai, *P. Peekel* 322 (holotype B).

Glabrous climber. *Leaves* petiolate. *Lamina* of lower leaves broadly ovate to somewhat rounded to cordate, c. 9 x 7 cm, those of the upper leaves usually smaller; apex shortly blunt-acuminate; base rounded to peltate, slightly unequal, glabrous on both surfaces. *Inflorescences* slender, as long as the leaves, peduncle as long as the petiole; bracts pedicellate. *Male flowers* 3-staminate, stamens subsessile. *Female flowers* with 3-fid stigmas.

Distribution: New Guinea, Bismarck Archipelago, Solomon Islands and New Caledonia.

Notes: Forster *f.* misidentified his collection from New Caledonia as *Piper siriboa* Forst. *f.* (auct. non L.). I have seen both Forster's and Vieillard's collections annotated by C.DC. and am confident that the collections belong to *P. austro-caledonicum*. Based on examination of the type specimens, *P. paitense*, *P. comptonii* and *P. peekelii* are all conspecific with this species because I cannot differentiate their type specimens from specimens of *P. austro-caledonicum*. They are therefore reduced to synonymy. *Piper austro-caledonicum* is closely related to *P. elbertii* C.DC. of Indonesia and *P.*

retrofractum Vahl of the Philippines. Further study is needed to assess their relationship.

Specimens examined: NEW GUINEA: Torricelli, *Schlechter 14381* (BO). BISMARCK ARCHIPELAGO: New Ireland (Neu-Mecklenburg), Namatanai, *P. Peekel 322* (B). SOLOMON ISLANDS: Guadalcanal, Wanderer Bay, *BSIP 12247* (LAE); Kolombangara, Kokove area, *BSIP 7579* (LAE); New Georgia, Kibukibu River, *BSIP 4819* (LAE); Ranongga Island, *BSIP 15572* (LAE); Santa Ysabel, Jejevo River, *BSIP 4700* (LAE), Sigana, *Brass 3451* (A, BRI), Vuranimala village, *BSIP 15401* (A, LAE). NEW CALEDONIA: Aoui, Mei, *Baumann-Bodenheim 10156* (P), *10176* (A, BRI, P); Bois du Mois de Mai, R. Blanche, *Baumann-Bodenheim 14071* (A, BRI, P), *15179* (A, BRI, P); Col de Vulcan, *Baumann-Bodenheim 8259* (A, BRI, P); Dambea, *Franc 3* (P), *Franc 3A* (L); Ermitage stream, *Compton 149* (P); Mt. Paita, alt. 300 m, *Schlechter 14964*, Oct 1902 (L, P, WRSL); Mt. Panie, *Compton 1805*, Aug 1914 (BM); Noudoure: *MacKee 2670* (A, P); Yaouhe, *Schlechter 14786* (P). SINE LOC: *Forster s.n.* (BM); *Vieillard 1227* (P); *Schlechter 14787* (L, WRSL).

4. ***Piper bosnicanum*** C.DC. in Gibbs, Phyt. Fl. New Guinea, (1917) 207; *Candollea* 1 (1923) 221, as '*bosniakanum*'. **Type**: New Guinea, Schouten Islands, Bosnic, *L.S. Gibbs 6277* (holotype K; isotype L).

Glabrous climber. *Lamina* ovate, to 15 x 10 cm, with 3 pairs of lateral veins arising directly from the base. *Petiole* to 2 cm long. *Inflorescence* to 5 cm long, shorter than leaves; peduncular stalks c. 2 cm long, bracts oblong with sinuous margin. *Female flowers* subsessile, spirally arranged; *stigmas* 3–4-fid, sessile, strongly reflexed. *Fruits* subsessile, obovoid to ovoid, c. 10 x 6 mm broad, crowded.

Distribution: New Guinea and the Solomon Islands.

Notes: *Piper bosnicanum* is very close to *P. buruanum* Miq. of Maluku: further study is needed to assess their relationship.

Specimens examined: IRIAN JAYA: Schouten Islands, Bisnik, *L.S. Gibbs 6277*, Jan (K; L); Vogelkop Peninsula, Aifact River, *van Royen & Sleumer 7260*, Nov (L). PAPUA NEW GUINEA: Sepik Distr., Aitepe Subdistr., along Pieni River, *Darbyshire & Hoogland 8007*, Jun (CANB). SOLOMON ISLANDS: Bougainville Island, north of Buin, *Craven & Schodde 256*, Aug (CANB, LAE); Guadalcanal, Wanderer Bay, *BSIP 9104* (LAE); Kolombangara, Bambari area, *BSIP 7511* (LAE); Malaita, Takwa, *BSIP 10785* (LAE); New Georgia Group, Roniane Lagoon, *BSIP 2918* (LAE); Wagina Island, *BSIP 5493* (LAE).

5. ***Piper lessertianum*** C.DC., *J. Bot.* 4 (1866) 164; Quisumbing, *Philip. Jour. Sci.*

43.1 (1930) 36, fig. 10, including var. *oblongibaccum* (C.DC.) Quisumbing. **Type:** Philippines, Luzon, *sine loc.* *Cuming 1343* ('1342'), 1841 (holotype BM).

Synonyms: *Chavica lessertiana* Miq., Syst. Piperac., (1843) 270 non *Piper lessertianum* C.DC. (1866); *Piper pseudo-chavica* C.DC. in DC., Prodr. 16.1 (1869) 351, *nom. superfl.* **Type:** Philippines: Luzon, Cagayan Province, *Cuming 1343* (holotype G, not seen; isotype K).

Piper biroi K.Schum. & Lauterb., Nachtr. Fl. Schutzgeb., (1905) 238, *syn. nov.* **Type:** New Guinea, near Malanaku, *Biro 32*, Oct. (holotype B).

Piper oblongibaccum C.DC. in Leaflet. Philip. Bot. 3 (1910) 777, **Type:** Philippines: Oriental Negros Prov., *Elmer 9456* (not seen).

Piper lineatipilum C.DC., Nova Guinea Bot., 8.6 (1914) 1009, *syn. nov.* **Type:** New Guinea, Mt. Hellwig, *Römer 962* (holotype L).

Piper viridibaccum Trel., J. Arn. Arb., 9 (1928) 150, *syn. nov.* **Type:** New Guinea, Mowabula, *L.J. Brass 1370* (holotype A, isotype BRI).

Climber, dioecious, glabrous to villose. *Leaves* shortly petiolate, petiole to 1 cm long. *Lamina* narrowly ovate, ovate to broadly cordate, 12–32 x 5–17 cm; base unequally rounded, one lobe acute to narrowly rounded, the other auriculate, lateral veins 3–4 pairs, the distal pair arising about 2 cm from the midrib, the others almost directly from the base; apex often very long acute to acuminate. *Inflorescences* 5–12 cm long, less than 5 mm thick; peduncle slender, 3–8 cm long, much longer than the petiole and the floriferous part of the inflorescences. *Male flowers* with 2 subsessile stamens, with pedicellate peltate bracts. *Female flowers* with 3-fid rounded sessile stigmas. *Fruits* oblong, to 2.5 x 1.5 mm, borne crowded but not concretescent at maturity.

Distribution: Philippines, Sulawesi, New Guinea (Irian Jaya and Papua New Guinea).

Notes: This species is attributable solely to C.DC. who published it in 1866 basing on *Cuming 1342* (in herb. BM) without reference to Miquel's earlier species *Chavica lessertiana* which is based on *Cuming 1343* (in herb. G). I am grateful to have the advice of J.F. Veldkamp of Leiden (pers. comm., 2003) that *Cuming 1342* in C.DC.'s protologue of 1866 should read *Cuming 1343* because *Cuming 1342* refers to a species of Gramineae. Nevertheless, the authority of *Piper lessertianum* (1866) remains attributable solely C.DC. without reference to Miquel.

Later, in DC. Prodr. 16.1 (1869) 351, when C.DC. combined Miquel's *Chavica lessertiana* (1843) with his own *Piper lessertianum* (1866), he created the name *Piper pseudo-chavica* for the combined species. By contemporary rules, the name *Piper pseudo-chavica* is superfluous because his own *Piper lessertianum* (1866) is perfectly legitimate and should have been used instead.

Our Malesian species is not to be confused with *Piper lessertianum* (Miq.) C.DC. in DC. Prodr. 16(1): 258 (1869) based on *Ottonia lessertiana* Miq., which refers to an American species and, which binomial is a later homonym of our species.

Piper lessertianum C.DC. (1866) is readily recognised by the petioles being very short and the peduncles very long, often more than five times longer than the petiole and the floriferous part of the inflorescence. Yet, it is most variable in leaf form with lamina ranging from very narrowly ovate with a long attenuate apex through ovate ob-pentagonal to broadly cordate or heart-shaped. Besides, leaves borne on the climbing parts are usually small and broadly cordate to heart-shaped while those borne on the freely hanging branches tend to be ob-pentagonal to very narrowly ovate with long attenuate apices.

All these leaf forms have now been observed to occur on the same plant as evidenced by *Vink & Schram BW 8871*. In the circumstances, I have to assign to synonymy *Piper biroi*, *Piper lineatipilum* and *Piper viridibaccum* as they are distinguished purely on these leaf forms. For the same reason and after examination of collections authenticated by Quisumbing, I am unable to maintain var. *oblongibaccum* (C.DC.) Quisumbing.

Specimens examined: PHILIPPINES: Luzon, Cagayan Prov., *Cuming 1343* (BM, K); Mindoro, Mt. Halcon, *Ramos & Edano 40676*, Mar (NSW); Panay, Capiz Prov., Mt. Bulilao, *Martelino & Edano 35706*, Jun (NSW); Jaminden, *Ramos & Edano 30861, 31272*, May-Apr (NSW); Libacao, *Martelino & Edano 35395* (NSW), *35442*, May-Jun (NSW); Mt. Macosolon, *Ramos & Edano 30776*, Apr-May (NSW). SULAWESI: Kabaena Island, *Elbert 3393* (BO). IRIAN JAYA. Wati, Mapon Distr., *Ijiri & Niimura 674*, Apr (L); Wissel Lakes, Doglia, *Vink & Schram BW 8871*, May (CANB, LAE). PAPUA NEW GUINEA: Milne Bay, near Mayu Island, *Streimann NGF 28829*, Apr (L, NSW); Morobe Distr., Asubazo, *Kairo NGF 24403*, Jul (L); Northern Division, Sibium Range, *R. Pullen 5924*, Sept (CANB).

6. *Piper longipilum* C.DC., Bot. Jahrb. 55: 216 (1918); Candollea 1: 206 (1923).
Type: New Guinea, Sepik, alt. 1–200 m, *Ledermann 7565* (holotype B, isotype B).

Climber, dioecious, lightly pilose. *Leaves* shortly petiolate, petiole to 2.5 cm long. *Lamina* ovate, c. 28 x 18 cm; base unequally cordate, lateral veins 5–6 pairs, the basal pair arising c. 1 cm from the base; apex acuminate. *Male inflorescences (immature)* c. 8 cm long, c. 3 mm thick; peduncle slender, c. 1.7 cm long. *Male flowers* with pedicellate peltate glabrous bracts. *Female* unknown.

Distribution: New Guinea.

Notes: The type material of this species consists of two sheets: the one with field

notes and annotation by C.DC in 1917 is the holotype, the other is the isotype. A cursory examination of the type material suggests an alliance with *Piper decumanum* L. of which it might represent a hairy variant. As the type seems to be the only material there is of this species, I am unable to determine its status until I see more collections, especially of female plants.

7. **Piper melula** Trel., J. Arn. Arb. 9 (1928) 148. **Type:** Papua New Guinea, Vaitata River, *L.J. Brass 1130* (holotype A; isotype BRI).

Dioecious glabrous climbers. *Leaves* moderately petiolate, petioles 2–4 cm long, much longer than peduncles. *Lamina* irregularly ovate, broadly ovate to pentagonal, c. 12 x 8 cm; apex bluntly shortly acuminate; base rounded to shallowly cordate; lateral veins 3 pairs, the distal pair arising alternately from the midrib about 0.5–1 cm from the base, the other 2 pairs directly from the base; only the distal pair reaching to the apex, the 2nd pair reaching to 1/2 the length of the lamina, the basal pair only to 1/3 of the length of the lamina. *Inflorescences* shorter than the leaves, males slightly longer than females. Male floriferous part to 6 cm long on a peduncle to 7 mm long; female floriferous part to 4 cm long on a peduncle to 1 cm long. *Bracts* circular, margin sinuate, peltate, very shortly pedicellate. *Male flowers* with strongly reniform anthers, dehiscing by long apical slits. *Female flowers* sessile, crowded; stigmas 3- to 4-fid, sessile, stigmatous part reflexed. *Fruits* almost entirely conerescent, free only at the apices.

Distribution: Papua New Guinea.

Notes: *Piper melula* has the same leaf venation pattern as *P. plagiophyllum* K.Sch & Laut., and in some cases even the lamina shape of that species, but it differs in being a climber amongst other characteristics.

The infructescences of *Piper melula* appear similar to those of *P. pachyarthrum* K.Sch., but these species differ in other respects.

Piper melula appears also to be related to *P. elbertii* C.DC. of the Lesser Sunda Islands and *P. austro-caledonicum* of the Solomon Islands and New Caledonia.

There is a collection, *Kellman ANU 1597* (CANB) from Mindanao in the Philippines, which is remarkably similar to *Piper melula*. However, as this collection has a very young inflorescence, I hesitate to identify it as this species.

Specimens examined: PAPUA: Gulf distr., Tauri River, *Schodde & Craven 4700*, Mar (CANB); Vailala River, *L.J. Brass 1130*, Mar (A, BRI); Milne Bay distr., Kwagira River, Peria Creek, *L.J. Brass 23997* (A, CANB, LAE), *24006*, Aug (A, CANB, LAE).

8. **Piper novo-guineense** Warb., Bot. Jahrb., 13 (1891) 284, K.Schumann & Lauterbach, Fl. Schutzgeb., (1900) 258. **Type:** New Guinea, Sattelberg bei Finnschlafen, *Warburg 20740* (holotype B; isotype A).

Glabrous climber. *Lamina* narrowly elliptic, narrowly ovate to broadly ovate or broadly pentagonal, 17–19 x 5–9 cm; apex shortly blunt acuminate to long acute; base cuneate to rounded, very slightly asymmetrical, not auriculate; lateral veins 3 pairs, the distal pair arising slightly alternately from the midrib c. 1–2 cm from the base, the other 2 pairs arising directly from the base, sometimes another faint short pair arising from the base; the veins on the underside, especially at the basal portion, often covered with minute reddish brown scales, petiole to 1 cm long. *Male inflorescences* thin, as long as the females, peduncle as long as the males. *Male flowers* with bracts as in the females; stamens subsessile with broadly crescent-shaped anthers. *Female inflorescences* to as long as the leaves, sometimes longer, usually to 15 cm long; peduncular stalk c. 2 cm long. *Female flowers* sessile, stigma 3–4-fid. *Fruits* sessile, oblong, crowded; bracts rounded peltate.

Distribution: New Guinea.

Notes: *Piper novo-guineense* is reported to be common in primary forest and older secondary forests, between 500 and 2000 m altitude. At higher altitudes, the plants tend to have smaller leaves.

This species is closely related to *Piper macropiper* Pennant and especially to *P. truncatibaccum* C.DC.

Specimens examined: IRIAN JAYA: Lake Habbema, *L.J. Brass 10299*, Oct (A). PAPUA NEW GUINEA: Morobe Distr., Boana Mt. *Clemens 8467* (A); Gurokar, *L.J. Brass 29499*, May (CANB, LAE); Huon Peninsula, Mt. Rawlison, *Hoogland 9054*, Jun (A, BRI, LAE); Sattelberg, *Warburg 20740* (B, A); Wantoat area, Kikiepa, *Womersley & Thorne NGF 11875*, Jun (BRI, LAE); Selileo, *Hellwig 580*, Apr (B); Sepik, near Kilifas village, *Forman & Kumul NGF 48261*, Mar (LAE).

9. **Piper pallidilimum** C.DC., Nova Guinea Bot. 8.6 (1914) 1009. **Type:** New Guinea, Mt. Hellwig, alt. 2600 m, *von Römer 1316* (holotype L).

Synonym: *Piper peracutilimum* C.DC., Nova Guinea Bot. 8.6 (1914) 1005, *syn.nov.* **Type:** New Guinea, Mt. Hellwig alt. 2600 m, *von Römer 1252* (holotype L).

Climber, glabrous. *Leaves* shortly petiolate. *Lamina* ovate, 6–8 x 2–4 cm; base rounded, apex acuminate. Lateral veins 2–3 pairs, distal pair arising from the midrib a little

above the base. *Inflorescence* shorter than leaves. Peduncular stalk 7–10 mm long, about as long as petiole. *Males* up to 4 cm long, *females* c. 2 cm long. *Flowers* borne crowded, sessile. *Infructescence* congested, to 12 mm diam. as in *Piper abbreviatum* Opiz.

Distribution: New Guinea.

Notes: The type material of *Piper peracutilimbium* is indistinguishable from specimens of *P. pallidilimbium*. Therefore I see no reason to keep the two species apart.

Piper pallidilimbium is very close to *P. abbreviatum* Opiz from which it differs in the lamina being furnished with fewer lateral veins, one of which issues from the midrib, and also by the peduncular stalk being somewhat filamentous.

Specimens examined: IRIAN JAYA: Mt. Hellwig, alt. 2600 m, von Römer 1316 (L), 1252 (L); *sine loc.*, Pulle 700 (L), 737 (L), 834 (L).

10. ***Piper pseudamboinense*** C.DC., Bot. Jahrb. 55 (1918) 206. **Type**: New Guinea, Keneyia, alt. 150 m, *Schlechter 18445* (holotype B).

Climber. *Leaves* very shortly petiolate. *Lamina* pentagonal to oblong, commonly c. 24 x 11 cm; apex bluntly acuminate, acumen to 1.5 cm long, base asymmetrically cordate, one side often forming a large lobe, the lobes often covering the node; lateral veins usually 5 pairs, the distal pair alternate, arising from the midrib c. 2–3 cm from the base, the 2nd pair often arising also from the midrib but very close to the base; the other 3 pairs, often very short, issuing directly from the base; intercostals very prominent: upper side of lamina glabrous, undersides with short brown pubescence on the veins. *Female inflorescences* to as long as leaves, 20–24 cm long; the floriferous portion as long or to only slightly longer than the peduncular stalk; peduncle glabrous. *Bracts* circular, peltate, long pedicellate. *Female flowers* sessile, congested. *Stigma* 2-lipped, spreading, subsessile. *Fruits* sessile, free.

Distribution: New Guinea.

Notes: A lowland climber, *Piper pseudamboinense* is a little known species. Of the two collections identified as this species, NGF 25678 appears to be the best match to the holotype, the other being a more hairy variant.

Piper pseudamboinense is very closely similar to *P. amboinense* (Miq.) C.DC. and from which it differs in the more prominent lateral veins and its stigma being 2-lipped. It is also closely similar to *P. lessertianum* C.DC. from which it can be distinguished by the 2-lipped stigma in addition to lamina and inflorescence characters.

Specimens examined: PAPUA NEW GUINEA: Morobe District, Buso River, *NGF* 25678 Aug (CANB, LAE); Oomsis Creek, *T.G. Hartley TGH 10564*, July (A, CANB, LAE); Keneyia, alt 150 m, *Schlechter 18445* (B).

11. **Piper reinwardtianum** (Miq.) C.DC., DC. Prodr. 16.1 (1869) 354. Merrill, Inter. Rumph. Herb. Amb., (1917) 182. **Basionym.** *Macropiper reinwardtianum* Miq., Linnaea 21 (1848) 481. **Type**: Indonesia, Maluku, Nussa Laut, *Reinwardt*, July 1821 (holotype L?).

Synonym: *Chavica reinwardtiana* (Miq.) Miq., Ann. Mus. Bot. Ludg. Bat. 1 (1863) 136.

Dioecious shrub, glabrous to lightly pilose. *Leaves* with petiole 2.5–5 cm long. *Lamina* broad ovate to rounded, c. 16 x 15 cm, slightly asymmetrical; apex shortly acute, base asymmetrically truncate-cordate, lateral veins usually 3–4 pairs, upper side of lamina glabrous, undersides lightly pilose on the veins. *Infructescences* to 11 cm long, peduncle glabrous to 2.5 cm long. *Female flowers* sessile, congested. *Stigma* 3, rarely 4, short thickset. *Fruits* sessile, somewhat obovoid, concrescent on the lower half.

Distribution: Indonesia, Maluku.

Notes: I have not seen any type material of this species which is probably in the Leiden Herbarium to which Reinwardt donated his collections from the region. The collections of *Robinson* and *Teysmann* cited herewith are all that I have seen of this species; and I must of necessity rely on C. de Candolle and Merrill in the interpretation of this apparently rare species.

In general growth habit, *Piper reinwardtianum* recalls that of *P. sundaicum* Blume, also a shrub from the same region. However, it has infructescences similar to *P. mestonii* Bailey of New Guinea and Australia from which it can be distinguished by the stigma being 3- or 4-fid, not bifid, and the plant a shrub, not a climber. In these respects, *P. reinwardtianum* appears to be an interesting species, and further investigation may yield insight into the phytogeographical relationship between the three species.

Specimens examined: INDONESIA: Maluku, Ambon, *Robinson 60* (L). Ceram, *Teysmann s.n.* (L).

12. **Piper subvirosum** C.DC., Bot. Jahrb. 55 (1918) 215. **Type**: New Guinea, Alexishafen, *Wiesenthal 68* (holotype B).

Climber, twigs minutely pubescent. *Lamina* broadly ovate, 15–20 x 10–12 cm, upper surface glabrous, lower surface sparsely covered with short stiff hairs especially on lateral veins on basal part of the lamina; apex shortly acuminate, acumen 1.5–2 cm long; base broadly cuneate, rounded to truncate; lateral veins 3 pairs, distal pair alternate, arising from midrib a little above the base, the others directly from the base; intercostals prominent. *Petiole* to 2 cm long. *Female inflorescence* to 27 cm long, peduncle to 3 cm long, floriferous part to 24 cm long; inflorescences usually longer than leaves, peduncle longer than petiole; mature inflorescence to 7 mm diam. *Female flowers* sessile, not conerescent, with 3- or 4-fid stigmas.

Distribution: New Guinea.

Notes: *Piper subvirosum* is related to *P. macropiper* Pennant from which it can be distinguished by the much larger leaves and inflorescences, at least one pair of the lateral veins arising from the midrib, the lamina base not auriculate, and the peduncle not excessively longer than the petiole.

Not much is known about this species. The two recent collections cited here are the closest match to the holotype.

Specimens examined: IRIAN JAYA: Star Mts., Sibil Valley, alt. 1200–1500 m, Kalkman & Nicholas 4160, May (L). PAPUA NEW GUINEA: Central Division, Mt. Tafa, L.J. Brass 4127 (A); Alexishafen, Wiesenthal 68 (B).

13. ***Piper sundaicum*** Blume, Verh. Bat. Genoots. 11 (1826) 187, fig. 14; C.DC., DC. Prodr. 16.1 (1869) 352; Koorders, Verh. Kon. Ak. Wet. Amsterdams. 2, 14.4 (1908) 42, *reprint*; Koorders, Exkursionsflora van Java. 2 (1912) 26; Koorders-Schumacher, Exkursionsflora Atlas. 4.2 (1924) 445, fig. 718G. **Type**: Maluku, Ambon. *Blume s.n.*, *Leiden Herb.* 908.363-43 (lectotype L, here designated).

Synonyms: *Chavica sundaica* (Blume) Miq. Syst. Piperac., (1843) 274; Fl.Ind. Bat 1(2) (1859) 446, exclusive of the synonym *P. album* Vahl.

Piper amplilimbus C.DC., Candollea 1 (1923) 213; Schroeder, Candollea 3 (1926) 135; Chew, Blumea. 20 (1972) 145, fig. 1, *syn nov.* **Type**: Maluku, Ambon, *Teysmann s.n.* 1905 (holotype BO).

Dioecious scandent shrubs, entirely glabrous. Twigs 5–8 mm diam.; internodes smooth; stipular scars prominent. *Lamina* symmetrically ovate, (23–)25–27 x 14–19 cm, somewhat coriaceous; apex acuminate, acumen to 2 cm long; base rounded; margin entire; lateral veins 3–4 pairs, very prominent, the distal pair arising alternately from the midrib at 2–3 cm from the base, the others directly from the base; intercostals

numerous, not straight, quite prominent. *Petioles* c. 2 cm long, smooth. *Stipules* to 8 x c. 1 cm, apparently not adnate to petioles. *Inflorescences*: male long, thin; female 11–13 x 0.7 cm, the peduncular stalk c. 1.5 cm long, glabrous. Bracts somewhat irregularly circular, peltate. *Female flowers* sessile; ovary pyramidal; stigmas 3-fid, short, sessile, slightly reflexed. *Fruits* ovoid, sessile, c. 3 cm long; crowded, not conrescent.

Distribution: Indonesia, Maluku.

Notes: Blume recorded this species as also occurring in Java. Koorders (1908, 1912) doubted the Javanese record as he failed to find any collection from that island. I have also been unsuccessful in finding any material of the species from Java. This is probably a very rare species: the type materials are all that is known of this species.

I have compared the type materials of *Piper sundaicum* with that of *P. amplilimbium* C.DC., and I am unable to distinguish the one from the other.

Piper sundaicum appears to have some relationship with *Piper reinwardtianum* from the same region (see above).

Piper sundaicum has been identified with *P. album* Vahl by previous botanists. The two species are however, quite distinct: *P. album* Vahl is a climber, our species is not.

Specimens examined: MALUKU: Ambon, Blume s.n. (L); Teysmann s.n. 1905 (BO).

Acknowledgements

I thank the curators of the following herbaria (identified by their acronyms) for loan of their collections, including type materials, for my study at the Herbarium of the Royal Botanic Gardens, Sydney where I held tenure as Senior Research Scientist from 1970 to 1975: A, B, BO, BRI, CANB, K, L, LAE, P, PR, PRC and WRS�.

A New Species of *Schismatoglottis* (Araceae) from Sabah, Malaysia

A. HAY AND C. HERSCOVITCH

Royal Botanic Gardens, Mrs Macquarie's Road, Sydney, NSW 2000, Australia

Abstract

Schismatoglottis tahubangensis A. Hay & Herscovitch is described, illustrated and inserted into the latest key to Bornean *Schismatoglottis* species.

Schismatoglottis tahubangensis A. Hay & Herscovitch, *sp. nov.*

A *Schismatoglottis platystigma* M. Hotta spadice tenuiore, staminodiis inter pistilla, connectivo longiore differt. - **Typus:** Malaysia, Sabah, just outside Kinabalu Park, 100 m to Tahubang River along route to Marai-Parai, 11,000 m alt. [sic], 12 Sep 1993, J. Nais, Dolois, Harry & Masius SP 05312 (KEP, holo).

Terrestrial herb c. 30 cm high. *Stem* creeping or decumbent, rooting between the nodes, c. 1 cm diam., with internodes c. 5 mm long. *Leaves* 6 together; petiole 10–17 cm, sheathing in the lower 1–2 cm, wings of sheath extending into a papery narrowly triangular ligule to 2.5 cm; blade 11–15 cm long, 3.5–5 cm wide, narrowly obovate, somewhat asymmetric, base truncate to acute, somewhat asymmetric, inserted into adaxial face of petiole, apex acute; midrib pronounced and minutely puberulent abaxially, with c. 10 primary lateral veins on each side diverging at c. 45°, interprimary veins somewhat conspicuous abaxially, obscure adaxially, fine. *Inflorescence* solitary, subtended by an inconspicuous papery cataphyll c. 6 mm long; peduncle 3 cm long. *Spathe* pinkish, 7 cm long, slender, weakly constricted; lower spathe 1.5 cm long, 3mm diam. *Spadix* very slender, cylindrical for most of its length, 5.3 cm long, 1.5 mm diam.; female zone 1.2 cm long, (not clear whether adnate to spathe at base); pistils closely packed, subglobose, 0.3 mm diameter; stigma discoid, almost as wide as the ovary; interpistillar staminodes conspicuous, round and flat-topped or concave, drying pale yellow, of the same height and diameter as pistils; sterile interstice c. 2 mm long comprised proximally of 2 irregular whorls of looser packed, 0.5 mm diam., flat-topped staminodes, differentiated from interpistillar staminodes by larger size, slightly convex top, and dark yellow colour on drying, and distally of 2–3 irregular whorls of sterile

stamens drying dark brown; male zone 1.2 cm long; stamens subsessile, more or less oblong ovate from above, more or less irregularly paired and oriented along long axis of spadix, c. 0.8 mm wide; thecae round, opening by a single apical pore; connective robust, columnar, flat-topped and somewhat impressed, slightly exceeding the thecae in height and about 1.5 times their diameter, rounded triangular from above with ends indented above thecae; appendix 2.8 cm long, tapering to a fine naked tip, composed of flat-topped, more or less rounded or irregularly polygonal staminodes c. 0.3 mm diam. similar to those of sterile interstice. *Fruit* unknown.

Distribution: Malesia – Borneo, Sabah, Kinabalu (known only from the type).

Habitat: On a steep slope in unspecified vegetation type at c. 1,100 m alt. [Note that the label on the type records the altitude as 11,000 m, which is, of course, impossible].

Notes: This species somewhat resembles *Schismatoglottis platystigma* (Brunei) in having discoid stigmas and relatively small thecae on the edge of a broad connective. However, it is readily distinguished from that species by the presence of interpistillar staminodes, the subsessile stamens with a much higher connective and the more slender spadix.

Schismatoglottis tahubangensis may be inserted into the key to Bornean *Schismatoglottis* provided by Hay & Yuzammi (2000) as follows:

- 17a. Inflorescence solitary or two together; anthers with broadly dilated connective 18
- 17b. Inflorescences c. 4–6 together; anthers dumb-bell-shaped, with the connective not dilated 19
- 18a. Interpistillar staminodes absent; appendix 1–2 cm long, blunt-tipped; Temburong, Brunei **S. platystigma**
- 18b. Interpistillar staminodes numerous; appendix c. 3 cm long, tapering to a fine point; Kinabalu, Sabah..... **S. tahubangensis**

19 etc = 18 etc in Hay & Yuzammi (2000).

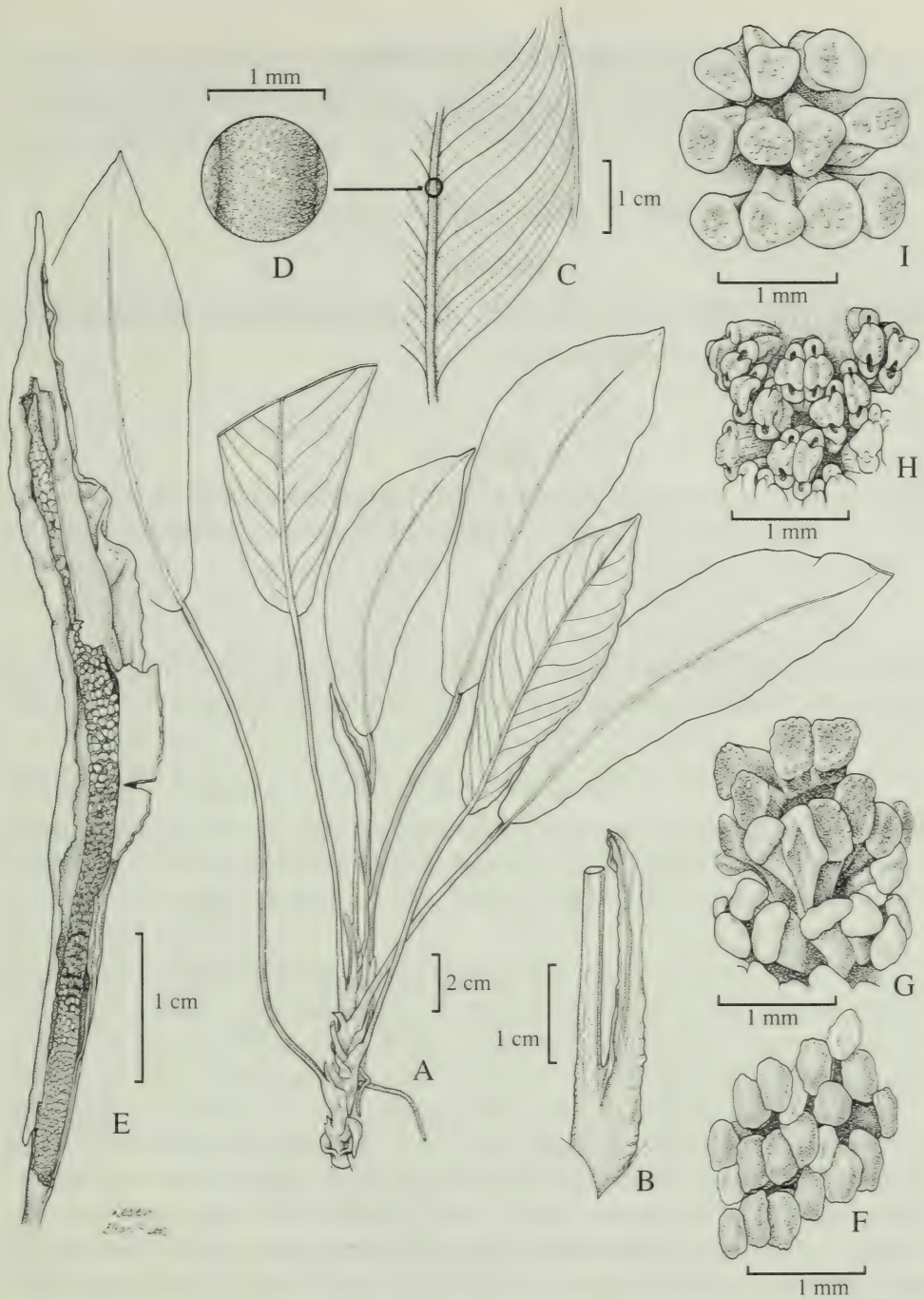


Figure 1. *Schismatoglottis tahubangensis* Herscovitch & A. Hay

A. habit; B. ligule at base of petiole; C. detail of leaf venation; D. midrib detail; E. inflorescence with part of spathe removed; F. pistils with interstaminal staminodes; G. sterile interstices with staminodes and sterile stamens; H. stamens; I. staminodes of appendix. J. Nais, Dolois, Harry & Masius SP 05312.

Acknowledgements

We thank Josef Bogner for drawing our attention to the specimen on which this species is based, Dan Nicolson for commenting on the ms and and Lesley Elkan for the illustration.

Reference

Hay, A. & Yuzammi. 2000. Schismatoglottideae (Araceae) in Malesia I – *Schismatoglottis. Telopea*. **9**: 1–177.

An Unusual New Species of *Homalomena* (Araceae) from New Guinea

C. HERSCOVITCH AND A. HAY

Royal Botanic Gardens, Mrs Macquarie's Road, Sydney, NSW 2000, Australia

Abstract

Homalomena impudica Herscovitch & A. Hay is described, illustrated and inserted into the latest key to *Homalomena* species of New Guinea.

Homalomena Schott was revised for New Guinea by Hay (1999). An overlooked specimen on loan to NSW from LAE represents a very distinctive undescribed species.

Homalomena impudica Herscovitch & A. Hay *sp. nov.*

Homalomena tenuispadix Engl. simulans sed inflorescentia femina spatham aequanti, inflorescentia mascula clavata tota exserta differt. - **Typus:** Papua New Guinea, West Sepik Province, Vanimo, Ossima, 28 Jan 1969, *H. Streimann & A. Kairo NGF 39239* (holo, LAE).

Erect multi-stemmed herb to c. 30 cm high. *Stem* condensed, 1.5 cm diam. *Leaves* to 8 together; *petiole* longer than blade, 17–32 cm long, glabrous, slender, sheathing in lower 6–7 cm; *blade* dull green above, green below, glabrous, sagittate to ovate-cordate, 14–19 cm long, anterior lobe 12–16.5 cm, c. 8 cm wide, posterior lobes triangular to rounded, 2.5–4 cm long; midrib more prominent abaxially, with c. 8 pairs of lateral veins diverging at c. 45°. *Inflorescences* to 9 together, each subtended by a narrow triangular papery cataphyll to 4 cm long; peduncle erect, later declinate, 4.5–6 cm long, longer than spadix. *Spathe* slightly constricted in bud, then narrow cylindrical, 2.0–2.8 cm long, 5 mm diam., with a conspicuous rigid darker sometimes reflexed apiculum 2–3 mm long. *Spadix* 2.7–3.6 cm long, much exceeding the spathe at anthesis, stipitate for c. 5 mm; female zone equalling to exceeding the spathe, 2.0–2.4 cm long; pistils very widely scattered along axis of female zone, becoming loosely and irregularly whorled distally, globose, c. 1 mm diam., infrapistillar staminodes absent; stigma button-like, sessile, 0.3 mm across; male zone narrow oblong-ovoid, 0.7–1.1 cm

long, whitish, fully exerted from spathe; male flowers (-)2-merous; stamens more-or-less oblong to irregularly polygonal from above, c. 1 x 0.3–0.5 mm, the thecae overtopped by connective. *Fruit unknown.*

Distribution: Malesia – New Guinea, Papua New Guinea, West Sepik Province (known only from the type locality).

Habitat: In a dry stream bed in lowland rain forest at c. 30 m alt.

Notes: This species resembles *Homalomena tenuispadix* Engl., but differs in the greatly elongated and lax female zone which equals to exceeds the spathe, and in the completely exerted and somewhat clavate male zone. The inflorescence at first resembles that of *Schismatoglottis* after the male zone has been exposed by the fall of the spathe limb, until it is noted that the spathe, as typical for *Homalomena*, is fully persistent.

While some New Guinea species of *Homalomena*, such as *H. davidiana* A. Hay and others (see Hay 1999), characteristically have the male zone partially exerted from the spathe after anthesis, this species extends the entire male zone beyond the apex of the spathe prior to anthesis. This characteristic, as distinct from the state where the male zone is exposed by the spathe being wide open during anthesis, appears not to be recorded for any other species in the genus.

Field notes describe the flower (sic) as white and the fruit green. The specimen includes fragments of declinate fruiting peduncle, but the infructescence is not present. It is unclear whether or not the colour observations refer to the spathe at different stages.

The specific epithet, meaning lewd or shameless, alludes to the fully exposed male zone of the spadix.

Homalomena impudica can be inserted into the key provided by Hay (1999) as follows:

10a. Spathe tip ± hood-forming; spadix contained within the spathe after anthesis; peduncle much shorter than the petioles **H. lauterbachii**

10b. Spathe with the tip reflexed; spadix exerted from the spathe during and/or after anthesis; peduncle c. 1/3–1/2 the length of the petioles 11

11a. Spadix with the male zone clavate and completely exerted from the spathe at anthesis **H. impudica**

11b. Spadix with the male zone cylindrical-tapering, not exceeding the spathe at anthesis, partially exerted from spathe after anthesis **H. tenuispadix**

12 etc. = 11 etc. in Hay (1999)



Figure 1. *Homalomena impudica* Hershovitch & A. Hay.

A. habit; B. inflorescence with part of spathe removed; C. tip of spathe; D. inflorescence in bud; E. pistils; F. stamens. *Streimann & Kairo NGF 39239.*

Acknowledgements

We thank LAE for the loan of the specimen on which this species is based and Catherine Wardrop for the illustration.

Reference

Hay, A. 1999. Revision of *Homalomena* (Araceae-Homalomeneae) in New Guinea, the Bismarck Archipelago and Solomon Islands. *Blumea*. **44**: 41–71.

***Pleuroschisma*, a New Section of *Cyrtandra* (Gesneriaceae) from Borneo**

O.M. HILLIARD¹, B.L. BURTT¹ AND M.H. BOKHARI²

¹Royal Botanic Garden Edinburgh, EH3 5LR, U.K.

²Multan, Pakistan

Abstract

Twelve Bornean species of *Cyrtandra* constitute a new section, Section *Pleuroschisma*, the name derived from an important diagnostic character, namely the unique fruit with a median septicial split on each side (not reaching either apex or base of the fruit). Nine of the species and two varieties are newly described, *C. angustieliptica* Hilliard & B.L.Burtt, *C. coacta* Hilliard & B.L.Burtt, *C. insolita* Hilliard & B.L.Burtt, *C. linauana* B.L.Burtt, *C. seganica* Hilliard & B.L.Burtt, *C. tessellata* Hilliard & B.L.Burtt, *C. tunohica* Hilliard & B.L.Burtt, *C. pendulifera* Kraenzl. var. *grossipilosa* Hilliard & B.L.Burtt and *C. sarawakensis* C.B.Clarke var. *longipilosa* Hilliard & B.L.Burtt. Two species recognized remain nameless because the material is inadequate to typify a name.

Introduction

There are already 40 sectional names in *Cyrtandra* and the limits and interrelationships of the groups so designated are far from being understood; the addition of yet another sectional name to the list may seem somewhat irresponsible. Nevertheless, the fruit characters that are used to diagnose this section - the smooth fruit wall (due to a thin layer of sclerenchyma beneath the epidermis, Fig. 3), and the septicial splits with inrolled margins (Fig. 1) form a unique combination in this small group. It is the lateral splits in the fruit-wall that form the basis for the sectional name *Pleuroschisma*; these splits, it should be noted, are septicial and there is some reason to suppose that septicial dehiscence may have been the primitive condition in the family as it is found in *Ramonda*, *Haberlea*, in the type species of *Corallodiscus*, all on the northern fringe of the subfamily Cyrtandroideae, and in the tribe Coronantherae, a basal tribe of subfamily Gesnerioideae found in New Caledonia, E. Australia, New Zealand and southernmost S. America. Its presence elsewhere in the family (e.g. in *Leptoboaea*) may be secondary. It must be noted, however, that the lateral splits in this new section of *Cyrtandra* do not reach from apex to base of the fruit (Fig. 1) and do not give rise to free fruit-valves, as in a fully septicial fruit. These features set section smaller.



Figure 1. Mature fruit of *Cyrtandra sarawakensis*

The two halves remain held together at apex and base. *Burt B4712* x4.

Pleuroschisma apart from all the other sections.

As so often in herbarium work on *Cyrtandra*, we have been much hampered by lack of flowers on many specimens, although mentioned in the collector's field notes. Nevertheless, it is not the flowers that provide the diagnostic features of the Section: it is the fruits. We have therefore felt justified in naming *C. tessellata* (no. 6), *C. seganica* (no. 7) and *C. insolita* (no. 11), which we know only in fruit. In the eight species where we have seen flowers, the major floral characters are uniform: calyx divided almost to the base into five deltoid lobes, corolla c. 35–40 mm long, white, cream or palest yellow with two orange/yellow bars in the throat, puberulous outside, disc cupular, occasionally deeply excavated on one side, ovary crowned with a coma of relatively long hairs, otherwise so minutely gland-dotted or pustulate as to appear glabrous on casual inspection, style puberulous, stigma distinctly bilobed, lobes relatively large, clavate in outline.

Leaf-venation provides a useful character in distinguishing some of the species, both the number of lateral veins on each side of the midrib, and the pattern described by the tertiary venation, of which three main types have been distinguished; for these we use the terms subscalariform, reticulate and pinnate (Fig. 2, A,B,C,D). In some species, the tertiary venation is invisible (e.g. *C. insolita*).

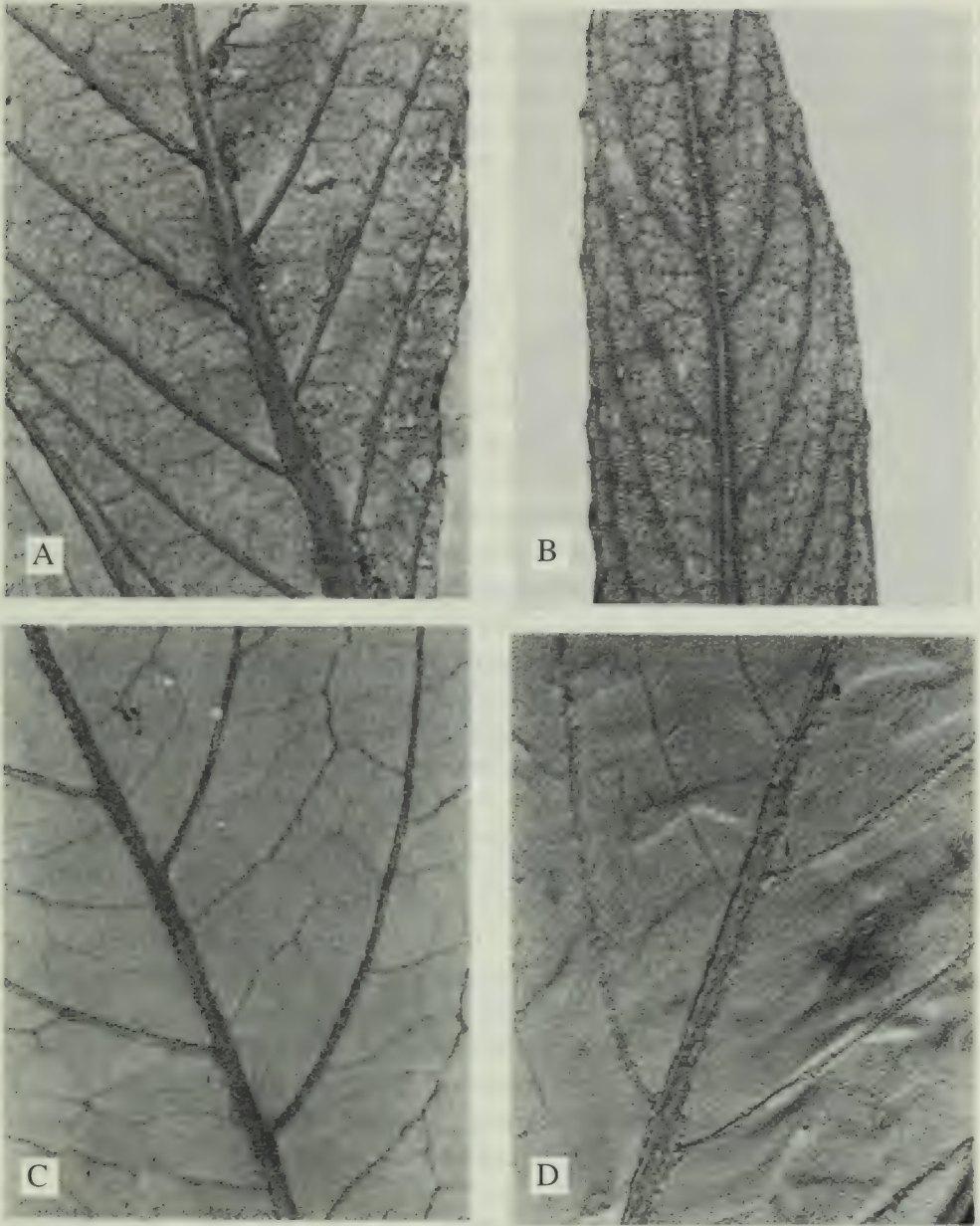


Figure 2. Types of tertiary venation found in *Cyrtandra* sect. *Pleuroschisma*
A. subscalariform (*C. sarawakensis*, Burt B1947, about actual size). B. finely reticulate (*C. tessellata*, Hotta 1417, slightly enlarged). C. coarsely reticulate (*C. sp. nov.* no. 12, Burt B2658, x2). D. pinnate (*C. coacta*, Beaman 10656, slightly enlarged).

The distinctive leaf anatomy, with tracheoids in the hypodermis, has already been illustrated (Bokhari & Burt, 1970, Plate 2, G,H): the tracheoids may have either parallel or reticulate bars of thickening (Fig. 4). In some species (e.g. *C. hoseana*), similar tracheoids are found in the mesocarp of the fruit; spheroidal sclereids are commonplace and abundant (Fig. 3), making fruit-sectioning very difficult. In several species, polymorphic sclereids occur in the mesophyll of the leaf (*C. tessellata*, *C. seganica*, *C. hoseana*, *C. angustieliptica*); in *C. penduliflora*, they may be present or absent. The other species in section *Pleuroschisma* lack sclereids. (*C. insolita* and sp. no. 12 have not been examined).

Protection of the apical bud in *Cyrtandra* is achieved in several ways. In section *Pleuroschisma* the bud is hidden between the erect petioles of the two fully developed uppermost major leaves on the stem. The following observations were made on herbarium material, and observations are needed on living plants to determine time-intervals in leaf development: when the developing leaf in *C. linauana* measured 38 mm, the young apical bud was only 2.5 mm long. We examined the stem apex of *C. linauana*, removing the tip of the stem and rehydrating it. The very young major leaf of the apical bud is hidden by the conduplicate base of the minor (stipule-like) leaf of the uppermost pair of fully developed leaves. It is plane, measured 38 x 8 mm including the petiole (scarcely developed at this stage), and both surfaces are thickly clad in long silky hairs. The minor leaf has similar indumentum and is well developed, being 20 mm long. In contrast, the fully developed leaves below the apex show no trace of the juvenile indumentum except over the midrib and lateral veins on the lower surface. There is the same abrupt transition from a very small juvenile leaf to a fully developed one in five other species where we had stem-apices suitable for inspection (*C. penduliflora*, *C. sarawakensis*, *C. coacta*, *C. angustieliptica*, *C. insolita*). These species in section *Pleuroschisma* are all strongly anisophyllous. A comparable condition in isophyllous species was noted by Burt (2001, p.399).

Field observations by one of us (B.L.B.) found that in *C. hoseana* and *C. penduliflora*, as the new apical leaf begins to grow out, the petiole is held erect but the young lamina is pendulous, the hairs in *C. hoseana* being silvery white, while in *C. penduliflora* they are dark red. As the leaf blades enlarge, the hairs become more spread out, and are eventually shed, resulting in the blade of the mature leaf being glabrous above. Whether or not these young leaves perform any attractive function is not known, but they certainly catch the eye of the plant-hunter.

Cyrtandra section *Pleuroschisma* Hilliard & B.L.Burt *sect. nov.* ab sectionibus omnibus ad huc descriptis fructibus duris laevibus (strato annulari subepidermalis schlerenchymatis uni- vel bi-seriato), parietibus in medio longitudinis fissuris duabus septicidalibus marginibus involutis notatis, foliis cellulis tracheoidalibus hypodermalibus praeditis facile distinguenda.

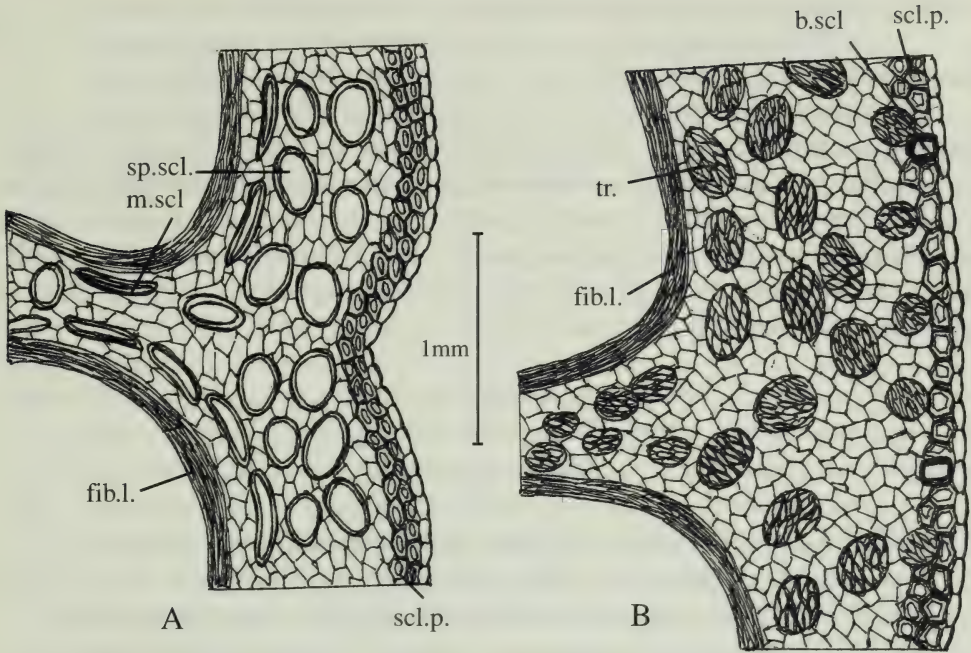


Figure 3. Transverse sections of part of fruit wall and septum

A. *Cyrtandra sarawakensis*; B. *Cyrtandra penduliflora*. b. scl. = brachysclereid; fib. l. = fibrous layer; m. scl. = macrosclereid; scl. p. = sclerified parenchyma [sclerenchyma]; sp. scl. = spheroidal sclereid; tr. = tracheoid [with reticulate thickening]. *M.H. Bokhari del.*

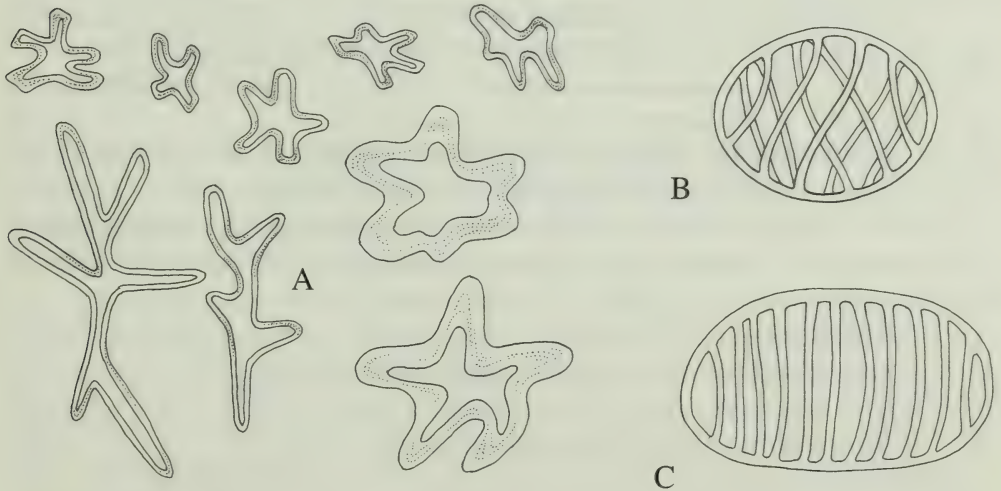


Figure 4. Sclereid and tracheoid types.

A. polymorphic sclereids. B. tracheoid with reticulate bars. C. tracheoid with parallel bars. *M. Mendum* after pencil sketches by *M.H. Bokhari*.

Species typica: *C. sarawakensis* C.B. Clarke

Distribution: Endemic to Borneo.

Simple-stemmed perennial herbs (*C. insolita* bushy), leaves usually strongly anisophyllous, tracheoids, as far as is known, in hypodermis, inflorescence a dichasial cyme, bracts free, bracteoles present or absent, calyx divided almost to base, corolla medium-sized, white to palest yellow ground colour, disc cupular, ovary crowned with a coma of relatively long hairs, style pubescent, stigmatic lobes large, clavate, fruit with two septicidal grooves (later splits).

Key to Species

- 1a. Lateral veins in largest mature leaves up to 10 each side of midrib2
- 1b. Lateral veins 11–20 on each side of midrib.....4
- 2a. Hairs (lower leaf surface) on midrib and lateral veins very inconspicuous, short (to 1 mm), strongly appressed, pedicels c. 20 mm long, calyx lobes 10–15 mm.....**8. *C. linauana***
- 2b. Hairs (lower leaf surface) on midrib and lateral veins long, silky, strongly appressed, sometimes matted together to produce a papery surface, pedicels c. 5–8 mm, calyx lobes to 8 mm.....3
- 3a. Largest leaves c. 60–165 mm broad, petioles 75–135 mm, bracts c. 35–40 x 10–16 mm, conspicuous, strongly veined.....**3. *C. coacta***
- 3b. Largest leaves c. 36–60 mm broad, petioles 40–45 mm, bracts c. 5.5–7 x 1.8–2 mm, inconspicuous, only midrib visible.....**10. *C. angustielliptica***
- 4a. Hairs (lower leaf surface) on midrib spreading.....5
- 4b. Hairs (lower leaf surface) on midrib strongly appress.....10
- 5a. Peduncle c. 45–240 mm long, inflorescence lax, trailing.....**1. *C. penduliflora* var. *grossipilosa***
- 5b. Peduncle c. 2–30 mm long, inflorescence neither lax nor trailing.....6
- 6a. Bracts c. 20–50 x 7–25 mm, 3–5 veins, clearly visible, calyx lobes 2–4 mm long.....7
- 6b. Bracts c. 15–18 x 2–3 mm, only midrib visible, calyx lobes c. 6–10 mm long.....9
- 7a. Inflorescence a several- to many-flowered cyme, both bracts and bracteoles present.....8
- 7b. Flowers 1–3, clustered and, at least when young, hidden by two foliaceous bracts, bracteoles wanting.....**11. *C. insolita***
- 8a. Petioles 80–150 mm long, peduncles 5–30 mm.....**2. *C. sarawakensis* var. *longipilosa***

- 8b. Petioles 30–70 mm long, peduncles 0–2 mm..... **5. *Cyrtrandra sp. nov.***
- 9a. Largest leaves c. 26–34 mm broad, lower surface displaying finely reticulate tertiary venation, petiole c. 20–25 mm long **6. *C. tesselata***
- 9b. Largest leaves c. 85–110 mm broad, lower surface displaying coarsely reticulate venation, petiole c. 45–50 mm long..... **12. *Cyrtrandra sp. nov.***
- 10a. Peduncles c. 50–175 mm long, inflorescence lax, trailing...
..... **1. *C. penduliflora***
- 10b. Peduncles c. 1–30 mm long, inflorescences neither lax nor trailing..... 11
- 11a. Bracts c. 10–20 mm broad..... 12
- 11b. Bracts c. 3–7.5 mm broad..... 13
- 12a. Tertiary venation on lower leaf surface subscalariform, hairs on stem, leaves (including petioles), bracts, bracteoles, pedicels and calyx appressed, all hairs separate..... **2. *C. sarawakensis***
- 12b. Tertiary venation more or less pinnate, hairs on all parts (as above) matted together giving a papery look to the surface..... **3. *C. coacta***
- 13a. Stem silky-villous, tertiary venation (lower leaf surface) coarsely reticulate, almost invisible, largest mature leaves c. 85–95 mm broad, ratio length: breadth c. 2.5–3.3:1..... **9. *C. hoseana***
- 13b. Stem pubescent, tertiary venation more or less subscalariform, leaves c. 35–60 mm broad, ratio length: breadth 4–5.7:1..... 14
- 14a. Largest leaves c. 35–50 mm broad, lateral veins 13–15 on each side of midrib, bracts 20–30 x 4–7.5 mm, at least midrib clearly visible..... **4. *C. tunohica***
- 14b. Largest leaves c. 55–60 mm broad, lateral veins 18 on each side of midrib, bracts c. 20 x 4 mm, midrib scarcely visible..... **7. *C. seganica***

1. *Cyrtrandra penduliflora* Kraenzl., Mitt. Inst. Allg. Bot. Hamburg 7:100 (1927); B.L. Burtt, Notes Roy. Bot. Gard. Edinb. 30:36 (1970).

Lectotype (Burtt, 1970): Kalimantan, Bukit Obat [c.0°56'N 113°20'E], 150m, *Winkler 1328* (lecto HBG, isolecto E).

Unbranched herb, stem to c. 600 mm long, 9–16 mm in diam., base often decumbent, rooting, prop roots present, young parts strongly appressed-pubescent. *Leaves* opposite, strongly anisophyllous, few forming a fan at apex of stem, reduced leaves stipule-like, c. 20–46 x 5–14 mm, lanceolate, acuminate, strongly appressed-pubescent, largest developed leaves c. 210–300 x 150–200 mm, very broadly elliptic, apex abruptly acute, base cuneate, very narrowly decurrent, briefly or to c. 40 mm, margins entire to obscurely to more distinctly irregularly serrate, lateral veins 11–13 on each side of midrib, tertiary venation more or less pinnate, upper surface glabrous

at maturity, coarsely pitted, lower surface with fine appressed hairs on veins and blade; petiole 130–210 mm long, hairy as midrib. *Inflorescence* an axillary very lax dichasial cyme, loosely branched, trailing, tending to spring from axils of fallen leaves, peduncle c. 50–175 mm long, pubescent. *Bracts* (lowermost pair) c. 15–57 x 4–18 mm, lanceolate, acuminate, finely pubescent. *Pedicels* 6–20 mm long, puberulous. *Calyx* 5-lobed almost to base, lobes subequal, c. 6–14 x 1.5 mm, deltoid, outside puberulous, inside minutely gland-dotted. *Corolla* c. 37 mm long (no complete flowers seen, only a big bud), white with an orange-yellow blotch or two bars in throat, puberulous all round mouth. *Stamens* inserted c. 15 mm above base of tube, filaments c. 5 mm long, glabrous, anthers 3.5 x 1.8 mm, cohering face to face by a small ligature, connective glabrous or a very few glandular hairs. *Disc* 1 x 1.8 mm, cupular. *Ovary* 6 x 1 mm, minutely pustulate, coma of hairs at apex. *Style* 12 mm, glandular-puberulous. *Stigmatic lobes* c. 1.5 x 1 mm (will enlarge), clavate. *Fruit* c. 20–45 x 5–7 mm, pericarp smooth. *Seeds* c. 0.3 x 0.25 mm, testa red-brown.

Notes: *Cyrtandra penduliflora* is a plant of the forest floor, often on steep banks, the stem supported by prop roots. It is distinctive by virtue of its trailing inflorescences, the peduncles mostly very long, the cyme always very lax, far laxer than in any other species of this group. The leaves are broad in relation to length, those of the type specimen, collected in southern Kalimantan, measuring roughly 300 x 200 mm, and exactly matched by those of *Burt* 2610 from Sarawak collected 1° of latitude north of the type collection and at very nearly the same degree of longitude (1°56'N 113°06'E versus 0°56'N 113°20'E), but nearly all specimens have the leaves very broad in relation to their length.

Tracheoids with parallel bars of thickening occur in the hypodermis; polymorphic sclereids are often present in the spongy mesophyll but they may be absent.

Other specimens examined: **Sarawak.** Miri distr., Niah Forest Reserve, [c. 3°52'N 113°44'E], *Anderson S31663* (E). Bintulu distr., Ulu Sungai Sinonok, 20–60 m, *Hotta 14247* (E, KYO). Tatau, Batang Anap, Ulu Sg. Kana [c. 2°54'N 112°50'E], *Mokhtar & Jugah S41779* (E). Sungai Kakus [c. 2°48'N 112°42'E], 30–80 m, *Hirano & Hotta 220* (E, KYO). Ulu Kakus [c. 2°48'N 112°42'E], Anap, *Haron S29980* (K, E). Ulu Segan [c. 2°30'N 113°E], N Setungan, c. 50 m, *Ashton S22019* (E). Pelagus Rapids on Rajang ['Rejang'], c. 2°10'N 113°E, *Burt & Woods B2559* (E). Sungai Bena [c. 1°56'N 113°06'E], a tributary of Sungai Sut, *Burt B2610* (E). Sungai Jelok, near Bukit Sengkajang [1°14'N 111°31'E], Lanjak-Entimau P.F, c. 2100 ft, *Chai S34034* (E, K). Bukit Ubah Ribu, Ulu Sungai Kaup, Lubok Antu [1°03'N 111°50'E], c. 200 ft, *Chai S33761* (E).

Cyrtandra penduliflora var. *grossipilosa* Hilliard & B.L.Burt var. *nov.* a planta

typica pilis longis grossis patentibus in caulibus petiolis et subtus in costis (nec pilis tenuibus valde appressis) filamentorum apicibus et antherarum connectivo dense glanduloso-puberulo (nec glabro vel fere glabro) differt.

Type: Sarawak, ascent to Gunung Mulu [4°01'N 114°52'E], 13 vi 1962, *Burt & Woods B2060* (holo. E).

Unbranched herb, stem up to 1 m long, 15 mm diam., base often decumbent, rooting, young parts villous, hairs coarse, spreading. *Leaves* opposite, strongly anisophyllous, few at apex of stem, reduced leaves stipule-like, largest developed leaves 190–370 x 85–160 mm, elliptic, apex acute to acuminate, base cuneate, very narrowly decurrent, margins entire to irregularly toothed, lateral veins 12–18 on each side of midrib, upper surface glabrous at maturity, coarsely pitted, lower surface with coarse spreading hairs scattered among short appressed ones on the midrib, similar appressed hairs on the blade; petiole 100–150 mm long, hairy as midrib. *Inflorescence* as in the typical plant, peduncle c. 45–240 mm long. *Bracts* c. 24–45 x 4–13 mm, finely pubescent. *Calyx* lobes c. 6–9 mm long, outside puberulous, inside minutely gland-dotted. *Corolla* (only one flower seen) 41 mm long, white to pale yellow with 2 orange-yellow bars in throat, outside puberulous, mouth glandular-puberulous inside, tube 27 mm long, cylindric in lower part, expanded above, upper lobes c. 8 x 8 mm, lower lip c. 14 x 22 mm, median lobe 9 x 8 mm, all lobes suborbicular. *Stamens* inserted 22 mm above base of tube, filaments c. 5 mm long, glandular-puberulous in upper part, strongly twisted post anthesis, anthers 3 x 2 mm, cohering face to face by a small apiculus, connective densely glandular-puberulous. *Disc* 1 x 1.5 mm, cupular. *Ovary* 6 x 1.2 mm, very minutely pustulate, coma of hairs at apex. *Style* 13 mm long, glandular-pubescent. *Stigmatic lobes* 3 x 2.5 mm, clavate. *Fruit* c. 25–35 x 5 mm, pericarp smooth. *Seeds* c. 0.4 x 0.2 mm, testa red-brown.

Notes: This plant differs from typical *Cyrtandra penduliflora* in the coarse spreading hairs on the stem and along the midrib on the undersurface of the leaf (versus fine strongly appressed ones). The tertiary venation also differs subtly: in the typical plant, the tertiary veins are not clearly visible on the lower surface of the leaf and they are more or less pinnate in arrangement; in the variety they are clearly visible, subscalariform, with a fine reticulum of lesser veins between them. The leaves closely resemble those of *C. sarawakensis*, distinguished at once by its compact inflorescence. The label on *Sands 5390* (cited below) described the leaves as 'paler beneath with reddish-brown veins'; *Church 2210* 'whitish-green beneath with purple veins distinctly raised'. There is also a difference in the shape of the leaves, those of the typical plant being broader in relation to length than in the variety, ratio of length to breadth being 1.2–1.6:1 versus 1.7–2.5:1; in absolute terms c. 150–200 mm versus 85–160 mm (largest leaves).

Anatomically there is some difference in the thickenings of the tracheoids in the hypodermis: parallel bars in the typical plant, reticulate thickenings in the variety often mixed with others with parallel bars.

The anther-connective in the typical plant is glabrous or nearly so, that in the variety densely glandular-puberulous.

From what is known of the distribution of the species, the variety tends to be more northern and eastern than the typical plant though the few collections from Kalimantan indicate close proximity.

Other specimens examined: **Brunei.** Temburong river at Wong Nguan rapids, 4°31'N 115°15'E, 120m alt., *Coode 6649* (E). Temburong distr., Sungai Belalong, 4°30'N 115°10'E, c. 100 m, *Argent et al. 911* (E). Slopes above Temburong headwaters NE of Gunung Retak, 4°22'N 115°17'E, *Sands 5309* (E). Tutong, Ladan Hills Forest Reserve, upstream from Belabau on E bank of Tutong river, 4°26'N 114°46'E, 20 m, *Coode 6409* (E). Sungai Tokat, a branch of Sungai Batu-Apoi, 50–100 m, *Hotta 13759* (E). **Sarawak.** Limbang [4°45'N 115°E], Ulu Medamit [4°27'N 114°55'E], Sungai Ensungei, Tanjong Long Amok, *George et al. S42368* (E). Gunong Api, Ulu Melinau, Tutoh, 4°07'N 115°15'E, 400 ft, *Anderson S31784* (E). Melinau Gorge pathway, c. 4°05'N 114°50'E, *Burtt & Woods B2239* (E). Gunong Mulu National Park, Gua Rusa, c. 4°02'N 114°50'E, *Argent et al. 809* (E). Ulu Belaga, Sungei Semawat, 3°N 113°54'E, c. 250 m, *Hansen 623* (E). Dulit Range [c.3°16'N 114°14'E], Sungai Sirui, 200 m, *Awa & Yii S46629* (E). Valley of Sungai Keyan Linau-Balui divide, Sungai Nawai, c. 2°26'N 114°10'E, c. 2600 ft, *Burtt B11456* (E). South of Punan Lusong, c. 2°28'N 114°12'E, *Burtt B11294* (E). **Kalimantan.** Sintang, Bukit Baka National Park, Sungai Ella and environs, 0°38'S 112°17'E, 320 m, *Church 280* (A, E, HBG). Serawai, Uut Labang, 750 m, 0°36'6"S 112°38'56"E, *Church 2210* (E).

2. *Cyrtandra sarawakensis* C.B. Clarke, DC., Monog. phan. 5:209 (1883); B.L. Burtt, Notes Roy. Bot. Gard. Edinb. 30:38 (1970).

Lectotype (Burtt 1970): Sarawak, Kuching, July 1865, *Beccari 153* (lecto FI, isolecto K, P).

Unbranched herb, stem c. 110–230 x 7–20 mm, erect or decumbent and rooting, young parts densely appressed-pubescent, hairs c. 2 mm long. *Leaves* opposite, strongly anisophyllous, c. 3–8 forming a fan at apex of stem, reduced leaves stipule-like, c. 30 x 3 mm, lanceolate, acuminate, closely appressed-pubescent; largest developed leaves c. 225–300 x 57–125 mm, elliptic, apex very acute, base cuneate, very narrowly decurrent, margins subentire to serrate, lateral veins 16–20 on each side of midrib, tertiary veins subscalariform, upper surface glabrous at maturity, coarsely pitted, lower surface appressed-pubescent on blade, long (to 3mm) delicate appressed hairs on midrib and lateral veins (tawny or purple in life); petiole c. 80–150 mm, hairy as

midrib. *Inflorescence* a several-flowered congested cyme, borne mainly in axils of fallen leaves, peduncle c. 5–30 mm long, stout, puberulous. *Bracts* persistent, c. 20–35 x 7–20 mm, lanceolate, acuminate, margins entire or toothed, strongly veined, both surfaces appressed-pubescent; bracteoles similar but smaller. *Pedicels* c. 10–12 mm, puberulous. *Calyx* 5-lobed almost to base, tube c. 0.5 mm, lobes subequal, 4.5–8 x 1–1.5 mm, narrowly deltoid, patent-puberulous outside, inside minutely gland-dotted. *Corolla* to c. 44 mm long, palest yellow, 2 orange-yellow bars on palate, outside puberulous, hairs acute, tube c. 27 mm long, narrowly cylindrical below, abruptly expanded above, two upper lobes c. 9 x 9 mm, lower lip 3-lobed, c. 14 x 24 mm, median lobe c. 8 x 8 mm, all lobes suborbicular, glandular-puberulous inside, with patch of longer hairs adjacent to sinus of upper lobes. *Stamens* inserted 20–25 mm above base of tube, c. 6 mm long, strongly twisted after anthesis, minute glandular hairs fringing connective; lateral staminodes c. 2 mm long, posticous staminode c. 1 mm. *Disc* c. 2 x 2 mm, cupular. *Ovary* c. 7 x 1.4 mm, minutely gland-dotted, coma of hairs at apex. *Stigmatic lobes* c. 3.5 x 1.2 mm, spatulate, conspicuous, stigmatic papillae relatively long. *Fruit* c. 20–25 x 4–5 mm, pericarp smooth. *Seeds* c. 0.25 x 0.2 mm, testa bright red-brown, reticulate.

Notes: *Cyrtrandra sarawakensis* was originally collected by Beccari at Kuching. Beccari had a hut on Mt. Matang, not far from Kuching, and this is possibly the type locality; *Burt & Woods B1947* (cited below) precisely matches the isoelectotype specimen in Paris. The other collections seen came from the Semengoh Forest Reserve a few miles south of Kuching. Many species of *Cyrtrandra* seem to have a very limited distribution and this may be the case here. The distinguishing features of *C. sarawakensis* are the many lateral veins, tertiary veins subscalariform and clearly visible especially on lower surface, hairs on veins (lower surface) strongly appressed, peduncles c. 5–30 mm long, bracts broad, strongly and conspicuously veined. It is a plant mainly of the forest floor.

Tracheoids with parallel bars occur in the 1–2-layered hypodermis of the leaf, and there are no sclereids in the spongy mesophyll. Stomatal turrets are well developed.

Other specimens examined: **Sarawak.** Mt. Matang [1°36'N 110°11'E], *Burt & Woods B1947* (E); Matang, Ulu Sungai Rayu, *Lee S54099* (E); Semengoh Forest Reserve, 12 miles S of Kuching [1°28'N 110°22'E], *Burt & Martin B4712* (E); Semengoh Forest Reserve, *Burt & Woods B2487* (E).

***Cyrtrandra sarawakensis* var. *longipilosa* Hilliard & B.L. Burt var. nov.** a planta typica primum pilis in caule et costa grossis et patentibus (nec tenuibus et valde appressis) et calycis lobis plerumque longioribus 4.5–8 mm (nec 2.5–4 mm) et apicibus foliorum longe acuminatis (nec acutis) differt.

Type: Sarawak [c.2°N 114°10'E, Hose Mts.], Melinau Community Forest, near base camp at Nanga Tunoh, *Burt & Martin B4772* (holo. E).

Notes: The variety has been collected north and east of Kuching. It resembles *Cyrtandra sarawakensis* in nearly all features, including habit, number of lateral veins in leaves, subscalariform tertiary venation, bracts and other floral characters, but it differs in its long-acuminate (not merely acute) leaf tips, hairs on stem, petiole and midrib on under surface of leaves being coarse and spreading (not fine and closely appressed) and possibly also in length of calyx lobes, 2.5–4 mm (not 4.5–8 mm).

The coarse spreading hairs are brightly coloured in life, and in the dried state the colour often persists in the cross walls of the hairs; the hairs on *C. sarawakensis* may also be coloured, but, being so much finer, the colour is more difficult to see in dried specimens. The occurrence of a variety with long coarse spreading hairs as opposed to appressed ones is paralleled in *C. penduliflora*, a species with tertiary venation indistinguishable from that of *C. sarawakensis*; *C. penduliflora* differs markedly in its lax inflorescence, and many specimens have fewer lateral veins in the leaves.

Other specimens examined: Sarawak. Tatau, path to Bukit Buan, 300 ft. [c.2°56'N 112°55'E], *Purseglove 5469* (E). Tatau, Ulu Anap [c. 2°56'N 112°49'E], *Mokhtar S44815* (E). Bukit Kana [2°42'N 112°54'E], 600–850 m, *Hirano & Hotta 1299* (KYO); Bukit Kana, 50–150 m, *Hirano & Hotta 15480* (E). Ulu Anap, Bukit Mersing [2°30'N 113°06'E], c.1000 m, *Ashton S17679* (E). Hose Mts., Bukit Temedu [2°24'N 113°41'E], c. 1100 m, *Ashton S19007* (E). Pelagus Rapids on Rajang River ['Rejang'], also on Bukit Raya nearby, c. 2°10'N 113°E, *Burt & Woods B2544* (E). Bukit Raya, *Smith S 27719* (E). SE end Hose Mts., Bukit Nibong, c. 2°6'W 113°42'E, *Burt & Martin B4845* (E). Sungai Bena, a tributary of Sungai Sut, c. 1°55'N 113°5'E, *Burt B2609* (E). Lundu distr., Gunung Gading [1°44'N 109°50'E], *Burt & Woods B2685* (E). Bukit Lumut, Ulu Amau [1°27'N 112°04'E], c. 950 m, *Ashton S21264* (E). Bukit Goram, Ulu Sungai Kapit [1°34'N 112°45'E], *Chai S36172* (E).

3. *Cyrtandra coacta* Hilliard & B.L.Burt, sp. nov. a *C. sarawakense* C.B.Clarke venis lateralibus foliorum 9–15 (nec 15–20), venis tertiariis plus minusve pinnatis (nec subscalariformibus) pilis in bracteis et in foliorum pagina inferiore papyraceo-coactis (nec pilis singulatis manifestis) distinguenda.

Type: Sabah, Ranau distr., road from Lohan to Mamut Copper Mine near Tank 47,6°01'N 116°41'E, 1100 m, 9 vii 1984, *Beaman 10656* (holo E).

Unbranched herb to c. 800 mm tall, stem horizontal at base then curving upwards, clad in a papery indumentum of matted hairs, leafy and floriferous on erect part. *Leaves* opposite, strongly anisophyllous, reduced leaf stipule-like, c. 25 x 2 mm, lanceolate, enveloped in papery indumentum; developed leaf c. 180–360 x 60–110(–165) mm, elliptic to broadly elliptic, apex acute to almost acuminate, base cuneate, very shortly decurrent, margins entire to obscurely or distinctly remotely serrate, lateral veins 9–15 on each side of midrib, tertiary veins more or less pinnate, upper surface glabrous, finely and closely pitted, lower surface papery, any loose hairs very delicate, to c. 3 mm long; petiole 75–135 mm, enveloped in papery indumentum. *Inflorescence* a several-flowered, very congested, axillary cyme, almost sessile. *Bracts* persistent, c. 35–40 x 10–16 mm, lanceolate, strongly veined, enveloped in papery indumentum, bracteoles similar but smaller. *Pedicels* c. 5 mm. *Calyx* 5-lobed almost to base, lobes subequal, c. 3.5 x 1 mm, narrowly deltoid, tube c. 0.5 mm, outer surface with papery indumentum, inside minutely gland-dotted. *Corolla* c. 40 mm long, white or cream with 2 orange-yellow bars in throat below the two sinuses of lower lip, outside minutely puberulous, hairs acute, tube c. 25.5 mm, cylindrical below for c. 12 mm then abruptly expanded, two upper lobes c. 9 x 6.5 mm, lower lip 3-lobed, c. 14.5 x 12 mm, median lobe c. 9 x 7.5 mm, all lobes more or less suborbicular, glandular-puberulous inside and down tube to insertion of filaments. *Stamens* inserted c. 19 mm above base of tube, filaments c. 5 mm, strongly coiled post anthesis, glandular-puberulous at apex, anthers c. 2 x 1.5 mm, cohering face to face by a prominent ligature, connective densely glandular-puberulous; lateral staminodes c. 2 mm, posticous staminode c. 1 mm. *Disc* 1.5 x 2 mm, cupular. *Ovary* c. 8 x 2 mm, minutely pustulate, coma of hairs at apex. *Style* c. 15 mm, glandular-puberulous. *Stigmatic lobes* c. 3 x 1.5 mm, clavate, conspicuous, stigmatic papillae relatively long. *Fruit* c. 20 x 6 mm (*Mendum & Lamb 23A*), pericarp smooth. *Seeds* c. 0.5 x 0.25 mm, testa red-brown.

Notes: This species has the aspect of *Cyrtrandra sarawakensis* but is at once distinguished by the indumentum on the vegetative parts: on stem, leaves (including petioles), bracts, bracteoles, pedicels and calyx, the hairs are matted together (*coactum* meaning felt), giving a papery look to the surface; in *C. sarawakensis*, hairs on the corresponding parts are appressed, the individual hairs all separate. The very striking difference is easily seen along the midrib on the lower surface where the matted hairs of *C. coacta* form a papery-looking skin in sharp contrast to the strongly appressed but distinctly separate hairs in typical *C. sarawakensis* and the long coarse spreading hairs in var. *longipilosa*. The indumentum of *C. hoseana* and *C. angustieliptica* is not unlike that of *C. coacta* but both species differ, *inter alia*, in their narrow bracts lacking conspicuous venation.

In *C. coacta*, there are 9–15 lateral veins on each side of the midrib, in *C. sarawakensis* 15–20, while the tertiary veins are more or less pinnate in *C. coacta*,

subscalariform in *C. sarawakensis*. Furthermore, the leaves differ in anatomical detail: the tracheoids in the hypodermis of *C. coacta* have reticulate bars and there are no stomatal turrets; in *C. sarawakensis* the tracheoids have parallel bars and there are prominent stomatal turrets.

The stamens may differ too, but too few flowers have been seen to be certain: in *C. coacta*, the connective in the anther and the top of the filament are densely glandular-puberulous; in *C. sarawakensis* both are glabrous or very minutely glandular.

Cyrtandra coacta is known mainly from Sabah and the northern part of Sarawak (Yii *et al.* S51691 came from the upper reaches of the Baleh River, in east central Sarawak), while *C. sarawakensis* is found in the southern part.

Other specimens examined: **Sabah.** Sinsuron road, 850–900 m, 5°40'N 116°22'E, Mendum & Lamb 23 (E), Sinsuron road, Mendum & Lamb 23A (E); Lahad Datu distr., Research Centre, Ulu Sungai Segama, 200m, *Argent et al.* SAN 108203 (E). Mt. Kinabalu, eastern shoulder, 6°05'N 116°36–40'E, 3400 ft, *Chew et al.* 963 (E, K), *Chew et al.* 647 (E, K). **Sarawak.** Seventh division, Ulu Belaga, Sungai Semawat, 3°N 113°54'E, c. 250 m, *Hansen 715* (E). NE slope Bukit Kama [2°42'N 112°54'E], c. 450 m, *Hirano & Hotta 1239* (E, KYO). Ulu Sungai Balan, Bukit Batu Tiban, *Yii et al.* S51691 (E).

4. *Cyrtandra tunohica* Hilliard & B.L.Burt **sp.nov.** a *C. seganica* Hilliard & B.L.Burt foliis minoribus (maxime 170–200 mm, nec 300 mm longis) et pro rata angustioribus (4–5.7:1, nec 2.5–4.5:1), bracteis plerumque majoribus (20–30 x 4–7.5 mm prope basin, nec 20 x 4 mm), costa et venis lateralibus praecipue in pagina inferiore visibilibus (nec costa vix, lateralibus haud visibilibus), calycis lobis 2–4 x 1 mm (nec 4.5–6 x 1.5 mm) distinguenda.

Type: Sarawak, Kapit distr., Sungai Melinau [Hose Mts.], Nanga Tunoh, c.2°3'40"N 113°38'20"E, c.450ft, *Burt B12664* (holo E).

Unbranched herb, stem c. 5–6 mm in diam. near apex, height unknown, base decumbent and rooting, erect part to c. 150 mm long, upper part finely pubescent, soon glabrescent. *Leaves* opposite, crowded near apex of stem, slightly to strongly anisophyllous even on one stem, highly reduced leaves, when present, to c. 65 x 2mm, almost filiform, major developed leaves 170–200 x 35–50 mm, narrowly elliptic, apex acuminate, base narrowly cuneate, very narrowly and shortly decurrent, margins obscurely serrate to crenulate, lateral veins 13–15 (as few as 10 in minor leaves), tertiary venation subscalariform, upper surface glabrous at maturity, pitted, lower surface thinly hairy on blade, more densely so on veins, all hairs to c. 1 mm long, appressed; petiole 50–70 mm long, hairy as midrib. *Inflorescence:* few-flowered congested cymes, axillary,

extending from near apex of stem to well down below the leaves, almost sessile. *Bracts* persistent, 20–30 x 4–7.5 mm, lanceolate, long-acuminate, both surfaces puberulous, midrib and lateral veins clearly visible especially on lower surface; bracteoles similar but much smaller. *Pedicels* c. 1–8 mm, puberulous. *Calyx* 5-lobed almost to base, tube c. 0.5 mm, lobes subequal, 2–4 x 1 mm, narrowly deltoid, outside and margins closely appressed-pubescent, inside minutely gland-dotted. *Corolla* c. 30 mm long, cream with yellow marks on palate, outside puberulous, hairs acute, tube c. 20 mm long, lower half narrowly cylindrical, upper part expanded, two upper lobes c. 5 x 3.5 mm, lower lip 3-lobed, median lobe c. 5 x 3.5 mm, all lobes subrotund, glandular-puberulous inside, hairs extending down into throat. *Stamens* inserted c. 14 mm above base of tube, filaments c. 4 mm long, strongly twisted, anthers 2 x 1.2 mm, cohering face to face by a small ligature, both anthers and filaments glabrous; lateral staminodes c. 2 mm, posticous staminode c. 0.5 mm. *Disc* 1–1.2 x 1.2–1.8 mm, cupular. *Ovary* c. 3.5–7 x 0.8–2 mm, very minutely gland-dotted, crowned with coma of relatively long hairs. *Style* 5–6 mm long, puberulous. *Stigmatic lobes* 3–4 x 1–2 mm, clavate. *Fruit* 10–18 x 4–6 mm, pericarp smooth, deeply grooved longitudinally. *Seeds* 0.3–0.5 x 0.2–0.3 mm, testa red-brown.

Notes: The outstanding feature of *Cyrtrandra tunohica* as we know it is variation in the degree of anisophylly; in the rest of the species in this section of *Cyrtrandra*, the minor leaf is always reduced to a stipule-like outgrowth (with the caveat that several species are ill-known). In *C. tunohica*, the size of the leaves in each pair ranges from subequal (when the stem is much more leafy than is usual in this section as a whole) through degrees of reduction culminating in an extraordinarily long, almost filiform, stipule-like leaf; this occurs on a single stem. As the species is known from only one locality, the taxonomic value of this character remains to be assessed. The plants (very few) were found on the steep shady earth bank of a stream gully, and were seen only once, despite further fieldwork in the area on this and other occasions.

In its relatively narrow leaves, *C. tunohica* resembles both *C. seganica* and *C. angustieliptica*; it is easily distinguished from both by its bracts, 4–7.5 mm broad near the base (not 1.8–4 mm) and with both midrib and lateral veins raised on the lower surface and thus clearly visible (in contrast to nearly or quite invisible). It is further distinguished from *C. seganica* by its leaves, the largest 170–200 mm long (not c. 300 mm) and relatively narrower (ratio of length to breadth 4–5.7:1 versus 2.5–4.5:1), short (to c. 1 mm long) appressed hairs along the midrib on the lower surface (not long coarse spreading hairs), and c. 13–15 (not 18) lateral veins on each side of the midrib.

Not only do the bracts differ from those of *C. angustieliptica*, but so do the leaves in several details: lateral veins 13–15 in major leaves (not 7–10), hairs on undersurface of leaves up to c. 1 mm long, sparse on the blade (in contrast to silky-villous, hairs c. 2 mm long, the blade eventually glabrous, hairs persistent on midrib), tertiary veins clearly visible (not invisible or very nearly so).

