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[Cover photo: Inflorescence of *Curcuma vitellina* (see p. 114); photo by Jana Leong-Škorničková.]

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Studies on Monstereae (Araceae) of Peninsular Malaysia II: *Rhaphidophora latevaginata*, Newly Recorded for West Malaysia

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Abstract

Rhaphidophora latevaginata M.Hotta, a neotenic, shingling, climbing aroid, hitherto considered a Bornean endemic, has recently been found and collected from the southern part of the east coast of Peninsular Malaysia (Johor: Kota Tinggi and Mersing), where so far it appears to be restricted to *kerapah* and the drier (raised podzol) facies of seasonally inundated peatswamp forest. This discovery of *R. latevaginata* takes to 18 the number of *Rhaphidophora* known to occur in Peninsular Malaysia, of which three are endemic. An updated description of *R. latevaginata*, a key to the *Rhaphidophora* species of Peninsular Malaysia, and a plate illustrating the diagnostic characters of those with shingle-stage juveniles is presented. A brief note on the significance of the new record with regard the Riau Pocket is made.

Introduction

Since the publication of an alpha-taxonomy for Peninsular Malaysia (Boyce, 1999), and the Peninsular-relevant taxonomic alterations made for Borneo (Boyce, 2001), further study of *Rhaphidophora* in Peninsular Malaysia has generated additional data that sheds light on possible biogeographical patterns not earlier apparent. Most recently the discovery in Perak of *R. megasperma* Engl. (Baharuddin & Boyce, in press), previously regarded as a Bornean endemic and furthermore belonging to a species group until now considered to be restricted to E Sunda, Papuasia, and the tropical Western Pacific, and now the discovery of *R. latevaginata* in Johor, is providing compelling non-woody plant support to the Riau Pocket phytochore (Corner, 1960; Ashton, 2005). All terminology used here follows Boyce (1999).

Key to *Rhaphidophora* in Peninsular Malaysia (adult plants)

1. Leaf lamina variously pinnately divided and/or perforated 2
1. Leaf lamina entire.....9

2. Leaf lamina abaxially pubescent, especially the mid-rib and primary lateral veins.....3
2. Leaf lamina abaxially glabrous.....4

3. Plants flowering on adherent stems; mature leaves with numerous perforations along both sides of the mid-rib .....***R. foraminifera***
3. Plants flowering on free stems; mature leaves with one to three perforations on one side of the mid-rib.....***R. puberula***

4. Rheophytes; leaves of flowering plants occasionally entire.....***R. beccarii***
4. Medium to high-climbing lianes; leaves of flowering plants never entire.....5

5. Active shoot apices with sparse to copious netted fibre; feeding roots conspicuously ramentose-scaly; lamina of mature plants pinnatisect, the pinnae often perforated basally and appearing stilted. Juvenile plants with leaves overlapping in the manner of roof shingles (shingle climbers).....***R. korthalsii***
5. Active shoot apices glabrous; feeding roots smooth or slightly corky-lenticillate; lamina of mature plants variously split and perforated but never with the pinnae perforated basally and appearing stilted. Juvenile plants not shingle climbers)...6

6. Leaf lamina at least partially pinnate.....6
6. Leaf lamina not pinnate, either entire or with a few, large ovate to rhomboid or trapezoid perforations, these sometimes extending almost to the margin.....8

7. Leaf lamina up to 53 × 105 cm; sparsely to rarely ± entirely pinnatipartite,or pinnatisect; petiole 40-70 cm long, petiolar sheath extending ½ - ¾ along petiole; spadix up to 14 × 2 cm, stoutly cylindrical, inserted decurrently from 2 cm on peduncle; plants exclusively of montane forest.....***R. nicolsonii***
7. Leaf lamina up to 42 × 38 cm but usually much smaller, sparsely to ± entirely deeply pinnatipartite to nearly pinnatisect, occasionally with large rhombic perforations adjacent to mid-rib; petiole 10-34cm long, petiolar sheath extending to base of apical pulvinus, inflorescences a few together, spadix up to 3.5 × 1 cm, cylindrical, inserted slightly decurrently on peduncle; plants of lowland forest.....***R. tetrasperma***

8. Inflorescence two (sometimes more?) together, each subtended by a prominent, soon falling, cataphyll, and arising from an elongated reiterative floral sympodium at the tip of a plagiotropic free lateral shoot; spathe caducous; stigma impressed irregularly elliptic, longitudinally orientated.....***R. corneri***
8. Inflorescence three or more together, each subtended by a prominent persistent, later marcescent cataphyll, and arising from an much abbreviated reiterative floral sympodium arising laterally on a climbing shoots; spathe marcescent; stigma raised, punctiform.....***R. megasperma***

9. Leaves always shingling, even in flowering individuals; leaf laminas stiffly coriaceous, broadly oblong-ovate-elliptic, 848 × 6.5-20.5 cm, bright green, slightly to markedly glaucous, base truncate-cordate to broadly cuneate. Flowering on clinging shoots ..... ***R. latevaginata***
9. Leaves spreading in adult and flowering individuals; leaf laminas variously coloured but never glaucous. Flowering on free or clinging shoots..... 10

10. Abaxial surface of lamina and apical pulvinus pubescent..... ***R. puberula***
10. Lamina and apical pulvinus not as above..... 11

11. Flowering shoots consisting of scattered fans of large litter-trapping leaves carried on short stout shoots and held at about 90" to the ± leafless main stem..... ..... ***R. angustata***
11. Flowering shoots not as above..... 12

12. Plant climbing; feeding roots smooth, or minutely asperate..... 13
12. Plant rheophytic; feeding roots conspicuously ramentaceous..... ***R. beccarii***

13. Stems sub-terete to weakly 4-angled, scabrid to asperous, older portions with thin, brittle pale brown epidermis; spathe exterior minutely puberulent..... ***R. lobbii***
13. Stems conspicuously 4-angled, smooth, older portions remaining green; spathe exterior glabrous..... 14

14. Apices of active stems with netted prophyll, cataphyll and petiolar sheath remains ..... ***R. maingayi***
14. Apices of active stems naked..... 15

15. Spadix at anthesis 9-20 cm long, tapering apically..... 16
15. Spadix at anthesis 3.5-6 cm long, cylindrical to weakly clavate..... 17

16. Spadix 9-11 cm long; sandstone & granite..... ***R. montana***
16. Spadix 15-20 cm long; limestone obligate..... ***R. burkilliana***

17. Spadix cylindrical..... 18
17. Spadix weakly clavate..... ***R. sylvestris***

18. Leaf lamina thickly coriaceous to almost fleshy, falcate-elliptic- lanceolate to falcate- oblong or falcate-oblanceolate, 4.5-25.5 × 1.5-5 cm; margins slightly reflexed, this becoming greatly accentuated in dried material..... ***R. crassifolia***
18. Leaf lamina thinly coriaceous, narrowly falcate-elliptic to falcate-lanceolate or falcate-oblanceolate, 2.5-16 × 1.2-3 cm, margins flat, leaf drying pale straw-coloured..... ***R. minor***

Plate 1. A-B. *Rhaphidophora latevaginata* M.Hotta. A. Leaf (abaxial view) showing the strongly unequal wings of the long-persistent petiolar sheath. Note that the sheath is mainly adnate to the moderately short petiole, with only a short free-auriculate portion. B. Juvenile plant. C-D. *Rhaphidophora kothalsii* Schott. C. Leaf (abaxial view) showing the equally winds to the swiftly-marcescent petiolar sheath. Note that the sheath is mostly free from the very short petiole, with the greater part forming a long, narrowly triangular, free-ligulate portion. D. Feeding root showing the diagnostic rammenta. Images © P.C.Boyce

Rhaphidophora latevaginata M. Hotta, Acta Phytotax. Geobot. 22: 44 (1966); Boyce, Gardens' Bulletin Singapore 53: 51-54, Fig. 10 (2001). –**Type**: Malaysia, Sarawak, Bintulu ('4th Division'), Bintulu District, about 4 km east from Minah Camp, Sg. Kakus, 4 Oct 1963, *Hirano & Hotta 140* (KYO, holo!). **Plate 1A & B.**

Moderate to very large, robust, pachycaul, homeophyllous neotenic **liane** to 12 m; seedling stage a non-skototropic shingling juvenile shoot; pre-adult plants forming small terrestrial colonies of shingling closely appressed leaves; adult shoot architecture comprised of clinging, physiognomically unbranched, shingling to very densely leafy, sterile stems and almost identical fertile stems. **Stems** weakly compressed-terete to weakly rectangular in cross-section, smooth, pale green, without prophyll and cataphyll fibre, internodes to 12 × 2 cm, separated by prominent straight scars, but scars obscured by leaf bases on all but the oldest stems, lower parts of stem later sub-woody with slightly shiny cracking thin pale brown epidermis; flagellate foraging stems moderately well developed although often somewhat short and leafy; clasping **roots** arising densely from the nodes and internodes, prominently scaly; feeding roots *ca* 3 mm diam., brown, minutely pubescent. **Leaves** distichous, appressed, ascending and shingling, becoming slightly scattered and spreading (often litter-trapping) towards fertile tips; cataphylls and prophylls membranous, soon drying black and persisting briefly before falling; petiole deeply canaliculate and winged, 3-22 × 0.5-2 cm, smooth, apical and basal pulvinus obscure in young leaves, later becoming prominent, especially the basal pulvinus; petiolar sheath very pronounced, up to 2.5 cm wide, rather thickly membranous, adnate to the petiole for much of their length, prominently rounded short-auriculate, especially the larger (outer) sheath, outer sheath (away from climbing surface) greatly expanded and partly to completely obscuring stem, both sheaths persisting some considerable time, much later (and then almost exclusively on adult plants) rotting to produce two large scars extending to the top of the petiole; lamina broadly oblong-ovate-elliptic, 8-48 × 6.5-20.5 cm stiffly coriaceous, bright green, slightly to markedly glaucous, base truncate-cordate to broadly cuneate, very briefly decurrent, apex rounded to acute with a tiny apicule; midrib prominently raised abaxially, slightly sunken adaxially; primary venation pinnate, slightly raised abaxially, more so adaxially; interprimaries sub-parallel to primaries, slightly raised on both leaf surfaces; secondary venation tessellate-reticulate, slightly raised abaxially, ± flush adaxially, all veins much more prominent in dried material. **Inflorescence** solitary on a clinging shoot, subtended by a fully developed foliage leaf and one or more cataphylls; peduncle laterally compressed-cylindrical, 6.5-11 × 0.5-0.7 cm; **spathe** not observed; **spadix** stoutly cigar-shaped, sessile, inserted + level on stipe, 17.5 × 1.5 cm, pale

green; stylar region rhombohexagonal, *ca* 2 × 1 mm, truncate; stigma slightly raised, elongated, longitudinally orientated, *ca* 0.75 × 0.2 mm; *anthers* not exserted at male anthesis; *infructescence* stoutly cigar-shaped, 15 × 2 cm, stylar region becoming convex at fruit maturity.

Specimens seen: MALAYSIA. **Johor Bahru**, Mersing, Kluang - Mersin Road, km 39, 02° 15' 78.2"; 103° 43' 79.2" 56, 18 Apr 2010, *P.C.Boyce, Siti Nurfazila Abdul Rahman & Ooi Im Hin AR- 3039* (KEP); Johor Bahru, Kota Tinggi, Hutan Simpan Panti, 01° 51' 65.6"; 103° 54' 10.7" 28, 19 Apr 2010, *P.C.Boyce, Siti Nurfazila Abdul Rahman & Ooi Im Hin AR- 3046* (KEP). For Borneo specimens see Boyce (2001).

Distribution: West Malaysia (Johor), Borneo (widespread throughout the N and W, but much under-sampled).

Habitat: Primary to secondary moist lowland to hill dipterocarp forest on clay and sandstone, in West Malaysia in *kerapah* and the drier (raised podzol) facies of seasonally inundated peat swamp forest; 20-840 m altitude.

Notes: The juvenile and pre-adult stages of *Rhaphidophora latevaginata* and *R. korthalsii* Schott are superficially similar and to non-specialist difficult to differentiate. The most readily observable characters concern the petiolar sheath, which in *R. latevaginata* is long-persistent (*vs* very swiftly marcescent), mostly adnate (*vs* mostly free) with the wings strongly unequal (*vs* weakly or not at all unequal), and shortly free-auriculate (*vs* long, narrowly triangular free-ligulate). Additionally, the petiole of *R. latevaginata* proportionately longer (petiole:lamina ca. 1:5 vs ca. 1:12). See Plate 1A & B.

Pre-adult climbing stages of *R. latevaginata* and *R. korthalsii* are also similar but aside from the petiolar sheath characters noted above are readily distinguished by the feeding roots which are minutely pubescent in *R. latevaginata* and conspicuously ramentaceous in *R. korthalsii*. See Plate 1C & D.

While abundant juvenile plants were located, often intermixed with those of *Rhaphidophora korthalsii*, but only a single pre-adult, and no adult, plants were located during the 4-days fieldwork; by contrast, pre-adult and adult plants of *R. korthalsii* were frequent. Nonetheless we have no doubt that the Bornean and West Malaysian plants are one and the same species. Adult and fertile details given above are furnished from Bornean collections.

Phytogeographical Implications

The discovery of another hitherto Bornean endemic in Peninsular Malaysia, following from the recent finding of *Rhaphidophora megasperma* in Perak (Baharuddin & Boyce, in press), gives further weight to the existence of a 'Riau Pocket' phytochore (Corner, 1960; Ashton, 2005).

Of particular interest is the growing evidence that the Riau Pocket phytochore involves plants other than trees, on which distribution and relationships the Riau Pocket was originally postulated. Of yet further interest is that while *R. latevaginata* occurs in the E coast of Riau Pocket phytochore fragment, *R. megasperma* is so far known only from the Perak phytochore fragment.

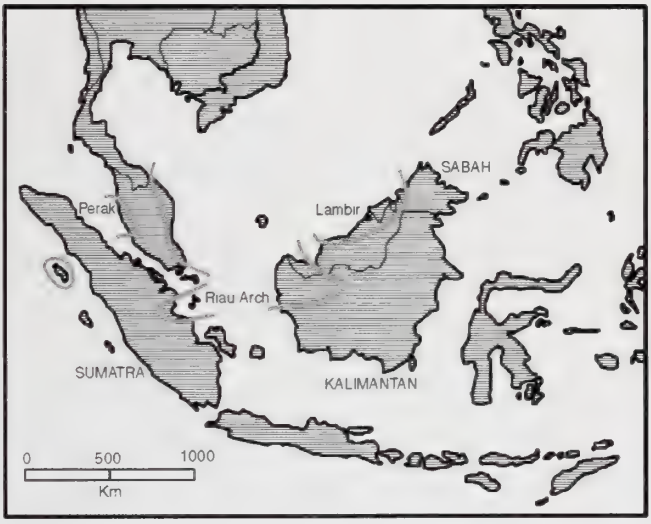

Figure 1. The Riau Pocket phytochore of West Malesia (areas enclosed within heavy lines on northwestern Borneo, Peninsular Malaysia, and Central Sumatra). From: P.S. Ashton. 2005. Lambir's Forest: The World's Most Diverse Known Tree Assemblage? p. 199, Fig. 17.6. Used with permission.

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Studies on Monstereae (Araceae) of Peninsular Malaysia III: *Scindapsus lucens*, a New Record for Malaysia, and a Key to Peninsular Malaysian *Scindapsus*

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Abstract

Scindapsus lucens Bogner & P.C.Boyce is a species of considerable horticultural potential, arguably rivalling the commercially important *S. pictus*, originally described from cultivated material of unknown provenance and only later found wild in Sumatera. It has recently been discovered and collected from several localities in southern Peninsular Malaysia, representing both a new record for Malaysia, and through clonal propagation via various tissue culture techniques would supply a sustainable potential source of a local commercial ornamental horticultural product. An enlarged description of *S. lucens*, and a key to the Peninsular Malaysian *Scindapsus* are offered. A plate illustrating the diagnostic characters of *S. lucens* is given.

Introduction

Scindapsus has not been revised in its entirety since 1908 (Engler & Krause, 1908), and not treated for Malaysia since Ridley's accounts for the flora (Ridley, 1907, 1925), when he recognized 5 species: *Scindapsus beccarii* Engl., *S. hederaceus* Miq., *S. perakensis* Hook.f., *S. pictus* Hassk., and *S. scortechinii* Hook.f. Since Ridley, fieldwork has revealed two further species: *S. treubii* Engl., a widespread species from Sumatera to Borneo, and *S. lucens* reported here.

Scindapsus lucens Bogner & P.C.Boyce (1994) was described based on material of unknown origin cultivated in the Botanischer Garten München, Germany, with a note added late in proof that it had subsequently been located in Kabupaten Tapanuli, western Sumatera Utara. Since publication,

consultation of all the major herbaria in Peninsular Malaysia, and other herbaria with significant Malaysian and Indonesian collections (K, L, SING) has not revealed a single collection of this distinctive and horticulturally promising species. It was thus with some considerable surprise that during a recent series of fieldwork in Peninsular Malaysia *S. lucens* proved to be a widespread species in Johor Bahru, Melaka, Negeri Sembilan, and Pahang. Plants seemingly favour the drier facies of perhumid podzolic shady lowland peatforest, although on occasions occurring with no less vigour in lowland mixed dipterocarp forest.

These new collections have revealed additional morphological details that were unavailable at the time of original publication, and have also shown that the leaf colour is more variable than was initially reported, with the leaf blade ranging from pale grey (as per the typical collection) to an unusual (for Araceae) shade of jade green.

Key to Peninsular Malaysian *Scindapsus*

1. Short-climbing to perching epiphyte or scandentsemi-terrestrial.....2
1. Lianes.....3

2. Stout, short-climbing to perching epiphyte; leaves large, up to 75 × 25 cm, carried in litter-trapping fan, glossy deep-green, oblanceolate. Spathe white. Lowlands.....***S. beccarii***
2. Scandent semi-terrestrial, leaves small, up to 15 × 9 cm, scattered along a sprawling stem, medium green, slightly glossy, ovate. Spathe yellow. Highlands.....***S. scortechinii***

3. Leaf blade oblong lanceolate, primary lateral veins impressed adaxially and raised abaxially; petiole broadly conspicuously open-winged to the pulvinus.....4
3. Leaf blade mostly cordiforme, if oblong-lanceolate then primary lateral veins irtually invisible; petiole not or only very obscurely winged to the pulvinus.....5

4. Spadix at anthesis *ca* 3.5 cm long.....***S. hederaceus***
4. Spadix at anthesis 10-15cm long.....***S. perakensis***

5. Stems smooth; leaf blade sub-succulent, markedly oblique, oblongo-lanceolate, concolorous deep green, less often with jagged grey markings in juvenile plants .....***S. treubii***
5. Stems scabrid or verruculose; leaf blade coriaceous but not markedly succulent, not markedly oblique, cordiforme.....6

6. Leaf blade conspicuously bullate, glossy pale grey to pale jade green; stems verruculose, older portions remaining green.....***S. lucens***
6. Leaf blade smooth, adaxially matte to somewhat scintillating, medium green, usually with silvery jagged spots or with these coalescing into larger areas; stems at most scabrid, older portions with conspicuous orange-brown, brittle epidermis.....***S. pictus***

Scindapsus lucens Bogner & P.C.Boyce, Kew Bull. 49: 789 (1994). – **Type**: Origin unknown, cultivated in Botanischer Garten München, *Bogner 2113* (holo,M!; iso,B!, K! (spirit)). **Plate 1.**

Slender, sparsely branched trunk climber to *ca* 4 m; **primary axis** sterile, physiognomically monopodial, comprising superposed sympodia; lateral branches fertile, rather few and short in wild plants, producing sub-terminal continuation shoots after flowering. **Stem** up to 4 mm diam., terete, epidermis markedly verruculate, glossy medium-green, verrucate similarly coloured, internodes of primary axis 3-8 cm long with one or two roots at each node; **roots** 1-2 mm diam., with grey, spongy epidermis. **Leaves** of primary axis rather distant, very regularly arranged, appressed to the substrate, those of lateral branches, somewhat densely grouped, petiole terete, adaxial surface slightly canaliculate; 3-5.5 cm × 2-3 mm, smooth, greyish to light green; pulvinate apically, pulvinus 1-1.5 cm, usually visible only on older leaves when the blade has moved its position relative to light; petiolar sheath 2-5 cm, almost reaching pulvinus; leaf blade 7-14 × 5-9.5 cm, cordiforme, conspicuously bullate, coriaceous, base cordate, posterior lobes sometimes overlapping, apex cuspidate to acuminate, margin entire, narrowly hyaline, lamina adaxially glossy greyish to jade green with the raised parts of bullae often paler, or in green forms tinged grey, paler and glossy abaxially; primary lateral veins 5-7 on each side of the middle vein, ascending towards apex; interprimary veins barely less prominent; secondary and tertiary venation reticulate, much less conspicuous. **Inflorescence** solitary on the tips of lateral branches: peduncle 5 cm × 4 mm diam., terete, green; subtending cataphyll with very small lamina, *ca* 1-2 cm × 5 mm, otherwise resembling petiole; spathe caducous during male anthesis, 5 × 15 cm, coriaceous, cuspidate, exceeding spadix, somewhat constricted above spadix apex and thence rostrate, very pale yellow, apical rostrum *ca* 7 mm long, pale green prior to anthesis, all except the very tip becoming same colour as spathe during anthesis; **spadix** *ca* 2.7 × 1 cm diam., oblong-ellipsoid, fusiform, pale yellow, shortly stipitate, stipe *ca* 2 mm long. **Flowers** bisexual, naked, truncate; gynoecium rhombohexagonal in plan view, 3.5-4.2 × *ca* 2 mm; stylar region broader than ovary, *ca* 1 mm thick, pale yellow; stigma longitudinal-linear, 1- 1.8 mm long, brown; ovary *ca* 3 mm diam., unilocular, locule globular,

ca 1.2 mm diam.; ovule solitary, *ca* 1 mm long, funicle short, placentation basal; stamens shorter than gynoecium, not extending markedly at pistillate anthesis; filaments flat, *ca* 1 × 1-1.2 mm; thecae ellipsoid, *ca* 0.8 × 0.5 mm, opening by a subapical slit. **Infructescence** unknown.

Specimens seen: MALAYSIA, **Johor Bahru**: Mersing, Kluang – Mersing road, km 39, Lenggor F.R., 02° 15.727', 103° 43.767', 18 April 2010, *P.C.Boyce, Siti Nurfazilah bt Abdul Rahman & Ooi Im Hin AR-3056* (KEP); Kota Tinggi, Panti F.R., 01° 52.226', 103° 54.755', 19 April 2010, *P.C.Boyce, Siti Nurfazilah bt Abdul Rahman & Ooi Im Hin AR-3057* (KEP); Kota Tinggi, Hutan Lipur Panti; 01° 48.077', 103° 57.202', 19 April 201, *P.C.Boyce, Siti Nurfazilah bt Abdul Rahman & Ooi Im Hin AR-3060* (KEP). **Melaka**: Machap, Hutan Simpan Bukit Sedana, 02° 24' 00.6"; 102° 20' 91.7", 11 May 2010, *P.C.Boyce & Ng Kiaw Kiaw AR-3059* (KEP); **Negeri Sembilan**: Pasoh Forest Reserve, 3° 0' 0; 102° 19' 60, 13 May 2010, *P.C.Boyce & Ng Kiaw Kiaw AR-3058*(KEP); **Pahang**: Kuala Rompin, Taman Negeri Endau Rompin, Waterfall trail, 02° 37' 08.9"; 103°20' 81.3", 12 May 2010, *P.C.Boyce & Ng Kiaw Kiaw AR-3063* (KEP); Jerantut, Krau Wildlife Centre, main trail to river, 03° 49' 39.2"; 102°13' 03.1", 13 May 2010 *P.C.Boyce & Ng Kiaw Kiaw AR-3054* (KEP).

Distribution: Malaysia (Johor Bahru, Melaka, Negeri Sembilan & Pahang). Indonesia, (western Sumatera Utara).

Habitat: Drier facies of perhumid lowland shady peatforest; less often in lowland mixed dipterocarp forest (e.g., at Pasoh F.R., Krau W.R.). 20-125 masl.

Notes: *Scindpasus lucens* appears to be a widespread species in southern Peninsular Malaysia, with occurrences so far recorded in four states. Curiously, given the complete absence of herbarium specimens, it appears to be more abundant than *S. pictus*, despite the abundance of material of the latter species in herbaria.

Potential of *Scindapsus lucens as* a sustainably-produced ornamental horticulture subject

Scindapsus lucens is a widespread species in the southern Peninsular, and although never abundant appears to be more prevalent than *S. pictus* Hassk., the species to which *S. lucens* is most similar. The very attractive

Plate 1. *Scindapsus lucens* Bogner & P.C.Boyce. A. Juvenile primary axis. Note the glossy quality of the leaf blade (*P.C.Boyce & Ng Kiaw Kiaw AR-3054*). B. Juvenile plant, jade-green type.(*P.C.Boyce & Ng Kiaw Kiaw AR-3063*). C. Type clone in cultivation, Jardin Botanique du Montet, Nancy, France (*Bogner 2311*). D. Detail of stem showing the diagnostic verrucate surface (*P.C.Boyce & Ng Kiaw Kiaw AR-3054*). Images A & B, D © P.C.Boyce; Image C © David Scherberich, used with permission.

Plate 2. A. *Scindapsus treubii* Engl. Note the subsucculent, strongly oblique leaf blade, and smooth stem. B-E. *Scindapsus pictus* Hassk. B. Primary axis showing the diagnostic and older portions with conspicuous orange, brittle scabrid epidermis. C-E. A selection of leaf markings typical of *S. pictus*. Notes the somewhat scintillating quality particulary in C & E. Images © P.C.Boyce.

leaves and, for a lianescent aroid, small habit make *S. lucens* an ideal subject for consideration as a commercial ornamental product with via various in vitro culture technology. The ease with which *S. pictus* is globally produced in tens of millions for the ornamental horticulture market augers well that *S. lucens* should also prove similarly amenable. In many respects *S. lucens* is a far more attractive plant than *S. pictus*, not in the least because it has a much more compact habit, and is not a heteroblastic species and thus the attractive juvenile stage is retained into adult-hood, unlike that situation with *S. pictus*, which requires regular pruning to retain the commercially desirable leaf form of the juvenile. Since *S. lucens* has a high potential as an attractive ornamental plant, it may be over-collected by irresponsible individuals to fulfil the public demand for new ornamental plant in the market. This may lead to the eventual extinction of this plant. To conserve the germplasm and prevent over-collection from its natural habitat, *S. lucens* can be mass propagated via induction of multiple shoots formation using shoot culture technique or the production of somatic embryogenesis using the leaf as explants. Millions of plantlets can then be produced to fulfil the market demand.

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Begonia droopiae Ardi (Begoniaceae), a New Species of *Begonia* from West Sumatra

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Abstract

A new species of *Begonia* (Begoniaceae), *B. droopiae* Ardi, is described from the Indonesian island of Sumatra. It belongs to *Begonia* sect. *Reichenheimia* and is a limestone endemic in the Sawah Lunto District. Its IUCN threatened category is considered to be 'Vulnerable'.

Introduction

During an expedition to West Sumatra in August 2009 organised by The Royal Botanic Garden Edinburgh, Kebun Raya Bogor and Andalas University Herbarium (ANDA), a new species of *Begonia*, *B. droopiae* Ardi, was collected from a limestone cave in the Batang Pangean I Nature Reserve, Sawah Lunto District, West Sumatra Province. *Begonia droopiae* is placed in *Begonia* sect. *Reichenheimia* because it exhibits the typical characters of the section: rhizomatous habit, protandrous inflorescences and three locular fruit with entire placentae.

This species-rich genus was previously represented by 52 species in Sumatra (Hughes, 2008; Hughes *et al.* 2009), although it is obvious from herbarium collections that many more remain to be described from the island. *Begonia* sect. *Reichenheimia* is the second-most species rich section of the genus in Sumatra, with 11 species. All available herbarium specimens in ANDA, BO, E and SING have been consulted, and hence it must be assumed, at least until more intensive collecting in West Sumatra may reveal otherwise, that this species has a very restricted range (Fig.1).

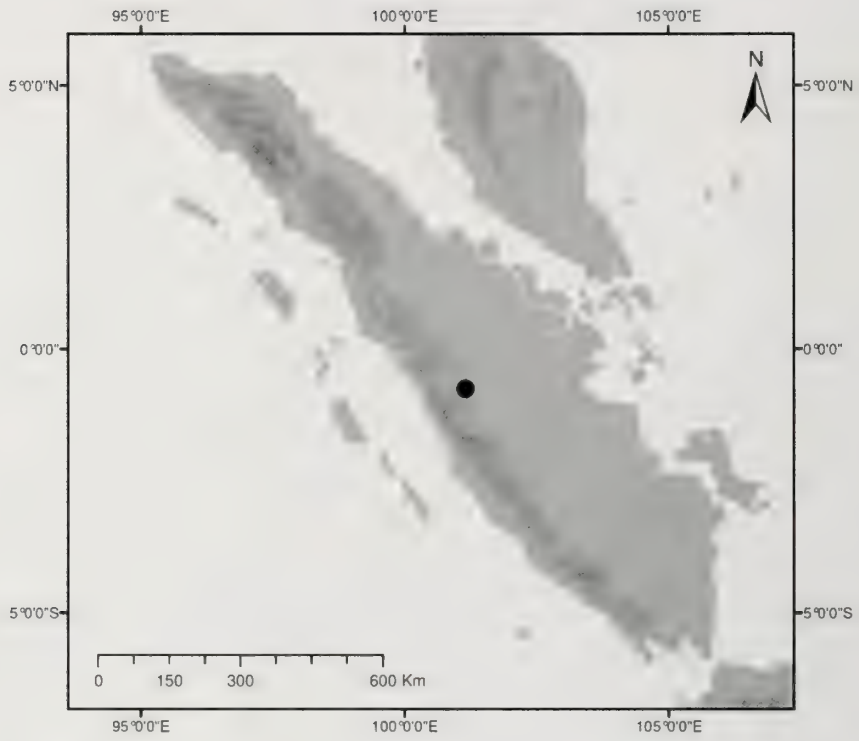

Figure 1. Distribution of *Begonia droopiae*.

Begonia droopiae Ardi, *sp. nov.* (Sect. *Reichenhemia*)
Haec species Begoniae nurii *similis est sed foliis magis asymmetricis, floribus femineis tepalis* 3 (*nec* 2) *provisis et stipulis secus costam pilosis recedit.* –**Typus**: Indonesia, Sumatra, West Sumatra (Sumatra Barat), Batang Pangean Nature Reserve, Sawah Lunto District, Nagari Solok Ambah, Perkaulan cave, 00° 43' 21.7" S, 101° 09' 01.0" E, 484 m, 21viii2009, *A. J. Droop, W. H. Ardi, Nurainas & Riki AJD173* (holo, BO; iso, E, BO, ANDA). **Plate 1.**

Perennial, creeping, monoecious **herb**, to *ca* 10 cm tall, rooting at the nodes, hairy with up to *ca* 2 mm long, multicellular hairs. **Stems** rhizomatous, internodes very short, up to *ca* 2 mm long, with scattered multicellular hairs; stipules 3-6 × 3-5 mm, triangular, with an abaxially prominent midrib forming an up to *ca* 4 mm long, thin, hairy appendage at the apex, abaxially densely hairy along the midvein, persistent. **Leaves** alternate; petioles 5-19.5 cm long, sparsely to densely hairy; lamina basifixed, 3.5-9.5 × 2-6.8 cm, very asymmetric, ovate to elliptic, base cordate, lobes sometime slightly overlapping, apex acuminate, margin broadly crenate and fringed with hairs, adaxial surface glabrous, purplish-green to dark purple between the

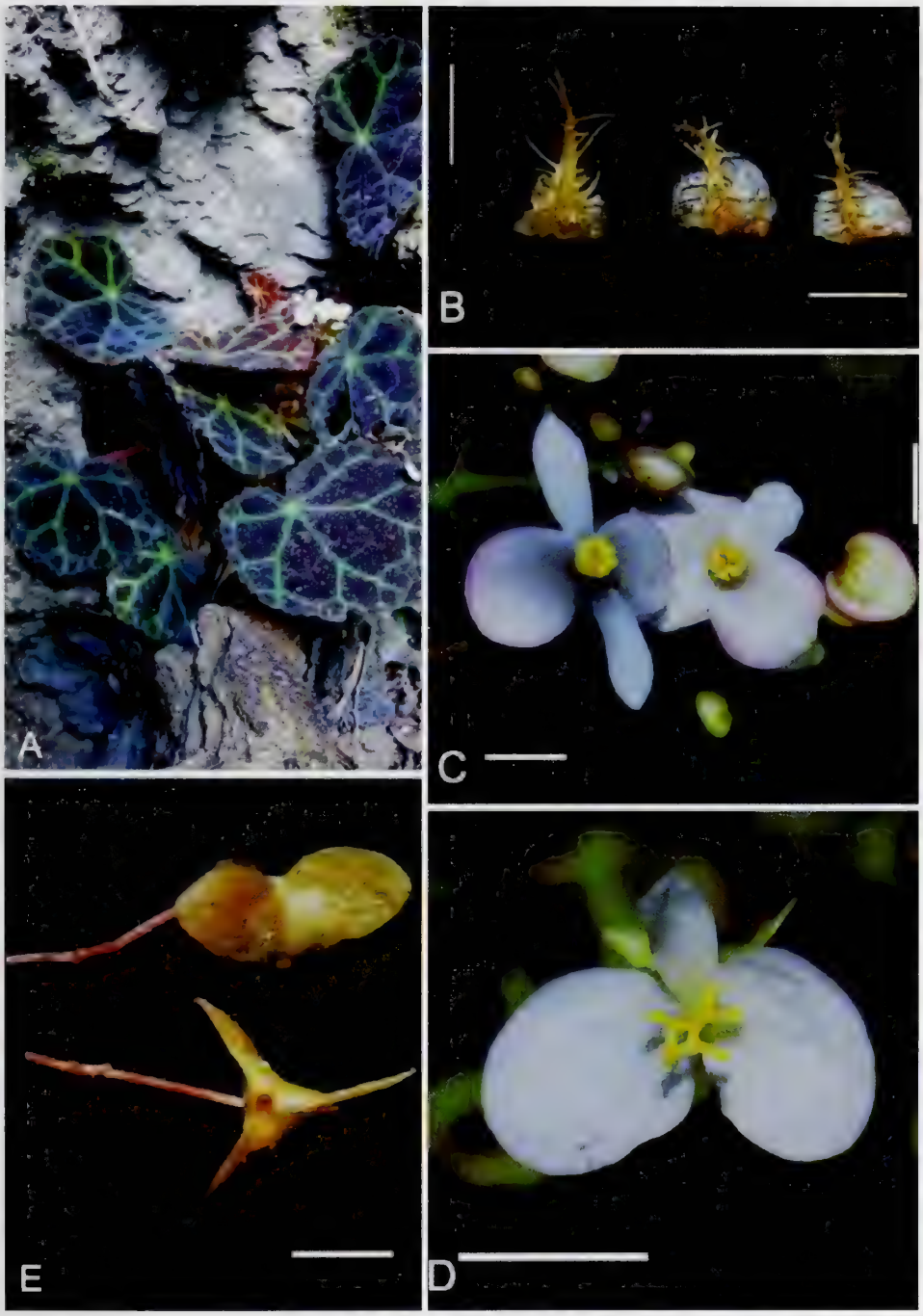

Plate 1. *Begonia droopiae* Ardi. A. Habit; B. Stipules (scale bar = 5 mm); C. Male flowers (scale bar = 5 mm); D. Female flower (scale bar = 5 mm); E. Fruits (scale bar = 5 mm). A-E based on A. J. Droop, W. H. Ardi, Nurainas & Riki AJD173.

veins, slightly raised, veins green, abaxial surface pale green to dark purple between the veins, hairy on the veins, venation palmate. **Inflorescences** cymose, axillary, protandrous, bisexual; peduncles 5-11 cm long, reddish, glabrescent to sparsely hairy; *bracts* sub orbicular, *ca* 1.5-2.5 × 1-2 mm, margin fimbriate, deciduous. **Male flowers,** pedicels 8-20 mm, moderately hairy; tepals 4, two outer tepals, white or white with a tinge of pink, 11-17 × 6-7 mm, elliptic to sub orbicular, base slightly cordate, apex rounded, abaxially moderately red hairy; two inner tepals white, 7-9.5 × 3-3.5 mm, oblong-obovate, glabrous; androecium of *ca* 40 stamens, yellow, filaments *ca* 1 mm long, fused at the base, anthers *ca* 1-1.5 mm long, obovate, dehiscing through unilaterally positioned slits *ca* 1/2 as long as the anther, connective not projecting. **Female flowers**, pedicels 6-9 mm, glabrous; tepals 3, unequal, two outer tepals orbicular to sub orbicular, 5.5-6 × 4.5-6 mm, one inner tepal, obovate, 5-6 × 1.4-1.6 mm; ovary 6-7 × 10-13 mm, orbicular, locules 3, placentation axile, placentae entire; wings 3, subequal, triangular, rounded at the and the apex, the widest point at the middle of the ovary, glabrous; style basally fused, 3-branched, each stylodium bifurcate in the stigmatic region, stigmatic surface a spirally twisted papillose band, yellow. **Fruits**, on thin, 6-9 mm long, sparsely hairy pedicels; capsules 8-8.5 × 10-7 mm, (excluding the wing) deflexed, dehiscent, splitting along the wing attachment, drying pale brown, glabrous, wings 4-5 mm wide at the widest point (at the middle of the ovary), wing shape as for ovary; **seeds** unknown.

Distribution: Indonesia, Sumatra, West Sumatra (Sumatra Barat), Batang pangean nature reserve, Sawah Lunto District, Nagari Solok Ambah, Perkaulan cave.

Habitat: This species is growing directly on vertical limestone wall in the front of cave at 484 m altitude.

IUCN Conservation category: We consider this species to belong to the VUD2 IUCN category, as it has a very restricted distribution. Although it resides in a protected area, there is some evidence of small scale agricultural activities encroaching the habitat nearby.

Notes: *Begonia droopiae* is morphologically similar to *Begonia nurii* Irmsch. Both species exhibit a rhizomatous habit, patterned leaves, and have male flowers with 4 tepals. However, *B. droopiae* can easily be distinguished from *B. nurii* by its very asymmetric leaves with an acuminate apex, and stipules which are hairy on the mid-vein (versus slightly asymmetric leaves, with a rounded apex and stipules which are glabrous on the mid-vein in *B. nurii*). The tepal number of the female flowers also differs; *B. droopiae* has

three tepals, whilst *B. nurii* has two. The wing shape of the fruits is a further difference: in *B. droopiae* the wings are rounded at the base and the apex, whilst in *B. nurii* the wings are rounded at the base and cuneate at the apex. *Begonia rajah* Ridl is another allied species from Peninsular Malaysia, similar in its rhizomatous habit, patterned leaves and male flowers with 4 tepals (R. Kiew, pers. comm.), but *B. droopiae* differs in having very oblique leaves (the midrib is clearly at an acute angle) which are soft and not succulent; *B. rajah* has thickly succulent leaves which are more bullate, i.e., raised between the veins. Further, *Begonia rajah* has never been found on limestone; most Peninsular Malaysia *Begonia* species grow either on limestone and not on other rock types or vice versa (Kiew, 2005). A comparison of the two species to *Begonia droopiae* is presented in Table 1. The epithet is after the first collector, Alison Jane Droop.

Table 1. Comparison of *Begonia droopiae*, *B. rajah* and *B. nurii*.

Character	*Begonia droopiae*	*Begonia rajah*	*Begonia nurii*
No. tepals (male flower)	4	4	4
No. tepals (female flower)	3	3	2
Lamina shape	Very asymmetric	Asymmetric	Slightly asymmetric
Lamina texture	Thin	Thickly succulent	Thin
Lamina size	3.5-9.5 × 2-6.8 cm	7-15 × 6-15 cm	2-7 × 3-11 cm
Lamina base	Cordate and slightly overlapping	Cordate and slightly overlapping	Cordate and often overlapping
Lamina apex	Acuminate	Short and acute	Rounded
Surface between the veins	Slightly prominent	Prominently raised	Slightly prominent
Stipules	Hairy on mid vein	Midvein glabrous	Midvein glabrous
Peduncle	5-11 cm long	10-25 cm long	4-19 cm long
Fruit size	8-8.5 × 10-12 mm	6-7 × 5-6 mm	5-9 × 10-16 mm
Wing shape	Rounded at the base and the apex	Rounded at the base, sub truncate at the apex	Rounded at the base, cuneate at the apex

Acknowledgements

We are grateful to the Indonesian Ministry of Research and Technology (RISTEK), the Indonesian Institute of Sciences (LIPI), Direktorat Jenderal Perlindungan Hutan dan Konservasi Alam (DITJEN PHKA) for giving us permission to conduct research in West Sumatra and for their help and assistance. The curators of herbaria ANDA, BO, E and SING are thanked for facilitating access to specimens. The fieldwork was supported by the ASEAN Centre for Biodiversity. Prof. Ruth Kiew is gratefully acknowledged for her constructive comments, and Dr. Robert Mill is thanked for his Latin expertise.

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Newly Recorded *Endiandra* R. Br. (Lauraceae) from Waigeo Island, Raja Ampat, Papua, Indonesia

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Abstract

Endiandra trees are not frequently encountered in the forest in Indonesia. Recent exploration in Waigeo Island resulted in the collection of three species of *Endiandra*. All three species were collected for the first time from Waigeo Island. The three species are restricted in distribution to eastern part of Indonesia (Papua Province) and Papua New Guinea. Key to the species and species description are provided.

Introduction

Waigeo Island is part of the Raja Ampat Islands, an archipelago that is situated at the northern extremity of Indonesia's easternmost Papua province. Waigeo Island is the largest island in the archipelago, 130 km long and 48 km wide and positioned at the northernmost of Raja Ampat Islands. Raja Ampat is very rich in both terrestrial and oceanic biodiversity including plant, coral reefs and fish (Anonymous 2006).

Endiandra is one of the genera in the family Lauraceae, a dominant plant family in tropical forests and occurs from lowland up to montane forests. Main distribution area of Lauraceae species is in the tropical forests of South East Asia and America (Heywood, 1993).

Endiandra was first described by R. Brown (1810) based on the type species, *Endiandra glauca*, from Australia. The genus consists of approximately 100 species distributed from South China, Taiwan, Malesia, and Australia up to Fiji (Rohwer, 1993). In Malesia, New Guinea is the main distribution centre of *Endiandra* with several endemic species. A floristic survey to Waigeo Island was carried out to study the occurrence of *Endiandra* on the island and to make additional collection for the Herbarium Bogoriense.

Materials and Method

Herbarium specimens studied for this research were collected from Waigeo Island. Additional specimens of *Endiandra* available at the Herbarium Bogoriense were also examined. Main localities explored on Waigeo Island are forests in the area of Teluk Mayalibit District and riverine forest along the Werabiyai River.

We collected vegetative, floral and fruiting parts of each plant species and took their pictures. Information, such as locality, plant habit, uses, color and scent of specimens, were noted to help make the species identification easier. Identification was done mainly by consulting references and comparing the recently collected herbarium with the herbarium available at the Herbarium Bogoriense. The descriptions for each species were constructed based on observed morphological characters of the collected specimens.

Results and Notes

The forests at the Waigeo Island are mostly of moist lowland type. The areas of Warsamdim and Werabiyai on the island vary from slightly hilly to steep slope. Easily accessible forests were disturbed, especially by logging activities in the past. However, good vegetation can still be found on hills and slopes.

Endiandra species are less known because they are not easily found in the forests in general, neither in Waigeo forests. The more common genera of Lauraceae in the area are *Actinodaphne*, *Cryptocarya* and *Litsea*, of which young trees are easily spotted inside the forests. However, it is very fortunate that in the recent floristic exploration in Waigeo Island, we encountered three species of *Endiandra*.

Three species of *Endiandra*, i.e., *Endiandra beccariana*, *E. grandifolia* and *E. papuana*, were collected from the island.

Endiandra R. Br. (Lauraceae)

Taxonomically, the genus *Endiandra* is characterized by having alternate, spiral and pinnately-veined leaves, inflorescences paniculate-determinate with ultimate flowers not strictly opposite. Flowers trimerous, bisexual, stamens 3, each with 2 thecae, glands present or absent. In some species glands are united forming a disc surrounding the stamens and pistil. Fruits are without cupule, free on receptacle.

The genus *Endiandra* is known for its wood. *E. palmerstonii* produces high quality wood commonly used for good furniture and for building construction.

Identification key to species of *Endiandra* in Waigeo Island

1. Lamina broadly elliptic, lateral veins 11-15 pairs, glands reniform, not united around stamens ..... 2. ***E. grandifolia***
1. Lamina elliptic, lateral veins 7-10 pairs, glands united forming disc-like appendages.....2

2. Leaf surfaces and panicles sparsely pubescent ..... 1. ***E. beccariana***
2. Leaf surfaces and panicles densely pubescent ..... 3. ***E. papuana***

Species description

1. ***Endiandra beccariana*** Kosterm., Reinwardtia 7: 5 (1969) 474. –**Type**: Morotai Isl., District Tobelo, N. Totodoku, 14 May 1949, *Kostermans & Tangkilisan 146* (A, BO). **Plate 1.**

Tree up to 32 m, 40 cm dbh. Bark greyish brown, lenticellate. Young **twigs** dense erect pubescent, rusty colored. Terminal buds densely pubescent, rusty colored, 8 mm long and 3 mm wide. **Leaves** spiral, stiffly chartaceous, elliptic; 8.5-19 × 6-11 cm; apex acuminate, base cuneate or slightly rounded; both surfaces finely reticulate; upper surfaces shiny, midrib flat, lateral veins slightly impressed; lower surfaces slightly shiny, sparsely pilose or glabrescent, midrib raised; lateral veins 7-10 pairs, prominent below, arcuate towards margin; petiole terete, densely pubescent to glabrescent, flat, 12-23 × 10-20 mm. **Inflorescences** paniculate, axillary, 4-11 cm long, pubescent. Pedicel slender, *ca* 3 mm long. **Flowers** yellow, *ca* 6 mm in diameter; tepals fleshy, spreading, narrowly elliptic, slightly acuminate, 2.5-3 mm long; glands united in a form of a disc, *ca* 0.75 mm thick, brownish yellow; anthers widely triangular, emerge from gland-like disc; locules large; ovary ellipsoid, glabrous; style 0.5 mm long, stigma unconspicous. **Fruit** ellipsoid, *ca* 1-2 cm long, green, free on the receptacle.

Recently collected specimens: INDONESIA. **Papua Province**: Kabupaten Raja Ampat, Waigeo Isl., District Teluk Mayalibit, Desa Warsamdim, 120 m, 8 Jun 2007, *D. Arifiani & Obaja 596* (BO); *ibid.*, ± 50 m, 13 Jun 2007, *D. Arifiani & Obaja 652* (BO).

Additional specimens examined: INDONESIA. **Sorong**, Kadamah, 14 Aug 1948, *Main 592* (BO); Manokwari, Warnapi 15 km N. of Ransiki, 10 m, 25 Sep 1948, *Kostermans 448* (BO); Manokwari, Warnapi, 20 m, 30 Sep 1948, *Kostermans 491* (BO); Morotai Isl., along Sambiki R. (S.E. Morotai), 30 m, 22 May 1949, *Kostermans 854* (BO); Morotai Isl., along Sambiki R., 100 m, 22 May 1949, *Kostermans 890* (BO); Morotai Isl., 23 May 1951, *Kostermans 934* (BO); N. slopes of upper Aifat Valley, between Senopi and Aifatfekaan, W. of Kebar Valley, 10 Dec 1961, *Moll BW 12908* (BO).

Note: *Endiandra beccariana* was first described by Kostermans in 1969 based on specimens from Morotai Island, Manokwari, Sorong, and Ramoi. In our exploration, we spotted the species in two locations on Waigeo Island.

This species is similar to the *E. papuana* Lauterbach, which both can only be differentiated by checking the amount of indument on the lower leaf surface and the inflorescences. Kostermans (1969) noted that the panicles of *E. beccariana* are glabrous and I would not agree with his statement given the fact that the panicles bear sparsely erect indument.

The specimens of *E. beccariana* collected from this floristic survey were a new record of the species occurrence on Waigeo Island. Known previously from Morotai Island and Northwest part of West Papua, its occurrence in Waigeo Island indicates a possible connection by seed dispersal from Morotai Island to Papua and/or vice versa (Fig. 2).

2. ***Endiandra grandifolia*** Teschn., Engl. Bot. Jahrb. 58 (1923) 417. –**Type**: Papua New Guinea, 10 May 1909, *Schlechter 17691* (K).

Tree up to 25 m high, 45 cm dbh. **Twigs** hairy. **Leaves** simple, coriaceous; broadly elliptic; 14-32 × 10-17 cm apex acute to rounded; base obtuse; both surfaces finely reticulate, upper surfaces shiny, midrib slightly raised, lateral veins slightly impressed, with indument; lower surfaces densely tomentose; midrib raised below; lateral veins 11-15 pairs, prominent below, arcuate towards margin; petiole 1.5 cm long, stiff, tomentose. **Inflorescences** paniculate, compact, up to 9 cm long, axillary, densely tomentose, reddish brown, many flowers. Tepals slightly unequal; elliptic; apex obtuse; tomentose. Stamens elliptic, tip rounded, pubescent; glands reniform, stalked, pilose; staminodia cordate, pilose, stalked. Ovary ovoid, glabrous. **Fruit** unknown.

Recently collected specimens: INDONESIA. **Papua Province**: Kabupaten Raja Ampat, Waigeo Isl., District Teluk Mayalibit, Desa Warsamdim, low alt., Jun 2007, *Mirmanto & Ruskandi 09305* (BO).

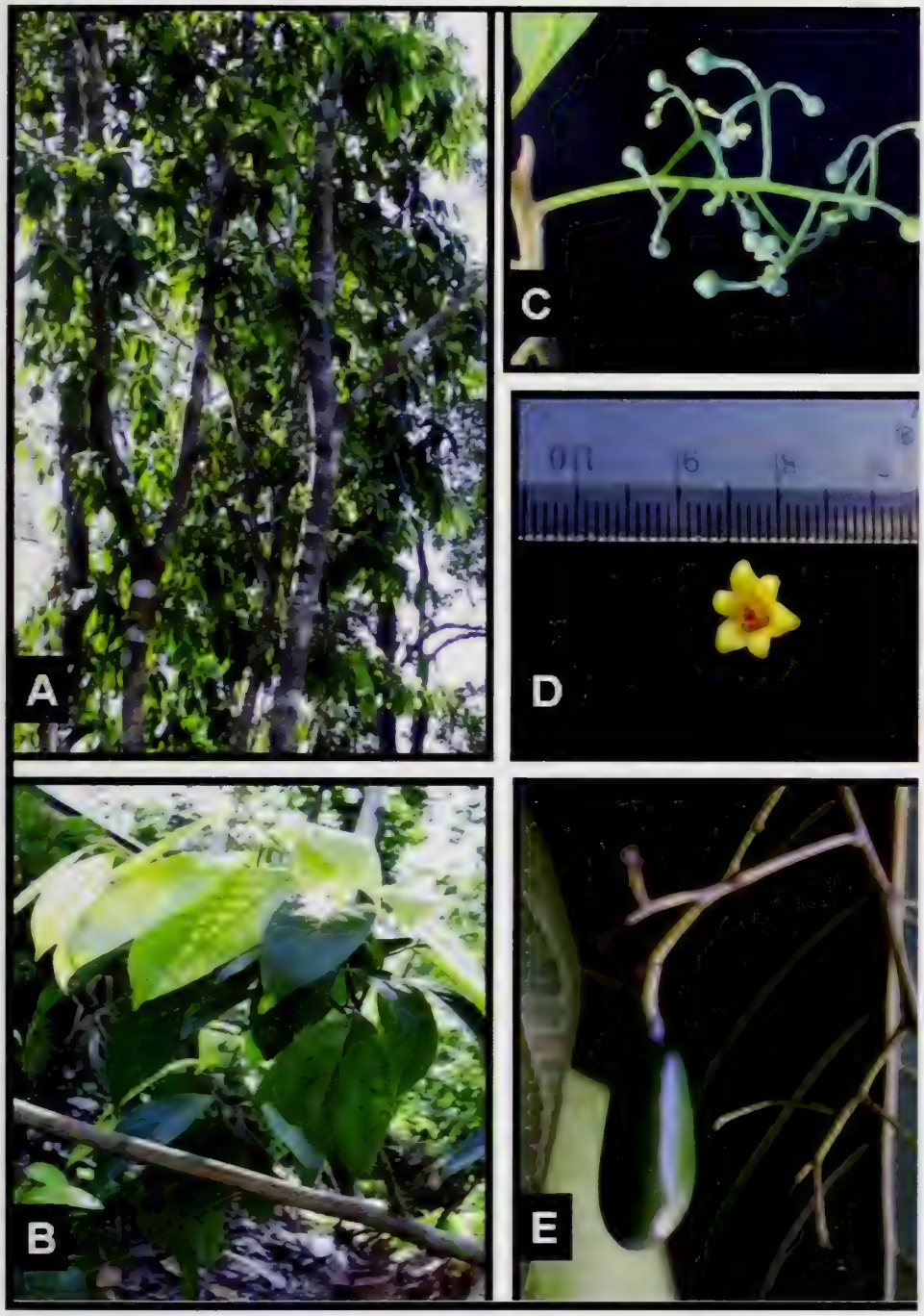

Plate 1. *Endiandra beccariana*: A. Tree habit (D. Arifiani & Obaja 652); B. Leaf arrangement; C. Flower buds; D. Mature flower, glands united forming disc-like appendages with stamens exposed from the middle; E. Young fruit. (Photos C-E: A. Hidayat).