The leaf of *C. tunohica* has tracheoids with reticulate thickening in the hypodermis and lacks sclereids in the mesophyll; *C. seganica* and *C. angustieliptica* have similar tracheoids but differ in having polymorphic sclereids in the mesophyll.

Other specimen examined: Sarawak. Kapit distr., Sungai Melinau [Hose Mts.], Nanga Tunoh, c. 2°3'N 113°38'E, *Burt B12665* (E).

5. *Cyrtandra* sp. nov.

Unbranched herb, stem very stout, c. 12 mm diam., c. 300–600 mm tall, young parts villous, lower parts glabrous. *Leaves* opposite, few crowded near apex of stem, strongly anisophyllous, reduced leaves stipule-like, c. 40 x 2 mm, narrowly linear-lanceolate, villous; largest developed leaves c. 195–260 x 80–90 mm, elliptic or oblanceolate, apex abruptly acuminate, base narrowly cuneate, very narrowly decurrent, margins entire, lateral veins 16–18, tertiary veins finely reticulate, upper surface glabrous, coarsely pitted (at maturity; densely pubescent when juvenile), lower surface densely pubescent, veins pilose; petiole c. 30–70 mm long, villous. *Inflorescence* a many-flowered, highly congested dichasial cyme, axillary, forming bracteate clusters borne on the leafless part of the stem; peduncle very stout, to 2 mm long. *Bracts* persistent, primary pair c. 20 x 7 mm, lanceolate, acute, midrib and lateral veins prominent, outside densely pubescent, inside hairs mainly near apex and base; bracteoles similar but narrower, a pair subtending each pedicel. *Pedicels* c. 5 mm, puberulous. *Calyx* 5-lobed almost to base, tube c. 0.5 mm, lobes c. 4 x 1 mm, outside puberulous, hairs patent, inside minutely gland-dotted. *Corolla* c. 30 mm long, white, 2 orange-yellow bars on palate, outside puberulous, hairs acute, tube c. 20 mm long, lower part narrowly cylindrical, upper part expanded, two upper lobes c. 5 x 3.5 mm, lower lip 3-lobed, median lobe c. 5 x 4 mm, all lobes subrotund, glandular-puberulous on lower lip, hairs extending down floor of tube, a median tuft of eglandular hairs at base of each upper lobe, a few glandular hairs towards outer margins. *Stamens* inserted c. 17 mm above base of tube, filaments c. 4–5 mm long, twisted once near base, anthers 2.2 x 1 mm, cohering face to face by a conspicuous ligature, connective minutely glandular, glands extending briefly down back of filaments; lateral staminodes c. 2 mm, apex strongly hooked, tip globular, pale yellow (as anthers), posticous staminode c. 1 mm. *Disc* 1.8 x 2 mm, almost cupular (deeply notched on one side). *Ovary* 7 x 2 mm, glabrous except for conspicuous coma. *Style* 10 mm (at anthesis), pubescent, hairs acute. *Stigmatic lobes* c. 2 x 1.5 mm (post anthesis), spatulate, stigmatic papillae conspicuous. *Fruit* 23 x 6 mm (one seen), pericarp smooth, split longitudinally, only apex and base cohering. *Seeds* c. 0.25 x 0.2 mm, testa red-brown.

Notes: This species is allied to *Cyrtandra tunohica* and *C. sarawakensis* var.

longipilosa. It is distinguished from *C. tunohica* by the relatively long patent indumentum on stems, petioles and backs of leaves (versus hairs short, appressed), leaves c. 80–90 mm broad (not 35–50 mm) and many- (not few-) flowered inflorescence. It differs from *C. sarawakensis* var. *longipilosa* by its shorter petioles (30–70 mm, not 80–150 mm) and almost sessile inflorescence. Also, the pubescence on the undersurface of the leaf blade is dense and patent (not appressed). This is obvious in *Haron S29978* (K), but not so well marked on the duplicate (E); it is also obvious in *Jugah Kudi S23712* (K) where the finely reticulate tertiary venation shows up well.

The two collections seen are not good: *Haron S29978* was obviously pressed when badly withered; the sheet at Kew is particularly bad, but this is the one with a nearly complete corolla and several buds, from which the floral details were extracted. Only an old fruit survives on the sheet in Edinburgh, and the base of a fruit on *Jugah Kudi S23712* appears to have eight loculi! The need for good collections before the species can be named is obvious.

The leaves have a 1–2-layered hypodermis, and tracheoids with parallel bars in the hypodermis.

Specimens examined: **Sarawak**, Anap, Ulu Kakus [c.2°30'N 113°E], *Othman Haron S29978* (E, K); Balingian, Ulu Sungai Arip, Bukit Iju [roughly 2°40'N 112°40'E], *Jugah Kudi S23712* (K, L).

6. *Cyrtrandra tessellata* Hilliard & B.L.Burt sp. nov. a *C. tunohica* (etiam folia anguste lanceolata gerente) caulibus et pagina foliorum inferiore villosis (nec breviter pubescentibus), petiolo 20–25 mm longo (nec 50–70 mm) villosa (nec pubescente), bracteis c. 15 x 1.8–2 mm venatione invisibili (nec 20–30 x 4–7.5 mm venatione elevata conspicua), calycis lobis c. 6–8 mm longis (nec 2.4 mm) differt.

Type: Sarawak, Bintulu distr., en route (survey route) from Sungai Mah to Sungai Shinonok, Ulu Sungai Minah, alt. 40–150 m, *Hotta 14117* (holo KYO).

Herb, probably unbranched, height unknown, stem collected 50 x 10 mm, villous, hairs 3–4 mm long, leafy throughout, internodes c. 10 mm long. *Leaves* opposite, strongly anisophyllous, reduced leaves stipule-like, c. 30 x 3 mm, narrowly lanceolate, long-acuminate, major mature leaves 150–230 x 26–34 mm, narrowly elliptic, apex gradually very acute, base narrowly cuneate, margins very obscurely serrulate, lateral veins 12–14 on each side of midrib, upper surface glabrous at maturity, pitted, lower surface villous, longest hairs (2–3 mm) on midrib, shorter on lesser veins, tertiary venation finely reticulate, all veins raised, hairs brownish (dried state) making venation very conspicuous; petiole 20–25 mm long, villous. *Inflorescence* a few-flowered axillary cyme, peduncle c. 4 mm, very stout. *Bracts* c. 15 x 1.8–2 mm, narrowly lanceolate, densely pubescent, venation obscure; bracteoles similar but

Pedicels c. 10 mm (in fruit), pubescent. *Calyx* 5-lobed almost to base, tube c. 0.5 mm, lobes 6–8 x 1 mm in fruit, narrowly deltoid, outside and margins puberulous, hairs patent, inside minutely gland-dotted. *Corolla* not seen, only very young buds present, puberulous outside, hairs acute, lobes minutely glandular inside (tube scarcely developed). *Stamens*: filaments scarcely developed, anthers 2 x 0.8 mm, minutely glandular on margins of connective. *Disc* cupular. *Ovary* and *style* very young, style pubescent. *Fruit* c. 35 x 5 mm, pericarp smooth, traces of coma still visible at apex. *Seeds* c. 0.25 x 0.2 mm, testa bright red-brown.

Notes: This species is so distinctive that lack of flowers should not preclude its formal recognition. The leaves are closely set down the 150 mm length of the piece of stem on the herbarium sheet, in contrast to most of its allies where the leaves appear to be quickly deciduous leaving a few, forming a fan, at the apex of the stem. Unfortunately, the collector gave no notes either on habit or habitat of his plant. The major leaves are short-petioled, narrowly elliptic, and at maturity glabrous above but villous below, with midrib, lateral and tertiary veins raised (the latter forming a fine reticulum) and conspicuous, partly owing to the dark hairs clothing them. Similar tertiary venation has not been seen in any other species in this section.

Cyrtandra tessellata is diagnosed above against *C. tunohica*, which has similarly narrowly lanceolate leaves, but the indumentum on stem, petioles and leaf undersurface in *C. tessellata* is villous (not merely shortly pubescent), the petioles are remarkably short (20–25 mm versus 50–70 mm), the bracts are c. 15 x 1–2 mm, venation invisible (not 20–30 x 4–7.5 mm, venation raised and conspicuous), calyx lobes c. 6–8 mm long (not 2–4 mm). In sharp contrast to that of *C. tessellata*, the tertiary venation in the leaves of *C. tunohica* is rather indistinct, and tends to be subscalariform.

The leaf anatomy of *C. tessellata* is unlike that of *C. tunohica*: vertically long tracheoids with parallel bars in the hypodermis, polymorphic sclereids in the mesophyll: the tracheoids in *C. tunohica* have reticulate bars and there are no sclereids in the mesophyll.

7. *Cyrtandra seganica* Hillard & B.L.Burt, **sp. nov.** a *C. sarawakense* C.B. Clarke bracteis tantum c. 4 mm latis (nec 7–20 mm) sine venatione conspicua (nec costa et venis lateraliibus prominentibus) et folia angustiora prorata longitudinis (5.5:1 nec 2.5–4.5:1) facile distinguenda.

Type: Sarawak, Bintulu distr., Ulu Segan [c. 2°30'N 113°E], rocky stream bank, 750 ft., *Ilias Paie* S27215 (holo E).

Unbranched herb, height unknown, stem c. 8 mm diam. near apex, apex densely pubescent, rest of stem quickly glabrous. *Leaves* opposite, strongly anisophyllous, few at apex of stem, reduced leaves stipule-like, c. 25 x 3 mm, lanceolate, acuminate, densely pubescent, hairs spreading; developed leaves c. 300 x 55–60 mm, elliptic, acute, base narrowly cuneate, very narrowly decurrent for c. 35 mm, margins entire, lateral veins c. 18 on each side of midrib, tertiary venation subscalariform, upper surface glabrous, pitted, lower surface with very small fine strongly appressed hairs on blade, coarse much longer (c. 1 mm) hairs on midrib and lateral veins, probably appressed and probably purplish in life (specimens well glued); *petiole* c. 55–70 mm long, hairy as midrib. *Inflorescence*: few-flowered congested cymes borne mainly in axils of fallen leaves, peduncle c. 4–8 mm long, very stout, puberulous. *Bracts* persistent, c. 20 x 4 mm, narrowly lanceolate, acuminate, margins entire, both surfaces puberulous, hairs spreading, midrib scarcely visible; bracteoles similar but smaller. *Pedicels* c. 8–10 mm. *Calyx* lobed nearly to base, lobes subequal, 4.5–6 x 1.5 mm, narrowly deltoid, tube c. 0.5 mm, outside and margins puberulous, inside minutely gland-dotted. *Corolla* not seen. *Fruit* c. 18–36 x 4–5.5 mm, pericarp smooth. *Seeds* immature.

Notes: *Cyrtandra seganica* is currently known with certainty only from the type collection. In the venation of the leaves, including the subscalariform arrangement of the tertiary veins, it resembles *C. sarawakensis*, but the leaves are narrower in relation to their length (ratio of length to breadth 5.5:1 versus 2.5–4.5:1). There is a striking difference in the bracts, only c. 4 mm broad near the base and with the midrib but faintly visible in *C. seganica*, in contrast to bracts c. 7–20 mm broad with prominent venation in *C. sarawakensis*. The leaves are similar anatomically in having tracheoids with parallel bars in the hypodermis, but differ in the presence of many polymorphic sclereids in the mesophyll of *C. seganica* whereas the leaves of *C. sarawakensis* lack sclereids.

Two collections from further south and west resemble *C. seganica* in leaf-venation and in narrow bracts. They appear to differ in the shape of the leaves (oblongate) and also in the ratio of length to breadth (3.25–4.6:1), this being within the range of *C. sarawakensis*. The leaves also appear to differ anatomically, in that the tracheoids have reticulate bars, not parallel bars; polymorphic sclereids occur in the mesophyll. These two collections come from Sarawak from Datu Permanent Forest [Bukit Datu? at 1°29'N 110°50'E], 420 m alt., on the ridge between two streams, Lee S41904 (E) and 17th mile Bau/Lundu road, Gunong Undan (1° 27'N 109° 59'E), stream bank, 50m, Yii S45942 (E).

Much more needs to be known about all three plants described here.

8. *Cyrtandra linauana* B.L.Burt, **species nova** ex affinitate *C. sarawakensis* C.B.Clarke et *C. hoseanae* B.L.Burt, ab ambabus nervis lateralibus foliorum 7–8 (nec 12–20) et calycis lobis 10–15 mm longis (nec usque ad 8 mm) differt.

Type: Sarawak, Belaga distr., hill just N of Long Linau [c.2°40'N 114°E], *Burt 11478* (holo E; iso BO, L, SAR).

Herb, stem simple, c.100 mm tall, 8 mm diam., puberulous, hairs very closely appressed. *Leaves* opposite, strongly anisophyllous, 5 pairs crowded near apex of stem, lower ones fallen, reduced leaf stipule-like, c. 35 x 5 mm, lanceolate, long-acuminate; developed leaf c. 210–300 x 82–83 mm, elliptic, somewhat falcate and eccentric, apex rather abruptly acuminate, base cuneate, very shortly and narrowly decurrent, margins entire, lateral veins 7–8 on each side of midrib, tertiary venation coarsely reticulate, upper surface mottled silver (living material), glabrous, pitted, lower surface with blade glabrous, midrib and lateral veins strongly appressed-pubescent, hairs very inconspicuous; petiole 70–80 mm, thickly appressed-pubescent. *Inflorescence* an axillary dichasial cyme, flowers few, branches of cyme very short (3–4 mm), bearing only 4 flowers (apical bud on each branch suppressed), peduncle c. 5–8 mm, very stout. *Bracts* persistent, c. 20 x 2 mm, narrowly lanceolate, acuminate, both surfaces strongly appressed-pubescent, bracteoles similar but smaller, a pair subtending each pedicel. *Pedicels* c. 20 mm, appressed-pubescent. *Calyx* 5-lobed almost to base, tube c. 0.5 mm, lobes 10–15 mm, narrowly linear-lanceolate, outside appressed-pubescent, inside minutely gland-dotted. *Corolla* 26–30 mm long, white, throat yellow shading to orange, outside minutely puberulous, hairs acute, red, tube 17–18 mm long, cylindric in lower third, abruptly expanded above, two upper lobes 7–8 x 5 mm, lower lip 3-lobed, c. 9–12 mm long, median lobe 7–8 x 5 mm, all lobes oblong-elliptic, glandular-puberulous inside. *Stamens* inserted 8.5 mm above base of tube, filaments 2.5 mm, glabrous, anthers 2.2x1.2mm, cohering face to face by a prominent ligature, connective fringed with stout red hairs; lateral staminodes 3 mm, posticous staminode 1.2 mm. *Disc* 1.5 x 2 mm, cupular but deeply excavated on one side. *Ovary* 5 x 1 mm, minutely pustulate, coma of hairs at apex. *Style* 7mm, glandular-puberulous. *Stigmatic lobes* 4 x 1.8 mm, clavate, conspicuous. *Fruit* 24 x 3.8 mm, pericarp smooth.

Notes: *Cyrtandra linauana* resembles both *C. sarawakensis* and *C. hoseana* in the size, shape and stance of its leaves but differs from both in having only 7–8 lateral veins on each side of the midrib (not 12–20). The tertiary venation also differs: in *C. linauana* it is rather indistinct and very coarsely reticulate though the veinlets may be more subscalariform towards the margins; in *C. sarawakensis* the veins are prominent and closely subscalariform; in *C. hoseana* they are very nearly invisible.

The tracheoids in the hypodermis have reticulate bars as in *C. hoseana* but there are no sclereids in the spongy mesophyll. In *C. sarawakensis* the tracheoidal bars are parallel and, as in *C. linauana*, there are no sclereids in the spongy mesophyll; *C. hoseana* has polymorphic sclereids.

The inflorescences of all three species differ: in *C. linauana*, the bracts are only c. 2 mm broad and the venation is not or scarcely visible; pedicels c. 20 mm long, making the inflorescence rather lax. In *C. sarawakensis*, the bracts are very conspicuous, being broad, venation prominent, pedicels c. 9–13 mm long, inflorescence congested. In *C. hoseana*, the bracts are c. 3–4 mm broad, venation inconspicuous, pedicels c. 5–10 mm long, inflorescence congested. Stout red hairs fringe the connective in *C. linauana*; in *C. sarawakensis* and *C. hoseana*, the connective is either glabrous or glandular.

Cyrtrandra linauana is known with certainty only from the type collection made at c. 2°40'N 114°E. There is another collection, made at c. 2°48'N 112°59'E, that is clearly very close to *C. linauana*, namely *Hirano & Hotta 881* (KYO, E) from Bukit Keyan, Ulu Sungai Kakus, alt. 100–300 m. It differs in several details: leaves not falcate and with 10 lateral veins, otherwise identical with those of *C. linauana*, flowers fascicled in the leaf axils, pedicels c. 15 mm long, calyx lobes 6.5–9 mm. The most significant difference is the fascicled flowers in contrast to the shortly pedunculate dichasial cyme of *C. linauana*, where the long pedicels produce a very lax inflorescence.

The leaves of *C. angustielliptica* have a deceptive similarity to those of *C. linauana*. That species is, however, distinguished by the short (to c. 1 mm) appressed and inconspicuous hairs on stem, petiole and midrib of leaves on lower surface (not 2–3 mm long, silky, appressed hairs matted together and easily seen), bracts c. 20 mm long (not 5–8 mm), connective of anthers fringed with stout red hairs (versus glandular puberulous ones all over). The inflorescence of *C. angustielliptica* is a nearly sessile, very congested, cyme.

9. *Cyrtrandra hoseana* B.L.Burt, Notes Roy. Bot. Gard. Edinb. 30:33 (1970).

Type: Sarawak, Lambir Hills, c. 4°7'N 113°55'E, sandstone banks, *Burt & Woods B2365* (holo E, iso SAR).

Unbranched herb, stem 20–150 cm long, c. 8 mm diam. near apex, hanging from sandstone cliffs and banks, sometimes supported by prop roots, young parts silky villous, hairs strongly appressed. *Leaves* opposite, strongly anisophyllous, few arranged in a fan at stem apex, reduced leaves stipule-like, c. 20 x 10 mm, broadly lanceolate, appressed silky-villous; largest developed leaves c. 255–320 x 85–95 mm, elliptic, apex abruptly acute, base cuneate, shortly and very narrowly decurrent, margins entire to obscurely serrulate, lateral veins 12–15 on each side of midrib, tertiary venation coarsely reticulate, upper surface glabrous at maturity, coarsely pitted, lower

surface with long, strongly appressed, silky hairs on midrib and lateral veins, blade glabrous or almost so at maturity; petiole c. 45–60 mm, hairy as midrib. *Inflorescence* an axillary, very congested, cyme, mainly in axils of fallen leaves, few-flowered, peduncle 2–6 mm long. *Bracts* c. 15–18 x 3–4 mm, persistent but inconspicuous, lanceolate, acuminate, closely appressed-puberulous, only midrib visible on lower surface. *Pedicels* c. 5–10 mm long, puberulous. *Calyx* 5-lobed almost to base, lobes subequal c. 2.2–3.5 x 1.25 mm, deltoid, outside appressed-pubescent, inside minutely gland-dotted. *Corolla* c. 32 mm long, white or creamy white outside, 2 orange-yellow bars in throat, outside puberulous, hairs acute, red, tube c. 20 mm long, lower half narrowly cylindrical, abruptly expanded above, two upper lobes c. 5 x 7 mm, lower lip 3-lobed, c. 12.5 x 20 mm, median lobe c. 6 x 7 mm, all lobes subrotund, glandular-puberulous inside and for a short way down tube. *Stamens* inserted c. 16 mm above base of tube, filaments c. 5 mm, curved and twisted once, minute globular glands at apex, anthers c. 3 x 1.6 mm, cohering face to face by a small ligature, connective with a few glandular hairs and globular glands; lateral staminodes c. 1.2 mm, posticous staminode c. 1 mm. *Disc* 1 x 1.8 mm, cupular. *Ovary* 8 x 1.6 mm, very minutely gland-dotted, coma of hairs at apex. *Style* 10 mm, glandular-puberulous. *Stigmatic lobes* not fully developed, c. 2 mm long, clavate. *Fruit* c. 27–45 x 5 mm, pericarp smooth. *Seeds* c. 0.4 x 0.25 mm, testa red-brown.

Notes: So far, *C. hoseana* is known with certainty only from the Lambir Hills. Now that more material is available, it is clear that *Burt & Woods B2212* (E, SAR) from the Melinau Gorge, which was cited in the original description, is a distinct species, described here as *C. angustielliptica*.

It is worth noting again that 'the youngest leaf is very densely covered with shining silky hairs and it hangs downwards at the top of the shoot, like a tiny silvery flag' (Burt, 1970). In this species, the tertiary veins are scarcely discernible on the lower surface of the leaf, but form a coarse reticulum that may just be visible on the upper surface (compare the tertiary veins of *C. sarawakensis*).

Tracheoids with reticulate bars occur in the 1–2-layered hypodermis, and a few polymorphic sclereids in the mesophyll.

Other specimen examined: **Sarawak.** Lambir National Park, Sungai Lapoh and nearby, *Burt 11546* (E).

10. *Cyrtandra angustielliptica* Hilliard & B.L. Burt sp. nov. a *C. hoseana* B.L. Burt foliis 36–60 mm latis (nec 85–90 mm) apice acuminato (nec abrupte acuto), venis lateralibus utrinque costae 7–10 (nec 12–15), calycis lobis 5–8 mm longis (nec 2.2–3.5 mm) distinguenda.

Type: Sarawak, Sungei Melinau Gorge, c. 4°5'N 114°50'E, sandstone hillock, *Burt & Woods B2212* (holo E).

Unbranched herb, stem of unknown height, c. 6–7 mm in diam. near apex, young parts silky-villous, hairs strongly appressed, matted together. *Leaves* opposite, strongly anisophyllous, reduced leaves stipule-like, c. 18 x 6 mm, lanceolate, silky-villous as stem, developed leaves up to c.10, largest 170–275 x 36–60 mm, elliptic, apex acuminate, base cuneate, margins entire to obscurely serrulate but teeth made conspicuous by apical tuft of hairs, lateral veins 7–10 on each side of midrib, tertiary venation obscure, upper surface glabrous at maturity, coarsely pitted, lower surface with long, strongly appressed, silky hairs on midrib and lateral veins, these also on blade but this eventually glabrous; petiole c. 40–45 mm, hairy as midrib. *Inflorescence* an axillary very congested cyme, flowers few, peduncle c. 2 mm. *Bracts* c. 5.5–7 x 1.8–2 mm, persistent but inconspicuous, lanceolate, acuminate, both surfaces densely appressed-pubescent. *Pedicels* c. 8 mm, puberulous. *Calyx* 5-lobed almost to base, tube c. 0.5 mm long, lobes subequal, 5–8 x 1.2 mm (in flower and fruit), deltoid, outside densely appressed-pubescent, inside minutely gland-dotted. *Corolla* c. 30–35 mm long, white or creamy white outside, 2 orange-yellow bars in throat, outside puberulous, hairs acute, tube c. 22–28 mm, lower half cylindrical, upper part expanded, two upper lobes c. 5 x 5 mm, lower lip 3-lobed, median lobe c. 6 x 7 mm, all lobes subrotund, glandular-puberulous inside and short way down tube. *Stamens* inserted c. 16 mm above base of tube, filaments c. 5 mm, curved and twisted once, glandular-puberulous at apex, anthers c. 2 x 1.5 mm, cohering face to face by a small ligature, connective glandular-puberulous; lateral staminodes c. 2 mm, posticous staminode not seen. *Disc* c. 1.5 x 1.8 mm, cupular. *Ovary* c. 6 x 1.2 mm, very minutely papillose, coma of hairs at apex. *Style* c. 6 mm elongating to c.10 mm, glandular-puberulous. *Stigmatic lobes* c. 3 x 2 mm, clavate. *Fruit* 25–48 x 5 mm, pericarp smooth. *Seeds* c. 0.3 x 0.2 mm, testa red-brown.

Notes: In his original description of *Cyrtandra hoseana*, Burt cited *Burt B2212* (above) as that species, but in the herbarium he later segregated it and further collections as differing in their narrower leaves. Not only are the leaves narrower, they are also shorter (170–275 x 36–60 mm versus 255–320 x 85–95 mm) and there are significantly fewer lateral veins than in *C. hoseana* (7–10 versus 12–15); also, the leaf tips are acuminate (not abruptly acute). They may differ further in the length of the calyx lobes (5–8 mm versus 2.2–3.5 mm, but see comments below). As in *C. hoseana* the tertiary veins are scarcely visible on the lower surface of the leaf; anatomically the leaves are similar, having tracheoids with reticulate bars in the hypodermis and polymorphic sclereids in the mesophyll.

Cyrtandra angustieliptica is known only from the Melinau Gorge (in Gunung Mulu National Park) at c.100 m above sea level. A plant with leaves exactly like those of *C. angustieliptica* in all morphological details has been collected several

times on the extreme headwaters of the Balleh, at c.1000–1700 ft altitude on a ridge between Sungai Balang and Sungai Balleh [$1^{\circ}35'N$ $114^{\circ}30'E$ at 1200 ft by *Anderson & Paie S28329* (E); at c.1000 ft by *Anderson & Paie 28739* (E); at c.1000 ft by *Anderson S28741* (E) and at 1700 ft by *Paie S28409* (E. L)]. However, these specimens differ anatomically in having no sclereids in the spongy mesophyll (a character possibly of little taxonomic significance), and the calyx lobes are 2.5–5 mm long (not 5–8 mm), corolla 20–25 mm (not 30–35 mm), filaments and anthers glabrous (not glandular), and the disc unilateral (not cupular).

Other specimens examined: **Sarawak.** Gunung Mulu National Park, Melinau Gorge, *Burt B8274* (E); Melinau Gorge, c. 100 m, *Nielsen 537* (E).

11. *Cyrtandra insolita* Hilliard & B.L.Burt **sp. nov.** nullae arcte affinis; pedunculo longo axillari bracteis duabus flores breviter pedicellatos 1–3 involucrantibus facile recognoscenda.

Type: Sarawak, Kapit, Upper Rajang [$^{\circ}$ Rejang $^{\circ}$] River, 1929, *Clemens 21236* (holo K).

Shrub (fide collector), 3 stems seen, 170–250 mm long, woody, leafy only at apex, young parts densely pubescent. *Leaves* opposite, strongly anisophyllous, reduced leaves stipule-like, c. 20 x 3 mm at base, linear-lanceolate, villous; developed leaves few, c. 160–190 x 55 mm, elliptic, apex long-acuminate, base cuneate, decurrent down petiole, margins obscurely serrulate, lateral veins c. 20 on each side of midrib, tertiary veins invisible, upper surface silky villous at first, soon glabrescent, coarsely pitted, lower surface densely pubescent, hairs very delicate, c. 4 mm long on midrib, shorter on blade; petiole c. 10 mm long, villous. *Inflorescence* mainly in axils of fallen leaves, 1–3-flowered, flowers springing from apex of peduncle and enfolded by bracts, peduncle 15–45 mm long, villous. *Bracts* 2, persistent, foliaceous, c. 35–45 x 10–22 mm, lanceolate, long-acuminate, 5-nerved, both surfaces villous; bracteoles wanting. *Pedicels* 4–5 mm, pubescent. *Calyx* 5-lobed almost to base, lobes subequal, 2 x 1.5 mm, deltoid, outside pubescent, inside gland-dotted. *Corolla* not seen. *Anthers* (in very young bud) 1.5 x 1.1 mm, glabrous. *Gynoecium* very young, but stigma clearly bilobed, disc cupular. *Fruit* c. 30 x 5 mm, pericarp smooth (young fruits retain an apical coma). *Seeds* c. 0.3 x 0.25 mm.

Notes: *Cyrtandra insolita* (*insolitus* = extraordinary) is highly distinctive among other species in this Section, from which the pair of foliaceous bracts enfolding one to three flowers at the apex of the long peduncle immediately mark it out. The other species all have few- to many-flowered cymes. Also, these species are unbranched herbs of the forest floor; Mrs Clemens described her plant as ‘shrub in thickets’.

12. *Cyrtrandra* sp. nov.

Unbranched herb, stem woody, height unknown, 10 mm diam., pilose, hairs coarse, spreading, red-purple, as on other vegetative parts. *Leaves* opposite, strongly anisophyllous, few at apex of stem, reduced leaves stipule-like, c. 75 x 6 mm at base, linear-lanceolate, long-acuminate, pilose; largest developed leaves 300–350 x 85–110 mm, elliptic, apex acuminate, base narrowly cuneate, decurrent, margins finely and remotely toothed (teeth being extensions of the veins beyond the margins), lateral veins 15–16 on each side of midrib, tertiary veins coarsely reticulate, upper surface glabrous, pitted, lower surface with short, fine appressed hairs on blade, long coarse spreading hairs on midrib; petiole c. 45–50 mm long, hairy as midrib. *Inflorescence* a congested several-flowered cyme, solitary in axils of fallen leaves, peduncle c. 6–12 mm long, pubescent. *Bracts* persistent, c. 18 x 3 mm, lanceolate, acuminate, midrib visible on lower surface, both surfaces densely pubescent; bracteoles similar but smaller, a pair subtending each pedicel. *Pedicel* c. 20 mm long (in fruit), densely puberulous. *Calyx* 5-lobed almost to base, tube c. 1 mm long, lobes subequal, c. 10 x 1.5 mm (in fruit), narrowly deltoid, outside densely puberulous, inside minutely gland-dotted. *Corolla* not seen. *Fruit* c. 30 x 5.5 mm, pericarp smooth, remains of coma visible at apex. *Seeds* not fully ripe.

Notes: This plant needs to be re-collected. Gunung Gaharu lies c. 96 km SE of Kuching on the road to Serian. The specimen seen is a unicate, in fruit but without flowers. It much resembles *Cyrtrandra sarawakensis*, particularly var. *longipilosa*, but is at once distinguished by the reticulate, not subscalariform, tertiary venation of the leaves, and by its much narrower bracts.

Specimen examined: Sarawak, Gunung Gaharu, c. 2000 ft., Burt 2658 (E).

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***Begonia peninsulae* (Begoniaceae), a Confused Species from Malesia**

RUTH KIEW

Singapore Botanic Gardens, Singapore 259569

Abstract

Begonia peninsulae Irmsch. subsp. *peninsulae* from Trengganu, Peninsular Malaysia, is synonymous with *B. rajah* Ridl. and *B. peninsulae* subsp. *tambelanense* Irmsch. is raised to specific rank as *B. tambelanense* (Irmsch.) Kiew.

Introduction

Irmscher (1929) recognised two subspecies within his *Begonia peninsulae*: ssp. *peninsulae* from Trengganu and ssp. *tambelanense* from the Tambelan Islands. These were both based on a mixture of plants cultivated in the Singapore Botanic Gardens and the Penang Botanic Garden. The ones collected from the Singapore Botanic Gardens in Ridley's time (one from Trengganu; the other from the Tambelan Islands) have a clear provenance. However, later collections are without provenance and, in the case of those from Penang, are from batches that include many exotic ornamental begonias. Indeed, there is no evidence to suggest that they are plants of wild-collected origin. In addition, these two subspecies are clearly not conspecific as one has a cordate leaf and the other a peltate one.

Subspecies *peninsulae*

Irmscher cited one specimen from Trengganu (which was spelt 'Tringganu' on the label), which is without a number or information on the date and collector. The botanical name is written as '*Begonia raja*'. 'Ridley' has been added as the collector in a different hand after Irmscher's publication.

This specimen matches those of *Begonia rajah* Ridl. in characters of the leaf, inflorescence and fruit. Despite the leaf being exceptionally large (11.5 x 16 cm as opposed to 5.5–7.5 x 5.5–7.5 cm in wild plants of *B. rajah*), the leaf base, like *B. rajah*, is deeply cordate and, even in the dried state, the variegation is conspicuous with the veins lighter than the rest of the lamina. This specimen might be one of the

plants originally collected in Trengganu (which Ridley spelt as Tringganu) or its progeny that was cultivated in the Botanic Gardens Singapore from where it was introduced into the ornamental trade in England. *B. peninsulae* ssp. *peninsulae* is therefore reduced to synonymy with *B. rajah*.

The other specimens of ssp. *peninsulae* cited by Irmscher are very different in that they are all peltate (*B. rajah* never has peltate leaves). These specimens, *Burkill Begonia* No. 16 July 1917 (SING), *Burkill* 6114 31 Aug 1920 (SING), were cultivated in the Penang Botanic Garden and have no provenance. In leaf size, shape, colour, surface ('coppery and bullate') and margin they are identical to *Begonia goegoensis* N.E. Brown from Sumatra, which is one of the few Asian begonias that is easy to grow under local conditions.

Begonia rajah Ridl.

Gard. Chron. III, 16 (1894) 213 & Fig. 31. **Type:** *Native Collector s.n.* 1892 'Tringganu' (Trengganu) (holo K *ex* SING¹)

Synonym nova: *Begonia peninsulae* Irmscher ssp. *peninsulae*, Mitt. Inst. Allg. Bot. Hamburg, 8 (1929) 98. **Type:** 'Tringganu' without collector, number or date (K *ex* SING¹).

Subspecies *tambelanense*

Irmscher described this subspecies (a begonia with peltate leaves) from a collection by Ridley made in 1895 from a plant that was cultivated in the Botanic Garden Singapore. This, in turn, was originally collected by Pereira from the Tambelan Islands, NW of Pontianak, Indonesian Borneo.

It is very different from the specimen of his subsp. *peninsulae* (= *B. rajah*) from Trengganu as not only are the leaves peltate with a long acumen but the petiole and lower surface of the veins are conspicuously hairy. (Those of *B. rajah* are deeply cordate with a short acumen and are more or less glabrous). Again, Irmscher included plants of unknown provenance collected from both Gardens – *Nur Begonia* No. 2 (SING), *Nur Begonia* No. 3 (K, SING) both dated March 1917 from the Botanic

¹ When Irmscher monographed the begonias of Peninsular Malaysia he borrowed the entire collection of the Singapore Botanic Gardens (SING) and these he annotated and cited in his monograph. He did not consult the collection at Kew (K) and none of their specimens is cited by him. A considerable number of unicate types are no longer to be found at SING but are now at K. We have no record of how they came to be transferred but they are definitely the Singapore types as they bear Irmscher's original annotations. These are cited as K *ex* SING in this account.

Gardens Singapore; and *Burkill Begonia No. 1* (SING) July 1917, *Burkill 6115* (SING) 31 Aug 1920 from the Penang Botanic Garden. These are among a gathering of begonias by Burkill that included ornamental begonias made over 20 years after the original Pereira specimen was introduced into Singapore. It is unlikely that the Tambelan plants had survived so long.

These garden plants differ from the original collection by Ridley in their more densely pilose petioles and distinctly toothed leaf margin. Irmscher had already raised the possibility that these were pot plants (Topfpflanzen) and that they differed from the Tambelan plant in leaf size (6.5–17 x 8.5–24 cm), margin and acumen length. The Tambelan plant is therefore regarded as a distinct species and is here raised to specific rank.

To add confusion, Irmscher also recognised a hybrid between the two subspecies, *Burkill 6113* 31 Aug 1920 (SING), because he considered it was intermediate between the two subspecies. This specimen is less hairy and has a less conspicuously toothed margin than *Burkill 6115* but it does not resemble *B. goegoensis* (*Burkill 6114*) at all.

Begonia tambelanense (Irmsch.) Kiew, **stat. nov.**

Basynym: *Begonia peninsulae* Irmsch. ssp. *tambelanense* Irmsch. Mitt. Inst. Allg. Bot. Hamburg. 8 (1929) 100. **Type:** *Ridley s.n.* 31 Aug 1895 Botanic Gardens Singapore originally collected by Pereira from Tambelan Is. (holo K *ex* SING¹).

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A New Species and a New Combination in Bornean *Kopsia* (Apocynaceae: Apocynoideae)

DAVID J. MIDDLETON

Harvard University Herbaria, 22 Divinity Avenue, Cambridge, MA 02138, U.S.A.

Abstract

A new species, *Kopsia rajangensis* D.J.Middleton, is described and a new combination, *Kopsia pauciflora* Hook.f. var. *mitrephora* (Sleesen) D.J.Middleton, is made.

Introduction

As preparation for an account of the Apocynaceae for the Tree Flora of Sabah and Sarawak, it is necessary to describe a new species of *Kopsia* and reduce *Kopsia mitrephora* Sleesen to a variety of *Kopsia pauciflora* Hook.f.

Kopsia rajangensis D.J.Middleton, *sp. nov.*

Frutex 1.2–4.6 m altus, ramis glabris. Folia elliptico-oblonga, 13.4–32 x 3.8–9.6 cm, nervis 9–25 paribus. Corollae tubus 21.5–25 cm, lobis 11–14 x 2.7–4.7 mm. **Typus:** Borneo, Sarawak, Kapit, Upper Rejang River, *Clemens & Clemens 21221* (holo MO; iso A, BM, BO, NY, SAR)

Small tree or shrub, 1.2–4.6 m tall. Branchlets glabrous, not or sparsely lenticellate, terete. *Leaves:* petiole 4–9 mm long, glabrous; blade papery to subcoriaceous, elliptic or oblong, apex caudate, base obtuse to cuneate, 13.4–32 x 3.8–9.6 cm, 2.6–4.3 times as long as wide, midrib shallowly sunken or raised and with a central groove above, secondary veins 9–25 with 6–25 mm spacing, 40–60° from midrib, prominent or flat above, prominent beneath, clearly discernable from tertiary venation above and beneath, straight or slightly ascending near margin, tertiary venation prominent above, prominent or flat beneath, reticulate or sub-perpendicular to midrib and oblique to secondary veins, intramarginal vein looped and inset from margin, glabrous above and beneath. *Inflorescences* dichasial and then with cincinnate branches, 4–15 cm long with axes 14–140 x 1.4–2.1 mm, glabrous to densely puberulent; peduncle 2–76

x 1.7–3.7 mm; pedicel c. 4 mm long; bracts persistent in inflorescence. *Sepals* ovate, apex rounded, 1.5–1.7 x 1.1–1.4 mm, 1.2–1.4 times as long as wide, ciliate, otherwise glabrous outside and inside. *Corolla* white; tube 21.5–25 x c. 2.3 mm, pubescent around stamens and slightly beneath inside, throat pubescent, glabrous outside, 1.8–2 times as long as lobes, 12.6–16.7 times as long as calyx; lobes elliptic or oblong, apex obtuse or acute, 11–14 x 2.7–4.7 mm wide, 3–4.5 times as long as wide, not ciliate, glabrous outside and inside. *Stamens* 17–21 mm from corolla base which is 0.79–0.84 of corolla tube length; anthers 1.7–2 x 0.6–0.8 mm, 2.5–2.8 times as long as wide, 1.1–2 mm from corolla throat; filaments c. 0.7 mm long. *Ovary* 0.9 mm high, glabrous to densely pubescent; style 20 mm long; pistil head 0.8 mm long. *Fruits* falcate with small blunt projection near the base, 15–16 x 4 x 6.5–7 mm; projection 3–4 mm long.

Distribution: Borneo – SARAWAK: endemic to the Rajang River area.

Habitat: In hill forest and disturbed primary forest on rich clay soil.

Notes: Merrill (1921) compared a specimen of this species, *Haviland 3042*, to *Kopsia macrophylla* Hook.f. but offered no further identification. Timmerman-Van der Sleenen (1959) was the first to note the peculiarity of the material and compared it to *Kopsia lapidelecta* Sleenen and *Kopsia tenuis* Leenh. & van Steenis, again without making a recommendation as to what it might be or describing a new species. Anderson (1980) and Ashton (1988) called this species *Kopsia larutensis* King & Gamble, a species known only from Peninsular Malaysia. *Kopsia rajangensis* differs from *K. larutensis* in its larger inflorescences, much larger flowers and relatively wider corolla lobes. Markgraf (1972) cited the specimens under *Kopsia arborea* Blume. As can be seen, there has been remarkably little agreement on the identification of the species around Kapit on the Rajang River, which the Clemenses spelt 'Rejang'. Part of the problem has been the lack of good material.

This new species is probably related to *Kopsia lapidelecta* and *Kopsia sleeteniana* Markgr. It differs from the former in its secondary venation, intramarginal vein and larger flowers, and from the latter in its smaller flowers and also its venation.

Specimens examined: Sarawak: Kapit, Upper Rajang River, *Clemens & Clemens 21211* (SAR), *Clemens & Clemens 21221* (A, BM, BO, MO, NY, SAR); Pelagus Rapids, *Ashton S17797* (L); Rajang River, *Haviland 3042* (BM, SAR, SING); Bukit Raya, *Smith S27738* (SAR).

Kopsia pauciflora* Hook.f. var. *mitrephora* (Sleenen) D.J.Middleton, *comb. nov.

Basionym: *Kopsia mitrephora* Sleenen, *Blumea* 10 (1960) 136. **Type**: *G.H.S. Wood SAN 16118*. Borneo, Sabah, Lahad Datu, Path between Sungai Sabahan and Sungai

Dok (holo L; iso BRI).

Notes: *Kopsia mitrephora* was formally described by Timmerman-Van der Sleseen (1960) following on from her earlier, but not validly published, account of the species (1959). In the earlier work she distinguished *K. mitrephora* on the basis of its stamens inserted in the lower part of the corolla tube, a character unusual in the genus, and on its delicate leaves. However, with the many more specimens available now, it is clear that the vegetative characters in this species are extremely variable and closely parallel the vegetative variation found in *K. pauciflora*. These variations include the size of the wings or angles on the stems, the thickness of the leaves, the length of the petiole and the degree of prominence of the venation. Despite long attempts to put some sort of order to this variation, and indeed there are character states concentrated in some geographical areas, no further taxa could be distinguished in either species. In addition, it became increasingly clear that the only character to distinguish *K. pauciflora* and *K. mitrephora* was the site of insertion of the stamens and that otherwise both species were remarkably similar, including in fruit characters. Therefore, varietal status is appropriate for *Kopsia pauciflora* var. *mitrephora*.

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New Species and Varieties of *Symplocos* (Symplocaceae) from Borneo

K.G. PEARCE

32, Lorong Kumpang 4, Kuching, Sarawak, Malaysia

Abstract

A new species of *Symplocos*, *S. buxifolioides* K.G.Pearce and two varieties, *S. iliaspaiensis* Noot. var. *pedunculata* K.G.Pearce and *S. laeteviridis* Stapf var. *alabensis* K.G.Pearce are described from Borneo.

Introduction

In his account of the Symplocaceae for the Flora Malesiana region, Nooteboom (1975, 1977, 1984, 1986, 1989) recognised 30 species with 19 varieties of the genus *Symplocos* Jacq. in Borneo. In the process of revising and preparing the manuscript for the Tree Flora of Sabah and Sarawak, one new species, *Symplocos buxifolioides*, and two varieties, *S. iliaspaiensis* var. *pedunculata* and *S. laeteviridis* var. *alabensis* are recognised. Descriptions and brief notes on the geographical distribution and morphological characters distinguishing these new taxa from those of previously known are given.

1. *Symplocos buxifolioides* K.G.Pearce, *sp. nov.*

Symplocos buxifoliae Stapf similis a qua differt ramulis distincte modo gallice et anglice 'zigzag' et margine foliae revoluto praeter interdum ad apicem et e basi foliorum non altae obscure denticulatae. **Typus:** Chew & Corner RSNB 5882, Borneo, Sabah, Mt. Kinabalu, Mesilau (holo SING; iso SAN).

Tree to 10 m tall, 10 cm diam. **Twigs** weakly, irregularly curved, *smaller ones distinctly zig-zag with nodes closely set*, slender, up to 4 mm diam., dark brown to black; young parts longitudinally ridged and sparsely appressed long-pilose; *older parts becoming horizontally cracked, glabrescent, without prominently raised leaf scars*. **Leaves** spirally arranged, coriaceous, glabrous above, hairy to virtually glabrous below, drying olive-brown above, yellow-green below; *blade broadly ovate-elliptic, 2.5–4.5 x 1–3*

cm, base shortly attenuate, *margin revolute except sometimes at apex, shallowly, obscurely toothed from near base, apex acute, shortly apiculate*; midrib narrowly channelled above; *lateral veins (6–)7–8 pairs*, joining to form an intramarginal vein; intercostal venation reticulate, raised above and prominent below; petiole 3.5–5 mm long, sharply flanged to base. **Inflorescences** racemous, borne in the axils of upper leaves and below on leafless twigs; *axis 2–5(–9) mm long*, shortly, moderately dense appressed–pilose; bracts early caducous. **Flowers** 1–3; pedicels to 0.5 mm long; calyx tube *c.* 0.3 mm long, lobes broadly ovate, chartaceous, ciliate almost to apex, moderately dense to sparsely appressed–hairy, *c.* 1 mm long; corolla white, glabrous, 3.5–4 mm long; ovary sparsely to densely appressed hairy, 1.5 mm high. **Fruits** solitary on a pedicel to 9 mm long, ovoid to curved ellipsoid, 1–1.5 x 0.5–0.7 cm, hardly to shallowly ridged, sparsely appressed–pilose to glabrescent, drying yellowish brown, with persistent and erect calyx lobes.

Distribution: Endemic in Borneo. Known only from Mt. Kinabalu, Sabah.

Ecology: Upper montane forest at 2400–3660 m altitude.

Other specimens examined: SABAH. Mt. Kinabalu: *Hotta 3840* (SAN), *Chew & Corner RSNB 5911* (SAN), *Mikil & Aban SAN 46593* (SAN) and *Aban et al. SAN 54254* (SAN).

Notes: *Symplocos buxifolioides* is similar to *S. buxifolia* Stapf but differs from the latter in its slender twigs, which are distinctly and shortly zig–zag between the closely set nodes; young parts of the twigs sparsely appressed pilose; broadly ovate–elliptic leaves (not obovate–elliptic as in *S. buxifolia*) with revolute and closely, obscurely denticulate margin from near the base, acute to shortly apiculate apex (not obtuse to rounded), and 6–8 pairs of lateral veins (not 4–6); inflorescences borne on leafless twigs as well as in the axils of upper leaves; calyx tube *c.* 0.3 mm long, ciliate almost to the apex (not sometimes ciliate at base), and moderately densely to sparsely appressed–hairy (not glabrous); and sparsely to densely appressed–hairy ovary (not glabrous). This species is named for its close morphological similarity to *S. buxifolia*.

2. *Symplocos iliaspaiensis* Noot. var. **pedunculata** K.G.Pearce, var. *nov.*

A var. *iliapaiense* differt racemis base ramosis ad 6.5 cm longis floribus (fere) sessilibus ad 2 mm pedicellatis. **Typus:** *Fedilis SAN 95642*, Borneo, Sabah, Kalabakan district (holo SAN; iso K, KEP, L, SAR, SING).

Tree to 13 m tall. **Leaves** 7.5–20 x 2.5–6 cm, base cuneate, apex with acumen to 1.4 cm long. Racemes *basally branched, to 6.5 cm long*. **Flowers** *virtually sessile or*

with short pedicel to 2 mm long.

Distribution: Endemic in Borneo. Sabah (Kalabakan, Sandakan and Tawau districts) and Brunei Darussalam.

Ecology: In primary and logged-over mixed dipterocarp forest at altitudes to 80 m, on flat or undulating lands and ridges.

Other specimens examined: SABAH. Sandakan district, *Sigin* SAN 56798 (KEP, SAR, SING), *Leopold & Kodoh* SAN 81396 (SAN, SAR), *Leopold & Kodoh* SAN 81424 (SAN, SAR); Lahad Datu *Sinanggul* SAN 56991 (SAN, SAR); Kinabatangan *Meijer* SAN 136314 (SAN), Pensiangan district *Goh* SAN 141166 (KEP, SAN). BRUNEI: Belait Wong WKM 1079 (SAN).

Notes: This new variety may reach 13 m tall (not 3.3 m tall as in the typical variety). It is vegetatively very similar to var. *iliaspaiensis* but can be distinguished by its basally branched raceme or unbranched spike or fascicle of racemes 1.5 to 6.5 cm long bearing virtually sessile to shortly pedicellate (to 2 mm long) flowers. In contrast, var. *iliaspaiensis* has fascicles of sessile flowers with the axis entirely absent. This variety is named for its pedunculate inflorescences.

3. *Symplocos laeteviridis* Stapf var. *alabensis* K.G.Pearce, var. nov.

Symplocos laeteviridis Stapf var. *mjöbergii* (Merr.) Noot. similis praeter ramunculos graciliores cum paginis infernis foliorum omnino glabros, foliis olivaceis, parvioribus, lanceolatis, ad 6.3 cm longis et 2.2 cm latis. **Typus:** *Madani & Majawat* SAN 119252. Borneo, Sabah, Penampang district, Gunung Alab (holo SAN, iso KEP).

Glabrous treelet to 2 m tall. **Twigs** slender, glabrous. **Leaves** drying olive green; blade glabrous below, lanceolate, to 6.3 x 2.2 cm, base cordate; lateral veins 10 pairs; petiole c. 1 mm long.

Distribution: Endemic in Borneo. Sabah, known only from Gunung Alab (the type specimen and *Kamaruddin* KMS 1431 (SAN, UKMS).

Notes: The new variety is similar to *Symplocos laeteviridis* Stapf var. *mjöbergii* (Merr.) Noot. except that the twigs and lower leaf surface are entirely glabrous and it has more slender twigs and smaller (to 6.3 x 2.2 cm) lanceolate leaves that dry olive green. It is named for the locality where it was collected.

Acknowledgements

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Five New *Begonia* species (Begoniaceae) from the Niah National Park, Sarawak, Malaysia

KATHARINE G. PEARCE

DANIDA/SWMPI Project, Sarawak Forest Department, Kuching, Malaysia

Abstract

Five new *Begonia* species, *Begonia kachak* K.G.Pearce, *B. kasutensis* K.G.Pearce, *B. niahensis* K.G.Pearce, *B. stichochaete* K.G. Pearce and *B. subisensis* K.G.Pearce, were collected from limestone habitats in the Niah National Park. A key, descriptions and illustrations are provided

Introduction

Sarawak's varied geology includes a number of isolated limestone outcrops dating from a range of geological epochs and varying in size. In north Sarawak the large Melinau formation falls partly within the Gunung Mulu National Park, while in west Sarawak there are a number of limestone outcrops around Bau and Serian and south towards Tebedu. Other exposures are scattered in the interior of Sarawak, for example, at Bukit Sarang (Tatau), Ulu Kakus and in the Middle Baram. Between Bintulu and Miri, in the Niah area about 16 km from the coast, there is an isolated limestone massif known as the Subis massif. In 1974, this massif and surrounding forest was constituted as the Niah National Park.

The Bau limestone outcrops, being relatively accessible from Kuching, have been a favourite destination for plant collectors since the mid 19th Century and the Mulu limestone was the focus of intensive botanical collection during the Sarawak Forest Department and Royal Geographic Society Expedition in 1978. In contrast, the Subis massif was, until recently, somewhat neglected by plant collectors. G.D. Haviland, Curator of the Sarawak Museum, Kuching, and C. Hose, District Officer in Baram and Sibiu, together made the first plant collections there in 1894. In 1932, P.M. Syngé, a member of the 1932–33 Oxford University Expedition to Sarawak, visited Subis, while in 1954, W.M.A. Brooke and Ahmad independently made collections in the area under the Sarawak Museum label. In 1962, B.L. Burt with P.J.B. Woods and Chew W.L. collected there as did H.P. Fuchs in 1963 and G.

Alphonso and Samsuri Ahmad of the Singapore Botanic Gardens in 1965. The Botany Unit staff, Sarawak Forest Department, made collecting trips to Niah on a number of occasions from the early sixties onwards, including J.A.R. Anderson, who had a particular interest in the limestone flora of Sarawak (Anderson, 1965) and who collected there in 1966 and 1972. Their collections included specimens of the five begonia species described below but which until now remained unnamed.

All five species are endemic to the Subis limestone.

The highest point of the Subis limestone massif is G. Subis. Bukit Kasut and Gua Pangomah are located on the west of the massif. G. Brangin and G. Bekajang are two discrete hills to the north and northeast of the massif, respectively. The latter is the site of the Niah Great Cave and the Painted Cave, which are important archaeological sites.

The botanical field investigations in Niah National Park were carried out as part of the Sarawak Forest Department/DANIDA Project 'Support to Wild Life Master Plan Implementation through the Improved Management of Totally Protected Areas in Sarawak, Malaysia' and enabled the five *Begonia* species to be re-collected from the limestone habitats and for detailed observation to be made.

Key to Begonias in the Niah National Park

- 1a. Leaf ovate, oblong-ovate or obovate2
- 1b. Leaf reniform to sub-orbicular4
- 2a. Leaf 1.5 times or more as long as broad3
- 2b. Leaf less than 1.5 times as long as broad 2. *B. niahensis*
- 3a. Leaf with lines of stiff hairs between veins 3. *B. stichochaete*
- 3b. Leaf without lines of stiff hairs between veins 5. *B. subisensis*
- 4a. Leaf more than 7 cm long and wide 1. *B. kachak*
- 4b. Leaf less than 7 cm long and wide 4. *B. kasutensis*

1. *Begonia kachak* K.G.Pearce, *sp. nov.*

Section *Petermannia*

A Begonia speluncae Ridl. foliis majoribus ob internodia longiora non in fasciculis dispositis nec peltatis nec glabris differt. **Typus:** Great Cave, Niah, Miri District J.A.R. Anderson, S. Tan & E.Wright S26074 (holo SAR).

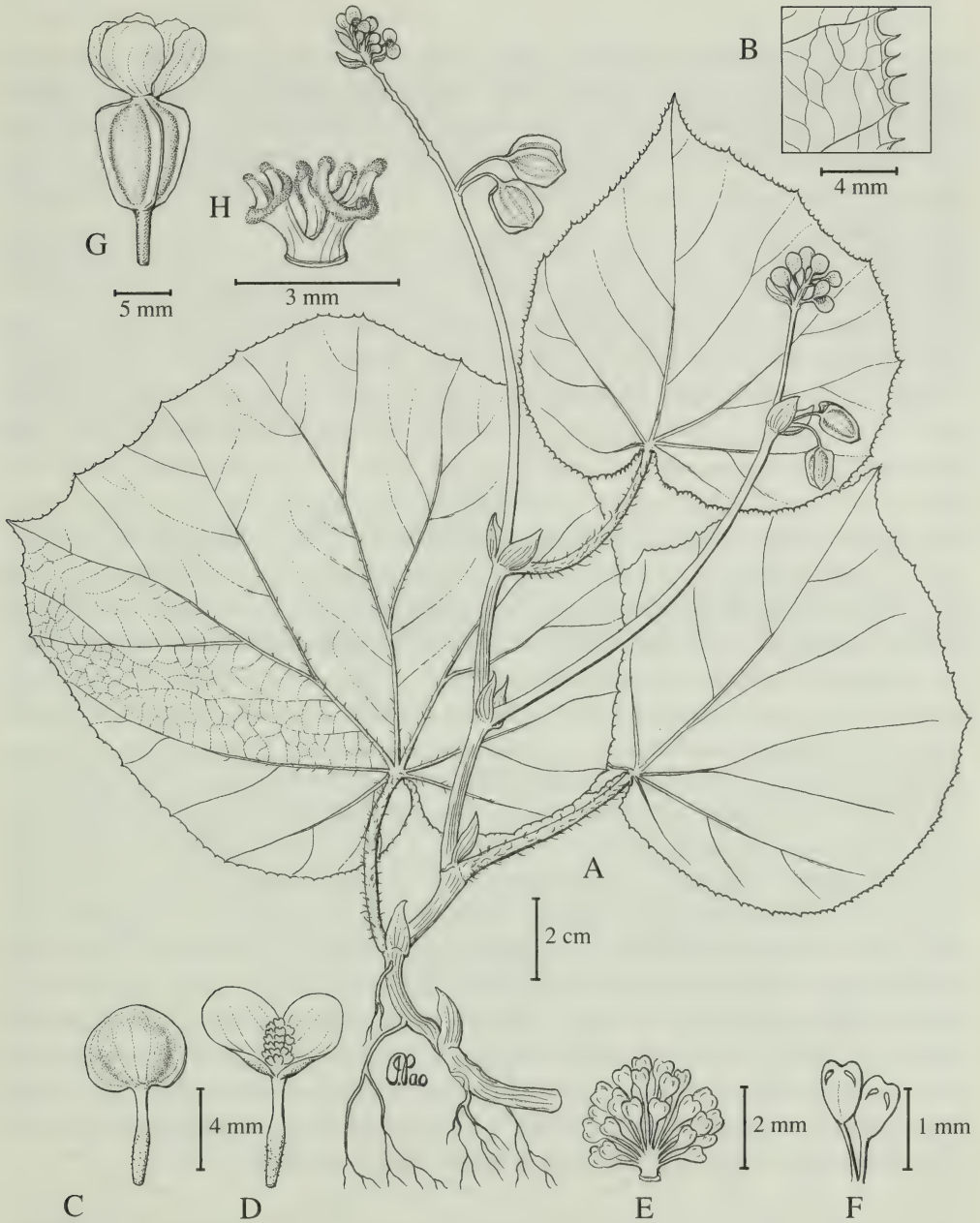


Figure 1. *Begonia kachak*

A Habit, B Detail of leaf margin, C Male bud, D Male flower, E Androecium, F Stamens, G Female flower, H Style and stigma. (from S26074).

Figure 1

Creeping herb or low root climber, roots fibrous, produced at the nodes in contact with the substrate. Stem and petiole with minute appressed to oblique brown hairs; distal end of young petiole, main veins on abaxial surface, margins of young leaf and main vein of stipule with stiff pink-brown trichomes to 1 mm long. *Leafy stem* 6–28 cm long, 3 mm diam., little branched, internodes 1–5 cm long. *Stipules* broadly triangular with a distinct midrib, 4.5 x 7 mm, margin entire, prolonged into an acuminate apex, persistent. *Leaves* alternate; petiole 1.8 cm in upper leaves, to 17 cm in lower leaves; lamina minutely papillose above and below, upper surface somewhat lustrous, olive-green to yellowish green especially near margins, lower surface pale green or in some specimens brownish pink with pale green veins, oblique, reniform to sub-orbicular, 7.5–12.5 x 7.5–15 cm, base cordate with the basal lobes hardly overlapping, rounded, 0.2–4.7 cm long, margin irregularly and indistinctly serrate, teeth setose, apex acute to acuminate, venation pinnate-palmate, main veins 4 pairs, branching about half way to the margin, with 2 more veins in the broader and one in the narrower basal lobe, sunken above, prominent beneath. *Inflorescences* axillary, protogynous, obliquely erect cymose panicles, 8.5–29 cm long, of which peduncle is up to 14 cm long, with one or two female flowers proximally and many male flowers distally; bracts pink, similar to stipules, 6.5 x 3 mm, persistent, bracteoles pale pink-brown, broadly ovate, 4 x 3 mm, apex setose, persistent. *Male flowers* with pink pedicel to 7.5 mm long, tepals 2, white translucent margins pink before anthesis, minutely papillose, orbicular, 7 x 5.5 mm, margin entire, apex rounded, stamens yellow, c. 29, in a spherical cluster, joined in a torus c. 3 mm diam., filaments to 1 mm long, anthers pale yellow, obovate, c. 0.7 mm long, emarginate. *Female flowers* on pedicels 5.5 mm long, minutely hairy; ovary pink, oblong-obovoid, 10.5 x 7 mm, wings pink, 3, subequal, c. 1.5 mm wide; tepals 5, white translucent or palest pink, with scattered minute, deeper pink hairs, unequal, oblong with rounded apex, to 9.5 x 5.5 mm, margin entire; styles 3, free, each 2 mm to bifurcation from where papillose stigmatic surface forms a continuous twisted band. *Fruits* with decurved pedicel, 1–1.9 cm long; capsule asymmetric, broadly oblong-elliptic, to 1.9 cm x 1.6 cm, minutely hairy, papillose, locules 3, each with 2 placentae, dehiscing between wing and locule, wings 3, unequal, thin, narrowed to base and apex, two narrower wings to 5 mm wide, broader wing to 7 mm wide, style caducous. *Seeds* cylindrical, c. 0.3 x 0.2 mm, surface areolate, areoles more or less equal sided at base and apex and elongate along seed axis.

Distribution: Borneo – SARAWAK: endemic in the Subis limestone (G. Brangin, Niah Great Cave and Gua Pangomah).

Habitat: Locally abundant in the shelter of overhangs in somewhat dry areas or

creeping up rocks at cave mouths, infrequently at level ground in deep shade adjacent to limestone outcrops.

Notes: This is a conspicuous begonia with large shiny leaves, commonly bearing a cluster of delicate, pale pink male flowers. It is easily observed on limestone outcrops along the Plank Walk to the Niah Great Cave and around the cave mouth. It takes its name from *kachak*, the Malay word meaning handsome.

Specimens examined: SARAWAK: Gunung Subis, Niah B.L. Burt & P.J.B. Woods B2010 (SAR), Mohidin S21603 (SAR); Great Cave K.G. Pearce, Bibian Diway, Saupel Atot & Dami Jude S78536 (SAR), Jemree Sabli S89062 (SAR); G. Brangin, Ulu Sg Subis Yii Puan Ching S40168 (SAR), Gua Pangomah J.A.R. Anderson S31691 (SAR, SING), Near Sg Subis K.G. Pearce S89463 (SAR); Niah Caves Alphonso & Samsuri A217 (SING), A222 (SING), A248 (SING).

2. *Begonia niahensis* K.G.Pearce, *sp. nov.*

Section *Petermannia*

A *Begonia congesta* Ridl. habitu erecto vel effuso (non cauli longo), capsula oblongo-ovoidea (non longa oblongaque) differt. **Typos:** Niah Caves B.L. Burt & P.J.B. Woods B 2009 (holo SAR).

Figure 2

Herb with *stems* to 75 cm long, branching near base with some spreading horizontally, some vertical and some drooping and then curving upward. Young stems and petioles with minute, erect translucent hairs. Older stems brown and semi-woody, to 1 cm diam., young stems brownish pink, internodes 2–8.5 cm long. *Stipules* green flushed brownish pink at centre, plicate, broadly ovate, 14 x 7 mm, margin entire with translucent hairs at base, apex acute, persistent. *Leaves* spirally arranged; petiole from c. 5 cm long in the upper leaves to 22 cm in the lower leaves, deep brownish pink; lamina medium green above, paler below, with veins on both surfaces deep pink at base and at the point where they branch, pinkish between, minutely papillose with a velvety appearance above, translucent hairy beneath, oblique, broadly ovate, 15–20 x 12–16.6 cm, base cordate with basal lobes not or hardly overlapping, rounded, to 9 cm long, margin irregularly and indistinctly serrate, translucent hairy, teeth with translucent setae, apex acute, venation pinnate-palmate, main veins 4–5 pairs, branching near base, with 2 or 3 smaller veins in broader basal lobe and 1 or 2 in narrower basal lobe. *Inflorescences* axillary, protogynous, obliquely upright, cymose panicles 3–8 cm long, of which the peduncle is 2.5–6 cm long, with 1 or 2 pairs of female flowers at the base with many male flowers tightly congested distally, bracts

plicate, pale green, broadly ovate, to 2–2.3 x 1.2 cm, persistent. *Male flowers* opening one at a time, pedicel obscured by congested bracts and male flower buds, tepals 2, white translucent, margins entire, orbicular, c. 6 x 7 mm, apex rounded; stamens yellow > 30, in hemispherical cluster, joined in a torus c. 1 mm diam., filaments c. 0.5 mm long, anthers yellow, emarginate, 0.8 mm long, opening by apical slits. *Female flowers* with pedicel c. 9 mm long; ovary yellow-green to pink, obovoid, 19 x 7 mm, wings 3, pale green, subequal, 1.5 mm wide; tepals 5, white translucent, subequal, broadly elliptic-obovate, 13 x 7 mm, margins entire except at fringed, obtuse apex, outer surface and margins minutely translucent hairy; styles 3, c. 1 mm long; stigmas bifurcated, stigmatic surface a minutely papillose, orange yellow spiral band. *Fruits* with a stiff, decurved pedicel, c. 1.5 cm long, pale green flushed pink at base; capsule oblong, to 3.2 x 1.4 cm, sparsely translucent-hairy, locules 3, each with 2 placentae, dehiscing between wing and locule, wings 3, subequal, thin, broadest at apex, c. 4 mm wide, style caducous. *Seeds* cylindrical to obovoid, c. 0.3 x 0.2 mm, surface areolate, areoles more or less equal sided at base and apex and elongate along seed axis.

Distribution: Borneo – SARAWAK: endemic in the Subis limestone (G. Brangin, Niah Great Cave and Painted Cave areas).

Habitat: Below cave mouths, rooted in pockets of soil on ledges and in crevices on steeply sloping limestone rock or in light shade under canopy of small trees.

Notes: This robust and handsome begonia has large, asymmetric, velvety hairy leaves that sometimes have a bluish cast. The leaves are positioned more or less vertically against the limestone rock face in somewhat sheltered sites. It can be observed on limestone outcrops along the Plank Walk to the Painted Cave. It has been named for the type location - the Niah Caves. Its habit of drooping and upcurving stems and handsome, velvety leaves held vertically, give this species potential as an ornamental plant.

Specimens examined: SARAWAK: G. Brangin *Yii Puan Ching S40166* (SAR); Great Cave *J.A.R. Anderson, S. Tan & E. Wright S26075* (SAR, SING), *K.G. Pearce, Bibian Diway, Saupel Atot & Dami Jude S78537* (SAR); Near Sg Subis *K.G. Pearce S89460* (SAR).

3. *Begonia stichochaete* K.G.Pearce, *sp. nov.*

Section *Petermannia*

A *Begonia congesta* Ridl. foliis angustioribus seriebus setarum inter venas gerentibus, capsulis longioribus oblongis (non oblongo-ovoideis) differt. **Typus:** Subis, Niah Caves *Ahmad 14* (holo SAR; iso SING).

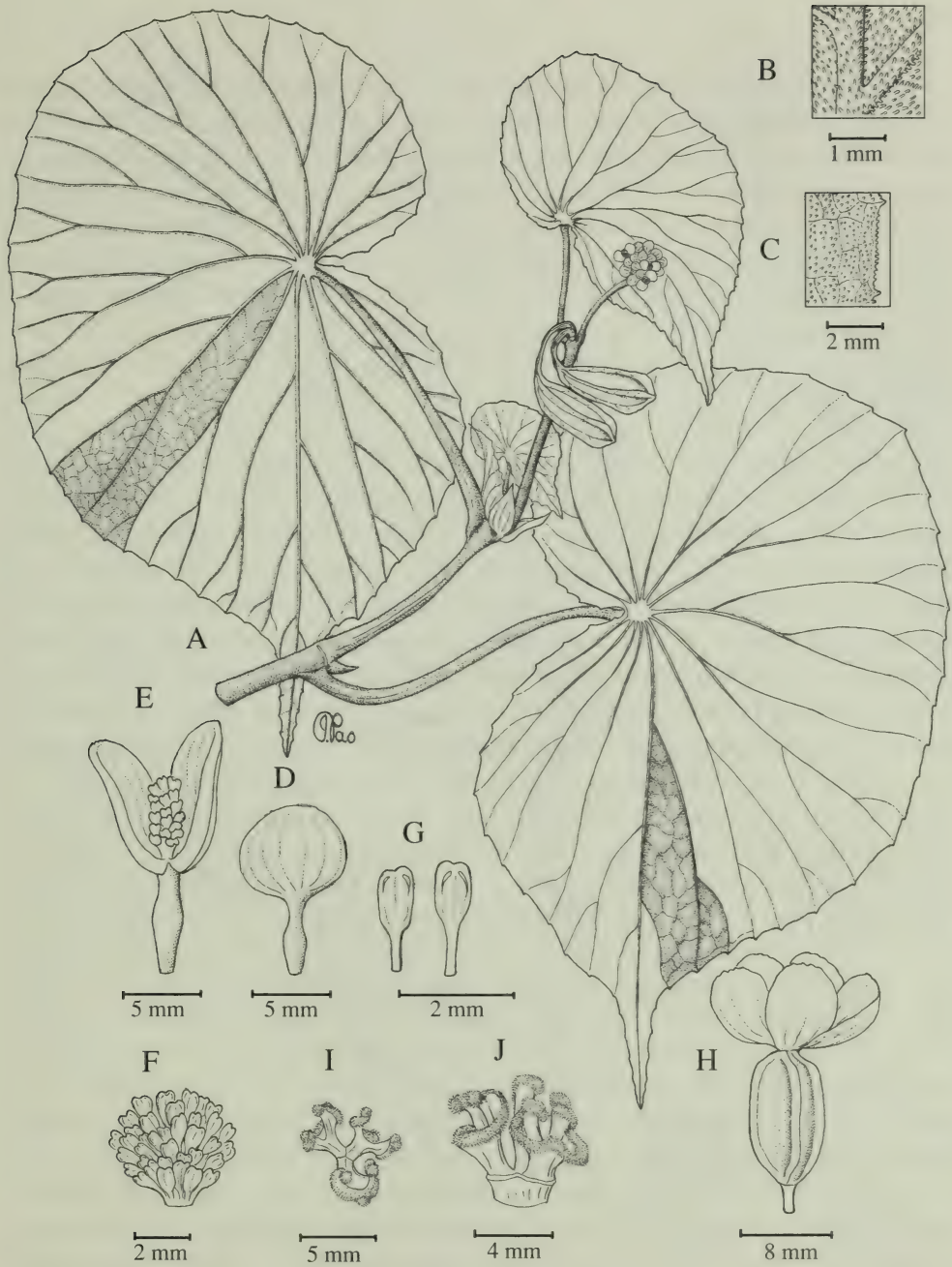


Figure 2. *Begonia niahensis*

A Habit, B Detail of leaf undersurface, C Detail of leaf margin and upper surface, D Male bud, E Male flower, F Androecium, G Stamens, H Female flower, I Style and stigma from above, J Style and stigma. (A—C from *Burt 2009*, D—I from *S89460*).

Figure 3

Erect herb rooting at the base of the stem and at nodes along the horizontal rhizome which creeps below the soil surface and gives rise to shoots at intervals. Indumentum of stiff trichomes to 2.2 mm long, each on a raised conical base, pale brown to pinkish brown to deep brownish red on stem, young petiole and veins on lower and upper lamina surfaces, dense on young stem and petiole, less so on stipule margin and sparse on outer surface of stipule midrib and on the main veins of the upper lamina surface, in a row or rows between each pair of veins and on and between the teeth of the dentate margin, moderately dense on the main veins of the lower leaf surface. Upright *stem* to c. 42 cm long, 5–9 mm diam., unbranched, internodes 2.5–5 cm long to 8 cm long at base of stem. *Stipules* oblong-ovate with a distinct midrib, 17 x 11 mm, margin entire, apex setose, caducous. *Leaves* spirally arranged; petiole 0.7 cm in upper leaves, to 2.5 cm in lower leaves; lamina at first yellowish green then medium green on upper surface (rarely dark blackish-green), lower surface paler yellowish green or olive-green or deep pink or red, asymmetric, irregularly obovate, 11–19 cm long, narrower side to 2.5 cm wide towards apex, curving inwards towards base and hardly or not lobed at base, broader side 6–7.5 cm wide with a cordate base and a rounded basal lobe to 17 mm long, margin irregularly serrate (appearing almost praemorse), each tooth setose, with several setae between each pair of teeth, apex toothed, venation pinnate, c. 4 pairs of veins, branching with another 1–3 veins in basal lobes, impressed above, prominent beneath. *Inflorescences* axillary, protogynous, erect cymose panicles to 3.4 cm long, of which the peduncle is 2.3 cm, with 1–2 female flowers at base with distally many male flowers crowded in a terminal cluster; bracts similar to stipules, deep red, 13 x 10 mm, persistent; bracteoles pale brown to deep pink, broadly ovate, to 12 x 12 mm, apex setose, persistent. *Male flowers* with a green to deep pink pedicel with deep pink bristles, 7 mm long; tepals 2 or 4, the outer pair translucent white flushed pink at margin and base, the inner pair translucent white, at first finely hairy on outer surface near base, broadly elliptic, c. 4 x 3 mm, margin entire, apex rounded; stamens pale yellow, c. 32, in an ovoid cluster, joined in a torus c. 1 mm diam., filaments to 1 mm long, anthers obovate, to 1.5 mm long, shortly apiculate, opening by terminal pores which develop into slits. *Female flowers* solitary or in pairs; pedicels 5 mm long, medium pink with minute appressed to slightly oblique hairs; ovary pale pink tinged green with deep pink bristles, oblong-obovoid, to 24 x 16 mm, wings 3, deep pink to translucent white with margins flushed pale pink, subequal, c. 7 mm wide; tepals 5, translucent white flushed pale pink at margins or palest pink, deeper pink at base and on marginal teeth with scattered deeper pink hairs, on outer surface sparsely hispid, oblong with rounded apex, inner two larger, c. 6 x 2–4 mm, margin toothed from near base to fringed apex; styles 3, free to base, 3 mm long, bifurcating; stigmas forming a continuous twisted band, yellowish-green to bright yellow. *Fruits* with stiff, decurved pedicels, 5–9 mm long; capsule oblong, to 29 x 18 mm,

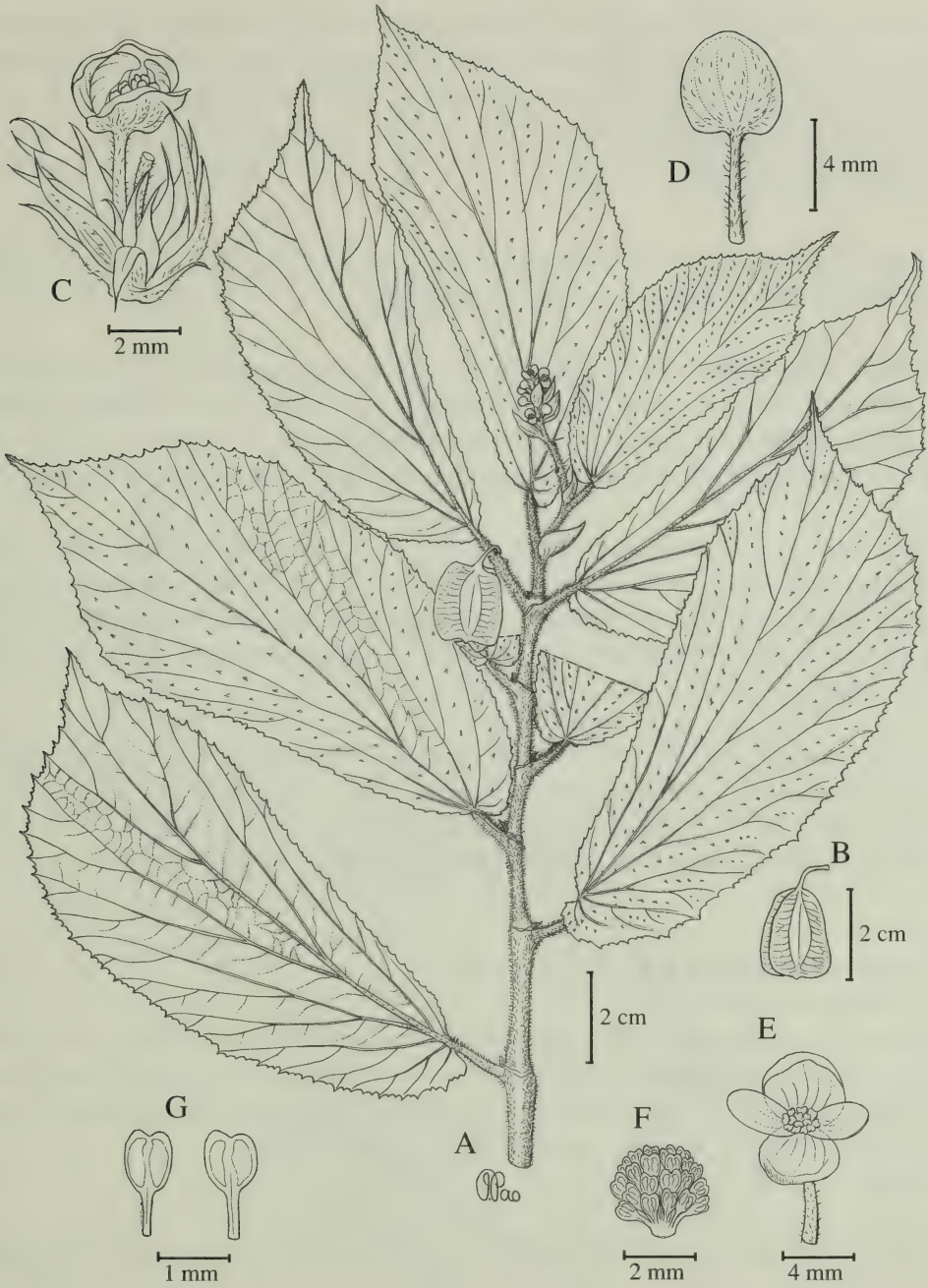


Figure 3. *Begonia stichochaete*

A Habit, B Fruit, C Male inflorescence, D Male bud, E Open male flower, F Androecium, G Stamens. (A from S40075, B from Ahmad 14, C–G from S89014).

sparsely hispid, minutely papillose, locules 3, each with 2 placentae, dehiscent between wing and locule, wings 3, subequal, thin, narrowed to base, truncate distally, two narrower wings to 5 mm wide at midpoint and 6 mm at apex, broader wing to 6 mm wide at midpoint to 7 mm at apex, style caducous. *Seeds* cylindrical-spherical, c. 0.3 x 0.25 mm, surface areolate, areoles more or less equal sided at base and apex and elongate along seed axis.

Distribution: Borneo – SARAWAK: endemic in the Niah National Park (Kuala Subis, the Sekaloh area and near the trail to Bukit Kasut).

Habitat: This species occurs both in limestone habitats and undisturbed Mixed Dipterocarp Forest on loamy soil or brown clay as well as in secondary forest on alluvial soil. On limestone, it grows on low outcrops with little soil and in soil at the base of limestone cliffs in deep shade and damp conditions, where it is locally frequent.

Notes: This erect begonia is characterised by its bristly leaves bearing rows of stiff hairs between the veins. It grows in shady sites, both on or near limestone outcrops and in forest away from the limestone. The species shows striking variation with the upper leaf surface ranging from mid-green to dark blackish-green. It is named for its bristly leaves.

Specimens examined: SARAWAK: Niah National Park *Bernard Lee S40075* (SAR), Kuala Niah near confluence with Sg Subis *K.G. Pearce, Bibian Diway, Saupel Atot & Dami Jude S78539* (SAR); Route to Bukit Kasut *K.G. Pearce & Narawi b. Johari S78597* (SAR); Sekaloh *Jemree Sabli S89014* (SAR), *K.G. Pearce S89267* (SAR).

4. *Begonia kasutensis* K.G.Pearce, *sp. nov.*

Section *Petermannia*

A *Begonia conipila* Irmsch. ex Kiew trichomatibus brevioribus sine basibus conicalibus, foliis suborbicularibus (non valde asymmetricis), punctis maculisque praesentibus, inflorescentiis contra folia insertis differt. **Typus**: Great Cave, Gunong Subis, Niah, Miri District *J.A.R. Anderson S31940* (holo SAR; iso SING).

Figure 4

Creeping herb with fibrous roots produced at the nodes. Stem and petiole with white minutely appressed hairs on distal end of petiole; main veins, lamina undersurface and margin with scattered pale orange-brown hairs to 0.7 mm long, more or less regularly arranged. *Leafy stem* to c. 15 cm long, 1.5 mm diam., not or hardly branched, internodes to 4 cm long. *Stipules* oblong-ovate with a distinct midrib, to 9 x 4 mm,

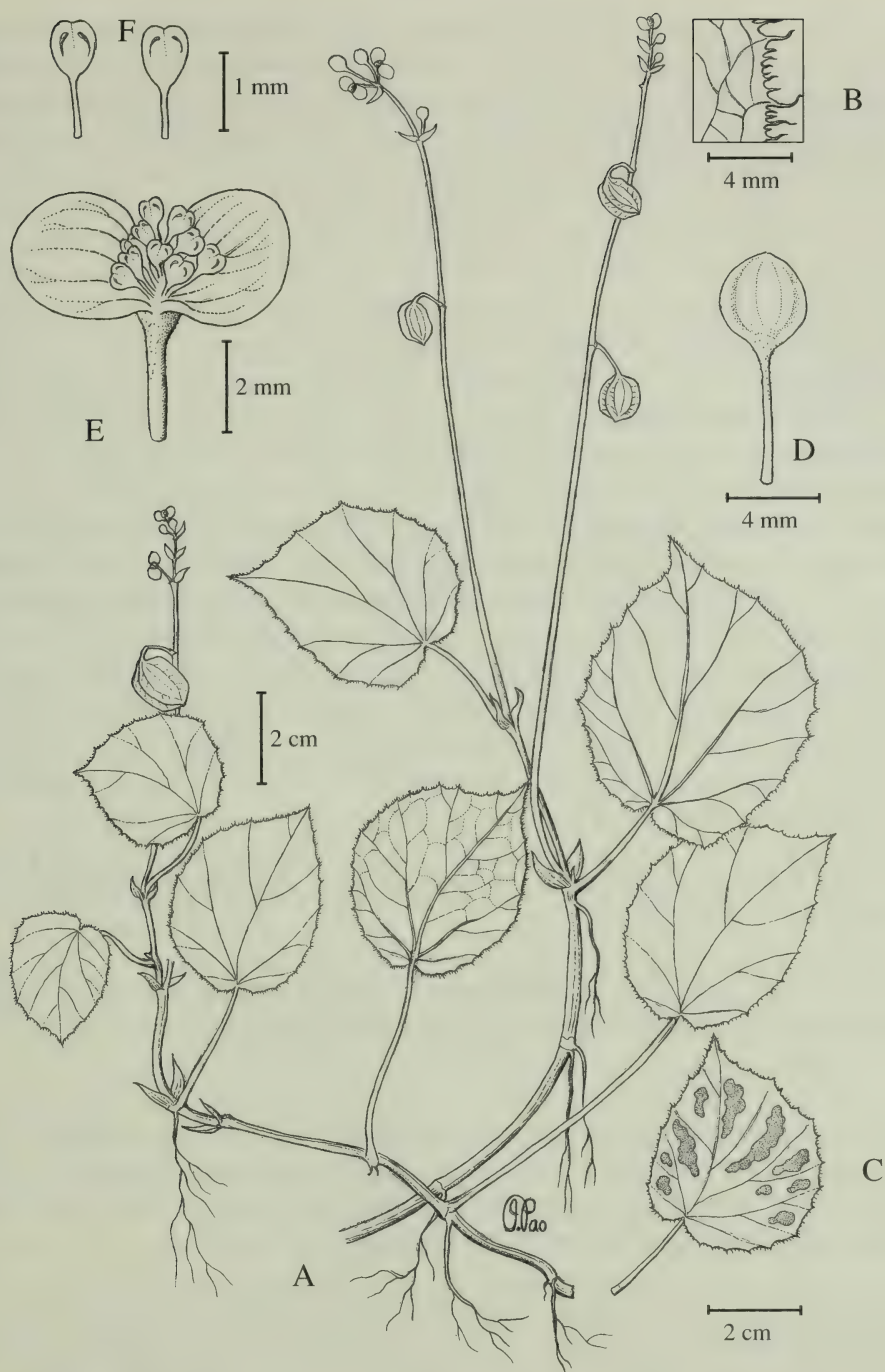


Figure 4. *Begonia kasutensis*

A Habit, B Detail of leaf margin, C Leaf showing variegation, D Male bud, E Male flower, F Stamens. (A & B from S31940, C from S27269, D-F from S31940).

margin entire, apex setose, caducous. *Leaves* spirally arranged; petiole 1.5 cm in upper leaves, to 3.8 cm in lower leaves; lamina minutely papillose above and beneath, variegated, upper surface slightly lustrous, olive to dark green with irregular spots and blotches of pale grey-green between veins, lower surface reddish, sometimes light green towards base, slightly asymmetric, sub-orbicular, 4.7–6.2 x 3.9–5.5 cm, base cordate with rounded basal lobes not overlapping, to 8 mm long, margin irregularly, indistinctly and distantly serrulate, apex cuspidate, venation palmate, main veins 2 pairs, the two 'middle' ones branching near mid-point or towards margin, with 1–2 veins in each basal lobe, sunken above, slightly prominent beneath. *Inflorescences* leaf-opposed, protogynous, racemes of cymules, to 11.5 cm long, including peduncle to 5.7 cm, with a single female flower at base and many male flowers distally; bracts similar to stipules, 4 x 2.5 mm, caducous; bracteoles pale green flushed pink, broadly ovate, 3.5 x 2 mm, apex setose, caducous. *Male flowers* with pink pedicel to 1 cm long; tepals 2, palest pink translucent, suborbicular, c. 7 x 4 mm, margin entire, apex rounded; stamens yellow, c. 20, in a more or less hemispherical cluster, joined in a torus 0.3 mm diam., filaments to c. 1 mm long, anthers bright yellow, c. 0.5 mm long, opening by pores, obovate, emarginate. *Female flower* not seen. *Fruits* with stiff, decurved pedicel, 7 mm long; capsule suborbicular, 1.6 x 1.2 cm, locules 3, each with 2 placentae, dehiscing between wing and locule, wings 3, unequal, thin, narrowed to base, truncate distally, the two narrower wings c. 1.5 mm wide, broader wing c. 2.5 mm wide, style caducous. *Seeds* cylindrical, c. 0.3 x 0.25 mm, surface areolate, areoles more or less equal sided at base and apex and elongate along seed axis.

Distribution: Borneo – SARAWAK: endemic in the Subis limestone (Niah Great Cave, Bukit Kasut and G. Subis).

Habitat: Infrequent, on limestone rock faces in shaded and dry crevices or in soil between limestone rocks on slopes of limestone hills up to where the canopy cover starts to thin out.

Notes: This decorative begonia is characterised by its diminutive, sub-orbicular variegated leaves that have a pink undersurface, and by its delicate inflorescences. Its small size and elegant features give it potential as an ornamental species. It has been named for Bukit Kasut, one of the locations where it occurs.

Specimens examined: SARAWAK: Subis *Ahmad No. 3* (SAR, SING); Niah Cave *Ahmad No. 65* (SING); Gunung Subis *Jemree Sabli S89049* (SAR); Southern slopes of G. Subis, near Sekaloh River *S. Tan & E. Wright S 27269* (SAR, SING); Route to Bukit Kasut *K.G. Pearce & Narawi b. Johari S78596* (SAR).