Additional specimens examined: PAPUA NEW GUINEA. Madang District, Terr. of New Guinea, near the Gogol River by Mawan village (*ca* 25 km inland), 60 m, 22 Jun 1955, *Hoogland 4919* (BO); Morobe District, Lae Subdistrict, Oomsis Logging area N.G.I., 180 m, *Millar NGF 12036* (BO); Morobe District, Menyamya Subdistrict, between Aseki & Menyamya, Spreader Divide, 21 Nov 1970, *Streimann & Kairo NGF 42451* (BO).

Note: *E. grandifolia* may be differentiated from both *E. beccariana* and *E. papuana* by observing the shape or fusion of the glands. Some species of *Endiandra*, including *E. grandifolia*, bear three pairs of glands at the bases of each stamen. However, these glands sometimes may unite to each other because of the limited space inside the flower and forming a disc-like appendage surrounding the stamens. This is the case with both *E. beccariana* and *E. papuana*.

This survey yielded the first collection of *Endiandra grandifolia* from western part of New Guinea. Previously, the species was only collected from Madang and Morobe districts of Papua New Guinea. Occurrence of *E. grandifolia* in Waigeo Island extend its distribution toward northwestern part of New Guinea (Fig. 2).

3. ***Endiandra* papuana** Lauterbach, Nova Guinea, Bot. 8: 2 (1912) 819. – **Type**: Papua New Guinea, 6 Dec 1907, *Branderhorst 263* (BO, K).

Tree up to 30 m. **Twigs** densely pilose, rusty colored. Terminal buds densely pubescent, smooth, rusty colored. **Leaves** spiral, elliptic, stiffly chartaceous, 10-19 × 7-10 cm, apex acute, base obtuse to acute; both surfaces densely reticulate; upper surface shiny, midrib flat, lateral veins slightly impressed; lower surface slightly shiny, densely pilose, midrib raised; lateral veins 7-8 pairs, raised, arcuate towards margin; petiole terete, densely pubescent, 1.5-2.0 × 0.20-0.25 cm. **Inflorescences** paniculate, densely pubescent, up to 18 cm long, axillary. Tepals spreading; glands large, united to form a disc-like appendage. **Fruits** spherical to ellipsoid, 1-1.5 cm long, free on the receptacles.

Recently collected specimens: INDONESIA. **Papua Province:** Kabupaten Raja Ampat, Waigeo Isl., along Werabiyai River, Jun 2007, *Mirmanto & Ruskandi 09304* (BO).

Additional specimens examined: WEST NEW GUINEA, Albatros Bivouac, 7 May 1926, *Docters van Leeuwen 9016* (BO). PAPUA NEW GUINEA, Morobe District, Wareo, 450 m, 5 Feb 1936, *Clemens 1782* (BO); Northern

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Note: *E. papuana* is more commonly encountered in the forests of Papua New Guinea. around Morobe District than in Indonesian part of New Guinea. Specimen of *E. papuana* collected from Waigeo Island is a good addition to the Herbarium Bogoriense collection (see Fig. 3).

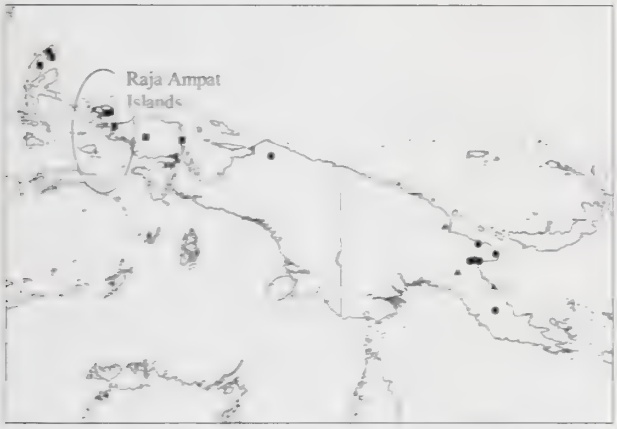

Figure 2. Distribution of *Endiandra beccariana* (■), *E. grandifolia* (▲) and *E. papuana* (●).

Figure 3. Occurrence of newly recorded species of Endiandra in Waigeo Island: *Endiandra beccariana* (■), *E. grandifolia* (▲) and *E. papuana* (●)

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Species of *Marasmius* (Agaricales: *Tricholomataceae*) from Kayan Mentarang National Park, East Kalimantan, Indonesia

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Abstract

Five species of *Marasmius* were encountered from forest surrounding Pa'raye village at Kayan Mentarang National Park, East Kalimantan; three of them are described as new taxa (1 new species and 2 new varieties). The five species of *Marasmius* are *M.* cf. *purpureostriatus*, *M. guyanensis*, *M. coklatus* var. *mentarangensis*, *var. nov.*, *M. caryote* var. *pa'rayeensis*, *var. nov.*, and *M. gypseus*, *sp. nov.* Comprehensive descriptions, illustrations, and comparison with similar taxa are presented.

Introduction

Among the *Agaricales* in the tropics, *Marasmius* has become a favorite collection item. Species of *Marasmius* grow relatively longer period of time than other agarics. They are very attractive and relatively easy to be spotted. It is the most common genus in tropic, and grows frequently on forest soil, fallen leaves, and on dead or living wood and other plant tissues, such as grass roots and bamboo twigs. Most species of *Marasmius* are saprophytic, some are even parasitic, and none goes into mycorrhizal association.

The earliest report of *Marasmius* from Indonesia with 28 species was made by Léveillé (1844, 1846) and many of them were reported from Java. This was followed by several reports by Moritzi (1845-1846), Zollinger (1854), Hennings (1900), Overeem and Overeem-de Haas (1922), Boedijn (1940). Desjardin, Retnowati, and Horak (2000) documented 37 species of the genus from Java and Bali. However, no species of *Marasmius* was recorded from Kalimantan, particularly from Kayan Mentarang National Park, East Kalimantan. This paper presents five species of *Maramius* encountered during a three weeks expedition to survey the fungal flora from the forests surrounding Pa'raye village at Kayan Mentarang National Park in April of 2003.

Kayan Mentarang National Park, which lies between altitudes 116°15'-115° E and 2°-4°30' N, embraces a total area of 1.35 million hectares. It is located in East Kalimantan, bordering with Sabah and Sarawak. The inventory was done from several collecting sites in the mountainous Pa'raye village located north of the National Park. Descriptions of the species are based on fresh collections made by the author. All micro characters were studied from dried materials rehydrated in distilled water and 3% of KOH solution, with the use of Melzer's reagent or Congo Red dye. Color terms and notations are those of Kornerup and Wanscher (1978). Spore sizes were based on measurements of 25 basidiospores.

Spore statistics include - $\bar{x}$ = the arithmetic mean of the spore length by spore width (± standart deviation); Q, the quotient of spore length and spore width in any one spore to indicate the range of variation in n spores measured; $\bar{q}$, the mean of Q-values in a single sample.

The basidiomes in illustration are of natural size, basidiospore (scale bar = 12 µm); basidia, cystidia, pileipellis and stipitipellis (scale bar = 15.7 µm). All collections examined are deposited in Herbarium Bogoriense (BO) and Harry D. Thiers Herbarium (SFSU).

Description of taxa

1. ***Marasmius*** cf. ***purpureostriatus*** Hongo
J. Jap. Bot. 33: 344. 1958. –**Type**: Japan, Otsu City, Ishiyama, 7 May 1957, *Hongo 1609* (Isotype, ZT [3221]). **Fig. 1.**

Pileus 55 mm diam, convex with slightly depressed center, sulcate; margin crenate, straight; surface pruinose, smooth; greyish magenta (13-E3) overall. Context thin, pale greyish magenta. **Lamellae** adnate, distant (12 attached stipe) with 1 series of lamellulae, narrow, non-marginate; pale greyish magenta. **Stipe** 180 × 5 mm, hollow, central, equal, cylindrical; smooth, pruinose; pale greyish magenta. Odor and taste not distinctive. **Basidiospores** unobserved. **Basidia** 46.4-56 × 12-12.8 µm, 4-spored, clavate. Basidioles clavate. **Cheilocystidia** common, 16-24 × 7.2-12.8 µm, clavate, broadly clavate, sub-globose to globose, hyaline to weakly yellow, thin-walled. Pleurocystidia absent. **Pileipellis** hymeniform, clavate to broadly clavate or subglobose, 16-25.6 × 8.8-9.6 µm, non-diverticulate, hyaline, thin-walled. **Stipe tissue** monomitic; cortical and medullary hyphae indistinguishable, 6.4-20 µm diam, parallel, cylindrical, hyaline, thin-walled, strongly dextrinoid. **Stipe vesture** common, composed of clavate, cylindrical to fusoid or irregular in outline, 18.4-32 × 8-12 µm, hyaline, thin-walled. Clamp connections present.

Specimen examined: INDONESIA. **East Kalimantan**, Kayan Mentarang National Park, forest surrounding Pa'raye village, 4 Apr 2003, *A. Retnowati 391* (BO, SFSU).

Distribution: Japan (type), Malaysia, Thailand, Republic of Korea, Papua New Guinea, and Indonesia.

Habit and habitat: Solitary on soil.

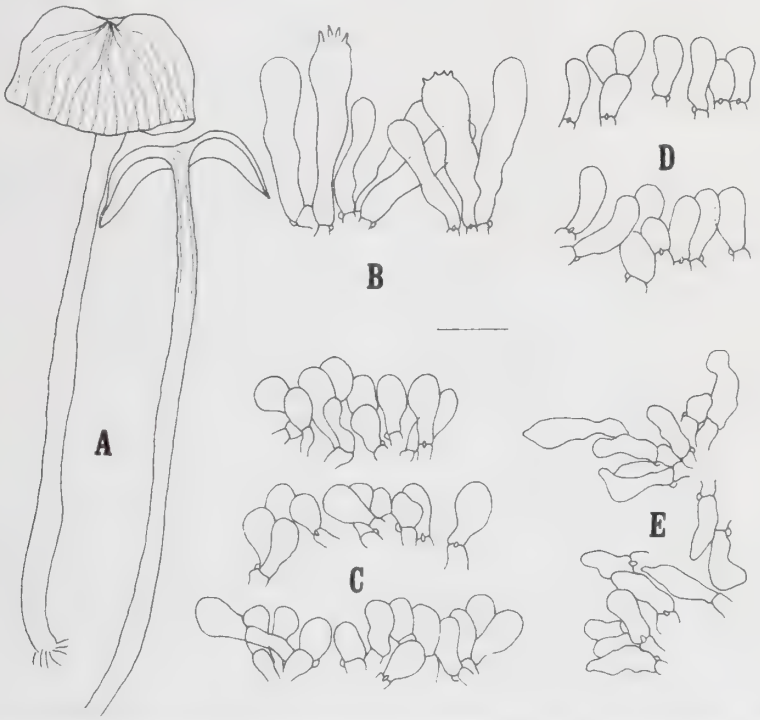

Figure 1. *Marasmius* cf. *purpureostriatus* Hongo (*A.Retnowati 391*). A. Basidiomes; B. Basidioles; C. Cheilocystidia; D. Pileipellis; E. Caulocystidia.

Notes: *M.* cf. *purpureostriatus* is characterized by several peculiar features, which include relatively large, greyish magenta pileus, sulcate, distant lamellae and absence of pleurocystidia. Basidiospores of the material examined are unobserved, but other characters match with description of *M. purpureostriatus* (*fide* Desjardin and Horak, 1997). As a result, I identify the material as *M.* cf. *purpureostriatus*.

M. purpureostriatus is allied with *M. musisporus* from Papua New Guinea (Desjardin and Horak, 1997). *M. musisporus* differs in forming smaller basidiome (8-25 mm diam), paller pileus, and the absence of stipe vesture (Desjardin and Horak, 1997).

2. ***Marasmius guyanensis*** Mont.
Mont., *Ann. Sci. Nat. Bot.* 4(1): 114. 1854. –**Type**: French Guyana, Leprieur, *Dennis 255*. (Holo, K). **Fig. 2.**

Pileus 2-5 mm diam, convex, with a small dark papilla at the depressed center; margin sulcate, straight, crenate; surface dull, dry, smooth, glabrous; orange (6-A6). Context thin, white. **Lamellae** adnate to a collarium, distant (7-9 reaching stipe) with no lamellulae, narrow, white to off-white, non-marginate. **Stipe** 5-7 × 0.1 mm, central, terete, pliant, smooth, glabrous, shiny, insititious, cylindrical; dark brown to black; no-nodes, stipe arises from dark rhizomorphs, black rhizomorphs association. Odor and taste not distinctive. **Basidiospores** (11.2)12-13.6 × 4 µm [$\bar{x}$ = 12.83 ± 0.67 x 4 ± 0 µm, Q = 2.80-3.40, $\bar{q}$ = 3.21 ± 0.17, n = 25 spores per one specimen], elongate-ellipsoid, smooth, hyaline, inamyloid, thin-walled. **Basidia** unobserved. **Basidioles** fusoid, clavate. **Cheilocystidia** common, composed of *Siccus*-type broom cells; main body 10.4-23.2 × 6.4-9.6 µm, cylindrical to clavate, broadly clavate, subglobose or irregular in outline; hyaline, thin walled; apical setulae 1.6-3.2 × 0.8 µm, cylindrical to conical, subacute to obtuse or irregular in outline, hyaline, thin-walled. Pleurocystidia absent. **Pileipellis** hymeniform, mottled, composed of *Siccus*-type broom cells; main body 8.8-16 × 5.6-10.4 µm, cylindrical, clavate, broadly clavate, to subglobose or irregular in outline, hyaline, thin-walled; apical setulae 2.4-3.2 × 0.8 µm, cylindrical to conical, obtuse to acute; hyaline, thin-walled. **Stipe tissue** monomitic; cortical hyphae 3.2-5.6 µm diam, parallel, cylindrical, smooth, hyaline; dextrinoid, thin-walled; medullary hyphae 2.4-7.2 µm diam, cylindrical, dextrinoid, thin-walled. **Stipe vesture** absent. Clamp connections present.

Specimens examined: INDONESIA. **Java**, Bogor Botanical Garden, 7 Jan 1998, *D.E. Desjardin 6713* (BO 98-4, SFSU); same location, 8 Jan 1998, *D.E. Desjardin 6719* (BO 98-19, SFSU); same location, 15 Jan 1998, *D.E. Desjardin 6797* (BO 98-198, SFSU); same location, 12 Jan 1999, *A.Retnowati 125* (BO 99-245, SFSU). **East Kalimantan**, Kayan Mentarang National Park, forest surrounding Pa'raye village, 5 Apr 2003, *A.Retnowati 412* (BO).

Distribution: Indonesia, Martinique, Dominica, and French Guiana.

Habit and habitat: Gregarious on leaves or arising directly from rhizomorphs.

Notes: *Marasmius guyanensis* firstly described by Montagne from French Guiana (*fide* Singer, 1976). It is apparently a widespread species throughout tropical Central and South America (Pegler, 1983) and Asia (Corner, 1996). This species is easily distingushed by having a small, orange pileus with dark

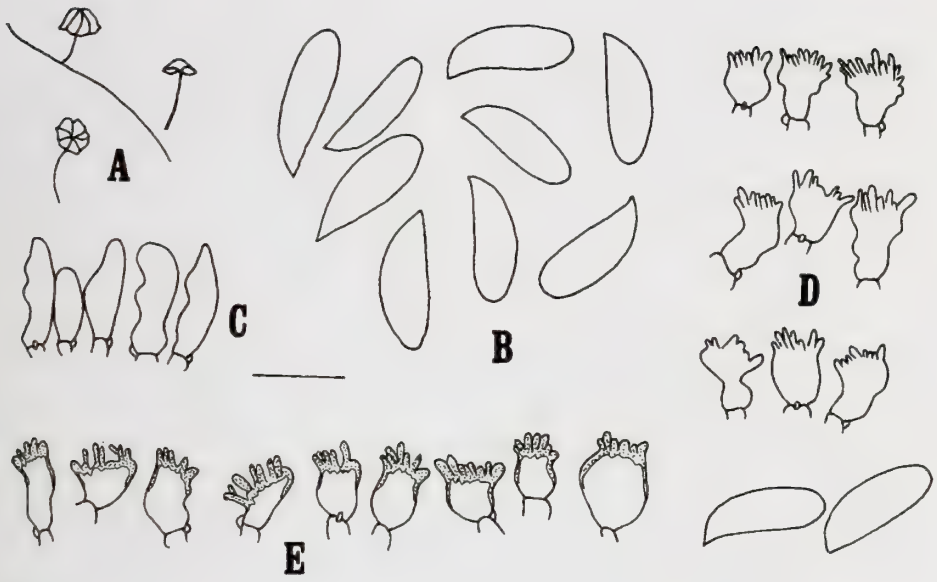

Figure 2. *Marasmius guyanensis* Mont. (*A. Retnowati 412*). A. Basidiomes; B. Basidiopores; C. Basidioles; D. Cheilocystidia; E. Pileipellis.

papilla at the center, a presence of collarium, and basidiospores 12-13.6 x 4 µm and it is abundant in research sites.

3. ***Marasmius coklatus*** var. ***mentarangensis*** Retnowati, *var. nov.*
Pileus latus, convexus, velutinus. Lamellae adnatae, brunneus marginatae. Stipes teres aequalis, minute pruinose, haud insititious. Odor saporque nulli. Basidiosporae (5.6) 6.4-7.2 × 3.2-4 µm, ellipsoideae, leves, hyalinae, inamyloideae, tenui-tunicate. Basidiola 21.6-30.4 × 6.4-7.2 µm, anguste clavata. Cheilocystidia cellulae typi Sicci, 11.2-4 × 4-8 µm, setulosae, clavate vel irregulars, hyalinae; 2-4 setulae ad apicem 6.4-13.6 × 0.8-2.4 µm. Pleurocystidia nulla. Pileipellis hymeniform, cellulae typi Sicci, 12-36 × 4.6-8 µm; 2-6 setulae ad apicem, 4-16 × 1.6-3.2 µm. Gregarius ad terra. –**Holotypus**: Indonesia. East Kalimantan, Kayan Mentarang National Park, 4 Apr 2003, A.Retnowati 390 (BO). **Fig. 3.**

Pileus 26-80 mm diam, conic at first, then convex in age, hygrophanous; margin incurved, surface strongly wrinkled at the disc, velutinous overall; dark brown overall (9–F8). Context white, thick up to 6 mm. **Lamellae** adnate, 24-26, closely attached to stipe, with 3 series of lamellulae, narrow, dark brown marginate; pure white. **Stipe** 50-100 × 9-14 mm, hollow, cylindrical, equal, center, non-insititious, smooth, pruinose; light brown. Odor and taste

Figure 3. *Marasmius coklatus* var. *mentarangensis* Retnowati, *var. nov.* (*A. Retnowati 390*, Holotype). A. Basidiomes; B. Basidiospores; C. Basidia and Basidioles; D. Cheilocystidia. E. Pileipellis; F. Caulocystidia.

not distinctive. **Basidiospores** (5.6) 6.4-7.2 × 3.2-4 µm ($\bar{x}$ = 6.46 ± 0.51 × 3.39 ± 0.35, Q = 1.60- 2.2 5, $\bar{q}$ =1.92 ± 0.17, n = 25 spores per 1 specimen), ellipsoid, smooth, hyaline, inamyloid, thin-walled. **Basidia** 21.6-30.4 × 6.4-7.2 µm, clavate, 4-spored. **Basidioles** clavate. **Cheilocystidia** common, composed of *Siccus*-type broom cells, main body 11.2-4 × 4-8 µm, clavate, subcylindrical to cylindrical or irregular in outline, yellowish brown, thin to thick-walled; apical setulae 6.4-13.6 × 0.8-2.4 µm, 2-4 setulae, narrowly cylindrical to conical or irregular in outline, subacute to acute, hyaline, thin to thick-walled. Pleurocystidia absent. **Pileipellis** hymeniform, mottled, composed of *Siccus*-type broom cells; main body 12-36 × 4.6-8 µm, clavate, subclavate, cylindrical to subcylindrical or irregular in outline, yellowish brown, thin to thick-walled; apicals setulae 4-16 × 1.6-3.2 µm, 2-6 setulae, often branched at the apex, narrowly cylindrical to irregular in outline, yellowish brown, thick-walled. **Stipe tissue** monomitic; cortical hyphae and medullary hyphae undifferentiated, 6.2-12 µm diam, hyaline to weakly yellowish brown, thin-walled, dextrinoid. **Stipe vesture** common, composed of two types of caulocystidia: a) *Siccus*-type broom cells, main body 20-66.4 x 3.2-4.8 µm, clavate, clavate to broadly clavate, cylindrical or irregular in outline, hyaline,

thin-walled; apical setulae 3.2-6.4 x 1.6 µm, not crowded, narrowly cylindrical to conical, obtuse to acute, thin to thick-walled up to 0.8 µm; b) non-setulae, main body 35-36 x 5.6 µm, clavate, cylindrical, thin-walled, hyaline. Clamp connections present.

Distribution: Indonesia.

Habit and habitat: Gregarious on soil.

Notes: *Marasmius coklatus* was described from Cibodas Botanical Garden by Desjardin, Retnowati and Horak (2000). This javanese materials have a dark chocolate brown, velutinous pileus, remote to distant, broad, greyish brown lamellae, a brownish orange to brown, pruinose stipe, moderately long and broad basidiospores, *Siccus*-type cheilocystidia and pleurocystidia with few (2-5), long (-30 µm) apical setulae and numerous pileo-, cheilo-, pleuro-, and caulosetae. The material collected from KMNP differs from the Javanese material in having shorter basidiospores (6.4-7.2 × 3.2-4) µm, and the absence of pleurocystidia. These two characters separate the KMNP collection as a new variety of *M. coklatus*.

4. ***Marasmius caryote*** var. ***pa'rayeensis*** Retnowati, *var. nov.*
Differt a pileo sulcatus, lamellis numerosus, basidiosporis longissimus (28)30.4-33.8 × 4.8-5.6 µm longis), stipitis caulocystidiis cylindricis deim ordinary. Sparsus ad solum. –**Holotypus**: Indonesia, East Kalimantan, Kayan Mentarang National Park, forest along Parinibung, 10 Apr 2003, *A.Retnowati 460* (BO). **Fig. 4.**

Pileus 17-48 mm diam, convex at first, then convex with upturned margin in age; hygrophanous, sulcate; margin straight at first, upturned in age; surface glabrous, smooth; light brown. Context thin, light brown. **Lamellae** adnate, close (18 reached stipe) with 2-3 series of lamellulae, narrow, non-marginate; light brown. **Stipe** 100-145 × 1.5-2 mm, equal, cylindrical, central, non-insititious; smooth, pruinose; light brown to dark brown; white base tomentose at the base. Odor and taste not distinctive. **Basidiospores** (28)30.4-33.8 × 4.8-5.6 µm [$\bar{x}$ = 31.85 ± 1.42 × 5.12 ± 0.40 µm, Q = 5.43-7, $\bar{q}$ = 6.25 ± 0.51, n = 25 spores per 1 specimen], cylindrical, smooth, hyaline, inamyloid, thin-walled. **Basidia** 42.4-44 × 10.4 µm, 4-spored, clavate. Basidioles clavate. **Cheilocystidia** abundant, 10.4-28 × 8-12.8 µm, clavate, broadly clavate to pyriform or globose, hyaline to weakly yellow, thin-walled. **Pleurocystidia** absent. **Pileipellis** hymeniform, not mottled, 12-21.6 × 5.6-9.6 µm, clavate to broadly clavate, subglobose or globose, hyaline, thin-walled. **Stipe tissue** monomitic; cortical hyphae 7.2-16.8 µm diam, parallel, cylindrical, hyaline,

thin-walled, smooth, weakly dextrinoid; medullary hyphae 5.6-10.4 µm diam, parallel, cylindrical, hyaline to yellowish brown, thin-walled, dextrinoid. **Stipe vesture** common, 16.8-40 × 4.8-7.2 µm, cylindrical to clavate or irregular shape, hyaline, thin-walled. Clamp connections present.

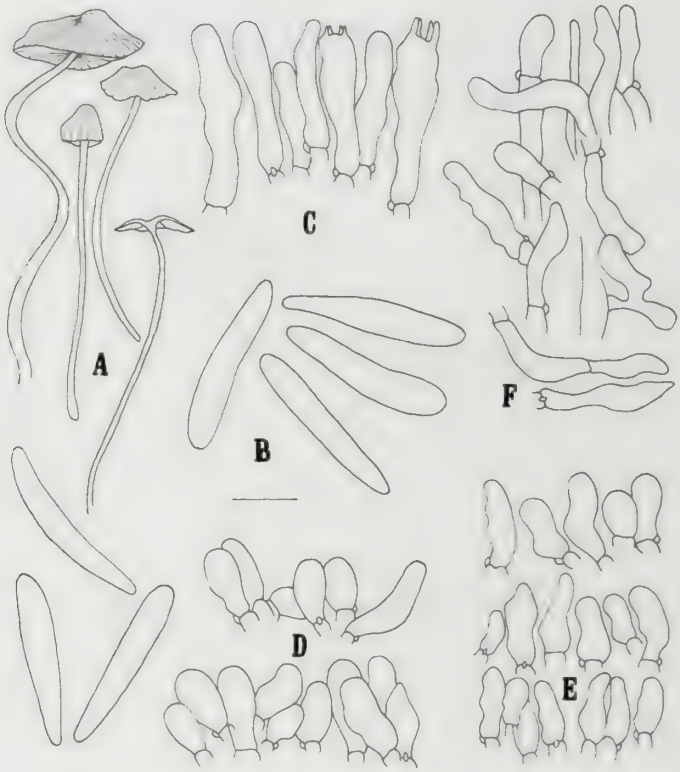

Figure 4. *Marasmius caryote* var. *pa'rayeensis* Retnowati, *var. nov.* (*A. Retnowati 460*, Holotype). A. Basiodiomes; B. Basidiospores; C. Basidia and basidioles; D. Cheilocystidia; E. Pileipellis; F. Caulocystidia.

Distribution: Indonesia.

Habit and habitat: Scattered on soil.

Notes: Some species of *Marasmius*, e.g., *M. bekolacongoli* Beeli (*fide* Singer, 1965) and *M. titanosporus* Reid & Guillarmod (Reid, 1988), are closely related to the *M. caryote* var. *pa'rayeensis*; however, the Kalimantan material differs in having longer basidiospores from *M. bekolacongoli* (16.5-23(-28) × 3.5-5 µm), and shorter basidiospores from *M. titanosporus* (22-36 × 5-7.2 µm). In addition, the presence of stipe vesture in this *Marasmius* makes it a new variety different from the related species. *M. caryote* variety typical had been reported from Krakatau Island by Boedijn (1940).

5. ***Marasmius gypseus*** Retnowati, *sp. nov.*
Pileus 22-41 mm latus, convexus, hygrophanous, crenatus, glabrus, gypseus. Lamella adnate, distantes, haud marginatae. Stipes 40-60 × 1.5-3 mm, aequalis, glabrus, Haud insititious, brunneus. K-Basidiospores 6.4-7.2 × 3.2-4 µm, ellipsoideae, leves, hyalinae, inamyloideae. Basidiola clavate, cheilocystidia et pleurocystidia nula. Pileipellis hymeniformis, clavate, prelate clavate, globosus vel subglobosus, leves, 16-26.4 × 8-18.4 µm. Stipitis caulocystidis ordinary, 20-24.8 × 6.4-12 µm, clavate, globosus vel subglobosus. Cespitosesus vel gregarious ad lignum. –**Holotypus**: Indonesia. East Kalimantan, Kayan Mentarang National Park, trail to sub-camp 1 in forest surrounding Pa'raye village, 3 Apr 2003, *A. Retnowati 371* (BO). **Fig. 5.**

Pileus 22-41 mm diam, convex with depressed center, strongly hygrophanous, crenate; margin straight, wavy; surface glabrous, wrinkle; white overall. Context thin, white. **Lamellae** adnate, distant with 2 series of lamellulae, narrow, non-marginate, white. **Stipe** 40-60 × 1.5-3 mm, cylindrical, center, hollow, equal, mooth, glabrous, non-insititious; brown. Odor and taste not distinctive. **Basidiospores** 6.4-7.2 × 3.2-4 µm [$\bar{x}$ = 6.78 ± 0.41 × 3.33 ± 0.30 µm, Q = 1.60-2.25, $\bar{q}$ = 2.05 ± 0.18, n = 25 spores per one specimen], ellipsoid, smooth, hyaline, inamyloid, thin-walled. **Basidia** unobserved. **Basidioles** clavate, fusoid. **Cheilocystidia and pleurocystidia** absent. **Pileipellis** hymeniform, composed of clavate, broadly clavate, globose to subglobose, non-diverticulate, 16-26.4 × 8-18.4 µm, hyaline, thin-walled. **Stipe tissue** monomitic; cortical and medullary hyphae indistinguishable, 5.6-12.2 µm diam, parallel, cylindrical, hyaline, smooth, thin-walled, dextrinoid. **Stipe vesture** common, composed of clavate, broadly clavate, globose to subglobose, non-diverticulate, scattered, 20-24.8 × 6.4-12 µm, hyaline, thin-walled. Clamp connections present.

Distribution: Indonesia.

Habit and habitat: Caespitose to gregarious on wood.

Notes: This new *Marasmius* can be distinguished by having convex with depressed center pileus, strongly hygrophanous and distant with 2 series of lamellulae, the lacking of cheilocyctidia and pleurocystidia, and basidiospores 6.4-7.2 × 3.2-4 µm. Several members of section *Globulares* have a similar

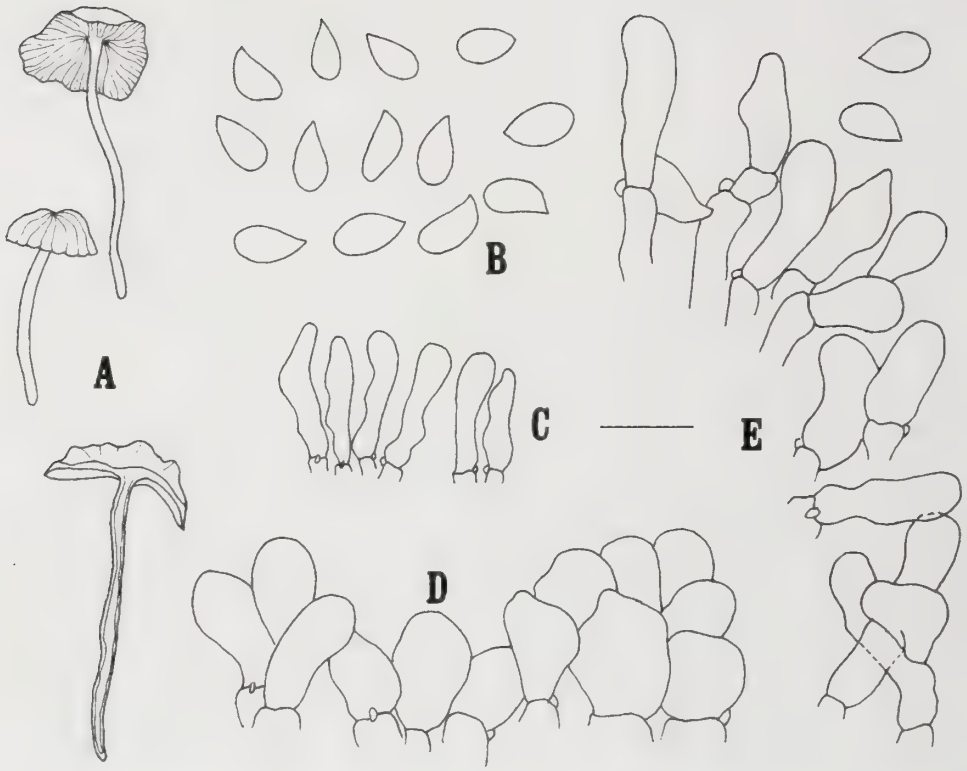

Figure 5. *Marasmius gypseus* Retnowati, *sp. nov.* (*A. Retnowati 371*, Holotype). A. Basidomes; B. Basidiopores; C. Basidioles; D. Pileipellis; E. Caulocystidia.

feature with this *Marasmius*. *M. albertianus* Singer described from Congo has longer basidiospores 8-10 × (3)-4(-5) µm, presence of cheilocystidia, and is host specific on bamboo (*fide* Pegler, 1977). *M. niveus* from French Guyana (*fide* Singer, 1976) also has longer basidiospores 6.5-9 × 2.5-3.5 µm, and absence of cheilocystidia and stipe vesture.

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Lectotypification of *Elatostema subscabrum* H.Schroet. (Urticaceae)

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Abstract

Descriptions of *Elatostema sessile* J.R.Forst. & G.Forst and *E. subscabrum* H.Schroet. (Urticaceae) are provided to clarify the morphological differences between these two species. The lectotype of *E. subscabrum* H.Schroet. (Urticaceae) is here selected.

Introduction

Elatostema J.R.Forst. & G.Forst. (Urticaceae) is a very speciose genus of at least 300 species occurring throughout the Old World tropics, subtropics and subtemperate regions. The general lack of knowledge about the systematics and circumscriptions of the species has resulted in the frequent incorrect application of plant names because there are no recent publications on the systematics of this group. The most recent account of the genus by Schröter and Winkler (1936) was based on the relatively few collections that were available. Furthermore, this publication only described species of subgenera *Elatostematoides*, *Pellionia*, and *Weddellia* (as circumscribed by them). Species of *Elatostema sensu stricto*, that Schröter and Winkler (1935) regarded as consisting of 240 species, were not included in their publication.

Recently, progress has been made on our understanding of the taxonomy and phylogeny of the Urticaceae (Friis, 1993; Hadiah *et al.*, 2003, 2008; Sytsma *et al.*, 2002; Wilmot-Dear, 2009) and tribes, in particular Elatostemateae (*sensu* Conn and Hadiah, 2009). Traditionally, the taxonomic studies of the genus were based on morphological characteristics (Robinson, 1910, 1911; Schröter and Winkler, 1935, 1936; and Weddell, 1854, 1856, 1857, 1869). A detailed discussion of the morphological characteristics used to circumscribe taxa within *Elatostema* and their usefulness in re-

construction of phylogenies are presented in Hadiah and Conn (2009). There has been a large volume of work on the taxonomy of the Chinese species of *Elatostema sensu lato* (Wang, 1980a, 1980b; Yang *et al.*, 1995), one of the centres of species diversity for the genus. However, little has been published on the Malesian species, which are part of another major centre of diversity. With relevance to this paper, the above studies provide an, albeit incomplete, framework for further systematic study of the genus.

During studies of the Malaysian species of Urticaceae, material of *E. sessile* has often been confused with *E. subscabrum*. Two herbarium sheets of type material of *E. subscabrum* were located at the herbarium of the Singapore Botanic Gardens (SING). These specimens clarify the circumscription of the latter species.

***Elatostema subscabrum* H.Schroet.**
Repertorium specierum novarum regni vegetabilis 83: 1 (1935) 20 in obs.; *Repertorium specierum novarum regni vegetabilis* 83: 2 (1936) 85.

Lectotype (here chosen)**:** Malaysia, Pahang, Telom, Nov 1908, *H.N. Ridley 13789* (upper left specimen, SING *s.n.*); isolectotype (lower right specimen, SING *s.n.*). Other syntype material: *H.N. Ridley 13789* (SING67093) (refer to discussion of lectotypification, below).

Terrestrial **herb**, 0.15-0.2 m high, self-supporting (erect/suberect) or spreading; internodes developed (elongate, distinct); branched hairs lacking; stinging hairs absent; monoecious. Stipules axillary, interpetiolar, persistent, free, 1-1.3 mm long. **Leaves** opposite, appearing alternate (by misinterpretation – nanophylls caducous); petiole absent (or < 2 mm long); megaphylls with lamina 23-60 mm long, 12-24 mm wide (length to width ratio 1.92-2.5), unequal-sided, larger side of lamina ovate to elliptic, smaller side elliptic to obovate; surface flat, not rugose, with 4 or 5 vein-pairs; venation actinodromous ('type IVd, semi pinnate nerved' *sensu* Schröter and Winkler, 1935); basal pair of secondary veins arising from above base of primary vein and arising from different points (more than 2 mm apart), both directed towards margin (or almost so), joined to next distal secondary vein; abaxial surface with cystoliths present on interstices (cystoliths linear), with hairs on primary, secondary and tertiary veins; adaxial surface lacking cystoliths, glabrous; base oblique, rounded or cuneate; margin toothed, not lobed, glabrous; apex short-acuminate; nanophylls not known. **Inflorescences** unisexual; male inflorescences not known; female inflorescence subsessile to shortly pedunculate, unbranched, head-like, involucral bracts narrowly ovate, sparely hairy to almost glabrous; bracteoles very long, narrowly ovate; **flowers** condensed/crowded, unisexual; actinomorphic (or slightly

asymetrical): tepals 4, free, unequal, one tepal c. 1mm long with appendage 1-1.5 mm long; 3 tepals slightly smaller, *ca* 0.75 mm long without appendage; staminodes present, 4, inflexed in bud; ovary straight; style absent; stigma oblong, filiform to linear. **Achene** not enclosed (or only partly so); surface ribbed or punctate.

Lectotypification of *Elatostema subscabrum* H.Schroet.

Hilde Schröter described the new species *E. subscabrum* from material collected from Telom, Pahang, Malaysia, with the type cited as *Ridley 13789* (SING) (Schröter and Winkler, 1936). Two sheets of syntype material are held at SING. One herbarium sheet is annotated: '*H.N. Ridley 13789*, Nov. 1908, Telom [all written in Ridley's hand], State of Pahang, Malay Peninsula [State and region part of pre-printed label – lower right of sheet]' (SING67093), with field identification '*Elatostema ?acuminatum*' [in Ridley's hand] has three separate samples of the plant; all specimens are female and largely in fruit (Fig. 1). The second sheet, '*H.N. Ridley 13789*, Nov. 1908, Telom, State of Pahang, Malay Peninsula' [as annotated above – upper left of sheet] (SING), except identified as '*E. acuminatum*, Brongn.' by 'CXF' [Caetano Xavier Furtado, Singapore Botanic Gardens, 1923-1952, then 1956-1960] and the label has been stamped '30 MAR. 1909.' presumably the date when the material was accessioned into the herbarium (Fig. 2). This second sheet has two female specimens, upper left with flowers and fruits, and the lower right specimen largely in fruit. Both sheets have been examined by Schröter and annotated as '*Elatostema subscabrum* Hilde Schröter [in her hand], dated '1935' [in her hand], and 'det. Hilde Schröter [pre-printed determinavit slip]. Furthermore, Schröter notes that she has not examined male inflorescences (refer protologue), only female inflorescence, female flowers and fruit. The upper left specimen of the latter sheet (SING) is a good match for the protologue. Therefore, it is here selected as the lectotype because it has both flowers and fruits (in accordance with Articles 7.11, 8.1-8.3: McNeil *et al.*, 2006).

Lectotype (chosen by Florence, 1997): *J.G.A. Forster* [*186*], Société, Tahiti (P-Forst); isolectotype: *Forster s.n.* (BM, K); probably isolectotype: '*Dorstenia pubescens*' (MW). For further discussion refer Nicolson and Fosberg (2003, pp. 677 & 678).

Distribution: Malaysia: Malay Peninsula, Pahang – only known from type.

Notes: Collections of *E. sessile* from Malaysia have frequently been misidentified as *E. subscabrum*; however, the two species can be distinguished by the morphological characters listed in Table 1 (below).

Figure 1. Isolectotypes of *Elatostema subscabrum* H.Schroet. (Urticaceae) (SING*67093*).

Figure 2. Lectotype (upper left) and isolectotype (lower) of *Elatostema subscabrum* H.Schroet. (Urticaceae) (SING *s.n.*).

Table 1. Diagnostic morphological features distinguishing *Elatostema subscabrum* from *E. sessile*.

Character	*E. subscabrum*	*E. sessile*
Female inflorescences	Appearing 'hairy' because of very long, narrowly ovate, tapering, unequal bracteoles	Not appearing 'hairy' because of shorter bracteoles not extending the involucral bracts
Tepals of female flower	4; unequal size, one of which is longer with a long appendage	3; unequal, without appendage
Female flower tepal size	Distinct and readily visible	Minute, difficult to observe

***Elatostema sessile* J.R.Forst. & G.Forst.**
Characteres Generum Plantarum 53, n. 2 (1775); ed. 2 (1776) 106.

Terrestrial **herb**, 0.3-0.5 m high, self-supporting (erect/suberect); internodes developed (elongate, distinct); branched hairs lacking; stinging hairs absent; monoecious. Stipules caducous. **Leaves** opposite, appearing alternate (by misinterpretation – nanophylls caducous); sessile (or petiole < 2 mm long); megaphylls (45-)50-135(-155) mm long, (21-)22-55(-64) mm wide (length to width ratio (2.1-)2.2-2.5), unequal-sided, larger side of lamina ovate to elliptic, smaller side as for larger side or to slightly obovate; surface smooth, not rugose, with 4 or 5 vein-pairs; venation asymmetric, actinodromous; basal pair of secondary veins arising above base of primary vein and arising from one point (or less than 2 mm apart), both directed towards apex (or almost so), joined to next distal secondary vein; abaxial surface with linear cystoliths on interstices and hairs on primary, secondary and tertiary veins; adaxial surface with linear cystoliths interstices and on primary, secondary and tertiary veins, hairs occasionally present on interstices; base oblique, rounded or cuneate; margin toothed, not lobed, sparsely hairy; apex acuminate; nanophylls absent. **Inflorescences** unisexual; **male inflorescences** (based on Weddell, 1869; not known by current authors) sessile or shortly pedunculate, depressed-globose, involucral bracts present, broadly ovate, hairy on margin; **female inflorescence** sessile or sometimes shortly pedunculate, unbranched, discoid; involucral bracts present, with margin hairy, with long appendage; bracteoles linear-spathulate, ciliate; flowers

condensed crowded, unisexual; actinomorphic (or slightly asymetrical); tepals 3, very minute (appearing absent), unequal, free, appendage absent; staminodes 3, inflexed in bud; ovary straight; style absent; stigma oblong, filiform to linear. **Achene** 0.4-0.63 × 0.25-0.35 mm not enclosed (or only partly so); surface smooth or ribbed.

Selected specimens examined: MALAYSIA. Perak: Rotan Segar limestone Hill near Tambun, 29 Nov 1960, *Allen 4652* (SING); Maxwell's Hill, 7 Dec 1965, *Shah & Sidek 1146* (SING); Ah Kee Iron Mine, Ipoh, 21 Oct 1958, *Sinclair 9890* (SING). INDONESIA. **Sumatera Utara**: Kabupaten Karo, Air terjun Sikulikap, Desa Mejuah-juah, 21 Jun 2001 *Hadiah, Conn & Ariyanti 453* (NSW); **Jawa Barat**: Gunung Gede-Pangrango National Park, track to air terjun Cibeureum, 25 Aug 1998, *Hadiah 148* (NSW); Bogor, Wana Wisata Curug Nangka, Curug Sawer, Warung Loa, 29 Sep 1998, *Hadiah 253* (NSW).

Distribution: Malaysia, Malay Peninsula: Perak, Perlis, Pahang and Kelantan. Indonesia, Sumatera: Sumatera Utara, Sumatera Barat and Jambi; Jawa: Jawa Barat, Jawa Tengah and Jawa Timur; Bali.

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Lejeuneaceae subfamily Ptychanthoideae (Hepaticae) in West Java

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Abstract

The subfamily Ptychanthoideae of the family Lejeuneaceae (Hepaticae) in West Java is still poorly known. A study of Ptychanthoideae in this area reveals the occurrence of 26 species, in 8 genera: *Acrolejeunea* (Spruce) Schiffn. (3 species), *Archilejeunea* (Spruce) Schiffn. (1 species), *Lopholejeunea* (Spruce) Schiffn. (10 species), *Mastigolejeunea* (Spruce) Schiffn. (3 species), *Ptychanthus* Nees (1 species), *Schiffneriolejeunea* Verd. (2 species), *Spruceanthus* Verd. (2 species) and *Thysananthus* Lindenb. (4 species). *Mastigolejeunea indica* and *Thysananthus minor* are newly reported for Java. The altitudinal and geographical ranges of the species of Ptychanthoideae from West Java are presented as well as a key to the species and an assessment of their phytogeography. It appears that the species are rather widespread; none of the species are endemic to Java or western Malesia. The widespread distribution of the species is probably due to their dispersal by spores, which may be easily carried by the wind over long distances, and by the rather old geological age of the group.

Introduction

Lejeuneaceae is a large, mostly tropical family of leafy liverworts, containing about 1000 species in 75 genera. According to Gradstein *et al.* (2001), Lejeuneaceae is subdivided into two subfamilies, Lejeuneoideae and Ptychanthoideae; the latter group is treated in this paper.

Ptychantheae is the only tribe of Ptychanthoideae, while Lejeuneoideae consists of three tribes, Brachiolejeuneeae, Lejeuneeae and Cololejeuneeae.

The subfamily Ptychanthoideae is characterized by the capsule valves spreading widely after dehiscence, elaters usually 72 per capsule, underleaves undivided, ventral merophytes 4 or more cells wide, and ocelli absent. In Lejeuneoideae the capsule valves are not spreading after dehiscence, elaters are 34 or less per capsule, underleaves bifid or undivided, ventral merophytes usually 1-4 cells wide, and ocelli sometimes present.

Ptychanthoideae include fewer genera and species than Lejeuneoideae and are generally better known (Gradstein, 1991). They contain about 175 species in 19 genera worldwide; 14 genera occur in tropical America. Most species are xerotolerant epiphytes of forest canopies or rather open, wooded vegetation, and usually occur at rather low elevation (Thiers and Gradstein, 1989; Gradstein *et al.*, 2001).

Based on several references (Verdoorn, 1933, 1934; Mizutani, 1961; Gradstein, 1975, 1991, 1994; Gradstein *et al.* 2002; Zhu and Gradstein, 2005; Gradstein *et al.*, 2005; Hasan and Ariyanti, 2004; Ariyanti and Gradstein, 2007), there are about 30 species of Ptychanthoideae in Java, in 10 genera: *Acrolejeunea* (Spruce) Schiffn, *Archilejeunea* (Spruce) Schiffn., *Caudalejeunea* (Steph.) Schiffn., *Dendrolejeunea* (Spruce) Lacout., *Lopholejeunea* (Spruce) Schiffn., *Mastigolejeunea* (Spruce) Schiffn., *Ptychanthus* Nees, *Schiffneriolejeunea* Verd., *Spruceanthus* Verd., and *Thysananthus* Lindenb. In addition, there is an old, unconfirmed report of the Pacific genus, *Phaeolejeunea* Mizut., from Java (Zhu and Gradstein, 2005, p. 88, originally described as *Lopholejeunea latistipula* (Schiffn.) Schiffn. var. *minor* Schiffn.).

Information about the distribution of the species of Ptychanthoideae within Java is very scarce. The publications on this subject are mostly from the 19th or early 20th century and outdated (e.g., Reinwardt, Blume and Nees von Esenbeck, 1824; Nees von Esenbeck, 1830; Sande Lacoste, 1856; Schiffner, 1898; Stephani, 1912; Verdoorn, 1933, 1934).

The aim of this study was to improve our understanding of the diversity of Ptychanthoideae in West Java (including West Java Province and Banten Province).

Material and Methods

The study was based on herbarium specimens of *Ptychanthoideae* collected from West Java and Banten province. A total number of 362 specimens deposited in the Herbarium Bogoriense (BO) and Herbarium Biotrop (BIOT), and some in the Herbarium of the University of Göttingen, Germany (GOET) and Herbarium Bangi, Malaysia (UKMB) kept in BIOT as duplicates, were examined. Additional specimens were collected by the

first author at several locations in West Java, i.e. Telaga Warna, Ciater, Bogor Botanical Garden, Bodogol Education Center and Conservation – Mt. Gede Pangrango National Park and Mt. Halimun Salak National Park.

Morphological characters were studied with a 10 × 4, 10 × 10, 10 × 20 and 10 × 40 magnification. Specimens with similar characteristic were grouped and identified using recent literature on the species of Ptychanthoideae, such as Thiers and Gradstein (1989), Gradstein *et al.* (2001), Gradstein *et al.* (2002) and Zhu and Gradstein (2005). Descriptions and illustrations of each species were prepared and an identification key to the species was developed.

Taxonomic treatment

Key to the species of West Javan Ptychanthoideae

1. Branching always *Frullania* type.....18. ***Ptychanthus striatus***
1. Branching *Lejeunea* or *Frullania type*.....2

2. Branching *Frullania* and *Lejeunea* type (*Schiffneriolejeunea*).....3
2. Branching *Lejeunea*-type only.....4

3. Lobule forming a distinct sac at the base and flattened above with 2 large teeth. Teeth erect, not pointing outwards towards leaf apex. Leaves squarrose when moist.. 20. ***Schiffneriolejeunea tumida*** var. ***haskarliana***
3. Lobule not forming a distinct sac at the base, free margin of the lobule plane and clearly visible, with 2 teeth. Teeth almost equal in size and pointing outwards towards leaf apex. Leaves not squarrose when moist .....19. ***Schiffneriolejeunea pulopenangensis***

4. Lobes with a distinct vitta ..... 25. ***Thysananthus retusus***
4. Lobes without vitta 5

5. Cells of the lobe with cordate trigones.....6
5. Cells of the lobe not with cordate trigones..... 14

6. Leaves and underleaves entire. Dorsal epidermis cells larger than inner stem cells 7
6. Leaves and underleaves usually toothed. Dorsal epidermis cells not larger than inner stem cells (*Thysananthus*).....12

7. Perianth 3 keels, with 1-2 innovations (*Mastigolejeunea*).....8
7. Perianth 8-10 keels, innovation lacking (*Acrolejeunea*)..... 10

8. Leaf lobule with several large, triangular teeth.....
.....16. ***Mastigolejeunea indica***
8. Leaf lobule with one tooth.....9

9. Lobule tooth 3-5 cells long, sharp, curved.....17. ***Mastigolejeunea virens***
9. Lobule tooth 1 cell long, blunt, not curved.....
.....15. ***Mastigolejeunea auriculata***

10. Lobule semicircular in outline, with 4-10 teeth, all or at least some teeth 2-3 cells long..... 2. ***Acrolejeunea fertilis***
10. Lobule not semicircular, with 2-3 teeth 11

11. Lobule narrow rectangular, with 2 teeth .....1. ***Acrolejeunea arcuata***
11. Lobule ovate-rectangular, with 3 teeth .....3. ***Acrolejeunea pycnoclada***

12. Plant very small, less than 1 mm wide ..... 24. ***Thysananthus minor***
12. Plant more than 1 mm wide 13

13. Upper part of leaf asymmetrical, turned to the ventral side ("ventrad"), leaf apex recurved.....23. ***Thysananthus convolutus***
13. Upper part of leaf symmetrical, not turned to the ventral side, leaf apex plane or recurved ..... 26. ***Thysananthus spathulistipus***

14. Stems robust, ventral merophyte 8-12 cells wide (*Spruceanthus*).....15
14. Stems thinner, ventral merophyte 4-6 cells wide..... 16

15. Leaf apex sharply acute.....22. ***Spruceanthus semirepandus***
15. Leaf apex rounded to obtuse.....21. ***Spruceanthus polymorphus***

16. Stem epidermis cells not larger than the inner cells. Plants light green. Perianth keels smooth or weakly toothed. Innovations present.....
.....4. ***Archilejeunea planiuscula***
16. Stem epidermis cells larger than the inner cells. Plants blackish-green, rarely brown. Perianth keels distinctly toothed (*Lopholejeunea*). Innovations lacking.....17

17. Leaf lobule connected to the leaf lobe by only one single cell.....18
17. Leaf lobule connected to the leaf lobe across several cells.....21

18. Leaf lobe acute .....5. ***Lopholejeunea applanata***
18. Leaf lobe rounded or obtuse 19

19. Lobule deeply constricted in the middle, free margin strongly involute ..... 7. ***Lopholejeunea herzogiana***
19. Lobule not deeply constricted in the middle, free margin not involute.....20

20. Underleaves distant to contiguous, orbicular. Female bracteole entire .....8. ***Lopholejeunea nigricans***
20. Underleaves imbricate, wider than long. Female bracteole toothed..... .....6. ***Lopholejeunea eulopha***

21. Underleaves very large, 6-8 × as wide as the stem 22
21. Underleaves smaller, 4-6 × as wide as the stem 23

22. Plants pale brown in the dried condition. Leaf lobules small, 1/5-1/4 of leaf length. Female bracteole toothed. Dioicous ....13. ***Lopholejeunea wiltensii***
22. Plants blackish or dark brown to blackish in the dried condition. Leaf lobules larger, 1/3-2/5 of leaf length. Female bracteole usually entire. Autoicous.....14. ***Lopholejeunea zollingeri***

23. Plants minute, less than 1 mm wide.....10. ***Lopholejeunea horticola***
23. Plants medium sized, more than 1 mm wide.....24

24. Margins of underleaves and leaves recurved. Underleaf large, more than ½ x lobe length.....11. ***Lopholejeunea recurvata***
24. Margins of underleaves and leaves plane. Underleaf less than ½ x lobe length.....25

25. Female bracteole entire. Female bract lobule very small or lacking .....12. ***Lopholejeunea subfusca***
25. Female bracteole crenate. Female bract lobule large..... ..... 9. ***Lopholejeunea ceylanica***

Species descriptions

1. ***Acrolejeunea arcuata*** (Nees) Grolle & Gradst., J. Hattori Bot. Lab. 38: 332 (1974).
Jungermannia arcuata Nees, Enum. Pl. Crypt. Javae 1:38 (1830). *Ptychocoleus arcuatus* (Nees) Trevis., Mem. Reale Ist. Lomb. Sci. Mat. Nat., Ser. 3, 4: 405

(1877). –**Type**: Indonesia. Java: Lebak Mts., *Reinwardt s.n.* (holotype, STR; isotypes, G, NY, W) – cf. Gradstein *et al.* (2002).