5. *Begonia subisensis* K.G.Pearce, *sp. nov.*Section *Petermannia*

A *Begonia pendula* O. E. Schulz habitu majore caulibus erectis rigidisque, foliis setis inter dentes setiferos carentibus, fructibus latioribus oblongis differt. **Typus:** G. Subis 'in Sekaloh River', Niah, Miri District *J.A.R. Anderson, S. Tan & E. Wright S27574* (holo SAR; iso SING).

Figure 5

Cane-like, semi-herbaceous begonia with woody stems ascending, then held at 45°, drooping at apex, arising at intervals from a woody, branched rhizome c. 7–9 mm diam. bearing roots at the nodes, some stem bases bearing adventitious roots. Stem and petiole with minutely appressed brown hairs. *Stems* to >76 cm long, from 6 mm diam. at base to 1.5 mm at apex, bearing leaves only near apex, unbranched or with few branches, internodes 1.2 to >5 cm long. Stipules lanceolate, without a distinct midrib, 5.5 x 1.5 mm, margin entire, apex setose, caducous. *Leaves* spirally arranged; petiole 1–2.5 cm; lamina minutely papillose above and below, upper surface with a reflective sheen, medium to olive-green (those of young vegetative shoots variegated, olive-green with irregular spots of pale grey-green between veins), lower surface dull green or pinkish between veins to deep pink near veins, asymmetric, oblong-ovate, to c. 11.3 x 3.6–4.1 cm, lower half of leaf somewhat inwardly curved, base cordate with a rounded basal lobe to 1.3 cm long on one side, cuneate or slightly lobed at base on the other side, margin irregularly serrate, apex acute, venation pinnate-palmate, veins 3–4 pairs, branching except for the outermost two or three, flat or very slightly raised above, deep pink and prominent beneath. *Inflorescences* axillary, protogynous, cymose panicles held obliquely above the subtending leaf, axis pale to deep brownish pink, to 7.5 cm long with 1 or 2 female flowers at the base and up to 10 male flowers distally or sometimes, in the lower leaf axils, by reduction, only the female flowers present; bracts similar to stipules, 4 x 2.5 mm, caducous; bracteoles pale green flushed pink, lanceolate, 1.5 x 6 mm, apex setose, caducous. *Male flowers* with pink pedicel to 9 mm long; tepals 2, translucent white to palest pink, some flushed deeper pink at base, elliptic, 6.5 x 4 mm, margin entire, apex rounded; stamens yellow, to 26, in a more or less obovoid cluster, joined in a 1 mm-diam. torus, filaments c. 1 mm long, anthers yellow, obovate, emarginate. *Female flowers* on a peduncle to 3 mm long; pedicels deep pink to 2.5 cm long, glabrous; ovary oblong, truncate, 1.6 x 2 cm, wings 3, subequal, c. 6 mm wide; tepals 5, palest pink flushed deeper pink at base, ovate, the outer two smaller than the inner three, c. 9 x 5 mm, margin entire, apex obtuse, glabrous; styles 3, bifurcated, 2–3 mm long to bifurcation, stigmatic surface orange with fine colourless papillae forming a continuous, twisted band. *Fruits* with flexuous pedicels, to 3 cm long; capsule oblong, 14 x 23 mm, locules 3, equal, each with 2 placentae, dehiscing between wing and locule, wings 3, unequal, thin, narrowed to base, truncate distally, two narrower wings 10 mm wide, broader wing 11.5 mm wide, style caducous.

Seeds cylindrical, c. 0.4 x 0.25 mm, surface areolate, areoles more or less equal sided at base and distally, and elongate along seed axis above base.

Distribution: Borneo – SARAWAK: endemic in the Subis limestone (Niah Great Cave and Bukit Kasut).

Habitat: Locally frequent on limestone rock faces and the steep slopes of limestone hills in deep litter layer or between limestone rocks where the canopy cover starts to thin out.

Notes: The leaves of this attractive cane begonia have a reflective sheen on the upper surface and are deep pink below. The young plant has variegated leaves. The inflorescence is delicate and, in fruit, the capsule dangles on a long, flexuous pedicel. It has been named for the type locality, G. Subis.

Specimens examined: SARAWAK: Great Cave J.A.R. Anderson S31939, Bukit Kasut K.G. Pearce, Bibian Diway, Saupel Atot & Dami Jude S78538 (SAR).

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Figure 5. *Begonia subisensis*

A Habit, B Juvenile shoot with variegated leaves, C Fruit. (A & C from S27574, B from S78538).

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A New Species of *Curcuma* L. (Zingiberaceae) from Mizoram, India

J. SKORNICKOVA, M. SABU AND M.G. PRASANTHKUMAR

Department of Botany, University of Calicut,
673 635 Kerala, India.

Abstract

Curcuma rubrobracteata Skornickova, M.Sabu & Prasanthkumar *sp. nov.* is described from Mizoram, India.

Introduction

Exploration for gingers in Mizoram, NE India, carried out by the authors for the research project 'Revision of Indian Zingiberaceae' has brought an interesting species of *Curcuma* to light.

The genus *Curcuma* L. naturally occurs in tropical and sub-tropical Asia with a few species extending to Australia and the South Pacific, but economically important or ornamental species are introduced elsewhere in the tropics. According to the latest records, *Curcuma* has the largest number of species in India, Thailand, Indonesia and China. The total number of species for this genus is still quite uncertain but is estimated at around 100 species (Sirirugsa, 1996; Larsen *et al.*, 1998). From India, 29 species have so far been reported and accepted (Karthikeyan *et al.*, 1989; Mangaly and Sabu, 1993). Several new species of *Curcuma* L. have been described in last 20 years from India (Skornickova and Sabu, 2002). While working on Indian Zingiberaceae in August and September 2002, the authors visited Mizoram, which is considered as the least surveyed corner of India, where an undescribed species of the genus *Curcuma* L. subg. *Curcuma* (*Eucurcuma* K. Schum.) was collected.

Curcuma rubrobracteata Skornickova, M. Sabu & Prasanthkumar, *sp. nov.*

Curcuma *roscoeanae* similis in coma inconspicua, spica c. 10 cm supra terram per vaginam protrudenti, bracteis floriferibus rubris, floribus luteo-aurantiacis, calyce trilobato, rhizomate repenti aromatico, lamina elliptico-lanceolata basi cuneata, infra glabra, supra pubescenti in venis principalibus elevatis differt. **Typus:** India, Mizoram, Lawngtlai District, on the way to Ngengpui Wildlife Sanctuary – Khomoi, 22° 30'N,

92° 46'E. 10.IX.2002. *Skornickova & Prasanthkumar 86241* (holo MH; iso CALI, K, SING).

Figure 1, Plate 1.

Rhizomatous herb, up to 1.5 m high. *Rhizome* creeping, slender, 10–30 cm long, c. 1 cm diam., tan outside, scales triangular, papery, light brown, underground quickly decaying, whitish yellow inside, aromatic, smell resembling *Kaempferia galanga* L., taste very bitter, sessile tubers absent, root tubers 2 x 1.5 cm, white inside, distanced c. 5 cm away from main rhizome on 2 mm thick roots. *Leafy shoot* up to 1.5 m long, leaves 4–6, pseudostem green, c. 40 cm long. *Leaves* petiolate, ligule 1 mm long, light green, translucent, petiole green, glabrous 10–45 cm long (lower leaves with shorter petioles). *Lamina* elliptic-lanceolate 35–60 x 10–16 cm, adaxially green, pubescent along the raised veins, abaxially pale green, glabrous, base attenuate, tip acuminate 2 cm long, midrib green, glabrous. *Inflorescence* terminal, but protruding through the base of the pseudostem through lateral slits c. 3–10 cm above ground. *Peduncle* 5–10 cm long, 7 mm diam., whitish, without vegetative bracts. *Spike* 10 x 7–9 cm. *Coma* absent. *Bracts* 20–26 per spike, all fertile, bright red or light red, yellowish or yellowish green towards the base, bract 3.5 x 3.5 cm, glabrous, margin 0.3 mm hairy, hairs 0.1 mm long, subtending a cincinnus of 5–6 flowers, usually only 1–3 flowers per spike open at the same time. *Bracteoles* one per flower, 2–3.5 x 1–3 cm, hyaline, glabrous, white, translucent with reddish dots on the apical part of the biggest bracteoles. *Flowers* 6 cm long, yellow-orange, exserted, 1.5–2 cm longer than the bracts. *Calyx* 1.2 cm, white, translucent, hyaline, glabrous, 3-toothed. *Corolla tube* 3.7–4 cm, light orange, glabrous. *Corolla lobes* light yellow-orange, dorsal lobe 14 x 8 mm fringed by red on upper mucronate portion; lateral lobes 12 x 7 mm. *Labellum* 15 x 17 mm, periphery yellow-orange, centre deep yellow-orange, obscurely 3-lobed, middle lobe split about 2 mm. *Lateral staminodes* 1 x 1.1 cm; yellow-orange, hooded over the anther. *Stamen* c. 9 mm long, anther versatile. *Anther* 6 x 2.5 mm, orange. *Anther spurs* 3 mm long, incurved, orange. *Anther thecae* white, 5 mm long. *Filament* yellow-orange, 5 mm long, constricted, 4 mm at base, 2 mm at upper part. *Ovary* trilobular, 2 x 2.5 mm, pubescent with 0.6 mm long hairs; ovules many. *Stigma* white, closely appressed within the anther lobes. *Epigynous glands* 2, pale orange, 4 mm long, 0.9 mm diam. *Fruits* not seen.

Flowering: August – September.

Distribution: Hitherto known only from the type locality. From personal communication with other specialists we suspect this species to be identical with unidentified plants growing along the Thai-Burmese border.



Figure 1. *Curcuma rubrobracteata*

A. Habit; B. Inflorescence; C. Detail of leaf venation (adaxial side); D. Flower and subtending bract; E. Bracteole; F. Part of flower showing lateral staminodes, dorsal corolla lobe and anther; G. Part of flower showing labellum and anterior corolla lobes; H. Flower (side view); I. Calyx; J. Lateral staminode; K. Anther (front); L. Anther (side); M. Stigma; N. Epigynous glands and ovary; O. Ovary (cross section). Based on the type material *Skornickova & Prasanthkumar 86241*. del. J. Skornickova.

Habitat: Growing in undergrowth in teak plantations and along roadsides.

Etymology: This gorgeous species takes its name from the striking red bracts of its inflorescence.

Other specimens examined: India, Mizoram, Lawngtlai District, on the way to Ngengpui Sanctuary – Khomoi, 22° 30' N 92° 46' E, 10.IX.2002, Skornickova & Prasanthkumar 86239 (CALI).

Notes: The most obvious characters of this species are the creeping rhizomes, bright red bracts with no distinct coma and, in particular, the position of its inflorescence. Inflorescences with no distinct coma are reported for a few species e.g. *Curcuma roscoeana* Wall., *C. albiflora* Thwaites, *C. ceratotheca* K.Schum. and the recently described *C. rhomba* J. Mood & K. Larsen, which also possesses a small rhizome with linear growth (Mood and Larsen, 2001). The unique character of *C. rubrobracteata* is the position of its inflorescence, which is so far unknown in the genus *Curcuma*.

Many of the earlier taxonomists made attempts to classify the genus into sections based on the position of the inflorescences. Roxburgh (1820) recognised two sections based on the lateral or central inflorescence, while Horaninow (1862) distinguished three sections, namely: I. Exanha (always lateral), II. Mesantha (inflorescence invariably terminal), and III. Amphiantha (inflorescences both terminal and lateral). However, the new species produces an inflorescence about 3–10 cm above ground, which breaks through the pseudostem through lateral slits. This feature has also been observed in the Zingiberaceae in the genus *Plagiostachys* Ridl., where the inflorescence is borne on a peduncle and projects from the side of the leafy stalk (Ridley, 1899). Smith (1985) pointed out that the inflorescence of *Plagiostachys* species, although pushed out laterally, is actually terminal on the leaf shoot and so shows affinity to the genus *Alpinia* Roxb., in which a few species, particularly *A. hansenii* R.M.Smith and *A. havilandii* K.Schum., have similar apparently laterally produced inflorescences.

Recently, Kress *et al.* (2002) carried out molecular studies on phylogeny and classification of the family Zingiberaceae. The results based on analysis of DNA sequences of the nuclear internal transcribed spacer (ITS) and plastid *matK* regions suggest that the genus *Curcuma*, as it is accepted nowadays, is paraphyletic with

Plate 1. *Curcuma rubrobracteata*

1. Detail of flower and spike – seen from above; 2. Detail of flower and dorsal corolla lobe – front view; 3. Detail of flower and bracts – lateral view; 4. Habit; 5. Detail of spike protruding through the pseudostem; 6. Creeping rhizome and root tubers. All photographs are of the type material Skornickova & Prasanthkumar 86241. Photo J. Skornickova.



genera *Hitchenia*, *Stahlianthus* and *Smithiatriis*, which also share cone-like inflorescences of few flowered, congested bracts, and that genus *Curcuma* is itself paraphyletic with three groups of species. Since the analysis was done with a limited number of samples (six *Curcuma* species), the authors recommended that more species of such large genus should be included in future molecular studies to shed more light on the difficult question of generic boundaries and allied genera.

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The Genetic Relations of *Musa* Species from Mount Jaya, New Guinea, and a Reappraisal of the Sections of *Musa* (Musaceae)

CAROL WONG¹, GEORGE ARGENT², RUTH KIEW³, OHN SET³
AND YIK YUEN GAN¹

¹National Sciences Academic Group, National Institute of Education, Nanyang Technological University, 1 Nanyang Walk, 637616 Singapore

²Royal Botanic Garden, Edinburgh, EH3 5LR, U.K.

³Singapore Botanic Gardens, 1 Cluny Road, 259569 Singapore

Abstract

Molecular analysis using amplified fragment length polymorphism (AFLP) confirms the status of *Musa banksii* F. Muell. as a subspecies of *M. acuminata* Colla and shows *M. johnsii* Argent to be genetically more similar to the Australian *M. jackeyi* W. Hill than to *M. lolodensis* Cheesman from New Guinea. In addition, AFLP analysis supports only two sections as genetically distinct, namely Sect. *Musa* (including Sect. *Rhodochlamys*) and Sect. *Callimusa* (including Sect. *Australimusa*). No material for Sect. *Igentimusa* was available for study. However, for practical purposes of grouping banana species, four informal groups are recognised – the ‘acuminata’ and ‘ornata’ groups within Sect. *Musa*, and the ‘coccinea’ and ‘textilis’ groups within sect. *Callimusa*. A key to the sections and informal groups is provided.

Introduction

Wild bananas are found throughout Asia and Malesia extending into Australia and the Pacific. They have become an increasingly conspicuous element of the vegetation as they invade forest margins along logging roads and openings in forest. As roads penetrate deeper into forests, new banana species are coming to light.

Much still remains to be discovered about the relationships between wild banana species, which have been grouped into five sections (Cheesman, 1947; Argent, 1976) based on chromosome number and morphology. However, some of the species recently described do not fit comfortably into these sections (Argent, 2000, 2001), which calls into question their taxonomic validity. Also, molecular studies indicate that not all the sections are genetically uniform and distinct from each other (Jarret &

Gawel, 1995; Wong *et al.*, 2002).

Bananas present a challenge to the collector who wishes to turn them into herbarium specimens, which unless accompanied by spirit material, detailed field notes and colour pictures, are often almost worthless. Molecular techniques are therefore particularly useful in this genus and have been used to study genetic diversity at the subspecific (Wong *et al.*, 2001a), specific (Wong *et al.*, 2001b) and sectional levels (Jarret & Gawel, 1995, Wong *et al.*, 2002). AFLP is a DNA fingerprinting technique, which was developed by Vos *et al.*, (1995). It is based on selective PCR amplification of DNA restriction fragments under stringent conditions. It can be used for DNA of any origin and complexity and is reported to be both reproducible and reliable (Vos *et al.*, 1995). AFLP combines the reliability of RFLP with the power of PRC.

In this study, AFLP (amplified fragment length polymorphism) was used to analyse the genetic relations of two species collected from Mt Jaya, Papua (formerly Irian Jaya), New Guinea: (a) to study the genetic relationship of *Musa johnsii* Argent, which is unique in the genus in having a fruit with a sterile mucilaginous pith chamber that occupies the distal third of the fruit (Argent, 2001); and (b) to reassess the status of *M. banksii* F. Muell., which was reduced to a subspecies of *M. acuminata* Colla by Simmonds (1956) but is still considered to be a distinct species by Argent (1976).

In addition, the taxonomic status of the five sections of *Musa* is reviewed in the light of molecular studies.

Materials and Methods

Plant Materials

Twelve samples were used for the present study (Table 1). These included *Musa* species from sections *Musa*, *Rhodochlamys*, *Callimusa* and *Australimusa* and a species of the related genus *Ensete* as an outgroup taxon. Voucher specimens were deposited in the herbaria of the Singapore Botanic Gardens and the Royal Botanic Garden Edinburgh.

DNA Extraction

Leaf tissue was used for AFLP analysis and prepared using a procedure from Zhang *et al.* (1997). Plant DNA was extracted using the CTAB method according to Reichardt and Rogers (1993) as outlined in Wong *et al.* (2001b).

AFLP analysis

The AFLP analysis was carried out according to Vos *et al.* (1995) with minor modifications. Restriction digests of genomic DNA with *EcoRI* and *MseI* were carried out at 37 °C for 1 h. Following heat inactivation of the restriction endonucleases, the genomic DNA fragments were ligated to *EcoRI* and *MseI* adapters overnight at 16 °C

Table 1 *Musa* and *Ensete* species studied

| Taxon | Accession No. | Source |
|--|---------------|--------|
| <i>Ensete superbum</i> (Roxb.) Cheesman | 94-96-8474 | SBG |
| <i>M. johnsii</i> Argent | 00562 | FMC |
| <i>Musa</i> sect. <i>Musa</i> | | |
| <i>M. acuminata</i> Colla ssp. <i>truncata</i> | RK4718 | CH |
| <i>M. acuminata</i> Colla ssp. <i>siamea</i> | GA s.n. | RBG |
| <i>M. acuminata</i> Colla ssp. <i>microcarpa</i> | RK4616 | UM |
| <i>M. banksii</i> F. Muell. | GA s.n. | FMC |
| <i>Musa</i> sect. <i>Rhodochlamys</i> | | |
| <i>M. sanguinea</i> Hook. f. | GA s.n. | RBG |
| <i>Musa</i> sect. <i>Callimusa</i> | | |
| <i>M. borneensis</i> Becc. | 19992248 | SBG |
| <i>M. violascens</i> Ridl. | RK4876 | FH |
| <i>Musa</i> sect. <i>Australimusa</i> | | |
| <i>M. lolodensis</i> Cheesman | 00613 | FMC |
| <i>M. textilis</i> Néé | AL 7 | AP |
| <i>M. jackeyi</i> W.Hill | 19990218 | SBG |
| RBG | | |
| CH | | |
| FMC | | |
| Royal Botanic Garden, Edinburgh | SBG | |
| Cameron Highlands, Malaysia | FH | |
| Freeport Mining Concession | UM | |
| Singapore Botanic Gardens, Singapore | AP | |
| Fraser's Hill, Malaysia | | |
| Ulu Melingau, Sabah | | |
| Agricultural Park, Tenom, Sabah, Malaysia | | |

to generate template DNA for amplification. PCR was performed in two consecutive reactions. The template DNA generated was first pre-amplified using AFLP primers each having one selective nucleotide. The PCR products of the pre-amplification reaction were then used as template after dilution 5-fold in sterile water, for selective amplification using two AFLP primers, each containing three selective nucleotides. A total of eight primer combinations were used in this study (Table 2). The final PCR products were run on a 6% denaturing polyacrylamide gel in 1X TBE buffer. The *EcoRI* primers used were not radioactively labelled as in the original protocol. Instead, a modified silver staining method was used (Loh *et al.*, 1999).

Table 2 The sequence of primers used in the AFLP analysis.

| Name / Abbreviation | Enzyme | Type | Sequence (5'-3') |
|---------------------|--------------|-----------|---------------------|
| GY Y 101/ EA+ | <i>EcoRI</i> | Adapter + | CTCGTAGACTGCGTACC |
| GY Y 102/ EA- | <i>EcoRI</i> | Adapter - | AATTGGTACGCAGTCTAC |
| GY Y 103/ MA+ | <i>MseI</i> | Adapter + | GACGATGAGTCCTGAG |
| GY Y 104/ MA- | <i>MseI</i> | Adapter - | TACTCAGGACTCAT |
| GY Y 105/ E-A | <i>EcoRI</i> | Primer +1 | GACTGCGTACCAATTCA |
| GY Y 107/ E-AAC | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCAAC |
| GY Y 108/ E-AAG | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCAAG |
| GY Y 109/ E-ACA | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCACA |
| GY Y 110/ E-ACT | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCACT |
| GY Y 111/ E-ACC | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCACC |
| GY Y 112/ E-ACG | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCACG |
| GY Y 113/ E-AGC | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCAGC |
| GY Y 114/ E-AGG | <i>EcoRI</i> | Primer +3 | GACTGCGTACCAATTCAGG |
| GY Y 106/ M-C | <i>MseI</i> | Primer +1 | GATGAGTCCTGAGTAAC |
| GY Y 115/ M-CAA | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACAA |
| GY Y 116/ M-CAC | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACAC |
| GY Y 117/ M-CAG | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACAG |
| GY Y 118/ M-CAT | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACAT |
| GY Y 119/ M-CTA | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACTA |
| GY Y 120/ M-CTC | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACTC |
| GY Y 121/ M-CTG | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACTG |
| GY Y 122/ M-CTT | <i>MseI</i> | Primer +3 | GATGAGTCCTGAGTAACTT |

Data analysis

For the diversity analysis, bands were scored as present (1) or absent (0) to form a raw data matrix. A square symmetric matrix of similarity was then obtained using Jaccard's Similarity Coefficient $[x/(y-z)]$, where x is the number of fragments in common between two taxa, y is the total number of fragments scored, z is the number of fragments absent in both taxa, from the raw data matrix. Genetic diversity estimates (GDEs) were then calculated as 1 minus Jaccard's Similarity Coefficient and used for cluster analysis using the Unweighted Pair Group Method with Arithmetic mean (UPGMA) technique of the NEIGHBOR program in PHYLIP version 3.5c (Felsenstein, 1993). The dendrogram was drawn using TREEVIEW version 1.6.1 (Page, 1996).

Results

AFLP Profiles

The AFLP profiles generated using eight primer combinations contained highly informative bands, which distinguished all taxa examined and provided valuable information on genetic relationships. Figure 1 illustrates an AFLP profile obtained. Only unambiguous bands of size 50–500 base pairs were scored. A total of 201 bands were analysed out of which (95%) were polymorphic across all samples examined. On average, 27 bands were scored per primer pair.

Fifty-nine unique bands were observed for the taxa examined (Table 3). All species except for *Musa textilis* were characterised by unique markers ranging from 1 to 18. *M. johnsii* is characterised by six unique bands, confirming it is a distinct species. *M. banksii* is characterised by four unique bands. The genetic markers observed will be useful for the development of probes in *Musa* breeding programmes. The genetic diversity estimates are shown in Table 4.

Discussion

Position of *Musa johnsii*

This species has strikingly distinct morphological characters, such as the compact, subglobose head of schizocarpic fruits that are unique in the distal third being filled with pale pinkish orange, mucilaginous pith (Argent, 2001). AFLP analysis confirms it is a distinct species (Fig. 2). Argent (2001) suggested it was closely related to the schizocarpic *M. lolodensis* as the seeds of the two species are remarkably similar but Table 4 and Fig. 2 show it is genetically more similar to the Australian *M. jackeyi* than

it is to the New Guinea *M. lolodensis*. All three species belong in Sect. *Callimusa* in the 'textilis' group (see below). This is another example where conspicuous morphological differences do not reflect genetic similarity (Jarret & Gawel, 1995).

Status of Musa banksii

Simmonds (1956) reduced this species to a subspecies of *Musa acuminata* based on experiment and field observations. However, Argent (1976) maintained it as a distinct species as it did not hybridise with *M. acuminata* subsp. *malaccensis* when they were grown together for many years in the Lae Botanic Garden, Papua New Guinea. This taxon also differs from the other *M. acuminata* subspecies in its female flowers having some fertile stemens, in the non-imbricating bracts in the male bud, and in producing a very large number of seeds (up to 400) as compared with 40–50 in subspecies from the lowlands of Peninsular Malaysia and Thailand (Simmonds, 1995).

Results of several studies using molecular techniques are now available. Gawel & Jarret (1991) used cpDNA RFLP, which generated a phenogram with *M. banksii* embedded among the other subspecies of *M. acuminata* studied, indicating that it is not genetically distinct at the species level. Jarret & Gawel (1995) using total-DNA RFLP again found that *M. banksii* clustered with the other *M. acuminata* subspecies in their phenogram. Our study using AFLP showed *M. banksii* clustering with the other subspecies of *M. acuminata* (Fig. 2), again indicating that genetically it is not a distinct species and that subspecific rank would be more appropriate. However, the genetic diversity estimates (Table 4) indicate it is the least similar among the four subspecies studied, perhaps a reflection of a combination of its unique characters listed above and its most south-easterly distribution of all *M. acuminata* subspecies.

Sections and groupings of wild banana species

Cheesman (1947) created four sections within the genus *Musa* - sections *Eumusa* (now *Musa*), *Rhodochlamys*, *Callimusa* and *Australimusa* - as a convenient way of grouping the species. He noted that the sections were not of equal rank and that in some characters sect. *Australimusa* was intermediate between sect. *Callimusa* and sect. *Musa*, and that the division between sect. *Musa* and sect. *Rhodochlamys* was 'unessential'. He speculated that sect. *Musa* and sect. *Australimusa* were the earliest to diverge and that sect. *Rhodochlamys* was an offshoot from sect. *Musa*. He was in two minds as to whether sect. *Callimusa* had diverged directly from sect. *Australimusa* or, as he considered the barrel-shaped seeds with a large oil/air space a very significant character, might be an earlier divergence from sect. *Musa*. Argent (1976a) described a fifth section, *Igentimusa*, with the single species *M. ingens* N.W. Simmonds.

Subsequent to Cheesman's work, new species have been described that do not conform to his concepts of the sections so that the distinction between the sections is becoming blurred. Molecular techniques have opened a new avenue of enquiry. Studies carried out so far (Jarret & Gawel, 1995; Wong *et al.*, 2002, and this study)

M 1 2 3 4 5 6 7 8 9 10 11 12



Figure 1. AFLP profile generated using primer pair 1 (E-AAC, M-CAA). Lane M: pUC19/HpaII molecular weight marker, lane 1: *Musa johnsii*, lane 2: *Ensete superbum*, lane 3: *M. lolodensis*, lane 4: *M. textilis*, lane 5: *M. jackeyi*, lane 6: *M. borneensis*, lane 7: *M. violascens*, lane 8: *M. banksii*, lane 9: *M. acuminata* ssp. *siamea*, lane 10: *M. acuminata* ssp. *truncata*, lane 11: *M. acuminata* ssp. *microcarpa*, lane 12: *M. sanguinea*.

Table 3. Number of unique molecular marker bands specific for each taxon detected upon AFLP analysis using eight primer combinations.

| Primer Pair | EcoRI | MseI | <i>M. johnsii</i> | <i>Ensete superbum.</i> | <i>M. lolodensis</i> | <i>M. textilis</i> | <i>M. jackeyi</i> | <i>M. borneensis</i> | <i>M. violascens</i> | <i>M. banksii</i> | <i>M. acuminata</i> ssp. <i>stamea</i> | <i>M. acuminata</i> ssp. <i>truncata</i> | <i>M. acuminata</i> ssp. <i>microcarpa</i> | <i>M. sanguinea</i> | Total number of unique markers per primer pair |
|-------------|-------|-------|-------------------|-------------------------|----------------------|--------------------|-------------------|----------------------|----------------------|-------------------|--|--|--|---------------------|--|
| 1 | AAC* | CAA** | 2 | 13 | - | - | 1 | 3 | 2 | 1 | 12 | 2 | 1 | 3 | 40 |
| 10 | AAG | CAC | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| 19 | ACA | CAG | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 28 | ACC | CAT | 2 | - | - | - | - | - | - | - | - | - | - | 1 | 3 |
| 37 | ACG | CTA | 1 | - | - | - | - | - | - | 1 | - | - | - | - | 2 |
| 46 | ACT | CTC | - | 1 | - | - | - | 1 | - | 1 | - | - | - | 1 | 4 |
| 55 | AGC | CTG | 1 | 2 | - | - | 2 | - | - | - | - | - | - | - | 5 |
| 64 | AGG | CTT | - | 2 | - | - | - | - | 1 | - | - | - | - | - | 3 |
| Total | | | 6 | 18 | 1 | 0 | 3 | 5 | 2 | 4 | 12 | 2 | 1 | 5 | 59 |

**EcoRI* : *EcoRI*-adapter based primer; the selective nucleotides added at the 3' end are indicated

**MseI* : *MseI*-adapter based primer; the selective nucleotides added at the 3' end are indicated

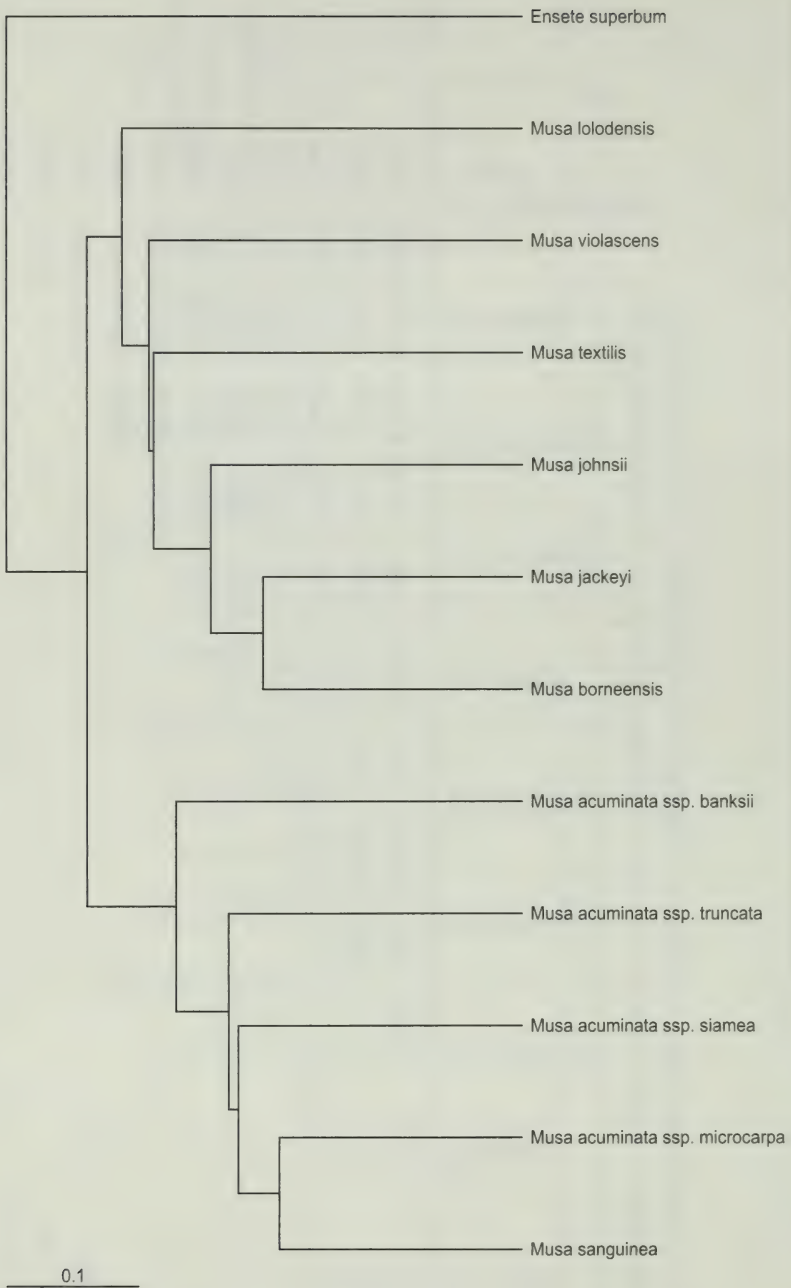


Figure 2. UPGMA cluster analysis of AFLP data generated by eight primer combinations for 12 taxa of *Musa* depicting patterns of genetic diversity. Scale depicts genetic diversity estimates (GDEs).

strongly support two main groups within the genus *Musa*, which correlate with chromosome number, i.e. those with a somatic number of $x=11$ (sect. *Musa* and sect. *Rhodochlamys*) and $x=10$ (sect. *Callimusa* and sect. *Australimusa*, including *M. beccarii* with a somatic number of $n=9$). On the other hand, they also show that sect. *Rhodochlamys* is not genetically distinct from sect. *Musa*, and that sect. *Australimusa* is not distinct from sect. *Callimusa*. No material of *Musa ingens* (sect. *Igentimusa*, somatic no. $x=7$) has been available for molecular analysis.

The conspicuous distinction between sect. *Musa* and sect. *Rhodochlamys* is the tall pseudostem and pendulous inflorescences with dull coloured bracts, which mostly become revolute on fading, of the former, compared with the short pseudostems and erect inflorescences and brightly coloured bracts that do not become revolute of the latter. Apart from pseudostem height, these characters are related to the pollination syndrome: the flowers on pendulous inflorescences being pollinated by nectiferous bats and the erect ones by nectiferous birds (sunbirds and spiderhunters). Molecular studies show that many species classed within sect. *Rhodochlamys* are in fact more closely related to species within sect. *Musa* than they are to other species in sect. *Rhodochlamys*, which indicates that bird-pollination in bananas has evolved independently several times. Simmonds (1962) considered bat pollination ancestral to bird pollination in the genus *Musa*. Both Simmonds (1962) and Shepherd (1999) suggested that these two sections be amalgamated. Molecular studies (Jarret & Gawel, 1995; Wong *et al.*, 2002 and this study) strongly support this view.

Cheesman (1947) was most impressed with the distinct barrel-shaped seeds with the large oil/air space of sect. *Callimusa*, so much so that he thought it would have warranted generic status had there not been species in sect. *Australimusa* that shared characters of both sect. *Musa* and sect. *Callimusa*. However, as more species have been discovered, seed morphology has been shown to be much more variable (Argent, 2000). In general, sect. *Callimusa* includes species with erect inflorescences with colourful bracts compared with most species in sect. *Australimusa* with pendent inflorescences (although there are exceptions in both sections), again indicating that the erect inflorescence with bird-pollinated flowers has evolved several times. Molecular studies (Wong *et al.*, 2002; and this study) also illustrate that there is no genetic justification for keeping them separate as species in sect. *Callimusa* cluster among species of sect. *Australimusa* (Fig. 2).

To put banana taxonomy on a firmer basis where the sections reflect genetic similarity among the species, three sections are recognised here:

Section *Musa* (Baker) Cheesman, Kew Bull. (1948) 108.

Basinym: subgen. *Eumusa* Baker, Ann. Bot. 7 (1893) 205, 208.

Type: *M. paradisiaca* L.

Syn: Sect. *Rhodochlamys* Baker, Ann. Bot. 7 (1893) 205.

Type: *M. ornata* Roxb.

Section *Callimusa* Cheesman, Kew Bull (1947) 112.

Type: *M. coccinea* Andrews

Syn. Sect. *Australimusa* Cheesman, Kew Bull. (1947) 110.

Type: *M. textilis* Nee

Section *Ingentimusa* Argent, Notes Roy. Bot. Gard. Edinb. 35 (1976) 111.

Type: *M. ingens* N.W. Simmonds.

However, Cheesman's point that his four sections are a convenient way of grouping bananas still holds as the bird-pollinated species with colourful bracts in sect. *Rhodochlamys* and sect. *Callimusa* are important horticulturally, while the edible bananas fall into the other two groups, sect. *Musa* with the *M. acuminata* x *M. balbisana* hybrids and sect. *Australimusa*, which includes the Fe'i cultivar group. In addition, as Cheesman remarked, some groups are easily identified in the field. For example, most species in the 'coccinea' group are readily recognised by the pronounced scarious auricle along the leaf shoulder (Argent, 1976). For these reasons, we suggest that an informal grouping be adopted to satisfy this need and, to avoid confusion with the sections, should be named for the 'type' species for each group. Thus, sect. *Musa* would include the 'acuminata' and 'ornata' groups and sect. *Callimusa* the 'coccinea' and 'textilis' groups.

Jarret & Gawel (1995) considered *M. coccinea* Andrews sufficiently distinct in their molecular study to be placed in a group of its own, though it should be noted that this result could be due to the fact that no other species in the 'coccinea' group was included in their study. In fact it differs from the rest of the group morphologically in lacking the pronounced rugose auricles but when other species in the 'coccinea' group are included, *M. coccinea* clusters with them (Wong *et al.*, 2002). In any case, if this argument is followed, it would end up with each of the unusual or anomalous species, such as *M. johnsii* or *M. suratii* Argent, each being placed in a group of their own, which defeats the purpose of grouping species in the first place.

To show the diagnostic characters of each of these groups, a key to the sections and informal groups is given below:

Key to Banana Groups

(based on Cheesman, 1947, and Argent, 1976)

1a. Section *Musa*. Chromosome number $x=11$. Bracts usually more or less sulcate, often more or less glaucous, rarely or never polished, convolute or more or less imbricate in the bud, usually strongly revolute on fading. Seeds often dorsiventrally compressed, sometimes subglobose..... 2

- 2a.** Pseudostems commonly exceeding 3 m tall. Inflorescences pendent or semi-pendent, fruits reflexing towards the base of the rachis. Bracts commonly dull-coloured, green, brownish or dull purple. Flowers many to a bract, in two series..... **acuminata group**
- 2b.** Pseudostems commonly less than 3 m tall. Inflorescences erect, fruits pointing towards the apex of rachis. Bracts brightly coloured, often pink or red. Flowers few to a bract, usually in a single series.....**ornata group**
- 1b.** Bracts plane, firm in texture, rarely or never glaucous, strongly imbricate in bud, polished or not, usually not revolute on fading. Seeds barrel-shaped or strongly angled3
- 3a. Section *Ingentimusa*.** Chromosome number $x=7$. Pseudostems c.15 m tall. Leaf shoulders reflexed, non-scarious. Inflorescences pendent. Bracts not polished. Seeds strongly angled, 8–9 mm diam.
- 3b. Section *Callimusa*** Chromosome number $x=10$. Pseudostems short or tall. Leaf shoulders scarious or non-scarious, never reflexed. Inflorescences erect or pendent. Bracts polished on the outside. Seeds barrel-shaped or strongly angled, up to 5 mm diam.....4
- 4a.** Pseudostems commonly less than 3 m tall and inflorescences erect or sometimes pseudostems more than 3 m tall and inflorescences pendent (e.g. *M. borneensis*). Leaf shoulders usually with well-developed scarious auricle, rarely absent (e.g. *M. coccinea*). Seed often barrel-shaped or cylindrical with a well-developed oil/air space, rarely angular.....**coccinea group**
- 4b.** Pseudostems more than 3 m tall. Inflorescence commonly pendent, sometimes erect (e.g. *M. maclayi*). Leaf shoulders commonly without a scarious auricle, sometimes scarious (e.g. *M. lolodensis*). Seeds subglobose or dorsiventrally compressed, sharply angled, without a well-developed oil/air space.....**textilis group**

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Begonias from the Bau Limestone, Borneo, including a New Species

RUTH KIEW¹ AND CONNIE GERI²

¹The Herbarium, Singapore Botanic Gardens, Singapore

²The Sarawak Biodiversity Centre, Kuching, Sarawak, Malaysia

Abstract

Six *Begonia* species (Begoniaceae) are found on limestone hills in the Bau area, Kuching, Sarawak. One, a new species, *Begonia lailana* Kiew & Geri, is described. A key and habitat notes for all species are provided. The male and female flowers of *B. calcarea* Ridl. and the female flowers of *B. congesta* Ridl., not previously recorded, are here described for the first time.

Introduction

In 1906, Ridley published a paper on the begonias of Borneo that included twenty species, of which five were new species from the Bau limestone (1° 25'N 110° 9'E), 35 km from Kuching, Sarawak. Most were based on his own collections. Two of these were imperfectly known so that descriptions of the male and female flowers of *Begonia calcarea* Ridl. and the female flowers of *B. congesta* Ridl. were lacking.

As part of the recent biodiversity survey of the Bau limestone carried out by the Sarawak Biodiversity Centre, we collected specimens of begonias from 20 hills. All the species described by Ridley were recollected with the addition of a new species, which is described in this paper. Flowering material of *B. calcarea* was also collected and the flowers are described below.

In addition, the habitats of the species, which are quite different, were recorded. The diversity of begonias on a single limestone hill can be attributed to individual species occupying different and non-overlapping niches (Kiew, 1998). Most of the hills at Bau are home to at least three species, *B. pendula* Ridl., *B. rubida* Ridl. and *B. speluncae* Ridl., with four species collected from Gunung (G.) Doya and G. Jebong and five from G. Kawa. *Begonia rubida* grows near the summit of limestone hills above the tree canopy exposed to sunlight or in light shade, while *B. pendula* grows below the tree canopy on damp, mossy, vertical shaded rock-faces. *B. speluncae*, as

its name suggests, is common around cave mouths but also grows on dry rock-faces near the base of the hills where it occurs. The less common species include *B. congesta*, which grows on limestone boulders or damp low rock-faces near the cliff base, and *B. calcarea* and the new species, *B. lailana* Kiew & Geri, which both grow close to limestone hills on soil associated with the limestone. This soil is frequently more friable and more free-draining than soil derived from other rock types and often supports a different suite of plant species. It is significant that these last three species are less common than the others as this habitat is more susceptible to disturbance, particularly from agriculture, which encroaches towards the base of the hills.

Several of these species are decorative and have ornamental value. *Begonia calcarea* is a handsome species with broad upstanding leaves, which are covered in striking long magenta hairs, particularly on the petiole. In addition, it has large, bright orange or orangey-red flowers with a wavy margin. *B. pendula* has attractive foliage – its leaves are variegated with silver-green spots. Ridley (1906) described *B. speluncae* as ‘one of the most attractive limestone species’ with its tufts of small round leaves.

For identifying species, Ridley’s key is not entirely satisfactory as both *B. pendula* and *B. rubida* key out under ‘stems short, erect and leafy’. *B. pendula* is a creeping and often pendulous species and *B. rubida* has tall stems. A key to the Bau limestone species is therefore provided.

Key to the Bau Limestone Begonias

- | | |
|--|-----------------------|
| 1a. Stems erect and cane-like | 2 |
| 1b. Stems rhizomatous or creeping | 4 |
| 2a. Leaves with veins prominently forked and narrowly diverging, fruits oblong | 2. B. congesta |
| 2a. Leaves with veins widely diverging when they fork, fruit much wider distally | 3 |
| 3a. Leaves ovate, petiole at an angle to the midrib | 5. B. rubida |
| 3b. Leaves oblanceolate, petiole straight with the midrib | 3. B. lailana |
| 4a. Stems thin and creeping, leaves widely spaced, longer than broad, spotted silver-green | 4. B. pendula |
| 4b. Stem thick and rhizomatous, leaves tufted, as wide as broad, dark green, not spotted | 5 |
| 5a. Robust plant, lamina more than 15 cm wide, petiole more than 15 cm long with dense long magenta hairs, flowers orange | 1. B. calcarea |

- 5b. Diminutive plant, lamina up to 4 cm wide, petiole up to 7 cm long, hairs not long nor magenta, flowers white

6. **B. speluncaea**

1. **Begonia calcarea** Ridl., J. Str. Br. Roy. As. Soc. 46 (1906) 260. **Holotype:** Sarawak, Gunung Bra'ang *Haviland s.n.* (not seen).
Sect. *Diploclinium*

Ridley (1906) described this handsome begonia from a fruiting specimen. It is a very striking plant due not only to its broad, upstanding leaves but also to its long magenta hairs, which cover the whole plant and are particularly striking on the petioles. It is unusual among Bornean begonias in having orange flowers (most begonias have pale pink or white ones). The flowers are produced below the leaves from the prostrate rhizome. They are described here from *SBC 3854* for the first time.

Inflorescences from the leaf axils or from the prostrate rhizome. Female flowers, 1–2 at one node, bracts c. 10 x 4 mm. Male flowers in umbels 2.5–5 cm long, rachis rosy pink to pale pink, male flowers 3–6; bracts lanceolate 7–10 x 2–4 mm, apex setose; bracteoles 2–6 x 1–3 mm. *Male flowers* with pedicel 4–19 mm long, *tepals* 4, orangey-red to deeper red around the margin, margin undulate, glabrous inside and out; isomorphic, outer two broadly oval to almost rotund, apex rounded, 7–11 x 5–9 mm, inner ones slightly narrower, 7–11 x 4–6 mm; stamen cluster hemispherical, c. 4–5 x 8 mm, almost sessile, *stamens* 25–35, filament c. 1.5–2 mm long, anthers deep yellow, obovate, c. 1.5–2 mm long, apex emarginate. *Female flowers* with rosy pink peduncle and pedicel, bracteole oval, c. 5 x 2 mm, apex acuminate, *ovary* c. 19 x 20 mm, glabrous, locules 3, placentas bifid; *tepals* 5, isomorphic, orangey-red, margin undulate, c. 6 x 7 mm, *stigma and styles* c. 4 mm long. *Fruits* with peduncle and pedicel 20–40 mm long, capsule 11–21 x 15–21 mm, wings 3, equal, rounded, 4–12 x 5–7 mm, thinly fibrous. *Seeds* barrel-shaped, light brown, c. 0.2 mm long, collar cells (0.25–)0.75 length of seed.

Doorenbos *et al.* (1998) doubtfully included *Begonia calcarea* in sect. *Diploclinium*. Examination of the female flower shows its ovary and fruit to have three locules and bifid placentas, which confirms its position within this section.

Haviland recorded its habitat as 'top of Mt Bra'ang, old jungle, limestone', hence the name 'calcarea' that Ridley gave. However until our survey, no further specimens had been identified as this species so that there was some doubt that it was a limestone plant. It is certainly a rare species as, although 20 hills were surveyed, it was only found at the base of two of them. It is the most endangered among the Bau limestone species because its habitat is vulnerable to encroaching agricultural practices

from farms close to the base of the hills.

A similar specimen (*Native Collector 1255*) was collected from Gunung Dulit casting doubt as to whether this species is restricted to limestone and endemic to limestone in the Kuching District.

Distribution: Malaysia, Sarawak - Kuching limestone and possibly also from non-limestone habitats on G. Dulit.

Specimens examined: Gunung (G.) Angob Anderson S27513 (SAR); G. Kawa Connie Geri et al. SBC 3577 (SBC); G. Lanyang (G. Meraja) Burt B8154 (SAR), G. Manok Burt B8134 (SAR), B8154 (SAR); G. Tabai Connie Geri et al. SBC 3854 (SBC).

2. ***Begonia congesta*** Ridl., J. Str. Br. Roy. As. Soc. 46 (1906) 253. **Holotype:** Sarawak, Bau Ridley *s.n.* (not seen).
Sect. *Petermannia*

This is a distinct begonia because its leaves are corrugate due to the many, narrowly bifurcating veins. As its name suggests, the inflorescence appears congested because the lateral branches are clustered at the base but above which there is a long (up to 14 cm long) rachis bearing male flowers. This rachis dies and falls before the fruits are mature and was obviously not present in the plants Ridley described. The plant is protogynous with two female flowers produced at the base followed by many small male flowers, which are produced later on short lateral branches and on the erect rachis.

Male flowers with pedicel 5–7 mm long, with pale brown hairs c. 0.25 mm long; *tepals* 2, cream and rosy pink at base, minutely hairy outside, glabrous inside, upper rotund, 4–5 x 4–5 mm, lower broadly oval, 4–5 x 3–4 mm; stamen cluster hemispherical, c. 3–3.5 x 3–4 mm, joined at base in a stalk c. 0.5 mm long; *stamens* c. 35, filament c. 0.75 mm long, anther obovate, c. 1 mm long, apex not emarginate. *Female flowers* with pedicel 4–11 mm long with dense glandular hairs, *ovary* oblong, to 20 x 17 mm, wing 3–4 mm wide, isomorphic, rounded distally, locules and wings minutely hairy, locules 3, placentas bifid; *tepals* 5, isomorphic, oval, c. 18 x 6 mm, toothed in distal half, each tooth terminating in a hair, minutely hairy outside, glabrous inside; *styles* 3, c. 3 mm long, bifid, stigma a spiral papillose band. *Fruits* pendent, broadly oblong, to 2.5 x 1.7 cm, wings 3, equal, thin and fibrous. *Seeds* barrel-shaped, c. 0.3 mm long, collar cells c. 0.75 seed length.

Ridley (1906) recorded the tepals as shorter than the stamens (surely an error as the stamens are less than 2 mm long) and the stamen number as 12. We counted

about 35 stamens.

The species is endemic in the Kuching limestone. Ridley cited a specimen from the Niah limestone under this species but this has proved to be a distinct species (Pearce, 2003).

Distribution: Malaysia, Sarawak - endemic in the Kuching limestone.

Specimens examined: Bau Abang Mohtar S52906 (SAR), Brooke 9875 (SING), Purseglove P4468 (SAR, SING); Bidi Mamit S42147 (SAR); Bukit Kapur Burt & Woods B1881 (SAR); Bukit Krian Anderson S25137 (SAR); Fairy Cave Jugah et al. S70076 (SAR); G. Angob Anderson S27493 (SING); G. Batu Martin S39276 (SAR), Meekiong et al. SBC 2125 (SBC); G. Doya Julia et al. SBC 2062 (SBC), Meekiong et al. SBC 2244 (SBC), Raymond et al. SBC 3459 (SBC); G. Jebong Meekiong et al. SBC 2076 (SBC), Paul & Ilias S25626 (SAR); G. Kawa George S38280 (SAR), Meekiong et al. SBC 3113 (SBC); G. Krian Meekiong et al. SBC 1614 (SBC); G. Lanyang Julia et al. SBC 1224 (SBC), SBC 2938 (SBC); G. Pambur Julia et al. SBC 1270 (SBC); G. Ropih Donny et al. SBC 2001 (SBC), Julia et al. SBC 1295 (SBC); Seburan Anderson 8984 (SAR), S14580 (SAR), Woods B2890 (SAR); G. Tai Ton Denis et al. SBC 1410 (SBC), Julia et al. SBC 726 (SBC); G. Tongga Burt B8179 (SAR).

3. *Begonia lailana* Kiew & Geri, sp. nov.

Differt a *Begonia oblongifolia* foliis latioribus (8–10 cm nec 5 cm latis), floribus nec albis et fructis alis latioribus (8–11 mm nec 5 mm latis).

Typus: Malaysia, Sarawak, Bau, Gunung Kawa. *Connie Geri et al. SBC 3753* (holo SAR, iso K, L, SAN, SBC, SING).

Section: *Petermannia*

Figure 1

Cane-like begonia up to 1 m tall with several erect stems from the base, some plants branching near the base to form a bushy crown. *Stem* succulent becoming woody, reddish or greenish brown, swollen at nodes, up to c. 7 mm diam., glossy and glabrous or hispid with uniseriate translucent hairs c. 2 mm long, dense on the upper internodes and petioles. *Stipules* lanceolate, pale green, 15–27 x 6–10 mm, midrib prominent, margin entire, apex narrowly pointed, caducous. *Leaves* alternate, 7(–11) cm apart; *petiole* reddish, densely hirsute, 3–5 mm in upper leaves, 8–10 mm in lower leaves, thickened at the base, slightly grooved above, in line with the midrib, *lamina* in juvenile leaves silver-spotted between the veins, in mature leaves matt, plain light green with a red patch at junction with petiole, beneath whitish or sometimes deep red or reddish purple, oblanceolate, asymmetric, 12.5–17 x 8–10 cm, broad side 5–6.5 cm wide,

upper surface glabrous or with scattered dark red bristles between veins and on the veins and midrib, the lower surface with lamina and veins glabrous or veins and midrib minutely hispid, succulent in life, papery when dry, base cuneate and subequal or unequal with the basal lobe of the larger side rounded, 0.5–1 cm long, margin minutely toothed, apex acuminate; venation palmate-pinnate with 2 pairs at base and 3 lateral pairs along midrib, branching towards margin, impressed above, beneath prominent and concolorous with lamina or sometimes red, basal lobe with 2 veins. Plant protogynous. *Inflorescences* axillary, erect, cymose panicle, 10–16 cm long of which peduncle is 0–3.5 cm long, greenish to dark red, minutely pilose, lowest node with 1–2 female flowers, above up to 11 short branches 1–1.5 cm long with many male flowers. Bracts green, ovate, 3–4 mm long. *Male flowers* with pale red pedicel 4–9 mm long, *tepals* 2, glabrous, deep pink or pale cream and deeper pink towards the base, rotund, 6–7 x 6–7 mm or oval 5–8 x 3–7 mm, apex rounded; stamen cluster 3–5 x 2–3 mm with a stalk c. 1 mm long, *stamens* more than 35, filament c. 0.5 mm long; anther pale yellow, obovoid, c. 1–1.5 mm long, apex emarginate, dehiscing by longitudinal slits in upper half. *Female flowers* with pedicel 7–9 mm long, reddish green; *ovary* pale green sometimes with red veins on the wings, 13–18 mm long, locules 3, each with 2 axile placentas, wings 3, equal, 3–5 mm wide; *tepals* 5, pale peach to pale pink or green, sometimes deep ruby red at the base, slightly obovate, 6–12 x 3–8 mm, innermost smaller 4–10 x 3–7 mm, the margin entire or with 4–5 minute teeth towards the apex, apex acute, the outer surface sometimes with scattered translucent hairs; *styles* 3, bifurcating, spirally twisted, yellowish-green to pale green, 2–6 mm long; *stigma* a glistening papillose spiral band. *Fruits* with stiff, decurved pedicel 10–13 mm long, capsule glabrous, 2–2.7 x 1.8–2.8 cm, wings slightly unequal, slightly pointed at tip, thinly fibrous, widest wing 8–11 mm wide, narrowest 6–8 mm wide, dehiscing between locule and wing, style not persistent. *Seeds* barrel-shaped, light brown, c. 0.4 mm long, collar cells c. 0.4 length of seed.

Distribution: Malaysia, Sarawak - endemic in Kuching limestone. Locally common on G. Aup, G. Poing and G. Tabai.

Habitat: At the base of limestone hills, in light shade.

Notes: *Begonia lailana* is named in honour of YABhg. Datuk Amar Puan Sri Dr Hajjah Laila Taib, wife of the Chief Minister of Sarawak.

This species belongs to sect. *Petermannia* because the ovary has three locules each with two placentas. It resembles *B. oblongifolia* in being a cane-begonia with obovate leaves, paniculate male inflorescences and oblong fruits about 2 cm long. However, it is distinct from this species in its leaves which are narrower, less than twice as long as broad (they are c. 5 cm wide and more than twice as long as broad in *B. oblongifolia*), in having fewer veins (8 in *B. oblongifolia*), larger, light red male

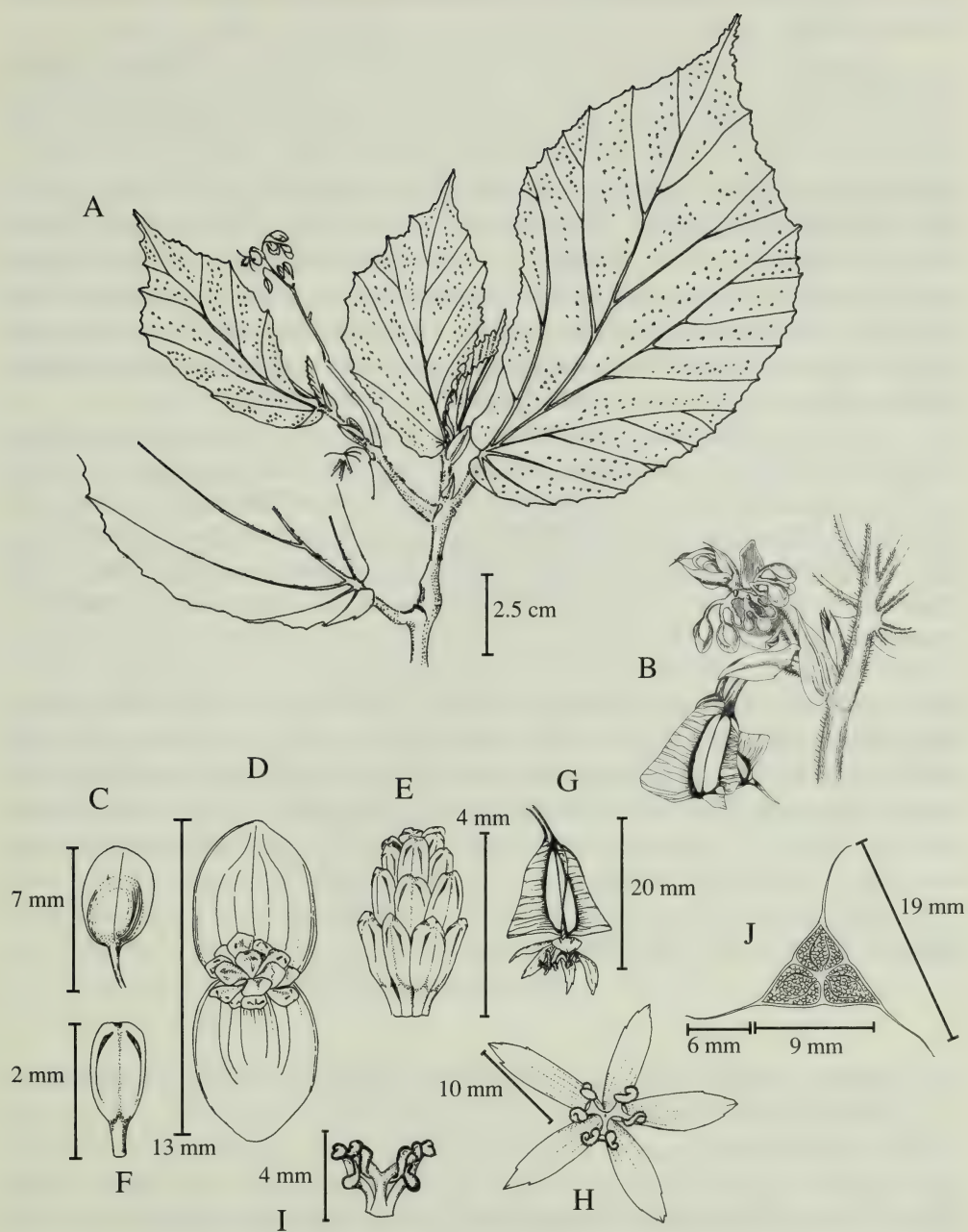


Figure 1. *Begonia lailana* Kiew and Geri.

A foliage; B partial inflorescence; C male bud; D male flower; E stamen cluster; F stamen; G & H female flower; I style and stigma; J. TS ovary.

flowers (3 mm long and green in *B. oblongifolia*) and wider wings (c. 5 mm wide in *B. oblongifolia*).

Begonia lailana populations and individuals show some variation in leaf colour and indumentum, and in ovary colour. Plants in some populations have completely green leaves (e.g. at G. Kawa), in others most plants have green leaves with some plants with red veins on the lower surface (e.g. at G. Tabai), or have most or some plants with a deep red or purplish red undersides to the leaf (e.g. at G. Poing and G. Aup, respectively). The shape of the silver spots on the juvenile leaves also varies between populations: either discrete (e.g. at G. Kawa and G. Poing) or coalescent (e.g. at G. Aup). Some populations have completely green ovaries (e.g. at G. Aup and G. Poing), or the wings of the green ovary have fine red veins (e.g. at G. Kawa and G. Tabai). Begonias are notoriously polymorphic for colour and patterning of the leaves so these differences are not considered significant taxonomically.

While the stiff red bristles on the upper lamina surface are conspicuous, they are not always present in all plants, e.g. the G. Aup population has glabrous leaves, the Poing population has mostly glabrous individuals with a few with bristly leaves, while the G. Kawa population has plants with bristly leaves. The female flower may also vary in that the tepal margin may be entire or slightly toothed. However, this difference does not correlate with any other character and is therefore not considered taxonomically significant.

Other specimens examined: Gunung (G.) Aup *Connie Geri et al. SBC 3756 (SBC), Malcom et al. SBC 3303 (SBC); G. Batu Meekiong et al. SBC 2136 (SBC); G. Doya Julia et al. SBC 2055 (SBC), Raymond et al. SBC 3451 (SBC), SBC 3473 (SBC); G. Kawa Connie Geri et al. SBC 3753 (SBC), SBC 3592 (SBC, SING), Meekiong et al. SBC 3114 (SBC); G. Lanyang Julia et al. SBC 2901 (SBC, SING); G. Podam Malcom et al. SBC 3364 (SBC); G. Poing Julia et al. SBC 353 (SBC); Connie Geri et al. SBC 3755 (SBC), Malcom et al. SBC 1555 (SBC); G. Tabai Connie Geri et al. SBC 3757 (SBC), Julia et al. SBC 3414 (SBC).*

4. ***Begonia pendula*** Ridl., J. Str. Br. Roy. As. Soc. 46 (1906) 257. **Holotype:** Jambusan Ridley 11772 (K).
Sect. *Petermannia*

This species is endemic in the Kuching District where it is common on most limestone hills. It creeps over vertical mossy cliff faces below the tree canopy with its thin stems rooting at the nodes. Ridley (1906) named it 'pendula' describing its habit as having trailing stems hanging down rock-faces. It is a decorative species as its bright green leaves are variegated with silver-green elongated spots between the veins that in some

plants are discrete and in others coalescent. Some plants have leaves with the lower surface maroon, others are green. The male flowers are deep pink and the female flowers are red.

Distribution: Malaysia, Sarawak - endemic in Kuching limestone.

Other specimens examined: Bau Abang Mohtar *et al.* S52914 (SAR), Anderson 7799 (SAR, SING), Brooke 9891 (SING), Ridley 11774 (K); Bidi Clemens 20680 (SAR), Yii *et al.* S50381 (SAR); Bukit Boring Yii *et al.* S50360 (SAR); G. Apin Donny *et al.* SBC 1360 (SBC), Jugah *et al.* S79954 (SAR), Makom *et al.* SBC 1107 (SBC), Malcom *et al.* SBC 1107 (SBC); G. Aup Julia *et al.* SBC 568 (SBC), Malcom *et al.* SBC 3301 (SBC); G. Batu Meekiong *et al.* SBC 2126 (SBC), Meekiong *et al.* SBC 2126 (SBC), SBC 2127 (SBC); G. Berloban Yii & Othman S46234 (SAR); G. Doya Burttt B8187 (SAR), Julia *et al.* SBC 2027 (SBC), SBC 2144 (SBC), SBC 2154 (SBC), SBC 2162 (SBC), Sheavy *et al.* SBC 3056 (SBC); G. Jebong Donny *et al.* SBC 2095 (SBC), Meekiong *et al.* SBC 2074 (SBC), Paul & Ilias S25623 (SAR); G. Juita Connie Geri *et al.* SBC 3425, 3426 (SBC), Julia *et al.* 1293 (SBC); G. Pambur Julia *et al.* SBC 1263 (SBC) G. Podam Meekiong *et al.* SBC 3206 (SBC); G. Poing Julia *et al.* SBC 364 (SBC); G. Ropih Julia *et al.* SBC 2101 (SBC), Meekiong *et al.* SBC 3186 (SBC), Shaevy *et al.* SBC 2426 (SBC); G. Selabor Sinclair SFN 38471 (SING); G. Setiak Martin S38660 (SAR); G. Stulang Malcom *et al.* SBC 640 (SBC), SBC 643 (SBC); G. Tabai Burttt B8158 (SAR), Julia *et al.* SBC 1293 (SBC), SBC 2513 (SBC), SBC 2563 (SBC); G. Tai Ton Julia *et al.* SBC 2677 (SBC), Stevens *et al.* 204A (SAR), Yii *et al.* S51208 (SAR), S51210 (SAR); G. Tongga Donny *et al.* SBC 1777 (SBC); G. Umbut Julia *et al.* SBC 2622 (SBC); Lobang Angin Yii *et al.* S51265 (SAR); Saburan Anderson S19119 (SAR).

5. **Begonia rubida** Ridl., J. Str. Br. Roy. As. Soc. 46 (1906) 256. **Lectotype:** Jambusan Ridley 12393 (K, here designated).
Sect. *Petermannia*

As the name suggests, this species has ruby-red male flowers and its stems are also bright red. It grows above the tree canopy on the shoulders of the summit, often on peaty soil among sparse vegetation in light shade to full sunlight. Its leaves are thick and succulent and are held vertically, unlike the leaves of the other cane-like begonias that grow in shaded conditions, e.g. *B. lailana* and *B. congesta*, the leaves of which are held horizontally. This difference is probably a response to light conditions: the horizontal leaf surface will intercept more light in shaded conditions, while leaves held vertically will absorb less heat in bright sunlit conditions.

Distribution: Malaysia, Sarawak – endemic in Kuching limestone.

Other specimens examined: Bau Brooke 9832 (SING), Bidi Clemens 20681 (SAR); Bukit Jebong Johnson S29403 (SAR), Paul & Ilias S25617 (SAR); Bukit Manok Anderson S27416 (SING), Erwin & Paul S27416 (SAR); Bukit Numpang Chai & Seng S22861 (SAR); Bukit Regu Paul et al. S37392 (SAR); G. Apin Donny et al. SBC 1361 (SBC), Jugah et al. S79953 (SAR), Malcom et al. SBC 1108 (SBC); G. Batu Meekiong SBC 2136, 2137 (SBC); G. Juita Connie Geri et al. SBC 3427 (SBC); G. Meraja Julia et al. SBC 315 (SBC); G. Pambur Julia et al. SBC 1240 (SBC), SBC 1264 (SBC); G. Ropih Julia et al. SBC 2100 (SBC), Connie Geri et al. SBC 3516 (SBC); G. Setiak Martin S38670 (SAR), G. Taiton Julia et al. SBC 710 (SBC); G. Tongga Denis et al. SBC 1722 (SBC), SBC 1732 (SBC); G. Umbut Julia et al. SBC 2584 (SBC).

- 6. *Begonia speluncae* Ridl., J. Str. Br. Roy. As. Soc. 46 (1906) 258. Lectotype:**
 Jambusan Ridley 11773 (K, here designated).
 Sect. *Reichenheimia*

This begonia is, as its name suggests, a species that grows around cave mouths. It also grows on dry rock cliff faces at the base of hills. It is endemic in the Kuching limestone and has been collected from most hills in this area.

Doorenbos et al. (1998) placed this species doubtfully in sect. *Reichenheimia* as the placenta type was not known. We confirm that it belongs to this section because the ovary and fruit have three locules and the placenta is unbranched, i.e. one per locule.

Other specimens examined: Bidi Anderson 75 (K), Brooks s.n. (K) Clemens 20644 (K, SAR), Mjoberg 177 (K); Bukit Pait Erwin & Paul S27429 (SAR); Bukit Selabor Paie S28044 (SAR, SING); Fairy Cave Rantai et al. S 70059 (SAR); G. Aup Julia et al. SBC 707 (SBC); G. Bar Rantai et al. S66034 (SAR); G. Batu Meekiong et al. SBC 2135 (SBC); G. Doya Julia et al. SBC 2159 (SBC), Shaevy et al. SBC 3047 (SBC); G. Jebong Lehman S30143 (SAR), Meekiong et al. SBC 2072 (SBC); G. Kawa Meekiong et al. SBC 2797 (SBC); G. Lanyang Julia et al. SBC 1229 (SBC), SBC 2905 (SBC), Denis et al. SBC 1439 (SBC); G. Manok Burt B8132 (SAR); G. Meraja Julia et al. SBC 301 (SBC); G. Podam Malcom et al. SBC 814 (SBC); G. Poing Julia et al. SBC 355 (SBC); Quop Hewitt s.n. (K); Sungai Serian Jacobs 5177 (SAR).

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New Species and New Records of Southeast Asian *Bulbophyllum* (Orchidaceae)

J.J. VERMEULEN

Singapore Botanic Gardens
Singapore 259569

AND

P. O'BYRNE

14 Clementi Crescent
Singapore 599517

Abstract

Seventeen new species of *Bulbophyllum* are described: *B. tectipes* (sect. *Aphanobulbon*, from Sulawesi), *B. pseudopelma* and *B. simplex* (both sect. *Desmosanthes*, from Sulawesi), *B. flavorubellum* (sect. *Desmosanthes*, from Sabah), *B. decurrentilobum* and *B. iterans* (both sect. *Hybochilus*, from Sulawesi), *B. furcillatum* (sect. *Hybochilus*, from Sumatra), *B. anisopterum* (sect. *Monilibulbus*, from Sabah), *B. anakbaruppui* and *B. illecebrum* (both sect. *Osyricera*, from Sulawesi), *B. uncinatum* (sect. *Polyblepharon*, from Sulawesi), *B. catillus*, *B. lyriforme* and *B. sinapis* (sect. *Sestochilus*, all from Papua New Guinea), *B. coweniorum* (sect. *Sestochilus*, from Laos), *B. incisilabrum* (sect. *Sestochilus*, from Sulawesi), and *B. turpis* (sect. *Sestochilus*, from Peninsular Malaysia). *Bulbophyllum plumatum* Ames, and *B. spissum* J.J. Verm. are newly recorded for Peninsular Malaysia.

Introduction

The collection of orchid species in Singapore Botanic Gardens appears an inexhaustible source of interesting plants. In this paper new species of the genus *Bulbophyllum* that recently came to light are described. Several more new species of the same genus, based on material from different sources (L, K) are added. Two *Bulbophyllum* species that are newly recorded for Peninsular Malaysia are discussed.

Bulbophyllum* sect. *Aphanobulbon

***Bulbophyllum tectipes* J.J. Verm. & P. O'Byrne, *sp. nov.* – Fig. 1.**

Bulbophyllum tectipes J.J. Verm. & P. O'Byrne, inter species rhizoma patenti ad pendentem inflorescentiam multifloram sect. *Aphanobulbonis* foliis 9.5–15 cm longis, pedunculo omnino bracteis 3 vel 4 in duabus seriebus imbricatis acute carinatis tecto notatum. – TYPE: Indonesia, Sulawesi, central part, *SBG-O 1953* (SING, holotype).

Roots creeping along the rhizome towards its point of attachment, then spreading over the substrate. *Rhizome* patent to \pm pendulous with stiff, \pm patent branches, up to 80 cm long, 2–2.5 mm diam., sections between pseudobulbs 8–9 cm long, bracts hardly persistent, distinctly keeled. *Pseudobulbs* distant, minute, cylindrical, 0.2–0.25 x 0.2–0.25 cm. *Petiole* 0.5–0.9 cm long. *Leaf blade* elliptic to ovate, 9.5–15 x 2.3–3.2 cm, index (length/width) 4.1–4.9; acute. *Inflorescence* patent, a rather dense raceme, 4.4–10.4 cm long, 14–26-flowered. *Peduncle* 1.4–2.2 cm, bracts 3–4, distichous, imbricate, the longest 14–20 mm long; acuminate, sharply keeled. *Rhachis* 3–8.2 cm. *Floral bracts* triangular, c. 3.8 x 1.5 mm, acute. *Flowers* not resupinate, not fully opening, many simultaneously. *Pedicel* and *ovary* c. 2.2 mm long, basal node \pm flush with the surface of the rhachis. *Median sepal* somewhat recurved, elliptic, c. 6 x 2 mm, index c. 3; acuminate, margins entire, base broadly attached; thin, 3-veined, glabrous. *Lateral sepals* recurved, free, oblique, triangular, c. 6 x 2.8 mm, index 2.1–2.2; acute, otherwise as the median sepal. *Petals* porrect, elliptic, c. 2.6 x 0.8 mm, index 3.2–3.3; acute, margins entire, slightly papillose towards the tip, base rather narrowly attached; thin but somewhat thickened towards the tip, 1-veined, surface glabrous. *Lip* recurved \pm half-way, general outline \pm elliptic, c. 2.8 x 1.4 mm, index c. 2 (all without artificial spreading); acuminate, margins entire; rather thin, glabrous; adaxially concave and with 2 conspicuous, rounded knobs near the base, with a median furrow up to half-way the length of the lip, surface slightly convex towards the tip; abaxially with a distinct, truncate ridge up to half-way the length of the lip. *Column* c. 1 mm long, column foot with a low ridge starting at the base of the stigma, and continuing over 2/3 of the length of the column foot, column foot without a tooth just above the ligament. *Stelidia* porrect, triangular, c. 0.5 mm long, acute, along the lower margin with a distinct, triangular, subacute tooth. *Anther* abaxially with a slight crest distally, surface \pm glabrous, front margin not drawn out. *Pollinia* 2, semi-ellipsoid; no appendages present.

Figure 1. *Bulbophyllum tectipes* J.J. Verm. & P. O'Byrne a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, above: abaxial side, below: adaxial side; g. Pollinia, left: single, right: a pair. – All from *SBG-O 1953* (living plant, spirit sample).

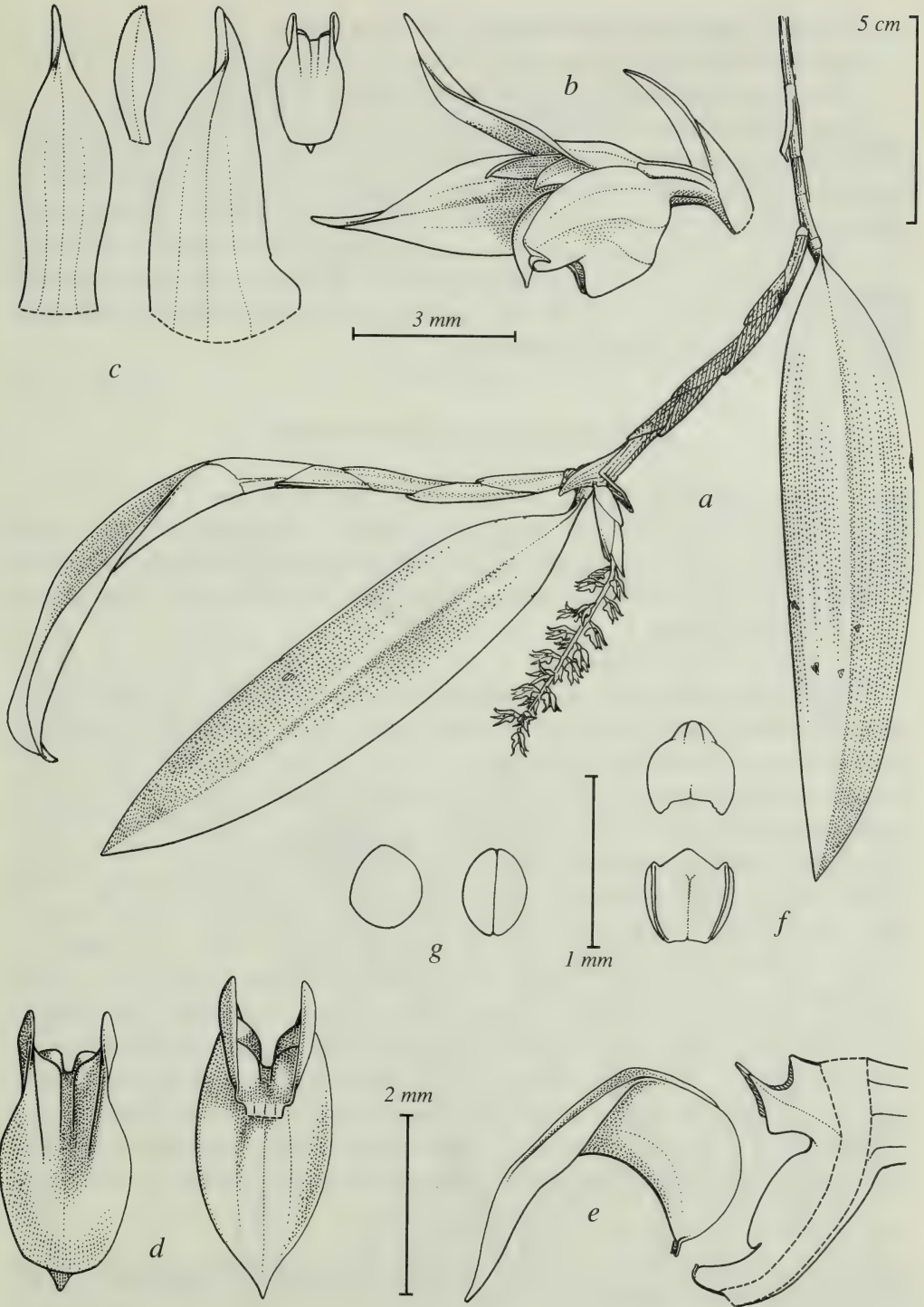


Figure 1. *Bulbophyllum tectipes* J.J. Verm. & P. O'Byrne

Colours: Plant glossy medium green. Flowers white.

Habitat: Epiphyte in montane forest, alt. 1100–1300 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: Most similar to *Bulbophyllum agapethoides* Schltr. and *B. falciculicorne* J.J. Sm., also from Sulawesi. The three species share a relatively inflexible rhizome. *B. tectipes* is much larger vegetatively; the leaves are consistently almost twice as long and more than twice as wide as in the species mentioned. Most characteristic, however, are the conspicuous distichous, sharply keeled peduncle bracts that cover most of the peduncle. *B. rhizomatosum* Ames & C. Schweinf. (Borneo, Peninsular Malaysia), *B. acuminatifolium* J.J. Sm., and *B. perpendiculare* Schltr. (both from Sulawesi) have limply pendulous rhizomes.

Bulbophyllum sect. *Desmosanthes*

***Bulbophyllum flavorubellum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 2.

Bulbophyllum flavorubellum J.J. Verm. & P. O'Byrne, a *Bulbophyllo flammulifero* rhachidi 0.5–1 cm longa floribus 4–8, stelidiorum margine basali sine ala antrorsa differt. – TYPE: Malaysia, Sabah, Interior Province, Nabawan, Vermeulen & Lamb 433 (K, holo., L, iso.).

Roots present along the entire rhizome. **Rhizome** creeping, 1–1.4 mm diam., sections between pseudobulbs 2–5 cm long, bracts hardly persistent. **Pseudobulbs** distant, narrowly ellipsoid to subcylindrical, 1.7–3 x 0.3–0.6 cm. **Petiole** 0.3–0.4 cm long. **Leaf blade** elliptic, 3.2–4.5 x 1.2–1.9 cm, index (length/width) 2.3–2.7; obtuse. **Inflorescences** (sub-)erect, short racemes, 6–11 cm long, 4–8-flowered. **Peduncle** 5.5–10 cm, bracts 5–7, the longest 5–9 mm long. **Rhachis** 0.5–1 cm. **Floral bracts** ovate, c. 4.8 x 2.2 mm, acuminate. **Flowers** not resupinate, not fully opening, several open simultaneously. **Pedicel** and **ovary** c. 4 mm long, basal node \pm flush with the surface of the rhachis. **Median sepal** somewhat recurved with an incurved top, subtriangular, c. 9.5 x 2 mm, index 4.7–4.8; acute, margins entire, base broadly attached; rather thin, 3-veined, glabrous. **Lateral sepals** recurved, free, oblique, triangular, c. 9.5 x 2 mm, index 4.7–4.8; otherwise as the median sepal. **Petals** porrect, ovate-triangular, c. 2.2 x 0.8 mm, index 2.7–2.8; obtuse, margins slightly erose distally, base broadly attached; thin, 1-veined, glabrous. **Lip** recurved distally, general outline \pm ovate, c. 1.8 x 1.2 mm, index c. 1.5, acute, margins entire, very finely papillose proximally; thick, surface glabrous; adaxially slightly concave near the base,

Figure 2. *Bulbophyllum flavorubellum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, above: adaxial side, below: abaxial side; e. Column and lip, lateral view; f. Anther, above: adaxial side, below: abaxial side; g. Pollinia, above: two pairs, below: single pair. – All from Vermeulen & Lamb 433 (living plant, spirit sample).

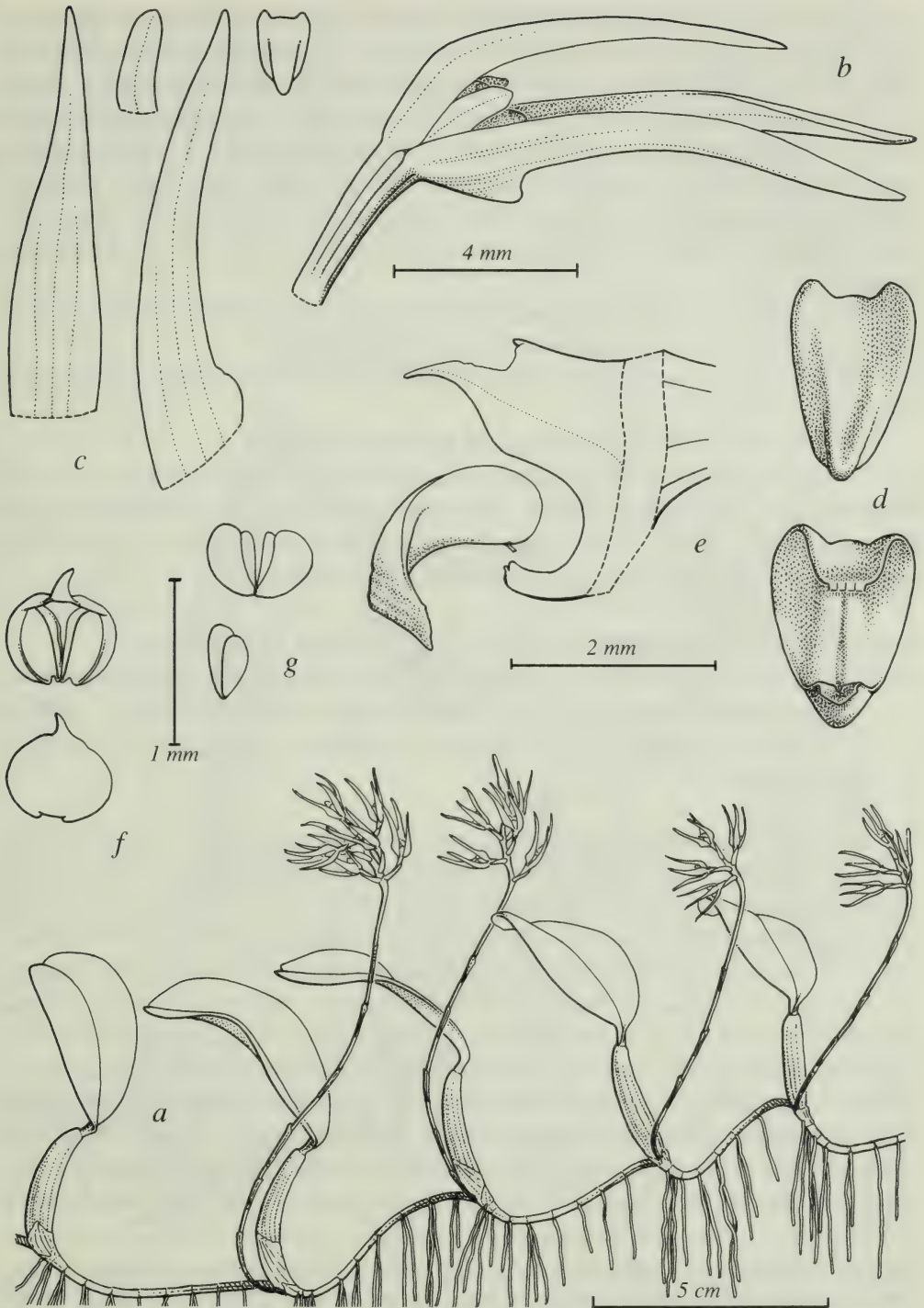


Figure 2. *Bulbophyllum flavorubellum* J.J. Verm. & P. O'Byrne

with 2 obtuse ridges over most of the length of the lip, towards the base inconspicuous and diverging, towards the tip distinct and fused to a V-shaped structure; abaxially with a distinct, retuse ridge over most of the length of the lip, surface glabrous. *Column* c. 2.2 mm long, stigma without a tooth at its base, column foot with a small, obtuse knob just above the ligament. *Stelidia* porrect, falcate, triangular, c. 1 mm long, acute, along the lower margin with an inconspicuous, deltoid, obtuse wing. *Anther* abaxially without a crest, surface \pm glabrous, front margin drawn out into a flat, triangular, acute tip. *Pollinia* 4, the inner slightly shorter than the outer, all obovoid, no appendages present.

Colours: Sepals yellow proximally, bright orange red distally. Petals very pale yellow. Lip orange. Column yellow. Flowers slightly scented.

Habitat: Terrestrial or as an epiphyte close to the forest floor, in lowland *kerangas* forest. Alt. c. 300 m.

Distribution: MALAYSIA: Sabah (1 specimen seen).

Notes: On first sight, this could be taken for an exceptionally small form of *Bulbophyllum flammuliferum* Ridl., from Peninsular Malaysia and Borneo. That species, however, has a 2.5–10 cm long rhachis with 12–25 flowers, and a distinct, antrorse, rounded wing along the lower margin of the stelidia.

***Bulbophyllum pseudopelma* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 3.

Bulbophyllum pseudopelma J.J. Verm. & P. O'Byrne, inter series speciebus inflorescentiis racemosis Sect. *Desmosanthes* labello brevi lato, stelidiis brevissimis notatum. – TYPE: Indonesia, Sulawesi, central part, SBG-O 3216 (SING, holo).

Roots present along the entire rhizome. *Rhizome* creeping or straggling away from the substrate, 3–4.5 mm diam., sections between pseudobulbs 4.5–26 cm long, bracts little persistent. *Pseudobulbs* distant, ovoid, 2.5–4 x 1.5–2 cm. *Petiole* 0.6–1.1 cm long. *Leafblade* elliptic-ovate, 9.5–17.5 x 1.9–2.5 cm, index (length/width) 5–7; obtuse. *Inflorescences* many, often tufted, along the entire rhizome, (sub-)erect, lax racemes, 2–5.5 cm long, 2–4-flowered. *Peduncle* 1–1.8 cm, bracts c. 3, the longest 4–5.5 mm long. *Rhachis* 0.4–3.5 cm. *Floral bracts* tubular proximally, 4–5 mm long, acute. *Flowers* not resupinate, not fully opening, several open simultaneously. *Pedicel* and *ovary* c. 4.5 mm long, basal node \pm flush with the surface of the rhachis. *Median sepal* somewhat recurved with an incurved top, elliptic-ovate, c. 7 x 3 mm, index c. 2.3–2.4; acuminate, margins entire, base rather broadly attached; thin, 3-veined, glabrous. *Lateral sepals* recurved, free, oblique, triangular, c. 7 x 2.5 mm, index c. 2.8; acute, base broadly

Figure 3. *Bulbophyllum pseudopelma* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, adaxial side; e. Lip, abaxial side; f. Column and lip, lateral view; g. Anther, above: abaxial side, below: adaxial side; h. Pollinia, above: two pairs, below: single pair. – All from SBG-O 3216 (living plant, spirit sample).