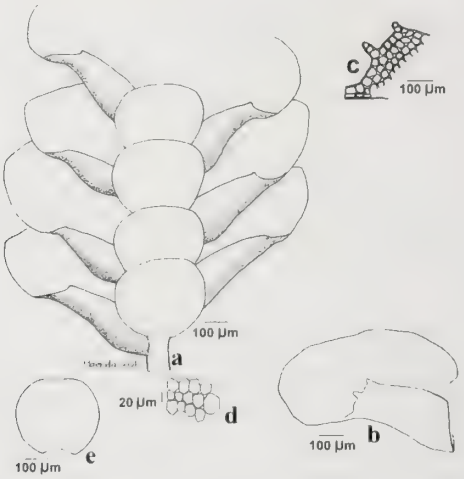

Figure 1. *Acrolejeunea arcuata* (Nees) Grolle & Gradst. Shoot (a); leaf-lobe (b); lobule (c); cells of midleaf (d); underleaf (e). Drawn from *Kornochalert 1408*, BIOT.

Plants up to 2 cm long, about 0.9 mm wide, dark brown to reddish brown in dried condition. Branching *Lejeunea*-type. Stem diameter 95-108 µm. Leaves closely imbricate, obliquely spreading. Lobe ovate-orbicular to obovate, 520-650 µm long, 410-520 µm wide, margin entire, apex subobtuse to sometimes rounded; cells of lobe thin-walled, hyaline, somewhat elongate, trigones ± cordate, intermediate thickening scarce; marginal cells 5-11 × 6-11 µm, midleaf cells 19-29 × 11-26 µm, basal cells 24-30 × 10-13 µm; oil bodies not seen. Lobule narrow rectangular, 300-400 µm long, 145-160 µm wide, apex truncate with 2 teeth, each tooth consisting of 2-3 cells, 2-3 cells long. Underleaves closely imbricate, subtriangular to suborbicular, 260-315 µm long, 295-435 µm wide, margins entire, apex truncate, base slightly auriculate, insertion line shallowly curved. Generative structures not seen.

Distribution: Java, Sumatra, Borneo, Philippines, Papua, Peninsular Malaysia.

Specimen examined: INDONESIA. **West Java**, Mt. Patuha, on bark of tree along the road to crater, 2000 m, *Kornochalert 1408* (BIOT!).

Notes: Diagnostic characters of *Acrolejeunea arcuata* are: 1) lobules 2(-3) times longer than wide, with 2 teeth, 2) lobe ovate-orbicular with entire margins, 3) cordate trigones. This species was found at *ca* 2000 m and occurs only at higher elevations in the mountains (Gradstein, 1975). It is readily

distinguished from other species of *Acrolejeunea* by the very long and narrow lobule with 2 teeth and the often reddish-brown color.

2. ***Acrolejeunea fertilis*** (Reinw. *et al.*) Schiffn., in Engler and Prantl, Nat. Pflanzenfam. 1, 3: 128 (1893); *Jungermannia fertilis* Reinw. *et al.*, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 211 (1824); *Ptychocoleus fertilis* (Reinw. *et al.*) Trevis., Mem. Reale Ist. Lomb.Sci. Mat. Nat., Ser. 3, 4: 405 (1877). –**Type**: Indonesia. Java, Lebak Mts., *Reinwardt s.n.* (holotype, STR; isotypes, G, NY, W) – cf. Gradstein *et al.* (2002).

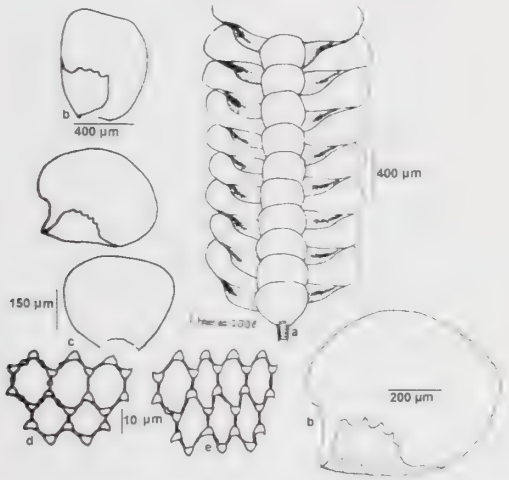

Figure 2. *Acrolejeunea fertilis* (Reinw. et al.) Schiffn. Shoot (a); leaf-lobe (b); underleaf (c); cells of midleaf (d); cells of basal part of the leaf (e); Drawn from *van Borssum Waalkes 549*, BO.

Plants up to 1 cm long, about 0.8 mm wide, dark green to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 100-124 µm. Leaves closely imbricate, obliquely spreading, squarrose. Lobe ovate-orbicular to subrectangular, 600-825 µm long, 500-660 µm wide, margin entire, apex truncate to sometimes rounded; cells of lobe thin-walled, light-yellow, somewhat elongate, trigones cordate, intermediate thickening scarce; marginal cells 7-8 × 7-10 µm, mid-leaf cells 18-23 × 12-20 µm, basal cells 17-30 × 13-17 µm; oil bodies not seen. Lobule semicircular, 200-290 µm long, 220-250 µm wide, apex obliquely truncate with 4-9 teeth, each tooth consisting of 2-3 cells, 1-2 cells long. Underleaves closely imbricate, broadly orbicular, 300-350 µm long, 310-570 µm wide, margins entire, apex truncate, base cuneate, insertion line shallowly curved. Generative structures not seen.

Specimens examined: INDONESIA. **Banten**, Pulau Panaitan, *van Borssum Waalkes 549* (BO!). **West Java**, Depok, Kampus Universitas Indonesia, 60-80 m, *Afiatri Putika 80* (BO!).

Distribution: Java, Sumatra, Borneo, Philippines, Moluccas, Papua, Peninsular Malaysia, Indochina, India, Sri Lanka.

Notes: Diagnostic characters of *Acrolejeunea fertilis* are: 1) lobule semicircular with 4-9 teeth, 2) lobe ovate-orbicular with entire margins, 3) trigones cordate. The species occurs in the lowlands, at *ca* 60-80 m, and is distinguished from other Javanese members of the genus *Acrolejeunea* by the squarrose leaves and the semicircular lobule with 4-9 teeth.

3. ***Acrolejeunea pycnoclada*** (Taylor) Schiffn., in Engler and Prantl, Nat. Pflanzenfam. 1, 3: 128 (1893); *Ptychanthus pycnocladus* Taylor, London J. Bot. 5: 385 (1846); *Ptychocoleus pycnocladus* (Taylor) Steph., Sp. Hepat. 5: 52 (1912). –**Type**: Peninsular Malaysia, without loc., *Cantor s.n.* (holotype, FH; isotypes, G, MANCH, NY, S, U, W) – cf. Gradstein *et al.* (2002).

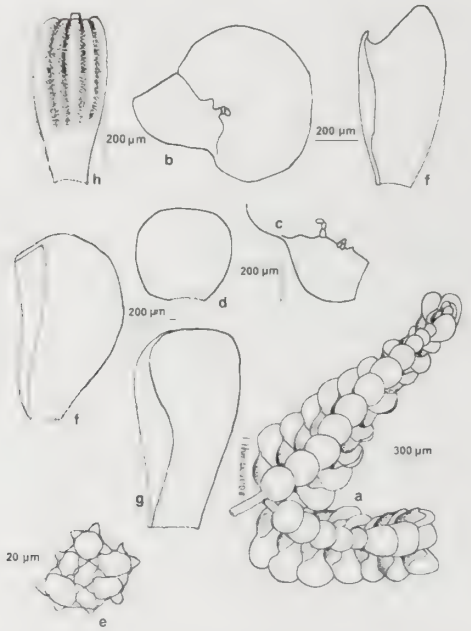

Figure 3. *Acrolejeunea pycnoclada*; (Taylor) Schiffn. Shoot (a); leaf lobe (b); leaf lobule (c); underleaf (d); leaf cells (e); female bract (f); female bracteole (g); perianth (h). Drawn from *Haerida 1484*, BO.

Autoicous. Plants up to 2 cm long, 0.5-0.7 mm wide, 1-1.5 mm wide in wet condition; dull green when fresh, greenish-brown in dried condition. Branching *Lejeunea*-type. Stem diameter 100-145 µm; cross-section of the stem with epidermis cells larger than medulla cells Leaves imbricate, widely spreading, convolute when dry. Lobe ovate, 680- 1050 µm long, 370-850 µm wide, margin entire, apex rounded; cells of lobe thin-walled, hyaline, in mid-

leaf elongate, trigones cordate, intermediate thickening frequent; marginal cells 7-16 × 6-13 µm, mid-leaf cells 17-31 × 11-25 µm, basal cells 24-52 × 11- 31 µm; oil bodies (7-)8-20 per cell, homogeneous, hyaline, globose to ellipsoidal. Lobule ovate to rectangular, large, 365-680 µm long, 170-310 µm wide, inflated, apex obliquely truncate with 2 conspicuous teeth, first tooth consisting of 3-4 cells, second tooth consisting of 2-3 cells, an additional small tooth present at the distal end of the free margin beyond the first tooth. Underleaves distant to contiguous, obovate-orbicular to wider than long, 270-480 µm long, 350-700 µm wide, margin entire, apex rounded to almost truncate, base cuneate, insertion line shallowly curved. Androecia intercalary on branches, bracts in 3-11 pairs, very similar to leaves but lobules slightly larger, 400-420 µm long, 180-250 µm wide, bract lobule 1/2-2/3 of the bract lobe, epistatic, bracteoles similar to underleaves in size and shape. Gynoecia on short or long branches, innovations lacking, bracts and bracteoles in 2 pairs, bract oblong to broadly oblong 720-1070 µm long, 270-500 µm wide, conspicuously incurved in the upper part, margin entire, apex obtuse to orbicular, sinus up to 1/3 of lobe length; bracteole oblong to broadly oblong 890-1010 µm long, 520-660 µm wide, margin entire to slightly undulate, apex truncate. Perianth immersed, obovate, 975 µm long, 430 µm wide, inflated, with ± 10 inflated keels, margins entire. Sporophytes and asexual reproduction not seen.

Distribution: Java, Sumatra, Borneo, Moluccas, Philippines, Papua New Guinea, Pacific, Peninsular Malaysia, Thailand, India, Sri Lanka, tropical Africa.

Specimens examined: INDONESIA. **West Java**, G. Gede, above Sukabumi, 1500-1900 m, *Verdoorn 46b* (BO!); Ciater, Subang, Sari Ater, *ca* 1500 m, *Haerida 1480, 1481, 1484, 1486, 1487* (BO!).

Notes: Diagnostic characters of *Acrolejeunea pycnoclada* are: 1) lobule with 2 conspicuous teeth and an additional, third small tooth present at the distal end of the free margin, beyond the first tooth, 2) trigones cordate, 3) female bracts conspicuously incurved in the upper part, covering the immersed perianth, 4) perianth with 10 keels. This species was found at ca 1500-1900 m but it has also been recorded at lower elevations, from sealevel upwards. It differs from other members of the genus *Acrolejeunea* by the lobule with 2 conspicuous teeth and a 3rd small tooth at the very end of the free margin, near the junction with the ventral margin of the leaf lobe, and by the conspicuously incurved female bracts.

4. ***Archilejeunea planiuscula*** (Mitt.) Steph., Sp. Hepat. 4: 731 (1911) : *Lejeunea planiuscula* Mitt., J. Proc. Lin.. Soc. 5: 111 (1861). –**Type**: Burma.

Rangoon, *McClelland s.n.* (holotype, NY) – cf. Thiers and Gradstein (1989).
- *Archilejeunea caramuensis* Steph., Hedwigia 34: 59 (1895). –Type: Philippines.Caramuan, 1884-85, *Micholitz 70* (G) – cf. Verdoorn (1934).
- *Archilejeunea falcata* Steph., Hedwigia 34: 60 (1895). –Type: Papua New Guinea. Madang Prov.: Stephansort, 1888, *Kärnbach s.n.* (G) – cf. Verdoorn (1934).
- *Mastigolejeunea paradoxa* Verd., Nova Guinea 18:5 (1935). –Type: Indonesia. West Irian, Jayawijaya Prov., Prauwenbivak, *Lam 1182a* (holotype, FH) – cf. Gradstein *et al.* (2002).

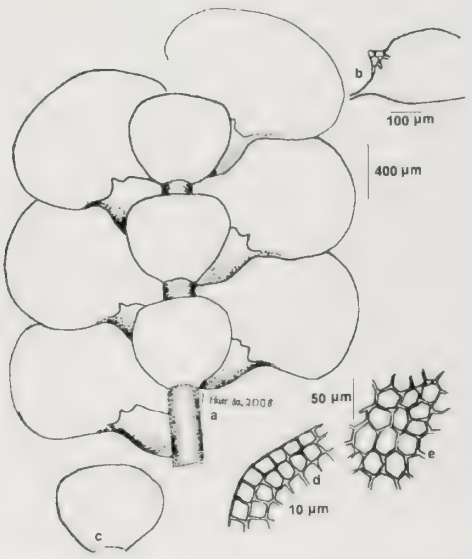

Figure 4. *Archilejeunea planiuscula* (Mitt.) Steph. Shoot (a); leaf lobule (b); underleaf (c); cells of leaf margin (d); cells of midleaf (e). Drawn from *Haerida 1489*, BO.

Plants up to 3 cm long, 0.8-2 mm wide; light green when fresh, darker green in dried condition. Branching *Lejeunea*-type. Stem diameter 90-135 µm; epidermis cells not large than inner cells; ventral merophyte 4-6 cells wide. Leaves contiguous, widely spreading. Lobe orbicular to oblong, 500-900 µm long, 370-700 µm wide, margin entire, apex rounded; cells of lobe thin-walled, hyaline, isodiametrical hexagonal, trigones triangular, never cordate, intermediate thickening scarce; marginal cells 3.5-7.5 × 5-10 µm, mid-leaf cells 17-24 × 14-18 µm, basal cells 22-37 × 13-17 µm; oil bodies not seen. Lobule ovate, 240-340 µm long, 130-200 µm wide, apex obliquely truncate with 1-2 teeth, first tooth with 2 cells long, second tooth small, 1 cell long, sometimes lacking. Underleaves distant to contiguous, obdeltoid, 280-420 µm long, 260-460 µm wide, margin entire, apex truncate, insertion line almost straight. Generative structures not seen [innovations present; perianth with 5 smooth or weakly toothed keels].

Specimens examined: INDONESIA. **West Java**. Bogor Bot. Garden. *Verdoorn 12a, 12b, 12c, 12e, 131, 134, 232, Meijer B55a, B61a, B49, B76, B3664, B27a, B56, B84a* (BO!); Cibodas Bot. Garden, 1450 m, *Schiffner 233, Haerida 813* (BO!); Ujung Kulon Nat. Park, *Dewi Dw922* (BO!).

Distribution: Java, Peninsular Malaysia, Papua New Guinea, Philippines, Solomon Is., Pacific, Australia, Indochina, India, Sri Lanka.

Notes: Diagnostic characters of *Archilejeunea planiuscula* are: 1) underleaves obdeltoid, 2) trigones triangular, never cordate, 3) plant light green in color when fresh. This species was found at *ca* 200-1450 m. It is readily distinguished from other members of the subfamily by the rather light green color and flat appearance of the plants, lobules with 1-2 teeth, isodiametrical leaf cells with small, simple trigones, obdeltoid underleaves and thin stems (ventral merophyte 4-6 cells wide) with epidermis cells not larger than inner cells.

5. ***Lopholejeunea applanata*** (Reinw. *et al.*) Schiffn., in Engler and Prantl, Nat. Pflanzenfam. 1, 3: 129 (1893); *Jungermannia applanata* Reinw. *et al.*, Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 210 (1824); *Phragmicoma applanata* (Reinw. *et al.*) Nees, Naturgesch. Eur. Leberm. 3: 248 (1838); *Lejeunea applanata* (Reinw. *et al.*) Nees, in Gottsche *et al.*, Syn. Hepat.: 314 (1845); *Symbiezidium applanatum* (Reinw. *et al.*) Trevis., Mem. Reale Ist. Lombardo Sci., Cl. Sci. Mat., Ser. 3, 4: 403 (1877). –**Type**: Indonesia, Java, collector unknown (holotype, STR; isotypes, G, S, W) – cf. Zhu and Gradstein (2005).
- *Lopholejeunea fleischeri* Steph., Sp. Hepat. 5: 79. 1912. –Type: Indonesia, Java, Tjibodas, Apr 1900, *M. Fleischer s.n.* (holotype, G) – cf. Zhu and Gradstein (2005).

Plants up to 5 cm long, 1-1.5 mm wide; dark brown in the dried condition. Branching *Lejeunea*-type. Stem diameter 120-200 µm Leaves imbricate, widely spreading. Lobe ovate, 800-1200 µm long, 500-800 µm wide, margin entire sometimes crenulate towards the apex, apex acute to acuminate; cells of lobe thick-walled, yellow, rectangular to isodiametric, trigones triangular, intermediate thickening frequent; marginal cells 15-21 × 12-15 µm, mid-leaf cells 26-30 × 20-24 µm, basal cells 30-40 × 20-31 µm; oil bodies not seen. Lobule ovate, 230-320 µm long, 170-220 µm wide, inflated, apex truncate with 1 small tooth, connected to the leaf lobe across only one single cell. Underleaves large, imbricate, broadly orbicular, 300-400 µm long, 400-900 µm wide, margin entire, apex truncate, insertion line deeply curved. Androecia intercalary on branches, bracts in 3-12 pairs, ovate with obtuse apex, 200-300 µm long, 150-220 µm wide, bract lobule about ½ of the lobe

length; bracteoles similar to underleaves in size and shape. Gynoecia not seen.

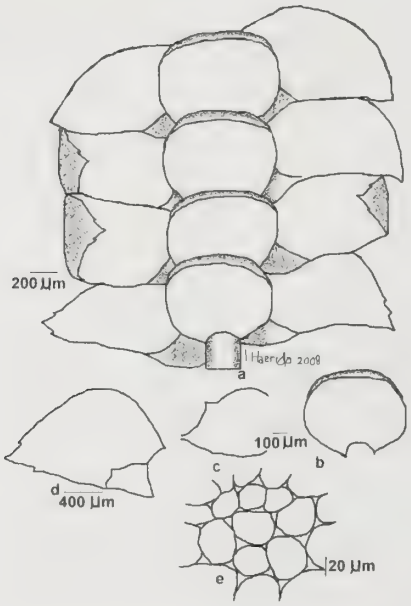

Figure 5. *Lopholejeunea applanata* (Reinw. *et al.*) Schiffn. Shoot (a); underleaf (b); leaf lobule (c); leaf lobe (d); cells of midleaf (e). Drawn from *Meijer 3696*, BO.

Distribution: Java, Sumatra, Borneo, Philippines, Peninsular Malaysia, Papua New Guinea, Pacific, Indochina, Sri Lanka, India.

Specimens examined: INDONESIA. **West Java**, Cibodas Bot. Garden, *Meijer B3696* (BO!); above Cibodas, Cibeureum, *Hasskarl s.n.* (BO!); G. Pangrango, "bij Tjisaroea" *ca* 1200 m, *Verdoorn 44b* (BO!); G. Patuha, Lake Situ Patengan, *ca* 1500 m, *Kornochalert 1413* (BIOT!).

Notes: Diagnostic characters of *Lopholejeunea applanata* are: 1) leaf lobes acute to acuminate at apex, 2) lobule apex connected to the lobe across only one single cell. This species grows at *ca* 1200-1500 m. It differs from other Javanese members of the genus *Lopholejeunea* by the acute to acuminate leaf apex and large, imbricate underleaves.

6. ***Lopholejeunea eulopha*** (Taylor) Schiffn., in Engler and Prantl, Nat. Pflanzenfam. 1, 3: 129 (1893); *Lejeunea eulopha* Taylor, London J. Bot. 5: 391 (1846); *Phragmicoma eulopha* (Taylor) Mitt., in Seeman, Fl. Vit. 413 (1873); *Symbiezidium eulophum* (Taylor) Trevis., Mem. Reale Ist. Lombardo Sci., Cl. Sci. Mat., Ser. 3, 4: 403 (1877). –**Type**: Pacific islands: locality unknown,

Nightingale s.n. (holotype, FH; isotypes, FH, NY) – cf. Zhu and Gradstein (2005).
- *Lopholejeunea nymannii* Steph., Sp. Hepat. 5: 84. 1912. –Type: Indonesia. Java, G. Salak, *E. Nyman s.n.* (holotype, G; isotype, W) – cf. Zhu and Gradstein 2005.

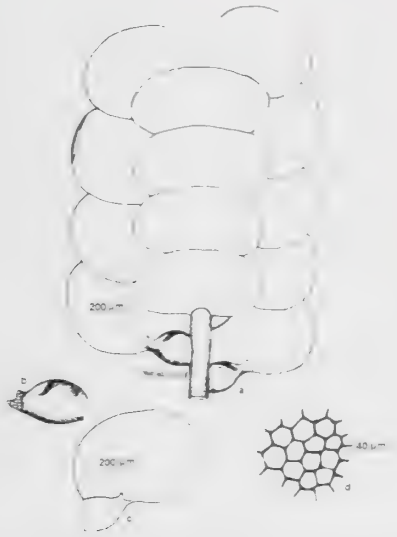

Figure 6. *Lopholejeunea eulopha* (Taylor) Schiffn. Shoot (a); leaf lobule (b); leaf lobe (c); cells of midleaf (d). Drawn from *Haerida 710*, BO.

Dioicous, sometimes autoicous. Plants up to 3 cm long, 1-1.5 mm wide, brownish green to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 130-190 µm. Leaves imbricate, widely spreading. Lobe oblong-ovate, 430-1090 µm long, 340-900 µm wide, margin entire, apex obtuse; cells of lobe thin-walled, pale brown, hexagonal to nearly isodiametric, trigones triangular, intermediate thickening frequent; marginal cells 7-15 × 10-17 µm, mid-leaf cells 14-31 × 10-21 µm, basal cells 22-40 × 18-24 µm; oil bodies (11-)18-20 per cell, homogeneous, hyaline, ellipsoidal. Lobule ovate, 120-270 µm long, 110-200 µm wide, inflated, apex with 1 triangular tooth consisting of 3-5 cells, connected to the leaf lobe by only one single cell. Underleaves imbricate, large, reniform, 300-500 µm long, 410-1070 µm wide, margin entire, apex rounded, insertion line deeply curved. Generative structures not seen.

Specimens examined: INDONESIA. **West Java**, Bogor Bot. Garden, *Meijer 94b, Schiffner 245, van Steenis s.n.* (BO!); Bogor, without locality, *Verdoorn s.n.* (BO!); Cibodas Bot. Garden, 1400 m, *Ariyanti 471* (BIOT!); G. Halimun Nat. Park, *Haerida 710* (BO!); G. Guntur, "bij Kawah Kamoedjan" 1500-1700 m.alt., *Verdoorn 50h, 50d* (BO!); G. Megamendung, *Verdoorn 68* (BO!);

Kota Batu. *Schiffner s.n.* (BO!): Kampung Jember, Geger Bentang ca 1350 m, *Neervoort 3087* (BO!): Ujung Kulon Nat. Park, *Dewi Dw922d* (BO!): G. Patuha, Lake Situ Patengan ca 1500 m, *Kornochalert 1418*, *Dian Apriana & Afiatri Putrika 25* (BIOT!).

Distribution: Java, Sumatra, Borneo, Bali, Sulawesi, Moluccas, Philippines, West Irian, Papua New Guinea, Solomon Is., Pacific, Australia, Indochina, India, Sri Lanka, China, Japan, tropical Africa, tropical America.

Notes: Diagnostic characters of *Lopholejeunea eulopha* are: 1) lobule ovate, with 1 triangular tooth consisting of 3-5 cells, 2) lobule apex connected to the leaf lobe across only one cell, 3) large, reniform underleaves. This common species grows at *ca* 200-1700 m. It resembles *L. applanata* by the very large, imbricate underleaves but differs by the rounded leaf apex.

7. ***Lopholejeunea herzogiana*** Verd., Rec. Trav. Bot. Neerl. 30: 217 (1933). – **Type**: Indonesia, Java, Cibodas, "ad arborum truncos," 1420 m, 1894, *Schiffner s.n.* (FH, lectotype designated by Zhu and Gradstein, 2005).
– *Lopholejeunea pullei* Verd., Nova Guinea 18: 4 (1935). –Type: Indonesia, Irian Jaya, Hellwig Mts., "an Gymnospermen", 2600 m, 10 Jan 1913, *Pulle s.n.* (holotype, FH; isotype, U) – cf. Zhu and Gradstein 2005.

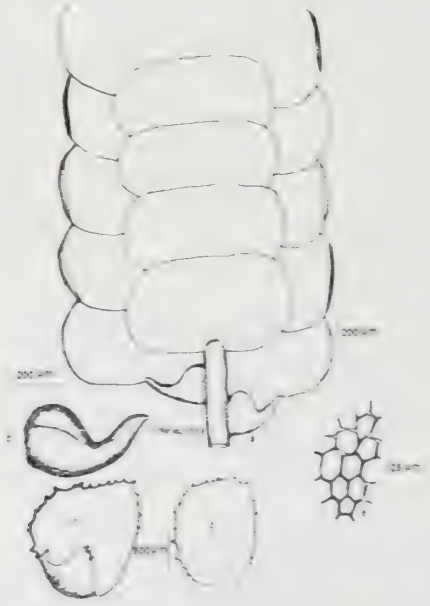

Figure 7. *Lopholejeunea herzogiana* Verd. Shoot (a); leaf lobule (b); female bract (c); female bracteole (d); cells of midleaf (e). Drawn from *Verdoorn 64a*, BO.

Plants robust, up to 4 cm long, 1-2.5 mm wide; blackish brown in the dried condition. Branching *Lejeunea*-type. Stem diameter 130-220 µm Leaves imbricate, widely spreading. Lobe obovate-triangular to broadly orbicular, 650-1050 µm long, 660-1420 µm wide, margin entire, apex obtuse to rounded, sometimes recurved; cells of lobe thick-walled, brownish-orange, rectangular to hexagonal, trigones triangular, intermediate thickening frequent; marginal cells 12-18 × 12-17 µm, mid-leaf cells 21-26 × 20-30 µm, basal cells 24-50 × 20-30 µm; oil bodies not seen. Lobule ovate, large, 300-540 µm long, 220-310 µm wide, inflated, free margin strongly involuted and with a conspicuous constriction in the middle, connected to the leaf lobe across only one single cell. Underleaves closely imbricate, reniform to transversely rectangular, 400-520 µm long, 600-1310 µm wide, margin entire, apex truncate, insertion line deeply curved. Androecia not seen. Gynoecia on short or long branches, innovations lacking, bracts and bracteoles in 1-2 pairs, bract ovate to nearly rectangular, 2-3 mm long, 1.5-2 mm wide, margin toothed, apex truncate, sinus up to 1/2 of lobe length, bract lobule ovate, margin ciliate-dentate, apex truncate to nearly acute; bracteole oblong 1.3-2.2 mm long, 0.5-1.4 mm wide, margin toothed, apex rounded. Perianth immersed, obovate, 550 µm long, 530 µm wide, inflated, with 5-7 keels, margins widely winged and toothed. Sporophytes and asexual reproduction not seen.