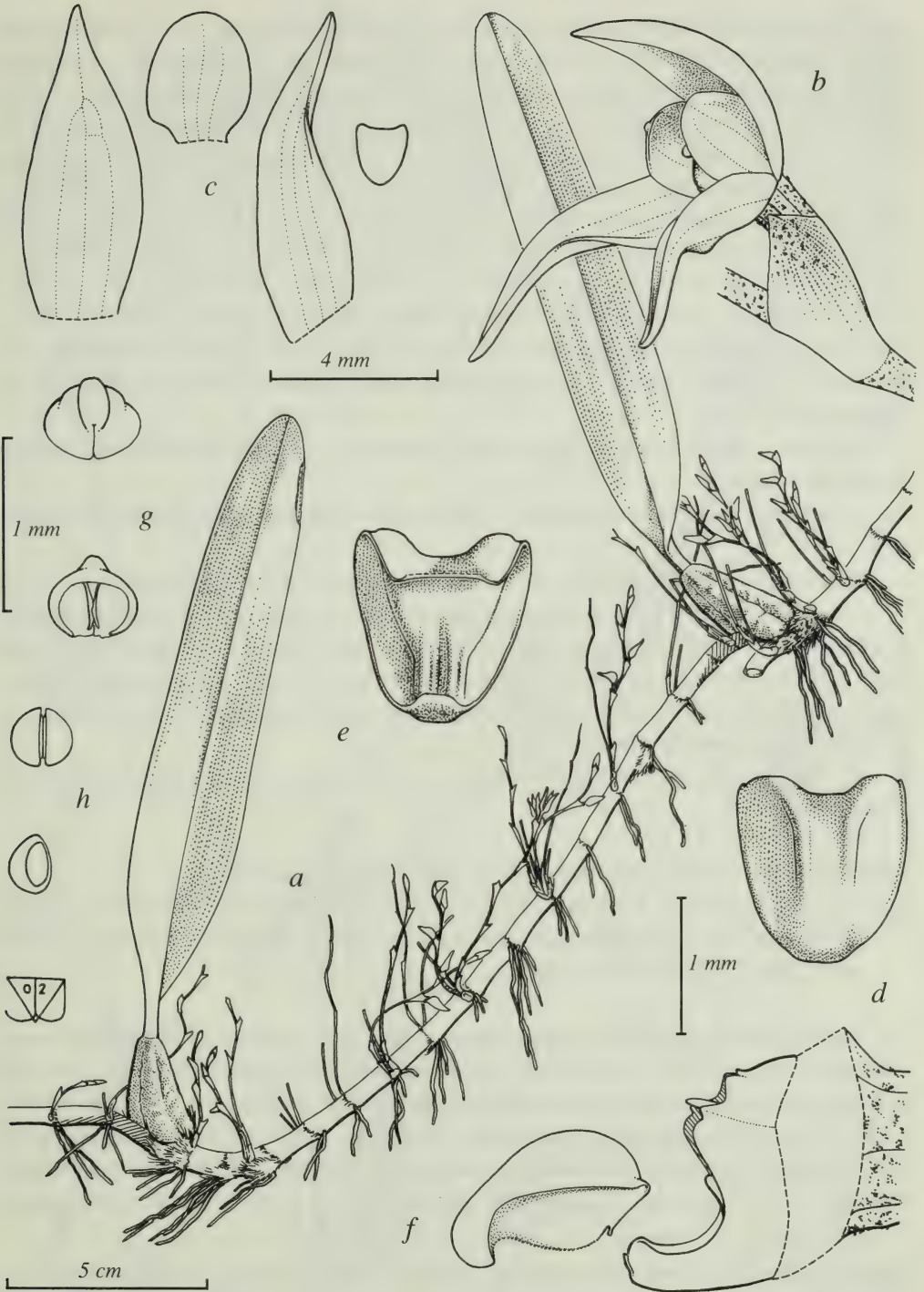


Figure 3. *Bulbophyllum pseudopelma* J.J. Verm. & P. O'Byrne

attached; otherwise as the median sepal. *Petals* porrect, ovate, c. 3.2 x 2.8 mm, index 1.1–1.2; rounded, margins entire, base rather narrowly attached; thin, 3-veined, glabrous. *Lip* recurved distally, general outline ovate, c. 1.4 x 1.2 mm, index 1.1–1.2; rounded, margins entire; thick and soft; adaxially slightly concave near the base, with 2 rather distinct, obtuse ridges proximally somewhat diverging and running parallel up to c. 2/3 of the length of the lip, surface slightly convex towards the tip, glabrous; abaxially with a distinct, retuse ridge over most of the length of the lip, surface finely papillose in centre. *Column* c. 0.7 mm long, stigma with a transverse ridge at its base, column foot with an obtuse knob just above the ligament. *Stelidia* minute, porrect, triangular, acute, along the lower margin with a distinct, antrorse, rounded wing. *Anther* abaxially with a distinct crest, surface \pm glabrous, front margin not drawn out. *Pollinia* 4, the inner slightly shorter than the outer, ellipsoid, the outer obovoid; no appendages present.

Colours: Floral bracts greyish white. Flowers very pale greenish, pale yellow towards the base.

Habitat: Epiphyte in montane forest, on the trunk and in the crown of a small tree.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: Among the racemose species of sect. *Desmosanthes*, *Bulbophyllum pseudopelma* is easily distinguished by the short and wide, fleshy lip and the very short stelidia. In its general aspect this plant is reminiscent of *B. reptans* Lindl., a species widespread in continental SE Asia. Apart from being sturdier, it is distinct in the those characters mentioned above.

In the general aspect of its inflorescence, *B. pseudopelma* resembles some species of sect. *Pelma*.

***Bulbophyllum simplex* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 4.

Bulbophyllum simplex J.J. Verm. & P. O'Byrne, a *Bulbophyllo trifloro* J.J. Sm. sepalis 9–10 mm longis sine apice incrassato differt. – TYPE: Indonesia, Sulawesi, central part, SBG-O 3210 (SING, holo.).

Roots present along the entire rhizome. *Rhizome* creeping or straggling away from the substrate, 0.8–1.5 mm diam., sections between pseudobulbs 5–28 cm long, bracts moderately persistent. *Pseudobulbs* distant, ovoid, 1.5–2.4 x 0.6–0.9 cm. *Petiole* 0.1–0.3 cm long. *Leaf blade* elliptic-ovate, 3.5–6.5 x 1.1–1.5 cm, index (length/width) 3.1–5; obtuse. *Inflorescences* often along the entire rhizome, (sub-)erect, subumbellate racemes, 1.8–2.5 cm long, 3–5-flowered. *Peduncle* 1.2–1.6 cm, bracts c. 2, the longest

Figure 4. *Bulbophyllum simplex* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, adaxial side; e. Lip, abaxial side; f. Column and lip, lateral view; g. Anther, left: abaxial side, right: adaxial side; h. Pollinia, above: two pairs, below: single pair. – All from SBG-O 3210 (living plant, spirit sample).

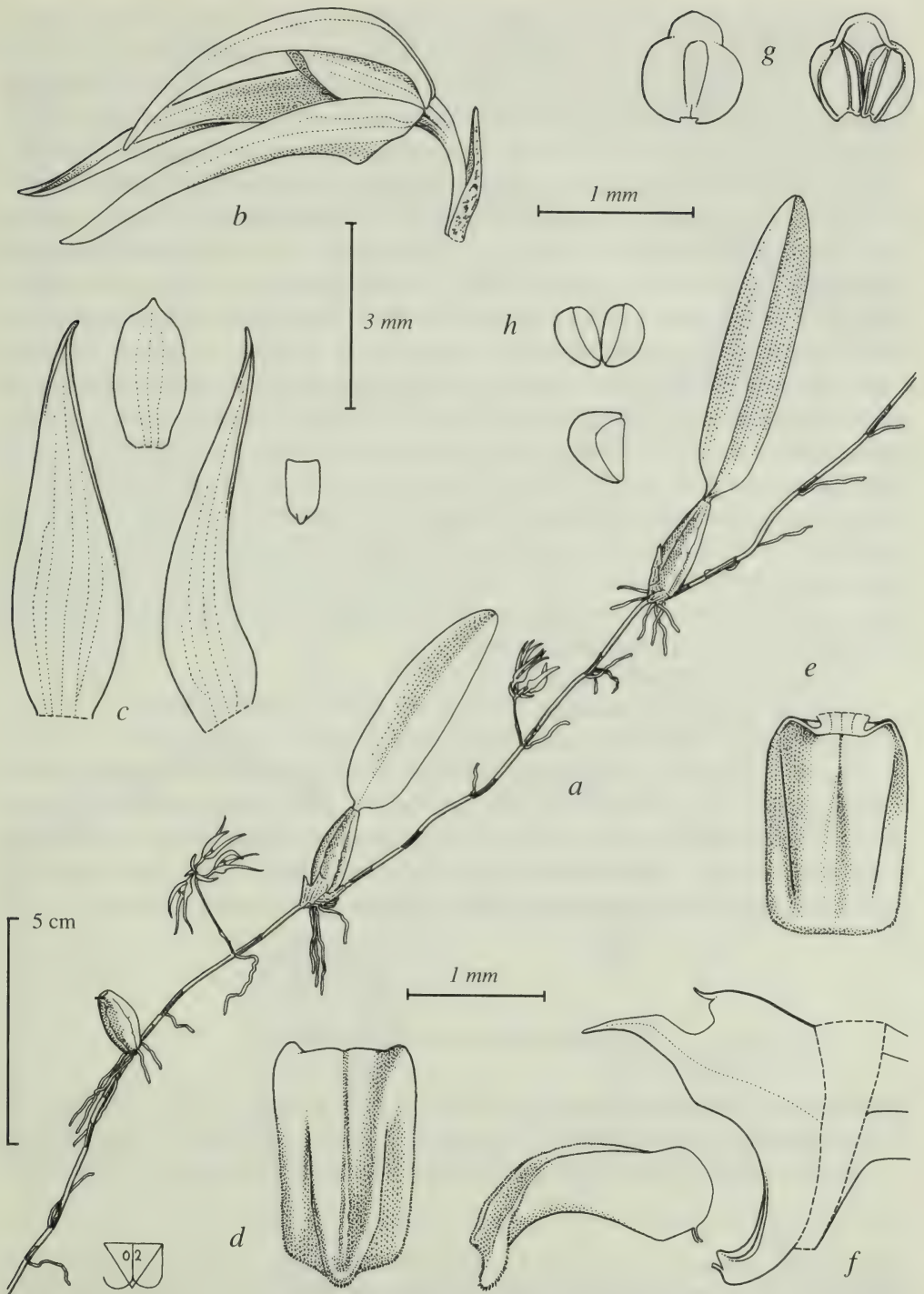


Figure 4. *Bulbophyllum simplex* J.J. Verm. & P. O'Byrne

4–5 mm long. *Rhachis* 0.2–0.25 cm. *Floral bracts* triangular, 3.2–3.6 x 1.2 mm, acute. *Flowers* partly resupinate, not fully opening, several open simultaneously. *Pedicel* and *ovary* 2.6–4.2 mm long, basal node \pm flush with the surface of the rhachis. *Median sepal* somewhat recurved with an incurved top, ovate, 9–10.5 x 3–3.3 mm, index 3–3.2; acuminate, margins entire, base rather narrowly attached; thin, 5-veined, glabrous. *Lateral sepals* recurved, free, oblique, triangular, 8–11.3 x 2.3–2.4 mm, index 3.4–4.4; acute-acuminate, base broadly attached; 3–4-veined, otherwise as the median sepal. *Petals* porrect, elliptic, 3.5–4 x 2–2.2 mm, index 1.7–1.9; acuminate, margins slightly erose, base narrowly attached; thin, 3-veined, glabrous. *Lip* recurved, general outline \pm oblong, 1.6–1.8 x 0.9–1.2 mm, index 1.5–1.8 (all without artificial spreading), obtuse, margins finely papillose distally; rather thick; adaxially \pm flat near the base, with 2 obtuse ridges over most of the length of the lip, towards the base inconspicuous and diverging, towards the tip distinct and fused to a v-shaped structure, adaxial surface finely papillose distally; abaxially with a distinct, retuse ridge over most of the length of the lip, surface glabrous. *Column* c. 2 mm long, stigma without a tooth at its base, column foot with a small, obtuse knob just above the ligament. *Stelidia* porrect, falcate, triangular, c. 1 mm long, acute, along the lower margin with an inconspicuous, deltoid, obtuse wing. *Anther* abaxially with a distinct crest, surface \pm glabrous, front margin drawn out into a concave, rounded beak. *Pollinia* 4, the inner \pm as long as the outer, all subtriangular, no appendages present.

Colours: Flowers completely white.

Habitat: Epiphyte in montane forest, in the crown of a small tree.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: Vegetatively and in the general aspect of the flowers *Bulbophyllum simplex* is fairly similar to *B. triflorum* J.J. Sm., from Java. That species differs in having consistently smaller flowers, with shorter sepals (3–4 mm long) with a thickened tip. *B. concinnum* Hook.f., from Thailand and west Malesia, differs in the same characters, as well as in having the pseudobulbs closer together and in having a narrower, ovate lip.

Bulbophyllum sect. *Hybochilus*

***Bulbophyllum decurrentilobum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 5.

Bulbophyllum decurrentilobum J.J. Verm. & P. O'Byrne, a *Bulbophyllo masarangico* Schltr. labello lobis lateralibus distaliter lobo mediali sine sinu transientibus

Figure 5. *Bulbophyllum decurrentilobum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: abaxial side, right: adaxial side; e. Column and lip, lateral view; f. Anther, left: abaxial side, right: adaxial side; g. Pollinia, left: single pair, right: two pairs. – All from SBG-O 3206 (spirit sample).

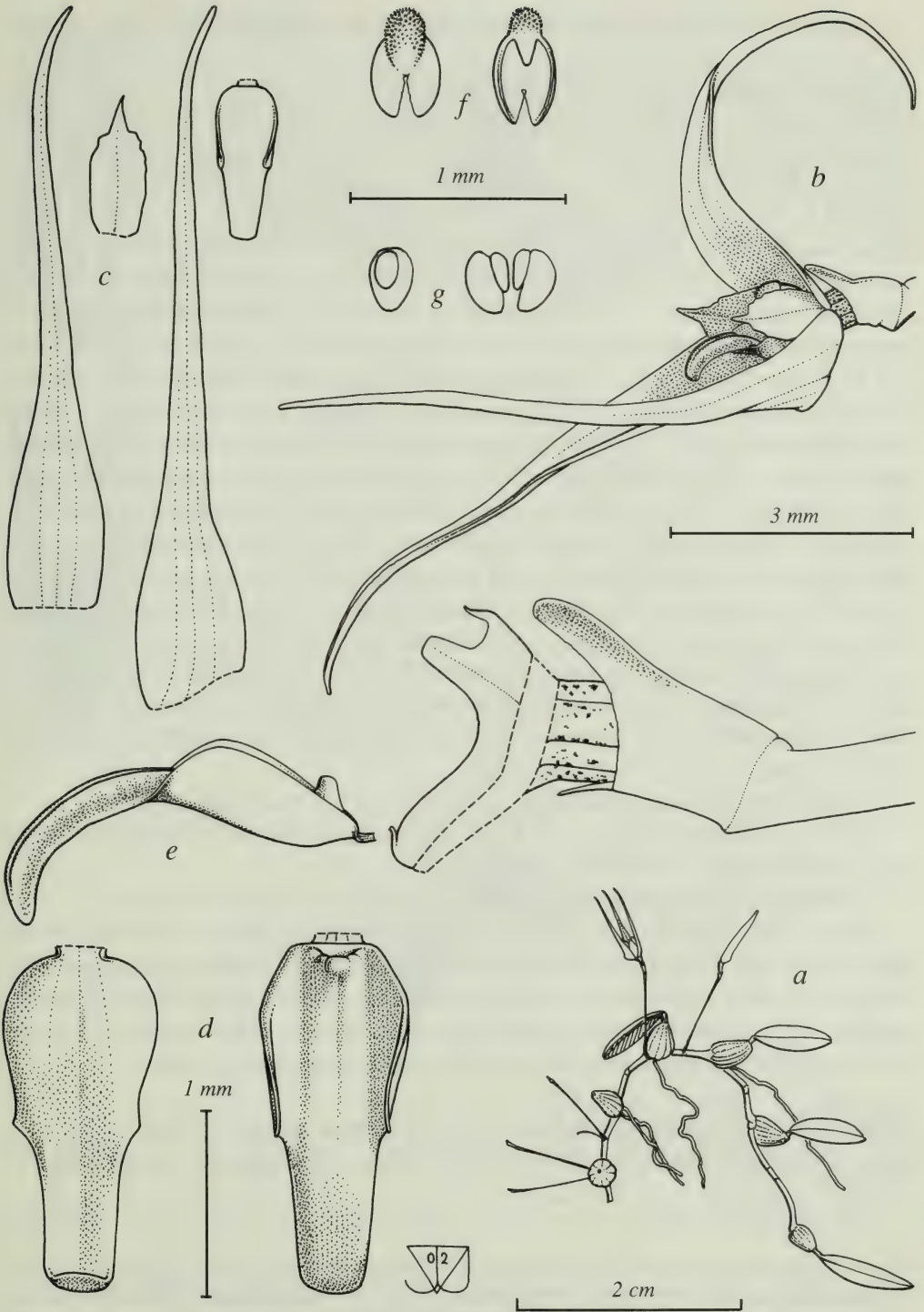


Figure 5. *Bulbophyllum decurrentilobum* J.J. Verm. & P. O'Byrne

differt. – TYPE: Indonesia, Sulawesi, central part, SBG-O 3206 (SING, holo.).

Roots mainly below the pseudobulbs. *Rhizome* creeping, 0.7–0.9 mm diam., sections between pseudobulbs 0.4–1 cm long, bracts not persistent. *Pseudobulbs* distant, ovoid, 0.3–0.5 x 0.2–0.45 cm. *Petiole* up to 0.05 cm long. *Leaf blade* elliptic, 0.6–1 x 0.2–0.25 cm, index (length/width) 3–4; acuminate. *Inflorescence* erect to patent, 1.5–1.7 cm long, 1-flowered. *Peduncle* 0.8–0.9 cm, bracts 1, c. 1.5 mm long. *Floral bracts* tubular proximally, c. 1.3 mm long, ± acute. *Flowers* not fully opening. *Pedicel* and *ovary* 1.1–1.2 mm long, basal node coinciding with the floral bract. *Median sepal* recurved, ovate, c. 7 x 1.3 mm, index 5.3–5.4; long acuminate, margins entire, base rather broadly attached; thin, 3-veined, glabrous. *Lateral sepals* oblique, c. 8 x 1.3 mm, index c. 6.1–6.2; otherwise as the median sepal. *Petals* porrect, elliptic, c. 1.8 x 0.7 mm, index c. 2.5–2.6; acuminate, margins erose distally, base rather narrowly attached; thin, 1-veined, glabrous. *Lip* recurved in the distal half, general outline ovate, c. 1.9 x 0.9 mm, index 2.1–2.2 (all without artificial spreading), margins entire; glabrous, 3-lobed; *midlobe* ovate, rounded, rather thin; adaxially somewhat convex and with a distinct, conical, obtuse knob near the base; abaxially without a ridge; *lateral lobes* erect, attached along the proximal half, c. 0.5 mm wide at c. 1/3 of the length of the lip, decurrent in front, rounded, thin. *Column* c. 0.6 mm long, stigma without a ridge at its base, column foot without teeth. *Stelidia* porrect, ovate, c. 0.3 mm long, ± truncate. *Anther* abaxially with a distinct, finely papillose crest, surface otherwise ± glabrous, front margin drawn out into an incurved, triangular, subacute beak with entire margins. *Pollinia* 4, the inner slightly more than half as long as the outer, all obovoid; no appendages present.

Colours: Sepals and petals purple, whitish near the base. Lip purplish.

Habitat: Epiphyte in montane forest, on the trunk and on thin branches in the crown of small trees. Alt. 1800–2500 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: Most similar to *Bulbophyllum masarangicum* Schltr., from the northern part of Sulawesi (Minahassa). The main difference between the two is in the shape of the lip: in *B. decurrentilobum* the front margin of the lateral lobes of the lip gradually merges with the midlobe, in *B. masarangicum* it does so with a distinct sinus. *B. masarangicum* also has smaller flowers, the sepals being 3–5 mm long.

***Bulbophyllum furcillatum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 6.

Bulbophyllum furcillatum J.J. Verm. & P. O'Byrne, a *Bulbophyllo camptochilo* J.J.

Figure 6. *Bulbophyllum furcillatum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, above: adaxial side, below: abaxial side; e. Column and lip, lateral view; f. Anther, left: adaxial side, right: abaxial side; g. Pollinia, above: two pairs, below: single pair. – All from SBG-O 0922 (spirit sample).

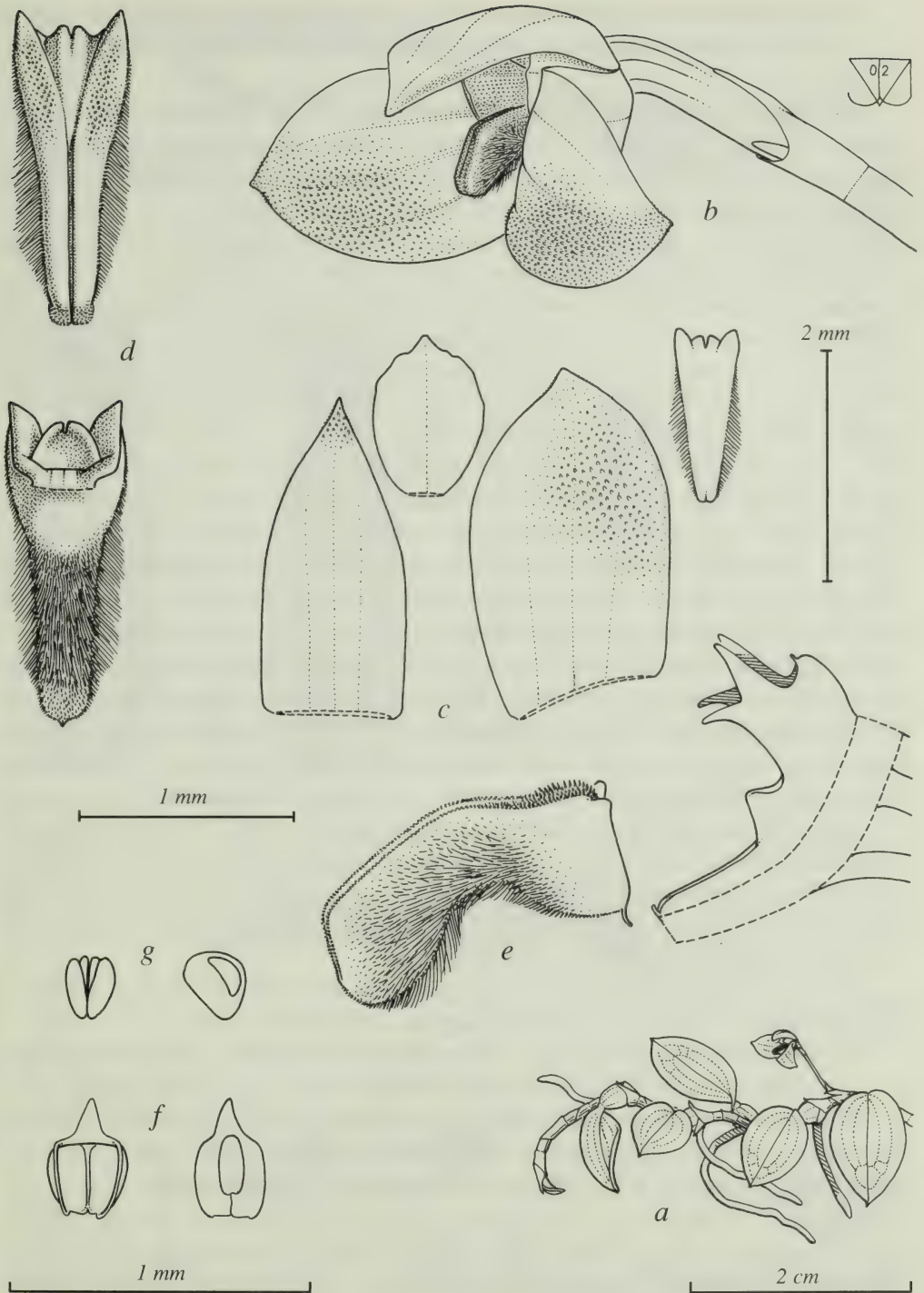


Figure 6. *Bulbophyllum furcillatum* J.J. Ve rm. & P. O'Byrne

Verm. sepalis lateralibus papillois, labello longioribus angustioribusque differt.
 – TYPE: Indonesia, Sumatra, Barisan Range, SBG-O 922 (SING, holo.).

Roots usually one below each pseudobulb. *Rhizome* creeping, 0.8–1 mm diam., sections between pseudobulbs 0.35–1 cm long, bracts not persistent. *Pseudobulbs* distant, ovoid, 0.15–0.32 x 0.15–0.25 cm. *Petiole* up to 0.05–0.13 cm long. *Leaf blade* elliptic to ovate, 0.6–1.2 x 0.4–0.7 cm, index (length/width) 1.5–2.3; mucronate. *Inflorescence* erect to patent, 9–14 mm long, 1-flowered. *Peduncle* 0.3–0.7 cm, bracts 2, the longest 1.3–2.2 mm long. *Floral bracts* tubular proximally, c. 1.6 mm long, acuminate. *Flowers* not fully opening. *Pedicel* and *ovary* 2.8–4 mm long, basal node coinciding with the attachment of the floral bract. *Median sepal* ± porrect, subtriangular, c. 2.8 x 1.3 mm, index 2.1–2.2; acuminate, margins finely papillose distally, base rather broadly attached; rather thin, thickened distally, 3-veined, adaxially finely papillose distally. *Lateral sepals* slightly oblique, obovate, c. 2.9 x 1.8 mm, index c. 1.6–1.7; ± acute, base broadly attached; adaxially finely papillose except the proximal part of the upper half; otherwise as the median sepal. *Petals* porrect, ± elliptic, c. 1.3 x 1 mm, index c. 1.3; subacute, margins erose distally, base narrowly attached; thin, 1-veined, glabrous. *Lip* recurved ± half-way, general outline triangular, c. 1.5 x 0.5 mm, index c. 3; ± obtuse, margins ciliate; thick; adaxially slightly concave near the base and with a rounded, glabrous ridge that is bifurcate proximally and runs up to c. 1/3 of the length of the lip, with 2 more distinct, rounded, papillose ridges diverging proximally and running up to c. 2/3 of the length of the lip, leaving a thin furrow in between them; abaxially without a ridge, surface glabrous in the proximal third, with long hairs elsewhere but with short hairs close to the tip. *Column* c. 0.9 mm long, stigma with a distinct, conical, obtuse tooth at its base, column foot without teeth. *Stelidia* porrect, triangular, c. 0.4 mm long, subacute, with a distinct, antrorse, triangular, subacute tooth along the lower margin. *Anther* abaxially with a distinct crest, surface ± glabrous, front margin drawn out into a triangular, acute beak with entire margins. *Pollinia* 4, the inner slightly more than half as long as the outer, narrowly elliptic, the outer obovoid; no appendages present.

Colours: Sepals and petals yellowish green, but lateral sepals blackish purple in the distal half except for the yellowish margins. Lip blackish purple.

Habitat: Understorey epiphyte on tree trunks and branches. Alt. 1400–1500 m.

Distribution: INDONESIA: Sumatra, Barisan Range (1 specimen seen).

Notes: Most similar to *Bulbophyllum camptochilum* J.J. Verm., from Brunei. This species, however, has glabrous sepals, much narrower petals (index 2.4–2.5), and a wider lip (index 1.3–1.4) that is subrectangular in general outline.

Figure 7. *Bulbophyllum iterans* J.J. Verm. & P. O'Byrne – a. Habit; b. top inflorescence; c. Flower; d. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; e. Lip, left: adaxial side, right: abaxial side; f. Column and lip, lateral view; g. Anther, left: abaxial side, right: adaxial side; h. Pollinia, above: single pair, below: two pairs. – All from SBG-O 3211 (spirit sample).

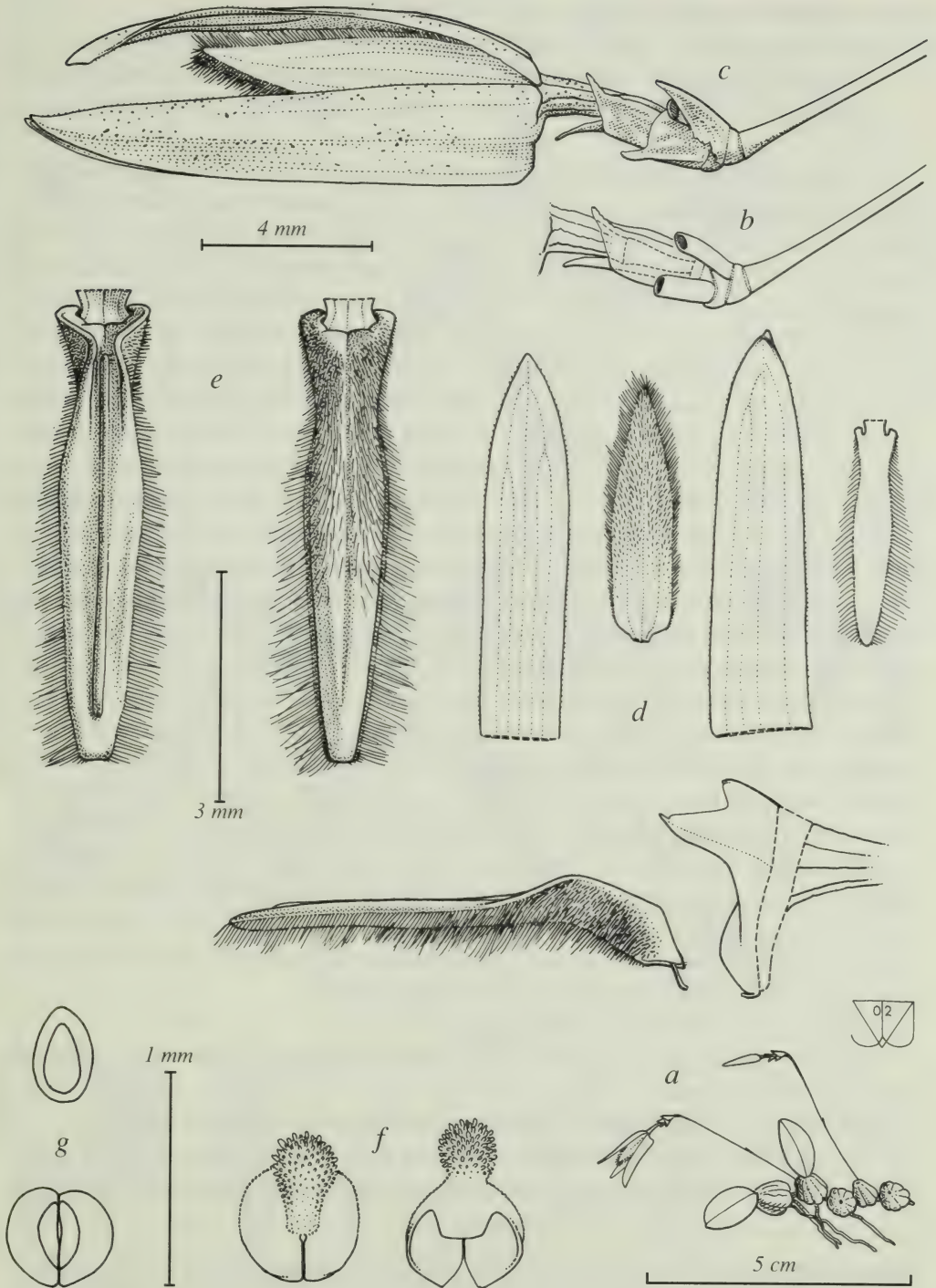


Figure 7. *Bulbophyllum iterans* J.J. Verm. & P. O'Byrne

Bulbophyllum iterans J.J. Verm. & P. O'Byrne, *sp. nov.* – Fig. 7.

Bulbophyllum iterans J.J. Verm. & P. O'Byrne, a *Bulbophyllo errato* Ames floribus c. 11 mm longis, petalis adaxialiter distincte pubescentibus, labello longo gracili differt. – TYPE: Indonesia, Sulawesi, central part, *SBG-O 3211* (SING, holo.).

Roots below the pseudobulbs. *Rhizome* creeping, 0.9–1.4 mm diam., sections between pseudobulbs 0.4–0.9 cm long, bracts not persistent. *Pseudobulbs* close or distant, ovoid, 0.4–0.9 x 0.3–0.8 cm. *Petiole* up to 0.06 cm long. *Leaf blade* elliptic to ovate, 0.8–1.5 x 0.5–0.8 cm, index (length/width) 1.6–2; obtuse to acute. *Inflorescence* a congested raceme, 3.5–4.3 cm long, 1–7-flowered. *Peduncle* erect to patent, 2.3–2.8 cm, bracts 2–3, the longest 1.8–2.5 mm long. *Rhachis* slightly nodding, spindle-shaped, up to 0.3 x 0.1 cm. *Floral bracts* triangular, 2.2–3 x 2–3 mm, acuminate. *Flowers* not fully opening, each one developing only after anthesis of the previous. *Pedicel* and *ovary* c. 2 mm long, basal node on a 1.5–2 mm long stump. *Median sepal* slightly recurved, elliptic, 10.5–11.2 x 2.1 mm, index 5–5.4; acute, margins ciliate, base broadly attached; thin, 3–5-veined, glabrous. *Lateral sepals* subtriangular, 11–12.2 x 2.5–2.7 mm, index 4.4–4.6; otherwise as the median sepal. *Petals* porrect, ovate, 7.6–7.9 x c. 1.9 mm, index 4–4.2; acute, margins ciliate, base narrowly attached; thin, 3-veined, adaxial surface with hairs except near the base. *Lip* slightly recurved near the base, general outline ovate, slightly constricted near the base where the margins approach each other over the adaxial surface, c. 5.8 x 1.2 mm, index 4.8–4.9; truncate, margins ciliate; rather thick; adaxially concave near the base and with a distinct, narrow, rounded, ridge running from the constricted part of the lip, near the base, almost to the tip, adaxial surface glabrous; abaxially without a ridge, surface with stiff hairs near the base, and with softer hairs up to + half way the length of the lip. *Column* c. 1.8 mm long, stigma without a tooth at its base, column foot without teeth. *Stelidia* porrect, triangular, c. 1 mm long, acute, with minute, antrorse, triangular, obtuse tooth along the upper margin, close to the tip. *Anther* abaxially with a distinct, papillose crest, surface otherwise finely papillose, front margin drawn out into an incurved, truncate beak with entire margins. *Pollinia* 4, the inner c. 3/4 as long as the outer, ovoid, the outer ellipsoid; no appendages present.

Colours: Flowers entirely dark purple.

Habitat: Epiphyte in montane forest, on the trunk and in the crown of small trees. Alt. 1800–2500 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: While this species fits very well in sect. *Hybochilus* on account of the floral characters it has a racemose inflorescence, a character that is very rare in that

Figure 8. *Bulbophyllum anakbaruppui* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, above: adaxial side, below: abaxial side; g. Pollinia, left: single pair, right: two pairs. – All from *SBG-O 3287* (spirit sample).

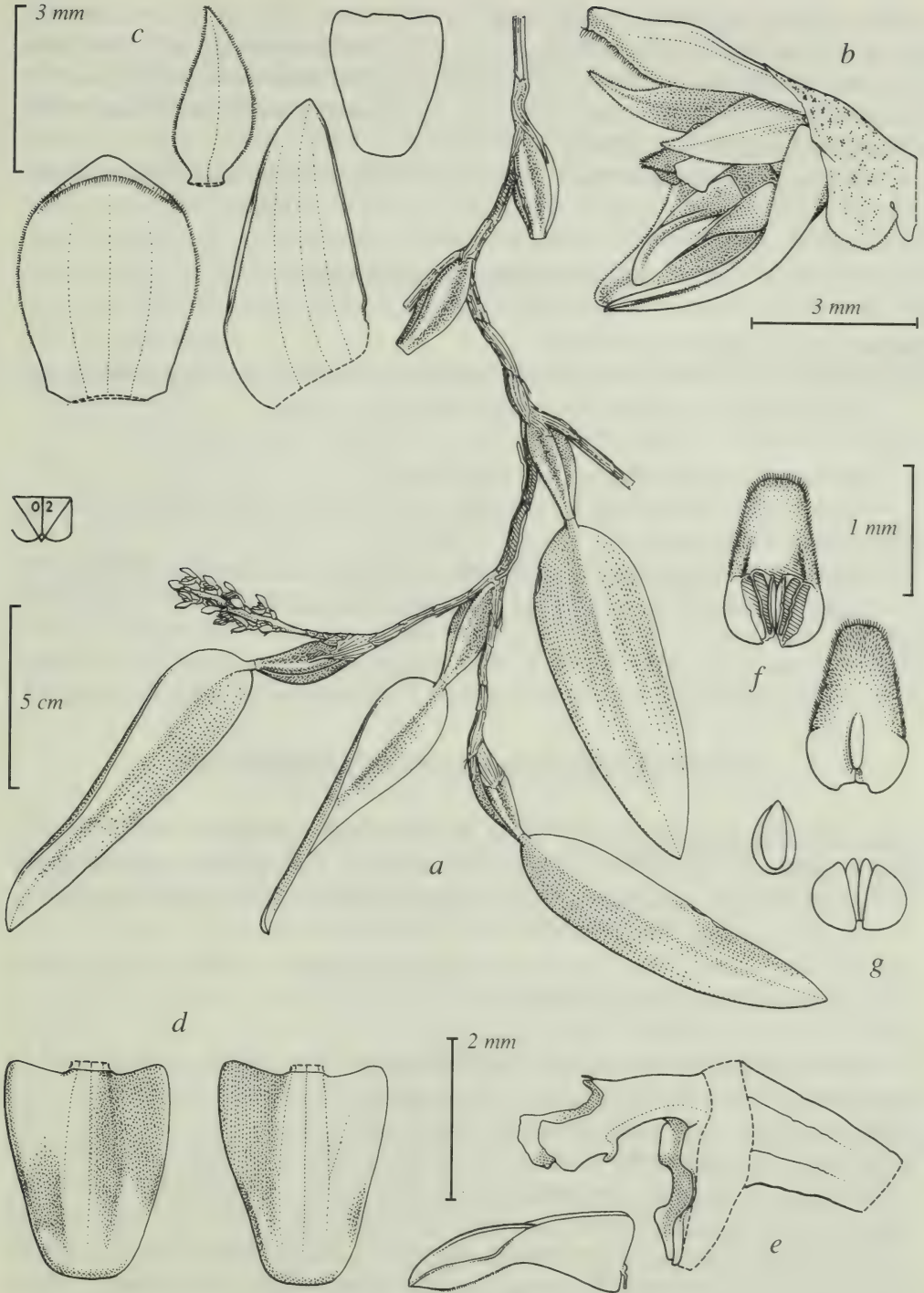


Figure 8. *Bulbophyllum anakbaruppui* J.J. Verm. & P. O'Byrne

section and the assumedly related sect. *Polyblepharon*. Only two other species in these sections display this character: *Bulbophyllum erratum* Ames (sect. *Hybochilus*, from the Philippines) and *B. vexillarium* Ridl. (sect. *Polyblepharon*, from Papua New Guinea). *B. iterans* differs from both in having petals that are distinctly hairy on the adaxial side, and the long, slender lip.

The name refers to the flowers that appear in succession on the inflorescence.

Bulbophyllum sect. *Leptopus*

***Bulbophyllum spissum* J.J. Verm.**

Bulbophyllum spissum J.J. Verm., Blumea 41 (1996): 360. – TYPE: Indonesia, Lingga Archipelago, Pulau Riau, O'Byrne LING 010 (L, holo.)

Habitat: Epiphyte in forest. Alt. 200–1000 m.

Distribution: MALAYSIA: Pahang, Pulau Tioman. INDONESIA: Lingga Archipelago, Pulau Riau.

Notes: The Tioman plants represent the first record of this species for Malaysia.

Material seen: MALAYSIA. Pahang, Pulau Tioman, SBG-O 737 (SING), 739 (SING).

Bulbophyllum sect. *Monilibulbus*

***Bulbophyllum anisopterum* J.J. Verm. & P. O'Byrne, sp. nov.**

Bulbophyllum anisopterum J.J. Verm. & P. O'Byrne, a *Bulbophyllo stormii* sepalis medio sepalis lateralibus 1/4-plo longiore differt. – TYPE: Malaysia, Sabah, Lamb 563/86 (K, holo.).

Bulbophyllum stormii sensu J.J. Vermeulen, Orch. Borneo 2 (1991) 227 (*pro parte, plate included*), non J.J. Smith.

Roots below the pseudobulbs. *Rhizome* creeping, c. 1 mm diam., sections between pseudobulbs c. 0.5 cm long, bracts not persistent. *Pseudobulbs* ovoid, basal half prostrate on and fused to the rhizome so that the new pseudobulbs arise c. half-way up the old, c. 0.9 x 0.4–0.5 cm. *Petiole* 0.5–0.8 mm long. *Leaf blade* elliptic, 1.8–2.5 x c. 0.5 cm, index (length/width) 3.5–5; obtuse. *Inflorescence* c. 6 cm long, 1-flowered. *Peduncle* erect to patent, 3.5–4 cm, bracts c. 3, the longest c. 2.5 mm long. *Floral bracts* tubular, c. 2.5 mm, acute. *Flowers* not fully opening. *Pedicel* and *ovary* c. 18 mm long, basal node on a c. 2 mm long stump. *Median sepal* porrect, ovate, c. 9.5 x 2.8 mm, index c. 3.4; acuminate, margins entire, base rather widely attached; thin,

glabrous. *Lateral sepals* recurved, free, oblique, c. 32 x 6 mm, index 5.3–5.4; caudate; otherwise as the median sepal. *Petals* porrect, ovate, c. 2 x 0.8 mm, index c. 2.5; obtuse, margins entire, base widely attached; thin, glabrous. *Lip* slightly recurved c. half-way, general outline ovate with a drawn-out top, c. 4.5 x 1.5 mm, index c. 3; rounded, margins entire; rather thick, glabrous; adaxially concave towards the base, convex and with the margins strongly recurved elsewhere; abaxially with a short, retuse ridge near the base. *Column* c. 2 mm long, stigma with a slight callus at its base, column foot without teeth. *Stelidia* subulate, c. 1.5 mm long, acute. *Anther* abaxially with a distinct, rounded, papillose crest, surface \pm glabrous, front margin not drawn out. *Pollinia* 4, the inner less than half as long as the outer, all about ovoid, without appendages.

Colours: Lateral sepals yellow, orange near the base. Petals translucent orange. Lip purple red.

Habitat: Understorey epiphyte in wet montane forest, at 1200–1900 m alt. Flowering observed in Jan, and Jun–Jul.

Distribution: MALAYSIA. Sabah, Ulu Padas (2 specimens seen).

Notes: In Vermeulen (1991) I thought this was an aberrant form of the widespread and variable *Bulbophyllum stormii* J.J. Sm. Since then, I have found it again several times, and it is now clear that it is a distinct species. It differs from *B. stormii* in having a much shorter median sepal (about 1/3 to 1/4 of the length of the lateral sepals). *B. anisopterum* is most similar to *B. hodgsonii* Henders., from Peninsular Malaysia, but differs in having a much shorter median sepal, and caudate lateral sepals.

Bulbophyllum sect. *Osyricera* (= sect. *Globiceps*)

***Bulbophyllum anakbaruppui* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 8.

Bulbophyllum anakbaruppui J.J. Verm. & P. O'Byrne, a *Bulbophyllo hastifero* Schltr. pseudobulbis quadrangulatis, petalis latioribus, labello ovato differt. – TYPE: Indonesia, Sulawesi, central part, SBG-O 3287 (SING, holo.).

Roots creeping along the rhizome towards its point of attachment, then spreading over the substrate. *Rhizome* \pm pendulous with \pm patent branches, up to 80 cm long, 2.5–4 mm diam., sections between pseudobulbs 3.8–7.4 cm long, bracts moderately persistent. *Pseudobulbs* distant, ovate, 2–3.4 x 0.9–1.3 cm, distinctly and obtusely 4-angled. *Petiole* 0.2–0.3 cm long. *Leaf blade* ovate, 8.5–12 x 2.1–3.1 cm, index (length/width) 2.8–5.3; acute. *Inflorescence* porrect, a rather dense raceme, 3.8–6.2 cm long, 13–17-flowered. *Peduncle* 2–2.5 cm, bracts c. 4, the longest c. 6.5 mm long. *Rhachis*, spindle-shaped, 2.2–3.2 x 0.38–0.43 cm. *Floral bracts* cordate, c. 4 x 5 mm, acute. *Flowers* not resupinate, arranged in regular spirals, not fully opening, many open simultaneously. *Pedicel* and *ovary* c. 2.2 mm long, basal node \pm flush with the surface of the rhachis. *Median sepal* \pm porrect, obovate, c. 4.3 x 3.3 mm, index c. 1.3;

top cucullate, rounded, margins entire, ciliolate, base rather narrowly attached; rather thick, 3-veined, surface very finely papillose adaxially towards the tip. *Lateral sepals* adnate along the lower margins, oblique, ovate-triangular, c. 5.8 x 3.2 mm, index 1.8–1.9, top flat, subacute, margins slightly papillose, base broadly attached; thick, otherwise as the median sepal. *Petals* porrect, ovate, c. 3.4 x 1.7 mm, index c. 2; acute, margins entire, ciliolate, base narrowly attached; rather thin, 1-veined, surface very finely papillose. *Lip* slightly recurved \pm half-way, general outline ovate, c. 3 x 2.2 mm, index 1.3–1.4; rounded, margins entire; rather thick, glabrous; adaxially slightly concave near the base, with 2 inconspicuous, rounded ridges proximally somewhat diverging and running from c. 1/3 of the length of the lip up to near the tip; abaxially \pm without a ridge near the base. *Column* c. 2.2 mm long, stigma without a tooth at its base, column foot with 2 truncate wings near its base, and two more, retrorse, triangular, obtuse ones just above the ligament. *Stelidia* minute, abruptly bent downwards but with an antrorse. \pm acute tip, along the upper margin with a very large (far more conspicuous than the stelidia themselves), antrorse, wedge-shaped wing with a broadly rounded, erose top margin. *Anther* abaxially with a crest near its base, surface \pm glabrous towards the base, coarsely papillose towards the tip, front margin drawn out into a distinct, concave, triangular, rounded, coarsely papillose beak. *Pollinia* 4, the inner \pm as long as the outer, all ellipsoid-ovoid; no appendages present.

Colours: Plant medium green. Flowers yellow, median sepal with thin red veins, petals with thin red veins and margins, lip slightly suffused with red proximally.

Habitat: Epiphyte in a large tree in coffee and cocoa gardens near a village. Alt. c. 1800 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: Suberect, patent or pendulous rhizomes occur only in two species of sect. *Osyricera*: *Bulbophyllum salaccense* Rchb.f., from West Malesia, and *B. hastiferum* Schltr, from Sulawesi. The latter is most similar to *B. anakbarupui*, but differs in having well rounded, not angular pseudobulbs, much narrower petals and a hastate lip. In flower structure *B. anakbarupui* resembles *B. trigonobulbum* J.J. Sm., from Sulawesi. That species, however, has a creeping or straggling rhizome, with many spreading roots. It also has narrower petals.

Named after the children of the Toraja village Baruppu, who collected the plant from a large tree in the village gardens.

***Bulbophyllum illecebrum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 9.

Bulbophyllum illecebrum J.J. Verm. & P. O'Byrne, a *Bulbophyllo osyricera* Schltr. et

Figure 9. *Bulbophyllum illecebrum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, left: adaxial side, below: adaxial side; g. Pollinia, left: two pairs, right: single pair. – All from SBG-O 3215 (living plant, spirit sample).

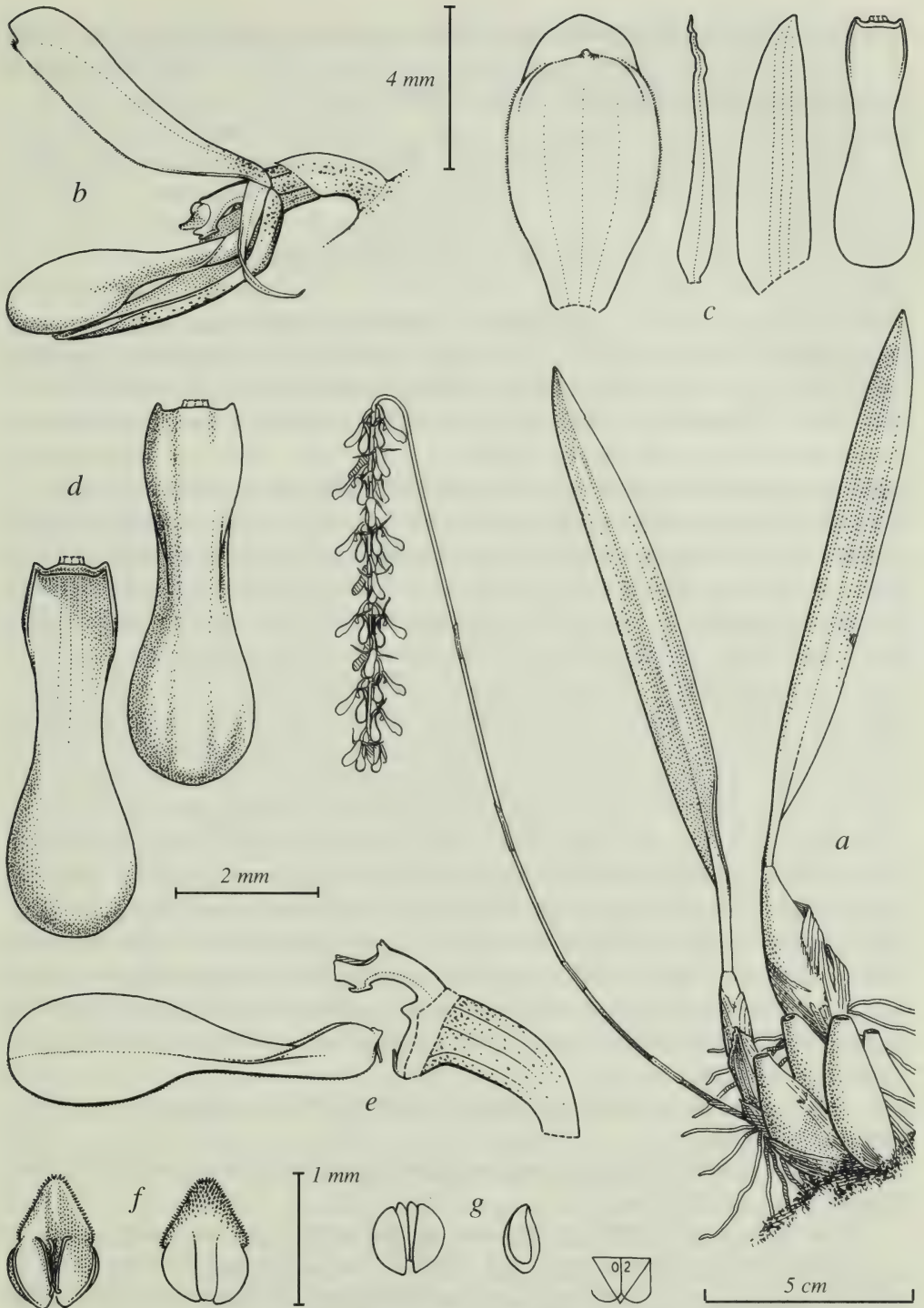


Figure 9. *Bulbophyllum illecebrum* J.J. Verm. & P. O'Byrne

B. osyriceroidi J.J. Sm. sepalo mediali distincte concavo, petalis multo longioribus angustioribusque, labello parte apicali spatulato differt. – TYPE: Indonesia, Sulawesi, Central part, *SBG-O 3215* (SING, holo.).

Roots mainly below the pseudobulbs. *Rhizome* creeping, 1.8–2 mm diam., sections between pseudobulbs 0.8–2 cm long, bracts barely persistent. *Pseudobulbs* close together, ovate, 1–3.5 x 0.7–1.1 cm, not angular. *Petiole* 0.7–2.8 cm long. *Leaf blade* obovate-elliptic, 5.5–12 x 0.8–1.3 cm, index (length/width) 4.2–12.8; acute. *Inflorescence* a rather dense raceme, c. 30 cm long, c. 24-flowered. *Peduncle* erect to patent, c. 21 cm, bracts c. 5, the longest c. 9 mm long. *Rhachis* nodding at the base, limply pendulous, not thickened, c. 9 cm long. *Floral bracts* ± triangular, c. 3 x 3 mm, acute. *Flowers* not resupinate, not fully opening, many open simultaneously. *Pedicel* and *ovary* c. 3.2 mm long, basal node ± flush with the surface of the rhachis. *Median sepal* somewhat recurved, elliptic-obovate, c. 7 x 3.5 mm, index c. 2; top cucullate, rounded, margins entire, papillose-ciliolate distally, base narrowly attached; very thin, 3-veined, surface glabrous. *Lateral sepals* adnate along the lower margins, recurved, top part slightly incurved, oblique, ovate-triangular, c. 7.5 x 2.1 mm, index 3.5–3.6, top flat, (sub-)acute, base broadly attached; thin, otherwise as the median sepal. *Petals* recurved to spreading, ovate, c. 7 x 0.9 mm, index 12–13; acute, margins entire, slightly erose near the tip, base narrowly attached; very thin, 1-veined, glabrous. *Lip* almost straight, general outline subspathulate with a slightly widened base, c. 6 x 2 mm, index c. 3, rounded, margins entire; proximally rather thick, distally very thick, almost circular in section, glabrous; adaxially concave near the base, with a transverse wall connecting the sides just above the ligament, top part distinctly convex; abaxially ± without a ridge near the base, top part distinctly convex. *Column* c. 2 mm long, stigma without a tooth at its base, column foot with a distinct, transverse ridge near its base. *Stelidia* minute, abruptly bent downwards but with an antrorse, ± acute tip, along the upper margin with a very large (far more conspicuous than the stelidia themselves), antrorse ± rectangular wing with a truncate, slightly erose top margin. *Anther* abaxially with a crest near its base, surface ± glabrous towards the base, papillose towards the tip, front margin drawn out into a distinct, concave, triangular, obtuse, papillose beak. *Pollinia* 4, the inner slightly shorter than the outer, ovoid; the outer ellipsoid; no appendages present.

Colours: Sepals and petals translucent with thin, red veins. Lip greenish yellow, margins red distally.

Habitat: Epiphyte in fairly mossy montane forest, on the trunk and in the crown of small trees. Alt. 2300 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: *Bulbophyllum osyricera* Schltr., from Java and Sumatra, and *B. osyriceroides* J.J. Sm., from Sumatra, are most similar to *B. illecebrum*. Both differ, however, in having a more or less flat median sepal, much shorter (less than half as

long as the median sepal) and wider petals, as well as a lip with an ovate, rather than a spatulate top part.

The diaphanous, widely spreading, antenna-like petals and the highly mobile, very thick and brightly coloured lip suggest a baiting of pollinators by simulating either prey or a sexual partner. The name refers to this.

Bulbophyllum sect. *Polyblepharon*

***Bulbophyllum uncinatum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 10.

Bulbophyllum uncinatum J.J. Verm. & P. O'Byrne, a *Bulbophyllo bisepalo* et *B. stenochilo* sepalis deorsum unciniformibus, labello proximaliter gradatim dilatato differt. – TYPE: Indonesia, Sulawesi, SBG-O 3835 (SING, holo.).

Roots all close to the base of the rhizome. *Rhizome* patent to hanging down perpendicularly, up to 25 cm long, c. 1 mm diam., bracts not persistent. *Pseudobulbs* ovoid-cylindrical, prostrate on and fused to the rhizome, so that the new pseudobulbs arise from near the top of the old, 0.9–1.3 x 0.2–0.3 cm. *Petiole* up to 0.5 mm long. *Leafblade* ovate, 2–2.7 x 0.8–1.1 cm, index (length/width) 2.4–2.5; acute. *Inflorescence* c. 0.6 cm long, 1-flowered. *Peduncle* porrect, c. 0.1 cm, bracts 1, c. 2 mm long. *Floral bracts* tubular, c. 1.7 mm, acute. *Flowers* not fully opening. *Pedicel* and *ovary* c. 1.3 mm long, basal node coinciding with the attachment of the floral bract. *Median sepal* incurved at the top, ovate, c. 3.8 x 1.3 mm, index 2.9–3; subacute, margins entire, ciliate towards the tip, base widely attached; thin, surface glabrous. *Lateral sepals* recurved, fused along the lower margin, oblique, c. 3.3 x 1.2 mm, index 2.7–2.8; obtuse; margins sparsely ciliate; otherwise as the median sepal. *Petals* porrect, ovate, c. 1 x 0.7 mm, index 1.4–1.5; acuminate, margins entire, base widely attached; thin, glabrous. *Lip* recurved at about 1/3 of its length, general outline ovate with a slightly narrowed top, c. 2.3 x 0.6 mm, index 3.8–3.9; acute, margins ciliate towards the base, ciliolate-papillose towards the tip; thin; adaxially slightly concave towards the base and with a median ridge starting near the base and running over about 1/4 of the length of the lip, surface convex and with the margins recurved towards the tip, entire surface finely papillose; abaxially without a ridge near the base, glabrous. *Column* c. 0.9 mm long, stigma without basal tooth, column foot distinctly thickened and with a retrorse, conical tooth near the base. *Stelidia* triangular, c. 0.7 mm long, acute, with a slightly antrorse, obliquely deltoid, obtuse tooth along the lower margin. *Anther* abaxially with a distinct, rounded, papillose crest, surface ± glabrous, front margin drawn out into a truncate beak with glabrous margins. *Pollinia*: 2, ovoid.

Colours: Sepals and petals yellowish near the base, purple towards the tip, abaxially with minute, blackish spots. Petals translucent white. Lip purple.

Habitat: Found in coppiced roadside trees, at 500 m alt. Flowering observed in

Jan–Mar and Dec.

Distribution: INDONESIA. Sulawesi: central part (1 specimen seen).

Notes: Similar to *Bulbophyllum stenochilum* Schltr., from Papua New Guinea. *B. uncinatum* differs in having only a low median ridge on the adaxial side of the lip, without a retrorse tooth near the base of the lip.

Bulbophyllum sect. *Sestochilus*

***Bulbophyllum catillus* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 11.

Bulbophyllum catillus J.J. Verm. & P. O'Byrne, a *Bulbophyllo lyriforme* et *B. cheiri* columella lateraliter aspectu aliquot sigmatoide curvato differt. – TYPE: Papua New Guinea, *Jongejan*, *P. cult.* 614 (L, holo).

Roots along the entire rhizome. *Rhizome* creeping, 4–5 mm diam., sections between pseudobulbs 4–6 cm long, bracts with veins persistent as coarse fibres. *Pseudobulbs* distant, ovoid, suberect, 1.5–2.0 x 0.8–1.2 cm. *Petiole* 1.8–2.5 cm long. *Leaf blade* elliptic, 11–13.5 x 5.5–6.5 cm, index (length/width) 1.8–2.3; rounded. *Inflorescence* c. 7 cm long, 1-flowered. *Peduncle* (sub-)erect, 1.2 cm, bracts c. 3, the longest c. 12 mm long. *Floral bracts* tubular, c. 14 mm, cuspidate. *Flowers* not resupinate, not fully opening. *Pedicel* and *ovary* 53–78 mm long, basal node on a 8–10 mm long stump, juga and valvae well-rounded. *Median sepal* somewhat incurved, elliptic to obovate, 21–31 x 8–11.5 mm, index 2.2–2.9; acute to acuminate, margins entire, base rather widely attached; rather thick, c. 11-veined, glabrous. *Lateral sepals* with the lower margins running more or less parallel, free, oblique, subtriangular, 20–28 x 9–16 mm, index 1.7–2.2, base widely attached; otherwise as the median sepal. *Petals* recurved to spreading, elliptic to obovate, 20–25 x 5.5–8 mm, index 3.2–3.8; (sub-)acute, margins entire, base rather narrowly attached; rather thin, c. 7-veined, glabrous. *Lip* recurved near the base, general outline ovate with a drawn-out top, 10–11 x 6–7 mm, index c. 1.4–1.9; obtuse, margins entire; top part thick, elsewhere thin, surface glabrous; adaxially widely concave towards the base; abaxially with a distinct, emarginate ridge over most of the length of the lip. *Column* 7–9 mm long, slightly sigmoid in profile, stigma without basal tooth, column foot without a tooth just above the ligament. *Stelidia* porrect, triangular, 1.5–2 mm long, obtuse, without teeth along the lower margin. *Anther* abaxially with a very distinct, conical crest, surface + glabrous, front margin drawn out into a rounded beak with erose margins. *Pollinia* 4, the inner as long as the outer, all sub-triangular, without appendages.

Figure 10. *Bulbophyllum uncinatum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, left: abaxial side, right: adaxial side; g. Pollinia, left: a pair, right: single. – All from SBG-O 3835 (spirit sample).

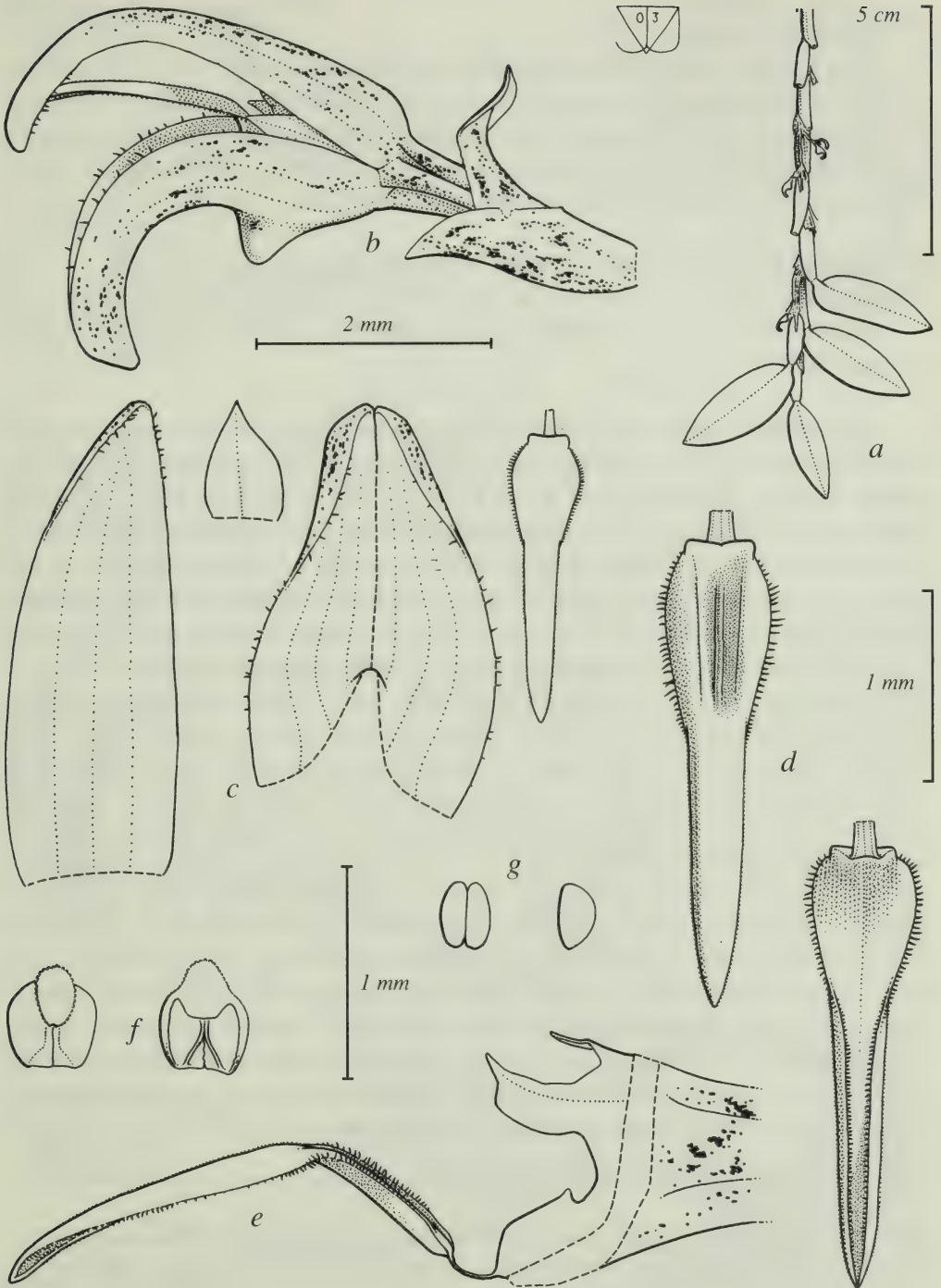


Figure 10. *Bulbophyllum uncinatum* J.J. Verm. & P. O'Byrne

Colours: Unknown.

Habitat: Unknown.

Distribution: PAPUA NEW GUINEA (4 specimens seen).

Notes: The slightly sigmoid profile of the column is diagnostic within the group of sect. *Sestochilus* with single, non-resupinate flowers. The lip widens abruptly towards the base into two thin wings, as in *Bulbophyllum lyriforme*, and *B. cheiri*. The top part, however, much shorter than in these species.

***Bulbophyllum coveniorum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 12.

Bulbophyllum coveniorum J.J. Verm. & P. O'Byrne, a *Bulbophyllo microglosso* in labelli latere adaxiali proximaliter pubescenti differt. – TYPE: Laos, SBG-O 3622 (SING, holo.).

Roots mainly below the pseudobulbs. *Rhizome* creeping, 5–6 mm diam., sections between pseudobulbs 8–9 cm long, bracts with veins persistent as fibres. *Pseudobulbs* distant, ovoid to ellipsoid, erect, 4–4.5 x 2.3–2.8 cm. *Petiole* 4–4.5 cm long. *Leaf blade* elliptic, 9.5–19 x 4–5.7 cm, index (length/width) 2.3–3.4; obtuse. *Inflorescence* 9.5–11.5 cm long, 1-flowered. *Peduncle* erect to patent, 1.1–1.4 cm, bracts c. 2, the longest c. 11 mm long. *Floral bracts* tubular, 15–18 mm, cuspidate. *Flowers* resupinate, not fully opening. *Pedicel* and *ovary* 80–95 mm long, basal node on a 9–11 mm long stump, juga and valvae well-rounded. *Median sepal* somewhat incurved, ovate, c. 23 x 9 mm, index 2.5–2.6; acute, margins entire, base widely attached; rather thin, 8–9-veined, glabrous. *Lateral sepals* recurved, lower margin without a fold, free, oblique, ovate, c. 22 x 13 mm, index c. 1.7; acute-apiculate; otherwise as the median sepal. *Petals* recurved to almost spreading, ovate, c. 18 x 6 mm, index c. 3; acute, margins entire, base widely attached; rather thin, c. 5-veined, glabrous. *Lip* recurved near the base, general outline \pm ovate, c. 8 x 8 mm, index c. 1; subacute, margins entire; rather thin; adaxially concave towards the base, surface finely papillose-pubescent towards the base, glabrous elsewhere; abaxially with a distinct, emarginate ridge from base to tip, surface glabrous. *Column* c. 4 mm long, stigma without basal tooth, column foot without a tooth just above the ligament. *Stelidia* minute, porrect, deltoid, subacute, without teeth along the lower margin. *Anther* abaxially with a very inconspicuous crest, surface \pm glabrous, front margin drawn out into a deltoid beak with glabrous margins. *Pollinia* 4, the inner slightly shorter than the outer, all ovoid; a large, fleshy lump of tissue attached to the inner pair.

Figure 11. *Bulbophyllum catillus* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, above: adaxial side, below: abaxial side; e. Column and lip, lateral view; f. Anther, above: abaxial side, below: adaxial side; g. Pollinia, left: a single pair, right: two pairs. – a. From LAE 77443 (herbarium material), with the flower reconstructed from *Jongejan cult. 1216*; b. From *Jongejan cult. 1216*; c–g. From *Jongejan cult. 614* (all spirit samples).

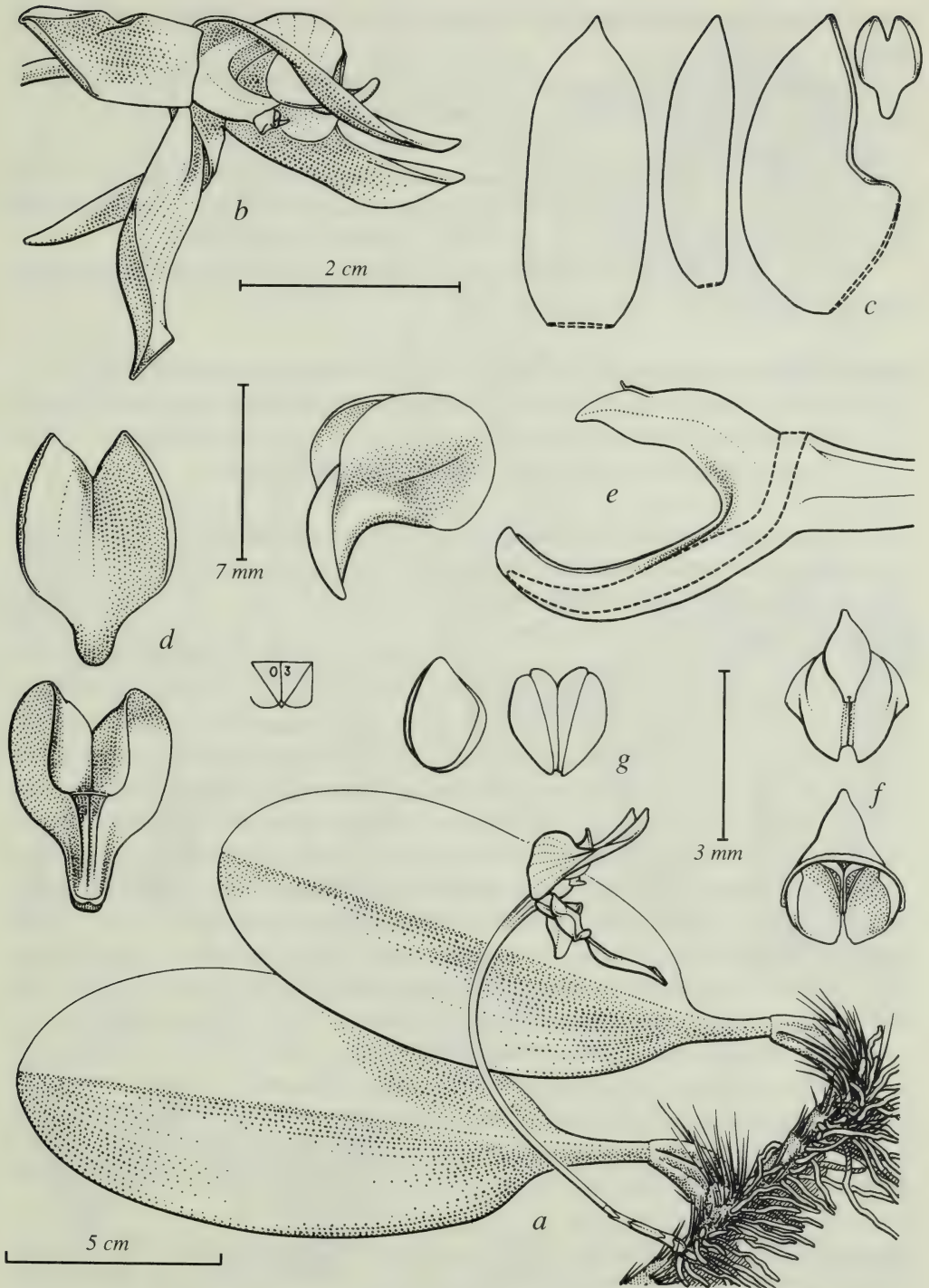


Figure 11. *Bulbophyllum catillus* J.J. Verm. & P. O'Byrne

Colours: Sepals and petals greenish with purple veins. Lip white, suffused with pinkish purple.

Habitat: Unknown. Grows and flowers well in cultivation in lowland conditions as well as at 1000 m alt. Flowering observed in Jan–Mar and Dec.

Distribution: LAOS: Locality unknown (1 specimen seen).

Notes: Most similar to *Bulbophyllum microglossum* Ridl. which, however, has a glabrous lip. *B. smitinandii* differs in having two distinct patches of much longer hairs on the adaxial side of the lip, as well as a distinct central callus.

Named after Bob and Chittima Cowen, Bangkok, Thailand, who successfully flowered this species in their nursery.

***Bulbophyllum incisilabrum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 13.

Bulbophyllum incisilabrum J.J. Verm. & P. O'Byrne, a *Bulbophyllo rugoso* Ridl. ovario cristis non-sinuosis, sepalo mediali petalisque rotundato differt. – TYPE: Indonesia, Sulawesi, central part, SBG-O 1879 (SING, holo.).

Roots mainly below the pseudobulbs. **Rhizome** creeping, 4.5–6 mm diam., sections between pseudobulbs 0.9–1.6 cm long, bracts with veins persistent as fine fibres. **Pseudobulbs** close, ovoid-cylindrical, erect, 3.5–5.5 x 1.2–1.6 cm. **Petiole** 3–5.5 cm long. **Leaf blade** elliptic to obovate, 10–16.5 x 2.7–4.2 cm, index (length/width) 3.2–4; obtuse. **Inflorescence** 11–12 cm long, 1-flowered. **Peduncle** erect to patent, 2.6–3 cm, bracts c. 3, the longest 14–18 mm long. **Floral bracts** tubular, 15–18 mm, cuspidate. **Flowers** resupinate, not fully opening. **Pedicel** and **ovary** 75–80 mm long, basal node coinciding with the floral bract, juga and valvae sharply crested, crests slightly curved towards the base of the flower. **Median sepal** somewhat recurved, ovate, c. 20 x 12 mm, index 1.6–1.7; rounded, margins entire, base narrowly attached; rather thick, 8–9-veined, glabrous. **Lateral sepals** ± spreading, lower margin with a distinct fold slightly below half-way the sepal, free, oblique, ovate-triangular, c. 23 x 12 mm, index c. 1.9–2; subacute, base broadly attached; otherwise as the median sepal. **Petals** ± recurved, ovate, c. 19 x 6 mm, index 3.1–3.2; rounded, margins entire, base broadly attached; rather thick, 8–9-veined, glabrous. **Lip** sharply recurved near the base and near the tip, general outline ± ovate, c. 10.5 x 7.5 mm, index c. 1.4; rounded, margins entire; thick, surface very coarsely warty near the tip; adaxially concave near the base, with a median slit from base to tip, with 2 rather conspicuous, rounded ridges diverging proximally and running up to c. 2/3 of the length of the lip, surface glabrous; abaxially with a distinct, emarginate ridge from base to tip, surface glabrous but with a finely papillose patch proximally along the median line. **Column**

Figure 12. *Bulbophyllum coveniorum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: abaxial side, right: adaxial side; e. Column and lip, lateral view; f. Anther, above: adaxial side, below: abaxial side; g. Pollinia, left: two pairs, right: a single pair. – All from SBG-O 3622 (spirit sample).

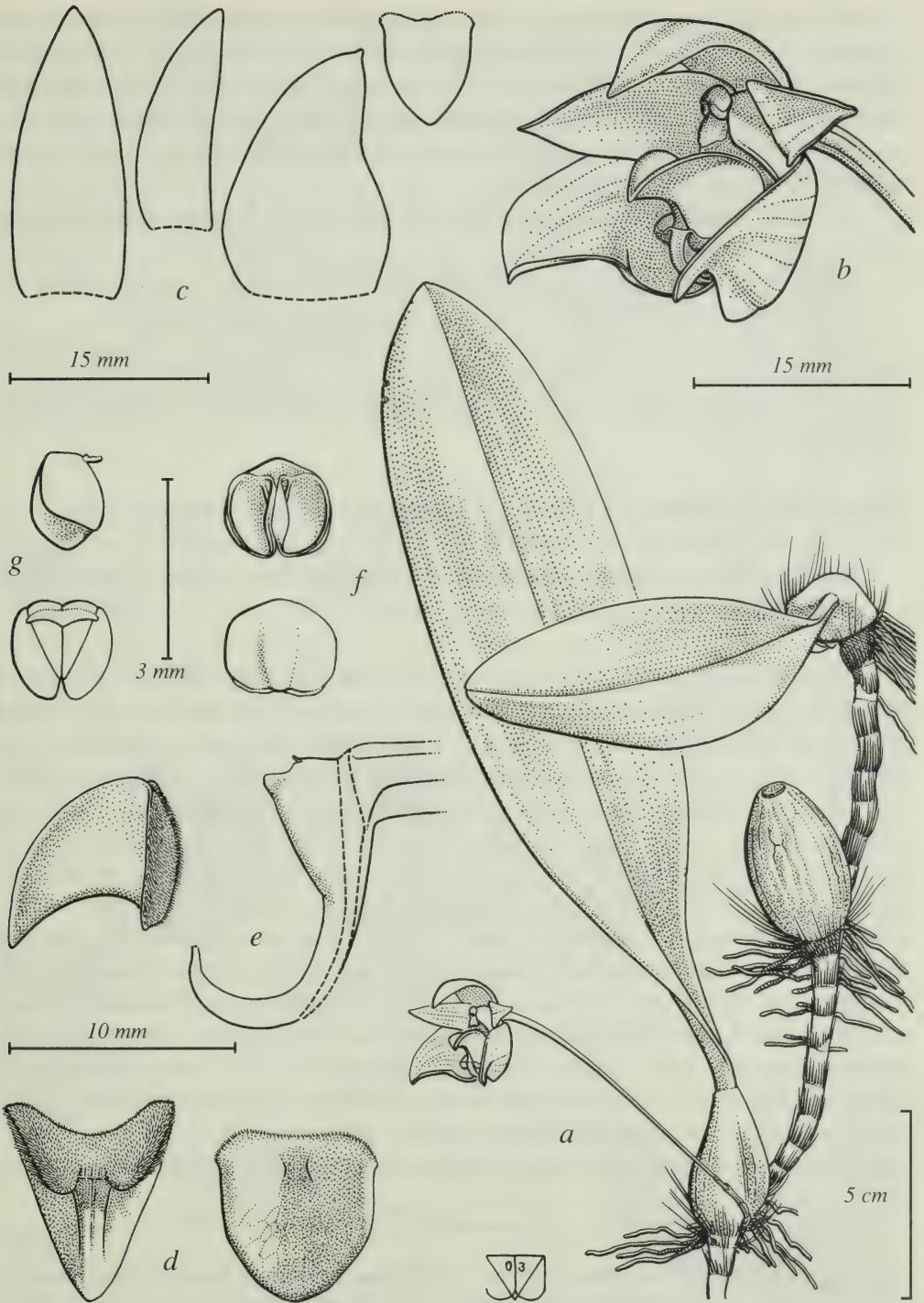


Figure 12. *Bulbophyllum coweniorum* J.J. Verm. & P. O'Byrne

c. 4 mm long, stigma without basal tooth, column foot without a tooth just above the ligament. *Stelidia* minute, porrect, triangular, acute, along the lower margin below the base with a distinct, subtriangular, 3–3.5 mm long, obtuse tooth. *Anther* abaxially with a rather distinct crest, surface \pm glabrous, front margin drawn out into a concave, rounded beak with erose and papillose margins. *Pollinia* 4, the inner \pm as long as the outer, all ovoid; no appendages present.

Colours: Sepals and petals yellow with red spots. Lip white, adaxially pink towards the margins.

Habitat: Epiphyte in forest. Alt. 1100–1200 m. Flowering observed in Feb.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: This pretty species is most similar to *Bulbophyllum rugosum* Ridl. It differs in having the crests on the ovary only slightly curved distally (not distinctly sinuous), in having a rounded median sepal and petals, and in having widely spreading lateral sepals.

***Bulbophyllum lyriforme* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 14.

Bulbophyllum lyriforme J.J. Verm. & P. O'Byrne, a *Bulbophylo cheiri* loborum lateralium margine dorsali (proximali) concava labelli basi differt. – TYPE: Papua New Guinea, *Jongejan*, *P. cult.* 282 (L, holo).

Vegetative parts not seen. Inflorescence c. 5 cm long, 1-flowered. *Floral bracts* tubular, c. 6 mm, cuspidate. *Flowers* not resupinate, not fully opening. *Pedicel* and *ovary* c. 40 mm long, basal node on a c. 5 mm long stump, juga and valvae well-rounded. *Median sepal* somewhat incurved, subtriangular, 23–31 x 6–8 mm, index 3.8–4.5; acute, margins entire, base rather widely attached; rather thick, c. 9-veined, glabrous. *Lateral sepals* recurved, free, oblique, 22–30 x 8–10 mm, index 2.5–3.4, base widely attached; otherwise as the median sepal. *Petals* spreading to reflexed, subtriangular, 21–28 x 2.2–4 mm, index 7–10.5; acute, margins entire, base widely attached; rather thin, c. 5-veined, glabrous. *Lip* slightly recurved near the base, general outline hastate-lyrate with a long drawn-out top part, margins slightly concave near the base of the lip, 17–19 x 7–8 mm, index c. 2.2–2.4; obtuse, margins entire; drawn out top part thick, elsewhere thin, surface glabrous; adaxially widely concave towards the base; abaxially with a distinct, emarginate ridge over c. 1/5–1/4 of the length of the lip. *Column* 6–8.5 mm long, stigma without basal tooth, column foot with a slight callus just above the ligament. *Stelidia* porrect, triangular, 1–1.8 mm long, obtuse, without teeth along the lower margin. *Anther* abaxially with a very distinct, flat crest,

Figure 13. *Bulbophyllum incisilabrum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, left: adaxial side, right: abaxial side; g. Pollinia, left: single pair, right: two pairs. – All from SBG-O 1879 (living plant, spirit sample).

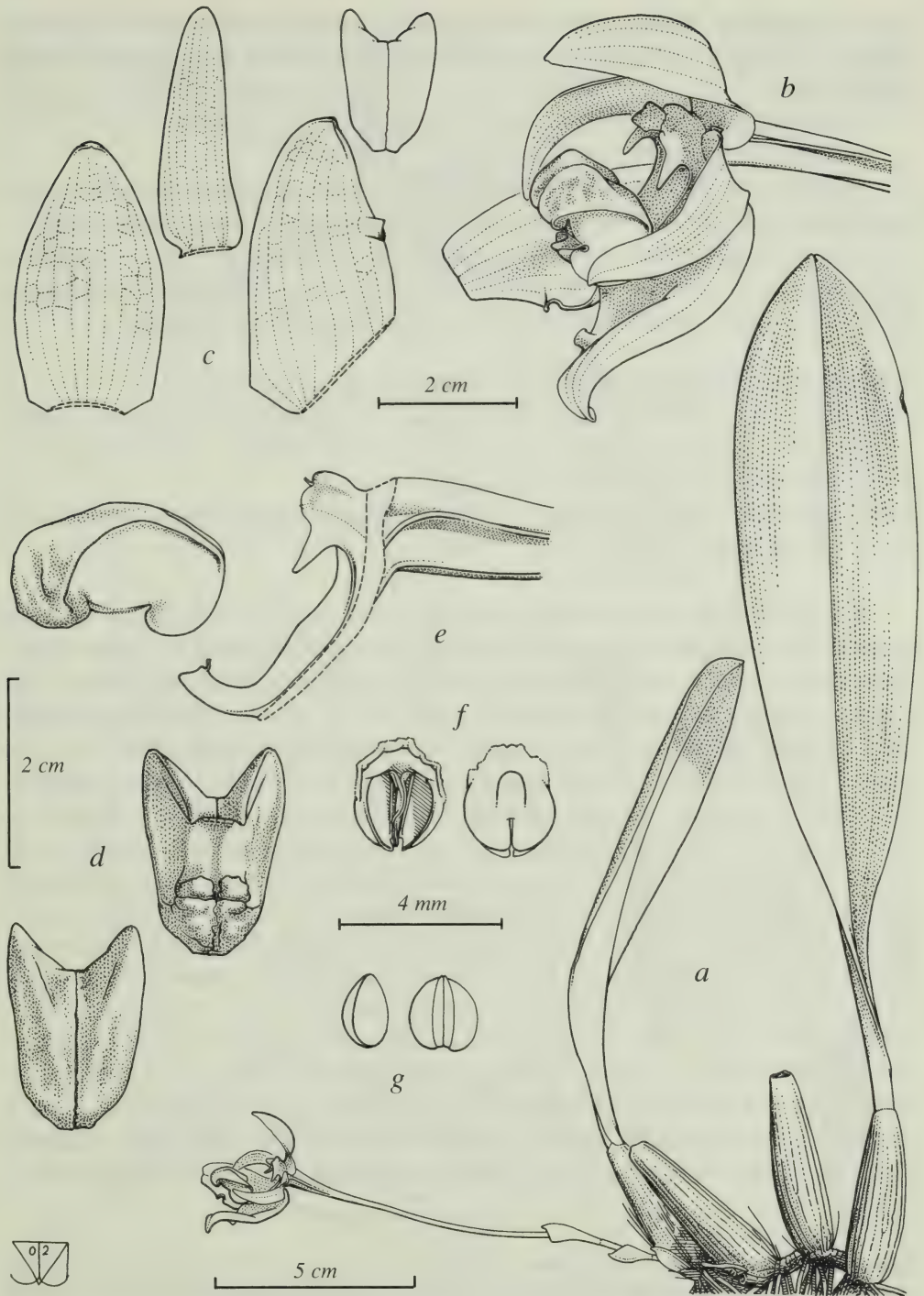


Figure 13. *Bulbophyllum incisilabrum* J.J. Verm. & P. O'Byrne

surface \pm glabrous, front margin drawn out into a widely rounded beak with entire margins. *Pollinia* 4, the inner as long as the outer, all about drop-shaped, without appendages.

Colours: Unknown.

Habitat: Unknown.

Distribution: INDONESIA: Irian Jaya (4 specimens distributed from BO by J.J. Smith, presumably from Irian Jaya). PAPUA NEW GUINEA (1 specimen seen).

Notes: *Bulbophyllum lyriforme* is most similar to *B. cheiri* Lindl.; it differs in having the lateral lobes at the base of the lip slightly bent backwards, so that their proximal margin is slightly concave. In *B. cheiri* this is invariably convex.

***Bulbophyllum sinapis* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 15.

Bulbophyllum sinapis J.J. Verm. & P. O'Byrne, a *Bulbophyllo macrantho* in sepalis lateralibus latioribus (indice 2–3.5 versus 1.5–1.7) differt. – TYPE: Papua New Guinea, *Jongejan*, *P. cult.* 171 (L, holo).

Bulbophyllum aff. *hahlianum* Schltr.: O'Byrne, *Lowland Orchids Papua New Guinea* (1994) 456.

Roots along the entire rhizome. *Rhizome* creeping, 4–5 mm diam., sections between pseudobulbs 8–12 cm long, bracts with veins persistent as coarse fibres. *Pseudobulbs* distant, ovoid-cylindrical, suberect, 1.5–2.0 x 0.5–0.8 cm. *Petiole* 2–4.5 cm long. *Leaf blade* elliptic to obovate, 12–19.5 x 3.3–7.4 cm, index (length/width) 1.9–5.4; obtuse. *Inflorescence* 5–12 cm long, 1-flowered. *Peduncle* (sub-)erect, 0.6–2 cm, bracts 3–5, the longest 9–19 mm long. *Floral bracts* tubular, 10–16 mm, cuspidate. *Flowers* not resupinate, not fully opening. *Pedicel* and *ovary* 65–88 mm long, basal node on a 13–16 mm long stump, juga and valvae well-rounded. *Median sepal* somewhat incurved, elliptic to ovate, 26–28 x 8–12 mm, index 2.1–3.5; acuminate, margins entire, base narrowly attached; rather thick, c. 11-veined, glabrous. *Lateral sepals* with the lower margins running more or less parallel, often touching at the tip, free, oblique, ovate-triangular, 16–22 x 10–13 mm, index 1.5–1.7, base widely attached; otherwise as the median sepal. *Petals* recurved to spreading, elliptic to obovate, 18–30 x 4.8–8 mm, index 2.7–5; acute to acuminate, margins entire, base narrowly attached; rather thin, c. 7-veined, glabrous. *Lip* recurved near the base, general outline almost hastate, 5–6.5 x 5–6 mm, index c. 0.8–1.2; obtuse, margins entire; thick, surface glabrous; adaxially hardly concave towards the base; abaxially with a distinct, emarginate ridge from base to tip. *Column* 4.5–6 mm long, stigma without basal

Figure 14. *Bulbophyllum lyriforme* J.J. Verm. & P. O'Byrne – a. Flower; b. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; c. Lip, above: adaxial side, below: abaxial side; d. Column and lip, lateral view; e. Anther, above: adaxial side, below: abaxial side; f. Pollinia, above: a single pair, below: two pairs. – All from *Jongejan cult.* 282 (spirit sample).

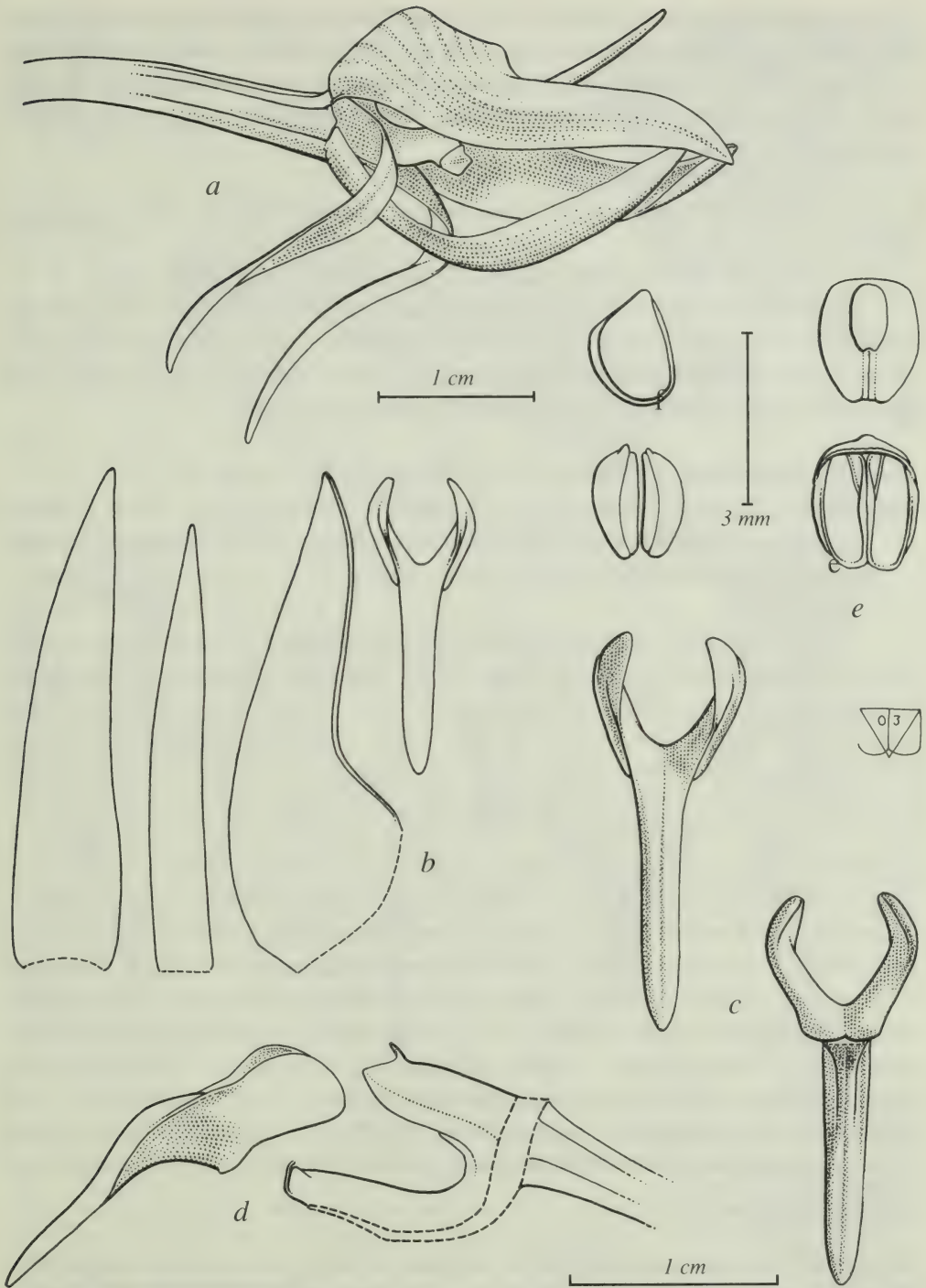


Figure 14. *Bulbophyllum lyriforme* J.J. Verm. & P. O'Byrne

tooth, column foot without a tooth just above the ligament. *Stelidia* porrect, triangular, 1–1.5 mm long, obtuse, without teeth along the lower margin. *Anther* abaxially with a flat crest, surface \pm glabrous, front margin drawn out into a rectangular beak with erose margins. *Pollinia* 4, the inner as long as the outer, all sub-triangular, without appendages.

Colours: Flowers yellow.

Habitat: Epiphyte in lowland forest, coastal woodland. Alt. 0–100 m. Flowering observed in Nov.

Distribution: PAPUA NEW GUINEA: New Britain (2 specimen seen).

Notes: Most similar to *Bulbophyllum macranthum* Lindl.; differs in having shorter and wider lateral sepals (index 1.5–1.7; in *B. macranthum* 2–3.5). *Bulbophyllum sinapis* has uniformly mustard-yellow flowers (hence the name), differing conspicuously from the cream-coloured, heavily spotted flowers of *B. macranthum*.

***Bulbophyllum turpis* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 16.

Bulbophyllum turpis J.J. Verm. & P. O'Byrne, a *Bulbophyllo wrayi* Hook. f. sepalomediali acuto, columna basi dente clitoriformi differt. – TYPE: Malaysia, Pahang, Gunung Brinchang, SBG-O 060 (SING, holo.).

Roots mainly below the pseudobulbs. *Rhizome* creeping, 7–8 mm diam., sections between pseudobulbs 2.8–3.5 cm long, bracts with veins persistent as fine fibres. *Pseudobulbs* close or distant, ovoid, erect, 4–5 x 2.2–3 cm. *Petiole* 16–18 cm long. *Leaf blade* elliptic, 28–29 x 4.8–5 cm, index (length/width) 5.6–5.9; acute. *Inflorescence* a rather dense raceme, 40–47 cm long, 40–50-flowered. *Peduncle* erect to patent, 23–28 cm, bracts c. 7, the longest c. 28 mm long. *Rhachis* arching, 17–19 cm. *Floral bracts* triangular, 4.5–15 x 2–2.5 mm, subacute. *Flowers* \pm resupinate, \pm secund, not fully opening, many open simultaneously. *Pedicel* and *ovary* 5–11 mm long, basal node \pm flush with the surface of the rhachis. *Median sepal* + porrect, ovate, c. 9.2 x 4.8 mm, index 1.9–2; acute, margins entire, base rather widely attached; rather thick, 3-veined, glabrous. *Lateral sepals* somewhat recurved, oblique, triangular, c. 9 x 5 mm, index c. 1.8, base rather narrowly attached; otherwise as the median sepal. *Petals* porrect, subtriangular, c. 4 x 2 mm, index c. 2; obtuse, margins entire, base broadly attached; thin, 1-veined, glabrous. *Lip* reflexed at c. 3/5 of its length, general outline ovate with an oblong, drawn-out top part, c. 3 x 2 mm, index c. 1.5 (all without artificial spreading), margins entire; glabrous, \pm 3-lobed; *midlobe* oblong, truncate-emarginate, rather thick; adaxially concave and with 2 knob-shaped ridges

Figure 15. *Bulbophyllum sinapis* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, above: adaxial side, below: abaxial side; e. Column and lip, lateral view; f. Anther, above: adaxial side, below: abaxial side; g. Pollinia, left: two pairs, right: a single pairs. – All from *Jongejan cult. 171* (spirit sample).

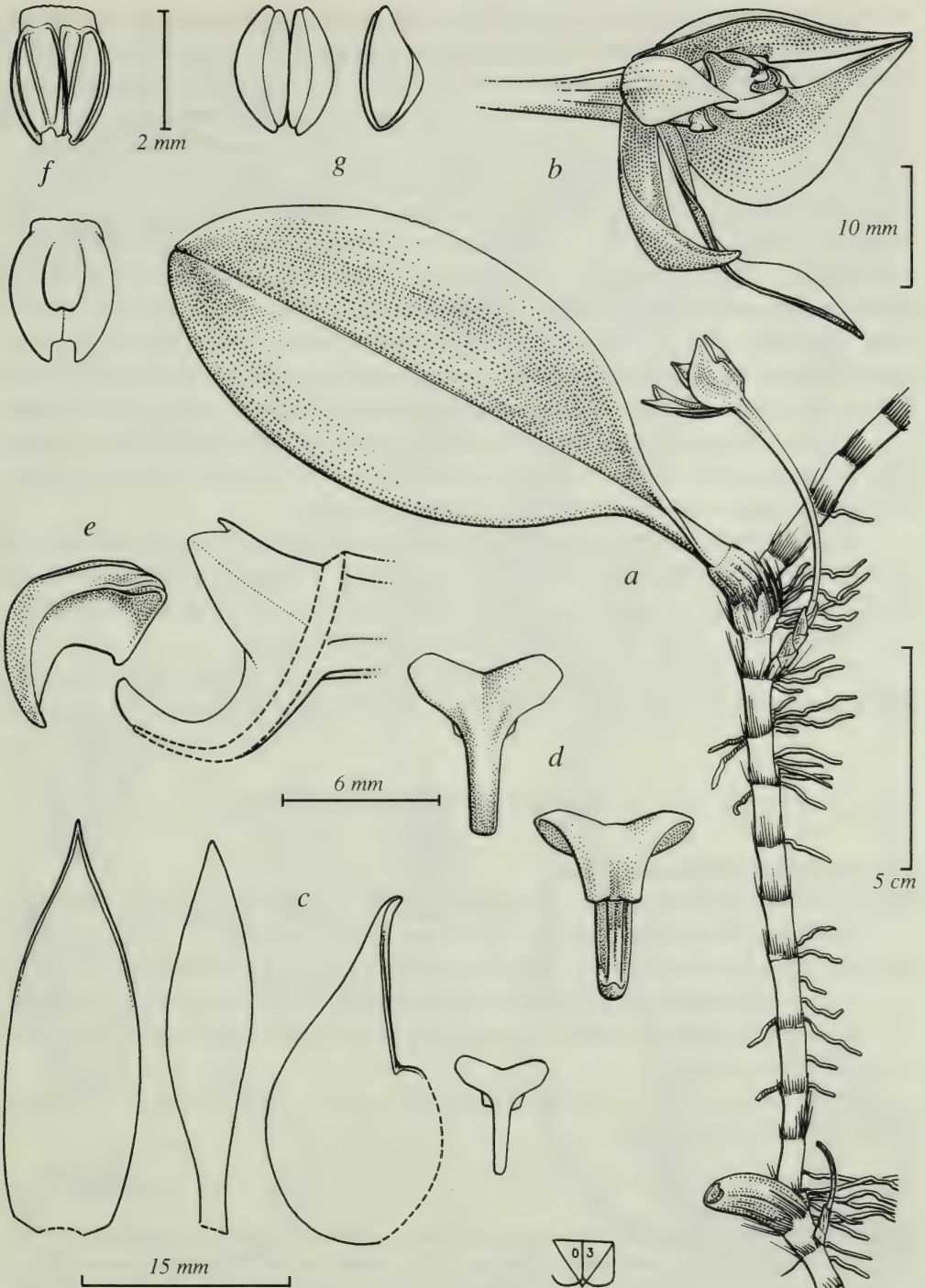


Figure 15. *Bulbophyllum sinapis* J.J. Verm. & P. O'Byrne

touching over a median furrow near the base, with 2 more rather inconspicuous, obtuse ridges proximally somewhat diverging and running parallel from about 1/3 to 2/3 of the length of the lip, the space in between channelled; abaxially with an inconspicuous, retuse ridge up to about 1/3 of the length of the lip; *lateral lobes* erect, attached along the proximal third of the lip, semi-circular, c. 1 mm high, rounded, thin. *Column* c. 2.8 mm long, stigma with a transverse ridge at its base, a longitudinal median ridge issuing from this, continuing up to \pm half-way the column foot, then splitting into two spreading lobes ending in a retuse tooth just above the ligament. *Stelidia* porrect, triangular, c. 1.2 mm long, obtuse to subacute, with a deltoid, acute tooth along the upper margin and a similar, obtuse tooth along the lower. *Anther* abaxially with a finely papillose crest, surface otherwise \pm glabrous, front margin drawn out into a porrect, triangular, acuminate beak with papillose margins. *Pollinia* 4, the inner slightly shorter than the outer, narrowly drop-shaped, the outer ovoid; no appendages present.

Colours: Rhizome scales densely spotted with dark red. Sepals yellow, stained with red except near the base. Petals yellow. Lip yellowish green, top part yellow. Flowers strongly scented, reminiscent of overripe apples.

Habitat: An understory epiphyte in thick moss cushions in permanently wet montane forest. *Bulbophyllum tahanense* Carr and *B. evansii* Henders., like similar conditions and grow in the same area. Alt. 1600-2000 m. Flowering observed in Mar.

Distribution: MALAYSIA: Peninsula (1 specimen seen).

Notes: This species differs from *Bulbophyllum wrayi* Hook.f. in having acute leaf tips, as well as a distinct bifurcate tooth on the column foot.

Bulbophyllum Incertae Sedis

Bulbophyllum plumatum Ames

Bulbophyllum plumatum Ames, Orch. 5 (1915) 184. – TYPE: Philippines, Mindanao, Bukidnon Subprovince, BSC (*L. Escritor*) 21479 (not seen).

Bulbophyllum jacobsonii J.J. Sm., Blumea 1 (1935) 320. – TYPE: Indonesia, Sumatra, West Coast, Soengai Dareh, *Jacobson E.R. cult. 2202 (Theunissen)* (not seen).

Habitat: In Malaysia found as an epiphyte in lowland swamp forest; in Sumatra found at 1000 m altitude.

Distribution: MALAYSIA: Peninsula, Johor. INDONESIA: Sumatra. PHILIPPINES: Mindanao.

Figure 16. *Bulbophyllum turpis* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, above: adaxial side, below: abaxial side; e. Column and lip, lateral view; f. Anther, left: abaxial side, right: adaxial side; g. Pollinia, left: two pairs, right: single pair. – All from SBG-O 0060 (living plant, spirit sample).



Figure 16. *Bulbophyllum turpis* J.J. Verm. & P. O'Byrne

Notes: The Johor plants represent the first records of this species for Malaysia and are the first fully documented records of this species in about 90 years. Plants of *Bulbophyllum plumatum* probably originating from Indonesia appeared in trade in some quantity a few years ago. The Johor plants differ slightly from these in having the lateral sepals coarsely transversely wrinkled.

Material seen: MALAYSIA. Johor, Endau basin, km 56 on road to Mersing, SBG-O 2533 (SING), Johor, Rompin area, *Hon Quik Pin* (WOC 17, 2002) 01 (SING).

Re-examination of *Vaccinium dialypetalum* (Ericaceae) – Erratum

S. P. VANDER KLOET

Department of Biology, Acadia University, Wolfville,
Nova Scotia, Canada B4P 2R6

In Vander Kloet (2002), I overlooked the fact that Sleumer had in 1941 already made combinations for the taxa in question under *Vaccinium*. Therefore the names I proposed are later homonyms and are illegitimate. The correct names for the taxa in question should be:

Vaccinium ridleyi Sleumer, Bot. Jahrb. 71 (1941) 424. *Agapetes parviflora* Ridl., J. As. Soc. Str. Br. 61 (1912) 26 *non* Dunn (1903), *nec Vaccinium parviflorum* Andr. (1800); *Agapetes micrantha* Ridl., Fl. Mal. Pen. 2 (1923) 205, *non Vaccinium micranthum* Dunal 1839; *Vaccinium micranthum* Vander Kloet 54 (2002) 181 *non* Dunal (1839). **Type:** Ridley 15768 (holo SING!).

Synonym: *Vaccinium pseudodialypetalum* Ng, Gard. Bull. Sing. 28 (1976) 231. **Type:** KEP 56673 (holo KEP).

Vaccinium urophyllum Merr., Pap. Mich. Ac. Sc. 19 (1934) 184. **Type:** Yates 2427 (holo MICH; iso NY, US).

Synonyms: *Vaccinium longilingua* Sleumer, Bot. Jahrb. 71 (1941) 424; *Agapetes perakensis* Ridl., Fl. Mal. Pen. 2 (1923) 205, *non Vaccinium perakense* Ridl. (1918); *Vaccinium perakensis* Vander Kloet, Gard. Bull. Sing. 54 (2002) 182 *non*. Ridl. (1918).

Type: Ridley 5532 (SING!).

Agapetes griffithii auct. *non* C.B. Clarke (1882); King, J. As. Soc. Beng. 74 (1906) II 59.

Acknowledgements

I acknowledge the help and advice of J.F. Veldkamp (L) and I.M. Turner (SING) in the preparation of this erratum.

Reference

- Kloet, S.P. Vander. 2002. Re-examination of *Vaccinium dialypetalum* (Ericaceae). *Gardens Bulletin Singapore*. **54**: 179–183.

OBITUARY

Mohamad Shah bin Hj Mohamad Noor

Mohamad Shah bin Hj Mohamad Noor, born in the staff quarters of the Singapore Botanic Gardens, was the son of Hj Mohamed Nur bin Mohamed Ghous. Like his father, he spent his working life in the herbarium exceeding his father's record of 47 years' service by one year.

Born on 22nd January 1935, he received his education at the Anglo-Chinese School in Penang and the Tanjong Rhu Boys School in Singapore. After leaving school in 1954, his father encouraged him to follow in his footsteps and so Mat Shah began his career in the Herbarium in 1955 as a Plant Collector. When his father died in 1958, he took over his post as Herbarium and Museum Assistant. He rose to become a Research Officer. No sooner did he retire in 1993 than he was re-employed until his untimely death on 18th June 2003.

Mat Shah's father was exceptionally diligent (Burkill, 1958) and never lost the opportunity to collect plants. We even have a specimen of a banana he collected from the market in Mecca while he was on the haj! Mohamed Nur undertook the massive task of re-organising the herbarium to follow H.N. Ridley's five-volume *Flora of the Malay Peninsula*. Many of the covers in use today still bear his handwriting. Besides his vast knowledge of plant names, he also amassed a vast collection of plants from all over Peninsular Malaysia.

Mat Shah's service in the Herbarium overlapped with his father's for four years, which gave him an invaluable grounding both in plant identification and herbarium management. As a Plant Collector, Mat Shah accompanied the Director, J. W. Purseglove, on three expeditions to Sarawak in 1955, 1956 and 1957. The longest stint he spent in the field was when he joined the two Royal Society Expeditions to Gunung Kinabalu in 1961 and 1964 (see Appendix). Except for these expeditions, Mat Shah kept his own collecting books and numbering series and had collected more than 5,000 specimens by the end of his career. Not only did he collect in Sabah and Sarawak, he also collected extensively in the Peninsular Malaysia where he climbed many of the major mountains (Gunung Belumut, G. Bujang Melaka, G. Lawit, G. Ledang, G. Rabong, G. Tahan and G. Ulu Kali). He also collected continuously in Singapore, from time to time being involved in extensive surveys, such as that of plants in the Singapore Botanic Gardens in 1974 (96 numbers), the Seletar Reservoir area in 1971 (51 nos.), MacRitchie Reservoir area in 1976 (77 nos.) and the Pierce and Seletar Reservoir areas in 1981 (56 nos.).

He has recounted some of his experiences in the field (Waterson, 2003): "My father taught me always to bring a mosquito net, because it can protect you against centipedes and scorpions, even snakes. One night on Gunung Tahan about nine or ten o'clock, I was lying under my net and I saw a very big cobra going up and over the

top of the net. One of the porters got a parang but I told him not to kill it. Because the second thing my father taught me about the jungle was never to kill any animals. On Gunung Rabung, there were tigers. We met a very big one, but the kampung people assured us they were not man-eaters and never hurt anybody.”

Mat Shah worked through the most turbulent period in the herbarium's history as Singapore emerged from colonial status to independence and prosperity. There were more changes in Director in his 48 years than in the previous 80 years. The nadir was reached when rumours circulated worldwide that the Herbarium was no longer valued and was up for sale!

He also experienced two major upheavals when the entire herbarium moved (Kiew, 2003). The first in 1963 was forced because the herbarium building was threatened with imminent collapse. The 400,000 specimens were moved inside the cupboards, the Gardens' labourers providing the muscle to move the heavy, solid teak cupboards. The second was last year (2002) when the 650,000 specimens were moved out so that the new state-of-the-art Herbarium could be built on the same site. Sadly, Mat Shah will not be able to see the Herbarium settled into the new building in 2005.

For the second move, Mat Shah worked steadily for more than six months with our team of ladies, Juriah Sabudin, Rohana Mohd Shari, Sariah Zelani and Sugaranthara Davi, to bring the family and generic concepts up-to-date and number the families according to D.J. Mabberley's *Plant Book* and the genera and species alphabetically. At the end of six months each box was numbered with its family and sequence within the family. All the overflow of specimens (over 50,000) that had accumulated over the years that could not be fitted into the old herbarium cupboards was incorporated into the sequence. This systematic work paid off as it enabled the 10,000 boxes to be put straight onto the shelf in the correct order, all within 10 days. This re-ordering the Herbarium is a lasting legacy to Mat Shah's dedicated work.

Quiet, dedicated work characterised Mat Shah and his supervision of staff over the years was firm yet harmonious. He will be remembered by the many visitors to the Herbarium from all over the world for his courteous helpfulness. But it was most particularly for his extensive knowledge of plant names (Kiew, 2001) that made his service invaluable and led to his re-employment for eight years beyond retirement age.

In 1993, he underwent a heart by-pass operation, which, although it curtailed his plant collecting activities, did nothing to dampen his dedication to herbarium work. He passed away peacefully in the early morning of 18th June 2003. He was due to finally retire in August 2003.

His ability to identify plants and his knowledge of where plants grow in Singapore will be sadly missed. In the words of Dr S.C. Chin, Director: "With his passing, the tiny pool of specialist plant collectors and field botanists who can put a name to most things green, shrinks further."

He leaves his wife, Madam Jamilah binte Osman, whom he married in 1963, three sons and a daughter, and four grandsons and three granddaughters.



Mohamed Shah in the old Herbarium.

H.M. Burkill, November 1959.

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Ruth Kiew

Singapore Botanic Gardens
Singapore

Appendix: Mohamad Shah's Collecting Expeditions Outside Singapore (Bk Bukit, FR Forest Reserve, G Gunung, NP National Park, Sg Sungai)

1955

12-27 Sept. Sarawak – Kuching, Bk Kitang, Bau; Setapok, Sebanding; G Gading, Lundu, Sematan, Kampung Pueh (with J.W. Purseglove, specimens numbered under Purseglove's collecting series)

1956

16 May-20 June. Sarawak – Bako NP, Telok Asam, Telok Tajor, Lokosan, Sg Serai, Telok Wakang, Telok Delima, Telok Lakei, Telok Lomi, Bk Buan, Tau Range, Bk Mayeng, Bk Merseng, Tatau (with Purseglove & H.B. Gilliland)

1957

2-18 Feb. Sarawak – Bako NP (with Purseglove)
6-9 May. Malacca – Fish Culture Research Station, Batu Berendam
18-22 Sept. Negeri Sembilan – Jendaram Estate, Nilai

1958

26 Jan–3 Feb. Pahang – Sabai Estate, Bentong
5-14 March. Perak – Bota Kiri FR, Ipoh (with Kadim bin Tassim)
2-9 April. Johore – Bk Paloh Estate (with Kadim)

1959

- 1 Feb. Johore – Kota Tinggi Waterfall (with H.M. Burkill)
28 Feb-8 March. Kelantan – Kampung Gobek, Tamangan (with Kadim)
24 Aug. Selangor/Pahang – Fraser's Hill (with Burkill and Mohd Noor bin Jamaat)
21-28 Sept. Johore – Kuala Sedili, Teluk Jereh, Tanjung Lembu, Sg Sedili Besar
(with Mohd Noor and on 26th with Chang Kiaw Lan)

1960

- 15-19 Aug. Pahang – Fraser's Hill (with Mohd Noor)

1961

- 18-26 May. Sabah – Pulau Gaya, Tanjung Aru, Bk Kepayang (with Kadim)
29 May-16 Aug. Sabah – G Kinabalu (1st Royal Society Expedition, with Chew W.-
L, specimens numbered under the RSNB series)

1964

- 10 Jan-20 May. Sabah – G Kinabalu (2nd Royal Society Expedition, with Chew)

1965

- 3-9 Dec. Perak – Maxwell Hill, Bk Berapit, Batu Hampar, Bk Kemunting (with Sidek
bin Kiah)

1968

- 16 Feb-7 March. Pahang – Taman Negara, Sg Tahan, Sg Teku, G Tuan Skeat, Kuala
Kenihan, Gua Luas, Sg Redap, Sg Belar (with herbarium of Forest Research
Institute Malaysia, KEP)
5 April. Johore – Mersing
1 Sept. Johore – Sg Pencharang, Bekok

1970

- 31 May. Johore – Sg Bantang, Labis F.R., Bekok (with E.A. Heaslett & Samsuri)
9-22 July. Pahang – Taman Negara, Ulu Sg Sat, Kuala Kelepah, Ulu Sg Sepia, Kuala
Aur, Ulu Sg Tembeling, Kuala Tahan (with KEP & Mohd Noor)
18-19 Aug. Johore – Bk Tangga Tujoh, Lak Heng Eststate, Kota Tinggi (with R. Hill,
Mohd Noor & Ahmad)
20-25 Sept. Johore – Sg Kahang, G Belumut (with KEP & Sanusi)

1971

- 29 Jan-4 Feb. Johore – Bk Pengantin, Sg Juasseh, Labis (with Ahmad)
22 April. Johore – Kota Tinggi Waterfall
5 Sept. Johore – Ulu Sg Segamat, Labis (with Samsuri Ahmad)
19 Sept. Johore – Padang Mulut, SE coast (with Ahmad)

1972

- 11-17 March. Kelantan – G Rabong, Ulu Sg Ketil (with KEP)
30 July. Johore – Sg Endau, G Janing (with Ahmad)
12-18 Aug. Pahang – Taman Negara, Bk Tersek, Kuala Trengan, Jeram Katak, Sg. Keniyan, Genut Tabing (with Ahmad, on 18th with Miss Lee Wai Chin)
30 Aug-2 Sept. Pahang – Fraser's Hill (with Miss Geh Siew Yin)
23 Nov. Johore – G. Lesong (with Ahmad)

1973

- 29 Jan-4 Feb. Kelantan – Gua Musang, Bk Brangkat, Bertam, G Brong, Kampong Sta (with Mohd Ali)
11 Mar. Johore – G. Panti East (with Heaslett & Samsuri)
10-15 June. Selangor – Ulu Gombak, G. Ulu Kali, Anak Takun, G Bunga Buah (with Mohd Ali)
23-30 Nov. Johore – G Lesong, Sg Rompin (with Ahmad)

1974

- 22-25 Feb. Kelantan – Bk Baka, Machang (with Ahmad)
27 Feb-1 March. Kelantan – Bk Yong, Pasir Puteh (with Ahmad)
31 May-4 June. Trengganu – G Tebu, Jabi, Sg Chabang Dua, Sg Belantan (with Ahmad & Mahmud Awang)

1975

- 11-14 Feb. Perak – G Bujang Melaka, Sg Chenderiang (with Ahmad)
15 Feb. Pahang – Brinchang, Cameron Highlands (with Ahmad)
16-17 Feb. Perak – Sg Selung, Sg Hidup, Telok Anson (with Ahmad)
12-16 March. Trengganu – G Lawit, Kuala Sg Bok, Bk Yong (with British Museum Gunung Lawit Expedition, with Ahmad and Samsuri)
11-17 July. Johore – G Ledang; Ma'okil, Cha'ah; Sg Batu Badak (with Samsuri)
23-28 Oct. Pahang – Bk Berkelah, G Serudom, Kuantan (with Samsuri & Sidek)

1976

- 3-5 March. Kelantan – Bk Bongkok, G Ayam (with Samsuri)
8 March. Kelantan – Ulu Sg Sat. (with Samsuri)

1978

- 9-13 June. Perak – G Bubu, Keledang Saiong FR (with Mahmud Awang)
5 Oct. Trengganu – Rantau Abang (with Samsuri)
22-26 Nov. Trengganu – Abang area, Jambu Bongkok, Gong Balai, Tanjung Juara (with Sidek)

1981

- 15 Sept. Johore – Jason Bay, K. Sedili, Jemaluang Road (with Ali Rahim)

1984

18-21 July. Trengganu – Bukit Tinggi (with Mahmud)

1989

10-15 Feb. Sabah - G Kinabalu (to summit) and Poring (with E.P. Tay, specimens numbered under Tay's series)

20 Feb. Sabah – Nabawan (with E.P. Tay, specimens numbered under Tay's series)

1991

23-26 July. Johore – Sg Lingui (with E.P. Tay and Ali Ibrahim, specimens numbered under Tay's series)

1993

2-5 May. Kedah – Sg Badak, Changlun, Bk Perangin; Bk Enggang, Sik.

INSTRUCTIONS TO AUTHORS

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Medinilla alternifolia Blume, Mus. Bot. Lugd.-Bat. I:2 (1849) 19.
Sterculia acuminatissima Merr., Philip. J. Sci. 21 (1922) 524.

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Are Any Plants Endemic to Singapore?

RUTH KIEW AND I. M. TURNER

Singapore Botanic Gardens, 1 Cluny Road, Singapore 259569

Abstract

Many taxa are reported in the literature as endemic to Singapore. Of the 19 investigated, seven are shown to be endemic. Of these six, *Bolbitis xsingaporensis* (Lomariopsidaceae), *Flickingeria laciniosa* (Orchidaceae), *Spatholobus ridleyi* (Leguminosae), *Strychnos ridleyi* (Loganiaceae), *Tectaria griffithii* var. *singaporeana* (Dryopteridaceae) and *Thunbergia dasychlamys* (Acanthaceae) are extinct, while *Cryptocoryne xtimahensis* (Araceae) is still alive in the Bukit Timah Nature Reserve. These seven taxa represent a mere 0.3% of Singapore's vascular flora of about 2300 species. A new combination is made for *Hypobathrum coniferum* (Ridl.) Kiew (Rubiaceae).

Introduction

In Ridley's 1900 enumeration of Singapore seed plants, the first listing for Singapore, he noted 33 species as endemic to Singapore although he pointed out that most would probably be discovered in neighbouring countries and this proved to be the case. In addition, he indicated that some names he listed from the literature as coming from Singapore were either invalid names or that Singapore had been wrongly given as the place of origin. (The latter was not an unusual practice in the case of professional plant collectors who did not want the true origin of a valuable plant to be known).

The preparation of the Flora of the Malay Peninsula, initiated at the Calcutta Botanic Garden, but eventually driven by the indefatigable Ridley, both while he was Director of the Botanic Gardens Singapore and later in retirement at the Royal Botanic Gardens, Kew, resulted in the description of many new species, some of which were known only from specimens collected from Singapore. The number of species named in honour of Ridley and the number of rare species that he collected (see Appendix) illustrate his diligence as a collector and that forest in Singapore was much more extensive and less disturbed in his day.

Since that period (1889–1925), a few new species apparently endemic to Singapore have been described often based on very old collections. Significant among these are two hybrids because hybrids often arise and survive in disturbed conditions so they may be a reflection of disturbance in the remaining forested areas in Singapore.

Candidates for Endemic Species

Among the species listed by Ridley (1900), one has proved to be endemic to Singapore. He described *Dendrobium lacinosum*, Orchidaceae (now known as *Flickingeria laciniosa* (Ridl.) A.D.Hawkes) from two plants collected in 1891 from Pulau Seletar. At one time, this species was confused with another orchid from Perlis, Peninsular Malaysia, but Seidenfaden & Wood (1992) believe the Perlis plant to be different. Incidentally, they erroneously record Pulau Seletar as in Johore, Peninsular Malaysia.

Later, Ridley described three more species and a variety as endemic to Singapore: *Didymocarpus perdita* Ridl. (Gesneriaceae), *Dischidia singaporensis* Ridl. (Asclepiadaceae), *Petunga conifera* Ridl. (Rubiaceae) and *Spatholobus ferrugineus* (Zoll. & Moritz) Benth. var. *sericophyllus* Ridl. (Leguminosae).

Didymocarpus perdita collected from Seletar in 1889, Ridley (1923) described as 'very rare, only 2 specimens seen in a ravine, now probably extinct'. This species has proved to be the same as *D. punctulata* Ridl. (now known as *Henckelia punctulata* (Ridl.) A. Weber), which grows in southern and eastern Peninsular Malaysia (Kiew, 1987).

Dischidia singaporensis is similarly a very rare species known only from one collection from the Changi Police Station in 1908. Later, *D. singaporensis* was collected from Endau-Rompin, Johore (Kiew, 1987).

Petunga conifera, now known as *Hypobathrum coniferum* (Ridl.) Kiew (see Appendix), in Ridley's time was known from a single tree in the Botanic Gardens Rain Forest, which at that time was called the Gardens Jungle (Ridley, 1923). Later, a specimen of this species was collected from Johore, disproving its status as endemic to Singapore. However, considering its extreme rarity and that it has not been recollected for more than a hundred years, it can be concluded that the Singapore population of this species is extinct.

Spatholobus ferrugineus var. *sericophyllus* was originally described from four collections from Singapore (Ridley, 1922). However, this variety has since proved to be widespread (Ridder-Numan & Wiriadinata, 1985). In Peninsular Malaysia, for example, it has been collected from Perak, Selangor, Malacca and Negri Sembilan.

From publications from Calcutta, five new species were described that were then known only from specimens collected in Singapore: *Litsea ridleyi* Gamble (Lauraceae), *Piper flavimarginatum* C.DC. (Piperaceae), *Polyosma ridleyi* King, *Spatholobus ridleyi* Prain ex King (Leguminosae) and *Strychnos ridleyi* King & Gamble (Loganiaceae).

Litsea ridleyi, first collected in the 1880s, has been sporadically collected since, the latest being in 1982 from the Bukit Timah Nature Reserve. However, several specimens from Borneo (for example, *Ridley s.n.* 1892 from Bongaya and *Senada Brunei 54121* from Baram) are conspecific with this species, which is therefore not

endemic to Singapore.

Ridley (1924) reported the wild pepper, *Piper flavimarginatum* as only from Singapore, where he described it as 'very common but rarely flowering'. However, it is widespread though not common in Peninsular Malaysia and has been collected from as far afield as Langkawi, Perak, Pahang, Trengganu, Negri Sembilan and Johore. It can therefore no longer be considered endemic to Singapore. It has not been recollected in Singapore since 1933.

Another rare endemic, *Polyosma ridleyi* King (Escalloniaceae), was known from a collection made by Ridley in 1892 from Seletar and another by Cantley in the 1880s without the locality specified. Much later it was shown by Saw (1989) to occur in Johore and Brunei as well as Singapore.

Spatholobus ridleyi is a distinctive species. It has only been collected from Singapore on three occasions and from nowhere else. It was last collected in 1899 and is an example of a rare Singapore endemic that is now extinct.

Strychnos ridleyi is known from just two specimens, both from Singapore, the last collected in 1894. Ridley (1923) reported that it was 'very rare in forests'. The most recent revision for the region by Leenhouts (1962) confirmed it as a valid species. *S. ridleyi* is another example of a rare Singapore endemic species that is now extinct.

In the post-war period, new species were sporadically described either because genera were being revised, such as the ferns *Bolbitis singaporensis* Holttum (Lomariopsidaceae) and *Tectaria griffithii* (Baker) C.Chr. var. *singaporeana* Holttum (Dryopteridaceae); *Thunbergia dasychlamys* Bremek. (Acanthaceae); *Psychotria* 'sp. 9' K.M.Wong (Rubiaceae) or, in one case, was recently discovered, *Cryptocoryne xtimahensis* Bastmeijer (Araceae).

In 1947, Holttum described the fern *Bolbitis singaporensis* and noted that it looked like a hybrid between what are now called *Bolbitis appendiculata* (Willd.) K.Iwatsuki ssp. *appendiculata* and *B. sinuata* (C. Presl) Hennipman that all grew together in one valley on Bukit Timah. In 1978, Hennipman formally designated this fern as a hybrid, *Bolbitis xsingaporensis* Holttum. As it is only known from Singapore, it is an endemic. Wee (1984) reported that it has not been seen 'for a very long time'. It was last collected in 1943. It is probably now extinct.

The case of the fern, *Tectaria griffithii* var. *singaporeana* is different. This variety was only ever known from a single plant collected in 1908 from Bukit Timah. The fact that it was not recollected by Holttum, who made an intensive study of ferns in Singapore, nor by other botanists suggests that it was a single aberrant plant that does not warrant taxonomic status.

Thunbergia dasychlamys, a slender climber, is extremely rare and known from only two specimens from Singapore, both collected by Ridley. It has not been recollected since 1906. It is therefore a Singapore endemic, which is now extinct.

Psychotria malayana Jack is a common and widespread species with fruits that dry conspicuously ribbed. However, some specimens that have fruits that are almost smooth and leaves that are broader and the base not tapered into the petiole were segregated from *P. malayana* by E.D. Merrill as recorded on his determination slips dated 1950 on the specimens. These specimens were formally recognised as distinct by Wong (1989) under the name *Psychotria* 'sp. 9'. The status of this taxon requires detailed investigation to decide whether *Psychotria* 'sp. 9' is in fact a distinct taxon or whether it is a southern form of *P. malayana*, something that is beyond the scope of this study. It is not, however, endemic to Singapore as Merrill assigned a specimen from Malacca (*Ridley s.n.* June 1892 from Gunung Mereng) to this taxon. In Singapore, this taxon was collected from several localities giving the impression that it was not rare. However, there are no specimens collected after 1906, which strongly suggests that the Singapore population is now extinct.

Recently, Bastmeijer & Kiew (2001) described a new hybrid from Singapore, *Cryptocoryne xtimahensis* Bastmeijer (Araceae) from the Bukit Timah Nature Reserve. Its present status is endemic to Singapore as it has not been collected from elsewhere, but considering how readily species of *Cryptocoryne* hybridise, it is likely that in future it will be encountered in southern Peninsular Malaysia, where both the putative parents grow.

Keng (1990) in his flora of Singapore cited two species, *Polyosma kingiana* Schltr. (Escalloniaceae) and *Sabia erratica* P.M. v.d. Water (Sabiaceae) as endemic to Singapore and both were listed as 'strictly endemic to Singapore' in Davis *et al.* (1995). The inclusion of *P. kingiana* appears to be an error as this species, together with the name it was originally described under, *P. flavo-virens* Ridl., was not recorded from Singapore by Ridley (1922).

The case of *Sabia erratica* is an interesting one as van de Water (1980) clearly stated in describing the species that the label on the type specimen at Kew, which gave its origin as Bukit Timah, was clearly the wrong one as it described the plant as a tree 30 m tall whereas *Sabia* is a genus of climbers. The data on the label recorded the collector as Ngadiman (not Ngadiwan as given by van de Water) with the Field Number 36149 (which is a Singapore Field Number, not a Kepong number as reported by van de Water), collected from Tree No. 454 in Bukit Timah on 22 May 1940 and the specimen was identified as *Scaphium* (Sterculiaceae). The collection belonging to this label is in the Singapore Herbarium (SING) and represents a specimen of *Scaphium macropodum* (Miq.) Beumee *ex* Heyne, which is indeed a tree. The type specimen of *Sabia* was distributed from Kepong to Kew and at some point the label from the *Scaphium* specimen was attached to the *Sabia* specimen. Van de Water commemorated this mix-up in the specific epithet 'erratica' meaning wandering.

Since *Sabia erratica* was described, two other specimens have been identified at Kew as belonging to this species. They are *Makoto Togashi* 622240 collected from

Cameron Highlands, Pahang, at 6500 feet on 1 Feb 1962 and *T & P 614* collected from the Palas Tea Estate, Gunung Brinchang, Cameron Highlands, on 1 April 1979. There is a duplicate of the latter specimen in SING. It is therefore now clear that *Sabia erratica* is a very rare endemic from Cameron Highlands (probably confined to Gunung Brinchang) and is not found in Singapore.

The status of *Hanguana* 'Singapur' (Hanguanaceae) suggested as a possible new taxon (Tillich & Sill, 1999) is discussed in the Appendix. It is not endemic.

Discussion

Out of the potential candidates, only seven can be considered endemics (Table 1). As mentioned above, two are hybrids that may have resulted from disturbance to the natural habitats in the last hundred years. One variety, *Tectaria griffithii* var. *singaporeana*, is doubtfully valid taxonomically as it is based on a single plant.

Singapore does not in fact possess a flora that is distinct from the surrounding region but is a part of the flora found in southern Johore as well as showing affinities with the northern flora of Borneo. The endemic status of the species in Table 1 may not stand the test of time as the flora of Johore is relatively poorly collected compared with that of Singapore and it is likely that these species also occur there.

It is interesting that three endemics are climbers, the life form most poorly represented in herbaria, because of the inaccessibility of their foliage, flowers and fruits high up in the canopy. Their endemic status in Singapore may therefore be an artefact of more intensive collecting. (Singapore has always had more botanists per km² than any other country in the region). If a search is carried out in neighbouring countries, these climbers can be expected to be found.

Table 1. Endemic species in Singapore

| Species | Life form | No. localities & date last collected | Status |
|--|-----------|---|---------|
| <i>Bolbitis xsingaporensis</i> | fern | 1 1943 | extinct |
| <i>Flickingeria laciniosa</i> | epiphyte | 1 1891 | extinct |
| <i>Spatholobus ridleyi</i> | climber | 2 1899 | extinct |
| <i>Strychnos ridleyi</i> | climber | 2 1894 | extinct |
| <i>Thunbergia dasychlamys</i> | climber | 2 1906 | extinct |
| <i>Tectaria griffithii</i> var. <i>singaporeana</i> | fern | 1 1908 | extinct |
| <i>Cryptocoryne xtimahensis</i> | aquatic | 1 | extant |

Most of these endemic species were always very rare and are known from only one or two localities. Their extreme rarity meant that habitat destruction or disturbance would tip them into extinction. Most of this extinction apparently occurred about a hundred years ago as Singapore was intensively botanised in the 1920s and 1930s without these species being re-collected. Now only one of the seven still survives.

Seven endemics for a flora of about 2300 species of vascular plants represents a very low level of endemism (0.3%), though it is higher (1.6%) if just ferns are considered. One would not expect the Singapore flora to include a large number of endemics as Singapore lacks many of the most biodiverse habitats with high endemism of the region, such as mountains, limestone hills and ultramafic areas.

Conclusion

This survey shows that seven species are endemic to Singapore and that of these six, *Bolbitis xsingaporensis*, *Flickingeria laciniosa*, *Spatholobus ridleyi*, *Strychnos ridleyi*, *Tectaria griffithii* var. *singaporeana* and *Thunbergia dasyclamys*, are extinct; only *Cryptocoryne xtimahensis* is still alive in the Bukit Timah Nature Reserve.

The other eight species thought at one time to be endemic have been shown, as regional floras have become better known, to have a wider distribution and grow outside Singapore. Seven of these were always very rare and have not been re-collected in Singapore for many years, which indicates that their Singapore population is extinct, although the species continues to survive elsewhere. These include *Dischidia singaporensis*, *Henckelia puncticulata*, *Hypobathrum coniferum*, *Piper flavimarginatum*, *Polyosma ridleyi*, *Psychotria* 'sp. 9' and *Spatholobus ferrugineus* var. *sericophyllus*. A population of the eighth, *Litsea ridleyi*, still survives in Singapore in the Bukit Timah Nature Reserve but is very rare (Maxwell, 1983).

The presence of the one extant endemic taxa and one rare species in the Central Catchment Reserve reinforces its value as a protected conservation area for the biodiversity of Singapore. The hybrid endemic to Singapore, *Cryptocoryne xtimahensis*, grows in two adjacent small pools within the Bukit Timah Nature Reserve. Its long-term survival is therefore vulnerable to any hydrological changes to that one stream. Active monitoring and management, particularly in dry periods, is therefore important.

Acknowledgements

This survey was prompted by Saifuddin Suran's enquiry as to the status of the 'endemic' species mentioned in the *Centres of Plant Diversity* book. We thank Josef Bogner for drawing our attention to the *Hanguana* 'Singapur'; S. Chan for permission to work in the Bukit Timah Nature Reserve; Saw L. G. for information on *Sabia* specimens at Kepong; C. Chia and Saifuddin Suran, Biodiversity Centre, NParks, for searching for

the location of Pulau Terijei; J.F. Veldkamp for help with tracing *Hypobathrum* names; and the Keeper of Herbarium at Kew for permission for R. Kiew to study specimens in his care, and to Lena Chan for comments on the manuscript.

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Appendix: Taxonomic notes with the inclusion of specimens in the Singapore Herbarium (SING).

Bolbitis xsingaporensis Holttum

Basionym: *Bolbitis singaporensis* Holttum. Gard. Bull. Str. Settl. 11 (1947) 271.

Type: Bukit Timah – *Hullett s.n.* March 1882 (holo SING, iso SING).

Other specimens: Bukit Timah – *C.G. Matthew 12567* 1906 (SING), *Holttum s.n.* 27 Feb 1923 (SING), *Holttum SFN 19799* 12 Nov 1928 (SING), *Holttum s.n.* 12 Dec 1928 (SING), *Holttum s.n.* Feb 1943 (SING).

Cryptocoryne xtimahensis Bastmeijer. Gard. Bull. Singapore. 53 (2001) 11.

Type: Bukit Timah - *Kiew et al. RK 5127* (holo SING).

Other specimen: Bukit Timah - *P. Blanc 91-1* (SING).

Dischidia singaporensis Ridl. J. Str. Br. Roy. As. Soc. 61 (1912) 31.

Type: Changi Police Station – *Ridley s.n.* 1908 (lecto SING).

Note: The other specimen Ridley listed as belonging to this species, Rintz (1980) identified as *Hoya lacunosa* Bl.

Flickingeria laciniosa (Ridl.) A.D.Hawkes.

Basionym: *Dendrobium lacinosum* Ridl. J. Linn. Soc. 32 (1896) 242.

Type: Pulau Seletar – *Ridley s.n.* 1891 (holo SING).

Other specimen: Pulau Seletar – Goodenough s.n. 1891 (SING).

Hanguana ‘Singapur’

Josef Bogner (letter dated 5th Nov 2002) suggested that the Bukit Timah population of *Hanguana*, based on his observations of a sterile plant in the Munich Botanic Garden grown from seed collected in Bukit Timah, may be a new species, because unlike *H. malayana* (Jack) Merr. (Hanguanaceae) with which it had previously been identified, it was much smaller and did not produce long runners with young plants at the tip. Tillich & Sill (1999) compared the morphology and anatomy of this sterile plant, which they called *H. ‘Singapur’*, with three other *Hanguana* species from Borneo, *H. major* Airy Shaw, *H. bogneri* Tillich & Sill and *H. ‘Borneo’*. However, they did not compare the Bukit Timah plant with *H. malayana*.

Hanguana malayana can be a confusing species as its extreme forms look very different. Plants that grow on lake or pond margins are robust plants that produce long runners (the aquatic form), while plants that grow in forest in wet hollows or on slopes (the terrestrial form) are more slender plants and their runners are much shorter. However, since there are so many plants that are intermediate between these two forms, Backer (1951) and Backer & Bakhuizen van den Brink (1968) concluded that the aquatic and terrestrial forms belonged to a single variable species. Unfortunately, neither of these characters (length of runners and robustness of the plant) can be seen on herbarium specimens and data on labels is also usually lacking.

In deciding whether the Bukit Timah population represents a new species, it was necessary to compare it with the complete range of variation in *Hanguana malayana* from the aquatic to the terrestrial form. To this end, a study was initiated to find, firstly, a suite of characters that can be examined from herbarium specimens, that can be used to assess whether the terrestrial form is different from the aquatic one in any characters other than robustness and runner length, and, secondly, to test whether the Bukit Timah population, which grows in forest, falls within the range of variation of either of these forms. This study was carried out by R. Kiew, A.T. Gwee, P.K.F. Leong, Mohd Shah Mohd Noor and Samsuri Ahmad.

Based on the literature, eleven characters were selected that could possibly separate the two forms, namely, leaf shape (ensiform v. lanceolate), indumentum (hairy v. glabrous), petiole (present or absent), lamina length, width, and the ratio of width to length, lamina tip (acute v. acuminate), inflorescence length (excluding stalk length), length of lowest inflorescence branch, indumentum of inflorescence, fruit shape (globose or fusiform) and fruit length. These were tested on herbarium specimens of both forms from Peninsular Malaysia.

As with previous studies (Backer, 1951; Backer & Bakhuizen van den Brink, 1968), no character could be identified that would reliably separate the aquatic from the terrestrial form. The characters either showed continuous variation, such as lamina

length and width or inflorescence length, or, if disjunct, such as fruit shape, did not correlate with other characters.

The Bukit Timah *Hanguana* population grows in forest along streams and on slopes, i.e. the habitat of the terrestrial form. Fertile specimens in the Bukit Timah population were examined in the field for nine characters (leaf shape, leaf tip, petiole and lamina length, lamina width, inflorescence length, length of the lowest inflorescence branch, fruit shape and length). Results showed conclusively that they fell within the range of the Peninsular Malaysian population although in lamina length, they were in the lower range (mean length 57 cm, range 41–118 cm) compared with mean length 76 cm, range 20.5–153 cm for *H. malayana* in Peninsular Malaysia. Their smaller size might be explained by the nutrient-poor habitat of most of the population, which grows on the coarse sand in an eroded streambed. Those on the slope above the stream where there is a litter layer are larger plants but nevertheless still fall within the range of variation seen in Peninsular Malaysia. There was no difference for the other characters between the Bukit Timah and Peninsular Malaysian populations. A few plants growing in water on the streambed had short runners up to 20 cm long.

This study therefore shows that the suggestion by Bogner that the Singapore population of *Hanguana* represents a new species cannot be upheld as it falls within the range of variation seen in *H. malayana*.

Backer, C.A. 1951. *Hanguana*. *Flora Malesiana*. Ser. 1. 4: 248–250.

Backer, CA. and R.C. Bakhuizen van den Brink. 1968. *Hanguana*. *Flora of Java*. 3: 23–24.

Henckelia puncticulata (Ridl.) A. Weber.

Synonym: *Didymocarpus perdita* Ridl. J. Str. Br. Roy. As. Soc. 44 (1905) 54.

Type: Seletar – Ridley s.n. 3 Nov 1889. (holo SING).

Hypobathrum coniferum (Ridl.) Kiew, *comb. nov.*

Basionym: *Petunga conifera* Ridl. J. Str. Br. Roy. As. Soc. 79 (1918) 81; Ridl. Fl. Mal. Pen. 2 (1923) 85.

Synonym: *Hypobathrum* sp. 11 K.M.Wong. Tree Fl. Mal. 4 (1989) 355.

Invalid name: *Hypobathrum coniferum* Bakh.f. in Keng, Concise Flora of Singapore Gymnosperms and Dicotyledons (1990) 156.

Type: Singapore – Gardens Jungle Ridley 10722 1899 (holo SING).

Notes: Bakhuizen f. never published the combination cited by Keng, which is therefore invalid. *Hypobathrum coniferum* resembles *H. venulosum* (Hook.f.) K.M.Wong but differs in its very short inflorescences (up to 1.5 cm long) and its larger and broader

leaves with more veins (15–18 x 6–7 cm with 7–9 veins) whereas *H. venulosum* has long inflorescences up to 8 cm long and leaves 9–13 x 3.5–5 cm with 5–7 pairs of veins. *H. coniferum* is therefore a valid species. All three specimens of *H. coniferum* were collected in flower so its fruit remains unknown.

Other specimens: Singapore – Gardens Jungle Ridley 8427 April 1897 (SING); Peninsular Malaysia – Johore, Sungai Kayu Kiah SFN 32366 10 March 1937 (SING).

Litsea ridleyi Gamble. Kew Bull. (1910) 317.

Type: Reservoir Wood - Ridley 5101 1893 (lecto SING (flowers), here designated).

Other specimens: Singapore (no locality) - Cantley s.n. 1880s (SING); Botanic Gardens - Cantley 193 (SING); Gardens Jungle Hill H1038 11 Aug 1970 (SING); Chan Chu Kang - Ridley s.n. 1894 (SING); Changi - Goodenough 3803 1892 (SING); Bukit Mandai - Ridley 3836 1892 (SING), Ridley 4701 1892 (SING), Goodenough 5064 1893 (SING), Ridley 10833 22 May 1900 (SING); Holland Road - Hullett s.n. 22 May 1893 (SING); Bukit Timah Nature Reserve - Hamzah Tambi H23 14 July 1971 (SING), Mohd Noor MN1878 22 April 1974 (SING), Shah & Samsuri 3946 1976 (SING), Maxwell 82-61 28 Feb 1982 (SING).

Notes: Among the Peninsular Malaysian species, it most resembles *Litsea accedens* Bl. (syn. *L. singaporensis* Gamble) in leaf and inflorescence characters but the latter species is distinct in its fine reticulations that in dried leaves are raised.

The description in Ridley's flora (1924) contains an error for petiole length, which he describes as 0.15 inches long, when Gamble (1910) originally described it as 1.5 cm long.

Piper flavimarginatum C.DC. Rec. Bot. Survey India. 4 (1912) 26.

Type: Chan-chu-kan Ridley 3772.

Other specimens: Bukit Timah – Ridley s.n. 1899 (SING), Corner SFN 3499 19 June 1938 (SING); Jurong – Corner s.n. 17 April 1933 (SING).

Polyosma ridleyi King. J. As. Soc. Beng. 66 (1897) 304.

Type: Seletar Ridley 3972 1892 (iso SING).

Note: Known from a single collection.

Psychotria 'sp. 9' K.M.Wong. Tree Fl. Mal. 4 (1989) 398.

Specimens: Singapore (without locality) - Cantley 2807 1880s (SING), Ridley 11272 1901 (SING); Chan Chu Kang - Hullett s.n. 1896 (SING); Bukit Mandai - Ridley 6556 1894 (SING); Bukit Panjang (?Puyan) Ridley 12530 1906 (SING); Bukit Timah - Ridley 11238 21 Oct 1900 (SING); Bukit Timah Road - Ridley 904 (SING); Jurong - Ridley 8422 March 1891 (SING).

Spatholobus ferrugineus (Zoll. & Moritz) Benth. var. *sericophyllus* Ridl. Fl. Mal. Pen. 1 (1922) 574.

Type: Upper Bukit Timah - *Ridley 5578* (lecto SING).

Other specimens: Kranji - *Ridley 6394* 1894 (SING), *Sinclair SFN 40687* 27 July 1955 (SING); Bukit Mandai *Goodenough s.n.* 1890 (SING); Mandai Road - *Ridley s.n.* 1900 (SING); Bukit Timah - *Corner & Furtado s.n.* 10 Nov 1929 (SING).

Spatholobus ridleyi Prain ex King. J. As. Soc. Beng. 66.II (1897) 80.

Type: Singapore Botanic Gardens *Ridley 6401* 1894 (iso SING).

Other specimens: Chan Chu Kang - *Mat 6795* 1894 (SING); Gardens Jungle - *Ridley s.n.* 1899 (SING).

Strychnos ridleyi King & Gamble. J. As. Soc. Beng. 74.II (1908) 621.

Type: Tuas [Toas] *Ridley 8313* 4 May 1894 (isolecto SING).

Other specimen: Pulau ?Terijej - *Goodenough s.n.* 1891 (SING).

Notes: The name of the island (?Terijej) is illegible and we were unable to find an island in the Singapore/Indonesian waters off Singapore that has a name that could possibly match.

Tectaria griffithii (Baker) C.Chr. var. *singaporeana* Holttum. Blumea 35 (1990) 551.

Type: Bukit Timah - *C.G. Matthew s.n.* Jan 1908 (K).

Note: This variety is known from a single plant so there are no specimens at SING.

Thunbergia dasychlamys Bremek. Verh. K. Nederl. Akad. Wetensch. Afd. Natuurk. Sect. II. 1.4 (1955) 53.

Type: Reservoir - *Ridley s.n.* 1906 (holo SING).

Other specimen: Tanglin - *Ridley s.n.* 1896 (SING).

Note: Bremekamp recorded 'locality illegible' for *Ridley's* 1896 specimen. The label in fact reads 'hedges in Tanglin'.

A Note on *Cordia premnifolia* Ridl. (Boraginaceae)

HASSAN IBRAHIM

Singapore Botanic Gardens
Singapore 259569

Abstract

Cordia premnifolia Ridl. is confirmed as a synonym of *C. dichotoma* G. Forst., not of *C. cochinchinensis* Gagnep., which does not occur in Malesia. *C. premnifolia* is lectotypified.

Introduction

This paper arises out of the exercise to verify the status of type specimens in the Singapore Herbarium (SING), in this case, to verify the type of *Cordia premnifolia* Ridl. The family Boraginaceae was revised by Riedl (1997) for Flora Malesiana, in which he regarded *C. premnifolia* as a synonym of *C. cochinchinensis* Gagnep. and stated no types were known for *C. premnifolia*. By including *C. premnifolia* in the latter, he considered that *C. cochinchinensis* occurs in Malesia. This paper discusses whether *C. premnifolia* should be included in the more widely distributed *C. dichotoma* G. Forst. as suggested by Ng (1989) or in *C. cochinchinensis* as suggested by Riedl (1997).

Cordia premnifolia

The three specimens that Ridley (1915) cited when he described *Cordia premnifolia* are all in the Singapore Herbarium. These specimens were collected in the Pahang river region, Peninsular Malaysia.

Ridley (1915) described the leaves of *C. premnifolia* as ovate, obtuse or subacute, 6.5 x 4 in (16.5 x 10 cm), with the base as rounded or cordate and margins slightly undulate to distantly serrulate. These characters distinguished it from *C. griffithii* C.B. Clarke (now a synonym of *C. dichotoma*), which Ridley (1923) described as having ovate-lanceolate acute to acuminate leaves with a slightly cuneate base, 1.5–3.5 x 1–1.75 in (3.8–9 x 2.5–4.4 cm).

A comparison of specimens of *Cordia premnifolia* and *C. dichotoma* from

Peninsular Malaysia and Singapore shows the three syntypes of the former to have large, broad leaves up to 17 x 11 cm with a rounded to cordate base and entire to slightly serrulate margins; while the majority of the latter has smaller, narrower leaves, 6.5–11 x 3.5–9 cm, with a cuneate base and wavy margin. However, some specimens of *C. dichotoma* have broader leaves with a rounded base and an entire margin. In addition, even on a single specimen of *C. premnifolia* there is a great range in leaf size, for example, from 7.5–9.5 x 7 cm to 12.5–15 x 10–11 cm, thereby overlapping with those of *C. dichotoma*. There are no differences in fruit shape and size and both have the characteristic conical calyx cup. Taking the Peninsular Malaysian and Singapore population of *C. dichotoma* as a whole, the *C. premnifolia* specimens, although representing individuals with the largest leaves, fall within the range of variation for that species. Ng (1989) was therefore correct in including *C. premnifolia* as a synonym of *C. dichotoma*. He did not, however, lectotypify *C. premnifolia*.

Riedl (1997) made *Cordia premnifolia* a synonym of *C. cochinchinensis* without giving a reason for his decision as well as without seeing any of the three syntypes at SING and, because of this, he considered that *C. cochinchinensis* occurred in Malesia.

Cordia cochinchinensis

In 1951, Johnston's account of *Cordia dichotoma* highlighted its wide distribution ranging from southern China and northern India, south through Indochina and Malesia (including Peninsular Malaysia) to northeastern Australia. Gagnepain & Courchet (1914) first described *C. cochinchinensis* from specimens collected in Cambodia, Vietnam and Thailand (the Taleng Mountains in the Petchabouri region). Riedl (1997) recorded *C. cochinchinensis* as occurring in Malesia presumably because he considered *C. premnifolia* as a synonym of *C. cochinchinensis*. There is no other documentation of this species being found elsewhere in Malesia. For example, it is not included in the Flora of Java (Backer & Bakhuizen, 1965), the Tree Flora of Malaya (Ng, 1989), the Tree Flora of Sabah and Sarawak (Dayang Awa, 1996) or Merrill's 1923 Enumeration of Philippine Flowering Plants.

There are no specimens of *Cordia cochinchinensis* at SING but from the descriptions by Gagnepain & Courchet (1914) and Johnson (1951), *C. cochinchinensis* and *C. dichotoma* are very similar species with overlapping geographical ranges. The main difference appears to be in the fruit: ovoid and up to 30 mm long and 22 mm wide with a campanulate fruit calyx in *C. cochinchinensis* compared with ovoid and about 22 mm long and 13 mm wide with a broadly cup-shaped to an inverted cone-shaped fruit calyx about 6 mm long and 12 mm wide with obscurely lobed edges in *C. dichotoma* (including *C. premnifolia*). Unfortunately, there is as yet no

revision of the Boraginaceae for the Flora of Thailand, where both species occur. It is beyond the scope of this paper to conclude whether *C. cochinchinensis* and *C. dichotoma* are conspecific. However, *C. cochinchinensis* does not occur in Peninsular Malaysia and therefore not in Malesia either.

***Cordia dichotoma* G. Forst.**

Cordia dichotoma G. Forst., Fl. Ins. Austr. (1786) 18, nr. 110; Johnston, J. Arnold Arbor. 32 (1951) 8; Backer & Bakh. f., Fl. Java 2 (1965) 459; Ng, Tree Fl. Malaya 4 (1989) 60, Dayang Awa, Tree Fl. Sabah & Sarawak 2 (1996) 98, fig. 2; Riedl, Fl. Malesiana I.13 (1997) 74.

Type: New Caledonia, *Forster s.n.*, (not seen)

Synonym: *Cordia premnifolia* Ridl., J. Str. Br. Roy. As. Soc. 68 (1915) 12; Fl. Mal. Pen. 2 (1923) 438.

Type: Peninsular Malaysia – Tanjong Antan, Pahang, *Ridley 2158* (lecto SING, here designated).

Other syntypes examined: Peninsular Malaysia – PAHANG: Pahang River *Burn Murdoch 186* (SING), Kuala Lipis *Machado 11567* (SING).

Notes: *Ridley 2158* is chosen as the lectotype among the specimens it is the most complete having mature fruits.

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New Species of, and Other Notes on, *Chisocheton* and *Walsura* (Meliaceae)

D. J. MABBERLEY

Nationaal Herbarium Nederland, University of Leiden, The Netherlands;

¹National Herbarium of New South Wales, Royal Botanic Gardens Sydney, Mrs Macquaries Road, Sydney 2000, Australia¹

Abstract

Chisocheton maxilla-pisticis Mabb., from Sabah, Malaysia, and Palawan, Philippines, and *C. velutinus* Mabb., from Sarawak, Malaysia, and Brunei, are described as new. A third new *Chisocheton* species, from Sarawak, is so far known only from a single fruiting specimen. *Walsura pinnata* Hassk. *sensu* T.Clark includes a number of distinctive Bornean entities, two of which are here afforded or re-afforded specific rank: *Walsura decipiens* Mabb., from northern Borneo and *W. grandifolia* Ridl. from the Sarawak limestone. *Chisocheton nicobarianus* Debnath & Sreek. is reduced to *C. macrophyllus* King, which is lectotypified here, while *Walsura yunnanensis* C.Y.Wu from China is reduced to *W. pinnata sensu lato* (*W. cochinchinensis* (Baill.) Harms).

Introduction

In preparing the text of Meliaceae for the *Tree Flora of Sabah and Sarawak*, it became clear that new *Chisocheton* species signaled in the author's monograph (1979; see also 1995) could now be described using materials collected since its publication. Examination of Borneo materials assigned by Clark (1994) to *Walsura pinnata* Hassk., a perplexingly variable species, has shown that two distinct species, one of them new, are better segregated from it. In passing, notes on allied taxa from outside Borneo are included.

Chisocheton Blume

1. *Chisocheton maxilla-pisticis* Mabb., sp. nov., Fig. 1

Chisocheton, *C. macrophylo* King *affinis*, *indumento dense-fulvo, foliolis costis paucioribus, pseudogemmula hiante vix circinnata, maxilla pisticis simulante, floribus pusillioribus, differt. Typus:* Malaysia, Sabah, Telupid, Pinangah F.R., 10 July 1993, *Sawan Tingki SAN 136830* (holo SAN!, iso KEP!, SAR!).

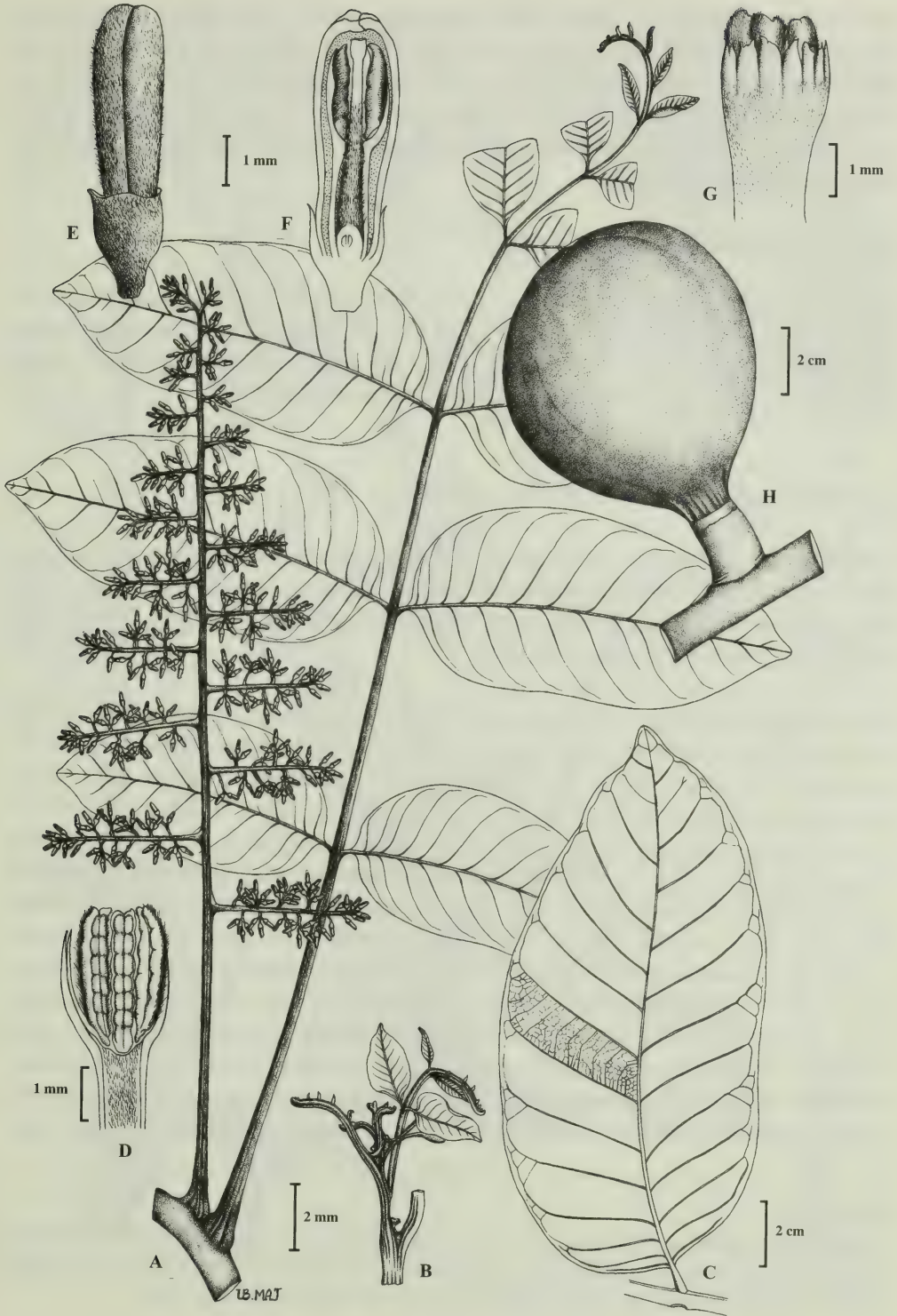
¹ Address for correspondence

Rather pachycaul tree with sparsely branched crown to 45 m tall; fluted bole to 90 cm diameter with steep buttresses to 1(–3) m tall. **Bark** smooth to scaly, markedly lenticellate; inner bark reddish brown; sapwood pale yellowish white. **Twigs** brown, with longitudinal cracks, cicatrices conspicuous, latex white. Leafy twigs 1.2–1.5 cm diameter, fulvous-tomentellous. **Leaves** in dense terminal spirals, to 1.3 m long, pseudogemmulate; petioles 8.5–16.5 cm long, more or less angled or grooved, like rachis, indumentum sericeous to pilose; leaflets in up to at least 17 pairs, oblong-ovate, weakly falcate, to 21 x 8.5 cm, rather fleshy (Pennington), young ones brownish or reddish, densely pilose on midrib and costae, also abaxially scattered between veins, bases asymmetrical, rounded or, particularly in juveniles, cuneate, apices acute to shortly acuminate, costae *c.* 17 on each side, spreading, rather prominent adaxially *in sicco*, petiolules to *c.* 9 mm long, densely pilose; pseudogemmula of rather unfurled leaflets, densely long-hairy. **Thyrse** to 50 cm long, narrowly paniculiform, tomentellous; peduncle *c.* 18 cm long, branches rather distant, to 10 cm long, squarrose; ultimate branchlets cymulose, many-flowered; pedicels tomentellous. **Calyx** *c.* 2 mm tall, cupular, sericeous, margin truncate to weakly 4-lobed. **Petals** 4 or 5, *c.* 11 mm long, *c.* 1.8 mm wide, linear-spathulate, sericeous without, glabrous within, imbricate, apices concave (corolla clavate in males). **Staminal tube** swollen at mouth, weakly adherent to petals at base, hairy at least along interlobe sutures near apex without, hairy within, margin with 6–8 linear, more or less 2- or 3-toothed, lobes to 2.5 mm long; anthers 5–8(9), *c.* 2 mm long, oblong, locellate, basifixed, slightly exerted. **Disc** obscure. **Ovary** 4-locular, sericeous; style sericeous in proximal 5/6; stylehead subcylindrical with flattened apex. **Infructescences** to 30 cm long, axillary or on twigs behind leaves. **Capsule** spherical, to at least 9 cm diameter, reddish brown, latex white; pedicel to 9 mm across. **Seeds** unknown.

Other material seen: SABAH: Kinabatangan, Tedong, 21 July 1962, *Singh SAN 31087* (K!, L!, SAN!, SAR!); Lahad Datu, Kretam, 28 May 1954, *Wood SANA 4769* (KEP!, L!, SING!), Lahad Datu, road to Taliwas, Danum Valley, 24 June 2000, *Madani et al. SAN 143512* (SAN!); Ranau, Lohan F.R., 28 Oct 1963, *Pennington 7934* (FHO!, K!, KEP!, L!, SAN!); Sandakan, Sepilok, boundary between Compts 4 & 5, 22 Oct 1963, *Pennington 7915* (FHO!, L!, SAN! = *Meijer SAN 39141* (SAN!)), Sg. Daghat 1960 Coupe, 18 Oct 1961, *Meijer SAN 27861* (SAN!), 'Keratom lined land', 27 May 1983, *Sigin & Lideh SAN 97058* (SAN!); Tawau, Kalabakan, 30 miles WNW of Tawau, 24 April 1954, *Wood SANA 3696* (KEP!, L!, SING!). KALIMANTAN: Loa Haur,

Figure 1.

Chisocheton maxilla-pisticis. A, flowering twig; B, young leafy shoot, C, older leaflet; D, adaxial view distal part of staminal tube; E, flower bud; F, longitudinal section of flower bud; G, abaxial view of distal part of staminal tube; H, fruit. (A from *SAN 31087*, B from *SAN 136830*, C from *Pennington 7915*, D–G from *SAN 31087*, H from *SANA 4769*.)



west of Samarinda, 60 m, 12 May 1952, *Kostermans* 6834 (A!, K!, KEP!, L!); Nunukan (northern part), 2 Dec 1953, *Kostermans* 8897 (K!, L!, SING!); W Kutei, Kelindjau River, 12 June 1954, *Kostermans* 9571 (K!, L!, SING!), *bb* 16168 (SING!); SE Borneo, Tidoeng vicinity, 15 m, *bb* 17894 (L!); Berouw, 400 m, 4 July 1934, *bb* 19239, (L!). PHILIPPINES: Palawan, Pagdanan Range, Ibangley Brookside Hill, 21 Apr. 1984, *Ridsdale SMH* 496 (KEP!).

Habitat: Lowland dipterocarp forest.

Notes: Some older sterile and fruiting specimens were previously referred with a '?' (Mabberley, 1979: 346) to the closely allied *Chisocheton macrophyllus* King, which does not occur in the *Tree Flora* area. The specific epithet, meaning shark-jaw, refers to the open pseudogemmula characteristic of the leaf of this tree.

2. *Chisocheton velutinus* Mabb., sp. nov., Fig. 2

Chisocheton, *C. erythrocarpum affinis*, sed inflorescentia longiore facile separanda est. In ser. *Sandoricocarpis indumento velutino distincta* est. **Typus**: Wong 1536, Brunei, Temburong Dist., Bt. Belalong, west ridge from summit, 650 m, 23 July 1989 (holo SAN!; iso KEP!, SAR!, SING!).

Tree to 25 m tall; bole to 35 cm diameter with small buttresses. **Bark** smooth, medium brown to greyish, hoop-marked, inner bark pinkish to reddish brown; sapwood straw; buttresses to 1.3 m x 7.5 cm. Leafy twigs 1.2–2.5 cm diameter. **Leaves** to 1 m long, pseudogemmulate; petioles 10–15 cm, more or less angled, like rachis, fulvo-velutinous; leaflets in up to at least 12 pairs, oblong, to 24 x 9 cm, minutely pubescent on sunken midrib, densely velutinous on abaxial surface, bases asymmetrical, rounded, apices shortly acuminate, lateral veins 15–17 on each side, spreading, rather prominent adaxially *in sicco*, petiolules to 9 mm long. **Thyrse** to 40 cm long, paniculiform, velutinous; branches rather distant, to 13 cm long; ultimate branchlets cymulose, few-flowered; pedicels densely pubescent. **Calyx** c. 6 mm tall, cupular, pubescent, green, margin very obscurely 4-lobed to truncate. **Petals** 4(5), linear-spathulate, to 16 mm long, imbricate, puberulous to pubescent without, glabrous within, cream. **Staminal tube** cream, weakly adherent to petals at base, more or less hairy without, margin with 6–8 2-toothed lobes to 1 mm long; anthers 6–8, oblong, c. 3 mm long,

Figure 2.

Chisocheton velutinus. A, flowering twig; B, flower buds; C, longitudinal section of flower bud; D, abaxial view of staminal tube; E, adaxial view of staminal tube; F, young new shoot; G, older leaflet; H, fruit. (A–E from Wong 1536, F–H from Kirkup *et al.* 940.)



locellate, basifixed, apices within the tube. **Disc** obscure. **Ovary** 4-locular, sericeous; style more or less glabrous; stylehead shortly cylindrical. **Infructescences** to 30 cm long, axillary or on twigs behind leaves. **Capsule** globose, c. 5 cm diameter (immature), rostrate when young, velutinous, yellow turning red.

Other material seen: Restricted to Borneo. SARAWAK: Ulu Luak, Sg. Setap road, Miri, 15 May 1964, *S* 21307 (K!, SAR!, SING!); Kapit, Ulu Merit, Ng. Sebatong, 6 Oct 1969, *S* 28793 (K!, SAR!, SING!). BRUNEI: Temburong, Bt. Belitun, 29 Jan 1994, *Kirkup et al.* 940 (K!, KEP!, SAN!, SAR!, SING!). KALIMANTAN: Balikpapan, *Kostermans* 10024 (L!); Peak of Balikpapan (G. Beratus), sandstone, 700 m, 9 July 1952, *Kostermans* 7383 (K!, SING!); Sg. Wain region, N of Balikpapan, 30 m, *Kostermans* 4175 (SING!).

Habitat: Rain forest at altitudes to 650 m.

Notes: Some of the older fruiting specimens cited above (*Kostermans* 7383, *Kostermans* 10024 and *S* 28793) were tentatively placed under *Chisocheton* species B (Mabberley 1979: 372; 1995: 186). The remaining specimens from the *Tree Flora* region cited there (*S* 25844 from Kapit, Melinau, Ulu Sapurau, Bt. Salong, Sarawak (K!, SAR!), with flowers are in bud) is the flowering element used in that description and remains the only flowering material I have seen of that tree. Apparently conspecific with it is the fruiting specimen *S* 45515 (from the 7th Division, Belaga, Linau, Sg. Iban in Sarawak (FHO!, L!, SAR!), collected as *C. medusae*).

3. *Chisocheton* sp. nov. *aff. diversifolius* Miq.

Collected as *Aglaia affinis* Merr. [= *A. odoratissima* Blume], this fruiting collection of a 4 m tall treelet (*P.C. Yii* *S* 48450, Sarawak, 7th Division, Batang Balleh, Bukit Melatai, Camp 2; FHO!, SAR!) has delicate twigs with 7-jugate leaves, with very narrow multi-veined leaflets 5–6 times as long as wide, and a very delicate fruiting rachis c. 20 cm long with pubescent spherical fruits 3–4 cm diameter. It appears to be close to *C. diversifolius* Miq. from Sumatra, but that rarely collected treelet is known for certain only in flower and has broader leaflets (see Mabberley 1979: 358; 1995: 174).

4. *Chisocheton nicobarianus* Debnath & Sreek.

The only other species described in the genus since the author's monograph, now almost a quarter of a century old, is *Chisocheton nicobarianus* Debnath & Sreek.

from the Nicobars. Examination of an isotype shows it to be conspecific with *C. macrophyllus* King:

Chisocheton macrophyllus King in J. Asiat. Soc. Bengal 64(2) (1895) 32; Mabb. in Bull. Brit. Mus. Nat. Hist. Bot. 6 (1979) 345. **Type:** (lectotype [selected here from King's syntypes] Curtis 2469, Peninsular Malaysia, Penang, 'Polo Boeting' (CAL!); isolectotypes BM!, K!, K [ex SING!]). **Synonym:** *C. nicobarianus* Debnath & Sreek. in J. Econ. Tax. Bot. 16 (1992) 553. **Type:** Dwivedi 8541, Gt Nicobar, Laful forest, 18 May 1981 (holo CAL, *n.v.*; iso L!, PBL *n.v.*). **syn. nov.**

Note: This brings the total number of species in the genus to 53, with 22 in Borneo (11 restricted to that island), all of which are found in the *Tree Flora* area.

Walsura Roxb.

In his revision of the genus *Walsura*, Clark (1994: 249, 279) discussed the variation in his concept of *W. pinnata* Hassk. and proposed informal entities for the major variants he recognised. In Sabah, these are the typical 'pinnata', represented by SAN 86994 (SAN!, SAR!) from Keningau in Ranau district, and also his 'villamilii' represented by SAN 57288 (SAN!, SAR!) from Lahad Datu, Sandakan, which has leaves with seven or nine, as opposed to five, leaflets with some costae failing to reach the leaf margin, but otherwise intergrading with 'pinnata', the form found throughout most of the range of this tree which, according to Clark (1994: 279, fig. 12) is distributed from the mainland SE Asia to Peninsular Malaysia, Borneo, the Philippines and NW New Guinea.

Although there is a wide range of costa number in the leaflets of Sabah specimens, the great majority fall into Clark's broadly circumscribed *W. pinnata*, though specimens with a very small number of leaflet costae (6 or 7 as opposed to 14–19) and short inflorescences and infructescences (e.g. SAN 30551 and SAN 31339; both in SAN!, SAR!) from Tawau, and SAN 44553 (SAN!, SAR!) from Keningau, seem rather distinctive, at least within the *Tree Flora* area.

Moreover there is a small number of other sheets included by Clark and these are more clearly separable and indeed represent a distinct species described below.

1. *Walsura decipiens* Mabb., **sp. nov.**, Fig. 3

Walsura, *W. trichostemon* Miq. *affinis sed foliolis ovatis-acuminatis glabris facile distinguenda est.* **Typus:** Meijer SAN 36201, Sabah, Labuk Rd mile 25.5 (holo SAN!; iso K!, KEP!, L!, SAR!, SING! [duplicate ('Burseraceae') also sent to BO, *n.v.*]). **Synonym:** *W. pinnata* Hassk. *sensu* Clark (1994: 276, 300), *p.p.* & (1995: 48), *p.p.*

Tree to 28 m tall with bole to 6 m, 30 cm diameter. **Bark** scaly, outer bark dark reddish brown, inner bark pinkish red. Young twigs pale brown, finely sericeous, lenticellate, leafy ones *c.* 4–5 mm diameter; apical buds strongly fulvous-hairy. **Leaves** to 25 cm long, 2-jugate; petiole 3–5 cm long, terete; leaflets 5.5–14.5 x 2.0–4.5 cm, the apical larger than laterals, ovate, articulated at petiolule apices, glabrous, somewhat glaucous abaxially *in sicco*, base acute, apex acuminate, costae 8–12 on each side, arising almost at right angles to midrib but strongly arcuate, looping together but not reaching margin; petiolules 8–18 mm long, that of apical leaflet to 25 mm long, conspicuously swollen at both ends. **Inflorescences** subcorymbose cymes to 20 cm long, in axils of current flush of which apical leaves scarcely developed, all axes densely fulvous pilose; peduncle to 7 cm long, with branches to 9 cm long, bearing apical head of branchlets, each branched once or twice more and bearing cymules of 1–5 flowers; bracts to 2 mm long, usually much less, triangular, densely hairy, caducous; pedicels *c.* 1 mm long; bracteoles 0.5–1 mm, triangular, densely hairy, persistent. **Calyx** *c.* 0.8 mm high, green, lobes broadly triangular, apices rounded to acuminate, very hairy without. **Petals** oblong, *c.* 3 mm long, *c.* 1 mm wide, white, hairy without, apex obtuse. **Stamens** 10, with the filaments alternately long and short, the longer almost as long as petals, weakly bifid, apically strigose, pale green; anthers *c.* 0.7 mm long, ovate, apiculate, sparsely hairy, bright yellow, inserted between 2 apical lobes. **Disc** fleshy, annular. **Ovary** glabrous; style to 1.2 mm long; stylehead flattened with apical papilla and peripheral flange. **Fruits** ellipsoid, 2.5–3 cm long, brownish green tomentellous, apex usually apiculate. **Seed** 1, ellipsoid.

Other material seen: Restricted to the northern parts of Borneo. SABAH: Nabawan, Sg. Millian, 7 Nov 1986, *Krispinus* SAN 118575 (L!, SAN!); Sandakan, Lungmanis Timber Camp, 9 Aug 1962, *Mikil* SAN 31560 (KEP!, L!, SAN!, SAR!); Tawau mile 12.5 Kalabakan road, 25 July 1962 (first record), *Aban Gibot* SAN 30552 (KEP!, L!, SAN!, SAR!); Keningau, Saang Lian logging area, LANAS, 28 Oct 1986, *Krispinus* SAN 118523 (E!, K!, KEP!, SAN!). SARAWAK: Baram, Batang Tinjar, Ulu Sg. Sekiwa, Long Kerangan, 1 Sept 1974, *Tong* S 35017 (KEP!, L!, SAN!, SAR!).