Specimens examined: INDONESIA. **West Java**, Telaga Warna, Puncak Pass, *ca* 1500 m, *Verdoorn 64a* (BO!); Cibodas Bot. Garden, *Meijer B3800b* (BO!); G. Pangerango, "bij Tjisaroea", *ca* 1200 m, *Verdoorn 44c* (BO!).

Distribution: Java, Peninsular Malaysia, West Irian, Papua New Guinea, New Caledonia.

Notes: Diagnostic characters of *Lopholejeunea herzogiana* are: 1) strongly winged and toothed obovate perianth, 2) lobule conspicuously constricted in the middle and with strongly involuted free margin, 3) lobule apex connected to the leaf lobe across only one single cell, 4) large, ± reniform underleaf with deeply curved insertion line. This rare species was found at ca 1200-1500 m, and usually grows in the mountains at higher elevation. It is readily separated from other species of the genus by the peculiar lobule with deep constriction in the middle.

8. ***Lopholejeunea nigricans*** (Lindenb.) Schiffn., Consp. Hepat. Arch. Ind. 293 (1898): *Lejeunea nigricans* Lindenb., in Gottsche *et al.*, Syn. Hepat. 316 (1845); *Symbiezidium nigricans* (Lindenberg) Trevis., Mem. Reale Ist. Lombardo Sci., Cl. Sci. Mat., Ser. 3, 4: 403 (1877). –**Type**: Indonesia, Java, without locality, collector unknown (holotype, W; isotypes, G, S) – cf. Zhu and Gradstein (2005).

– *Lejeunea intermedia* Lindenb., in Gottsche *et al.*, Syn. Hepat. 316 (1845); *Symbiezidium intermedium* (Lindenberg) Trevis., Mem. Reale Ist. Lombardo Sci., Cl. Sci. Mat., Ser. 3, 4: 403 (1877); *Lopholejeunea intermedia* (Lindenberg) Steph., Sp. Hepat. 5:77 (1912). Type: Indonesia. Java, without locality, collector unkown (holotype, W) – cf. Zhu and Gradstein 2005.
– *Lejeunea javanica* Nees, in Gottsche *et al.*, Syn. Hepat. 320 (1845); *Symbiezidium javanicum* (Nees) Trevis., Mem. Reale Ist. Lombardo Sci., Cl. Sci. Mat., Ser. 3, 4: 403 (1877); *Lopholejeunea javanica* (Nees) Schiffn., in Engler and Prantl, Nat. Pflanzenfam. 1, 3: 129 (1893). –Type: Indonesia. Java, without locality, collector unknown (holotype, W; isotypes, G, S) – cf. Zhu and Gradstein (2005).

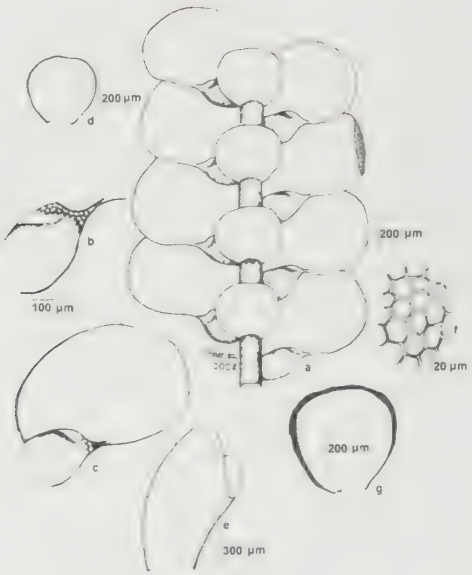

Figure 8. *Lopholejeunea nigricans* (Lindenb.) Schiffn. Shoot (a); leaf lobule (b); leaf lobe (c); underleaf (d); female bract (e); cells of midleaf (f); female bracteole (g). Drawn from *Meijer 387c*, BO.

Plants up to 1 cm long, 0.5-0.7 mm wide, blackish brown in dried condition. Branching *Lejeunea*-type. Stem diameter 40-110 µm Leaves imbricate, widely spreading. Lobe oblong-orbicular, 250-500 µm long, 200-400 µm wide, margin entire, apex rounded; cells of lobe thick-walled, dark brown, isodiametric to hexagonal, trigones triangular, intermediate thickening scarce; marginal cells 6-10 × 5-10 µm, mid-leaf cells 16-22 × 7-20 µm, basal cells 20-28 × 16-20 µm; oil bodies not seen. Lobule ovate, 120-230 µm long, 80-150 µm wide, inflated, apex obliquely truncate, plane, connected to the leaf lobe across only one single cell. Underleaves distant to contiguous, obdeltoid to orbicular, 120-200 µm long, 150-190 µm wide, margin entire,

apex rounded to almost truncate, insertion line shallowly curved. Androecia not seen. Gynoecia on short or long branches, innovations lacking, bract oblong, 510-700 µm long, 270-330 µm wide, margin entire, apex obtuse to orbicular, sinus up to 2/3 of lobe length, bract lobule about the same length as the bract lobe; bracteole obdeltoid to orbicular 330-700 µm long, 350-500 µm wide, margin entire, sometimes recurved, apex broadly rounded. Perianth exserted, obovate, 300-900 µm long, 250-500 µm wide, inflated, with 4 keels, margins toothed. Sporophytes and asexual reproduction not seen.

Distribution: Java, Sumatra, Borneo, Sulawesi, Moluccas, West Irian, Papua New Guinea, Australia, Peninsular Malaysia, Philippines, Indochina, India, Bhutan, Nepal, China, Japan, tropical Africa, tropical America.

Specimens examined: INDONESIA. **West Java**, without locality, collector unknown (BO!); Bogor Bot. Garden, *van Borssum Waalkes 122*, *Meijer B995*, *B368*, *55d4*, *Verdoorn 242* (BO!); Telaga Warna, Puncak Pass, 1500 m, *Verdoorn 64d*, *64b* (BO!); G. Pangrango, "Tjisaroea", *ca* 1200 m, *Verdoorn 44a* (BO!); G. Guntur, "Kawah Kamoedjan", 1500-1700 m, *Verdoorn 50c* (BO!).

Notes: Diagnostic characters of *Lopholejeunea nigricans* are: 1) ovate leaf lobules, apex of lobule connected to the leaf lobe across only one single cell, 2) entire margin of female bract and bracteole, 3) female bract lobule of almost the same length as the bract lobe, 4) perianth long exserted beyond the bracts, with 4 toothed keels (rarely entire). This species was found at *ca* 200-1700 m. It is separated from other species of the genus by the combination of characters mentioned above.

9. ***Lopholejeunea ceylanica*** Steph., Sp. Hepat. 5: 86 (1912). –**Type**: Sri Lanka, Horton Plain, *Giesenhagen s.n.* (G, lectotype designated by Verdoorn, 1934).
– *Lopholejeunea levieri* Schiffn., Ann. Bryol. 6: 134 (1933). –Type: Indonesia, Sumatra, Mt. Singalang, "inter *Riccardiam hymenophylloideum*", 1878, *Beccari s.n.* (holotype, FH) – cf. Zhu and Gradstein (2005).
–*Lopholejeunea schiffneri* Verd., Ann. Bryol. 6: 134 (1933). –Type: Indonesia, Java, Cibodas, "ad cortices," Jan 1895, *Massart 1546 p.p.* (holotype, FH) – cf. Zhu and Gradstein (2005).

Dioicous. Plants up to 1.5 cm long, about 0.8 mm wide; blackish brown in the dried condition. Branching *Lejeunea*-type. Stem diameter 90-120 µm. Leaves imbricate, widely spreading. Lobe ovate-orbicular, 450-870 µm long, 350-750 µm wide, margin entire, apex rounded to obtuse; cells of lobe thick-walled,

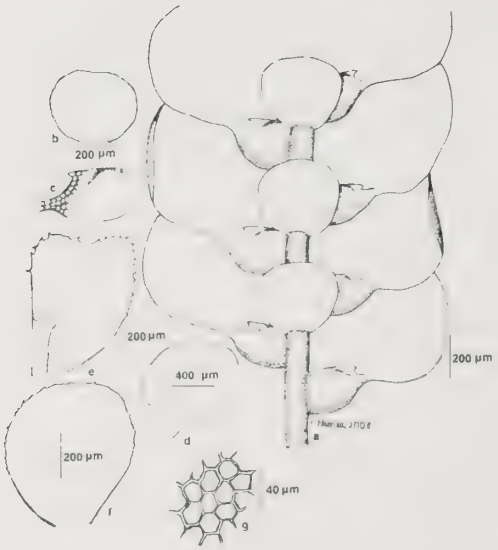

Figure 9. *Lopholejeunea ceylanica* Steph. Shoot (a); underleaf (b); leaf lobule (c); leaf lobe (d); female bract (e); female bracteole (f); cells of midleaf (g). Drawn from *Haerida 1479*, BO.

brown, hexagonal to isodiametric, trigones triangular, intermediate thickening scarce; marginal cells 8-11 × 4-8 µm, mid-leaf cells 14-30 × 15-23 µm, basal cells 27-32 × 22-25 µm; oil bodies not seen. Lobule oblong 250-450 µm long, 200-300 µm wide, inflated, apex truncate with 1 small, unicellular tooth pointing towards the leaf apex, connected to the leaf lobe across 2-3 cells. Underleaves distant, orbicular, 150-300 µm long, 190-350 µm wide, margin entire, apex rounded, insertion line nearly straight. Androecia intercalary on branches, bracts in 5-9 pairs, similar to leaves but lobules larger, 400-430 µm long, 250-350 µm wide, bract lobule about 2/3 of the bract lobe, bracteoles similar to underleaves in size and shape. Gynoecia on short or long branches, innovations lacking, bract oblong to broadly obovate 1000-1370 µm long, 1050-1200 µm wide, margin crenate, apex truncate to orbicular, bract lobule large, about the same length as the bract lobe, oblong, margin entire, apex acute; bracteole obovate 900-1200 µm long, 1050-1100 µm wide, margin entire, crenulate towards the apex, apex rounded. Perianth immersed, obovate, 850 µm long, 630 µm wide, inflated, with 4 keels, margins toothed. Sporophytes and asexual reproduction not seen.

Specimens examined: INDONESIA. **West Java**, Telaga Warna, *Haerida 1479* (BO!); Cibodas Bot. Garden, *ca* 1450 m, *Meijer B3801, 3810, Neervoort 811, 3353* (BO!); G. Pangrango, tea estate Mandalawangi, *ca* 1600 m, *Meijer B387g* (BO!); G. Gede, Kandang Badak 2400 m, subalpine forest (forest canopy *ca* 10 m high), common on tree trunks, *Gradstein10241* (BIOT!, GOET!);

G. Cikurai, W slope, *ca* 1700 m, *Verdoorn 59j* (BO!); Cigombong (Pondok Gedelanden), *ca* 500 m, *Verdoorn 43c* (BO!); G. Patuha, *Kornochalert 1405* (BIOT!).

Distribution: Java, Sumatra, Borneo, Peninsular Malaysia, Sri Lanka, Indochina.

Notes: Diagnostic characters of *Lopholejeunea ceylanica* are: 1) lobule large, *ca* ½ x leaf length, with one small, unicellular tooth pointing towards the leaf apex, 2) apex of leaf- lobule attached to the lobe across 2-3 cells, 3) crenate margin of female bract, 4) female bract lobule large, acute. This species grows at *ca* 500-2400 m. It resembles the very common *L. subfusca* but differs by the more brownish color, the larger lobule (*ca* ½ × leaf length; in *L. subfusca ca* 1/3 × leaf length) and the large lobule of the female bract (very small in *L. subfusca*).

10. ***Lopholejeunea horticola*** Schiffn., Ann. Bryol. 6: 133 (1933). –**Type**: Indonesia. Java, Bogor Bot. Garden, on trees ("In horto Buitenzorgensi ad arbores"), Dec 1894, *Massart 941* (holotype, FH; isotypes, FH, W) – cf. Zhu and Gradstein (2005).
– *Lopholejeunea glomerata* Herzog, Ann. Nat. Mus. Wien 53: 370 (1942). –Type: Indonesia. Sumatra, Padang, *Schild 119* (holotype, W) – cf. Zhu and Gradstein (2005).

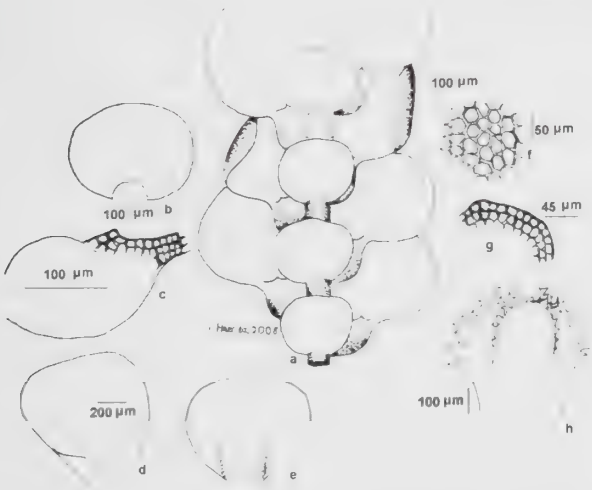

Figure 10. *Lopholejeunea horticola* Schiffn. Shoot (a); underleaf (b); leaf lobule (c); female bract (d), female bracteole (e); cells of midleaf (f); cells of margin of leaf (g); perianth (h). Drawn from *Haerida 809*, BO.

Dioicous. Plants up to 2 cm long, 0.6-0.9 mm wide, dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 90-190 µm Leaves imbricate, obliquely spreading. Lobe orbicular, oblong to quadrate, 450-800 µm long, 270-600 µm wide, margin entire, apex rounded to obtuse; cells of lobe thick-walled, dark brown, hexagonal, trigones triangular, intermediate thickening scarce; marginal cells 7-10 × 6-8 µm, mid-leaf cells 17-27 × 11-23 µm, basal cells 28-36 × 18-30 µm; oil bodies not seen. Lobule ovate, 190-360 µm long, 120-200 µm wide, inflated, apex obliquely truncate, plane, sometimes with 1 small tooth, connected to the leaf lobe across 2-3 cells. Underleaves distant to contiguous, broadly-orbicular, 200-350 µm long, 330-610 µm wide, margin entire, bases cuneate, apex rounded to almost truncate, insertion line nearly straight. Androecia intercalary on branches, bracts in 3-11 pairs, similar to leaves but lobules larger, 190-230 µm long, 140-180 µm wide, bract lobule 2/3 of the bract lobe, strongly inflated, bracteoles similar to underleaves in size and shape, 100-180 µm long, 120-200 µm wide. Gynoecia on short or long branches, innovations lacking, bract obovate or oblong ± 1200 µm long, 900 µm wide, margin entire, apex obtuse to truncate, bract lobule large, about the same length as the bract lobe, oblong, margin entire, apex obliquely truncate; bracteole obovate, about 800 µm long, 900 µm wide, margin entire, apex truncate. Perianth immersed, obovate, about 800 µm long, 570 µm wide, inflated, with 4 keels, margins strongly toothed. Sporophytes and asexual reproduction not seen.

Specimens examined: INDONESIA. **West Java**, Cibodas Bot. Garden, *Neervoort 2098* (BO!); G. Gede, Cibeureum, above "Soekaboemi", 1200-1400 m, *Verdoorn 47b, 47a, 46 c* (BO!); G. Gede Pangrango Nat. Park, Bodogol, *Haerida 809* (BO!); G. Malabar, SW slope, *ca* 1650 m, *Verdoorn 62a* (BO!); G. Guntur, "Kawah Kamoedjan", *ca* 1500-1700 m, *Verdoorn 50a* (BO!); G. Gegerbentang, E slopes, *ca* 1500-2000 m, *Verdoorn 67h* (BO!); without locality, Pondok, *Kurz s.n.* (BO!); G. Patuha, *ca* 2000-2400 m, *Verdoorn 60a* (BO!).

Distribution: Java, Sumatra, Bali, Moluccas, Peninsular Malaysia, Thailand.

Notes: Diagnostic characters of *Lopholejeunea horticola* are: 1) minute plant, less than 1 mm wide, 2) lobule apex connected to the leaf lobe across 2-3 cells, 3) female bract lobule almost as large as the lobe, 4) margins of female bract entire, 5) immersed perianth. This species grows at *ca* 800-2400 m. It closely resembles the very common *L. subfusca* but differs by the much smaller plant size and the large female bract lobule (very small in *L. subfusca*).

11. ***Lopholejeunea recurvata*** Mizut., J. Hattori Bot. Lab. 46: 369 (1979). –**Type**: Indonesia. Java, Gn. Gede, Cibodas, 1420 m, on bark of trees, Jun 1930, *F. Verdoorn s.n.* (holotype, NICH; isotypes, FH, JE, L, S, U) – cf. Zhu and Gradstein (2005).

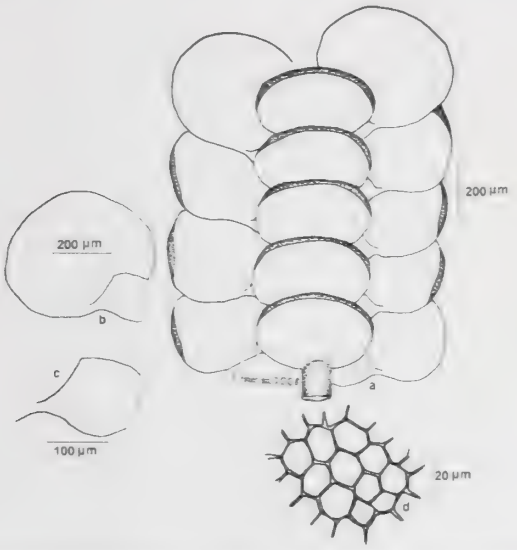

Figure 11. *Lopholejeunea recurvata* Mizut. Shoot (a); leaf lobe (b); leaf lobule (c); cells of midleaf (d). Drawn from *Verdoorn 20f*, BO.

Autoicous. Plants up to 1.5 cm long, 1-1.2 mm wide; dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 60-130 µm. Leaves imbricate, widely spreading. Lobe oblong-rectangular, 430-760 µm long, 390-530 µm wide, margin entire, apex truncate; cells of lobe thick-walled, brownish-orange, hexagonal to isodiametric, trigones triangular, intermediate thickening scarce; marginal cells 6-11 × 6-9 µm, mid-leaf cells 13-20 × 10-17 µm, basal cells 26-33 × 11-19 µm; oil bodies not seen. Lobule ovate, 160-220 µm long, 130-180 µm wide, inflated, apex obliquely truncate, plane, connected to the leaf lobe across 2-3 cells. Underleaves contiguous to imbricate, wider than long, 150-250 µm long, 220-400 µm wide, margin entire, apex recurved, rounded to almost truncate, insertion line curved. Androecia intercalary on branches, bracts in 4-8 pairs, similar to leaves but lobules larger, 200-250 µm long, 100-150 µm wide, bract lobule 1/2-2/3 of the bract lobe, bracteoles similar to underleaves in size and shape. Gynoecia not seen.

Specimen examined: INDONESIA. **West Java**, Cibodas Bot. Garden, *Verdoorn 20f* (BO!).

Distribution: Java, Sumatra, Bali, Peninsular Malaysia, Papua New Guinea.

Notes: Diagnostic characters of *Lopholejeunea recurvata* are: 1) recurved margins of leaf lobes and underleaves, 2) lobule apex connected to the leaf lobe across 2-3 cells. This rare species grows at *ca* 500-1900 m. It differs from other Javanese species of the genus by the recurved leaf margins.

12. ***Lopholejeunea subfusca*** (Nees) Schiffn., Bot. Jahrb. Syst. 23: 593 (1897); *Jungermannia subfusca* Nees, Enum. Pl. Crypt. Jav. 1: 36 (1830); *Lejeunea subfusca* (Nees) Nees & Mont., Ann. Sci. Nat., Bot., Sēr. 2, 5: 61 (1836); *Phragmicoma subfusca* (Nees) Nees, Naturgesch. Eur. Leberm. 3: 248 (1838); *Symbiezidium subfuscum* (Nees) Trevis., Mem. Reale Ist. Lombardo Sci., Cl. Sci. Mat., Ser. 3, 4: 403 (1877); *Lopholejeunea sagraeana* var. β *subfusca* (Nees) Schiffn., Consp. Hepat. Archip. Ind.: 294 (1898). –**Type**: Indonesia. Java, without locality, *Blume s.n.* (holotype, STR; isotypes, W, S) – cf. Zhu and Gradstein (2005).

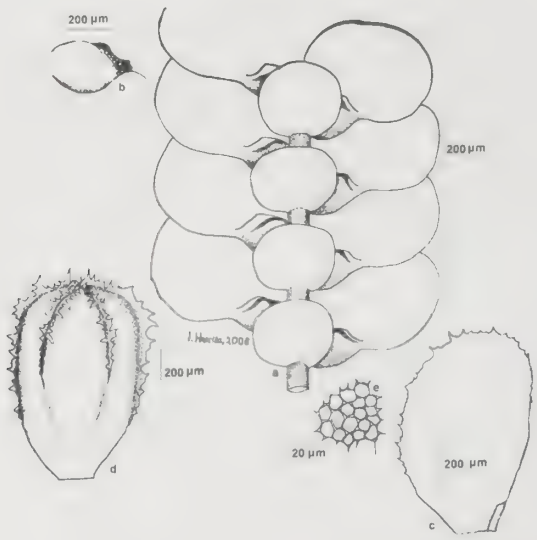

Figure 12. *Lopholejeunea subfusca* (Nees) Schiffn. Shoot (a); leaf lobule (b); female bract (c); perianth (d); cells of midleaf (e). Drawn from *Haerida 850*, BO.

Autoicous. Plants up to 2 cm long, 1-1.3 mm wide, dark brown to black in dried condition. Branching *Lejeunea*-type. Stem diameter 90-120 µm. Leaves imbricate, widely spreading. Lobe oblong-orbicular, 410-700 µm long, 420-620 µm wide, margin entire, apex rounded; cells of lobe thick-walled, pale brown to orange, hexagonal to isodiametric, trigones triangular, intermediate thickening scarce; marginal cells 6-9 × 5-7 µm, mid-leaf cells 17-24 × 15-20 µm, basal cells 22-30 × 16-23 µm; oil bodies not seen. Lobule ovate, small, 180-220 µm long, 120-150 µm wide, inflated, apex obliquely truncate, plane, connected to the leaf lobe across 2-4 cells. Underleaves distant to

contiguous, broadly-orbicular, 220-400 µm long, 340-610 µm wide, margin entire, apex truncate, insertion line shallowly curved. Androecia intercalary on branches, bracts in 3-16 pairs, similar to leaves but lobules larger, 230-430 µm long, 170-320 µm wide, bract lobule almost the same size of the bract lobe, bracteoles similar to underleaves in shape, 170-270 µm long, 180-450 µm wide. Gynoecia on short or long branches, innovations lacking, bracts and bracteoles in 2 pairs, bract ovate to broadly oblong 700-850 µm long, 700-860 µm wide, margin irregularly toothed, apex orbicular to nearly truncate, sinus up to 1/4 of lobe length, bract lobule very small; bracteole broadly orbicular 170-280 µm long, 180-450 µm wide, margin entire, apex rounded. Perianth immersed, obovate, about 870 µm long, 600 µm wide, inflated, with 2 keels, margins toothed. Sporophytes and asexual reproduction not seen.

Specimens examined: INDONESIA. **West Java**, Bogor Bot. Garden, *Meijer 92b, 26b, Verdoorn 124, 141, 249* (BO!); Cibodas Bot. Garden, *Neervoort 952, Verdoorn 20e, 20d, Schiffner 250* (BO!), ibid., *Lee & Nova Indri 49* (BIOT!, UKMB!), ibid., *ca* 1425 m, *Meijer B4017, B3800* (BO!); G. Gede Pangrango Nat. Park, Bodogol, *ca* 800 m, *Haerida 850, 844* (BO!); G. Pangrango, ravine above Kampong G. Mas, *Meijer B616i* (BO!); Geger Bentang, *Neervoort 1344* (BO!); G. Halimun Nat. Park, Citalahab, 1065 m, *Radhiah Zakaria 254c* (BIOT!); G. Papandayan, Tji Paroegpoeg, *ca* 2300-2500 m, *Verdoorn 54b* (BO!); G. Cikurai, W slope, *ca* 1700 m, *Verdoorn 59i* (BO!); G. Patuha, *Kornochalert 1416, 1400* (BIOT!).

Distribution: Java, Sumatra, Borneo, Bali, Sulawesi, Moluccas, Philippines, Papua New Guinea, Pacific, Peninsular Malaysia, Indochina, China, Japan, India, Sri Lanka, Nepal, tropical Africa, tropical America.

Notes: Diagnostic characters of *Lopholejeunea subfusca* are: 1) lobule apex truncate, connected to the leaf lobe across 2-4 cells, 2) very small size of female bract lobule, 3) entire margin of female bracteole, 4) immersed perianth. This very common species is very grows at *ca* 200-2500 m. Like in several other Javanese species of *Lopholejeunea*, the lobule apex is connected to the leaf lobe surface across 2-4 cells; the flat leaves with rounded apex, the orbicular, distant underleaves, the rather small leaf lobule, and the characters of the gynoecium mentioned above, readily separate this species from its relatives.

13. ***Lopholejeunea wiltensii*** Steph., Hedwigia 35: 112 (1896). –**Type**: Indonesia. Sumatra, Padang, *A. Wiltens* (holotype, G) – cf. Zhu and Gradstein (2005).

– *Lopholejeunea serrifolia* Steph., Sp. Hepat. 5: 84 (1912). –Type: Indonesia. Java, without locality, collector unknown (G, lectotype designated by Mizutani, 1979).

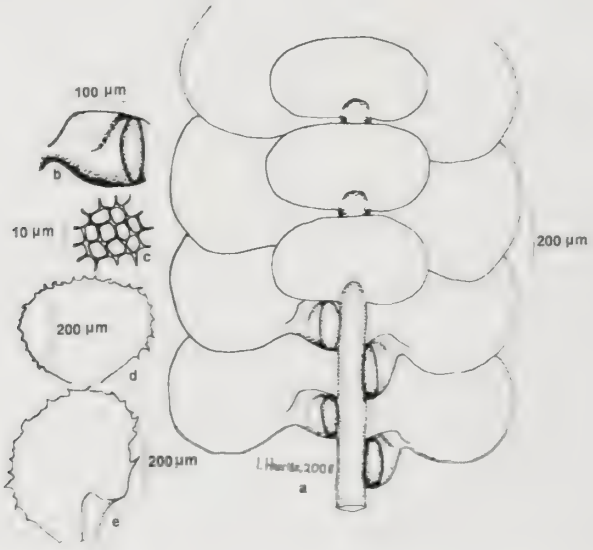

Figure 13. *Lopholejeunea wiltensii* Steph. Shoot (a); leaf lobule (b); cells of midleaf (c); female bracteole (d); female bract (e). Drawn from *Verdoorn 30d*, BO.