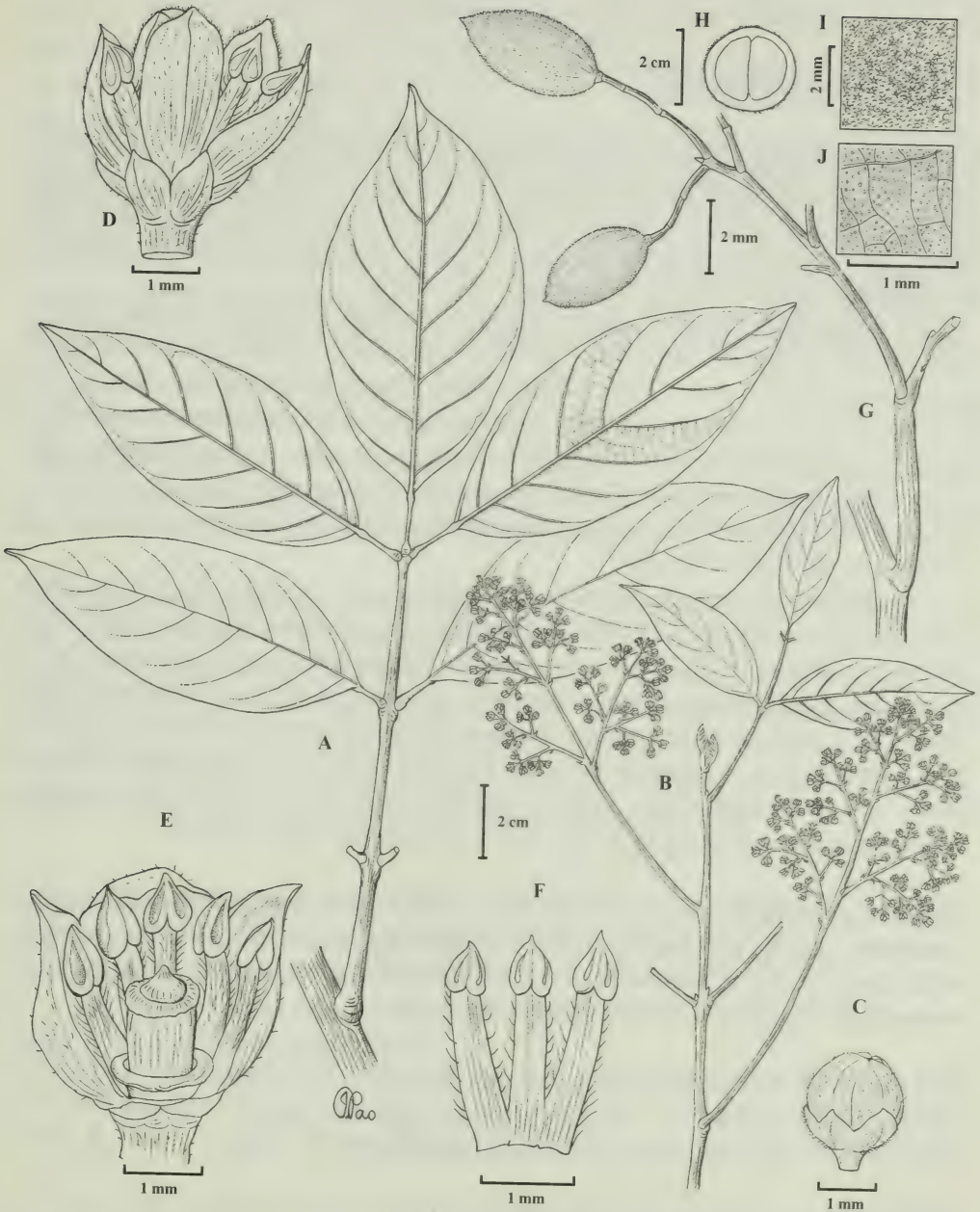
Habitat: Rain forest, at least sometimes on sandstone, to 150 m.

Notes: The only flowering material known to me is that of the type.

Plants of this species have misled many field collectors who have referred

Figure 3.

Walsura decipiens. A, leafy twig; B, flowering twig; C, flower bud; D, open flower; E, open flower with some sepals and petals removed; F, stamens; G, fruiting twig; H, cross-section of fruit; I, indumentum of fruit wall; J, indumentum of lower leaflet surface. (A from SAN 31560, B–F from SAN 36201, G–J from S 35017.)



them variously to *Dialium* (Leguminosae), Burseraceae and to several genera in the Sapindaceae, curators filing them variously (and even in Lauraceae), so the wide deception is commemorated in the specific epithet.

2. *Walsura grandifolia* Ridl.

In Sarawak, 'typical' *Walsura pinnata* has rarely been collected, though forms with a wide range of costa number (see above) are preserved (e.g. *S* 64519 from Kuching (SAR) and *S* 23959 (SAR) [18 or 19 costae], *Pennington* 8000 [8 or 9] (SAR) from Kapit), but *S* 35017 from Baram District included by Clark in his broad concept of the species is here referred to *W. decipiens* (see above).

Some other Sarawak sheets included by Clark constitute another discrete entity worthy of specific rank, much as he has afforded the striking stout-shooted *W. pachycaulon* Mabb. ex T. Clark. (Clark, 1994). These distinctive specimens, with very large rugose leaflets and long inflorescences, were collected from treelets apparently restricted to limestone and they include the type of *W. grandifolia* Ridl., which is here resurrected from Clark's synonymy, bringing to 16 the number of extant species of *Walsura* now recognised, seven in Borneo (to which six are restricted), all recorded in the *Tree Flora* area.

Walsura grandifolia differs from *W. pinnata* not only in its very large leaflets, inflorescences and flowers, but also in its androecium of almost free filaments, which have no apical teeth, its larger disc and its longer cylindrical stylehead. In its androecium therefore it more approaches sect. *Surwala* (M. Roem.) Hook.f. (see Clark 1994, 1995), such that the distinction between that section and sect. *Walsura*, to which *W. pinnata* belongs, seems hardly worth maintaining. On the other hand, the third group, sect. *Ruswala* T. Clark, with the sole species *W. dehiscens* T. Clark, is marked by its distinctive dehiscent fruit and, in that, approaches *Heynea* Roxb.

***Walsura grandifolia* Ridl.** in Bull. Misc. Info. Kew 1930 (1930) 370, *q.v.* for description, amplified in *Tree Flora* account. **Type:** *Kalong in Haviland* 1635, Sarawak, nr Kuching ['e.s.f.' = 5 Oct 1892] (holo K!; iso SAR!). **Synonym:** *W. pinnata* Hassk. *sensu* Clark (1994: 276, 300) & (1995: 48), *p.p.*

Distribution: Restricted to Kuching Division, Sarawak. Other sheets seen: Teng Bukap, mile 32 Padawan Road, *S* 32633 (SAR!); Bt Mentawa, mile 34 Padawan Road, *S* 41069 (SAR!); Bt. Bidi, Bau, *S* 50390 (L!, SAR!); and Bt. Taipu, *S* 74985 (SAR!).

Habitat: Forest on limestone at altitudes to 220 m.

Notes: Of other specimens referred to *Walsura pinnata* by Clark (1994: 300), *Mogea*

3711 (L!) is *Sandoricum borneense* Miq.; SAN 28613 (SAR!) is *Aglaia leptantha* Miq. (and, of those referred to *Pseudoclausena chrysogyne* (Miq.) T. Clark there): Kokawa & Hotta 3069 (SAN!) = *Heynea trijuga* Roxb.; S 26985 (SAR!) = *Aphanamixis borneensis* (Miq.) Harms; S 35236 (SAR!) = *Micromelum minutum* (Forst.f.) Wight & Arn. [Rutaceae]; and S 39029 = *Aglaia leptantha* [C.M. Pannell, pers. comm.]. Nonetheless, the rest of the perplexing complex (see diversity of costa-number and inflorescence size above) around *W. pinnata* needs further collecting and analysis in the field across its range, particularly concentrating on whether certain small flowering trees are really juvenile forms of larger ones, or comprise distinct species like *W. grandifolia*. As it stands, even shorn of all the above, *W. pinnata* still seems to me to be heterogeneous, and certainly so across its range, a conviction confirmed by a cursory examination of Peninsular Malaysian material now available.

3. *Walsura yunnanensis* C.Y.Wu

Among his 'insufficiently known species', Clark (1994: 290) has *W. yunnanensis* C.Y.Wu. Examination of the type preserved at KUN shows it to be *W. pinnata sensu lato* (*W. cochinchinensis* (Baill.) Harms), already known from Yunnan:

Walsura pinnata Hassk., *Retzia* 1 (1855) 147, 235, *sensu lato*; Clark (1994: 276), *p. maj. p.* **Type** (selected by Clark, *l.c.*): *Koorders* 971, Java, Bogor, tree no. III b 20 [grown from material coll. Hasskarl, South Bantam, Sept-Oct 1841], 26 June 1892 (neotype BO; 'clonotype' *Anon. s.n., idem*, L [Acc. 926258-685]!). **Synonym:** *Walsura yunnanensis* C.Y. Wu, *Fl. Yunnanica* 1 (1997) 226 cum tab.; Luo *et al.* in *J. Nat. Prod.* 63 (2002) 947 & *Acta Bot. Yunn.* 23 (2001) 515. **Type:** *Y.H. Li* 2927, Yunnan, Mengla, highway km. 20–37, Feb. 1961 (holo KUN!), **syn. nov.**

4. ***Walsura xizangensis*** C.Y.Wu & H.Li, referred to *Glycosmis* Corrêa (Rutaceae) by Clark (1994) on the advice of van Balgooy, has been transferred to that genus as *G. xizangensis* (C.Y.Wu & H.Li) D.D.Tao (syn. *G. motuoensis* D.D.Tao, *G. medogensis* D.D.Tao ex P.H.Huang) in *Acta Phytotax. Sin.* 32 (1994) 369, though *Glycosmis* is badly in need of a thorough overhaul.

Acknowledgments

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***Arisaema fimbriatum* (Araceae) and its Intraspecific Variation**

G. GUSMAN

Université Libre de Bruxelles (CP 232), Faculté des Sciences,
Bd. du Triomphe, B-1050 Bruxelles, Belgium

Abstract

The status of *Arisaema fimbriatum* Mast. is discussed based on the examination of herbarium material as well as living plants in the wild and in cultivation. *A. fimbriatum* is recognised as having two subspecies: subsp. *fimbriatum* and subsp. *bakerianum* (Engl.) G.Gusman established here.

Introduction

Arisaema fimbriatum Mast. occurs exclusively on limestone in Peninsular Malaysia and the southernmost provinces of Thailand, i.e. in the Malesian phytogeographical region. The species name recalls the spadix-appendix covered with long, thin and filiform bristles. The crimson and crinate appendage, protruding far out from the spathe is so outstanding that *A. fimbriatum* is one of the most remarkable *Arisaema* species yet described from this area.

M.T. Masters encountered the plant in autumn 1884 in Sander's Nursery, St. Alban's, England, and described it the same year in *The Gardeners' Chronicle*.

In 1911, a new plant was introduced in the trade, first called *A. bakeri* Hort. ex Ridley or *A. bakerianum* (Hort.) Sander, which Engler (1920) eventually described as *A. fimbriatum* var. *bakerianum* in *Das Pflanzenreich*. Nevertheless, some authors question the relevance of this variety and treat *A. fimbriatum* var. *bakerianum* as synonymous with *A. fimbriatum*.

I have gathered new information from examination of herbarium specimens, living plants in the field in Malaysia and Thailand, and also in cultivation. As a result of their morphological differences, the two taxa are considered distinct, and, from their separate geographical distributions, the two varieties of *A. fimbriatum* are changed to subspecies.

History

Arisaema fimbriatum was first discovered in cultivation in Sander's nursery among orchids collected in the Philippines (Masters, 1884). Later, when reintroduced by Charles Curtis from Langkawi Islands, its correct Malaysian origin was established

in the south of Langkawi. Its distribution extends in Peninsular Malaysia from Perlis, Kedah, Perak, Kelantan, Pahang, as far south as Selangor. In Perlis it is found in the Tale-Ban National Park, along the Thai border, always growing in crevices in limestone rocks. Its northernmost limit seems to be in Kuan Nieng, Khao Chang Low, Thailand, where Kerr collected it in 1928 (Jacobs, 1962) as no specimen of *A. fimbriatum* has been found further north of Kerr's location.

Gagnepain (1941), apparently unaware of Master's species, described Kerr's specimen as *A. putii* Gagnep. Hetterscheid & G.Gusman (2003) have shown that the three syntypes of *A. putii* cited by Gagnepain include at least two different species! This confusion was recently resolved and the lectotypification of *Kerr 15899* (K) established the synonymy of *A. putii* with *A. fimbriatum*.

Arisaema fimbriatum subsp. *bakerianum* was first collected by Curtis in 1896 during a boat trip along the coast from Penang to Kasom (Curtis, 1897). As noted on *Curtis 3281*, it was collected in "Kasoom on limestone island near the mouth of the river", today in the Ao Phang Nga National Park.

1. *Arisaema fimbriatum* Mast. subsp. *fimbriatum*, Gard. Chron. 22 (1884) 680.

Type: Gard. Chron. 22 (1884) fig. 119.

Synonym: *Arisaema putii* Gagnep., Notul. Syst. (Paris) 9 (1941) 127. **Lectotype:** *Kerr 15899*, THAILAND, Kuan Nieng, Khao Chang Low, 24 July 1928 (K).

Plant deciduous, up to 60 cm tall and wide. *Subterranean stem* a subglobose tuber, 3–5 cm wide, 2–3.5 cm high, cream. *Roots* fleshy, few. *Pseudostem* the length of the petioles or longer, 25–30 cm long, 1.8 cm wide at the base, pale magenta or pale green. *Cataphylls* up to 5, lanceolate, 2–30 cm long, similar in colour to the pseudostem. *Petiole* 20–25 cm long, 1 cm wide at the base, similar in colour to the pseudostem with faint, pink stripes in the upper part. *Leaves* usually 2, trifoliolate. *Leaflets* glossy dark green above, paler with slightly prominent veins beneath; subsessile or shortly petiolulate; margins entire; apex acuminate ending in a short arista, 0.5 cm long. *Central leaflet* elliptic ovate, 20–24 cm long, c. 15 cm wide; base cuneate or convex. *Lateral leaflets* ovate, slightly asymmetrical, nearly the size of the central leaflet; base convex. *Inflorescence* above the foliage, emerging when the leaves unfold. *Peduncle* 20–30 cm long, 6 mm wide at the base, similar in colour to the petioles. *Spathe-tube* cylindrical, slender, 6–7 cm long, 1.5–2 cm wide, dark crimson with pale green stripes outside and white stripes inside; mouth-margins straight to hardly recurved. *Spathe-limb* horizontal, ovate lanceolate, 7–10 cm long, 3.5–4 cm wide, dark crimson and white striped, with a green hue outside. *Spathe-tip* acuminate. *Spadix-appendix* long exerted from the spathe at anthesis, 8–15 cm long, slender; exerted portion a crimson, pendulous, whip-like tail, covered with c. 25 mm long, filiform,

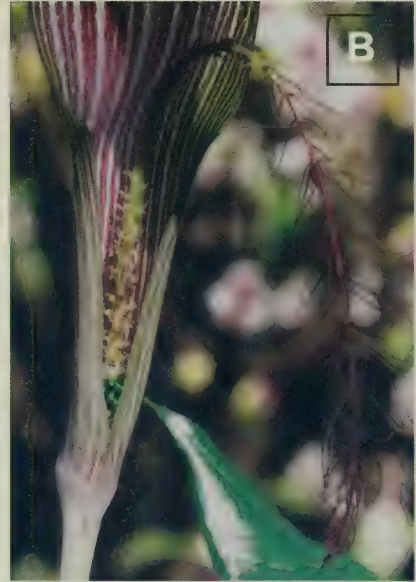


Figure 1: *Arisaema fimbriatum* subsp. *fimbriatum*
A) Flowering plant; B) Spadix appendage; C) Spathe

dark crimson, bristly projections; included portion light yellow-green, crimson striped, 4–6 mm across at the base; with scattered green neuters, c. 5 mm long; lower part sessile. *Spadix* male or bisexual. *Male part* c. 3 cm long, 0.5 cm across; stamens loosely arranged, borne on a green stalk, c. 1 mm long, 2–4-anded, anthers crimson; thecae dehiscent by an elongated pore. *Female part* c. 2 cm long and 1.5 cm across; pistils loosely packed; ovaries ovoid and green, stigma stalked and penicillate. *Infructescence* subcylindrical, c. 2.2 cm long and 1.8 cm across, borne on an erect peduncle when ripe; receptacle cream. *Berries* densely packed. Seeds 1 mm in diam.; testa brown. *Germination* a simple eophyll is produced just after germination.

Flowering period: May to August. *Ripening time*: November.

Distribution: Peninsular Malaysia (Kedah, Kelantan, Pahang, Perak, Perlis, Selangor) and SW Thailand (Songkhla).

Habitat: Primary, tropical lowland evergreen rain forest, 100–300 m altitude, growing in rich humus, limestone crevices.

Additional material: MALAYSIA – KEDAH: Langkawi, Curtis 1890 (SING), Curtis 1893 (SING), Moosa 1896 (SING), Bukit Puteh Corner s.n. 20 November 1941 (SING), Pulau Dayang Bunting FRI 44601 7 May 1996 (KEP), Telok Apau Haniff & Nur SFN 7490 (SING). KELANTAN: Gua Musang UNESCO Limestone Expedition 427, 6 August 1962 (SING). PAHANG: Bukit Sagu Nur SFN 25160, 14 October 1931 (SING); Kota Glanggi Ridley s.n., 1891 (SING). PERLIS: Pulau Rabana Henderson SFN 23099 (SING). PERAK: 10 km south of Ipoh Ng FRI 1605, 4 October 1966 (SING). SELANGOR: Batu Takun near Kanching Nur SFN 34376, 3 November 1937 (SING).

Notes: FRI 44601 clearly shows that the subterranean stem is tuberous and not rhizomatous as has sometimes been erroneously stated in the literature (Govaerts & Frodin, 2002).

2. *Arisaema fimbriatum* subsp. *bakerianum* (Engl.) G.Gusman stat. nov.

Type: Curtis 3281, THAILAND, Kasom, “on limestone island near mouth of the river”, November 1896 (lectotype SING, selected here).

Synonym: *A. bakeri* Ridl., Journ. Roy. Asiat. Soc. Bengal 59 (1911) 218. *A. bakerianum* Engl. Pflanzenr. 73:4, 23F (1920) 152, pro syn. *A. fimbriatum* var. *bakerianum* Engl. Pflanzenr. 73:4, 23F (1920) 152.

Subspecies *bakerianum* differs from subsp. *fimbriatum* by the following characters: *Shoot* usually with 1 leaf, rarely 2. *Leaflets* pale green beneath with a reddish hue when unfolding. *Inflorescence*: *spathe-tube* white-green, unstriped outside and inside; mouth margins light green; *spathe-limb* crimson outside paler inside with a white



Figure 2: *Arisaema fimbriatum* subsp. *bakerianum*
A) Inflorescence; B) Spadix appendage; C) Habitat

spot at throat level, surrounded by light green margins; *spadix-appendix* included portion pale yellow-green and glabrous.

Distribution: SW Thailand, endemic on islands in Ao Phang Nga (Bay of Phang Nga) and Ao Phra Nang.

Habitat: North facing slopes in limestone crevices, beneath bushes, just above sea level.

Additional material: THAILAND. From islands facing Kasom: *Curtis* 3262, November 1896 (SING); *Curtis* 3281, November 1896 (BM, SING); *Curtis* s.n., 1897, a specimen which flowered in Penang BG in April 1897 (SING); *Curtis* 8947, 1897 (SING). Krabi, Ao Phra Nang: *Gusman* 03076, July 2003 (BR).

Notes: *Curtis* 3281 has a tuberous subterranean stem. *Curtis* also noted that “*A. fimbriatum* has always two leaves, this has one”, in full agreement with observations I made in the field. I had the opportunity to observe hundreds of plants, which were always on islands and near the seashore. By contrast, limestone outcrops on the mainland along Ao Phang Nga and Ao Phra Nang did not harbour any specimens of *A. fimbriatum*. This may result from the coolness the proximity to the sea provides on these islands.

Discussion

Reliable morphological characters that separate the two subspecies are summarized in Table 1 and illustrated in Figures 1 and 2.

Table 1. Morphological differences between *Arisaema fimbriatum* subsp. *fimbriatum* and subsp. *bakerianum*.

| SUBSPECIES | <i>fimbriatum</i> | <i>bakerianum</i> |
|---------------------------|----------------------------|-----------------------------|
| CHARACTERS | | |
| Number of leaves | usually 2 | usually 1 |
| Colour of the spathe-limb | crimson with white stripes | crimson without stripes |
| Colour of the spathe-tube | crimson with white stripes | white-green without stripes |
| Base of appendix | hairy | glabrous |

In addition, there are clear differences in both geographic distribution and habitat. Their distributions are allopatric, which justifies the modification of status from variety to subspecies. *A. fimbriatum* subsp. *fimbriatum* is widespread on limestone in Peninsular Malaysia from the Langkawi Islands south to Selangor. Curtis, who visited the west coast of the Peninsular Malaysia from Penang to Kasom, did not collect specimens of subsp. *fimbriatum* north of Langkawi, nor do I know of other specimens collected north of Songkhla. In contrast, *A. fimbriatum* subsp. *bakerianum* is restricted to islands southwest of the Thai coast, roughly from Kasom to Krabi. A gap separates the distributions of the subspecies.

Nor do they share the same habitat even though both are always found growing on limestone rocks. All specimens of subsp. *fimbriatum* I know were collected on hills at c. 100 m altitude or above, sometimes quite far from the coast, while I always found populations of subsp. *bakerianum* on islands growing on cliffs close to the shore only a few metres above sandy beaches.

Taxonomic position

Hara (1971) chose *Arisaema fimbriatum* as the lectotype of *Arisaema* sect. *Fimbriata* Engl. Today, sect. *Fimbriata* has been revised (G. & L. Gusman, 2002) and includes only tuberous and deciduous species. The rhizomatous, evergreen species are now included in the new sect. *Anomala* G. & L. Gusman (in Hettterscheid & G. Gusman, 2003). All species in sect. *Fimbriata* are tropical species found in NE India, Myanmar, Thailand, Cambodia, Vietnam, S China, Malaysia, Indonesia, the Philippines, and possibly in Laos. All of them have spadix appendages with neuters, at least in female or bisexual appendages, present at the base and, often also to the part of the appendage protruding from the spathe-mouth. In most species, these bristles are stiff and fleshy. In *A. fimbriatum*, the appendage, outside the spathe-tube, is densely covered with long, flexuous, bristly filaments. In sect. *Fimbriata*, the closest species is *A. barbatum* Buchet from Java, which has the same kind of hairy appendage. Engler specially created sect. *Barbata* for *A. barbatum* (and *A. balansae*), a section no longer in use today. They are easy to separate: namely by their spathes. It is auriculate at the mouth in *A. barbatum*; the margins of the spathe-mouth are straight in both subspecies of *A. fimbriatum*.

Acknowledgments

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providing valuable information. Thanks also to Simon Mayo (K), Nguyen Van Du (HN) and Cees Lut (L) for their help during this study and the reviewers for advice on nomenclature.

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A Revision of *Dyera* (Apocynaceae: Rauvolfioideae)

DAVID J. MIDDLETON

Harvard University Herbaria
Cambridge, USA

Abstract

The genus *Dyera* is revised. Two species, *Dyera costulata* and *Dyera polyphylla*, are recognised. A key to the species is presented and descriptions given.

Introduction

This account of *Dyera* is the latest in a series of revisions of the genera of Apocynaceae for the forthcoming account of subfamilies Apocynoideae and Rauvolfioideae in Flora Malesiana. The species of *Dyera*, under the name *jelutong* or its spelling variants, are familiar to many people in western Malesia: *Dyera costulata* (Miq.) Hook.f. is a widespread forest tree which is sometimes also cultivated, and *Dyera polyphylla* (Miq.) Steenis is a common tree in peat swamp forests. Even though these species are reasonably well known, the purpose of this revision is to provide a key to and descriptions of these two species, clarify the nomenclatural issues and typify the names. Monachino (1946) provided a detailed discussion of the traditional and economic uses of *Dyera* and an extensive bibliography of the previous literature. He summarised the taxonomic information on the genus at that time but stated that his work was to be regarded as provisional. He did, however, provide a great deal of useful information on what was known on the species of *Dyera* up to 1946 including wood anatomy, commercial yields, silviculture and field observations. I have provided distribution maps in this work but, as Monachino indicates and I can confirm from my own observations, most of the trees are only rarely in flower and are, therefore, rarely collected. The distribution maps must be considered an indication of the range of distribution of the species rather than the precise localities in which they can be found.

Monachino (1946) and others have suggested that the distinction between the two species is not clear. Monachino stated: "I emphasize that it is highly dubious whether *D. lowii* [= *D. polyphylla*] merits specific separation from *D. costulata*." He does, however, maintain it, a fate that he does not accord the then often recognised *D. laxiflora*, considered by him and by me as a synonym of *D. costulata*. Although the two species recognised here are closely related, in my view their delimitation is not as difficult as has been hitherto suggested. I have found that the number of specimens that are not clearly assignable to one species or the other are very few and that the two

species differ in several quite distinct characters (see key). In addition, Monachino (1946) suggested that the distinction based on altitude is misleading as *D. costulata* is also found at the lower altitudes characteristic of *D. polyphylla*. However, the issue is not altitude *per se* but whether the habitat is peat swamp forest or not. This is a habitat largely confined to lower altitudes but not all low altitude forests are in peat swamps. *D. polyphylla* is found only in peat swamp forest and has not been collected above 30 m altitude, whereas *D. costulata* is found in a wider variety of forests and on different soils up to 1220 m altitude but at lower altitudes never in peat swamps.

Monachino (1946) provided a long bibliography for the literature on *Dyera*. Below I have cited the literature from 1946 or earlier only if it is directly concerned with the taxonomy of *Dyera* and the reader is directed to Monachino's work for further references.

Herbarium material was studied from the following herbaria: A, BKF, BM, E, GH, K, KEP, L, NY, P, SAN, SAR, SING, U, US (Holmgren *et al.*, 1990). All specimens cited have been seen unless otherwise stated. The dimensions given in the descriptions are for dried material except for the gynoecium and androecium characters which are for flowers rehydrated with water.

***Dyera* Hook.f.**

J. Linn. Soc. 19 (1882) 293; K. Schumann *in* Engler & Prantl, Nat. Pflanzenfam. 4, 2 (1895) 139; Monachino, Lloydia 9 (1946) 182; Pichon, Mém. Mus. Nat. Hist. Nat. sér. 2, 27 (1948) 190.

Trees, often growing to enormous size; buttresses absent; white latex present in all plant parts. **Branchlets** usually strongly longitudinally ribbed when young, occasionally weakly so. **Leaves** verticillate; petioles relatively long with noticeable intrapetiolar stipules; blade often weakly crenulate at margin, glabrous. **Inflorescence** of umbelliform or paniculate cymes, lax or somewhat congested in upper parts. **Sepals** with colleters inside, connate at base, lobes often of different sizes. **Corolla** lobes overlapping to the left in bud; mature corolla platter-shaped, lobes oblong to lanceolate, more or less symmetrical, auriculate at the base on both sides, glabrous outside and inside. **Stamens** free from the pistil head, completely included in the corolla tube; filaments short and narrow; anthers lanceolate, base cordate, apex apiculate, sterile at apex, dehiscing laterally. **Disc** annular, inconspicuous, adnate to the ovary. **Ovary** apocarpous but carpels closely associated and appearing syncarpous, pubescent; ovules many per carpel; style and pistil head short. **Fruit** of paired, divergent follicles, these heavy and woody, dehiscing at maturity. **Seeds** elliptic, flattened, with a broadly membranous wing.

Key to the species of *Dyera*

- Trees without pneumatophore roots; leaf blades mostly obtuse to shortly acuminate at apex, only rarely rounded (and then not exclusively so), broadly cuneate to subcordate at base**1. *D. costulata***
 Trees with pneumatophore roots; leaf blades emarginate at apex, only rarely with some (but not all) leaves on a plant with rounded or apiculate apices, cuneate and decurrent onto petiole at base.....**2. *D. polyphylla***

1. *Dyera costulata* (Miq.) Hook.f. (Map 1)

Dyera costulata (Miq.) Hook.f., J. Linn. Soc. 19 (1882) 293; Hook.f., Fl. Brit. Ind. 3 (1882) 644; King & Gamble, J. As. Soc. Beng. 74, 2 (1907) 443; Winkler, Bot. Jahrb. 49 (1913) 372; Merrill, Bibl. Enum. Born. Pl. (1921) 498; Ridley, Fl. Mal. Pen. 2 (1923) 345; Kerr in Craib, Fl. Siam. Enum. 2 (1939) 441; Masamune, Enum. Phan. Born. (1942) 619; Monachino, Lloydia 9 (1946) 190; Browne, Forest Trees of Sarawak and Brunei (1955) 60; Backer & Bakhuizenf., Fl. Java 2 (1965) 227; Smythies, Common Sarawak Trees (1965) 21; Whitmore, Tree Fl. Mal. 2 (1973) 13; Cockburn, Trees Sabah 1 (1976) 19; Anderson, Checkl. Trees Sarawak (1980) 148; Whitmore & Tantra, Checkl. Sumatra (1986) 19; Ashton, Man. non-Dipt. Trees Sarawak (1988) 32; Corner, Wayside Trees Mal. ed. 3, 1 (1988) 154; Whitmore & Tantra, Checkl. Sulawesi (1989) 14; Whitmore, Tantra & Sutisna, Checkl. Kalimantan. (1990) 25; Kessler & Sidiyasa, Trees Balikpapan-Samarinda. (1994) 53; Turner, Gard. Bull. Sing. 47 (1997) 12; PROSEA 5, 2 (1995) 229; Coode *et al.* (eds.), Checkl. Pl. Brunei (1996) 26; Middleton in Argent *et al.*, Man. Non-Dipt. Trees Central Kalimantan 1 (1997) 83; Kochummen, Tree Fl. Pasoh For. (1997) 151; Middleton, Fl. Thailand 7(1) (1999) 36; PROSEA 18 (2000) 65. **Basionym:** *Alstonia costulata* Miq., Fl. Ind. Bat. Suppl. (1861) 556. **Type:** *Diepenhorst HB 1114* Sumatra, Priaman (lecto U, designated here; iso K, L).

Synonyms: *Alstonia grandifolia* Miq., Fl. Ind. Bat. Suppl. (1861) 555. **Type:** *Teijsmann HB 4044*, Sumatra, Palembang (lecto U, designated here; iso K, L).

Alstonia eximia Miq., Fl. Ind. Bat. Suppl. (1861) 555. **Type:** *Teijsmann HB 3358* Sumatra, Bangka, near Djebus (lecto U, designated here; iso L).

Dyera laxiflora Hook.f., Fl. Brit. Ind. 3 (1882) 644; King & Gamble, J. As. Soc. Beng. 74, 2 (1907) 444; Ridley, Fl. Mal. Pen. 2 (1923) 345. **Type:** *Cantley 226* Singapore (lecto K, designated here).

Dyera sp. indet. Coode *et al.* (eds.), Checkl. Pl. Brunei (1996) 27.

Tree to 80 m high, to 3 m diameter, sometimes with somewhat exposed roots but not with knee-shaped pneumatophores. **Bark** dark grey, brown or black, smooth with

squarish scales; inner bark cream, pale grey or pale reddish; wood cream or white. **Twigs** 3.5–9 mm diameter, glabrous. **Leaves** in whorls of 4–8; stipules 3–6 mm long; petiole 2–6.2 cm long, glabrous; blade coriaceous to papery, obovate, oblong or elliptic, 5.5–42 x 1.8–14 cm, 1.6–4.3 times as long as wide, glabrous above and beneath, glaucous beneath or not; base subcordate to rounded (sometimes from a narrowed base), rarely cuneate, margin crenulate or weakly crenulate, apex short acuminate to rounded; midrib sunken to slightly raised above; secondary veins 12–24 pairs, at 45–80° from midrib, clearly distinguishable from tertiary venation, prominent or flat above, prominent beneath; tertiary venation reticulate or subscalariform, prominent above and beneath. **Inflorescences** arranged in whorls, 4–18 cm long, glabrous, many-flowered; peduncle 2.5–9.2 cm long; pedicels 1.5–6.5 mm long. **Sepals** ovate or orbicular, apex rounded to acute, 1–3 x 0.8–2 mm, 1–1.5 times as long as wide, ciliate or not, glabrous. **Corolla** white, yellowish green or pinkish yellow; tube 1.1–3 mm long, 0.3–0.6 times as long as lobes, glabrous inside and outside; lobes 3–9 x 1.2–2.3 mm, 1.7–4.4 times as long as wide, glabrous outside and inside. **Stamens** inserted at 0.5–0.6 mm from corolla base which is 0.2–0.36 of tube length; anthers 1.1–1.4 x 0.4–0.5 mm, 2.7–3 times as long as wide, exerted 0–0.88 mm from corolla throat. **Ovary** 0.3–0.6 mm long; style 0–0.2 mm long; pistil head 0.5–0.7 mm long. **Fruit** 18–40 cm long, 2.5–4 cm diameter. **Seed grains** c. 2.5 x 1.5 cm, c. 5 x 2 cm with wing.

Habitat and Ecology: In a range of evergreen forest types on brown or yellowish soil, at altitudes to 1200 m.

Distribution: Southern Thailand (6 collections), Sumatra (24 collections), Peninsular Malaysia (31 collections), Singapore (2 collections), and Borneo (Brunei, 2 collections; Kalimantan, 26 collections; Sabah, 32 collections; Sarawak, 10 collections).

Note: Specimens of *Dyera costulata* from Sumatra more often have a cuneate leaf base than those from other parts of its range, making it more difficult to distinguish herbarium material of the two species from Sumatra.

Monachino (1946) and a number of later authors following Monachino listed *Dyera costulata* as possibly occurring in Sulawesi. However, I have not seen any material from Sulawesi and doubt it occurs there. Kessler *et al.* (2002) do not include it in their checklist to the woody plants of Sulawesi. It is also absent from Java.

2. *Dyera polyphylla* (Miq.) Steenis (Map 2)

Dyera polyphylla (Miq.) Steenis, Blumea 14 (1967) 316; Anderson, Trees Peat Swamp Forests Sarawak (1972) 23; Cockburn, Trees Sabah 1 (1976) 20; Anderson, Checklist Trees Sarawak (1980) 148; Ashton, Man. non-Dipt. Trees Sarawak (1988) 32;



Map 1. Distribution of *Dyera costulata* (Miq.) Hook.f.

Whitmore, Tantra & Sutisna, Checkl. Kalimantan. (1990) 25; PROSEA 5.2 (1995) 230; Middleton in Argent *et al.*, Man. Non-Dipt. Trees Central Kalimantan. 1 (1997) 83. **Basionym:** *Alstonia polyphylla* Miq., Fl. Ind. Bat. Suppl. (1861) 556. **Type:** *Teijsmann HB 3212* Sumatra, Bangka, near Djebus (holo U; iso BO n.v., L).

Synonyms: *Dyera lowii* Hook.f., J. Linn. Soc. 19 (1882) 293; Merrill, Bibl. Enum. Born. Pl. (1921) 498; Masamune, Enum. Phan. Born. (1942) 619; Monachino, Lloydia 9 (1946) 194; Browne, For. Trees Sarawak & Brunei (1955) 63; Smythies, Common Sarawak Trees (1965) 21; Whitmore & Tantra, Checkl. Sumatra (1986) 19; Coode *et al.* (eds.), Checkl. Pl. Brunei (1996) 26. **Type:** *Beccari 3570* Sarawak (lecto K, designated here; iso FI n.v., P).

Dyera borneensis Baill., Bull. Soc. Linn. Paris 1 (1888) 751; Merrill, Bibl. Enum. Born. Pl. (1921) 498, Masamune, Enum. Phan. Born. (1942) 619. **Type:** *Beccari 3570* Sarawak (holo P).

Tree to 60 m tall, to 2 m diameter; knee-shaped pneumatophore roots present, these chocolate-brown and with paler lenticels. **Bark** chocolate-brown or greyish brown with corky paler lenticels and horizontal ridges; inner bark cream; wood cream. **Twigs** 11–14 mm diameter, glabrous. **Leaves** in whorls of 6–8; stipules 4.5–5 mm long; petiole 2.1–4.5 cm long; blade coriaceous or subcoriaceous, obovate, 4–24 x 2.3–10.7

cm, 1.7–2.9 times as long as wide, glabrous above and beneath, glaucous beneath, base cuneate, margin not crenulate or only weakly so, apex retuse or, more rarely, rounded, obtuse or apiculate; midrib flat or slightly raised above; secondary veins 17–32 pairs with 3–12 mm spacing, 65–75° from midrib, more or less straight to curved ascending, slightly prominent or flat above, not prominent beneath; tertiary venation reticulate to somewhat scalariform, not prominent above or beneath. **Inflorescences** arranged in whorls, 8.5–14 cm long, glabrous; peduncle 4–11 cm long, sometimes with reduced leaves at apex; pedicels 1.5–3 mm long. **Sepals** ovate to orbicular, apex rounded or obtuse, 1–1.4 x 1–1.4 mm, 0.9–1.2 times as long as wide, not ciliate, glabrous. **Corolla** tube 1–3 mm long, 0.35–1 times as long as lobes, glabrous or, slightly pubescent beneath stamens inside, glabrous outside; lobes 1.8–4 x 1–1.7 mm, 1.4–3 times as long as wide, glabrous outside and inside, not ciliate. **Stamens** inserted at 0.5–0.6 mm from corolla base which is 0.4–0.43 of the tube length; filaments *c.* 0.3 mm long; anthers 0.8–1.5 x 0.3–0.4 mm, 2.7–3.8 times as long as wide, exerted 0.1–0.8 mm from corolla throat. **Ovary** 0.5–0.9 mm long; style 0–0.1 mm long; pistil head *c.* 0.5 mm long. **Fruit** 22–30 cm long, 1.8–4 cm diameter. **Seed grains** 1.8–2 x 0.8–1.2 mm, 3.7–4.5 x 1.2–1.5 with wing.

Habitat and Ecology: Known only from peat swamp forest, often in association with *Alstonia pneumatophora* Backer ex Den Berger. Both species have pneumatophore roots that can easily be distinguished in the field by the chocolate-brown bark with corky paler lenticels and horizontal ridges of *Dyera polyphylla* and the grey bark with non-corky horizontal lenticels of *Alstonia pneumatophora* even when the connection to the parent tree is not obvious.

Distribution: Sumatra (10 collections) and Borneo (Brunei, 5 collections; Kalimantan, 13 collections; Sabah, 6 collections; Sarawak 10 collections).

Notes: Flowering material of *Dyera polyphylla* is extremely scarce and, therefore, the description given for flowers above is likely to be expanded once more material can be collected. The initial findings suggest that there is a complete overlap in flower dimensions for the two species of *Dyera*. However, the scarcity of flowers for *D. polyphylla* makes it more difficult to be conclusive when comparing the flower characters in the genus. I was unable to confirm the differences in sepals and anthers tentatively suggested by Monachino (1946). However, the two species are very easily separable on vegetative characters.

In the publication of the new combination of *Dyera polyphylla* by Van Steenis, the type specimen was given as “*HB 2312* in U, isotype L, BO”. However, *HB 2312* is a typographical error for *HB 3212*. I have not seen the isotype specimen in Bogor.

Dyera lowii was originally described by J.D. Hooker with a number of syntypes, *Low s.n.*, *Beccari 3570* and *Lobb s.n.*, and although it was clearly named in



Map 2. Distribution of *Dyera polyphylla* (Miq.) Steenis

honour of Sir Hugh Low and therefore it would seem appropriate to lectotypify his collection the only specimen I have seen, from Kew, is sterile. The Beccari collection mentioned without number in the protologue is *Beccari 3570*. The Kew specimen of this collection is fertile and given that there are also duplicates would much better serve as the lectotype. The Paris duplicate of *Beccari 3570* is also the holotype of *Dyera borneensis* Baill. This name is legitimate as *Dyera lowii* contained a number of syntypes and was not lectotypified before the publication of *Dyera borneensis*. The holotype of *D. borneensis* in Paris can therefore simultaneously serve as an isolectotype of *D. lowii*.

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Acknowledgements

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Specimens examined

Only the specimens with a clear collector and collector number are listed. (1) = *Dyera costulata*; (2) = *Dyera polyphylla*.

Aban & Toshifumi SAN 60108 (1), 95171 (1); Abdullah BRUN 16911 (2); Abu 1772 (1), 2258 (1), 3328 (1); Agama 4414 (1), 38790 (1); Ahmad 10816 (2), 94494 (1), 3885 (1); Allen & Kadim 468 (1); Aloysius & Dewol SAN 73963 (1); Ambri & Arifin W312 (1), W513 (1); Amiruddin 47 (1); Ampuria SAN 32633 (1); Anderson S 9730 (2), S 28738 (1); Anggana bb 37128 (2); Asah anak Unyong BRUN 3152 (1); Awang 47831 (1); Awang Enjah S 58063 (2).

Beccari 3570 (2); Binideh SAN 58586 (1); Boschproefstation bb. 804 (1), bb 7334 (2), bb 10553 (2), bb 15222 (1), bb 35690 (1), bb 36151 (1); Bujang 30496 (2), 30549 (2); Burley *et al.* 1408 (1).

Cantley 226 (1); Carroll 546 (2); Castillo & Valderrama 10 (1); Castro A 820 (1); Cheng FRI 27548 (1), FRI 27908 (1); J. Clemens & M.S. Clemens 502 (1), 21502 (1); Clements SAN 138208 (1); Cuadra A 1296 (2).

Daris 53560 (1); De Hulster 6 (2); Diepenhorst HB 1114 (1), Dumas 1541 (1); Edwards 3894 (2); Edwards 36671 (2), BNB 3893 (2); Egon A 0613 (2); Endert 37E (1), 479 (1), 509 (1); Enggoh 7252 (1).

Fischer 754 (1); Flemmich 29323 (1); Foxworthy 4906 (1).

Gadoh KLU. 1355 (1); Garai 2049 (1); Grashoff 56 (2), 677 (2), 784 (1).

Hamid 971 (1), 4917 (1), 5499 (1), SF 24216 (1); Haviland 2170 (2); Haviland & C. Hose 3495 (2); Heyne 765 (2); Holttum SFN 9904 (1).

Ibrahim 14382 (1).

Jawa S 65627 (1).

Kadir A 3509 (1), KEP 55431 (1); Kawasan SAN 79623 (1); Keith A 7137 (1); Kerr 13909 (1); Kochummen KEP 76696 (1); Kostermans 107A (1), 4171 (1), 10164 (1), bb 34207 (1), bb 35355 (1); Kunstler 4689 (1).

L.T.S. SAN 64858 (1); Lai *et al.* S 68565 (1); Lakshnakara 353 (1); Lasan SAN 102531 (1); Leeuwenberg & Rudjiman 13075 (1); Lobb s.n. (2); Low s.n. (2).

Madani SAN 36768 (1); Maingayi 1097 (1); Mat Yatim 26173 (1); Meijer & Wood SAN 130247 (2); Van Meurs s.n. (2); Mikil SAN 28098 (1), SAN 31802 (1); Mohamad 17169 (1); Mujin & Tuyok SAN 78716 (1).

Native Collector 804 (2); Neth. Ind. For. Service bb 10589 (2); bb 6315 (1), bb 9847 (2), bb 10644 (2), bb 12936 (1), bb 15221 (1), bb 16255 (1), bb 16265 (1), bb 16280 (1), bb 16400 (1), bb 16407 (1), bb 16742 (1), bb 16962 (1), bb 17952 (1), bb 18112 (2), bb 18246 (1), bb 18400 (2), bb 19973 (2), bb 21178 (1), bb 21212 (1), bb 21263 (2), bb 23480 (1), bb 23929 (2), bb 24663 (1), bb 27601 (1), bb 27744 (1), bb 28079 (2), bb 28122 (1), bb 28446 (1), bb 28564 (2), bb 29133 (2), bb 29145 (2), bb 29444 (2), bb 29993 (1), bb 30122 (1), bb 31601 (1), bb 31754 (1), bb 31997 (1), bb 32283 (2); Ngah 21954 (1); Nicholson 22297 (2); van Niel 3966 (2); Nooteboom 5033 (1); Nur SFN 35475 (1).

Omar 8855 (1); Onggib 7137 (1); Orolfo 4786 (1); Othman Ismawi *et al.* S 56417 (1).

Paie S 37571 (1); Pickles S 3565 (1); Pilis Malahim SAN 95257 (1).

Raji 55439 (1); Ramos 1912 (1); Richards 1308 (1); Ridley 62 (1), 4922 (1), 5656 (1); Ridsdale PBU195 (1).

Sadau SAN 49557 (1); Saikeh SAN 72224 (1); Sharin 35177 (1); Sinclair 6335 (1); Sitam 603 (2); Smitinand & Williams 17003 (1), 17004 (1), 17213 (1), 17214 (1); Soewanda bb. 32655 (2), bb. 36716 (1); Symington C.F.22122 (1).

Tahja 7 (2); Talib Bidin SAN 84691 (1), SAN 84751 (1), SAN 84752 (1); Talip SAN 55688 (1); Tan SAN A 0617 (2); Tantra 75 (2), bb 35858 (2); Tarmiji SAN 73884 (1); Tarmiji & M. Alexius SAN 79883 (1); Tarmiji & A. Tasan SAN 82940 (1); Teijsmann HB 3212 (2), HB 3358 (1), HB 4044 (1).

Watson 39633 (2); Winkler 2435 (1); Wong WKM 252 (1); Wyatt-Smith KEP 79326 (2).

Yakim 1988 (1).

***Curcuma codonantha* (Zingiberaceae) – A New Species from the Andaman Islands, India**

J. SKORNICKOVA, M. SABU AND M.G. PRASANTHKUMAR

Department of Botany, University of Calicut,
673635 Kerala, India

Abstract

Curcuma codonantha Skornickova, M. Sabu & Prasanthkumar *sp. nov.* from the Andaman Islands, India, is described and illustrated.

Introduction

Species delimitation in the genus *Curcuma* L., Zingiberaceae, is rather complicated due to superficial similarity of several species, lack of type material, the short duration of flowering and the necessity of studying fresh material. Approximately 100 species are distributed in tropical and subtropical Asia with a few species extending to Australia and the Pacific Islands. However, the economically important or ornamentally interesting species are found naturalized all over the tropics and elsewhere, because they are popular among gardeners. Several new species of *Curcuma* have been described from Asia during the past five years (Mood & Larsen, 2001; Sirirugsa & Newman, 2000). To date, in India about 30 species are reported and accepted (Karthikeyan *et al.*, 1989; Jain & Prakash, 1995; Skornickova & Sabu, 2002). Many of them were early described by Roxburgh (1810, 1820), while others were described or reported quite recently (Bhat, 1987; Mangaly & Sabu, 1988; Mangaly & Sabu, 1993; Sabu & Mangaly, 1988; Sivarajan & Balachandran, 1983; Skornickova *et al.* 2003; Velayudhan *et al.*, 1990 & 1991).

As part of the project 'Revision of Indian Zingiberaceae', we studied *Curcuma* extensively in the field in the Andaman Islands resulting in the documentation of ten species. Previously, only four species had been reported from the Andamans (Balakrishnan and Bhargava, 1984; Dagar and Singh, 1997; Srivastava 1998). While exploring the northern part of the Andaman Islands, flowering specimens of a *Curcuma* with a lateral spike, oblong-lanceolate, glabrous leaves and prominent bell-shaped flowers, which were strongly exerted from the bracts, were collected. Critical examination of fresh material showed that it did not match completely any other

Indian species of *Curcuma*. Due to presence of anther spurs the specimen belongs to subgenus *Curcuma* (*Eucurcuma* K. Schum.). After scrutinising original descriptions of all the Asian species so far known under the subgenus and, after consulting others working on the genus in Thailand and Myanmar, we are confident that this species is new. It is described and illustrated below.

Curcuma codonantha Skornickova, M. Sabu & Prasanthkumar, *sp. nov.*

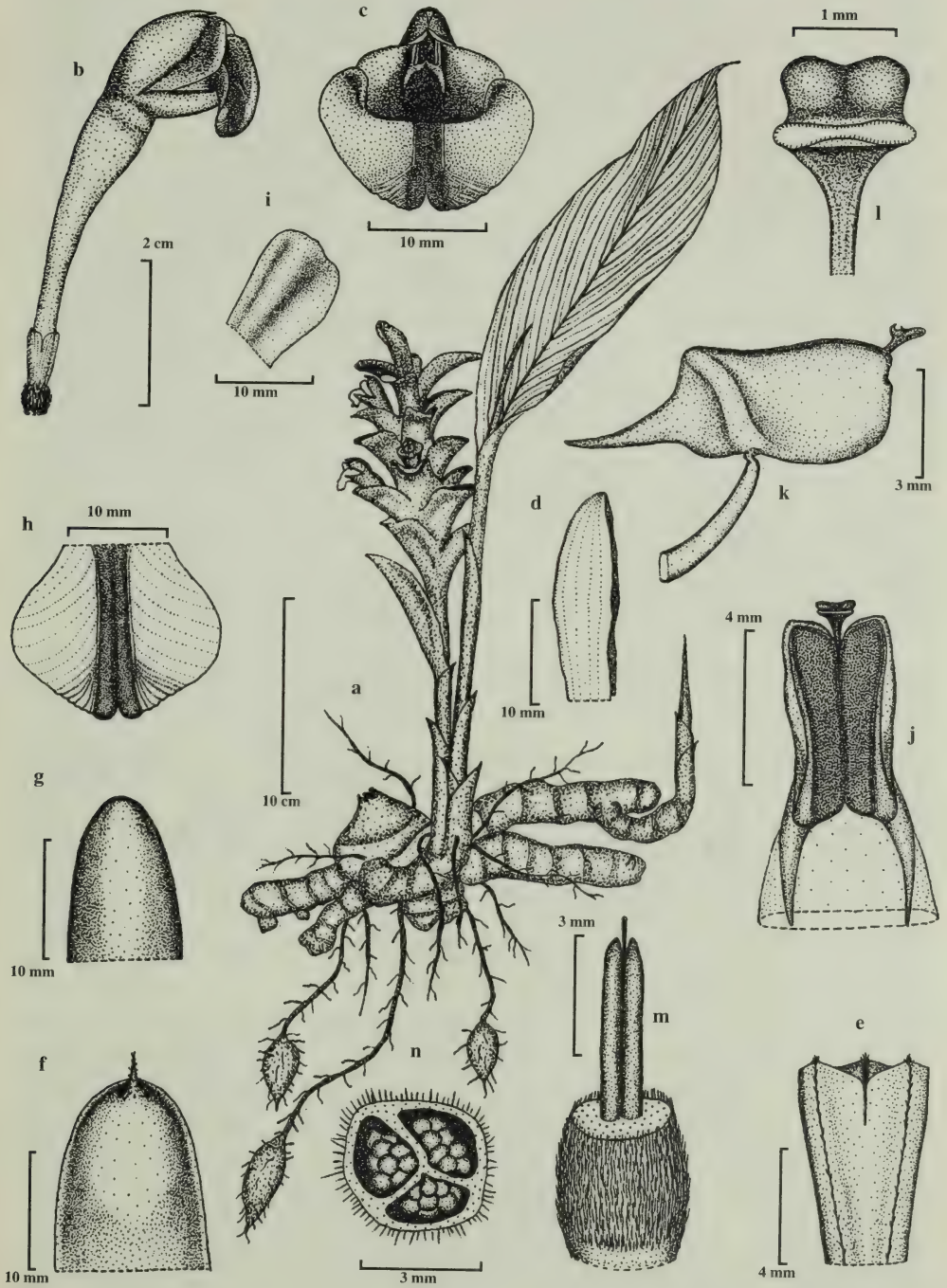
Curcuma aeruginosae Roxb. similis rhizomatis figura et colore cremeo, foliis viridibus macula purpurea secus costam carentibus, coma rosioe bracteis apicaliter macula brunneopurpurea, floribus campanulatis e bracteis fertilibus exsertis differt.

Typus: India, Andaman Islands, North Andaman, Diglipur District, Kalighat, Alt. 15 m, 13° 09' N 92° 57'E, 22.V.2002, *Skornickova & Prasanth Kumar 73319* (holo MH; iso K, CALI, SING).

Figure 1, Plate 1.

Rhizomatous herb, up to 1.50 m tall. *Rhizome* 3.5–6 x 3–6 cm, sessile tubers present 5–13 cm long, 1.5–2 cm in diam., sometimes almost on the soil surface, light brown outside, skin glabrous, creamy-yellowish inside, aromatic (camphoraceous), bitter in taste, scales triangular, papery, brown, glabrous, present on main rhizome and sessile tubers, in soil usually quickly decaying and leaving scars; root tubers 3–5 x 1.5–2 cm, elliptic, white inside, on 2–3 mm-thick roots c. 5–20 cm away from main rhizome. *Leafy shoot* up to 1.50 m tall, *leaves* 3–6; pseudostem 20–45 cm long, sheathed by 2–4 reddish-green bracts (clearly visible only at the beginning of the season, later drying and decaying), innermost as long as the pseudostem, outer ones gradually smaller in length, 3–4 cm broad; ligule 3 mm, hyaline, greenish translucent, 2-lobed, hairy along the margin, hairs 0.5 mm long; petiole 10–30 cm long, winged and gradually tapering into lamina; lamina lanceolate or oblong-lanceolate, 35–75 x 8–14 cm, green, paler on the lower surface, margin translucent white, hyaline, 0.5 mm wide; upper surface mostly glabrous, but slightly hairy at the apical part of the leaf, especially on veins and near margins, hairs 0.3 mm long, lower surface glabrous; tip acuminate c. 1–1.5 cm hairy, base oblique, attenuate, gradually tapering into 1.5–2 mm-wide wings along the petiole. *Inflorescence* vernal, lateral. *Peduncle* 14–23 cm, 0.7–1.5 cm diam., covered with 4–6 reddish-green sheaths, glabrous, the innermost longest, structurally similar to the fertile bracts above, outer sheaths gradually smaller, broad 3–4 cm.

Figure 1. *Curcuma codonantha*. a. Habit; b. Flower (side view); c. Flower (front view); d. Bracteole; e. Calyx; f. Dorsal corolla lobe; g. Lateral corolla lobe; h. Labellum; i. Lateral staminode; j. Anther (front); k. Anther (side); l. Stigma; m. Epigynous glands and ovary; n. Ovary (cross section). Based on the type material *Skornickova & Prasanthkumar 73319*. Del. J. Skornickova.



Spike 12–20 x 6–8 cm, formed by c. 30–35 bracts including coma. *Coma* forming 1/3–1/4 the length of the inflorescence, coma bracts 7–9, c. 5–6 x 2.5–3 cm, bright pink with darker brownish-violet patch on the tips, lower side almost glabrous, upper side shortly hairy, hairs 0.2 mm long, lower coma bracts fertile, 3–4 uppermost sterile. *Fertile bracts* 3.5 x 4–4.5 cm, green, tips sometimes tinged with red, upper side very shortly hairy, lower side quite glabrous. *Cincinnus* with 4–6 flowers. *Bracteoles* 1.7–2.5 x 0.6–1.4 cm, hyaline, translucent white, glabrous. *Flowers* 6 cm long, yellow, longer than the bracts, exserted 1.5–2 cm from the bracts. *Calyx* 8 mm long, translucent white, 3-dentate, unilaterally split for about 3 mm, hairy, hairs 0.4 mm long. *Corolla tube* 3.2–3.5 cm, towards base light yellow, towards lobes pink, glabrous. *Corolla lobes* pink, glabrous, dorsal lobe 2 x 1.3 cm, mucronate, mucro 4–5 mm, lighter in colour (whitish pink), hairy, hairs 0.3 mm long, lateral lobes 1.5 x 0.9 cm, pink, glabrous. *Labellum* 2 x 1.8 cm, emarginate, yellow, deep yellow in the centre with whitish lines on the outside border (golden median band), middle lobe emarginate, 3 mm deep. *Lateral staminodes* 12 x 9 mm, light yellow, with short glandular hairs on inner side. *Anther* spurred, 8 mm, anther thecae whitish, 4–5 mm long, filament light yellow, 4 mm long, constricted, 5 mm at base, 2 mm at upper part. *Anther spurs* 3 mm long, whitish yellow, divergent, but slightly incurved. *Ovary* trilocular, 3–4 x 3 mm, densely hairy, glabrous at the base, hairs 0.3–0.4 mm long, ovules many. *Stigma* exserted c. 1–1.5 mm from between anther thecae, white, ciliate, 1.4 x 1.4 mm. *Epigynous glands* 2, yellowish-green, c. 5 mm long, 0.5 mm diam. *Fruits* not seen.

The plant description is based on observation of material from the type locality as well as measurements of fully-grown plants in the Calicut University Botanical Garden. The leafy shoot at the beginning of season, when the plant is flowering, is about 60–70 cm with only 2–3 leaves. Later in the season, the plant grows to 1.50 m with about six leaves. The green-reddish sheaths covering the pseudostem are most prominent at the beginning of the season, later they dry and decay.

Flowering: May to June, inflorescences occur together with the first leaves.

Distribution: So far known only from the type locality. We have also seen this species in Havelock Island (south part of Andaman Islands), but unfortunately we were not able to collect it. Since most of the *Curcuma* species in the Andamans are recent introductions connected with migration of people from various parts of India to the Andaman and Nicobar Islands, it is doubtful if this species is native there. Thus, in future, the species may be found elsewhere in India.

Plate 1. *Curcuma codonantha*. 1. Habit; 2. Detail of inflorescence; 3. Coma (seen from above); 4. Rhizome with roots and tubers; 5. Detail of flower in subtending bract (side view). All photographs are of the type material *Skornickova & Prasanthkumar 73319*. Photo J. Skornickova.



Table 1. Comparison of morphological characters of *Curcuma codonantha* and *C. aeruginosa*. (The diagnostic characters are in bold).

| | <i>C. codonantha</i> sp. nov. | <i>C. aeruginosa</i> Roxb. |
|----------------------|--|--|
| Rhizome | <p>Main rhizome c. 3.5–6 x 3–6 cm, sessile tubers present 5–13 cm, 1.5–2 cm in diameter. Inwardly creamy-yellowish colour.</p> <p>Root tubers 3–5 x 1.5–2 cm, white inside.</p> | <p>Main rhizome c. 10 x 5 cm, obovate-conical, sessile tubers 5–15 cm, 1.5–2.5 in diameter. Inwardly aeruginous (bluish-green) colour.</p> <p>Root tubers 2.5–5.5 x 1.5–2.5, whitish inside.</p> |
| Leafy shoot | <p>Leafy shoot up to 1.5 m, 3–6 leaves. Pseudostem and peduncle sheathed by reddish-green bracts.</p> <p>Ligule 3 mm, 2-lobed, hairy along the margin, hairs 0.5 mm long.</p> | <p>Leafy shoot up to 1.9 m, 4–6 leaves. Pseudostem and peduncle sheathed by green bracts.</p> <p>Ligule 2 mm, obscurely 2-lobed, glabrous.</p> |
| Lamina | <p>Lamina up to 35–75 x 8–14 cm, base oblique, attenuate. Adaxially plain green with no coloration, abaxially pale green.</p> | <p>Lamina up to 40–90 x 10–20 cm, base attenuate. Adaxially green with dark purple cloud along the midrib on the distal half of the leaf, abaxially pale green.</p> |
| Inflorescence | <p>Vernal, lateral, flowering in May. <i>Peduncle</i> 14–23 cm, sheathed by reddish-green bracts, spike c. 12–20 x 6–8 cm. <i>Coma</i> c. 1/3–1/4 of the inflorescence. Coma bracts bright pink with darker brownish-violet patch at the tips, c. 5–6 x 2.5–3 cm, lower side almost glabrous, upper side shortly hairy. <i>Fertile bracts</i> 3.5 x 4–4.5 cm, green, tips sometimes tinged with red, upper side very shortly hairy, lower side quite glabrous. <i>Cincinnus</i> 4–6 flowers.</p> | <p>Vernal, lateral, flowering in April–May. <i>Peduncle</i> 10–25 cm, sheathed by green bracts, spike c. 14–20 x 6–9 cm. <i>Coma</i> c. 1/3 of spike. Coma bracts pink or light pink, with no obvious patch at the tips, c. 5–7 x 1.22 cm, sparsely hairy on both surfaces, tip mucronate 0.2–0.3 mm. <i>Fertile bracts</i> 4.5–5 x 3.5–4.5 cm, green with tips tinged with red-purple, quite glabrous both sides. <i>Cincinnus</i> 4–6 flowers.</p> |
| Flowers | <p>Flower 6 cm, bell-shaped, well exerted from the fertile bracts.</p> <p><i>Bracteoles</i> 1.7–2.5 x 0.6–1.4 cm, hyaline, translucent white, glabrous.</p> | <p>Flower 5–5.5 cm, same length as fertile bracts, not exerted.</p> <p><i>Bracteoles</i> 1.7–2.5 x 0.7–1.5 cm, hyaline, whitish translucent, hairy at the tip.</p> |

Table 1. Continued:-

| | |
|---|---|
| <p><i>Calyx</i> 8 mm long, unilaterally split 3 mm, translucent white, 3-dentate, hairy.</p> <p><i>Corolla tube</i> 3.2–3.5 cm, glabrous, towards base light yellow, towards lobes pink.</p> <p><i>Labellum</i> 2 x 1.8 cm, emarginate, yellow, deep yellow in the centre, yellow towards margin.</p> <p><i>Lateral staminodes</i> 12 x 9 mm, light yellow.</p> <p><i>Anther thecae</i> 4–5 mm, anther spurs 3 mm, whitish-yellow, divergent.</p> <p><i>Ovary</i> 3–4 x 3 mm, densely hairy.</p> <p><i>Epigynous glands</i> c. 5 mm long, 0.5 mm diameter, yellowish-green.</p> | <p><i>Calyx</i> 11–12 mm, dentate, unilaterally split 4–5 mm, whitish translucent with pink at the teeth tips sparsely hairy.</p> <p><i>Corolla tube</i> 2.8–3.2 cm, glabrous, whitish yellow base, pink tinged towards lobes, lobes of rich pink colour.</p> <p><i>Labellum</i> 1.8–1.9 x 1.9–2 cm, emarginate, deep yellow in centre, lighter towards margin.</p> <p><i>Lateral staminodes</i> 14 x 7 mm, yellow.</p> <p><i>Anther thecae</i> 4.5 x 0.7 mm, anther spurs 3 mm, white, divergent.</p> <p><i>Ovary</i> 3.5 x 3 mm, hairy.</p> <p><i>Epigynous glands</i> 4.5–5.5 mm long, 0.7 in diameter, yellowish green.</p> |
|---|---|

Habitat: Open moist places along stream banks.

Uses: Bengali settlers at the type locality use this species for the extraction of starch from the rhizomes. Extraction of starch, commonly known as East Indian arrowroot, has been reported for many *Curcuma* species all over India and it seems that people use any *Curcuma* species that grows locally.

Vernacular name: Bengalis living near the type locality call this plant *Shodhi*. The name *Sat'hi* or *Sotee* was mentioned by Roxburgh (1810) and *Shuthee* (Roxburgh, 1820) as the vernacular name for *Curcuma zerumbet* Roxb., which is nowadays usually treated as synonym of *C. zedoaria* (Christm.) Roscoe. Even though Roxburgh's description of *C. zerumbet* consists of only a few lines, it is obvious that it is not *C. codonantha*, since Roxburgh's *C. zerumbet* has a purple cloud down the middle of leaf and the flowers are shorter than their bracts. Also, from our fieldwork in Bengal over the past few years we have observed that the name *Sotee* or *Shuthee* is used for several different species of *Curcuma*.

Etymology: The epithet "codonantha" is derived from the Greek words "codon" (bell) and "anthos" (flower) referring to the peculiar bell shape of the flowers exerted from the fertile bracts, the most obvious character of this species.

Notes: The closest species to *Curcuma codonantha* is *C. aeruginosa* Roxb., which is commonly distributed throughout Kerala and is found in several localities in the Andaman Islands. Distinguishing these species in the field might be difficult due to similar habit and coloration of flower parts, both have a deep yellow labellum and lateral staminodes with pink corolla lobes, and lateral spikes and they flower at the same time. The most obvious difference between them lies in the flowers, which in *C. codonantha* are bell-shaped and well exerted from fertile bracts, while they are the same size as the fertile bracts and do not extend beyond them in *C. aeruginosa*. They can also be told apart by the rhizome, which in *C. codonantha* is inwardly creamy-yellowish in contrast to the inwardly aeruginous (bluish-green colour) of *C. aeruginosa*; *C. codonantha* leaves are plain green, quite glabrous excepting on the prominent veins and margin areas at the distal half on the upper side of the lamina, which are sparsely hairy, while *C. aeruginosa* leaves are glabrous, have a deep purple cloud, which runs along the both sides of midrib and which is especially prominent at the distal half of lamina; and the coma bracts of *C. codonantha* are marked at the tips by a brownish-violet or red brownish patch unlike of those of *C. aeruginosa*, which are pink or light pink and although they can be somewhat darker at the tips, but do not have a prominent patch of such a deep colour (Table 1).

According to our observations in the field, *Curcuma* species that do not set seed and reproduce exclusively vegetatively by sessile tubers are uniform within a population as well as between populations. Characters like the red patch on the leaves, indumentum and coloration of flower parts or the inner colour of the rhizome, which may vary in the case of seed-setting species, are stable for non seed-setting species.

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Three new species of *Porterandia* (Rubiaceae) from Mount Kinabalu, Borneo

M.S. ZAHID

Institute of Biological Sciences,
University of Malaya,
50603 Kuala Lumpur, Malaysia

Abstract

Three new species of *Porterandia* (Rubiaceae), *P. beamanii*, *P. chanii* and *P. puffii*, which occur on Mount Kinabalu, Borneo, are described.

Introduction

In the earlier enumerations of plants on Mount Kinabalu, Stapf (1894) and Gibbs (1914) did not list any species that could be identified as *Porterandia*, a genus described by Ridley in 1939. As material accumulated, the Bornean taxa were wrongly named *Porterandia anisophylla* from Peninsular Malaysia and Sumatra in herbarium identification. A revision of the genus has been carried out at the University of Malaya, where a number of new species have been recognized for Borneo. These include three undescribed species from Mount Kinabalu. The new species are described here in anticipation of the forthcoming Volume 5 of *The Plants of Mount Kinabalu* by Professor John Beaman's team. A full revision of *Porterandia*, consisting of 22 species in all, will be published subsequently.

The new species

1. *Porterandia beamanii* MS Zahid, sp. nov.

Fig. 1

Porterandiae minori Ridl. *similis sed foliis typice minoribus (ad 5-6 cm latis) lobisque calycis florum femineorum foliaceis in statu fructifero differt.* **Typus:** Pereira et al. JTP 144 Sabah, Tambunan, road to Trusmadi, lower montane forest, 1180 m (9 Mar 1995, fruiting) (holotypus SAN!, isotypus SING).

Gynodioecious or possibly gynomonocious trees, to 35 m high, to 25 cm diameter, not buttressed. Bark smooth to slightly fissured to grid-cracked; pale brown to dark brown. Shoot tips, distal branch internodes, petioles and leaf veins with erect-suberect

hairs. Stipules ovate-triangular and fused along the edges to form a tube, 1–1.5 cm long, densely hairy. Mature **leaves** with petiole (0.4–)0.5–1.5(–2) cm long, 1–3 mm thick; lamina usually elliptic, rarely obovate, 8–20.5 cm long, 3–6(–8.5) cm wide; leaf base cuneate; leaf apex acute to acuminate to short-caudate; when dry chartaceous; secondary veins 9–15 pairs, on upper side flattened to slightly raised, on lower side distinctly prominent; tertiary venation a much-branched network between pairs of secondary veins.

Bisexual inflorescences: Peduncle 0.2–0.6 cm long; habit compact, with 1–2 distinct branching orders. Flowers 5–21 per cyme, usually in 1–3 clusters; pedicels 1–3 mm long, 1.5–2 mm thick; calyx tube/limb densely covered by hairs (most of calyx surface hidden); calyx lobes short to narrow-triangular to linear, often also spatulate becoming foliaceous in fruit, 2.5–7 mm long; corolla hypocrateriform, the tube 5–8 mm long, 2–3 mm wide at the throat, with a slightly to conspicuous inflated part just below the throat, outer surface totally covered by upward-pointing hairs; corolla lobes ovate to narrowly elliptic, 4–5 mm long; anthers 4–5 mm long, with pollen; style 4–5 mm long, stigma 1–2 mm long. **Female inflorescences:** Peduncle 0.2–0.7 cm long; habit sparsely branched, with 1 distinct branching order. Flowers 1–3 per cyme; pedicels 2–3 mm long, 1.5–2 mm thick; calyx tube/limb densely covered by hairs (most of calyx surface hidden); calyx lobes narrowly triangular to linear to spatulate becoming foliaceous in fruit, 3–8 mm long; corolla hypocrateriform, the tube 5–9 mm long, 2–3 mm wide at the throat, with a slightly inflated part just below the throat, outer surface totally covered by upward-pointing hairs; corolla lobes narrowly elliptic to ovate, 4–5 mm long; anthers 4–5 mm long, without pollen; style 4–5 mm long, stigma 3–4 mm long. **Fruit** sub-globose to ellipsoid, 2–3.5 cm long, 2–3 cm wide, short-tomentose when young, becoming glabrous. Seeds flattened, lens-shaped to rounded, 4–6 mm x 5–7 mm, testa surface finely areolate.

Notes: Bisexual and female cymes can occur together on the same branch (*Ampuria* SAN 32690).

Distribution: Borneo, so far known only from Sabah (including Mt Kinabalu and the Crocker Range) and Sarawak, in lower montane forest at 3700–6000 ft [1147–1860 m] elevation.

Specimens Examined: BORNEO. SABAH: Ranau, Kundasang, 4300 ft [1333 m], Singh SAN 28254, 10 Nov 1961, female inflorescences (BO! L!), bisexual inflorescences

Figure 1. *Porterandia beamanii*. **A**, leafy branch with bisexual inflorescences. **B**, bisexual flower, longitudinal section. **C**, leafy female fruiting branch. Note foliaceous calyx lobes in B and C.

A from Pereira JTP 141 (SAN), B from Singh SAN 28254 (SAR) and C from Pereira JTP 144 (SAN).



(KEP! SAN! SAR!), Kinabalu National Park headquarters, 5300 ft [1643 m], *Aban SAN 57718*, 13 Mar 1967, fruiting (KEP! SAN!), Mount Kinabalu, Ulu Liwagu and Ulu Mesilau. *Chew, Corner & Stainton RSNB 2661*, 2 Apr 1961, female inflorescences (K! L!), trail from Kiau Nulu to Marai Parai, near Tohubang River, 3700 ft [1147 m], *Wong WKM 2366*, 12 Sep 1993, fruiting (KEP! SAN! SING), Penibukan, 4000–5000 ft [1240–1550 m], *Clemens & Clemens 30492*, 28 Dec 1932, bisexual inflorescences (K! L! SING), Gurulau Spur, 6000 ft [1860 m], *Clemens & Clemens 50573*, 30 Nov 1933, female inflorescences (K! L!); Ranau, Tenompok FR. *Wong WKM 2876*, 30 Aug 2001, female inflorescences (KLU! SAN!); Tambunan, Crocker Range, Km 62.5 on Kota Kinabalu–Tambunan road, *Beaman 7183*, 9 Oct 1983, fruiting (L!), road to Trusmadi, 1180 m, *Pereira et al. JTP 141*, bisexual inflorescences (SAN! SING) & *JTP 144*, 9 Mar 1995, fruiting (holotype SAN! isotype SING), Mount Trus Madi, 1200 m, *Nooteboom 1451*, 20 Mar 1969, fruiting (L! SAN!); Penampang, Crocker Range, Km 51.8 on Kota Kinabalu–Tambunan road, *Beaman 8945*, 16 Mar 1984, fruiting (L!); Keningau, Ulu Sg Tinagalan FR, *Fidilis & Asik SAN 113143*, 22 Nov 1985, bisexual inflorescences (KEP! SAN!); Sandakan, Mamahat Camp, K.F.L, 4000 ft [1240 m], *Ampuria SAN 32690*, 1 Dec 1962, female inflorescences (L!), bisexual inflorescences (KEP!). SARAWAK: 4th Division, proposed Gunung Murud National Park, along Sungai Taramusu, 1500 m, *Yii S 44635*, 14 Sep 1982, fruiting (K! KEP! L!), Kapit, Melinau, Ulu Sampurau, Bukit Sampadai, 1433 m, *Ilias S 40721*, 6 Apr 1980, fruiting (KEP! SAN! SAR!).

This species is named after Professor John Beaman, who is well known for his work on the enumeration of Mount Kinabalu plants.

2. *Porterandia chanii* MS Zahid, sp. nov.

Fig. 2

Porterandiae anisophyllae (Jack ex Roxb.) Ridl. *similis sed limbo calycis sparsim piloso et tubo corollae tecto pilis sursum directis differt.* **Typus:** Singh SAN 34727 Sabah, Sandakan, along north boundary Sepilok FR (1 May 1962, bisexual inflorescences) (holotypus SAN! isotypi BO! L! SAR! SING).

Gynodioecious tree, to 16 m high, to 18 cm diameter, not buttressed. Bark smooth with transverse lenticels to slight grid-cracked; pale brown to dark grey. Shoot tips, distal branch internodes, petioles and leaf veins with erect-suberect hairs. Stipules ovate-triangular and fused along the edges to form a tube, 1.5–2 cm long, sparse to densely hairy. Mature **leaves** (not immature leaves near the shoot-tips) with petiole

Figure 2. *Porterandia chanii*. A. leafy branch with bisexual inflorescences. B. mature bisexual flower, longitudinal section. Note very sparsely hairy calyx.

A from Singh SAN 34727 (L), B from Agama A 525 (K).



1–2.5(–3) cm long, 1–4 mm thick; lamina mostly obovate to elliptic, 16–42 cm long, 8–19 cm wide; leaf base cuneate; leaf apex acute to obtuse to caudate; when dry chartaceous; secondary veins 16–21 pairs, on upper side flattened to slightly raised, on lower side distinctly prominent; tertiary venation a much-branched network between pairs of secondary veins.

Bisexual inflorescences: Peduncle 0.3–0.6 cm long; habit laxly branched, rarely compact, with 4–5(–8) distinct branching orders. Flowers 12–34(–45) per cyme, usually in 1–3 clusters; pedicels 3–6 mm long, about 1 mm thick; calyx tube/limb sparsely covered by hairs (much of calyx surface visible); calyx lobes triangular to linear, 0.5–2 mm long; corolla hypocrateriform, the tube 11–15 mm long, 3–4 mm wide at the throat, without any conspicuous inflated part just below the throat, outer surface totally covered by upward-pointing hairs; corolla lobes narrowly elliptic to ovate, 7–10 mm long; anthers 5–6 mm long, with pollen; style 8–10 mm long, stigma 3–4 mm long. **Female inflorescences:** Peduncle 0.3–0.7 cm long; habit sparsely branched, with 2(–3) distinct branching orders. Flowers 5–12 per cyme; pedicels 3–7 mm long, 1–2 mm thick; calyx tube/limb sparsely covered by hairs (much of calyx surface visible); calyx lobes triangular to linear, 0.5–2 mm long; corolla hypocrateriform, the tube 10–12 mm long, 2–4 mm wide at the throat, without any conspicuous inflated part just below the throat, outer surface totally covered by upward-pointing hairs; corolla lobes narrowly elliptic to ovate, 7–9 mm long; anthers 3–4 mm long, without pollen; style 7–8 mm long, stigma 3–4 mm long. **Fruit** sub-globose to ellipsoid, 3–4 cm long, 3–3.5 cm wide, sparsely hairy when young, becoming glabrous. Seeds flattened, lens-shaped to rounded, 3–5 mm \times 3–7 mm, testa surface finely areolate.

Distribution: North and northeast Borneo, in the Sabah-Tarakan region, in primary and disturbed lowland forest, c. 100–1800 ft [30–560 m].

Specimens Examined: BORNEO. SABAH: Kudat, Bandau, Tagabu F.R., 1800 ft [558 m], *Mait & Anthony* SAN 37667, 16 Oct 1963, fruiting (SAN!); Kota Belud, Bukit Matindok, 1000 ft [310 m], *Lajangah* SAN 32158, 3 Oct 1962, female inflorescences (SAR!), bisexual inflorescences (BO! KEP! SAN!); Kota Marudu, Marak-Parak, *Ag. Amin & Mancus* SAN 118990, 1 Apr 1987, fruiting (KEP! SAN!); Ranau, west of Kg. Nabutan, *Aban* SAN 94542, 22 Mar 1982, fruiting (KEP! SAN!), Kinabalu, Kg. Melangkap Tamis, Sg. Kepungit, *Lorence* LL 669, 4 Jul 1995, fruiting (KEP! SAN!); Tenom, Crocker Range FR, *Aban* SAN 66787, 18 Apr 1970, bisexual inflorescences (K! L! SAR! SING); Nabawan, Sg. Millian, *Sumbing* SAN 118626, 12 Nov 1986, bisexual inflorescences (SAN!); Sipitang, near Mt. Muruk Miau, *Pius & Soinin* SAN 143167, 13 Apr 2000, fruiting (SAN!); Sandakan, Kabili F.R., compt. 14,

Agama A 525, 21 Oct 1947, bisexual inflorescences (BKF! K! KEP!), along north boundary of Sepilok F.R., *Singh SAN 34727*, 1 May 1962, bisexual inflorescences (holotype SAN! isotypes BO! KEP! L! SAR!); Kinabatangan, Bukit Mansuli, 200 ft [62 m], *John & Markus SAN 144631*, 16 May 2002, bisexual inflorescences (KLU! SAN!); Lahad Datu, Danum Valley, plot 1, *Campbell SAN 112095*, 12 Jun 1986, fruiting (SAN!); Tawau, east of Sg. Serudong, 100 ft [31 m], *Bakar SAN 26154*, 6 Sep 1961, fruiting (SAN!); Kalabakan, Gunung Tembuku, *Fedilis & Sumbing SAN 91472*, 8 Mar 1980, fruiting (KEP! SAN!). KALIMANTAN: Nunukan Island, 30 m, *Kostermans 9182*, 31 Dec 1953, bisexual inflorescences (K! L!).

This species commemorates Datuk C.L. Chan, who has provided field support for my study of this genus and much encouragement in my learning of Bornean botany.

3. *Porterandia puffii* MS Zahid, *sp. nov.*

Fig. 3

Porterandiae scortechinii (King & Gamble) Ridl. *similis sed limbo calycis sparsim tecto pilis brevibus, lobis calycis linearibus 1/3 to 1/2 longitudine limbi calycis, et tubo corollae tecto pilis sursum directis differt. Typus: Clemens & Clemens 33834* Sabah, Mount Kinabalu, Colombon River (Jun 1933, bisexual inflorescences) (holotypus L! isotypus K!).

Gynodioecious tree, to 15 m high, to 16 cm diameter, not buttressed. Bark grid-cracked; greyish white. Shoot tips, distal branch internodes, petioles and leaf veins with sparse appressed hairs. Stipules ovate-triangular and fused along the edges to form a tube, 0.6–1.5 cm long, sparsely hairy. Mature **leaves** (not immature leaves near the shoot-tips) with petiole 1–2.3 cm long, 1–1.5 mm thick; lamina mostly obovate to elliptic, 10.5–15(–19) cm long, 4.5–7(–10.5) cm wide; leaf base cuneate; leaf apex broadly acute to obtuse with a short point; when dry chartaceous; secondary veins 10–15 pairs, on upper side flattened to slightly raised, on lower side distinctly prominent; tertiary venation a much-branched network between pairs of secondary veins.

Bisexual inflorescences: Peduncle 0.2–0.3 cm long; habit compact, with 1–2 distinct branching orders. Flowers (2–)6–10 per cyme, usually in 1–2 clusters; pedicels 3–6 mm long, 1–1.5 mm thick; calyx tube/limb sparsely covered by hairs (much of calyx surface visible); calyx lobes narrow and linear, 2–5 mm long; corolla hypocrateriform, the tube 8–12 mm long, 4–5 mm wide at the throat, with a conspicuous inflated part just below the throat, outer surface totally covered by upward-pointing hairs; corolla lobes ovate-elliptic, 6–9 mm long; anthers 5–6 mm long, with pollen; style 4–6 mm long, stigma 4–5 mm long. **Female inflorescences** (in young flower-bud stage): Peduncle 0.1–0.3 cm long; habit unbranched. Flowers 1 per cyme; pedicel 3–5 mm long, 1–1.5 mm thick; calyx tube/limb sparsely covered by hairs (much of calyx surface visible); calyx lobes narrowly triangular, 2–4 mm long; corolla hypocrateriform,

the tube with a conspicuous inflated part just below the throat, outer surface totally covered by upward-pointing hairs; corolla lobes ovate-elliptic; anthers not known. **Fruit** sub-globose to ellipsoid, 2.7–4.8 cm long, 2.6–4.5 cm wide, sparsely hairy when young, becoming glabrous. Seeds flattened, lens-shaped to rounded, 5–6 mm x 6–8 mm, testa surface finely areolate.

Distribution: Sabah (on Mount Kinabalu and the Crocker Range) and Sarawak, in lower montane to mossy forest, c. 5000–6560 ft [1550–2000 m].

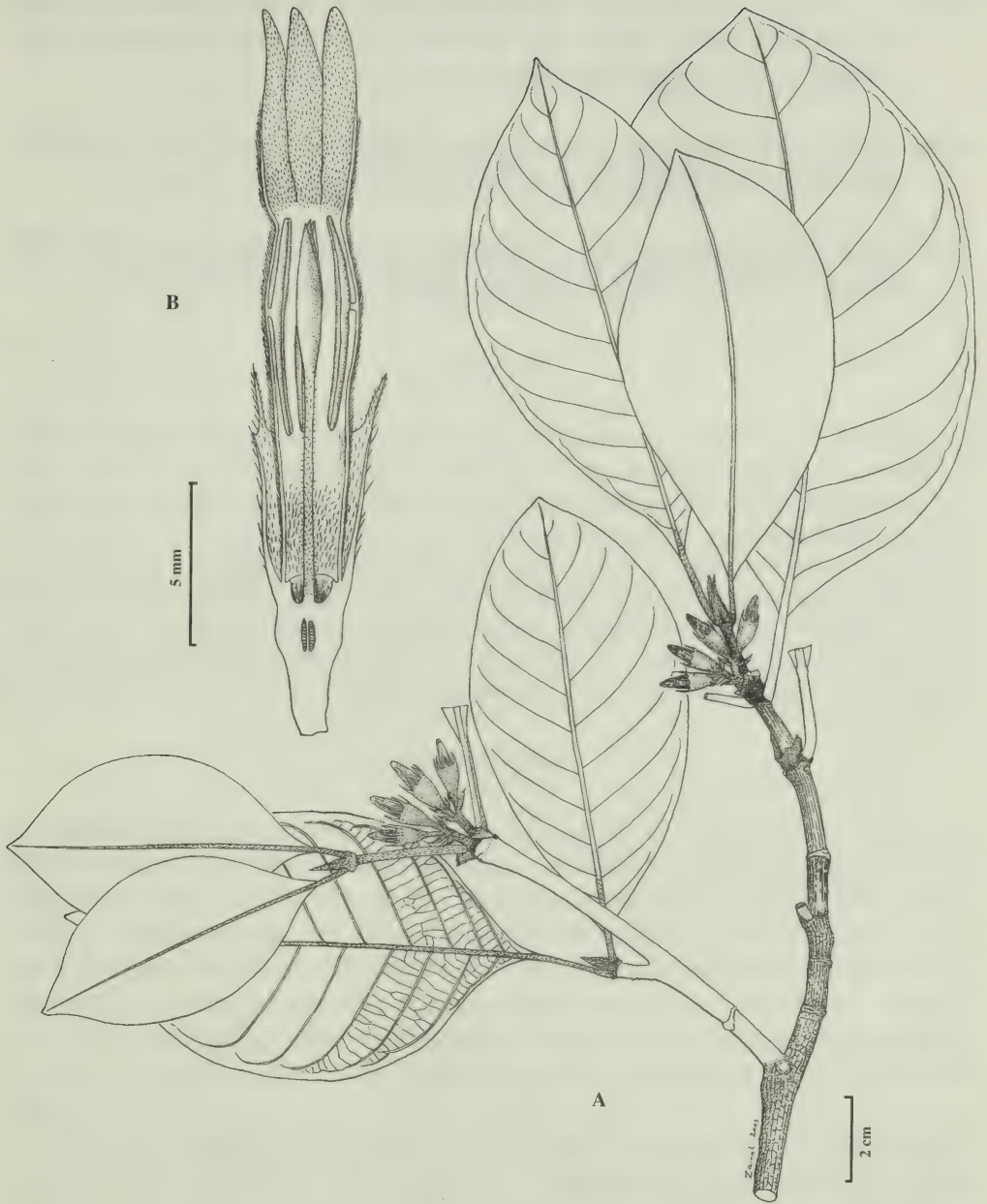
Specimens Examined: BORNEO. SABAH: Ranau, mile 35 Ranau road, 5000 ft [1550 m], *Aban SAN 57767*, 10 May 1967, bisexual inflorescences (KEP! SAN!), Mount Kinabalu, Mesilau River, *Chew & Corner RSNB 4873*, 8 Apr 1964, fruiting (K! L!), Colombon River, *Clemens & Clemens 33834*, Jun 1933, bisexual inflorescences (holotype L! isotype K!), 1 mile north of Tenompok on path to Lumu Lumu, *Wood A 4463*, 18 Jul 1954, bisexual inflorescences (L!); Tambunan, road to G. Alab, *Pereira et al. JTP 118*, 3 Mar 1995, female inflorescences (SAN!). SARAWAK: 4th Division, Kelabit Highland, summit of Apad Runan, 2000 m, *Yii S 56231*, 10 May 1988, bisexual inflorescences (SAN!).

This species is named for Professor Christian Puff, whose work on the Rubiaceae is well known and who has given much help and encouragement to my own studies.

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Figure 3. *Porterandia puffii*. **A**, leafy branch with bisexual inflorescences. **B**, bisexual flower, longitudinal section. Note sparse appressed hairs on petioles and leaf veins. A from *Clemens & Clemens 33834* (L), B from *Wood A 4463* (L).



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The Significance of Pollen Morphology in the Taxonomy of *Grewia* and *Microcos* (Tiliaceae) in Peninsular Malaysia and Borneo

R. C. K. CHUNG¹, E. SOEPADMO¹ AND A. L. LIM²

¹Forest Research Institute Malaysia
Kepong, 52109 Kuala Lumpur, Malaysia

²Institute of Biological Sciences, University of Malaya
50603 Kuala Lumpur, Malaysia

Abstract

The pollen morphology of 5 species of *Grewia* and 31 species of *Microcos* (including their type species) from Peninsular Malaysia and Borneo were studied using light, scanning and transmission electron microscopy. The pollen of *Grewia* species differs from that of *Microcos* in being larger with a mean polar axis of 53–75 µm and an average equatorial diameter of 39–55 µm, having a coarsely reticulate tectum, a lumina diameter of more than 1.5 µm and a mean exine thickness of 1.55–2.15 µm. *Microcos* pollen is characterised by its smaller size with a mean polar axis of 25–35 µm and an average equatorial diameter of 19–27 µm, a finely reticulate tectum, a lumina diameter of less than 1.5 µm and a mean exine thickness 0.84–0.90 µm. The pollen of all species examined conforms to the previously recognised 'Grewia-type'.

Introduction

The genus *Grewia* consists of about 280–300 species of trees, shrubs or climbers, distributed from Madagascar, tropical Africa northwards and southeastwards to the Himalayas, China and Taiwan, India, Sri Lanka, Myanmar, Thailand, Indo-China, Malesia, Western Pacific and the northern parts of Australia. In the Malesian region about 30 species are known, of which four occur in Peninsular Malaysia and Borneo. *Microcos* is a genus of about 80 species of trees and shrubs, occurring in tropical Africa (not Madagascar) and Indo-Malesia. In Malesia, some 42 species are known, of which 31 occur in Peninsular Malaysia and Borneo (Chung, 2001; Bayer and Kubitzki, 2003).

Previous studies on members of the order Malvales showed that pollen morphological characters were useful for segregating the Tiliaceae from the Bombacaceae, Malvaceae and Sterculiaceae (Erdtman, 1952; Nair, 1962; Chaudhuri, 1965; Chaudhuri and Mallik, 1965; Sharma, 1969; Coetzee and Van Der Schijff, 1978; Martínez-Hernández *et al.*, 1978; Zhang and Chen, 1984; Sudhakar and Rao, 1987).

Palynological literature on the family Tiliaceae has been reviewed by Erdtman (1952). He described over 70 species of the family, including some Peninsular Malaysian and Bornean representatives, distributed over 45 genera. Since then there have been a number of studies on the pollen of *Grewia* and/or *Microcos* from India (Sharma, 1969; Sudhakar and Rao, 1987), China (Long, 1982; Zhang and Chen, 1984; Wang *et al.*, 1995) and Sudan (El Ghazali, 1993). These studies show the Tiliaceae to be a eurypalynous family. Based mainly on aperture type and using tectum ornamentation as subsidiary characters, Sharma (1969) recognised 7 major and 18 minor pollen types, while Zhang and Chen (1984) recognised four pollen types and Erdtman (1952) noted only three pollen types in the Tiliaceae.

Erdtman (1952) classified the pollen of *Grewia* as belonging to a single pollen type, i.e. the 'Grewia-type' characterised by tricolporate grains with reticulate tectum. He, however, did not examine the pollen of *Microcos*. Later, Long (1982), Zhang and Chen (1984) and Wang *et al.* (1995) categorised pollen of *Grewia* and *Microcos* as belonging to the 'Grewia-type'. However, Sharma (1969), using characters of the tectum ornamentation and lumina width, distinguished four pollen types in the Indian species of *Grewia*.

Based on pollen morphological data, Erdtman (1952), Zhang and Chen (1984), Christensen (1986), and Nilsson and Robyns (1986) concluded that the pollen morphology of Tiliaceae closely resembled that of Bombacaceae and Sterculiaceae but differed from that of Malvaceae. Zhang and Chen (1984) supported the separation of *Microcos* from *Grewia* in the Tiliaceae. Sharma (1969) suggested that pollen morphological characters, when combined with other morphological data, can provide useful additional taxonomic characters for delimitating genera and species of the Tiliaceae.

The aim of this study is to investigate the morphological variation in the pollen of *Grewia* and *Microcos*; to assess the taxonomic value of the pollen in the Peninsular Malaysian and Bornean species; and to contribute to a better understanding of the pollen morphology of both genera.

Materials and methods

Pollen used in the present study was obtained from herbarium specimens listed in Table 1.

The pollen samples were acetolysed following the method of Erdtman (1960). The acetolysed pollen samples were divided for light microscopy (LM) and scanning electron microscopy (SEM) studies. For LM observations, pollen grains were mounted in glycerine jelly stained with safranin and sealed with paraffin wax. Measurements of polar length, equatorial width, colpus length and width were carried out using an Olympus BX41 microscope. For each sample, 20 pollen grains were measured using a calibrated eyepiece micrometer. For SEM observations, the acetolysed pollen grains

Table 1. Source of materials studied.

| Species ^s | Collector | Herbarium |
|---|--|-------------------------------|
| <i>Grewia</i> | | |
| <i>G. occidentalis</i> L. (type species) | Moss 3959 [*] ; Relinhoonk 483 [#] | BM; L |
| <i>G. huluperakensis</i> I.M. Turner | Turner 94-94 [*] | SING |
| <i>G. laevigata</i> Vahl | Hashim SAN 33470 [#] ; Kostermans 5234 [#] ; Lee S. 41948 [#] ; Sigin <i>et al.</i> SAN 110601 [#] ; Stone 11856 [#] ; Whitmore FRI 3729 [#] | SAN; SING; KEP; SAN; KLU; KEP |
| <i>G. multiflora</i> Juss. | Motley 240 [*] | K |
| <i>G. polygama</i> Roxb. | Kiah SFN 35286 [#] ; Symington FMS 46716 [#] | KEP; KEP |
| <i>Microcos</i> | | |
| <i>M. paniculata</i> L. (type species) | Cramer 3405 [#] ; Kanodia 88480 [*] | L; BM |
| <i>M. antidesmifolia</i> (King) Burret var. <i>antidesmifolia</i> | Cockburn FRI 7816 [#] ; King's Collector 4029 [#] ; Whitmore FRI 3417 [#] | KEP; K; KEP |
| <i>M. antidesmifolia</i> (King) Burret var. <i>hirsuta</i> (King) Burret | Creagh <i>s.n.</i> [#] ; Elmer 20911 [#] ; Sibat S. 25179 [#] | K; SING; KEP |
| <i>M. borneensis</i> Burret | Haviland 2837 [#] ; Tiggi S. 3311 [#] | SAR; SAR |
| <i>M. cinnamomifolia</i> Burret | Anderson S. 25147 [#] ; Charington SAN 29852 [#] ; Coode MC 7716 [#] | SAR; KEP; KEP |
| <i>M. dulitensis</i> Airy Shaw | Richards 1767 [#] | SING |
| <i>M. erythrocarpa</i> (Ridl.) Airy Shaw | Kochummen FRI 16417 [#] ; Mohd. Shah MS 2757 [#] | KEP; SING |
| <i>M. fibrocarpa</i> (Mast.) Burret | Kochummen KEP 80640 [#] ; Maingay 1080 [#] ; Mohd. Shah and Sidek MS 1164 [#] | KEP; K; SING |
| <i>M. globulifera</i> (Mast.) Burret | Maingay 3064 [#] ; Ogata KEP 105036 [#] | K; KEP |
| <i>M. gracilis</i> Stapf <i>ex</i> Ridl. | Chai SAN 26066; Coode <i>et al.</i> MC 6776; Haviland 1683 | SAN; KEP; SAR |
| <i>M. henrici</i> (Baker <i>f.</i>) Burret <i>ssp. acuta</i> R.C.K.Chung | Ahmad and Termiji SAN 67973 [#] ; Ilias S. 45121 [#] ; Kostermans 10424 [#] | SAN; KEP; L |
| <i>M. hirsuta</i> (Korth.) Burret | Clemens 27284 [#] ; Haviland 1471 [#] ; Korthals <i>s.n.</i> (L sheet no. 944.56.122) [#] | SING; SING; L |
| <i>M. kinabaluensis</i> R.C.K.Chung | Chew and Corner RSNB 4994 [#] ; Sadau SAN 49708 [#] | SAN; SAN |
| <i>M. lanceolata</i> (Miq.) Burret | Chelliah KEP 104621 [#] ; Mahmud FMS 3717 [#] | KEP; SING |
| <i>M. latifolia</i> Burret | King's Collector 7762 [#] ; Sarawak Museum Series 165 [#] ; Wong WKM 1545 [#] | K; SAR; SING |

Table 1 continued

| Species [§] | Collector | Herbarium |
|--|---|--------------------|
| <i>M. latistipulata</i> (Ridl.) Burret var. <i>latistipulata</i> | Burkill SFN 7826 [#] ; Elmer 20310 [#] ; Teo TP 391 [#] | SING; L; SING |
| <i>M. laurifolia</i> (Hook. ex Mast.) Burret | Kochummen FRI 16338 [#] ; Zainuddin FRI 17887 [#] | KEP; KEP |
| <i>M. malayana</i> R.C.K.Chung | Loh FRI 19249 [#] ; Symington and Kiah SFN 28797 [#] | KEP; SING |
| <i>M. membranifolia</i> R.C.K.Chung | Singh SAN 30672 [#] ; Yii S. 61492 [#] | KEP; KEP |
| <i>M. opaca</i> (Korth.) Burret | Korthals <i>s.n.</i> (L sheet no. 908.253.752) [#] ; Lee S. 43227 [#] | L; SAR |
| <i>M. ossea</i> Burret | Clemens 21071 [#] ; Haviland 42 [#] ; Wong WKM 1290 [#] | SAR; SING; BRUN |
| <i>M. pachyphylla</i> Merr. | Aban SAN 35880 [#] ; Salleh <i>et al.</i> BRUN 15315 [#] | SAN; KEP |
| <i>M. pearsonii</i> (Merr.) Burret | Singh and Aban SAN 30135 [#] ; Wright S. 29113 [#] | SAN; SAR |
| <i>M. phaneroneura</i> Burret | Hallier 2868 [#] ; Ilias S. 28128 [#] | BO; SAR |
| <i>M. reticulata</i> Ridl. | Ashton S. 17800 [#] ; Creagh <i>s.n.</i> [#] | KEP; K |
| <i>M. riparia</i> (Boerl. & Koord.) Burret | Hallier 2208 [#] ; Yeob FMS 3190 [#] | BO; KEP |
| <i>M. stylocarpoides</i> Burret | Burley <i>et al.</i> NGS 3243 [#] ; Othman S. 37444 [#] | KEP; SAR |
| <i>M. subcordifolia</i> R.C.K.Chung | Kirkup and Thomas DK 727 [#] ; Niga NN 118 [#] | KEP; KEP |
| <i>M. subpetala</i> Stapf <i>ex</i> Ridl. | Haviland 1885 [#] | K |
| <i>M. sumatrana</i> (Baker <i>f.</i>) Burret | Fedilis SAN 95781 [#] ; Forbes 2684 [#] | KEP; L |
| <i>M. tomentosa</i> Sm. | Ang FRI 21599 [#] ; Suppiah FRI 28239 [#] ; Zainuddin and Latiff AZ 1731 [#] | KEP; KEP; KEP |
| <i>M. triflora</i> (Blanco) R.C.K.Chung var. <i>triflora</i> | Anon. PNH 35319 [#] ; Tai SAN 58042 [#] | KEP; SING |
| <i>M. triflora</i> (Blanco) R.C.K.Chung var. <i>longipetiolata</i> (Merr.) R.C.K.Chung | Singh SAN 30375 [#] ; Suib S. 23458 [#] | KEP; KEP |

[#] used for LM and SEM

^{*} used for LM, SEM and TEM

[§] *Microcos crassifolia* Burret without any flowering material was excluded from this study

were dehydrated through an ethanol series and critical point dried by using liquid CO₂ as the exchange medium. After coating with gold, they were observed with a Jeol JSM-6400 scanning electron microscope. For transmission electron microscopy (TEM) studies, the pollen samples were fixed in 1% OsO₄ for 90 min, dehydrated through an ethanol series, and then embedded in epoxy resin. Ultrathin sections, cut with a glass knife, were stained with 8% uranyl acetate for 5 minutes and then Reynold's lead citrate (Reynolds, 1963) for 10 minutes. Observations were made using a Philips CM12 TEM.

Pollen morphological data for all species are summarised in Table 2. The size classes of pollen following Erdtman (1952) are classified as small (10–25 µm), medium (25–50 µm) or large (50–100 µm). Terminology follows that of Erdtman (1952) and Punt *et al.* (1994).

Results

GREWIA L.

(Table 2; Plates 1A–C, 2A–C, 3A–D and 4A–B)

Light Microscopy

The pollen grains of *Grewia* species are single, isopolar, radially symmetric, tricolporate, and rounded-triangular in equatorial outline (ambis). The pollen grains is medium to large (44–80 µm polar length) with an average polar length of 52.9–74.8 µm and an average equatorial axis 38.6–55 µm (Table 2). Pollen grain shape varies from subprolate (P/E = 1.26) to prolate (P/E = 1.36–1.45).

The apertures are tricolporate. The colpi are 1/2–3/4 of polar axis length, narrow (c. 1.5 µm) to wide (3.5–4.5 µm), provided with acute apices and delimited by a clearly defined margin. The endoapertures are lolongate or lalongate, either as wide as, or slightly wider than the colpi.

Scanning Electron Microscopy

The pollen grains of *Grewia* have a bireticulate-tectate exine. The muri of the primary reticulum are smooth, but somewhat irregular in thickness. The lumina of the primary reticulum are coarsely reticulate and variable in width and shape, and are infilled by a secondary reticulum comprising few to many finer reticulations and/or perforations of varying width and shape. Two types of tectum ornamentation were observed in *Grewia* pollen: type C (coarsely reticulate with a few perforations/microreticulations) and type D (coarsely reticulate with numerous perforations/microreticulations).

Transmission Electron Microscopy

The exine is 1–2.54 µm thick and consists of an outer ectexine and an inner endexine.

Table 2. Pollen morphological characters of *Grewia* and *Microcos* species in Peninsular Malaysia and Borneo.

| Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|--|----------------|----------------|------|-----|----|------|-----|-------|---|----|----|----|----|
| Column: | | | | | | | | | | | | | |
| Grewia | | | | | | | | | | | | | |
| <i>occidentalis</i> (type species) | (58-)62.7(-68) | (38-)42(-48) | 1.49 | l | p | 36.7 | 3 | la | D | co | po | mt | nu |
| <i>lutiperakensis</i> | (44-)52.9(-60) | (38-)41.9(-46) | 1.26 | l/m | sp | 28.6 | 1.5 | la | D | co | po | mt | nu |
| <i>laevigata</i> | (70-)74.8(-80) | (48-)55(-62) | 1.36 | l | p | 45.5 | 4.5 | lo | D | co | rs | mt | nu |
| <i>multiflora</i> | (60-)66(-72) | (38-)45.6(-52) | 1.45 | l | p | 35.6 | 4.4 | la | D | co | po | mt | nu |
| <i>polygama</i> | (50-)55.6(-60) | (32-)38.6(-44) | 1.44 | l | p | 34.2 | 3.5 | la | C | co | po | mt | fe |
| Microcos | | | | | | | | | | | | | |
| <i>paniculata</i> (type species) | (26-)28.9(-32) | (18-)20.2(-22) | 1.43 | m | p | 14.5 | 1.9 | la | A | fi | po | lt | fe |
| <i>antidesmifolia</i> var. <i>antidesmifolia</i> | (20-)25.8(-29) | (19-)21.6(-24) | 1.19 | s/m | sp | 15.5 | 1.4 | ci | A | fi | po | lt | fe |
| <i>antidesmifolia</i> var. <i>hirsuta</i> | (23-)27(-31) | (15-)22.6(-31) | 1.21 | s/m | sp | 14.7 | 1 | ci | A | fi | po | lt | fe |
| <i>borneensis</i> | (23-)25.3(-28) | (16-)18.8(-22) | 1.35 | s/m | p | 16.7 | 1.7 | ci | A | fi | po | lt | fe |
| <i>cinnamomifolia</i> | (23-)25.1(-26) | (16-)18.6(-22) | 1.35 | s/m | p | 15 | 1.2 | ci | A | fi | po | lt | fe |
| <i>dulitensis</i> | (26-)31.1(-36) | (19-)23.5(-27) | 1.32 | m | sp | 16.8 | 1.8 | ci | A | fi | po | lt | fe |
| <i>erythrocarpa</i> | (29-)32.9(-37) | (19-)22.2(-29) | 1.49 | m | p | 19.7 | 2.1 | ci | A | fi | po | lt | fe |
| <i>fibrocarpa</i> | (27-)30.4(-34) | (18-)22(-27) | 1.38 | m | p | 18.1 | 1.6 | ci | B | fi | po | lt | nu |
| <i>globulifera</i> | (24-)29.6(-34) | (20-)22.6(-24) | 1.31 | s/m | sp | 18.9 | 1.4 | la | B | fi | po | lt | nu |
| <i>gracilis</i> | (24-)27(-29) | (17-)19.1(-22) | 1.41 | s/m | p | 17.7 | 1.6 | ci | A | fi | po | lt | fe |
| <i>henrici</i> ssp. <i>acuta</i> | (23-)30.4(-39) | (25-)26.9(-30) | 1.13 | s/m | ps | 16.3 | 1.5 | ci | B | fi | po | lt | nu |
| <i>hirsuta</i> | (29-)33.6(-37) | (19-)22(-24) | 1.53 | m | p | 17.1 | 1.5 | ci | B | fi | po | lt | nu |
| <i>kinabaluensis</i> | (28-)32.4(-37) | (22-)23.1(-27) | 1.40 | m | p | 17.7 | 1.2 | ci | B | fi | po | lt | nu |
| <i>lanceolata</i> | (29-)32.3(-34) | (17-)21(-24) | 1.54 | m | p | 19.7 | 3.1 | ci | B | fi | po | lt | nu |
| <i>latifolia</i> | (32-)33(-34) | (20-)21.6(-24) | 1.53 | m | p | 24.3 | 1.7 | ci | A | fi | po | lt | fe |
| <i>latistipulata</i> var. <i>latistipulata</i> | (26-)29.6(-33) | (17-)21.1(-24) | 1.42 | m | p | 16.3 | 3.1 | ci | B | fi | po | lt | nu |
| <i>laurifolia</i> | (24-)25.6(-27) | (17-)19(-22) | 1.35 | s/m | p | 17.6 | 1.5 | ci | B | fi | po | lt | nu |
| <i>malayana</i> | (29-)33.7(-39) | (19-)22.2(-27) | 1.52 | m | p | 19 | 1 | ci | B | fi | po | lt | nu |
| <i>membranifolia</i> | (30-)32.6(-35) | (23-)27.1(-30) | 1.20 | m | sp | 20.4 | 1.5 | ci | B | fi | po | lt | nu |
| <i>opaca</i> | (24-)34.1(-42) | (17-)21.4(-28) | 1.60 | s/m | p | 16.8 | 1.2 | ci | A | fi | po | lt | fe |
| <i>osseae</i> | (27-)31.1(-37) | (17-)20.8(-24) | 1.51 | m | p | 20 | 1.5 | ci | A | fi | po | lt | fe |
| <i>pachyphylla</i> | (28-)30.1(-33) | (20-)23.1(-28) | 1.30 | m | sp | 16.7 | 1.3 | ci/la | A | fi | po | lt | fe |
| <i>pearsonii</i> | (31-)35(-38) | (20-)21.5(-23) | 1.62 | m | p | 20 | 1.3 | ci/la | B | fi | po | lt | nu |

Table 2. Continued:-

| Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|--|----------------|----------------|------|---|----|------|-----|-------|---|----|----|----|----|
| <i>Microcos</i> | | | | | | | | | | | | | |
| <i>phaneroneura</i> | (33-)34.5(-38) | (20-)23.2(-25) | 1.49 | m | p | 19.6 | 2.3 | ci | A | fi | po | lt | fe |
| <i>reticulata</i> | (28-)28.8(-31) | (19-)21.1(-23) | 1.37 | m | p | 15 | 1.4 | ci | B | fi | po | lt | nu |
| <i>riparia</i> | (27-)29.7(-32) | (18-)21.6(-24) | 1.38 | m | p | 16.9 | 3.1 | ci | A | fi | po | lt | fe |
| <i>stylocarpoides</i> | (33-)34.8(-40) | (23-)25.7(-30) | 1.35 | m | p | 18.2 | 1.5 | ci | A | fi | po | lt | fe |
| <i>subcordifolia</i> | (30-)32.3(-38) | (20-)23.1(-28) | 1.40 | m | p | 14.7 | 1.7 | ci | A | fi | po | lt | fe |
| <i>subpetala</i> | (28-)30.6(-35) | (20-)21.6(-25) | 1.42 | m | p | 17.2 | 1.4 | ci | A | fi | po | lt | fe |
| <i>sumatrana</i> | (28-)30.8(-33) | (18-)20.6(-23) | 1.50 | m | p | 16.8 | 1.2 | ci | B | fi | po | lt | nu |
| <i>tomentosa</i> | (26-)27.2(-28) | (19-)20.9(-23) | 1.30 | m | sp | 16.3 | 3.5 | ci/la | B | fi | po | lt | nu |
| <i>triflora</i> var. <i>triflora</i> | (28-)29.6(-33) | (19-)20.6(-23) | 1.44 | m | p | 17.8 | 1.6 | ci/la | B | fi | po | lt | nu |
| <i>triflora</i> var. <i>longipetiolata</i> | (30-)32(-35) | (23-)24.5(-28) | 1.31 | m | sp | 16.8 | 1.4 | ci/la | B | fi | po | lt | nu |

Legend: / = or

Columns:

1. Length polar axis, P (in μm)
2. Equatorial diameter, E (in μm)
3. Ratio between length of the polar axis and equatorial axis (P/E ratio)
4. Size classes (Erdtman, 1952: s = small, 10-25 μm ; m = medium, 25-50 μm ; l = large, 50-100 μm)
5. Shape classes (Erdtman, 1952: p = prolate; ps = prolate spheroidal; sp = subprolate)
6. Average length of colpus (in μm)
7. Average width of colpus (in μm)
8. Endoaperture shape (ci = circular; la = lalongate; lo = lolongate)
9. Type of tectum ornamentation (A = finely reticulate with a few perforations/microreticulations; B = finely reticulate with numerous perforations/microreticulations; C = coarsely reticulate with a few perforations/microreticulations; D = coarsely reticulate with numerous perforations/microreticulations)
10. Muri of primary reticulum (co = coarse; fi = fine)
11. Lumina shape (po = polygonal; rs = reticulate subrugulate)
12. Lumina diameter (lt = < 1.5 μm ; mt = > 1.5 μm)
13. Lumina perforations/microreticulations (fe = few; nu = numerous)

The ectexine is thicker than the endexine except at the aperture region. The tectum is 0.23–0.86 μm thick. The columellae are simple, straight, distinctly arranged in single rows in a reticulate pattern, and either support the raised muri of the primary reticulum or support the sunken secondary reticulum. The columellae are 0.46–1.46 μm tall and 0.29–0.77 μm thick. The spaces between columellae range 0.47–1.1 μm in height and 0.18–1 μm in width. The foot layer is 0.24–0.53 μm thick at the mesocolpia, and is often thickened near the aperture.

The endexine appears smooth, thin and is not always discernible except at the aperture region. Below the endexine, at the apertural region, there are generally darkly stained, stout, radial elements towards the intine. The intine is fibrillar and, particularly at the apertures, stratified into a fibrillar layer and enveloping a lens-shaped body with a microtubule layer.

Remarks

Apart from minor differences, the pollen morphological characters of the Peninsular Malaysian and Bornean species of *Grewia* conform to those of *G. occidentalis* (the type species of the genus), the pollen of *G. occidentalis* compared with *Grewia* species from Peninsular Malaysia and Borneo has a thinner tectum and columellae (0.73–1.23 μm), and foot layer and endexine (0.06–0.2 μm).

The pollen of *Grewia laevigata* can be distinguished from pollen of other *Grewia* species by the perforations of the secondary reticulum that encroach into the margins of the primary muri. Pollen of *G. polygama* differs from that of *G. huluperakensis* and *G. multiflora* by having fewer microreticulations/perforations of the lumina.

Sharma (1969) reported that pollen size of *Grewia* species from India was (27.2–) 31(–78.2) μm in polar length and (18.7–)21(–57.8) μm in equatorial diameter. However, among the 17 species he studied, one was a *Microcos* species: *G. microcos* L. is now *Microcos paniculata*. By omitting the pollen size of this species (P=(27.2–) 31(–34) μm ; E = (18.7–)21(–22.1) μm) from the data, the pollen size of these *Grewia* species in India was (40.8–)47.4(–78.2) μm in polar length and (28.9–)32.6(–57.8) μm in equatorial diameter. Therefore, in India pollen size of *Grewia* species was larger than that of *Microcos* species (= *G. microcos*).

The exine thickness of *Grewia* species from China was reported by Zhang and Chen (1984) as more than 2.3 μm . This falls within the range of the present study, 0.73–2.54 μm thick.

MICROCOS L.

(Tables 2 and 3; Plates 1D–F, 2D–F, 3E–H and 4C–D)

Light Microscopy

The pollen grains in *Microcos* are single, isopolar, radially symmetric, tricolporate, and rounded-triangular in equatorial outline (ambis). Size ranges from small to medium

(20–42 μm polar length) with an average polar length of 25.1–35 μm and an average equatorial diameter of 18.6–26.9 μm . Most *Microcos* species possess medium-sized pollen grains (Table 2). Pollen grain shape varies from prolate spheroidal ($P/E = 1.13$) to subprolate ($P/E = 1.19$ – 1.32) or prolate ($P/E = 1.35$ – 1.62).

The colpi are $1/2$ to $3/4$ the length of the polar axis, narrow to wide, with acute apices, and delimited by a distinct margin. In most species the endoapertures are circular, but are lalongate in *M. globulifera* and circular to lalongate in *M. pachyphylla*, *M. pearsonii*, *M. tomentosa*, and *M. triflora* (both varieties). In most species, the endoapertures are as wide as or slightly wider than the colpi.

Scanning Electron Microscopy

The tectum of *Microcos* species are biretulate-tectate. The muri of the primary reticulum are smooth and of somewhat irregular thickness. The lumina of the primary reticulum are finely reticulate and are infilled by secondary reticulum with minute to large microreticulations/perforations of variable number and shape. Two types of tectum ornamentation are found in *Microcos* pollen: type A (finely reticulate with a few perforations/microreticulations) and type B (finely reticulate with numerous perforations/microreticulations).

Transmission Electron Microscopy

The exine is 0.70–1.05 μm thick and consists of an outer ectexine and an inner endexine. The ectexine is thicker than nexine except at the aperture region. The tectum is 0.18–0.46 μm thick. The columellae are simple, straight, and distinctly arranged in single rows in a reticulate pattern, either supporting the raised muri of the primary reticulum or supporting the sunken secondary reticulum. The columellae are 0.2–0.5 μm tall and 0.14–0.32 μm thick. The spaces between columellae is 0.18–0.45 μm in height and 0.14–0.55 μm in width. The foot layer varies in thickness but is generally markedly thickened at the aperture margin.

The endexine is usually thin and always traceable except towards the apertures, where it may be thicker. The intine often has numerous microtubule layers enveloped by the fibrillar layer. At the apertural region there are relatively stout, darkly stained, radial elements between intine and endexine.

Remarks

The pollen morphology in the species examined matches that of *M. paniculata* (the type species of the genus). The palynological data in this study conform well with the results reported in China by Long (1982), Zhang and Chen (1984), Wang *et al.* (1995); and in India by Sharma (1969; *G. microcos* = *M. paniculata*).

Among the Peninsular Malaysian and Bornean *Microcos* species examined, three main groups can be discerned based on whether the pollen is prolate-spheroidal,

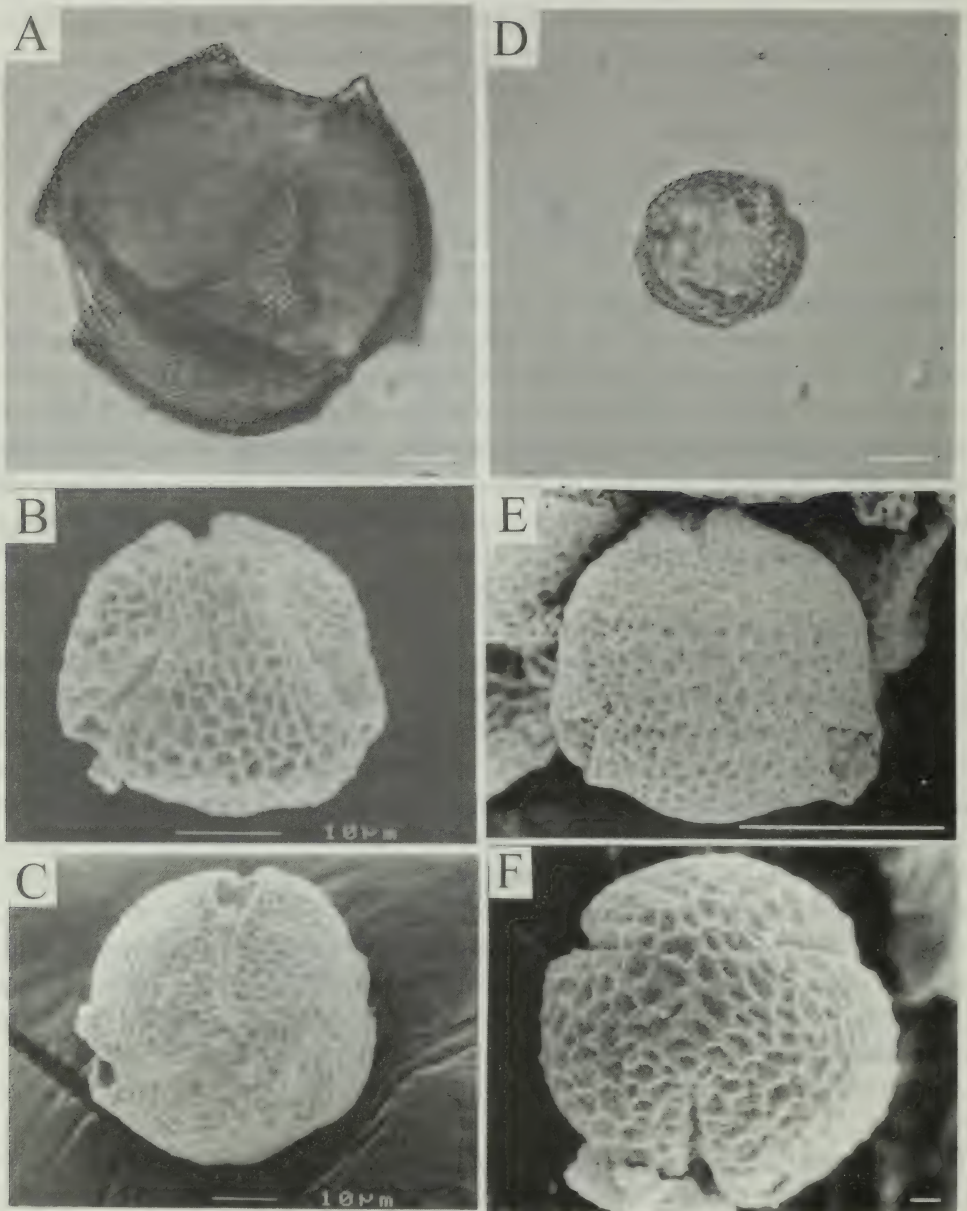


Plate 1. LMs and SEMs of selected *Grewia* and *Microcos* species showing tricolporate grains in polar view. **A & C:** *G. laevigata* (A: Whitmore 3729; C: Hashim SAN 33470). **B:** *G. multiflora* (Motley 240). **D:** *M. fibrocarpa* (Kochummen 80640). **E:** *M. paniculata* (Cramer 3405). **F:** *M. malayana* (Loh FRI 19249). Scale bar = 1 µm in F; 10 µm in A–E.

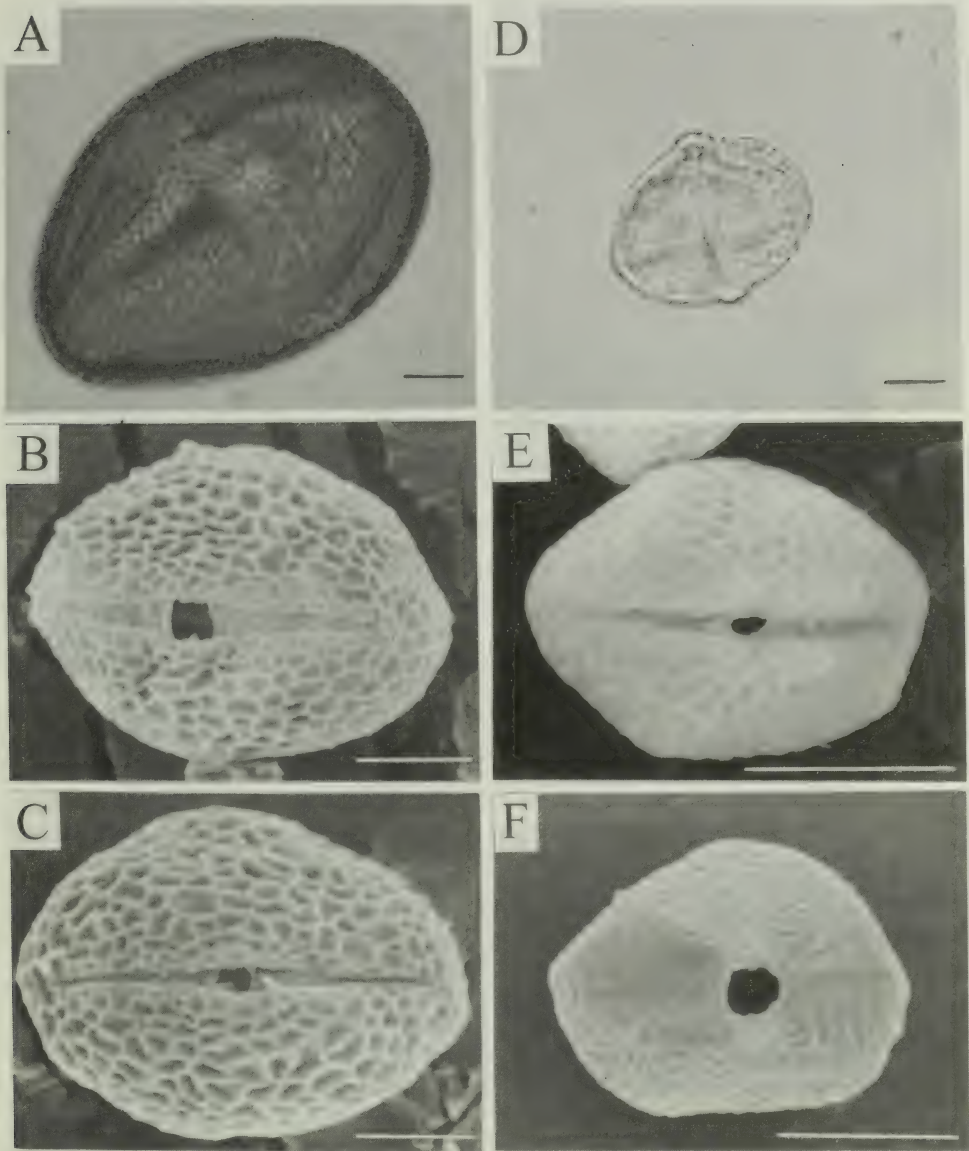


Plate 2. LMs and SEMs of selected *Grewia* and *Microcos* species showing tricolporate grains in equatorial view. **A:** *G. laevigata* (Whitmore 3729). **B:** *G. laevigata* (Hashim SAN 33470) with lolongate endoaperture. **C:** *G. multiflora* (Motley 240) with lalongate endoaperture. **D:** *M. fibrocarpa* (Kochummen 80640). **E:** *M. dulitensis* (Richards 1767) with circular endoaperture. **F:** *M. riparia* (Hallier 2208) with circular endoaperture. Scale bar = 1 μ m in F; 10 μ m in A–E.

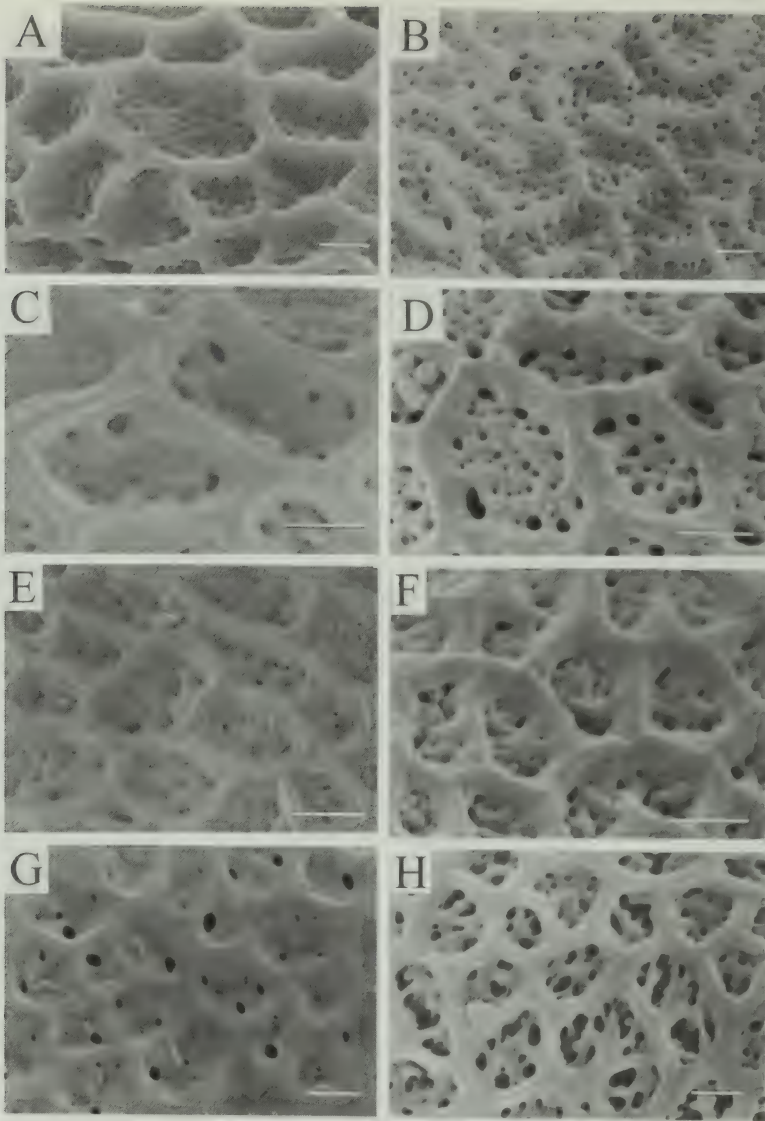


Plate 3. SEMs of selected *Grewia* and *Microcos* species showing exine detail of coarsely reticulate pattern (A–D) or finely reticulate pattern (E–H) and lumina detail. **A:** *G. multiflora* (Motley 240), muri variable in width and shape. **B:** *G. laevigata* (Hashim SAN 33470), muri branching inwards toward the lumina forming reticulate subrugulate sculpturing. **C:** *G. polygama* (Kiah SFN 35286), lumina occupied by a few microreticulations/perforations. **D:** *G. huluperakensis* (Turner 94-94), lumina occupied by numerous microreticulations. **E:** *M. henrici* ssp. *acuta* (Ilias S 45121), muri variable in width and shape. **F:** *M. kinabaluensis* (Chew & Corner RSNB 4994). **G:** *M. dulitensis* (Richards 1767), lumina occupied by a few microreticulations. **H:** *M. membranifolia* (Singh SAN 30672), lumina occupied by numerous microreticulations. Scale bar = 1 μ m in A–H.

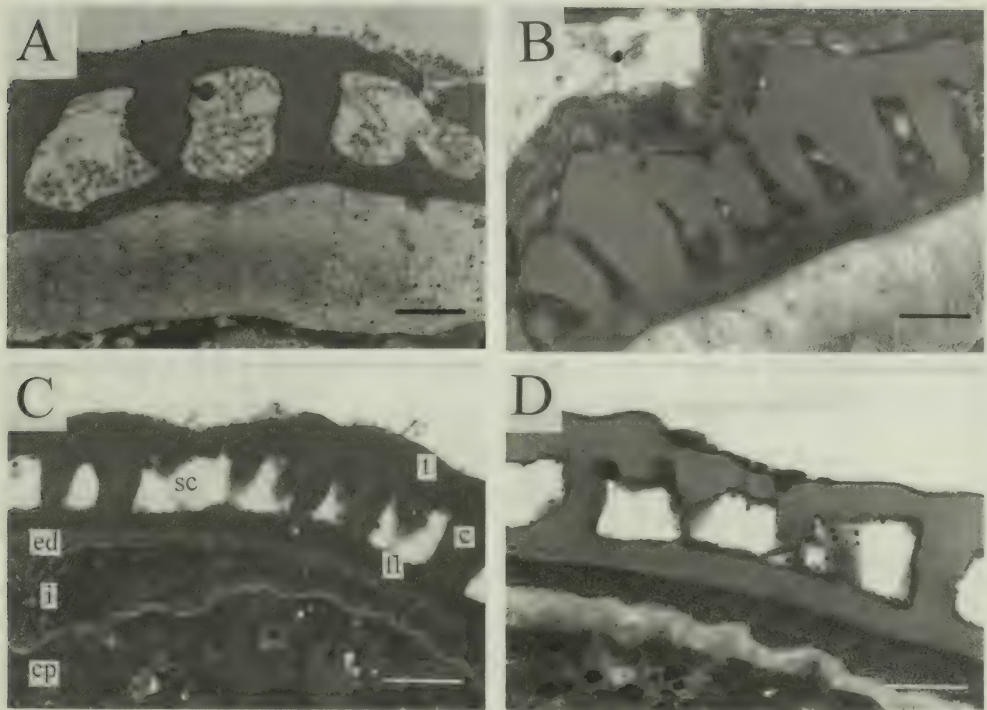


Plate 4. TEMs micrograph of selected *Grewia* and *Microcos* species showing structure of ectexine and endexine. **A:** *G. occidentalis* (Moss 3959). **B:** *G. multiflora* (Motley 240). **C:** *M. paniculata* (Kanodia 88480). **D:** *M. tomentosa* (Suppiah FRI 28239). Scale bar = 0.36 μm in D; 0.45 μm in A & C; 0.59 μm in B. Abbreviation used: c = columellae; cp = cytoplasm; ed = endexine; fl = foot layer; i = intine; sc = spaces between columellae; t = tectum.

subprolate or prolate. In species with subprolate pollen grains, three subgroups can be distinguished based on whether the endoapertures are circular, alongate or circular-alongate. Other pollen morphological characters, e.g. P/E ratio and number of lumina perforations, can be used to further subdivide these subgroups. Likewise, in species with prolate pollen grains, by using palynological characters such as the number of perforations of the lumina, P/E ratios and endoapertures shape, further subdivisions to smaller groups can be made (Table 3).

Discussion

The pollen morphology of both genera is very similar and adds further confirmation that species of *Grewia* and *Microcos* in Peninsular Malaysia and Borneo have pollen morphological characters belonging to the 'Grewia-type' of Erdtman (1952).

Table 3. Grouping of *Microcos* species in Peninsular Malaysia and Borneo based on pollen morphological characters.

| Prolate-spheroidal | POLLEN SHAPE | | | | Prolate |
|---|-------------------------------|-----------------------|---|---|--|
| | Subprolate | | Prolate | | |
| <i>M. antidesmifolia</i> (both varieties), <i>M. dulitensis</i> , <i>M. globulifera</i> , <i>M. membranifolia</i> , <i>M. pachyphylla</i> , <i>M. tomentosa</i> , <i>M. triflora</i> var. <i>longipetiolata</i> | ENDOAPERTURES | | NUMBER OF LUMINA PERFORATIONS | | |
| | Circular | Lalongate | Circular-lalongate | A Few | Numerous |
| <i>M. antidesmifolia</i> (both varieties), <i>M. dulitensis</i> , <i>M. membranifolia</i> | | <i>M. globulifera</i> | <i>M. pachyphylla</i> , <i>M. tomentosa</i> , <i>M. triflora</i> var. <i>longipetiolata</i> | <i>M. borneensis</i> , <i>M. cinnamomifolia</i> , <i>M. erythrocarpa</i> , <i>M. gracilis</i> , <i>M. latifolia</i> , <i>M. opaca</i> , <i>M. ossea</i> , <i>M. phaneroneura</i> , <i>M. riparia</i> , <i>M. stylocarpoides</i> , <i>M. subcordifolia</i> , <i>M. subpetala</i> | <i>M. fibrocarpa</i> , <i>M. hirsuta</i> , <i>M. kinabaluensis</i> , <i>M. lanceolata</i> , <i>M. latistipulata</i> var. <i>latistipulata</i> , <i>M. laurifolia</i> , <i>M. malayana</i> , <i>M. pearsonii</i> , <i>M. reticulata</i> , <i>M. sumatрана</i> , <i>M. triflora</i> var. <i>triflora</i> |
| | NUMBER OF LUMINA PERFORATIONS | | P/E RATIO | | ENDOAPERTURES |
| | A Few | Numerous | < 1.40 | > 1.40 | Circular-lalongate |
| <i>M. antidesmifolia</i> (<i>M. membranifolia</i> (both varieties)) ¹ , <i>M. dulitensis</i> ¹ | | <i>M. pachyphylla</i> | <i>M. antidesmifolia</i> (both varieties) ¹ , <i>M. dulitensis</i> ¹ | <i>M. borneensis</i> , <i>M. cinnamomifolia</i> , <i>M. riparia</i> , <i>M. stylocarpoides</i> , <i>M. subcordifolia</i> | <i>M. pearsonii</i> ³ , <i>M. triflora</i> var. <i>triflora</i> ³ |
| <i>M. antidesmifolia</i> (<i>M. membranifolia</i> (both varieties)) ¹ , <i>M. dulitensis</i> ¹ | | <i>M. pachyphylla</i> | <i>M. tomentosa</i> ² , <i>M. triflora</i> var. <i>longipetiolata</i> ² | <i>M. erythrocarpa</i> , <i>M. gracilis</i> , <i>M. latifolia</i> , <i>M. opaca</i> , <i>M. ossea</i> , <i>M. phaneroneura</i> , <i>M. subpetala</i> | Circular |
| Remarks: | | | | | |
| ¹ pollen of <i>M. dulitensis</i> differs slightly from that of <i>M. antidesmifolia</i> (both varieties) in being larger, (26–)31.1(–36) x (19–)23.5(–27) µm, with P/E ratio of 1.32. | | | | | |
| ² pollen of <i>M. tomentosa</i> only slightly differs from that of <i>M. triflora</i> var. <i>longipetiolata</i> in being smaller (26–)27.2(–28) x (19–)20.9(–23) µm. | | | | | |
| ³ pollen of <i>M. pearsonii</i> can be differentiated from that of <i>M. triflora</i> var. <i>triflora</i> by its larger size, (31–)35(–38) x (20–)21.5(–23) µm, and larger P/E ratio, 1.62. | | | | | |
| ^{4,5} The P/E ratio of pollen is either ≤ 1.40 (<i>M. fibrocarpa</i> , <i>M. kinabaluensis</i> , <i>M. laurifolia</i> , and <i>M. reticulata</i>) or > 1.40 (<i>M. hirsuta</i> , <i>M. lanceolata</i> , <i>M. latistipulata</i> var. <i>latistipulata</i> , <i>M. malayana</i> , and <i>M. sumatрана</i>). | | | | | |

On the basis of palynological characters, the genus *Microcos* in Peninsular Malaysia and Borneo can be distinguished from *Grewia* by a combination of the following characters: pollen size, exine thickness, tectum ornamentation and lumina diameter. The main morphological differences between pollen of *Grewia* and *Microcos* are summarised in Table 4. To some extent, this study supports Burret's view (1926) for segregating *Microcos* from *Grewia*.

Table 4. Main differences between pollen of *Grewia* and *Microcos* species in Peninsular Malaysia and Borneo.

| Genus: | <i>Grewia</i> | <i>Microcos</i> |
|--|---------------------|---------------------|
| Characters | | |
| Size | | |
| Length polar axis, P (μm) | (44–)53–75(–80) | (20–)25–35(–42) |
| Equatorial diameter, E (μm) | (32–)39–55(–62) | (15–)19–27(–31) |
| Exine | | |
| Thickness (μm) | (1–)1.55–2.15(–2.5) | (0.70)0.84–0.90(–1) |
| Tectum | | |
| Ornamentation | coarsely reticulate | finely reticulate |
| Lumina diameter (μm) | > 1.5 | < 1.5 |

Chung (2001, 2002) identified a total of 42 morphological and micromorphological characters, which in combination can be used to distinguish *Grewia* from *Microcos* species in Peninsular Malaysia and Borneo, and concluded that the two genera are distinct. The findings support previous conclusions reached by Burret (1926) and Bayer and Kubitzki (2003) based on the morphology of inflorescences, flowers and fruits; by Chattaway (1934) based on wood anatomy; Zhang and Chen (1984) based on pollen morphology; and by Bayer *et al.* (1999) based on combined analyses of plastid *atpB* and *rbcL* DNA sequences.

Conclusions

This study confirms that within the Tiliaceae the pollen of *Grewia* and *Microcos* species occurring in Peninsular Malaysia and Borneo conforms well with the so-called 'Grewia-type' (Erdtman, 1952). Comparison based on results of this study and all available published information indicates that pollen of *Microcos* differs from that of *Grewia* in having smaller size, thinner exine, finer tectum reticulation and smaller lumina, which supports the segregation of *Microcos* from *Grewia*.

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Six New Species of *Bulbophyllum* (Orchidaceae) from Sulawesi

J.J. VERMEULEN

Singapore Botanic Gardens
Singapore 259569

AND

P. O'BYRNE

14 Clementi Crescent
Singapore 599517

Abstract

Six new species of *Bulbophyllum* are described, all from Sulawesi: *B. trichorhachis* (sect. *Hybochilus*), *B. valeryi* (sect. *Leptopus*), *B. auriculatum* and *B. tubilabium* (both sect. *Monilibulbus*), *B. stenurum* (sect. *Osyricera*), and *B. reductum* (sect. *Pelma*).

Introduction

The six new species described below once more underline the uniqueness of the Sulawesi orchid flora. The dual origins of its flora are demonstrated by the fact that, for instance, *Bulbophyllum reductum* belongs to an almost exclusively Papuan section of the genus, whereas *B. auriculatum* and *B. tubilabrum* have their phylogenetic roots in Asia, particularly the Sunda Shelf. *B. stenurum*, together with *B. hastiferum* Schltr., and *B. anakbaruppui* J.J. Verm. & P. O'Byrne, form a small, very distinctive series within sect. *Osyricera* entirely restricted to Sulawesi; they demonstrate the amount of speciation that has occurred on the island. *B. trichorhachis* is the second Sulawesi species of sect. *Hybochilus* with a racemose inflorescence. This character is otherwise almost absent in sect. *Hybochilus* as well as in assumedly related sections. Clearly, the Sulawesi flora deserves more attention than it gets at present.

Bulbophyllum sect. *Hybochilus*

Bulbophyllum trichorhachis J.J. Verm. & P. O'Byrne, *sp. nov.* – Fig. 1.

Bulbophyllum trichorhachis J.J. Verm. & P. O'Byrne, a *Bulbophyllo iteranti* floribus multo minoribus (sepalum medianum 3.8 mm longum), labello carina medialis carenti differt. —TYPE: Indonesia, Sulawesi, central part, SBG-O4348 (SING,holo.).

Roots below the pseudobulbs. *Rhizome* creeping, 0.8–1 mm diam., sections between pseudobulbs 0.2–0.6 cm long, bracts not persistent. *Pseudobulbs* close together, ovoid, 0.4–0.65 x 0.2–0.4 cm. *Petiole* up to 0.02 cm long. *Leaf blade* elliptic to (ob)ovate, 1.3–1.9 x 0.35–0.5 cm, index (length/width) 2.6–5.4; acute. *Inflorescence* an elongated raceme, 3–4.8 cm long, 1–22-flowered. *Peduncle* erect to patent, 2.5–2.9 cm, bracts 3, the longest c. 1.5 mm long. *Rhachis* porrect or arching, zigzag bent, not thickened, up to 1.7 cm. *Floral bracts* tubular at the base, 0.7–1 mm, acute. *Flowers* not fully opening, each one developing only after anthesis of the previous. *Pedicel* and ovary 1.9–2.8 mm long, basal node on a c. 0.7 mm-long stump. *Median sepal* recurved, ovate, c. 4 x 1.5 mm, index 2.6–2.7; subacute, margins entire, base broadly attached; thin, 3-veined, glabrous. *Lateral sepals* 4 x 1.5 mm, index 2.6–2.7; lower margin somewhat ciliolate; otherwise as the median sepal. *Petals* porrect, ovate, c. 2.9 x 1.2 mm, index 2.4–2.5; subacute, margins ciliate, base narrowly attached; thin, 1-veined, glabrous. *Lip* slightly recurved near the base, general outline triangular, c. 2.9 x 0.7 mm, index c. 4.1 (all without artificial spreading); rounded, margins ciliate; rather thick; adaxially concave near the base, convex elsewhere, surface glabrous; abaxially without a ridge, surface with stiff hairs near the base, and with softer hairs elsewhere. *Column* c. 0.9 mm long, stigma without a tooth at its base, column foot absent. *Stelidia* porrect, triangular, c. 0.6 mm long, acute, with a slight, rounded wing along the upper margin. *Anther* abaxially with a distinct, papillose crest, surface otherwise finely papillose, front margin drawn out into an incurved, truncate beak with entire margins. *Pollinia* 4; ovoid, the inner c. 3/4 as long as the outer; no appendages present.

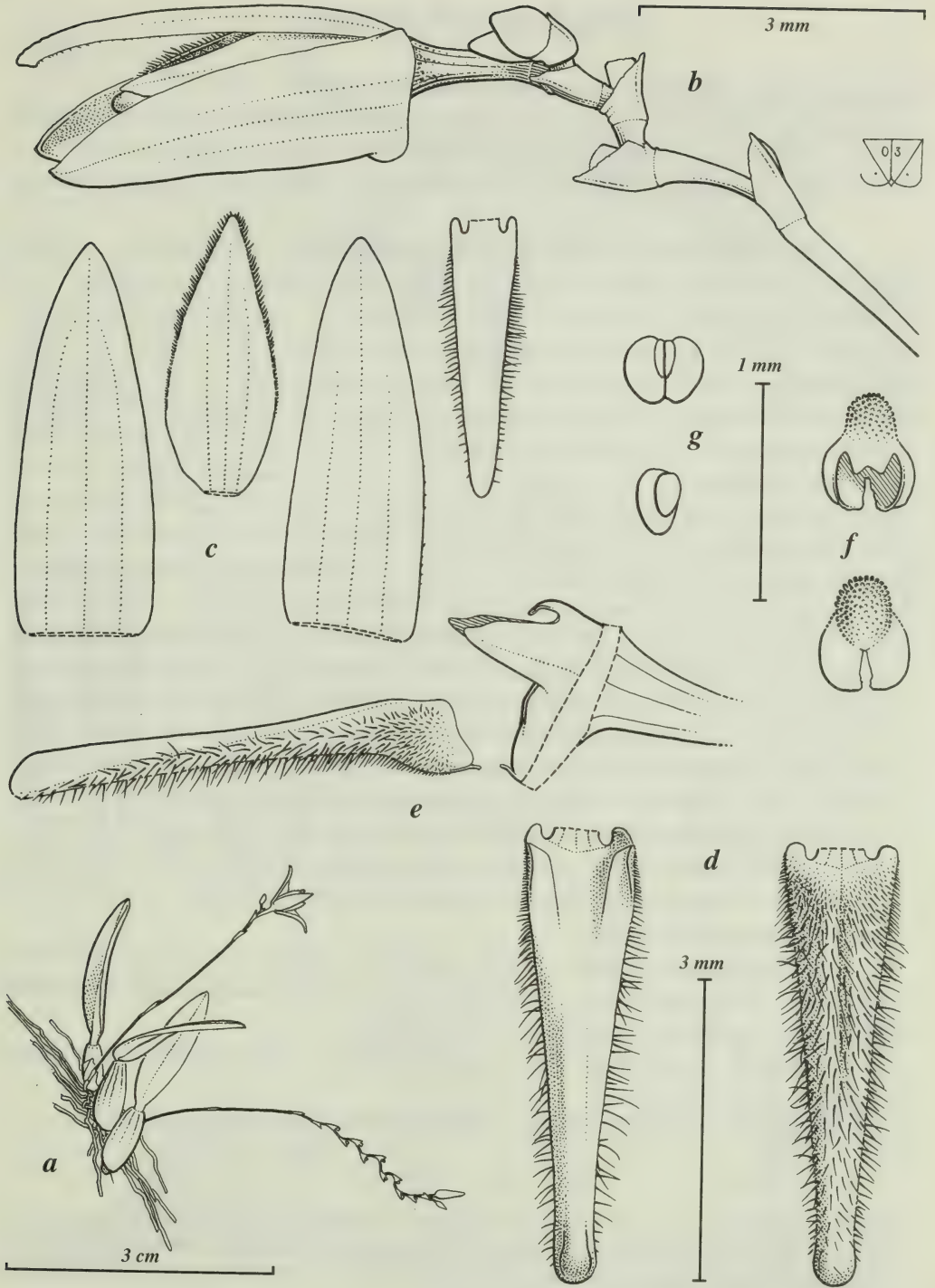
Colour: Flowers entirely dark purple.

Habitat: Epiphyte in montane forest, on branches of medium-sized trees. Alt. c. 1000 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: Similar to *Bulbophyllum iterans* J.J. Verm & P. O'Byrne, differs in having an unthickened, more elongated rhachis, smaller flowers (median sepal in *B. iterans* 10.5–11.2 mm long, in *B. trichorhachis* c. 4. mm long) and a lip without a median ridge.

Figure 1. *Bulbophyllum trichorhachis* J.J. Verm. & P. O'Byrne – a. Habit; b. Inflorescence; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, above: adaxial side, below: abaxial side; g. Pollinia, above: two pairs, below: a single pair. — All from SBG-O 4348 (spirit sample).



Bulbophyllum* sect. *Leptopus

***Bulbophyllum valeryi* J.J. Verm. & P. O'Byrne, *sp. nov.* – Fig. 2.**

Bulbophyllum valeryi J.J. Verm. & P. O'Byrne, a *Bulbophyllo melinantho* pedunculo 2 mm longo, infra stigmatem umbonibus duobus distinctis differt. — TYPE: Indonesia, Sulawesi, central part, SBG-O 4834 (SING, holo.).

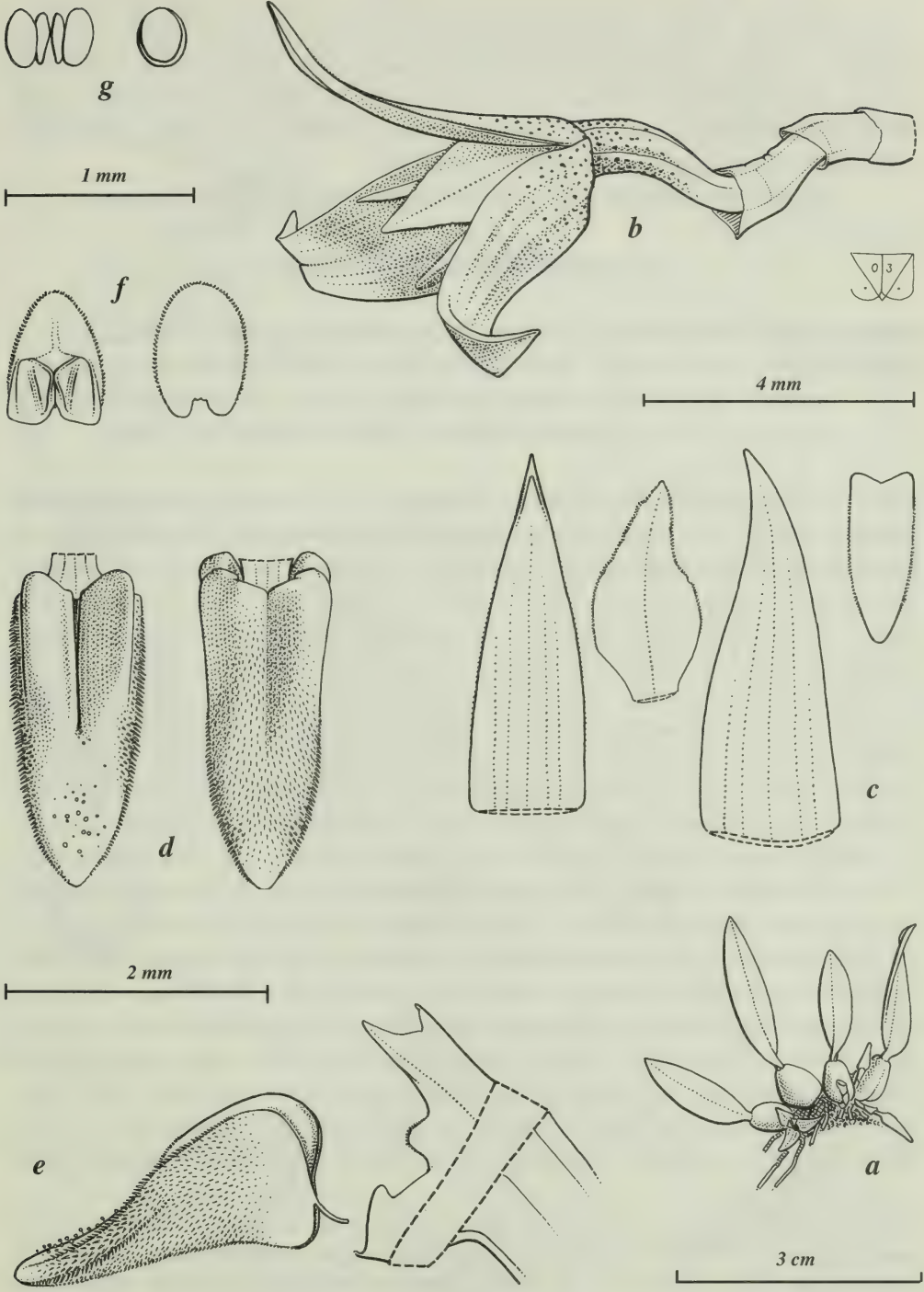
Roots below the pseudobulbs. *Rhizome* creeping, 1–1.5 mm diam., sections between pseudobulbs 0.25–0.4 cm long, bracts not persistent. *Pseudobulbs* close together, ovoid, 0.45–0.7 x 0.3–0.55 cm. *Petiole* up to 0.1 cm long. *Leaf blade* elliptic to ovate, 1.2–2.8 x 0.4–0.5 cm, index (length/width) 3–5.6; obtuse to acute. *Inflorescence* 1–1.2 cm long, 1-flowered. *Peduncle* patent, 0.15–0.2 cm, bracts 2, the longest c. 1.8 mm long. *Floral bract* tubular, c. 2 mm, acute. Flowers not fully opening. *Pedicel and ovary* c. 4 mm long, basal node on a c. 1.2 mm-long stump. *Median sepal* recurved, triangular, c. 5.3 x 2 mm, index 2.6–2.7; acute, margins slightly and very finely papillose, base widely attached; thick, glabrous. *Lateral sepals* free, oblique, c. 5.8 x 2.2 mm, index 2.6–2.7; margins glabrous, otherwise as the median sepal. *Petals* porrect, ovate, c. 3.3 x 2 mm, index 1.6–1.7; acute, margins slightly erose and papillose, base narrowly attached; thin, glabrous. *Lip* hardly recurved, ovate, c. 2.8 x 1.2 mm, index 2.3–2.4 (all without artificial spreading), obtuse, margins papillose; thick; adaxially concave and with a median furrow in the basal half, slightly convex in the top half, surface glabrous but papillose towards the margins about half-way up the lip and with a patch of scattered glandular hairs in the top half; abaxially with a retuse median ridge near the base, surface finely papillose, coarser papillose along the margins towards the tip. *Column* c. 1.2 mm long, stigma with 2 distinct, papillose knobs at its base, column foot with retrorse, triangular, obtuse wings near the tip. *Stelidia* triangular, c. 0.5 mm long, acute. *Anther* abaxially with a slight, rounded crest, surface finely papillose, front margin not drawn out. *Pollinia* 4; ellipsoid, the inner c. as long as the outer; no appendages present.

Colour: Sepals translucent pale greenish, suffused with ochrish red, veins ochrish red. Petals translucent, some dark purple specks near the base, tip entirely dark purple. Lip white, heavily suffused with purple.

Habitat: Epiphyte growing in small clusters on thin branches in montane forest. Alt. c. 1000 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Figure 2. *Bulbophyllum valeryi* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, left: adaxial side, right: abaxial side; g. Pollinia, left: two pairs, right: a single pair. – All from SBG-O 4834 (spirit sample).



Notes: This belongs to a suite of species within sect. *Leptopus* that is characterized by densely clustered pseudobulbs on a creeping or shortly ascendent rhizome, and a lip shape approaching what is commonly found in sect. *Fruticicola* and in sect. *Epibulbon*. The species most similar to *Bulbophyllum valeryi* is *B. melinanthum* Schltr, from New Guinea. *B. valeryi* differs in having a very short peduncle and two distinct knobs below the stigma.

Named after Valeryus, son of Joseph Nasaret, who discovered this species.

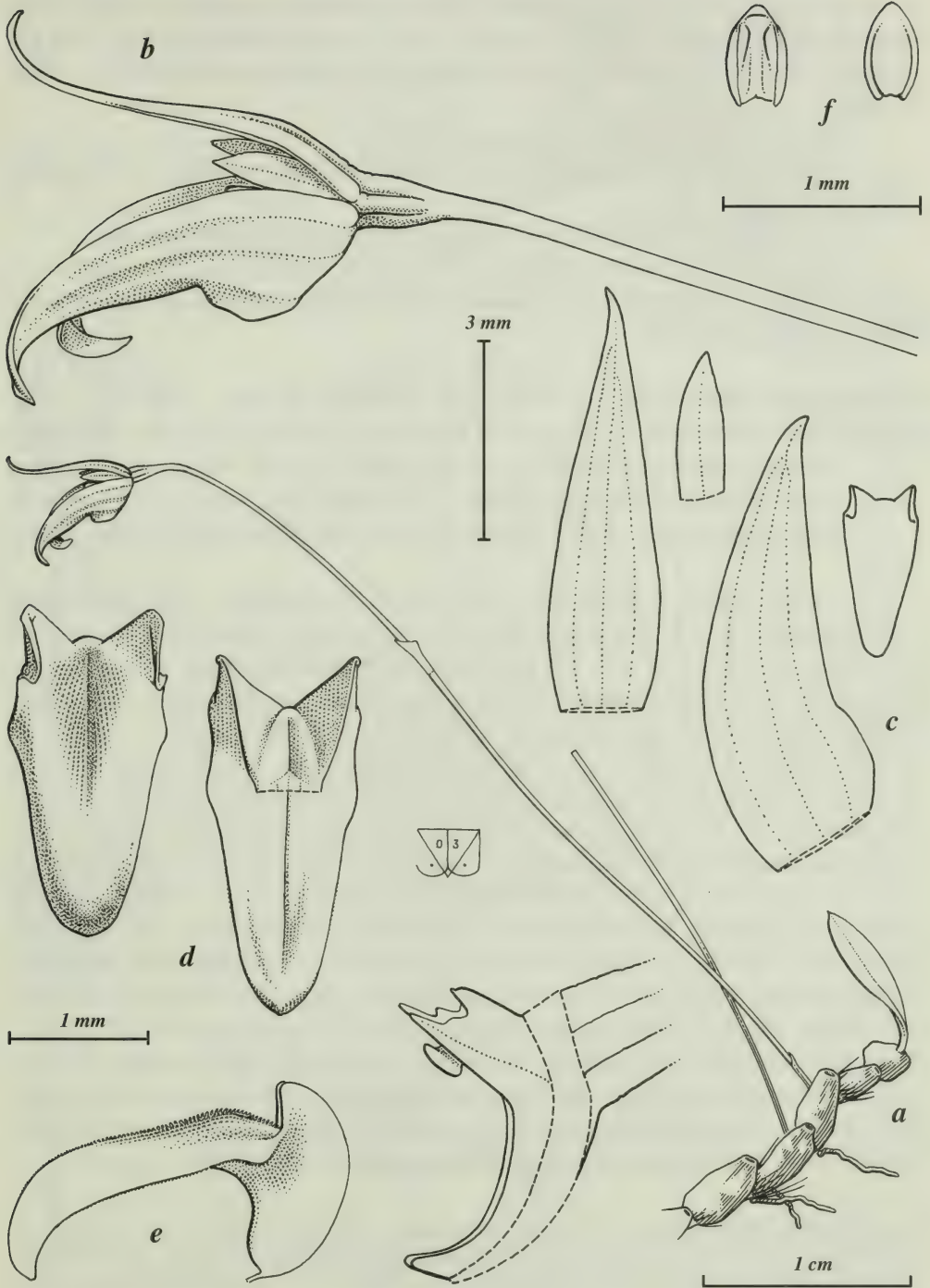
Bulbophyllum sect. *Monilibulus*

***Bulbophyllum auriculatum* J.J. Verm. & P. O'Byrne, sp. nov.** — Fig. 3.

Bulbophyllum auriculatum J.J. Verm. & P. O'Byrne, a *Bulbophyllo minutulo* et *B. schefferi* ad labelli basin lobis lateralibus antrorsis triangularibus obtusis differt. — TYPE: Indonesia, Sulawesi, SBG-O 4360 SING, holo.).

Roots below the pseudobulbs. *Rhizome* creeping, 1.2–1.5 mm diam., sections between pseudobulbs 0.25–0.6 cm long, bracts not persistent. *Pseudobulbs* orbicular to narrowly ovoid, basal half prostrate on and fused to the rhizome, so that the new pseudobulbs arise c. half-way up the old, 0.35–0.9 x 0.28–0.35 cm. *Petiole* 1.8–3 mm long. *Leaf blade* ovate to elliptic, 0.65–1 x 0.22–0.32 cm, index (length/width) 2–3.5; acuminate. Inflorescence c. 5 cm long, 1-flowered. *Peduncle* erect to patent, c. 2.5 cm, bracts 2, the longest 3–3.5 mm long. *Floral* bracts tubular, c. 2 mm, acute. *Flowers* not fully opening. *Pedicel and ovary* c. 16.5 mm long, basal node on a c. 1.4 mm-long stump. *Median sepal* porrect with recurved top, ovate, c. 6.2 x 1.8 mm, index 3.4–3.5; acute, margins slightly erose-papillose towards the tip, base rather widely attached; thin, glabrous. *Lateral sepals* recurved, free, oblique, triangular, c. 7 x 2.3 mm, index 3–3.1; otherwise as the median *sepal*. *Petals* porrect, ovate, c. 2.3 x 0.8 mm, index c. 2.9; acute, margins slightly erose-papillose towards the tip, base widely attached; thin, glabrous. *Lip* recurved at c. 1/3 of its length, \pm 3-lobed; *midlobe* ovate, c. 2.4 x 1.2 mm, index c. 2 (all without artificial spreading), rounded, margins very finely papillose; thick; adaxially concave and with 2 short ridges near the base converging distally and then fused to a small callus, beyond this callus a median furrow reaching up to about half-way the lip, adaxial surface papillose in the centre; abaxially with barely a median ridge, top part slightly concave, surface glabrous; *lateral lobes* erect, antrorse, attached along the proximal third of the lip, obliquely triangular, c. 0.5 mm high, obtuse, thin, glabrous. *Column* c. 1.4 mm long, rostellum thick, knob-shaped,

Figure 3. *Bulbophyllum auriculatum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, left: adaxial side, right: abaxial side. – All from SBG-O 4360 (spirit sample).



stigma without a tooth at its base, column foot without teeth. *Stelidia* triangular, c. 0.4 mm long, acute, with a small, antrorse, obliquely deltoid, rounded to obtuse tooth along the upper margin. *Anther* abaxially with a widely rounded crest, surface \pm glabrous, front margin somewhat drawn out into a triangular, obtuse beak. *Pollinia*: not seen.

Colour: Sepals yellowish orange. Lip red.

Habitat: Understorey epiphyte in montane forest, at c. 1800 m alt. Flowering observed in Sept.

Distribution: INDONESIA. Sulawesi, central part (1 specimen seen).

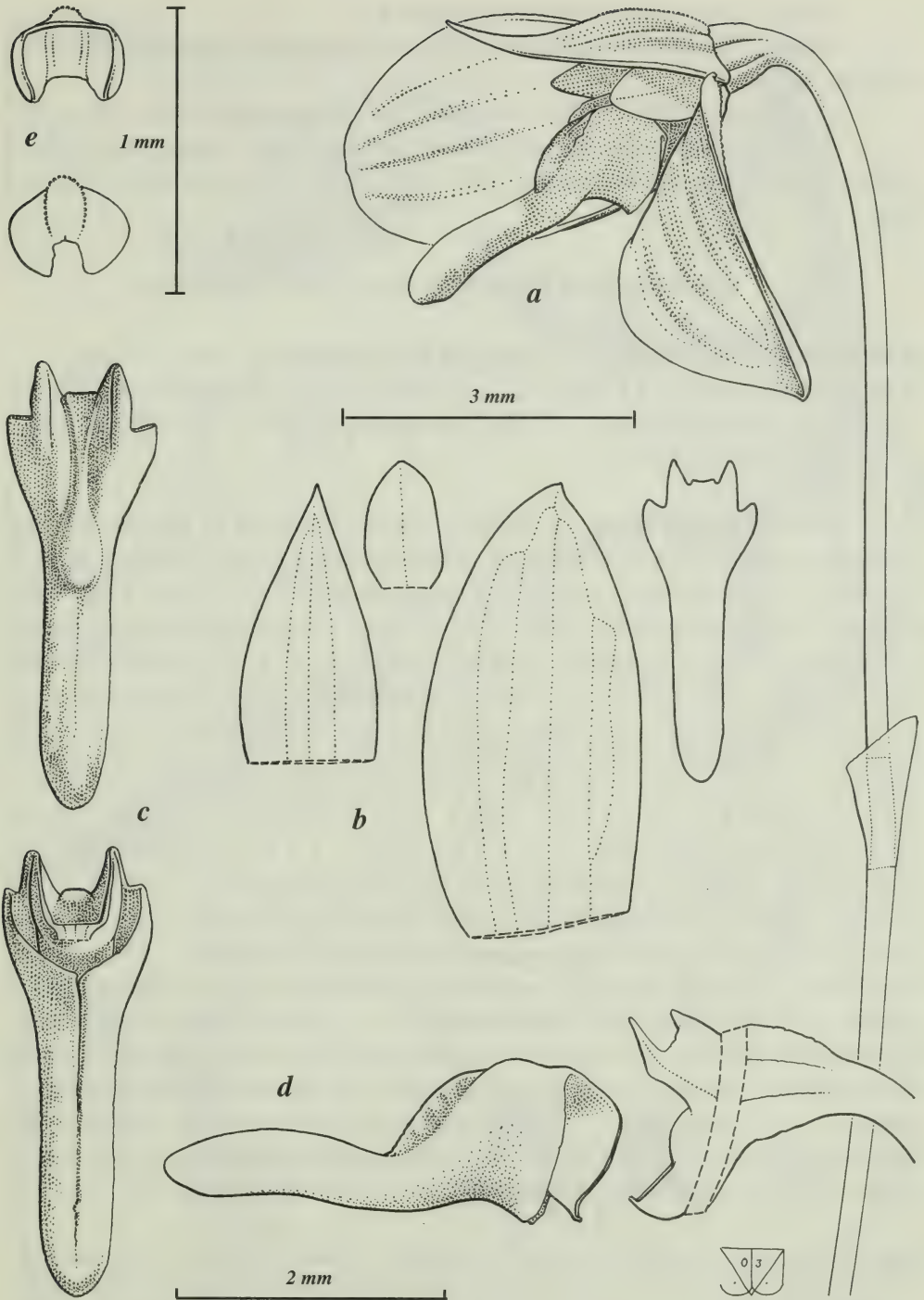
Notes: Most similar to *Bulbophyllum minutulum* Ridl., and *B. schefferi* (O. Kuntze) Schltr., *Bulbophyllum auriculatum* differs from both in having distinct lateral lobes at the base of the lip.

***Bulbophyllum tubilabrum* J.J. Verm. & P. O'Byrne, sp. nov.** — Fig. 4.

Bulbophyllum tubilabrum J.J. Verm. & P. O'Byrne, a *Bulbophyllo hodgsonii* sepalos mediano brevi lato (index 1.7–1.8 contra 4–5 in *B. hodgsonii*), floribus multo minoribus (sepala lateralia c. 4.8 mm longa contra c. 15 mm in *B. hodgsonii*) differt. — TYPE: Indonesia, Sulawesi, SBG-O 4935 (SING, holo.).

Peduncle erect to patent, c. 2.5 cm, bracts 2, the longest c. 2 mm long. *Floral bracts* tubular, c. 1.7–2 mm, acute. *Flowers* fully opening. *Pedicel and ovary* c. 10 mm long, basal node on a c. 1.2 mm-long stump. *Median sepal* porrect, ovate-triangular, c. 3 x 1.7 mm, index 1.7–1.8; acute-acuminate, margins entire, base widely attached; thin, glabrous. *Lateral sepals* recurved, free, oblique, elliptic-ovate, c. 4.8 x 2.8 mm, index c. 1.7; acute; otherwise as the median sepal. *Petals* porrect, ovate, c. 1.4 x 0.9 mm, index 1.5–1.6; subacute, margins entire, base rather narrowly attached; thin, glabrous. *Lip* somewhat recurved at c. 1/4 of its length, triangular near the base, cylindrical elsewhere with the margins folded back over the abaxial side and fused, c. 3.4 x 1.5 mm, index c. 2.2–2.3 (all without artificial spreading), rounded, margins entire; thick, glabrous; adaxially concave near the base, with a small cavity just above the ligament, ending in a knob that distally continues as a median strip of slightly thickened tissue ending about half-way up the lip as a drop-shaped callus, and with 2 short ridges bordering this median strip from 1/5 to 2/5 of the lip, abaxially with a rounded median ridge near the base. *Column* c. 1 mm long, stigma without a tooth at its base, column foot without teeth. *Stelidia* triangular, c. 0.4 mm long, acute, with a small, deltoid, rounded tooth along the lower margin. *Anther* abaxially with a widely rounded crest, surface papillose, front margin not drawn out. *Pollinia*: not seen.

Figure 4. *Bulbophyllum tubilabrum* J.J. Verm. & P. O'Byrne — a. Flower; b. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; c. Lip, above: adaxial side, below: abaxial side; e. Column and lip, lateral view; f. Anther, above: adaxial side, below: abaxial side. — All from SBG-O 4935 (spirit sample).



Colour: Sepals yellowish. Lip orange red.

Habitat: Understorey epiphyte in montane forest, at c. 1800 m alt. Flowering observed in Sept.

Distribution: INDONESIA. Sulawesi, central part (1 specimen seen).

Notes: *Bulbophyllum hodgsonii* Hend. is most similar but has larger flowers with narrower sepals: median sepal 12–15 x 3 mm, index 4–5, lateral sepals c. 15 mm long.

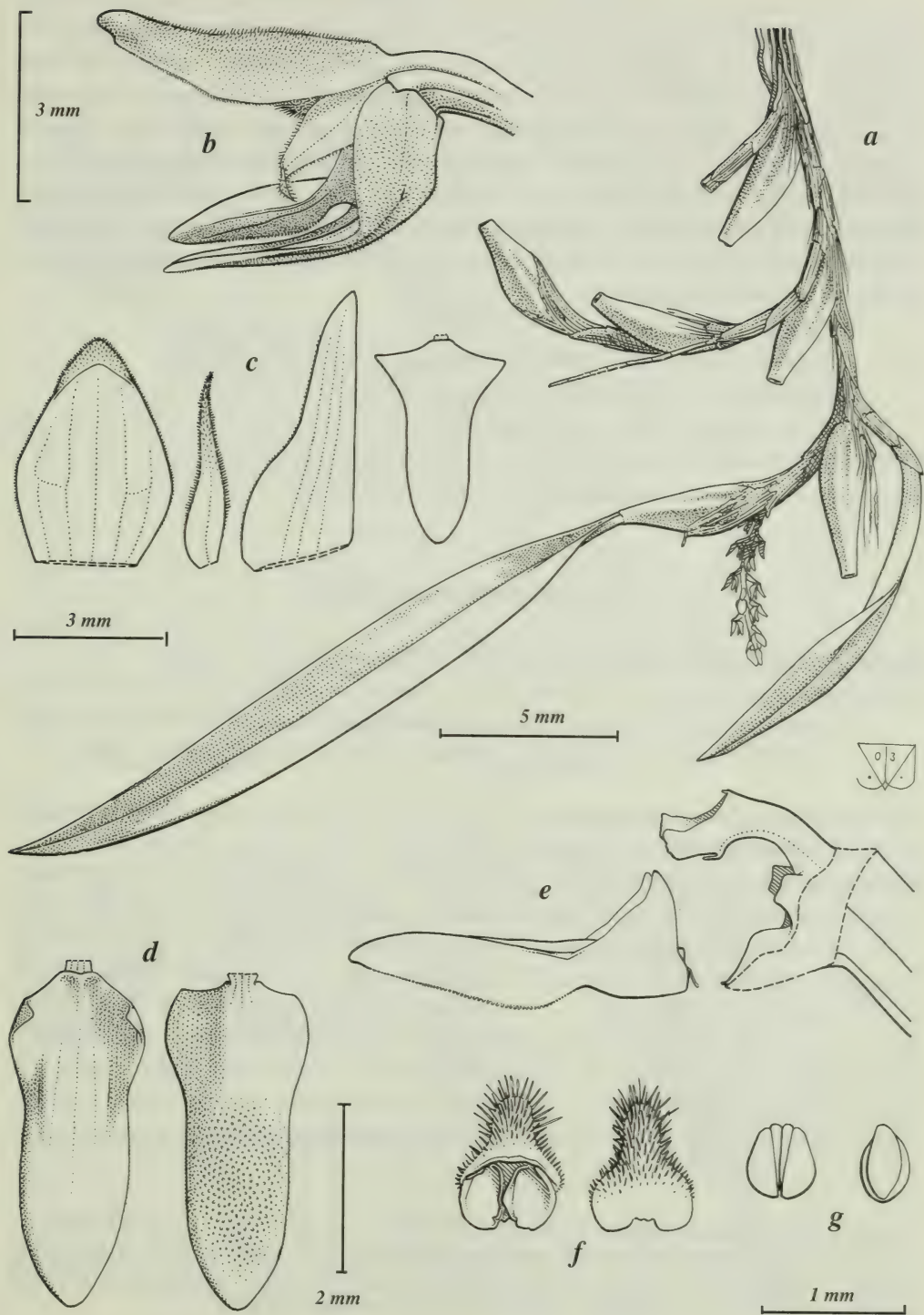
***Bulbophyllum* sect. *Osyricara* (= sect. *Globiceps*)**

***Bulbophyllum stenurum* J.J. Verm. & P. O'Byrne, sp. nov.** — Fig. 5.

Bulbophyllum stenurum J.J. Verm. & P. O'Byrne, a *Bulbophyllo hastifero* rhachidi non incrassata differt. — TYPE: Indonesia, Sulawesi, central part, SBG-O 4902 (SING, holo.).

Roots creeping along the rhizome towards its point of attachment, then spreading over the substrate. *Rhizome* ± pendulous with ± patent branches, up to 50 cm long, 4.5–5 mm diam., sections between pseudobulbs 3–5.6 cm long, bracts persistent. *Pseudobulbs* distant, ovate, 3.6–4.8 x 1–1.2 cm, distinctly and rather sharply 4–5-angled. *Petiole* c. 1 cm long. *Leaf blade* ovate, c. 19 x 2.2 cm, index (length/width) 8.6–8.7; acute. *Inflorescence* porrect to recurved, a rather dense raceme, c. 6.5 cm long, c. 15-flowered. *Peduncle* c. 1.4 cm, bracts 2, the longest c. 8 mm long. Rhachis not thickened, c. 5 cm long. *Floral bracts* c. 3.5 mm, acute. *Flowers* not resupinate, spirally arranged, not fully opening, many open simultaneously. *Pedicel* and ovary 2.4–2.7 mm long, basal node ± flush with the surface of the rhachis. *Median sepal* ± porrect, ovate, c. 4.5 x 3.1 mm, index 1.4–1.5; top cucullate, rounded, margins entire, papillose-ciliolate, base rather narrowly attached; thin, 5-veined, surface adaxially glabrous, abaxially shortly hirsute. *Lateral sepals* adnate along the lower margins, basal part recurved, top part incurved, oblique, triangular, c. 5.6 x 2.4 mm, index 2.3–2.4, top flat, subacute, base broadly attached; 3-veined, otherwise as the median sepal. *Petals* recurved, ovate-triangular, c. 4 x 0.9 mm, index 4.4–4.5; acute, margins entire, ciliolate, base narrowly attached; very thin, 1-veined, surface adaxially finely papillose towards the tip, abaxially glabrous. *Lip* about straight, general outline ovate, c. 4 x 1.7 mm, index 2.3–2.4 (all without artificial spreading, hastate with a drawn out, elliptic midlobe and deltoid, acute sidelobes when spread); obtuse, margins entire; rather thick, glabrous; adaxially slightly concave near the base, with 2 parallel,

Figure 5. *Bulbophyllum stenurum* J.J. Verm. & P. O'Byrne – a. Habit; b. Flower; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, left: adaxial side, right: abaxial side; g. Pollinia, left: two pairs, right: a single pair. — All from SBG-O 4902 (spirit sample).



short, inconspicuous, rounded ridges at c. 1/3 of the length of the lip, adaxial surface glabrous; abaxially \pm without a ridge near the base, surface papillose in the distal 1/3 of the lip. *Column* c. 2 mm long, stigma without a tooth at its base, column foot with 2 truncate wings near its base, and a conspicuous swelling just above the ligament. *Stelidia* minute, abruptly bent downwards but with an antrorse, \pm acute tip, along the upper margin with a very large (far more conspicuous than the stelidia themselves), antrorse, wedge-shaped wing with a broadly rounded, erose top margin. *Anther* abaxially with a crest largely overtopping the front margin, surface coarsely papillose, front margin not drawn out. *Pollinia* 4, the inner \pm as long as the outer, all ellipsoid-ovoid; no appendages present.

Colour: Unknown.

Habitat: Epiphyte in montane forest. Alt. c. 1000 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: *Bulbophyllum hastiferum* Schltr. is most similar but differs in having a thickened, spindle-shaped rhachis. It also has a narrower median sepal, a lip with a narrower midlobe, and an anther with a wider abaxial crest.