Dioicous. Plants up to 4 cm long, 0.9-1.3 mm wide; pale brown in dried condition. Branching *Lejeunea*-type. Stem diameter 50-100 µm Leaves imbricate, widely spreading. Lobe broadly ovate to broadly orbicular, 500-650 µm long, 580-610 µm wide, margin entire, apex rounded; cells of lobe thick-walled, pale yellow, quadrate to isodiametric, trigones triangular, intermediate thickening scarce; marginal cells 5-7 × 2-6 µm, mid-leaf cells 11-13 × 7-10 µm, basal cells 20-25 × 13-23 µm; oil bodies not seen. Lobule triangular to quadrate, small, 190-220 µm long, 110-130 µm wide, inflated at the basal part forming somewhat a longitudinally elliptical sac, apex obliquely truncate with 1 tooth consisting of 1-2 cells, connected to the leaf lobe across 2-3 cells. Underleaves distant to contiguous, reniform, 210-360 µm long, 310-610 µm wide, margin entire, apex rounded to almost truncate, insertion line strongly curved. Androecia not seen. Gynoecia on short or long branches, innovations lacking, bract oblong-ovate to broadly ovate, about 470 µm long, 460 µm wide, margin irregularly toothed, apex obtuse to orbicular, sinus up to 1/3 of lobe length, bract lobule oblong about 1/3 of the bract lobe length, margin entire; bracteole broadly ovate about 350 µm long, 410 µm wide, margin irregularly toothed, apex truncate. Perianth immersed, obovate, about 970 µm long, 670 µm wide, inflated, with 4 keels, margins toothed. Sporophytes and asexual reproduction not seen.

Distribution: Java, Sumatra, Peninsular Malaysia, Philippines, Sulawesi, Moluccas, West Irian, Papua New Guinea, New Caledonia.

Specimens examined: **West Java**, Cibodas Bot. Garden, 1400 m, *Ariyanti 458* (BIOT!), *ibid.*, along the road to Huis ten Bosch, *Meijer B1078* (BO!); above Cibodas, Cibeureum, *Schiffner 252, 253*, *Verdoorn 30d, 30c, 30a* (BO!); G. Gede, Soekaboemi, *Verdoorn 46a* (BO!); G. Pangrango, "Tjisaroea", *ca* 1200 m, *Verdoorn 44a* (BO!); Tugu, tea estate G. Mas, *Meijer & van der Wijk B659b* (BO!); above tea estate G. Mas, Jalan Mandalawangi, *Meijer B335a* (BO!); G. Guntur, "Kawah Kamoedjan", *ca* 1500-1700 m, *Verdoorn 50b* (BO!).

Notes: Diagnostic characters of *Lopholejeunea wiltensii* are: 1) pale color of the plant in the dried condition, 2) lobule small, in the basal part forming a somewhat longitudinally elliptical sac, 3) lobule apex connected to the leaf lobe across 2-3 cells, 4) reniform underleaves. This species grows at *ca* 1200-1900 m. *Lopholejeunea wiltensii* is closely related to *L. zollingeri* and was sometimes considered a synonym of the latter. It differs from *L. zollingeri* by the characters given in the key.

14. ***Lopholejeunea zollingeri*** (Steph.) Schiffn., Consp. Hepat. Arch. Ind.: 296 (1898); *Lejeunea zollingeri* Steph., Hedwigia 29: 14 (1890). –**Type**: Indonesia. Java, without locality, collector unknown (W, lectotype designated by Mizutani, 1979).
– *Lopholejeunea latialata* Mizut., J. Hattori Bot. Lab. 46: 365 (1979). –Type: Indonesia. Java: without locality, collector unknown, ex Herb. Sande Lacoste (holotype, L) – cf. Zhu and Gradstein (2005).

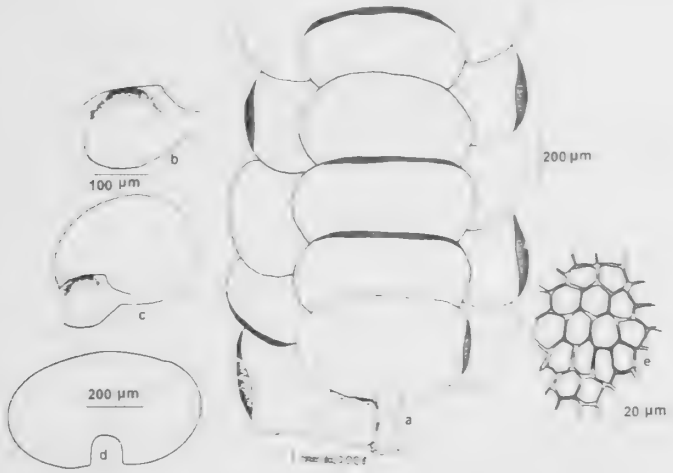

Figure 14. *Lopholejeunea zollingeri* (Steph.) Schiffn. Shoot (a); leaf lobule (b); leaf lobe (c); underleaf (d); cells of midleaf (e). Drawn from *Meijer 387c*, BO.

Autoicous. Plants up to 3 cm long, 0.7-1.2 mm wide, blackish brown in dried condition. Branching *Lejeunea*-type. Stem diameter 60-160 µm. Leaves imbricate, widely spreading. Lobe orbicular to broadly ovate, 200-420 µm long, 230-460 µm wide, margin entire, apex rounded, usually recurved; cells of lobe thick-walled, brown, hexagonal to isodiametric, trigones triangular, intermediate thickening frequent; marginal cells 5-11 × 7-9 µm, mid-leaf cells 11-19 × 9-15 µm, basal cells 25-30 × 19-22 µm; oil bodies not seen. Lobule ovate, large, almost 1/3 of the leaf lobes length, 190-210 µm long, 160-180 µm wide, inflated at the middle part forming a globose sac, apex obliquely truncate with 1 small tooth or without tooth but forming a sharp angle, connected to the leaf lobe across 3-4 cells. Underleaves closely imbricate, reniform, 190-420 µm long, 370-710 µm wide, margin entire, apex rounded to almost truncate, insertion line strongly arched. Androecia intercalary on branches, bracts in 4-9 pairs, similar to leaves but lobules larger, 200-220 µm long, 160-190 µm wide, bract lobule 1/3 of the bract lobe, bracteoles similar to underleaves in shape, 110-170 µm long, 180-300 µm wide. Gynoecia not seen.

Specimens examined: INDONESIA. **West Java**, G. Pangrango, tea estate Mandalawangi, *ca* 1600 m, *Meijer B387c* (BO!); G. Patuha, ca 1600 m, *Kornchalert 1413, Gradstein 12169* (BIOT!).

Distribution: Java, Sumatra, Borneo, Sulawesi, Peninsular Malaysia, Philippines, Papua New Guinea, Sri Lanka, China, Japan, Fiji.

Notes: Diagnostic characters of *Lopholejeunea zollingeri* are: 1) broadly orbicular leaf lobe with recurved apex, 2) leaf lobule large, apex connected to the leaf lobe across 3-4 cells, 3) closely imbricate, large, reniform underleaves with strongly arched insertion line. This species grows at *ca* 1350-1600 m. *Lopholejeunea zollingeri* has very large, reniform underleaves like in *L. wiltensii*, *L. eulopha* and *L. applanata* but differs from the latter two by the lobule apex which is attached to the lobe across 3-4 cells (across 1 cell in *L. eulopha* and *L. applanata*). For differences with *L. wiltensii* see the characters given in the key.

15. ***Mastigolejeunea auriculata*** (Wils.) Schiffn., in Engler and Prantl, Nat. Pflanzenfam. 1, 3: 129 (1893); *Jungermannia auriculata* Wils., in Drummond, Musci Amer. Exsicc. (Southern States) nr. 170 (1841); *Ptychocoleus auriculatus* (Wils.) Trevis., Mem. Reale Ist. Sci. Mat. Nat., Ser. 3, 4: 405 (1877). –**Type**: USA. Louisiana, New Orleans, *Drummond s.n.* (holotype, BM; isotypes, MANCH, PC) –cf. Gradstein *et al.* (2002).
–*Phragmicoma humilis* Gottsche, in Gottsche *et al.*, Syn. Hepat. 299 (1845); *Mastigolejeunea humilis* (Gottsche) Schiffn., in Engler and Prantl, Nat.

Pflanzenfam. 1, 3: 129 (1893). –Type: Indonesia. Java, without locality, *Junghuhn s.n.* (isotypes, B, W) – cf. Gradstein *et al.* (2002).

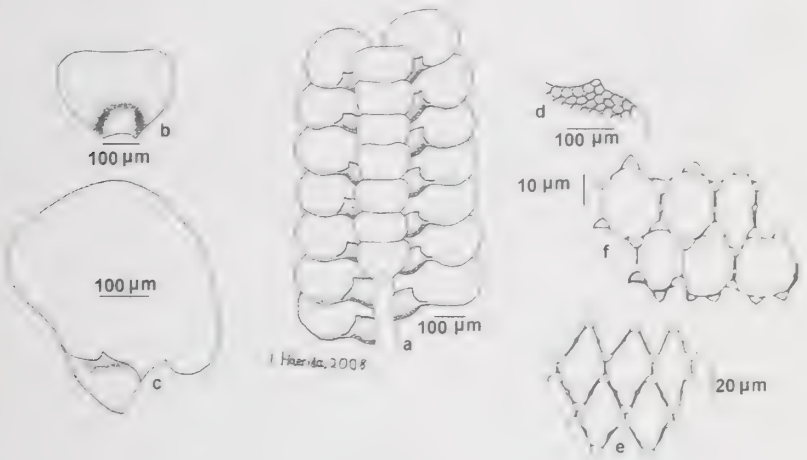

Figure 15. *Mastigolejeunea auriculata* (Wils.) Schiffn. Shoot (a); underleaf (b); leaf lobe (c); leaf lobule (d); cells of basal part of the leaf (e); cells of midleaf (f). Drawn from *Meijer 92a*, BO.

Plants up to 2 cm long, 0.8-1 mm wide, dull green to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 70-170 µm. Leaves imbricate, obliquely spreading, somewhat squarrose. Lobe ovate, 440-1030 µm long, 410-730 µm wide, margin entire, apex rounded to obtuse; cells of lobe thick-walled, light yellow, rhomboidal to hexagonal, trigones cordate, intermediate thickening scarce; marginal cells 11-15 × 6-10 µm, mid-leaf cells 18-21 × 9-12 µm, basal cells 25-34 × 16-19 µm; oil bodies not seen. Lobule oblong to subrectangular, 190-440 µm long, 130-200 µm wide, apex truncate to obliquely truncate with 1 small tooth. Underleaves imbricate, obdeltoid to nearly triangular, 200-530 µm long, 220-490 µm wide, margin entire, apex truncate, base cuneate, insertion line curved. Androecia not seen. Gynoecia on short or long branches, with 1-2 lejeuneoid innovations, bract oblong to broadly oblong, 1000-1070 µm long, 600-800 µm wide, margin entire, apex subrounded to nearly truncate, sinus 1/3 to 2/3 of lobe length, bract lobule oblong-ovate to subrectangular, 500-670 µm long, 340-360 µm wide, margin somewhat undulated towards the apex; bracteole obdeltoid 600-770 µm long, 850-960 µm wide, margin entire, apex truncate. Perianth obovate, 1010 µm long, 440 µm wide, with 3 keels, margins entire. Asexual reproduction not observed.

Specimens examined: INDONESIA. **West Java**, Bogor Bot. Garden, *van Borssum Waalkes 122a, Meijer 92a, 552d* (BO!). **Banten**, Taman Nasional Ujung Kulon, *Dewi Dw 922b* (BO!).

Distribution: Java, Borneo, Sulawesi, Moluccas, West Irian, Papua New Guinea, Australia, Solomon Is., India, Indochina, China, Japan, tropical Africa, tropical America.

Notes: Diagnostic characters of *Mastigolejeunea auriculata* are: 1) leaf lobe ovate in shape, margins entire, 2) leaf cells elongate, with cordate trigones 3) lobule with truncate to obliquely truncate apex, with 1 small tooth, 4) underleaves obdeltoid, 5) perianth 3-keeled, with smooth keels and 1-2 innovations. This species grows at *ca* 200-1700 m. It is very similar to *M. virens* but differs by the very short, blunt lobule tooth.

16. ***Mastigolejeunea indica*** Steph., Sp. Hepat. 4: 776 (1912). –**Type**: India. Nicobar Is., *Man s.n.* (holotype, G) –cf. Gradstein *et al.* (2002).
–*Thysananthus integrifolius* Steph., Sp. Hepat. 4: 788 (1912). *Mastigolejeunea integrifolia* (Steph.) Verdoorn, Blumea 1: 231, 239 (1934). –Type: Australia. Torres Str., Possession I., *Micholitz s.n.* (holotype, G; isotype, FH) –cf. Gradstein *et al.* (2002).

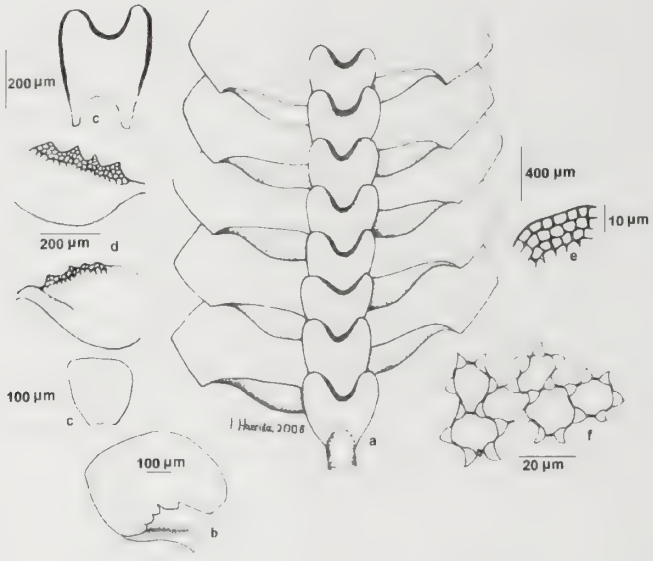

Figure 16. *Mastigolejeunea indica* Steph. Shoot (a); leaf lobe (b); underleaf (c); leaf lobule (d); cells of margin of leaf (e); cells of midleaf (f). Drawn from *Meijer 75a*, BO.

Dioicous. Plants up to 2.5 cm long, 0.6-1 mm wide, 1-1.5 mm wide in wet condition, greenish-brown in dried condition, becoming more green towards the apex of the plant. Branching *Lejeunea*-type. Stem diameter 100-250 µm, epidermis cells very unequal in size, dorsal one much large than ventral ones, hyalodermis lacking. Leaves imbricate, obliquely spreading, convolute when

dry. Lobe ovate-oblong, 520-1150 µm long, 300-890 µm wide, margin entire, apex acute to obtuse; cells of lobe thin-walled, light yellow, rhomboidal, trigones cordate, intermediate thickening scarce; marginal cells 6-11 × 3-5 µm, mid-leaf cells 7-18 × 6-14 µm, basal cells 21-35 × 17-20 µm; oil bodies not seen. Lobules ovate to triangular, 180-390 µm long, 160-280 µm wide, slightly inflated along the keel, apex obliquely truncate with 3-4 triangular teeth, each tooth consisting of 3-4 cells, 2-3 cells long, first and second tooth sometimes blunt, only 1-2 cells long, sometimes with or without fourth, 1-2 cells long tooth. Underleaves imbricate, obdeltoid, 230-520 µm long, 250-540 µm wide, margin entire, apex truncate, usually recurved and seemingly emarginate, base auriculate, insertion line curved. Generative structures not seen.

Specimens examined: Inodnesia. **West Java**, Bogor Bot. Garden, *ca* 250m, *Meijer 75a* (BO!).

Distribution: Java, China, India (Nicobar), Philippines, Papua New Guinea, Australia.

Notes: Diagnostic characters of *Mastigolejeunea indica* are: 1) plant like *M. auriculata* but lobule with 3-4 large teeth, 2) stem cross section with very unequal epidermis cells, dorsal ones much large than ventral ones (hyalodermis lacking). *Mastigolejeunea indica* is new to Java. The species has only been collected in the Botanical Garden of Bogor, at *ca* 250 m. It is readily separated from all other species of the genus *Mastigolejeunea* by the lobule with 3-4 large triangular teeth (usually only one tooth in other species of the genus).

17. ***Mastigolejeunea virens*** (Ångstr.) Steph., in Sp. Hepat. 4: 776. 1912; *Thysananthus virens* Ångstr., Öfv. K.Vetensk Akad. Förh. 5: 131. 1873. – **Type**: Society Is., Moorea, *Andersson s.n.* (holotype, S; isotypes, FH, G) –cf. Gradstein *et al.* (2002).
–*Mastigolejeunea humilis sensu* Verdoorn 1933 *p.p.*

Autoicous. Plants up to 3 cm long, 0.9-2 mm wide, brown to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 60-190 µm Leaves closely imbricate, widely spreading. Lobe ovate to oblong, 340-920 µm long, 200-640 µm wide, margin entire, apex rounded to obtuse; cells of lobe thick-walled, light-yellow, rhomboidal, trigones cordate, intermediate thickening scarce; marginal cells 6-11 × 5-6 µm, mid-leaf cells 11-16 × 5-7 µm, basal cells 18-26 × 8-10 µm; oil bodies not seen. Lobule ovate, 140-280 µm long, 60-170 µm wide, inflated, apex obliquely truncate with 1 long tooth consisting of 3-5 cells. Underleaves imbricate, quadrangular to nearly

triangular, 190-560 µm long, 250-600 µm wide, margin entire, apex truncate, sometimes recurved forming a hearth shaped. Androecia intercalary on branches, bracts in 5 pairs, similar to leaves but lobules larger, bract lobule 2/3 of the bract lobe, 100-110 µm long, 50-60 µm wide, bracteoles similar to underleaves in size and shape, 90-120 µm long, 100-120 µm wide. Gynoecium with 1-2 subfloral innovations; innovation type lejeuneoid; bract lobe ovate-oblong, ventral margin incurved, margin entire, apex rounded, 1160 µm long, 460 µm wide; bract lobule about ½ of bract lobe length, oblong, margin crenulate; bracteole oblong, margin entire, apex rounded. Perianth 820 µm long, oblong, inflated, with 3 keels, margins entire. Sporophytes and asexual reproduction not seen.

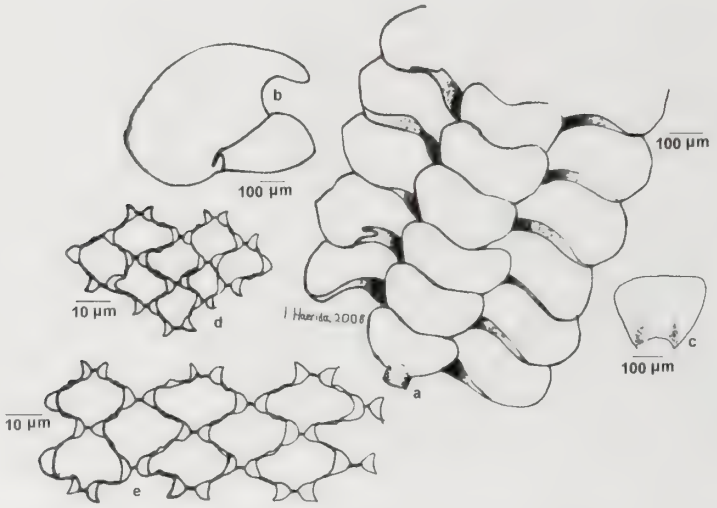

Figure 17. *Mastigolejeunea virens* (Ångstr.) Steph. Shoot (a); leaf lobe (b); underleaf (c); cells of midleaf (d); cells of basal part of the leaf (e). Drawn from *Meijer 62a*, BO.

Specimens examined: INDONESIA. **West Java**, Bogor, without locality, *Verdoorn* 149 (BO!); Bogor Bot. Garden, *Schiffner 257*, *W. Meijer B24, 62a, B55f, B998b*, *Verdoorn 12z, 12d, 143, 255* (BO!); Cibodas Bot. Garden, *Neervoort 154, 918*, *Meijer B3720, B3815* (BO!), *ibid.*, *Lee & Nova Indri 62* (BIOT!, UKMB!), *ibid.*, *Ariyanti 472* (BIOT!); Telaga Bodas, *Verdoorn 58a, 58b* (BO!); G. Megamendung, above "Toegoe", *Schiffner 256* (BO!).

Distribution: Java, Borneo, Moluccas, Philippines, Peninsular Malaysia, Thailand, Sri Lanka, Papua New Guinea, Australia, Pacific Islands.

Notes: The occurrence of *Mastigolejeunea virens* in Java has not been reported before, therefore this species is new for Java. Verdoorn (1933)

treated the species as a synonym of *M. humilis* (= *M. auriculata*), but it is readily separated from the latter by the longer lobule tooth (see key). The diagnostic characters of *Mastigolejeunea virens* are: 1) leaf lobe rounded to obtuse at apex, 2) lobule with 1 long tooth consisting of 3-5 cells, 3) perianth with 3 keels. This species grows at *ca* 200-1500 m.

18. ***Ptychanthus striatus*** (Lehm. & Lindenb.) Nees, Naturgesch. Eur. Leberm. 3: 212 (1838); *Jungermannia striata* Lehm. & Lindenb., Nov. Stirp. Pug. 4: 16 (1832); *Bryopteris striata* (Lehm. & Lindenb.) Mitt., in Seemann, Fl. Vit. 411 (1873). –**Type**: Nepal. *Wallich s.n. & s.d.* (holotype, S; isotypes, G, W) –cf. Gradstein *et al.* (2002).
–*Jungermannia retusa* Reinw. *et al.* var. β Nees, Enum. Pl. Crypt. Javae 1: 39 (1830); *Ptychanthus retusus* (Reinw. *et al.*) Nees var. β Nees, in Gottsche et al., Syn. Hepat. 292. 1845; *Ptycholejeunea retusa* (Reinw. *et al.*) Steph., Hedwigia 28: 258 (1889); *Ptychanthus retusus* (Reinw. *et al.*) Steph., Sp. Hepat. 4: 743 (1912); *Ptychanthus striatus* var. *retusus* (Reinw. *et al.*) Verd., Ann. Bryol. Suppl. 4: 122 (1934). –Type: Indonesia. Java, without locality, *Blume s.n.* (holotype, STR; isotype, W) –cf. Gradstein *et al.* (2002).

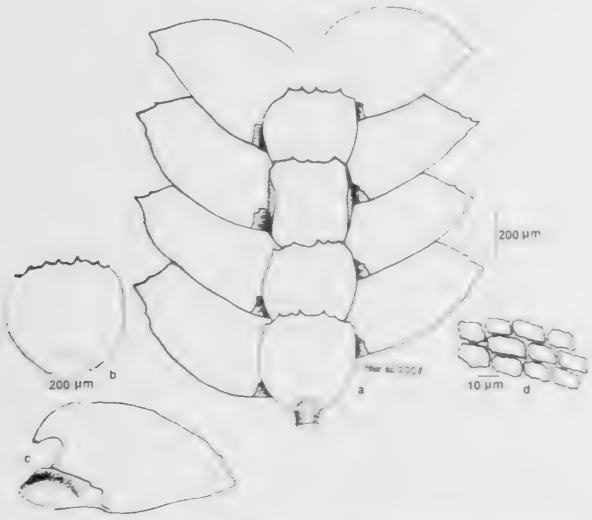

Figure 18. *Ptychanthus striatus* (Lehm. & Lindenb.) Nees. Shoot (a); underleaf (b); leaf lobe (c); cells of midleaf (d). Drawn from *Meijer 840*, BO.

Autoicous. Plants robust, up to 10 cm long, 1-1.5 mm wide, standing up away from the substrate or pendent, pinnate, greenish-brown in dried condition. Branching *Frullania*-type. Stem diameter 130-300 µm Leaves imbricate, flat, obliquely spreading. Lobe broadly-ovate, 650-2170 µm long, 300-1260 µm wide, margin entire or slightly toothed towards the apex, apex acute, base auriculate at the proximal side; cells of lobe thick-walled, light-yellow,

rhomboidal to hexagonal, trigones cordate, intermediate thickening frequent; marginal cells 7-16 × 4-11 µm, mid-leaf cells 20-27 × 8-14 µm, basal cells 26-38 × 11-20 µm; oil bodies not seen. Lobule ovate, small, 240-370 µm long, 110-170 µm wide, inflated, apex with 1-2 teeth, teeth consisting of 1 small cell. Underleaves distant to contiguous, broadly-ovate, sometimes subrectangular in outline, 480-760 µm long, 470-1000 µm wide, base auriculate, margin entire, apex irregularly toothed. Androecia intercalary on branches, bracts in 5-10 pairs, bract lobe ovate, 560-1150 µm long, 300-520 µm wide, margin entire, apex acute, bract lobule 1/2 of the bract lobe, inflated, 390-500 µm long, 200-240 µm wide, bracteoles similar to underleaves in size and shape. Gynoecia on short or long branches, innovation type lejeuneoid, bract lobe ovate with small bract lobules, 1220-1320 µm long, 550-630 µm wide, margin toothed towards the apex, apex acute, bract lobules oblong, 460-710 µm long, 80-150 µm wide; bracteole broadly ovate, 1110-1150 µm long, 1220-1330 µm wide, margin toothed, apex rounded. Perianth immersed, elliptical, 1770 µm long, 730 µm wide, inflated, with ± 10 keels, margins entire. Sporophytes and asexual reproduction not seen.

Specimens examined: INDONESIA. **West Java**, G. Salak, *ca* 1000 m, *Zollinger 3560*, *Schiffner 259* (BO!); G. Gede, above Cibodas, 1600-1900 m. *Neervoort 107, 129, 227, 2775, 2401, 282, 2271*, *Verdoorn 30g, 30f, 21a, 30n*, *Iwamasa s.n.*, *Meijer B4137, B4076, B160* (BO!), ibid., above Tanjung Mas waterfall (Pancuran Mas), *Alston 12807* (BO!), *ibid.*, Cibeureum, *Schiffner 266*, *Verdoorn 30h, 30i, 30j, 30n* (BO!), *ibid.*, trail Cibeureum falls to Kandang Badak 1700-2200 m, montane forest, epiphytes on trunk bases, common, *Gradstein 10215, 10217* (BIOT!, GOET!); G. Pangrango, "Tjisaroea", *ca* 1200 m, *Verdoorn 44a, 44b, 44c* (BO!); Tugu, slope of Gede-Pangrango, above G. Mas, *Meijer B3394a, B840, B421* (BO!); G. Geger Bentang, E slopes, 1500-2000 m, *Neervoort 2890*, *Verdoorn 67a, 67b, 267*, *Meijer B5584* (BO!); G. Megamendung, *Schiffner 265* (BO!); G. Malabar, SW slopes of Punciak Besar 1650-2300 m, *Verdoorn 61a, 61b, 61c, 62b, 62d* (BO!); G. Patuha, 2000-2400 m, *Verdoorn 60b* (BO!), *Kornochalert 1414* (BIOT!).