Bulbophyllum sect. *Pelma*

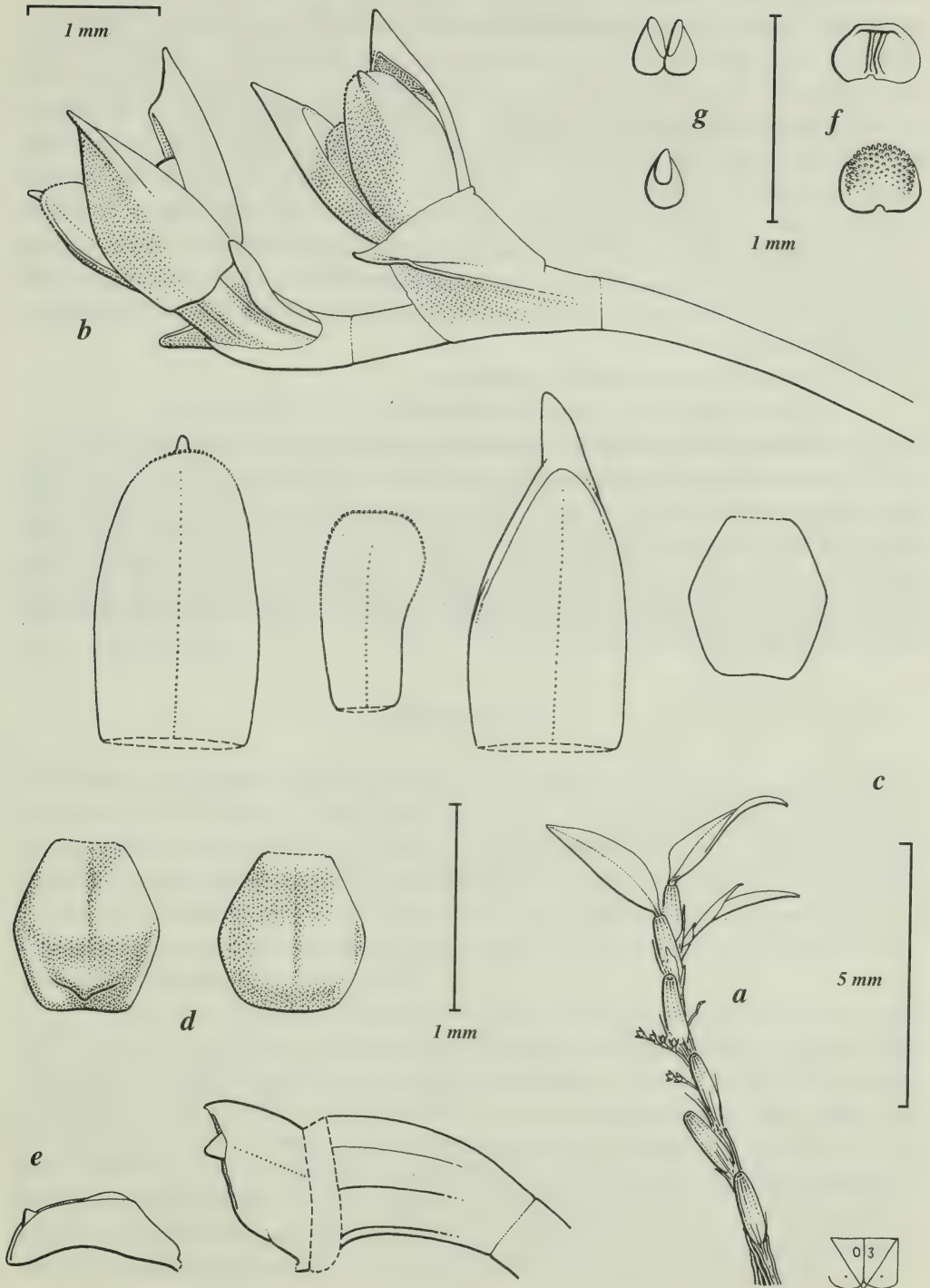
***Bulbophyllum reductum* J.J. Verm. & P. O'Byrne, sp. nov.** – Fig. 6.

Bulbophyllum reductum J.J. Verm. & P. O'Byrne, a *Bulbophyllum savaiensi* ssp. *subcubico* columnae pede carenti, ad labelli basin sine cavitate distincta differt.

– TYPE: Indonesia, Sulawesi, central part, SBG-O 3886 (SING, holo).

Roots growing along the rhizome towards its point of attachment, then spreading over the substrate. *Rhizome* erect to patent, up to 10 cm long, 1.8–2.4 mm diam., sections between pseudobulbs 0.8–1.2 cm long, bracts persistent. *Pseudobulbs* distant, ovoid, 1.2–1.6 x 0.25–0.4 cm. *Petiole* 0.05–0.1 cm long. *Leaf blade* ovate, 2.3–3.4 x 0.75–0.85 cm, index (length/width) 3–4; acute. *Inflorescences* along the entire rhizome, porrect or recurved, lax racemes, 0.5–1.05 cm long, 1–4-flowered. Peduncle 0.3–0.5 cm, bracts 4–5, the longest 2–3.5 mm long. *Rhachis* up to 0.55 cm. *Floral* bracts tubular proximally, 1.4–1.9 mm long, acuminate. *Flowers* not resupinate, little opening, several open simultaneously. *Pedicel and ovary* 1.3–1.7 mm long, basal node on a c. 0.6 mm-long stump. *Median sepal* porrect, ovate, c. 1.4 x 0.8 mm, index 1.7–1.8; rounded and apiculate, margins papillose towards the tip, base broadly attached; thick,

Figure 6. *Bulbophyllum reductum* J.J. Verm. & P. O'Byrne – a. Habit; b. Inflorescence; c. Flower analysis, from left to right: median sepal, petal, lateral sepal, lip; d. Lip, left: adaxial side, right: abaxial side; e. Column and lip, lateral view; f. Anther, above: adaxial side, below: abaxial side; g. Pollinia, above: two pairs, below: a single pair. – All from SBG-O 3886 (spirit sample).



1-veined, glabrous. *Lateral sepals* ovate-triangular, c. 1.7 x 0.8 mm, index 2.1–2.2; acuminate, margins entire; otherwise as the median sepal. *Petals* porrect, obovate, c. 0.9 x 0.55 mm, index 1.6–1.7; truncate-rounded, margins papillose towards the tip, base rather narrowly attached; thin, 1-veined, glabrous. *Lip* slightly recurved at c. 3/5 of its length, general outline elliptic, c. 0.8 x 0.7 mm, index 1.1–1.2 (all without artificial spreading); truncate-rounded, margins entire; rather thick, glabrous; adaxially slightly concave near the base, with a slight transverse callus about half way, top half concave with a transverse, triangular, subacute, thick tooth in the centre; abaxially without a ridge. *Column* c. 0.7 mm long, stigma without a tooth at its base, column foot absent. *Stelidia* about absent. *Anther* abaxially without a crest, surface papillose, front margin not drawn out. *Pollinia* 4; ovoid, the inner c. 2/3 as long as the outer; no appendages present.

Colour: Flowers cream-coloured.

Habitat: Epiphyte in mossy montane forest. Alt. 1100–1200 m.

Distribution: INDONESIA: Sulawesi, central part (1 specimen seen).

Notes: Deceptively similar in general habit to *Bulbophyllum savaiense* Schltr. ssp. *subcubicum* (J.J. Sm.) J.J. Verm. Only when analyzing the minute flowers can *B. reductum* be distinguished at once by the absence of a column foot, and of a distinct cavity at the base of the lip. The absent column foot makes inclusion of *B. reductum* in sect. *Pelma* problematic, but the marked overall similarity between *B. reductum* and *B. savaiense* leaves no other option.

A Botanical Survey of Chek Jawa, Pulau Ubin, Singapore

SERENA LEE¹, SAMSURI AHMAD¹, PAUL LEONG¹,
ALI IBRAHIM² AND AIK-TECK GWEE¹

¹Singapore Botanic Gardens, Singapore 259569

²Conservation Division, Operations Department,
National Parks Board,
Singapore 189720

Abstract

A botanical survey in 2002/2003 collected 245 species in 171 genera and 80 families of vascular plants excluding alien species. Among the seven habitats on Chek Jawa, the intertidal zone with seven species of seagrasses, the rocky shore and the mangrove communities are relatively diverse and undisturbed. The coastal forest, although heavily disturbed, is not secondary forest. Based on the Singapore Red Data Book, 11 species were recorded as 'extinct', 11 as endangered and 16 as vulnerable. The re-finding of these extinct species makes Chek Jawa an important conservation site in the Singapore context. *Elephantopus mollis* (Compositae) is a new record for the Singapore flora.

Introduction

Pulau Ubin, an island situated northeast of Singapore, covers an area of 10.2 km² measuring 1.5 km north to south and 8 km east to west. About a hundred residents still live on the island (The Straits Times, 24 Aug 2002) and its rustic charm makes it a popular outdoor attraction for city dwellers (Chua, 2000, 2003). Tanjung Chek Jawa is a headland on the northeast tip of the island (Fig. 1) that includes the intertidal area of about 100 ha and the hinterland of 10.5 ha (N 1° 0' 30" E 103° 59' 30" coordinates at the site of beacon on top of the hill).

Chek Jawa became the focus of attention when its intertidal area was surveyed and found to be extremely rich in marine life (Tan and Yeo, 2003). It was already earmarked for land reclamation under the Development Guide Plan in 1997 and the Master Plan in 1998 (URA, 2003). Public support for conserving Chek Jawa was strong as it was one of the few areas of natural marine heritage left. Petitions to the government to preserve the area were heeded and Chek Jawa was saved just nine days prior to start of reclamation work (The Straits Times, 2 Jan 2002). The island has been largely zoned as 'open space and reserve land' in the 2001 Concept Plan and will now be left intact for at least 10 years (The Straits Times, 15 Jan 2002).

While attention by both scientists and the public has focused on the intertidal ecosystem of Chek Jawa, the vegetation on the headland has never been subject to a systematic survey. It was with this end in view that the survey was undertaken to provide a comprehensive checklist of vascular plants and to evaluate their conservation status. Another reason for carrying out the survey was that there is very little coastal forest left in Singapore and so it is important to document this habitat.

History of Botanical Collecting on Pulau Ubin

The earliest collections were made by Ridley, Hullet and Goodenough in the 1880s. A few specimens were later collected by Furtado in the 1920s and Allen in the 1940s. Those appear to be random samplings of the flora of Pulau Ubin. Neither the precise locality of the collections nor their habitat was given. In the 1990s, Ali and Lai collected 15 and 20 specimens from Pulau Ubin, respectively. In 1990, Turner *et al.* (1992) carried out a botanical survey of Pulau Ubin, of which two specimens were collected from Chek Jawa. The online Checklist of Chek Jawa (Lai, undated; <http://habitatnews.nus.edu.sg/news/chekjawa/checklists.htm#1>) was not supported by herbarium specimens.

Methodology

Specimens were collected from October 2002 to October 2003 until no more new records were found. However, about half of the area in the coastal forest habitat is inaccessible and so was not surveyed due to the dense thickets of climbers, debris of dead tree stumps and branches on the steep slope. Wherever possible, fertile material was collected. In its absence, sterile material was also included. All specimens are deposited and databased in the Herbarium, Singapore Botanic Gardens (SING). Common weeds and alien species were collected but not included in the survey statistics.

Conservation status was assessed using the categories from *The Singapore Red Data Book* (Ng & Wee, 1994) in which [Ex] denotes Extinct in Singapore; [En] denotes Endangered; [V] denotes Vulnerable and [R] denotes Rare. In addition, [exotic] denotes plants that do not originate in the region and [C] denotes Common. Long-term viability of these plant populations is dependent on their ability to regenerate and the security of their habitat.

A compilation of all previous collections in SING from Pulau Ubin was compared with the current checklist.

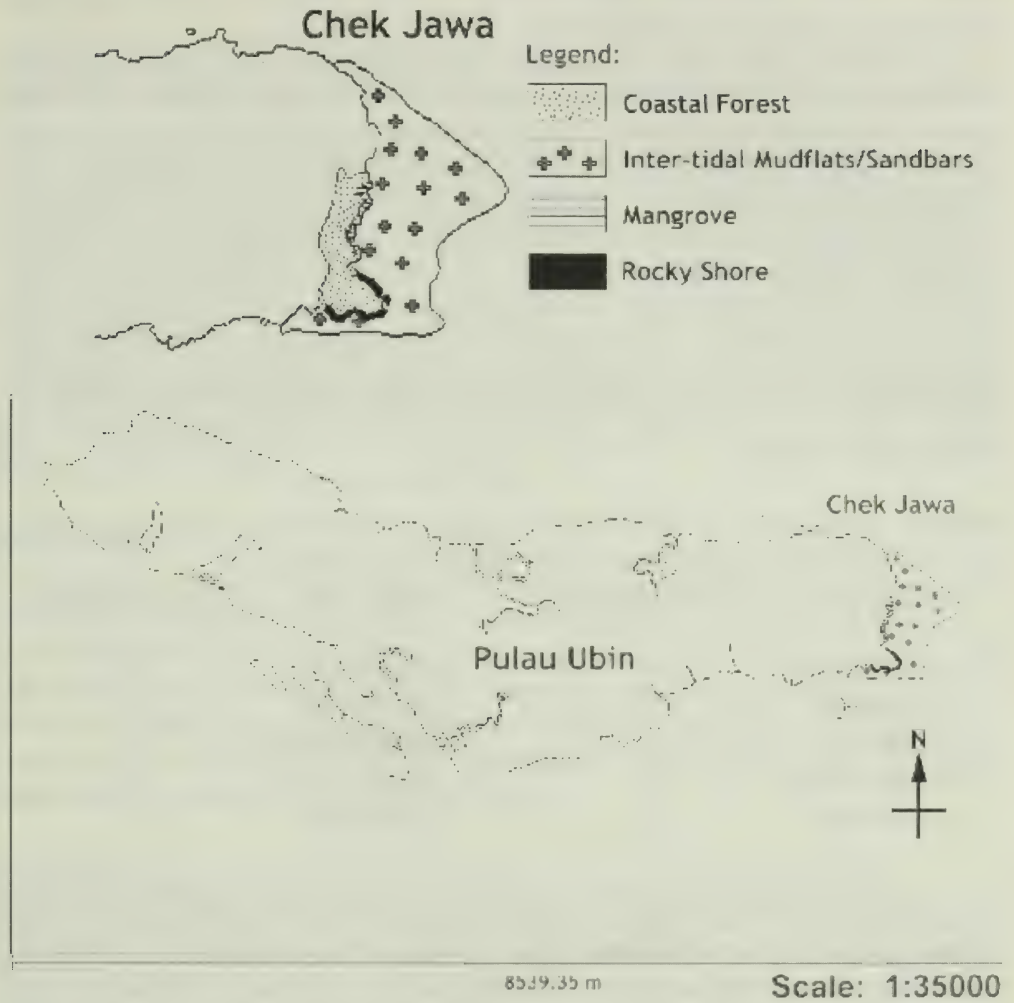


Figure 1. Location of Chek Jawa (N 1° 0' 30" E 103 ° 59' 30")

Results and Discussion

Species Composition

This survey collected a total of 245 species in 171 genera and 80 families of which 7 species were seagrasses, 20 were ferns, 3 were gymnosperms and 215 were terrestrial flowering plants (Appendix). This compares with the survey carried out by Turner *et al.* (1992) for the whole of Pulau Ubin, which listed 261 species with a further 71

species of aliens. This shows that Chek Jawa is an important site and a significant component of the entire island of Ubin.

In Chek Jawa, the Leguminosae and Rubiaceae are the best represented families (Table 1). The Leguminosae are represented by climbers and trees and includes most of the smothering climbers, such as *Aganope thyrsoflora*, *Derris amoena* and *Entada spiralis*. On the slope of the coastal forest, small trees and shrubs of the Rubiaceae such as *Aidia* spp., *Canthium* spp. and *Timonius* spp. are common. The common climber of this family, *Morinda umbellata*, is ubiquitous in the coastal forest: on slopes, ridges as well as near the beach fringe. Moraceae are represented by species of *Artocarpus* and *Ficus*, many of which are big trees. Many of the secondary forest trees are represented by the Euphorbiaceae, such as species of *Glochidion* and *Macaranga*. Annonaceae are represented by shrubs, such as *Desmos chinensis*, and lianas, such as *Artabotrys suaveolens* and *Uvaria* spp. These are mainly found in the coastal forest habitat.

Table 1. Comparison of the five most common plant families (excluding aliens) collected in Chek Jawa and Pulau Ubin (Turner *et al.*, 1992).

| Chek Jawa | No. of species | Pulau Ubin | No. of species |
|---------------|----------------|---------------|----------------|
| Leguminosae | 18 | Gramineae | 18 |
| Rubiaceae | 17 | Cyperaceae | 18 |
| Moraceae | 12 | Euphorbiaceae | 16 |
| Euphorbiaceae | 11 | Leguminosae | 15 |
| Annonaceae | 9 | Compositae | 15 |

The most speciose families (Table 1) collected in the Pulau Ubin survey (Turner *et al.*, 1992) were grasses (Gramineae) and sedges (Cyperaceae). The high representation of these families indicates that many of the collections were from the grassland/wasteland habitats as does the inclusion of the Compositae. Secondary forest species, such as species of *Macaranga* (Euphorbiaceae) and *Mimosa* (Leguminosae) are also well represented. Leguminous climbers, such as *Derris* spp. *Desmodium* spp. and *Entada spiralis* are plants that were commonly found both in the Pulau Ubin and Chek Jawa surveys.

Elephantopus mollis (Compositae) is a new record for the Singapore flora.

Habitats

The sites covered in this survey included seven distinct habitats: the intertidal zone, the rocky/sandy shores, mangrove, coastal forest, abandoned rubber plantation and *dusun* (mixed fruit orchard) and patches of wasteland.

Intertidal zone

Seagrass beds are becoming rare in Singapore. Tan and Yeo (2003) illustrated the seagrasses found at Chek Jawa. We collected seven species of seagrass, excluding

Enhalus acoroides that is known to occur on the seaward side of the sandbar in water too deep for collection at the time of survey. Three species belong to the Cymodoceaceae and four to the Hydrocharitaceae. Out of these, three species, *Halodule pinifolia*, *Halodule uninervis* (Cymodoceaceae) and *Thalassia hemprichii* (Hydrocharitaceae), were listed as 'extinct': and two, *Halophila beccarii* and *Halophila spinulosa* (Hydrocharitaceae), as endangered. The two most commonly found seagrasses were *Halophila ovalis* and *Halophila spinulosa* (Hydrocharitaceae), both of which thrive on sandbars with coral rubble. Also found on sandy areas were *Halophila beccarii* and *Halophila pinifolia*, while *Cymodocea rotundata*, *Halodule uninervis* and *Thalassia hemprichii* occurred on mud flats.

Rocky shore

Singapore has very few undisturbed rocky shore habitats. Plants around the rocky shore face conditions similar to plants on the fringe of the coastal forest. Trees here do not grow very tall; they are slow growing because of the adverse conditions and the nutrient-poor soils. However, the height of some individual trees, such as *Memecylon edule* (7 m), *Garcinia hombroniana* (8 m), *Intsia bijuga* (9 m), *Pouteria linggensis* (10 m) can be considered exceptional by any standard. *Garcinia hombroniana* is listed as an endangered species.

Mangroves

The mangrove pockets on Chek Jawa are rich in biodiversity, supporting 20 species of mangrove plants, many of them mature, good-sized trees as well as 14 species of transitional mangrove plants. Of the true mangrove plants, *Bruguiera parvifolia* (the only one found in Chek Jawa) is endangered; *Rhizophora stylosa* and *Xylocarpus moluccensis* are vulnerable. A *Ceriops* species was recently discovered, which is substantially different from the adjacent *C. tagal* trees and has been re-identified as *C. decandra*. *Nypa fruticans*, is found in brackish water. Transitional mangrove plants were represented by trees such as *Terminalia catappa*, *Cerbera manghas* and *Diospyros ferrea*; shrubs such as *Allophylus cobbe*, *Clerodendrum inerme* and *Ximenea americana*; climbers such as *Flagellaria indica*, *Salacia chinensis* and *Dalbergia candenatensis*; as well as the pandan, *Pandanus odoratissimus* and the palm, *Oncosperma tigillarum*. Epiphytes such as *Dischidia major*, *D. nummularia* and *Hoya verticillata* were common on transitional mangrove trees.

Coastal forest

The coastal forest is a unique habitat in that plants that inhabit the area are adapted to

the harsh conditions often associated with the coast. Strong, drying winds, salt spray, intense light reflection from the sea and other factors can affect their growth and survival. Trees along the edge of the hill cling precariously to the steep slope. They were observed to grow outwards from the forest towards the sea. This could be the result of simple phototropism or in some cases, soil erosion at the fringe of steep slope, where a tree fell but was halted in its fall by surrounding vegetation and then continued to grow with the main trunk at a sharp incline. *Scaphium macropodum* and *Aidia densiflora* were examples of this.

Unlike the lowland dipterocarp forest, the coastal forest does not exhibit the typical five-layer stratification. Coastal forest on Chek Jawa more resembles that described by Corner (1985) for the flora of coastal islets on the east coast of Peninsular Malaysia both in species composition and tree height (maximum 21 m).

On Chek Jawa, other than a few large trees, there is a lack of the emergent layer. Below the low main canopy of trees (about 5 m tall) and climbers were sparse populations of shrubs and treelets. On steep slopes, sparsely populated with trees, their canopies struggle with the climbers for light. The largest trees observed (Table 2) were a *Pouteria malaccensis* tree about 7–8 m tall and a *Chrysophyllum roxburghii* tree 8–10 m tall, the latter with three trunks, the largest, 0.5 m in diameter. These taller trees were found on the more level part of the slope. Other trees observed growing on the slope included *Adenanthera malayana*, *Archidendron contortum* and *A. ellipticum*, *Diospyros* spp., *Elaeocarpus pedunculatus*, *Eurycoma longifolia*, *Ficus vasculosa*, *Garcinia atroviridis*, *G. hombroniana*, *Glochidion superbum*, *Campylospermum serratum*, *Ixonanthes reticulata*, *Knema globularia*, *Neolitsea zeylanica*, *Pouteria linggensis*, *P. obovata*, *Triadica cochinchinensis*, *Suregada multiflora* and *Vitex pinnata*. A clump of the monocot tree, *Dracaena maingayi*; the palm *Licuala spinosa* and the clumping palm, *Oncosperma tigillarum* as well as the 'extinct' pandan *Pandanus tetradon* were also observed. The 'extinct' climber, *Gnetum latifolium* was also found here. The understory layer was interspersed with shrubs such as *Clerodendrum laevifolium* and saplings of *Olea brachiata*, *Archidendron contortum* and other treelets. The flora, hence typifies the characteristics of a coastal forest habitat. In alarming proportions are the climbers, some of which reached substantial height and formed a dense mass that smothered the surrounding plants as well as blocking sunlight from reaching the forest floor. Examples of these climbers are *Aganope thyrsoiflora*, *Derris amoena*, *Entada spiralis*, *Linostoma pauciflorum* and *Fibraurea tinctoria*.

At the fringe of the coastal hill towards the landward side, on more level terrain, where the forest merges with the abandoned rubber estate, plants of the more typical secondary forest species were seen. Examples are climbers such as *Embelia ribes*, *Morinda umbellata* and *Tetracera indica*; shrubs such as *Ixora congesta*, *Clerodendrum laevifolium* and *Memecylon amplexicaule* (the last listed as vulnerable); trees such as *Fagraea racemosa*, *Syzygium lineatum*, *S. zeylanicum* and *Rhodamnia*

Table 2. The Tallest Trees at Chek Jawa

| Height (m) | Family | Species | Habitat |
|------------|------------------|---------------------------------|----------------|
| 25 | Burseraceae | <i>Dacryodes rostrata</i> | Coastal Forest |
| 20 | Anacardiaceae | <i>Mangifera indica</i> | Coastal Forest |
| 20 | Bombacaceae | <i>Durio zibethinus</i> | Coastal Forest |
| 18 | Myristicaceae | <i>Knema globularia</i> | Coastal Forest |
| 15 | Dracaenaceae | <i>Dracaena maingayii</i> | Coastal Forest |
| 10 | Meliaceae | <i>Xylocarpus granatum</i> | Mangrove |
| 10 | Moraceae | <i>Artocarpus dadah</i> | Coastal Forest |
| 10 | Moraceae | <i>Ficus kerkhovenii</i> | Coastal Forest |
| 10 | Moraceae | <i>Ficus superba</i> | Coastal Forest |
| 10 | Sapotaceae | <i>Chrysophyllum roxburghii</i> | Coastal Forest |
| 10 | Sapotaceae | <i>Pouteria linggensis</i> | Rocky Shore |
| 9 | Leguminosae | <i>Intsia bijuga</i> | Rocky Shore |
| 8 | Apocynaceae | <i>Cerbera manghas</i> | Rocky Shore |
| 8 | Chrysobalanaceae | <i>Maranthes corymbosa</i> | Coastal Forest |
| 8 | Guttiferae | <i>Garcinia hombroniana</i> | Rocky Shore |
| 8 | Sonneratiaceae | <i>Sonneratia alba</i> | Mangrove |
| 7–8 | Sapotaceae | <i>Pouteria malaccensis</i> | Coastal Forest |

cinerea were found. Of interest is the common occurrence of the 'extinct' tree *Knema globularia*, albeit at the coastal fringes. The liana, *Cnestis palala* was found along the fringe of a gravel pathway, some reaching 10 m high. Larger trees were mostly found in this part of the forest where the forest floor is flatter and thus more stable (Table 2).

Abandoned rubber estate, dusun and wasteland

The area surrounding the coastal forest includes the long abandoned Ong Ting Lye Rubber Estate and *dusun* (mixed fruit orchards) of the villages. Fruit trees that still persist include *Artocarpus altilis* (breadfruit), *A. heterophyllus* (jackfruit), *A. integer* (chempedak), *Averrhoa carambola* (starfruit), *Durio zibethinus* (durian), *Garcinia mangostana* (mangosteen), *Manilkara zapota* (chiku), *Nephelium lappaceum* (rambutan), *Psidium guajava* (guava), *Spondias pinnata* (kedondong) and *Syzygium aqueum* (jambu ayer). These relics of cultivation are now all that remains of the people who were re-located to the mainland.

Escapes from cultivation, which include *Tinospora crispa* (a medicinal plant used locally for malaria fever, jaundice and intestinal worms), *Passiflora laurifolia* (passion fruit) and garden escapes, such as *Gloriosa superba*, still persist in these areas.

Villagers and the plantation owner probably cleared tracks that are now wasteland. Thickets of ferns, for example, *Nephrolepis auriculata*, *Pityrogramma calomelanos*, *Acrostichum aureum*, and a number of sedges and grasses have invaded these wasteland patches.

Plants of Interest

Enhalus acoroides

This seagrass species was found on the seaward side of a sandbar that is for most of the time inundated by water. Its long leaves about 1.5 m are reported to be the food of the dugong.

Fagraea racemosa

The big leathery leaves and inflorescences with peachy cream flowers are attractive and could be used more frequently in horticultural planting.

Gnetum latifolium

This climber is listed as 'extinct', but was seen in various patches in the coastal forest. Of particular interest, other than its status, is that it and *G. microcarpum* are the only gymnosperms found growing wild here. (*G. gnemon*, meninjau, an escape from cultivation, is also found on Chek Jawa). *Cycas rumphii* s.l. commonly found on seashores is not found here.

Intsia bijuga

This valuable timber species can grow to an impressive height in more conducive environments. Its pinkish white fragrant flowers and thick, round leaves are attractive.

Knema globularia.

The fruits of the sea nutmeg exhibit bright red pulp when ripe thus attracting larger birds that eat and disperse the seeds. These trees are found on the seaward side of the coastal forest and rocky shoreline and, because of its rarity elsewhere in Singapore, has become an integral attraction of Chek Jawa.

Lasianthus hirsutus

This species, listed as 'extinct', is found along the edge of the gravel pathway at the landward fringe of the coastal forest. Its large velvety leaves and stunning metallic blue fruits lend it horticultural potential.

Memecylon edule

With its gregarious flowering and captivating blue-purple flowers, the plant has become an icon of the rocky shoreline of Chek Jawa. When in flower, it adds a splash

of blue-purple - a rare colour in the tropics, to the already picturesque scenery.

Large trees

The largest of all was *Dacryodes rostrata* with an impressive height of 25 m (Table 2) and trunk 1 m in diameter. Along the rocky shore, a *Knema globularia* about 7 m tall grew in a reclining position. In the mangroves, *Xylocarpus granatum* with its snake-like roots anchored well into the substratum, provided support for its 10 m tall crown.

Orchids

Surprisingly, orchids were poorly represented. Only two common orchids were found. The epiphytic *Dendrobium crumenatum* and the terrestrial *Eulophia graminea*, the latter growing on the sandy beach in the mangrove patch.

Hemiparasitic plants

Dendrophthoe pentandra was the only hemiparasite encountered in the survey. It was seen perched on rubber trees about 10 m above the ground. It was too high to collect.

Disturbance

Turner *et al.* (1992) analysed the early collections from Pulau Ubin and concluded that even in the 1880s, the vegetation was largely secondary with no primary forest species. They went so far as to conclude that at one time the terrestrial vegetation might have been cleared. The survey of Turner *et al.* (1992) found that plant diversity on Pulau Ubin was low and that the frequency of aliens was relatively high indicating a high degree of human interference. Their species list comprised largely of common weeds, secondary forest and mangrove species. Primary forest species were almost completely lacking.

The coastal forest on Chek Jawa does not exhibit the species composition typical of secondary forest. Corlett (1994) in discussing a definition of secondary forest, mentioned that ‘virtually all tropical forests have suffered some form of human impact’ and that ‘the question is: how much disturbance is needed to make a forest secondary?’ In his opinion, ‘the key difference is the break in the continuity of forest occurrence on the site and the consequent dependence for recovery on dispersal from outside.’ He mentioned that it would be preferable to use “primary” – qualified where necessary by terms such as “logged”, “depleted” or “degraded” – to indicate continuity of forest presence at a site and to use “unmodified” or “virgin” to describe forests that have not obviously been changed by significant human impact.

In Chek Jawa’s coastal forest, secondary forest species such as *Adinanandra dumosa*, *Ficus grossularioides*, *Macaranga* spp. and *Dillenia suffruticosa* although present, are not in abundance; whereas species such as *Adenantha malayana*,

Archidendron contortum, *A. ellipticum*, *Diospyros ferrea*, *Eurycoma longifolia*, *Garcinia atroviridis*, *G. hombroniana* and *Knema globularia*, which are not typical representatives of secondary forest, occur there. The forest does show signs of heavy disturbance but it is obvious that the area was not cleared in the past. Therefore, by Corlett's definition, the coastal forest of Chek Jawa is degraded primary coastal forest not secondary forest. Further, 65 species listed by Corner (1985) on the uninhabited and undisturbed coastal islets are also found in Chek Jawa.

The canopy, though, is not continuous or lofty. Most trees on the steep hill are not very tall ranging between 4–6 m in height. This low canopy is indicative of a history of disturbance. Part of the disturbance is undoubtedly man-made as there are remains of building foundations at the top of the hill. The bamboo (*Bambusa vulgaris*) that occurs in clumps throughout Chek Jawa is one such indication of disturbance. However, the frequency of trees near the slope in coastal forest with a decayed main trunk and abundant coppicing, such as *Chrysophyllum roxburghii* that has side shoots up to 0.5 m in diameter, suggests that in the past natural phenomena such as high winds might have brought down the larger trees.

In contrast, the rocky shore vegetation does not show signs of disturbance and many species are represented by large and presumably old specimens such as *Cerbera manghas*, *Garcinia hombroniana*, *Knema globularia*, *Intsia bijuga*, *Memecylon edule* and *Pouteria linggensis* typifying the flora of such a habitat.

Conservation status

Eleven species collected during this survey (inclusive of seagrasses) are listed in *The Red Book* as 'extinct', 11 as endangered and 16 as vulnerable species (Table 3).

Blechnum orientale is relatively common on Chek Jawa, while the other extinct, endangered and vulnerable ferns are niche specific. The 'extinct' fern *Adiantum flabellulatum* was found at one shady spot on a slope.

Of the mangrove species in the endangered and vulnerable categories, *Bruguiera parviflora* is represented by a single tree, *Sonneratia ovata* by several individuals, while *Rhizophora stylosa* is thriving and several saplings were seen around the mother trees.

Litsea elliptica is relatively common. *Archidendron ellipticum* was found growing in a sunny patch in the hill forest but saplings were not noted.

On the rocky shore, only one individual of *Memecylon amplexicaule* was located. In contrast, *Olea brachiata* is common along forest margins on the seaward side.

Aidia densiflora, a small tree, is common. A single specimen of *Scaphium macropodum* was found. *Garcinia hombroniana* is represented by saplings along the secondary forest pathways. *Strobilanthes palawanensis*, thought 'extinct', is ubiquitous

Table 3. 'Extinct', endangered and vulnerable species collected during the Chek Jawa survey**'Extinct'**

| | |
|---------------|--|
| Acanthaceae | <i>Strobilanthes palawanensis</i> |
| Adiantaceae | <i>Adiantum flabellulatum</i> |
| Cymodoceaceae | <i>Halodule pinifolia</i> |
| Cymodoceaceae | <i>Halodule uninervis</i> |
| Cymodoceaceae | <i>Thalassia hemprichii</i> |
| Gnetaceae | <i>Gnetum latifolium</i> |
| Lauraceae | <i>Litsea myristicifolia</i> |
| Myristicaceae | <i>Knema globularia</i> |
| Palmae | <i>Calamus erinaceus</i> |
| Pandanaceae | <i>Pandanus tetradon</i> |
| Rubiaceae | <i>Lasianthus hirsutus</i> (as <i>L. cyanocarpus</i>) |

Endangered

| | |
|------------------|--------------------------------|
| Guttiferae | <i>Garcinia hombroniana</i> |
| Hydrocharitaceae | <i>Halophila beccarii</i> |
| Hydrocharitaceae | <i>Halophila spinulosa</i> |
| Leguminosae | <i>Archidendron ellipticum</i> |
| Moraceae | <i>Artocarpus nitidus</i> |
| Moraceae | <i>Ficus superba</i> |
| Pteridaceae | <i>Pteris tripartita</i> |
| Rhizophoraceae | <i>Bruguiera parviflora</i> |
| Rubiaceae | <i>Diplospora malaccensis</i> |
| Sonneratiaceae | <i>Sonneratia ovata</i> |
| Schizaeaceae | <i>Schizaea dichotoma</i> |

Vulnerable

| | |
|-----------------|-------------------------------|
| Blechnaceae | <i>Blechnum orientale</i> |
| Celastraceae | <i>Salacia chinensis</i> |
| Dracaenaceae | <i>Dracaena maingayi</i> |
| Lauraceae | <i>Litsea elliptica</i> |
| Lauraceae | <i>Litsea umbellata</i> |
| Leguminosae | <i>Dalbergia pseudosissoo</i> |
| Leguminosae | <i>Millettia pinnata</i> |
| Loganiaceae | <i>Strychnos maingayi</i> |
| Melastomataceae | <i>Memecylon amplexicaule</i> |
| Meliaceae | <i>Xylocarpus moluccensis</i> |
| Moraceae | <i>Ficus dubia</i> |
| Oleaceae | <i>Olea brachiata</i> |
| Rhizophoraceae | <i>Rhizophora stylosa</i> |
| Rubiaceae | <i>Aidia densiflora</i> |
| Schizaeaceae | <i>Lygodium circinnatum</i> |
| Sterculiaceae | <i>Scaphium macropodium</i> |

on Chek Jawa. (It is possible that this species, which has pretty pink flowers, is a garden escape). The seashore nutmeg, *Knema globularia*, is common on the seaward side of coastal forest on Chek Jawa with several adult trees.

The first step in conservation would be to invest in a long-term monitoring programme to follow the species flowering and fruiting seasons. Seeds should be gathered and germinated so that saplings can be transplanted back into the surrounding area. For example, *Pandanus tetrodon* was found on the steep slope in the coastal forest is represented by a single huge plant with offshoots. Unless the offshoots are transplanted elsewhere, it will remain the only plant on Chek Jawa. Even then the gene pool for most of these rare plants must be rather depleted. Unless something is done to increase the number of lone plants, the species will eventually become extinct.

Table 4. Specimens collected from Pulau Ubin before 1950 that occur on Chek Jawa (Ex 'Extinct'; V Vulnerable; R Rare; C Common)

| Family | Genus | Species | Status | Collector | No. | Year collected |
|----------------|-----------------------|---------------------|--------|------------------|-------|----------------|
| Adiantaceae | <i>Adiantum</i> | <i>flabellatum</i> | Ex | Ridley, H.N. | 5865 | 1892 |
| Adiantaceae | <i>Pityrogramma</i> | <i>calomelanos</i> | exotic | Ridley, H.N. | s.n. | 1894 |
| Apocynaceae | <i>Willughbeia</i> | <i>edulis</i> | R | Ridley, H.N. | 9501 | 1901 |
| Asclepiadaceae | <i>Dischidia</i> | <i>nummularia</i> | C | Allen, B.E.G.M. | s.n. | 1949 |
| Celastraceae | <i>Salacia</i> | <i>chinensis</i> | V | Ridley, H.N. | s.n. | 1890 |
| Compositae | <i>Pluchea</i> | <i>indica</i> | R | Hullett, R.W. | 341 | 1884 |
| Cyperaceae | <i>Fimbristylis</i> | <i>ferruginea</i> | R | Ridley, H.N. | 5806 | 1892 |
| Davalliaceae | <i>Davallia</i> | <i>denticulata</i> | C | Hullett, R.W. | 50 | 1880 |
| Dracaenaceae | <i>Dracaena</i> | <i>maingayi</i> | V | Hullett, R.W. | s.n. | 1885 |
| Euphorbiaceae | <i>Macaranga</i> | <i>heynei</i> | C | Furtado, C.X. | 18338 | 1927 |
| Euphorbiaceae | <i>Suregada</i> | <i>multiflora</i> | R | Ridley, H.N. | 9497 | 1898 |
| Leguminosae | <i>Derris</i> | <i>trifoliata</i> | C | Hullett, R.W. | s.n. | 1885 |
| Linaceae | <i>Indorouchera</i> | <i>griffithiana</i> | R | Allen, B.E.G. M. | sn | 1949 |
| Loganiaceae | <i>Fagraea</i> | <i>racemosa</i> | R | Goodenough, J.S. | 1146 | 1890 |
| Menispermaceae | <i>Fibraurea</i> | <i>tinctoria</i> | R | Ridley, H.N. | sn | 1893 |
| Menispermaceae | <i>Tinospora</i> | <i>crispa</i> | exotic | Ridley, H.N. | 1650 | 1890 |
| Moraceae | <i>Artocarpus</i> | <i>dadah</i> | R | Ridley, H.N. | 4721 | 1890 |
| Moraceae | <i>Ficus</i> | <i>kerkhovenii</i> | R | Ridley, H.N. | sn | 1901 |
| Moraceae | <i>Ficus</i> | <i>variegata</i> | C | Ridley, H.N. | s.n. | 1894 |
| Ochnaceae | <i>Campylospermum</i> | <i>serratum</i> | R | Ridley, H.N. | sn | 1897 |
| Palmae | <i>Licuala</i> | <i>spinosa</i> | R | Ridley, H.N. | sn | 1894 |
| Rhizophoraceae | <i>Bruguiera</i> | <i>cylindrica</i> | R | Ridley, H.N. | 366 | 1890 |
| Rubiaceae | <i>Oxyceros</i> | <i>longiflora</i> | R | Ridley, H.N. | 9487 | 1898 |
| Rutaceae | <i>Clausena</i> | <i>excavata</i> | R | Ridley, H.N. | 389 | 1890 |
| Sapindaceae | <i>Lepisanthes</i> | <i>rubiginosa</i> | R | Hullett, R.W. | 386 | 1884 |
| Sapindaceae | <i>Mischocarpus</i> | <i>sundaicus</i> | R | Ridley, H.N. | 9495 | 1890 |
| Verbenaceae | <i>Clerodendrum</i> | <i>inerve</i> | R | Ridley, H.N. | 373 | 1890 |
| Verbenaceae | <i>Premna</i> | <i>serratifolia</i> | R | Ridley, H.N. | sn | 1893 |
| Verbenaceae | <i>Vitex</i> | <i>pinnata</i> | C | Hullett, R.W. | 373 | 1880 |

Historic Collections

As mentioned above, it is not possible to determine if the specimens collected from 1800 to 1950 were collected from Chek Jawa as the locality was only recorded as Pulau Ubin. Out of the 109 specimens from this period, only 29 species were collected from Chek Jawa during this survey (Table 4) of which, *Adiantum flabellulatum* is listed as 'extinct', and *Salacia chinensis* and *Dracaena maingayi* as vulnerable. However, many other 'extinct', endangered and vulnerable species collected during these early times were not seen on Chek Jawa (Table 5).

Conclusions

For its size, the flora of Chek Jawa is rich in biodiversity with 245 species in 171 genera and 80 families of vascular plants excluding alien species. This compares with the survey for the whole of Pulau Ubin (Turner *et al.*, 1992), which listed 261 native species and 71 aliens. From the conservation point of view, with 11 species listed as 'extinct', 11 as endangered and 16 as vulnerable, Chek Jawa is an important conservation site and a significant component of Pulau Ubin flora. It has a good representative flora of the seagrasses, the rocky shore and mangrove habitats. The coastal hill, although heavily disturbed, is not secondary forest and harbours many of the 'extinct', endangered or vulnerable species so conservation efforts should be afforded to ensure its survival.

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Table 5. Vulnerable, endangered or 'extinct' species from old records that were not found on Chek Jawa**'Extinct'**

| | |
|---------------|---------------------------------|
| Apocynaceae | <i>Willughbeia flavescens</i> |
| Araliaceae | <i>Schefflera lanceolata</i> |
| Commelinaceae | <i>Pollia secundiflora</i> |
| Connaraceae | <i>Connarus planchonianus</i> |
| Fagaceae | <i>Lithocarpus wallichianus</i> |
| Leguminosae | <i>Aganope heptaphylla</i> |
| Leguminosae | <i>Albizia retusa</i> |
| Loganiaceae | <i>Fagraea auriculata</i> |
| Orchidaceae | <i>Corymborkis veratrifolia</i> |
| Orchidaceae | <i>Thrixspermum calceolus</i> |
| Rubiaceae | <i>Coelospermum truncatum</i> |

Endangered

| | |
|-------------|-------------------------------|
| Myrsinaceae | <i>Aegiceras corniculatum</i> |
| Myrsinaceae | <i>Ardisia singaporensis</i> |
| Myrtaceae | <i>Tristaniopsis whiteana</i> |

Vulnerable

| | |
|------------------|------------------------------------|
| Annonaceae | <i>Cyathostemma viridiflorum</i> |
| Celastraceae | <i>Salacia viminea</i> |
| Dipterocarpaceae | <i>Dipterocarpus sublamellatus</i> |
| Lauraceae | <i>Actinodaphne macrophylla</i> |
| Melastomataceae | <i>Diplectria viminalis</i> |
| Palmae | <i>Nenga pumila</i> |
| Rhamnaceae | <i>Ventilago malaccensis</i> |
| Rubiaceae | <i>Ophiorrhiza singaporensis</i> |
| Selaginellaceae | <i>Selaginella willdenowii</i> |

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Appendix

Checklist of Vascular Plants Collected from Chek Jawa

[Ex] Extinct; [En] Endangered; [V] Vulnerable and [R] Rare; [exotic] plants not originating in the region and [C] Common status from *The Singapore Red Data Book* (1994).

Ferns

Adiantaceae

Adiantum flabellulatum L.; *habit* : herb; *occurrence*: rare; *habitat* : coastal forest; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 92.

Adiantum latifolium Lam.; *habit* : herb; 0.75m tall; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 145.

Pityrogramma calomelanos (L.) Link; *habit* : herb; 0.5m tall; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 148.

Taenitis blechnoides (Willd.) Sw.: *habit* : herb; 0.3m tall; *occurrence*: locally frequent; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 187.

Blechnaceae

Blechnum orientale L.: *habit* : herb; 1.5m tall; *habitat* : coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 167.

Stenochlaena palustris (Burm.f.) Bedd.: *habit* : herb; *occurrence*: frequent; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 210.

Davalliaceae

Davallia denticulata (Burm.f.) Mett. ex Kuhn: *habit* : epiphytic herb; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 57.

Dennstaedtiaceae

Pteridium esculentum (G. Forst.) Cockayne: *habit* : herb; *habitat*: sandy shore; *specimen(s)*: Gwee, A.T. GAT 316.

Oleandraceae

Nephrolepis auriculata (L.) Trimen: *habit* : herb; *occurrence*: frequent; *habitat* : wasteland / coastal hill; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 251.

Polypodiaceae

Drynaria quercifolia (L.) J.Sm.: *habit* : epiphytic herb; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 44.

Microsorium scolopendrium (Burm.f.) Copel.: *habit* : epiphytic herb; *habitat*: coastal forest; *specimen(s)*: Gwee, A.T. GAT 173.

Pyrrosia nummulariifolia (Sw.) Ching; *habit* : climber; *habitat* : coastal forest; *specimen(s)*: Gwee, A.T. GAT 351.

Pyrrosia piloselloides (L.) M.G. Price; *habit* : climber; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 199.

Pteridaceae

Acrostichum aureum L.: 2.5 tall; *habitat*: mangrove; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 152.

Acrostichum speciosum Willd.; *habit* : herb; *habitat*: mangrove; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 283.

Pteris ensiformis Burm.f.; *habit* : herb; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Leong, P. PL 22.

Pteris tripartita Sw.; *habit*: herb; *habitat*: coastal forest; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 186.

Schizaeaceae

Lygodium circinnatum (Burm.f.) Sw.; *habit* : herb; *habitat*: wasteland; *conservation status*: V; *specimen(s)*: Leong, P. PL 8.

Lygodium salicifolium C. Presl; *habit*: climber; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 335.

Schizaea dichotoma (L.) J. Sm.; *habit* : herb; *habitat* : coastal forest; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 340.

Schizaea digitata (L.) Sw.; *habit* : herb; *specimen(s)*: Gwee, A.T. GAT 292.

Gymnosperms

Gnetaceae

Gnetum gnemon L.; *habit* : tree; *habitat* : wasteland; *conservation status*: R; *specimen(s)*: Leong, P. PL 3.

Gnetum latifolium Blume; *habit* : climber; *habitat*: coastal forest; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 222.

Gnetum microcarpum Blume; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 64.

Monocotyledons

Colchicaceae

Gloriosa superba L.; *habit*: climber; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 252.

Cymodoceaceae

Cymodocea rotundata Ehrenb. & Hempr.; *habit* : seagrass; *habitat*: intertidal zone; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 326.

Halodule pinifolia (Miki) Hartog; *habit*: seagrass; *habitat*: intertidal zone; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 325.

Halodule uninervis (Forssk.) Asch.; *habit*: seagrass; *habitat*: intertidal zone; *conservation status*: Ex; *specimen(s)*: Tan, R. et al. GAT 398.

Cyperaceae

Cyperus cyperoides (L.) Kuntze; *habit*: herb; occurrence: frequent; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Leong, P. PL 23.

Cyperus imbricatus Retz.; *habit*: herb; 1m tall; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 154.

Cyperus javanicus Houtt.; *habit*: herb; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 264.

Cyperus trialatus (Boeck.) Kern; *habit*: herb; 0.3m tall; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 190.

Fimbristylis ferruginea (L.) Vahl; *habit*: herb; occurrence: locally frequent; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 263.

Kyllinga polyphylla Willd. ex Kunth; *habit*: herb; *habitat*: wasteland; *specimen(s)*: Gwee, A.T. GAT 150.

Mapania enodis (Miq.) C.B. Clarke; *habit*: herb; occurrence: locally frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 96.

Scleria ciliaris Nees; *habit*: herb; *habitat*: wasteland; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 297.

Dracaenaceae

Dracaena angustifolia Roxb.; *habit*: shrub; *habitat*: coastal forest; *specimen(s)*: Gwee, A.T. GAT 253.

Dracaena maingayi Hook.f.; *habit*: tree; *habitat*: coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 55.

Flagellariaceae

Flagellaria indica L.; *habit*: climber; occurrence: locally frequent; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 192.

Gramineae

Bambusa vulgaris Schrad.; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 334.

Centotheca lappacea (L.) Desv.; *habit* : herb; 0.35m tall; *habitat* : wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 159.

Mnesithea glandulosa (Trin.) de Koning & Sosef; *habit* : herb; 1.5m tall; *habitat* : wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 147.

Panicum nodosum Kunth; *habit* : herb; *habitat* : wasteland; *specimen(s)*: Gwee, A.T. GAT 12.

Thysanolaena latifolia (Roxb. ex Hornem.) Honda; *habit* : herb; *habitat*: wasteland; *specimen(s)*: Gwee, A.T. GAT 345.

Hydrocharitaceae

Halophila beccarii Asch.; *habit* : seagrass; *habitat*: intertidal zone; *conservation status*: En; *specimen(s)*: Tan, R. et al. GAT 396.

Halophila ovalis (R.Br.) Hook.f.; *habit* : seagrass; *occurrence*: frequent; *habitat* : intertidal zone; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 324.

Halophila spinulosa (R.Br.) Asch.; *habit* : seagrass; *occurrence*: frequent; *habitat* : intertidal zone; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 322.

Thalassia hemprichii (Ehrenb.) Asch.; *habit* : seagrass; *habitat*: intertidal zone; *conservation status*: Ex; *specimen(s)*: Tan, R. et al. GAT 393.

Hypoxidaceae

Molineria latifolia (Dryand.) Herb. ex Kurz var. **latifolia**; *habit*: herb; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 68.

Orchidaceae

Dendrobium crumenatum Sw.; *habit* : herb; *habitat*: rocky shore; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 171.

Eulophia graminea Lindl.; *habit* : herb; *habitat* : sandy shore; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 268.

Palmae

Calamus erinaceus (Becc.) J. Dransf.; *habit* : rattan; *habitat*: coastal forest; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 53.

Daemonorops sepal Becc.; *habit* : rattan; *habitat*: coastal forest; *specimen(s)*: Gwee, A.T. GAT 343.

Licuala spinosa Wurmbe.; *habit* : shrub; 3m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 9.

Nypa fruticans Wurmbe.; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 317.

Oncosperma tigillarum (Jack) Ridl.; *habit* : tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 385.

Pandanaceae

Pandanus odoratissimus L.f.; *habitat* : mangrove; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 266.

Pandanus tetradon Ridl.; *habitat* : coastal forest; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 392.

Phormiaceae

Dianella ensifolia (L.) DC.; *habit* : herb; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 332.

Smilacaceae

Smilax megacarpa A. DC. & C. DC.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 79.

Smilax setosa Miq.; *habit* : climber; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 75.

Zingiberaceae

Zingiber griffithii Baker; *habit* : herb; 0.3m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 160.

Dicotyledons**Acanthaceae**

Strobilanthes palawanensis Elmer; *habit* : herb; 0.75m tall; occurrence: locally frequent; *habitat* : wasteland; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 146.

Aizoaceae

Sesuvium portulacastrum (L.) L.; *habit*: herb; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 225.

Alangiaceae

Alangium javanicum (Blume) Wangerin; *habit*: tree; 3m tall; *habitat*: wasteland; *specimen(s)*: Gwee, A.T. GAT 110.

Amaranthaceae

Cyathula prostrata (L.) Blume; *habit* : herb; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 347.

Anacardiaceae

Buchanania sessifolia Blume; *habit* : tree; 1.5m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 184.

Mangifera indica L.; *habit* : tree; 20m tall; *habitat*: coastal forest; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 76.

Annonaceae

Artabotrys suaveolens (Blume) Blume; *habit* : climber; occurrence: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 183.

Desmos chinensis Lour.; *habit* : tree; occurrence: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 63.

Melodorum aberrans (Maingay ex Hook.f. & Thomson) J. Sm.; *habit* : climber; *habitat*: coastal forest; *specimen(s)*: Gwee, A.T. GAT 196.

Phaeanthus ophthalmicus (Roxb. ex G. Don) J. Sinclair; *habit*: tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 276.

Popowia fusca King; *habit* : tree; 0.75m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 130.

Uvaria cordata (Dunal) Alston; *habit*: climber; 1m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 124.

Uvaria grandiflora Roxb. ex Hornem. var. *grandiflora*; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 386.

Uvaria hirsuta Jack; *habit*: climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 337.

Xylopia malayana Hook.f. & Thomson; *habit* : tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 302.

Apocynaceae

Cerbera manghas L.; *habit*: tree; *habitat* : mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 281.

Willughbeia edulis Roxb.; *habit* : climber; *occurrence*: locally frequent; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 106.

Aquifoliaceae

Ilex cymosa Blume; *habit* : tree; 5m tall; *habitat* : wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 206.

Asclepiadaceae

Dischidia major (Vahl) Merr.; *habit* : epiphytic herb; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Leong, P. PL 16.

Dischidia nummularia R.Br.; *habit* : epiphytic herb; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 10.

Hoya verticillata (Vahl) G. Don var. *verticillata*; *habit*: climber; *occurrence*: frequent; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 109.

Avicenniaceae

Avicennia alba Blume; *habit* : tree; 6m tall; *occurrence*: locally frequent; *habitat*: mangrove; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 117.

Avicennia officinalis L.; *habit* : tree; 4m tall; *occurrence*: frequent; *habitat* : mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 226.

Avicennia rumphiana Hallier f.; *habit* : tree; 4m tall; *habitat* : mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 235.

Boraginaceae

Cordia curassavica (Jacq.) Roem. & Schult.; *habit* : shrub; 1m tall; *habitat*: sandy shore; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 174.

Burseraceae

Dacryodes rostrata (Blume) H.J. Lam; *habit* : tree; 25m tall; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 158.

Celastraceae

Salacia chinensis L.; *habit* : climber; *habitat*: mangrove; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 86.

Salacia korthalsiana Miq.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 387.

Chrysobalanaceae

Licania splendens (Korth.) Prance; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 309.

Maranthes corymbosa Blume; *habit* : tree; occurrence: locally frequent; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 320.

Combretaceae

Combretum sundaicum Miq.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 376.

Lumnitzera littorea (Jack) Voigt; *habit* : tree; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 287.

Terminalia catappa L.; *habit* : tree; *habitat*: sandy shore; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 260.

Compositae

Ageratum conyzoides L.; *habit* : herb; occurrence: frequent; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 348.

Elephantopus mollis Kunth; *habit*: herb; 0.75m tall; occurrence: frequent; *habitat* : wasteland; *specimen(s)*: Gwee, A.T. GAT 195.

Pluchea indica (L.) Less.; *habit* : shrub; occurrence: frequent; *habitat* : wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 229.

Synedrella nodiflora (L.) Gaertn.; *habit*: herb; occurrence: frequent; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 363.

Wollastonia biflora (L.) DC.; *habit* : herb; *specimen(s)*: Leong, P. PL 13.

Connaraceae

Cnestis palala (Lour.) Merr.; *habit* : climber; occurrence: locally frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 126.

Rourea fulgens Planch.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 99.

Rourea mimosoides (Vahl) Planch.; *habit*: climber; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 122.

Rourea minor (Gaertn.) Leenh.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 375.

Convolvulaceae

Erycibe malaccensis C.B. Clarke; *habit* : climber; occurrence: locally frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 277.

Erycibe tomentosa Blume; *habit* : climber; occurrence: locally frequent; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 54.

Cucurbitaceae

Coccinea grandis (L.) Voigt; *habit* : climber; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Leong, P. PL 11.

Dilleniaceae

Tetracera akara (Burm.f.) Merr.; *habit* : climber; *habitat* : coastal forest; *specimen(s)*: Gwee, A.T. GAT 127.

Tetracera indica (Christm. & Panz.) Merr.; *habit* : climber; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 4.

Tetracera macrophylla Wall. ex Hook.f. & Thomson; *habit* : climber; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 306.

Ebenaceae

Diospyros ferrea (Willd.) Bakh.; *habit* : tree; 5m tall; *occurrence*: locally frequent; *habitat*: rocky shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 177.

Diospyros lanceifolia Roxb.; *habit* : tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Leong, P. PL 18.

Elaeocarpaceae

Elaeocarpus pedunculatus Wall. ex Mast.; *habit* : tree; 2.5m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 157.

Erythroxylaceae

Erythroxylum cuneatum (Miq.) Kurz; *habit*: tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 344.

Euphorbiaceae

Aporosa frutescens Blume; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 298.

Breynia racemosa (Blume) Müll.Arg.; *habit* : shrub; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 205.

Croton hirtus L'Hér.; *habit* : shrub; *habitat* : coastal forest; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 114.

Excoecaria agallocha L.; *habit*: tree; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 224.

Glochidion littorale Blume; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 296.

Glochidion superbum Baill.; *habit* : tree; 5m tall; *occurrence*: locally frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 131.

Macaranga heynei I.M. Johnst.; *habit* : tree; 3m tall; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 5.

Macaranga hypoleuca (Rech.f. & Zoll.) Müll.Arg.; *habit* : tree; 3m tall; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 189.

Macaranga lowii King ex Hook.f.; *habit* : tree; 3m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 77.

Triadica cochinchinensis Lour.; *habit* : tree; 4m tall; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 133.

Sauropus androgynus (L.) Merr.; *habit* : shrub; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 6.

Suregada multiflora (Juss.) Baill.; *habit* : tree; occurrence: locally frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 164.

Flacourtiaceae

Flacourtia inermis Roxb.; *habit* : tree; *habitat* : wasteland; *specimen(s)*: Gwee, A.T. GAT 207.

Goodeniaceae

Scaevola taccada (Gaertn.) Roxb.; *habit* : shrub; *habitat*: rocky shore; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 358.

Guttiferae

Garcinia atroviridis Griff. ex T. Anderson; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 275.

Garcinia hombroniana Pierre; *habit* : tree; 8m tall; *habitat*: rocky shore; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 141.

Garcinia parvifolia (Miq.) Miq.; *habit* : tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 274.

Icacinaceae

Gonocaryum gracile Miq.; *habit* : tree; 6m tall; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 129.

Ixonanthaceae

Ixonanthes icosandra Jack; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 291.

Labiatae

Hyptis brevipes Poit.; *habit* : herb; occurrence: frequent; *habitat* : wasteland; *conservation status*: exotic; *specimen(s)*: Leong, P. PL 12.

Lauraceae

Cinnamomum iners Reinw.; *habit* : tree; 6m tall; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 70.

Litsea elliptica Blume; *habit* : tree; 5m tall; *habitat* : coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 188.

Litsea myristicifolia (Wall. ex Nees) Hook.f.; *habit* : tree; 1m tall; *habitat*: coastal forest; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 185.

Litsea umbellata (Lour.) Merr.; *habit*: tree; 2m tall; *habitat*: coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 93.

Neolitsea zeylanica (Nees) Merr.; *habit* : tree; 15m tall; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Leong, P. PL 2.

Leguminosae

Adenanthera malayana Kosterm.; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 381.

Aganope thyrsoflora (Benth.) Polhill; *habit*: climber; *habitat* : rocky shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 82.

Archidendron contortum (Martelli) I.C. Nielsen; *habit* : tree; *occurrence*: locally frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 119.

Archidendron ellipticum (Bl.) Nielsen; *habit* : tree; *habitat*: coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 308.

Archidendron jiringa (Jack) I.C. Nielsen; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 198.

Canavalia cathartica Thouars; *habit* : climber; *habitat* : wasteland; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 212.

Canavalia rosea (Sw.) DC.; *habit* : climber; *habitat*: sandy shore; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 250.

Clitoria pubescens; *habit*: climber; *habitat*: sandy shore; *specimen(s)*: Leong, P. PL 21.

Dalbergia candenatensis (Dennst.) Prain; *habit* : climber; occurrence: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 179.

Dalbergia pseudosissoo Miq.; *habit* : climber; *habitat* : coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 120.

Dalbergia velutina Benth.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 216.

Dendrolobium umbellatum (L.) Benth.; *habit* : tree; 1.5m tall; *habitat*: wasteland; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 115.

Derris amoena Benth. var. **amoena**; *habit* : climber; occurrence: frequent; *habitat* : coastal forest; *specimen(s)*: Gwee, A.T. GAT 355.

Derris trifoliata Lour.; *habit* : tree; *habit* : climber; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 162.

Desmodium heterocarpon (L.) DC. ssp. **heterocarpon**; *habit* : shrub; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 373.

Entada spiralis Ridl.; *habit*: climber; occurrence: frequent; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 8.

Intsia bijuga (Colebr.) Kuntze; *habit* : tree; 9m tall; occurrence: rare; *habitat* : rocky shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 138.

Millettia pinnata (L.) G. Panigrahi; *habit* : tree; *habitat*: sandy shore; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 241. \

Linaceae

Indorouchera griffithiana (Planch.) Hallier f.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 1.

Loganiaceae

Fagraea fragrans Roxb.; *habit*: tree; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 61.

Fagraea racemosa Jack ex Wall.; *habit* : tree; 4m tall; occurrence: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 217.

Strychnos ignatii Berg.; *habit*: climber; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 95.

Strychnos maingayi C.B. Clarke; *habit*: climber; *habitat*: coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 285.

Malvaceae

Sida acuta Burm.f.; *habit*: shrub; *habitat*: wasteland; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 153.

Sida rhombifolia L.; *habit*: shrub; 1m tall; *habitat*: wasteland; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 111.

Urena lobata L.; *habit*: shrub; *occurrence*: frequent; *habitat*: wasteland; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 156.

Melastomataceae

Clidemia hirta (L.) D. Don; *habit*: shrub; *occurrence*: frequent; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 67.

Memecylon amplexicaule Roxb.; *habit*: tree; *habitat*: coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 338.

Memecylon edule Roxb. var. *edule*; *habit*: tree; 6m tall; *habitat*: rocky shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 65.

Memecylon edule Roxb. var. *ovatum* (Sm.) C.B. Clarke; *habit*: tree; 7m tall; *habitat*: rocky shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 74.

Meliaceae

Xylocarpus granatum J. König; *habit*: tree; 10m tall; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 140.

Xylocarpus moluccensis (Lam.) M. Roem.; *habit*: tree; *habitat*: mangrove; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 254.

Menispermaceae

Fibraurea tinctoria Lour.; *habit*: climber; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 56.

Tinospora crispa (L.) Hook.f. & Thomson; *habit* : climber; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 112.

Moraceae

Artocarpus dadah Miq.; *habit* : tree; 9-10m seen tall; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 219.

Artocarpus nitidus Trécul ssp. *griffithii* (King) F.M. Jarrett; *habit* : tree; *habitat*: coastal forest; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 295.

Ficus aurantiacea Griff.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 204.

Ficus dubia Wall. ex King; *habit* : tree; *habitat*: coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 104.

Ficus grossularioides Burm.f.; *habit*: tree; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 78.

Ficus heteropleura Blume; *habit* : tree; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 203.

Ficus kerkhovenii Valetton; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 270.

Ficus microcarpa L.f.; *habit* : tree; 1m tall; *habitat*: sandy shore; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 169.

Ficus superba (Miq.) Miq.; *habit* : tree; *habitat*: sandy shore; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 259.

Ficus variegata Blume; *habit* : tree; 7m tall; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 113.

Ficus vasculosa Wall. ex Miq.; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 52.

Ficus villosa Blume; *habit* : climber; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 197.

Myristicaceae

Knema globularia (Lam.) Warb.; *habit* : tree; 4-18m tall; *habitat*: rocky shore/ coastal hill; *conservation status*: Ex; *specimen(s)*: Gwee, A.T. GAT 102.

Myrsinaceae

Ardisia crenata Sims; *habit* : shrub; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 202.

Ardisia crispa A.DC.; *habit* : tree; 1m tall; *habitat*: coastal forest; *specimen(s)*: Gwee, A.T. GAT 2.

Embelia ribes Burm.; *habit*: climber; *occurrence*: frequent; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Leong, P. PL 5.

Myrtaceae

Psidium cattleianum; *habit*: tree; *habitat* : wasteland; *specimen(s)*: Gwee, A.T. GAT 372.

Rhodamnia cinerea Jack; *habit* : tree; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A. T. GAT 69.

Syzygium lineatum (DC.) Merr. & L.M. Perry; *habit* : tree; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 89.

Syzygium zeylanicum (L.) DC.; *habit* : tree; 3.5m tall; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 249.

Ochnaceae

Campylospermum serratum (Gaertn.) Bittrich & M.C.E. Amaral; *habit* : tree; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 81.

Olacaceae

Ximения americana L.; *habit* : shrub; 4m tall; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 245.

Oleaceae

Jasminum elongatum (Bergius) Willd.; *habit* : climber; *habitat* : coastal forest; *conservation status*: exotic; *specimen(s)*: Leong, P. PL 7.

Olea brachiata (Lour.) Merr.; *habit* : tree; 2m tall; occurrence: frequent; *habitat* : coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 72.

Onagraceae

Ludwigia hyssopifolia (G. Don) Exell; *habit* : herb; 0.5m tall; *habitat*: wasteland; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 194.

Opiliaceae

Champereia manillana (Blume) Merr.; *habit* : tree; 4m tall; occurrence: frequent; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 118.

Pandaceae

Microdesmis caseariifolia Planch.; *habit* : tree; 4m tall; occurrence: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 128.

Passifloraceae

Adenia macrophylla (Blume) Koord. var. *macrophylla*; *habit* : climber; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 368.

Passiflora foetida L.; *habit* : climber; *habitat* : wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 193.

Passiflora laurifolia L.; *habit* : climber; occurrence: frequent; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 59.

Polygalaceae

Polygala paniculata L.; *habit* : herb; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 367.

Polygonaceae

Muelenbeckia platyclados; *habit*: herb; *habitat* : wasteland; *specimen(s)*: Gwee, A.T. GAT 228.

Portulacaceae

Portulaca pilosa L.; *habit* : herb; 0.1m tall; *habitat* : rocky shore; *conservation status*: exotic; *specimen(s)*: Leong, P. PL 10.

Rhamnaceae

Colubrina asiatica L. ex Brongn.; *habit* : shrub; *habitat*: sandy shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 243.

Rhizophoraceae

Bruguiera cylindrica (L.) Blume; *habit* : tree; 2.5m tall; occurrence: frequent; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 211.

Bruguiera gymnorhiza (L.) Lam. ex Savigny; *habit* : tree; 7m tall; *habitat* : mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 215.

Bruguiera parviflora (Roxb.) Wight & Arn. ex Griff.; *habit* : tree; occurrence: rare; *habitat*: mangrove; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 329.

Carallia brachiata (Lour.) Merr.; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 378.

Ceriops decandra (Griff.) W. Theob.; *habit* : tree; occurrence: frequent; *habitat*: mangrove; *specimen(s)*: Gwee, A.T. GAT 256.

Ceriops tagal (Pers.) C.B. Rob.; *habit* : tree; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 261.

Rhizophora apiculata Blume; *habit* : tree; 5m tall; occurrence: frequent; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 240.

Rhizophora mucronata Lam.; *habit* : tree; 3m tall; occurrence: frequent; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 214.

Rhizophora stylosa Griff.; *habit* : tree; occurrence: rare; *habitat* : mangrove; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 267.

Rubiaceae

Aidia auriculata (Wall.) Ridsdale; *habit* : climber; *habitat* : rocky shore; *specimen(s)*: Gwee, A.T. GAT 356.

Aidia densiflora (Wall.) Masam.; *habit* : tree; occurrence: frequent; *habitat*: coastal forest; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 80.

Canthium confertum Korth.; *habit* : tree; 3m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 149.

Canthium horridum Blume; *habit*: shrub; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 383.

Diplospora malaccensis Hook.f.; *habit* : tree; 3m tall; *habitat*: coastal forest; *conservation status*: En; *specimen(s)*: Gwee, A.T. GAT 83.

Guettarda speciosa L.; *habit*: tree; 6m tall; *habitat*: rocky shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 163.

Gynochthodes coriacea Blume; *habit* : climber; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 200.

Ixora congesta Roxb.; *habit* : shrub; 2m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Leong, P. PL 1.

Ixora lobbii King & Gamble; *habit* : shrub; *specimen(s)*: Gwee, A.T. GAT 293.

Lasianthus hirsutus (Roxb.) Merr.; *habit* : shrub; occurrence: rare; *habitat*: coastal forest; *conservation status*: Ex; *specimen(s)*: Leong, P. PL 9. (formally known as *L. cyanocarpus*).

Morinda citrifolia L.; *habit*: tree; *habitat* : wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 238.

Morinda umbellata L.; *habit* : climber; occurrence: frequent; *habitat* : coastal forest; *conservation status*: common; *specimen(s)*: Leong, P. PL 4.

Oxyceros fragrantissima (Ridl.) K.M. Wong; *habit* : climber; *habitat*: rocky shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 357.

Oxyceros longiflora (Lam.) T. Yamaz.; *habit* : shrub; 1m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 136.

Psychotria malayana Jack; *habit*: shrub; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 321.

Scyphiphora hydrophyllacea C.F. Gaertn.; *habit* : tree; 2m tall; *habitat* : sandy shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 170.

Timonius flavescens (Jack) Baker; *habit* : tree; 1.5m tall; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 125.

Timonius wallichianus (Korth.) Valetton; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 389.

Rutaceae

Clausena excavata Burm.f.; *habit* : shrub; occurrence: frequent; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 97.

Glycosmis chlorosperma (Blume) Spreng. var. *chlorosperma*; *habit* : shrub; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 87.

Melicope hookeri T.G. Hartley; *habit* : tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 294.

Sapindaceae

Allophylus cobbe (L.) Raeusch.; *habit* : shrub; *habitat* : Sandy shore, wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 265.

Guioa pubescens (Zoll. & Moritzi) Radlk.; *habit* : tree; *habitat* : coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 71.

Lepisanthes rubiginosa (Roxb.) Leenh.; *habit*: tree; occurrence: frequent; *habitat*: coastal forest; *specimen(s)*: Gwee, A.T. GAT 88.

Mischocarpus sundaicus Blume; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 175.

Sapotaceae

Chrysophyllum roxburghii G. Don; *habit* : tree; *habitat* : coastal forest; *specimen(s)*: Leong, P. PL 19.

Pouteria linggensis (Burck) Baehni; *habit* : tree; *habitat* : rocky shore; *specimen(s)*: Gwee, A.T. GAT 107.

Pouteria malaccensis (C.B. Clarke) Baehni; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 379.

Pouteria obovata (R.Br.) Baehni; *habit* : tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 73.

Scrophulariaceae

Scoparia dulcis L.; *habit*: herb; 0.75m tall; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 191.

Simaroubaceae

Brucea javanica (L.) Merr.; *habit*: tree; *habitat*: wasteland; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 361.

Eurycoma longifolia Jack; *habit*: tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 58.

Sonneratiaceae

Sonneratia alba J.J. Sm.; *habit*: tree; 4m tall; *habitat*: mangrove; *specimen(s)*: Gwee, A.T. GAT 100.

Sonneratia ovata Back.; *habit*: tree; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 271.

Sterculiaceae

Heritiera littoralis Dryand.; *habit*: tree; *habitat*: mangrove; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 255.

Scaphium macropodum (Miq.) Beumée ex Heyne; *habit*: tree; *habitat*: rocky shore; *conservation status*: V; *specimen(s)*: Gwee, A.T. GAT 178.

Symplocaceae

Symplocos fasciculata Zoll.; *habit*: tree; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 221.

Thymelaeaceae

Linostoma pauciflorum Griff.; *habit*: climber; *occurrence*: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 98.

Turneraceae

Turnera ulmifolia L.; *habit*: herb; 0.5m tall; *habitat*: wasteland; *conservation status*: exotic; *specimen(s)*: Gwee, A.T. GAT 13.

Ulmaceae

Trema tomentosa (Roxb.) Hara; *habit*: shrub; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Leong, P. PL 6.

Verbenaceae

Clerodendrum inerme (L.) Gaertn.; *habit* : shrub; occurrence: f srequent; *habitat* : sandy shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 213.

Clerodendrum laevifolium Blume; *habit* : shrub; 2m tall; occurrence: frequent; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 60.

Premna serratifolia L.; *habit* : shrub; 1.8m tall; *habitat*: sandy shore; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 209.

Vitex pinnata L.; *habit* : tree; *habitat*: coastal forest; *conservation status*: common; *specimen(s)*: Gwee, A.T. GAT 101.

Vitaceae

Ampelocissus elegans (Kurz) Gagnep.; *habit* : climber; *habitat*: coastal forest; *conservation status*: R; *specimen(s)*: Gwee, A.T. GAT 311.

Cissus repens Lam.; *habit*: climber; *habitat* : wasteland; *conservation status*: R; *specimen(s)*: Leong, P. PL 15.

OBITUARY

Dr Chang Kiaw Lan, 31 July 1927-14 August 2003

Dr Chang Kiaw Lan was appointed Botanist to the Singapore Botanic Gardens Service on 7 July 1959 and as Keeper of the Herbarium in 1970. She retired on 30 July 1987. Throughout most of her career she was based at the Botanic Gardens at Cluny Road, attached to and in charge of the Herbarium there, whence she made the acquaintance of a great number of taxonomic botanists and other botanical visitors from throughout the world. Her role in editing the *Gardens' Bulletin, Singapore* for 17 years was particularly significant because it was during a period when taxonomic research at the Gardens was at an ebb and yet the Bulletin was the only actively produced, dedicated botanical journal in Southeast Asia.

Kiaw Lan was born in Koetaradja (today called Banda Aceh) in north Sumatra, to Mr Thio Kie San, Kapitan or leader of the Chinese community there, and Madam Jong Lie Nio, when Indonesia was under Dutch administration. She was their second daughter and youngest of six children (including an adopted first child). Kiaw Lan attended early schooling there, which was interrupted by the Second World War, and continued her education in Penang, Malaysia, from January 1948 until July 1953. (It was in Penang that she began to use the name Chang Kiaw Lan consistently, one of several translated phonetic versions of her name in Chinese that included Thio Kiauw Lan, Tjong Kiauw Lian and Tjong Su Yun!) She moved to Singapore to read Botany and Philosophy at the University of Malaya (1953-1958) and in 1959 gained an Upper II Honours in Botany. She obtained a Certificate of Naturalisation under the British Nationality Act to stay in Singapore in May 1959 just prior to her joining the Botanic Gardens Service and in December, 1959, became a Singapore citizen. Her first field trip as a botanist in the Botanic Gardens appears to have been during 21–28 September 1959, in the Sedili area in Johore, in the company of Mohamad Shah, a plant collector who eventually rose to become Herbarium Assistant and Research Officer and who would ably assist her with the functions of the Herbarium throughout her career there.

Following her appointment to the Botanic Gardens, under H.M. Burkill's directorship, she was awarded a British Commonwealth Scholarship from October 1962 to July 1964 for a PhD in Botany at the University of Cambridge. She worked under the supervision of E.J.H. Corner, Professor of Tropical Botany at the Botany School, an exceedingly talented botanist with wide interests covering mycology and seed plants. Corner had served as an Assistant Director at the Singapore Botanic Gardens and was already well known as the author of *Wayside Trees of Malaya* by the time the Second World War overtook events in Singapore in 1942. Kiaw Lan was attached to Newnham College and completed her thesis, "The Structure and Taxonomy of *Lentinus* Fr." (xii + 247 p., 65 pl.) in July 1965. The thesis provided a resume of



Chang Kiaw Lan at the Singapore Herbarium upon return from Cambridge, 1965 (A); at her desk, December 1974 (B); attending a friend's reception, sometime 1970s (C); and while on tour in Vietnam shortly after retirement (D). (Courtesy of Christina Tan)

characters of taxonomic value in the classification of the gill-fungus *Lentinus*, which is well-represented in Malaysia and Singapore, and provided a new definition and typification for the genus, previously poorly circumscribed. It also confirmed the value of hyphal analysis as a taxonomic method. Then, accurate identification of the Asian tropical species was virtually impossible because there were no keys.

She resumed her service at the Gardens on 21 September 1965, coming back to a rather active schedule trying to settle in, but based at a temporary work station in the library while the office she was to occupy in the new three-floor Herbarium (completed in 1964) was still used by James Sinclair. He had been Curator since

1948, retired in 1963, was re-employed until 1965, when he worked in an honorary capacity until 1967. In August/September 1966 she attended the Eleventh Pacific Science Congress in Tokyo, where she presented a paper on "Criteria for the classification of *Lentinus* species". There, she also attended the Marine Park Symposium and the 1st U.S.-Japanese Algal Culture Conference in Ueno Park. Her trip was sponsored by the Singapore Industrial Research Unit and financed by the American Embassy and the Asia Foundation. During 1-5 October in the same year, she collected fungi in the Cameron Highlands, Peninsular Malaysia, together with Professor Corner and Dr Chew Wee Lek, the first local graduate appointed as botanist in 1956, obtaining his PhD from Cambridge in 1965.

In 1967, the Botanic Gardens was about to enter a trying period. Following her training in mycology, Kiaw Lan had already identified the need to carry out developmental studies of basidiomycete fungi because of the paucity of any information on the tropical species. For this, she realized that facilities for experimental work at the Gardens had to be set up. On the other hand, work on orchid culture (which involved another botanist, Hardial Singh, engaged in 1963) was already well established. That year, when the Singapore government's beautification programme became significant, she was also asked to be in charge of advisory work for the new Tree Planting Campaign.

Then, on 2 May 1968, she was seconded to the Primary Production Department, engaged in mushroom cultivation research. Kiaw Lan's duties in 1968 included studying the pests and diseases of cultivated plants, investigating the commercial production of edible mushrooms, and mycological research and routine maintenance of fungal collections. She was particularly interested in the mushroom genus *Termitomyces*, noting, "It is well-known that the termite mushroom is the most delicious in tropical countries." The name of the mushroom alludes to its association with the subterranean nest of *Odontotermes* termites, which do not build conspicuous mounds. The fungus is cultivated in so-called fungus gardens in the nest chambers of these termites, and helps in the digestion of cellulosic material brought in by the termites. But just over a year later, on 1 July 1969, she was returned after Dr Chew drew attention to an "acute shortage of botanists in the Botanic Gardens". In 1970, Chew assumed the duties of Director and Kiaw Lan became the Keeper of the Herbarium. So her duties continued to be defined around mycology but the contexts were different and rather wide-ranging.

Ironically, her role became more significant as taxonomic research waned in Singapore, particularly after the retirement of Burkill and departure of Chew, just before the Garden came under the organisation of The Parks & Recreation Service in 1973. The new department was overwhelmingly dedicated to the development of a superior Garden City that has come to be Singapore's signature theme. In 1970, Geh Siew Yin was appointed botanist, but she was moved to administrative duties as Assistant Commissioner of the Garden in 1973. By 1975, Hardial Singh was also

transferred to non-research duties in the expanding Parks & Recreation Department.

Hence, while one important aspect was fulfilled, resulting in a very successful urban and suburban horticultural management, the other, which would have been based on a traditional strength in tropical botanical research, faded. In retrospect, both areas could have flourished, as Singapore could well afford such development and was central, in terms of service and expertise, to a rapidly developing resource-rich region. Whereas, previously, many standard works on the botany of the region, such as *Wayside Trees of Malaya*, *Malayan Wild Flowers*, and numerous taxonomic revisions in the Gardens' Bulletin, were crafted by botanists at the Singapore Botanic Gardens, the 1970s and 1980s saw a dearth of such activity. In that period, the taxonomic output from the Gardens itself declined sharply and the key regional work of the time, the four-volume *Tree Flora of Malaya*, a project spanning over twenty years and involving 19 botanists, had no Botanic Garden participation in authorship. (It was to be in the late 1980s before the resuscitation process for the taxonomic and floristic research functions in the Garden began gathering momentum, leading to renewed botanical activity so evident since the 1990s.)

In her 1948 Pupil's Report Book at the Convent School, Penang, where Kiaw Lan first came to study from Sumatra, she was said to have "faulty accents" and it was recommended she paid more attention to reading and pronunciation. From this uncertain start, she made great progress in mastering English until, later, even members of the English Department at the University of Malaya admired her command of the language (Zaibun Siraj, *pers. comm.*). She was outgoing and found all manner of expression interesting. In *A Private Landscape*, a 1967 anthology of contemporary Malaysian poetry by David Ormerod, who taught in the English Department at the University of Malaya, Kiaw Lan contributed a poem called "The woman who cried Adohi", a tongue-in-cheek poke at male perception, under the pen-name Muh Lan. Kiaw Lan spoke English, Dutch, French, Chinese (Mandarin and the Hokkien and Hakka dialects), Indonesian Malay and some German. If there was a single area that was Kiaw Lan's forte, it would have been language, and this was much recognized as she became involved with the editing of the *Gardens' Bulletin, Singapore*, the Botanic Gardens' official journal.

Ranu Dally, one of her best friends from early youth, recalls that they appreciated the Malay/Indonesian cultures by virtue of their background (Ranu from Kelantan, Kiaw Lan from Sumatra). Kiaw Lan was much fascinated by things Indonesian and was always captivated by interesting hand-made textiles, including especially cloths with bold patterns (called *ikat*), which she collected, and other objects of art from the region. In this and in Dutch-Indonesian adaptations and habits, she found much common ground with another special friend, Singapore philanthropist Ted di Ponti. She had also learnt pottery under John Shelly in Devon in August 1963, close-up photography with the Nature Society in 1978, and newspaper design and layout in a course run by the School of Journalism of the Times Press Foundation in

December 1984.

Kiaw Lan took charge of the Herbarium, a vast specimen archive of the botanical wealth of the Malaysian-Indonesian region, and the Gardens' botanical library for a long time, when development opportunities for these were scarce. She was a prolific correspondent and prompt in addressing requests from visitors to the Gardens and Herbarium. She was kept busy with the *Gardens' Bulletin*, and was careful, judicious and accurate in her editorial work and correspondence, which became one of its hallmarks. Later, looking back, she was especially proud of several works relating to a former supervisor she admired greatly. Together with David Mabberley, Kiaw Lan had also edited the Corner Festschrift (*Tropical Botany, Essays presented to EJH Corner for his Seventieth Birthday*, Gardens' Bulletin Vol. 29), published in 1977. She helped bring out Corner's *The Freshwater Swamp-forest of South Johore and Singapore*, which was issued as the Bulletin's Supplement No. 1 (1978). She also assisted in the preparation of other works, such as the much applauded Proceedings of the 11th World Orchid Conference held in Singapore (published in 1985). After 1987, the *Bulletin* came under the editorship of Geh Siew Yin, with whom Kiaw Lan had worked for some years prior to retirement. Geh also assumed Keepership of the Singapore Herbarium from 1987, amid other duties.

Outside the Gardens, Kiaw Lan was treasurer or committee member of the Singapore Branch of the Malayan Nature Society from 1970 to 1980, including being Branch Chairman for 1976-77. She served on the committee of the Alliance Francaise de Singapour as member or treasurer between 1971 and 1980, and was one of its registered School Managers. In 1976, she was honoured by the French government as a Knight in the National Order for Academic Excellence. She was also a member of the Amateur Radio Society and the University of Singapore Society. Kiaw Lan was also involved in the Nature Reserves Board as secretary for a number of years.

After she retired at age 60, Kiaw Lan tried various editing assignments, including technical writing and editing with a company that printed user manuals for radio equipment, and editing the odd book and magazine issue outside Botany. She learnt various word-processing software programmes on computer and even word-processed some books for the Braille Production Unit of the Visually Handicapped Society. She took more interest in the apartment complex where she stayed, as a member of its management council, found occasion for treating friends to her cooking, but also went on tours from Singapore. Old botanical acquaintances continued to call on her, and she enjoyed accommodating one or two as they visited the Herbarium for work. She continued to entertain her visitors at the Cricket Club, which she often used as a member.

Several jobs gave her a sense of familiarity. Kiaw Lan was sought for indexing the 3rd edition of Corner's *Wayside Trees of Malaya*, which was published in 1988 by the Malayan Nature Society. For such a classic work, it was unfortunate that the cover picture on Volume 1 was captioned with the wrong name (*Alstonia angustifolia*

instead of *Alstonia angustiloba*) during production. When Kiaw Lan wrote a personal note to explain the mistake, a very magnanimous professor wrote back to one of his favourite former students: “*I never supposed that the mistake. . . was your doing. . . Perhaps the photographer made the mistake. Anyhow it is a battered old tree that has lost its top and not a picture that I would have chosen. However, old trees must not be scorned. . . I have always been proud of the book and Ed. 3 is your gift and more to S.E.Asia.*” Later Corner sent another manuscript, *Moments Botanique*, a biography of botanical tales from the Malay Peninsula to the Solomon Islands and South America, for Kiaw Lan to word-process from handwritten material, as he believed she could interpret his handwriting well enough and she offered good comment and suggestion. Another job was the compilation of the master index accompanying the issue of the final (fourth) volume of the *Tree Flora of Malaya*, published in 1989 by Longman.

It was to be in the 1990s before positions in taxonomic botany became available again in the Singapore Botanic Gardens. It was during this period, after the departure of Burkill and Chew, and when the new effort for the Garden City ironically overshadowed other aspects at the Botanic Gardens, that Chang Kiaw Lan remained steadfast in her role as the Keeper of the Singapore Herbarium and a fixture in the affairs of the Gardens’ Bulletin. Today, both herbarium and journal continue their development, having emerged from the very edge of botanical history.

Kiaw Lan suffered a minor heart attack on 17 February 1987 and was diagnosed with cancer in April 2002, when also a condition of dementia became more obvious, with recurring memory lapses. She was indeed most fortunate to have had a special friend in Christina Tan, who with her husband Christopher Lim accommodated Kiaw Lan into their lives, and later arranged for her consistent care in July 2002. Kiaw Lan was admitted to Hospice care in July 2003, and died on 14 August 2003. Kiaw Lan leaves behind a brother, Paul Gaudiamo (Indonesia), and a sister, Meta de Visser (U.S.A.), nephews, nieces, and their families; her other siblings have passed on. In her will, she left her body to medical research and also wished for a gathering of her friends to be arranged. Many of her family members and friends were present at the Memorial Gathering for her on 19 August 2003 at the Orchard Guild House on Grange Road, Singapore. The venue was chosen by Christina to recall Kiaw Lan’s liking for meeting with friends at the original Guild House of the National University of Singapore Society at Evans Road, not far from the Botanic Gardens.

*Does not, then, the charm of life remain for me long and lasting,
when my burdens are gone, my surroundings are quiet, my body is
free and my heart leisurely?*

] Lin Yutang, "The Importance of Living"

K.M. Wong

University of Malaya,

Kuala Lumpur