Distribution: Java, Sumatra, Peninsular Malaysia, Borneo, Sulawesi, Moluccas, Philippines, West Irian, Papua New Guinea, Australia, New Zealand, Pacific Islands, India, Sri Lanka, Taiwan, Indochina, China, Japan, tropical Africa.

Notes: Diagnostic characters of *Ptychanthus striatus* are: 1) *Frullania*-type branching, 2) lobe with acute apex and entire or toothed margins, 3) leaf cells elongate, with cordate trigones, 4) perianth with 10 smooth keels, and with innovation, 5) plant robust, pinnate, usually pendent. This species is common in the mountains where it occurs at *ca* 1000-2400 m. By its large

size, its pinnate, Frullania-type branching and acute leaf lobes the speciers is unmistakable and cannot be confused with any other Javanese member of Lejeuneaceae.

19. ***Schiffneriolejeunea pulopenangensis*** (Gottsche) Gradst., J. Hattori Bot. Lab. 38: 335 (1974); *Phragmicoma pulopenangensis* Gottsche, Syn. Hepat. 299 (1845); *Ptychocoleus pulopenangensis* (Gottsche) Trevis., Mem. Reale Ist. Lombardo Sci., Cl. Sci. Mat., Ser. 3, 4: 405 (1877). –**Type**: Peninsular Malaysia. Pulo Penang, *Delessert s.n.* (holotype, PC-Mont; isotypes, BM, S, W).

Plants up to 6 cm long, 1.5-2 mm wide, brown to dark brown in dried condition. Vegetative branching *Frullania*-type, or *Lejeunea*-type. Stem diameter 150-260 µm. Leaves imbricate, obliquely spreading, convolute when dry. Lobe broadly ovate to somewhat triangular, 700-1060 µm long, 500-850 µm wide, margin entire, apex obtuse to nearly acute; cells of lobe thick-walled, hyaline, rhomboidal to hexagonal, trigones cordate, intermediate thickening scarce; marginal cells 9-24 × 7-16 µm, mid-leaf cells 17-26 × 8-19 µm, basal cells 25-45 × 13-23 µm; oil bodies not seen. Lobule ovate, 300-420 µm long, 150-280

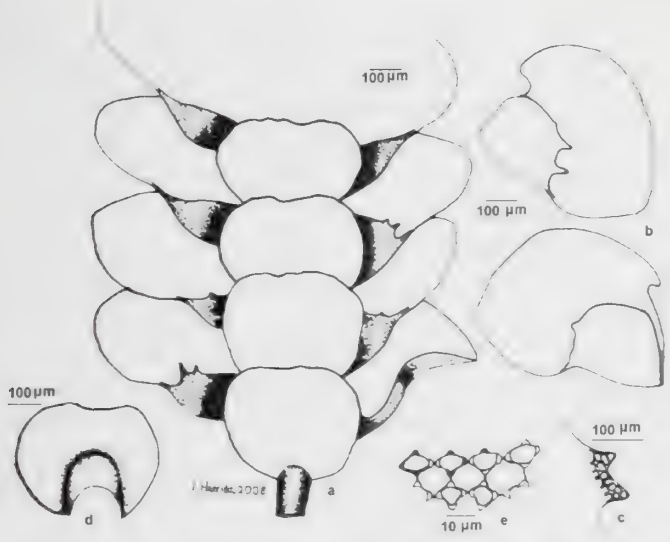

Figure 19. *Schiffneriolejeunea pulopenangensis* (Gottsche) Gradst. Shoot (a); leaf lobe (b); apex of leaf lobule (c); underleaf (d); cells of midleaf (e). Drawn from *Meijer & Alston 5329*, BO.

µm wide, apex with 2 conspicuous teeth that point outwards towards the leaf apex, first tooth consisting of 3-4 cells, second tooth consisting of 2-3 cells, lobule free margin plane, with 2 clearly visible teeth. Underleaves imbricate, obdeltoid-orbicular sometimes with recurved apex seemingly emarginate, 360-420 µm long, 480-610 µm wide, margin entire, apex truncate,

insertion line deeply curved. Androecia on lateral branches, inflated, in 3-11 pairs, about 1/3-1/2 of the vegetative lobe, hypostatic, bracteoles oblong to obdeltoid, apex truncate, smaller than the underleaves. Gynoecia not seen.

Specimen examined: INDONESIA. **West Java**, Bogor Bot. Garden, *Meijer & Alston 5329* (BO!).

Distribution: Indomalesia, Australia.

Notes: Diagnostic characters of *Schiffneriolejeunea pulopenangensis* are: 1) branching Lejeunea and Frullania type, 2) leaf lobule ovate, with plane free margin and with 2 long teeth that point outwards to the leaf apex, 3) leaves not squarrose when moist, convolute when dry, 4) trigones cordate. This species is apparently rare in Java and has only been collected in the Botanical Garden of Bogor at *ca* 250 m. The species is closely related to *S. tumida* but differs by the lobule without saccate base and by the flat leaves (squarrose in *S. tumida*).

20. ***Schiffneriolejeunea tumida*** var. ***haskarliana*** (Gottsche) Gradst. & Terken, Occas. Pap. Farlow Herb. 16: 77 (1981); *Phragmicoma hasskarliana* Gottsche, in Gottsche *et al.*, Syn. Hepat. 299 (1845); *Acrolejeunea hasskarliana* (Gottsche) Schiffn., in Engler and Prantl, Nat. Pflanzenfam. 1, 3: 129 (1893); *Ptychocoleus hasskarliana* (Gottsche) Steph., Sp. Hepat. 5: 44 (1912). –**Type**: Indonesia. Java, without locality, *Hasskarl 20* (holotype, B; isotypes, G, S, W) – cf. Gradstein and Terken (1981).
–*Mastigolejeunea badia* Gottsche ex Steph., Sp. Hepat. 4: 779 (1912). –Type: Solomon Is., Vanikoro, *Lesson s.n.* (isotypes, BM, FH) –cf. Gradstein and Terken (1981).

Plants up to 6 cm long, 2-3 mm wide; brown to dark brown in the dried condition. Vegetative branching Frullania-type, or Lejeunea-type. Stem diameter 160-270 µm. Leaves imbricate, obliquely spreading, somewhat squarrose, convolute when dry. Lobe broadly ovate to somewhat triangular, 900-1150 µm long, 700-1200 µm wide, margin entire, apex obtuse to nearly acute; cells of lobe thick-walled, hyaline, rhomboidal to hexagonal, trigones cordate, intermediate thickening scarce; marginal cells 13-24 × 9-22 µm, mid-leaf cells 19-29 × 18-27 µm, basal cells 25-40 × 18-32 µm; oil bodies not seen. Lobule ovate-rectangular, 300-620 µm long, 130-270 µm wide, apex with 2 teeth, each tooth consisting of 3-4 cells, lobule free margin strongly involute, forming a sac at the base of the lobule. Underleaves imbricate, obdeltoid sometimes with recurved apex seemingly emarginate, 420-840 µm long, 490-720 µm wide, margin entire, apex truncate, insertion line deeply curved. Generative structures not seen.

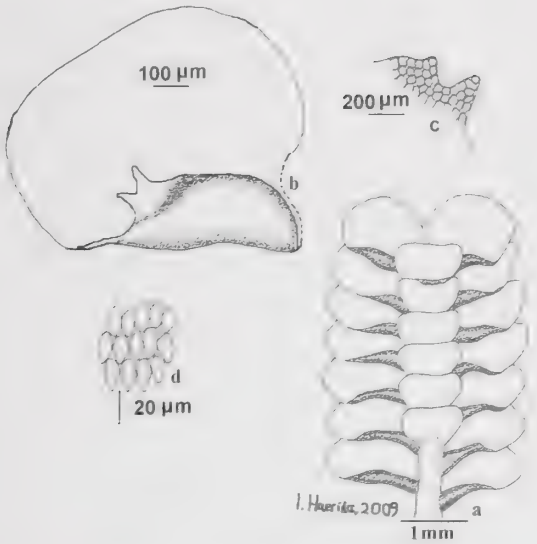

Figure 20. *Schiffneriolejeunea tumida* var. *haskarliana* (Gottsche) Gradst. & Terken. Shoot (a); leaf lobe (b); apex of leaf lobule (c); cells of midleaf (d). Drawn from *Haerida 724*, BO.

Specimens examined: INDONESIA. **West Java**, Cibodas Bot. Garden, *Neervoort 2120* (BO!), *ibid.*, on bark of *Altingia excelsa*, *ca* 1400 m, *Gradstein 10202* (BIOT!, GOET!); above Cibodas, trail to Cibeureum waterfall, on tree trunk, *Lee & Nova Indri 58* (BIOT!, UKMB!); G. Halimun Nat. Park, *Haerida 724* (BO!).

Distribution: Java, Papua New Guinea, Solomon Is., Australia.

Notes: Diagnostic characters of *Schiffneriolejeunea tumida* var. *haskarliana* are: 1) branching *Lejeunea*- and *Frullania*-type, 2) leaf lobule with 2 conspicuous, erect teeth and with a sac at the base by the strongly involute free margin, 3) leaves somewhat squarrose when moist, convolute when dry, 4) cordate trigones. This species grows at *ca* 1000-1500 m. It is closely related to *S. pulopenangensis* but occurs at higher elevations; for morphological differences see under the latter species and the key.

21. ***Spruceanthus polymorphus*** (Sande Lac.) Verd., Ann. Bryol. Suppl. 4: 155 (1934); *Phragmicoma polymorpha* Sande Lac., Ned. Kruidk. Arch. 34: 420 (1854); *Phragmolejeunea polymorpha* (Sande Lac.) Schiffn., Forschungsr. Gazelle 4: 25. (1890); *Thysananthus polymorphus* (Sande Lac.) Schiffn., Consp. Hepat. Arch. Ind. 305 (1898); *Archilejeunea polymorpha* (Sande Lac.) B. Thiers & Gradst., Mem. N.Y. Bot. Garden 52: 10 (1989). –**Type**: Indonesia. Java, *Junghuhn s.n.* (holotype, L; isotype, NY) –cf. Gradstein *et al.* (2002).

Autoicous. Plants up to 4 cm long, 1.5-2.5 mm wide, pale green to greenish brown in dried condition. Branching *Lejeunea*-type. Stem diameter 100-250 µm; ventral merophyte 8-12 cells wide. Leaves imbricate, widely spreading. Lobe ovate-oblong, 730-1300 µm long, 430-640 µm wide, margins entire or toothed, plane or undulate, apex rounded to obtuse; cells of lobe isodiametric, with large, nodulose intermediate thickenings, hyaline, trigones not cordate; marginal cells 7-12 × 6-13 µm, mid-leaf cells 20-26 × 19-24 µm, basal cells 26-52 × 13-18 µm; oil bodies not seen. Lobule ovate, 110-230 µm long, 80-130 µm wide, apex obliquely truncate with 1-2 small teeth. Underleaves closely imbricate, obdeltoid to orbicular, 230-400 µm long, 400-500 µm wide, margin entire at lateral part, serrate towards the apex, apex rounded to truncate, insertion line shallowly curved. Androecia intercalary on branches, bracts up to 14 pairs, similar to leaves but lobules larger, 580-650 µm long, 250-300 µm wide, hypostatic, bracteoles similar to underleaves in size and shape. Gynoecia with 1-2 lejeuneoid innovations, bract ovate, about 900 µm long, 600 µm wide, margin entire, apex rounded, bract lobule ovate about 2/3 of the lobe length, toothed; bracteole orbicular to oblong, 530-600 µm long, 580-900 µm wide, margin toothed. Perianth oblong, about 1300 µm long, 430 µm wide, with 7 smooth keels, margins entire. Sporophytes and asexual reproduction not seen.

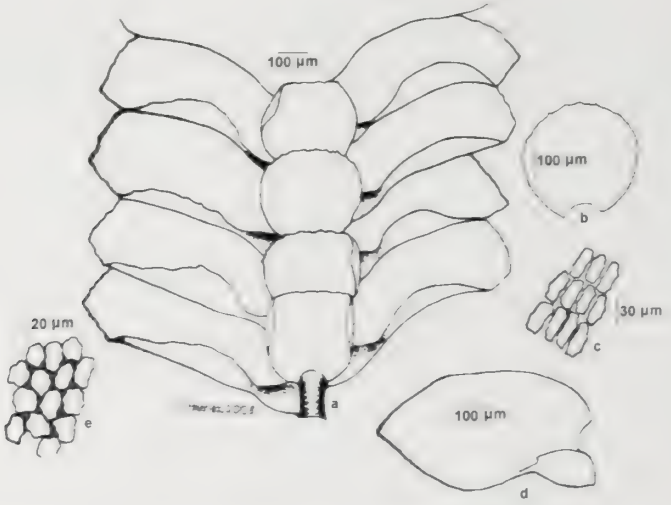

Figure 21. *Spruceanthus polymorphus* (Sande Lac.) Verd. Shoot (a); underleaf (b); cells of basal cells of the lobe (c); leaf lobe (d); cells of midleaf (e). Drawn from ***Borssum Waalkes 450***, BO.

Specimens examined: INDONESIA. **West Java**, Cibodas Bot. Garden, *Meijer B3820, B178* (BO!), *ibid.*, on bark of *Araucaria, ca* 1400 m, very common, *Gradstein 10207* (BIOT! GOET!), *ibid.*, near the guest house, on base of

tree, *Gradstein 10206* (BIOT! GOET!); Gn. Pangrango, *Meijer B605* (BO!); Gn. Gede, 1500-1900 m, *Verdoorn 46e, 46d, 47c, Meijer B589a2* (BO!), ibid., N slope above "Artja", *ca* 1100 m, *Schiffner 287, 285* (BO!); Rawa Denok, *ca* 1900 m, *Neervoort 2380* (BO!); Gn. Halimun, *ca* 930 m, collector unknown (BIOT!); Gn. Cikurai, *ca* 1700 m, *Verdoorn 59a, 59b,59c, 59d, 59e, 59f* (BO!); Geger Bentang, *Neervoort 1366, 1089* (BO!); Gn. Malabar, *Verdoorn 62c* (BO!). **Banten**, Pulau Panaitan, Gn. Putri, *ca* 75 m, *van Borssum Waalkes 450* (BO!); Taman Nasional Ujung Kulon, *Dewi Dw928, 922c* (BO!).
Distribution: Java, Sumatra, Borneo, Sulawesi, Philippines, New Guinea, Australia, Pacific, Japan, Taiwan, India.

Notes: Diagnostic characters of *Spruceanthus polymorphus* are: 1) rather robust plant, ventral merophyte 8-12 cells wide, 2) underleaves serrate towards the apex, 3) leaf lobes rounded to obtuse at apex, with entire or toothed, plane or undulate margin, 4) leaf cells isodiametrical, 5) female bract lobe entire, female bracteole toothed 6) perianth with up to 7 smooth keels, 1-2 innovations present. This species grows at *ca* 75-1900 m. *Spruceanthus polymorphus* may be confused with *S. semirepandus* and *Archilejeunea planiuscula*. *S. semirepandus* differs by the acute leaf apex (rounded to obtuse in *S. polymorphus*) and *A. planiuscula* by the thinner stems and the segmented oil bodies (although we did not observe the oil bodies, they are supposedly homogeneous in *S. polymorphus*).

22. ***Spruceanthus semirepandus*** (Nees) Verd., Ann. Bryol. Suppl. 4: 153 (1934): *Jungermannia semirepanda* Nees, Enum. Pl. Crypt. Javae 1: 39 (1830); *Ptychanthus semirepandus* (Nees) Nees, Naturg. Eur. Leberm. 3: 212 (1838); *Phragmicoma semirepanda* (Nees) Gottsche, in Gottsche *et al.*, Syn. Hepat. 302 (1845); *Lejeunea semirepanda* (Nees) Mitt., J. Proc. Linn. Soc. Bot. 5: 111 (1861). –**Type**: Indonesia. Java. *Blume s.n.* (holotype, STR?) – cf. Verdoorn (1934).

Autoicous. Plants robust, up to 8 cm long, 1.5-3 mm wide, pale brown to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 120-300 µm; ventral merophyte 8-12 cells wide. Leaves imbricate, widely spreading. Lobe ovate, 1000-2300 µm long, 550-1590 µm wide, margin entire, crenulate towards the sharply acute apex; cells of lobe thick-walled, light yellow, hexagonal and almost isodiametric, trigones not cordate, intermediate thickening frequent; marginal cells 5-15 × 4-10 µm, mid-leaf cells 20-31 × 13-20 µm, basal cells 30-41 × 21-30 µm; oil bodies not seen. Lobule ovate, 240-450 µm long, 120-220 µm wide, inflated, apex truncate with 1-2 small teeth. Underleaves imbricate, obdeltoid to rectangular, 500-1200 µm long, 390-850 µm wide, margin entire, apex truncate, base auriculate. Androecia not seen.

Gynoecia with 1-2 lejeuneoid innovations, bracts ovate about 3050 µm long, 1530 µm wide, margin toothed at the upper part, apex acute, bract lobule oblong, margin entire about 1/3 of the lobe lenght; bracteole broadly ovate to suborbicular with emarginate apex, toothed, about 2010 µm long, 1500 wide. Perianth, oblong-ovate, about 2700 µm long, 1600 µm wide, with 7-9 smooth keels, margins entire. Sporophytes and asexual reproduction not seen.

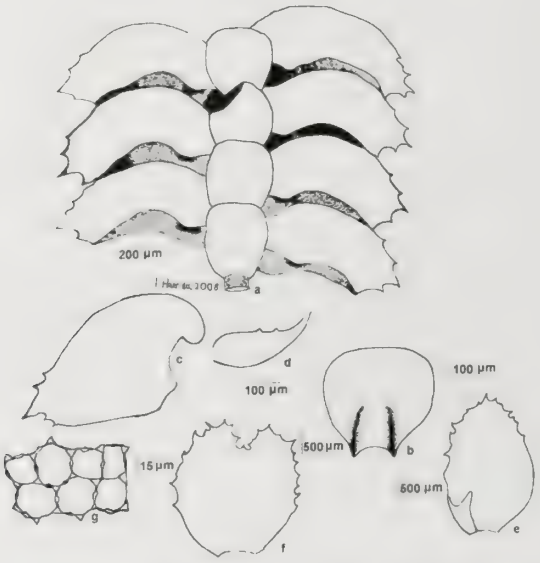

Figure 22. *Spruceanthus semirepandus* (Nees) Verd. Shoot (a); underleaf (b); leaf lobe (c); leaf lobule (d); female bract (e); female bracteole (f); cells of midleaf (g). Drawn from *Verdoorn 20c*, BO.

Specimens examined: INDONESIA. **West Java**, Cibodas Bot. Garden, *Verdoorn 20c, 20b* (BO!); Gn. Gede, *Iwamasa s.n.* (BO!); Gn. Malabar, 1800-2300 m, *Verdoorn 61d* (BO!); Gn. Cikurai, *ca* 1700 m, *Verdoorn 59k* (BO!); Gn. Patuha, *ca* 1500 m, *Kornochalert 1417* (BIOT!).

Distribution: Java, Borneo, Moluccas, Philippines, China, Taiwan, India, Sri Lanka, Japan.

Notes: Diagnostic characters of *Spruceanthus semirepandus* are: 1) robust plant, ventral merophyte to 12 cells wide, 2) underleaves with entire margin, 3) leaf lobe acute at apex, coarsely dentate at margin, 4) leaf cells isodiametric 4) female bract lobule entire, 5) perianth with 7-9 smooth keels, innovation present. This species grows at 1200-2300 m. It is closely related to *S. polymorphus* but the leaf apex in the latter species is broader, rounded to obtuse. By its acute leaves *S. semirepandus* may be confused with

Ptychanthus striatus but the very different branching types (*Lejeunea*-type in *Spruceanthus*, Frullania-type in *Ptychanthus*) readily separates the two.

23. ***Thysananthus convolutus*** Lindenb., in Gottsche *et al.*, Syn. Hepat. 288 (1845).–**Type**: Indonesia. Java, unknown locality, collector unknown., ex hb. Lindenberg (isosyntype: G) – cf. Gradstein *et al.* (2002).

Plants up to 5 cm long, 0.8-1.2 mm wide, pale brown to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 100-280 µm Leaves closely imbricate, attached to the stem at an angle approx. 45-65°. Lobe ovate with recurved apex, asymmetric, upper part of leaf distinctly ventrad, 700-1150 µm long, 600-810 µm wide, margin toothed or entire, apex rounded; cells of lobe thick-walled, sometimes nodulose, trigones cordate, intermediate thickening frequent; marginal cells 7-20 × 6-11 µm, mid-leaf cells 22-40 × 11-13 µm, basal cells 36-52 × 11-15 µm; oil bodies not seen. Lobule ovate, 250-320 µm long, 110-130 µm wide, inflated, apex truncate with 1-2 teeth, first tooth consisting of 3-4 cells, second tooth small consisting of 1 cell, sometimes without first tooth. Underleaves imbricate, suboblong, 500-720 µm long, 290-430 µm wide, margins usually toothed, apex truncate, recurved, base not auriculate, insertion line shallowly curved. Generative structures not seen.

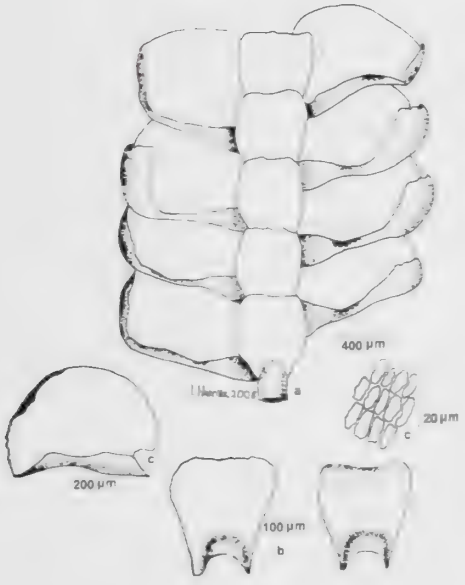

Figure 23. *Thysananthus convolutus* Lindenb. Shoot (a); underleaves (b); leaf lobe (c); cell of midleaf (d). Drawn from *Iwamasa 5435*, BO.

Specimens examined: INDONESIA. **West Java**, without locality, *Teysmann s.n.* (BO!); Kampung Dawuan, 1390 m, *Neervoort* 898 (BO!); Cibodas Bot. Garden, Pasir Sintek, *ca* 1410 m, *Neervoort* 3368 (BO!), *ibid.*, on bark of trees at garden entrance, abundant, *Gradstein 10205*, on bark of *Araucaria*, *Gradstein 10203* (BIOT!, GOET!); above Cibodas, trail to Cibeureum waterfall, *Lee & Nova Indri 45* (BIOT!, UKMB!); Cibeureum, *ca* 1600-1900 m, *Verdoorn 30k, 30q, 20L, 21b, Iwamasa 5435, Neervoort 195, 308, Dadi & Noerta 134, Meijer B3578, B3705, B3789, B3578, V. Schiffner 283, 282a* (BO!), *N.S. Ariyanti 472* (BIOT!); Gn. Gede, boven Soekaboemi, *ca* 1500-1900 m, *Verdoorn 46c, 46b, 46a* (BO!); Gede-Pangrango, Tugu, above G. Mas, along Jl. Mandalawangi, *Meijer B3374, B3325, B387f, B607* (BO!); Geger Bentang, 1400-1540 m, *Neervoort 1178, 1059, 1024, 1806, 1019, 988, 2987, 3005* (BO!); Rawa Panjang, *Neervoort 1166* (BO!); Cihoerang, *ca* 1380-1460 m, *Neervoort 138, 2241, 2242, Meijer B3681, B3741* (BO!); Telaga Warna, Puncak Pass, "Kratermuurtje", *Verdoorn 64f, 64i, 64h, 64e* (BO!); Gn. Halimun-Salak Nat. Park, Gn. Kendeng, *ca* 1250 m, *Radhiah Zakaria 221c* (BIOT!); Gn. Malabar, SW slopes of Puncak Besar, 1800-2300 m, *Verdoorn 61h* (BO!).

Distribution: Java, Sumatra, Peninsular Malaysia, Borneo, Sulawesi, Moluccas, Papua New Guinea, Philippines, Solomon Is.

Notes: Diagnostic characters of *Thysananthus convolutus* are: 1) asymmetric leaf lobe with upper part ventrad and recurved, margin toothed or entire 2) underleaves suboblong, margins usually toothed or crenulate, 3) lobule with 2 teeth. This species grows at *ca* 1300-2300 m. Forms with toothed leaves may be confused with *T. spathulistipus* but the leaves in the latter species are symmetrical while those of *T. convolutus* are asymmetric. Forms with entire leaves may be confused with *Mastigolejeunea* but the dorsal epidermis cells in *Mastigolejeunea* are larger than the inner stem cells, while in *Thysananthus* the epidermis cells are not larger than the inner cells.

24. ***Thysananthus minor*** Verd., in Rec. Trav. Bot. Neerl. 30: 231 (1933). –**Type**: Indonesia. Sumatra, Brastagi, Petani Falls, 1930, *Verdooorn s.n.* (holotype, FH) –cf. Verdoorn (1933).

Dioicous. Plants small, up to 1.5 cm long, 0.5-0.7 mm wide, brown to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 100-130 μm Leaves imbricate, convolute when dry, widely spreading. Lobe oblong-ovate, 430-900 μm long, 250-390 μm wide, lateral margin irregularly toothed toward the apex, apex acute; cells of lobe thick-walled, light yellow, rhomboidal, trigones cordate, intermediate thickening frequent; marginal cells 8-13 × 5-7 μm, mid-leaf cells 13-29 × 13-17 μm, basal cells 16-38 × 6-

14 µm; oil bodies not seen. Lobule ovate, 150-270 µm long, 50-90 µm wide, inflated, apex obliquely truncate with small tooth. Underleaves closely imbricate, oblong, 200-490 µm long, 150-650 µm wide, margin entire, apex truncate to emarginate, toothed, insertion line shallowly curved. Androecia not seen. Gynoecia with 2 lejeuneoid innovations, bract ovate, 970-1380 µm long, 440-550 µm wide, toothed at apex and upper margin, apex acute, sinus up to 1/2 of lobe length; bracteole oblong to broadly oblong about as long as bracts or shorter, 500-670 µm long, 350-410 µm wide, margin serrulate, coarsely serrate towards the apex, apex emarginate. Perianth, oblong, 1800 µm long, 500 µm wide, with 3 keels, margins serrulate in the upper part. Sporophytes and asexual reproduction not seen.

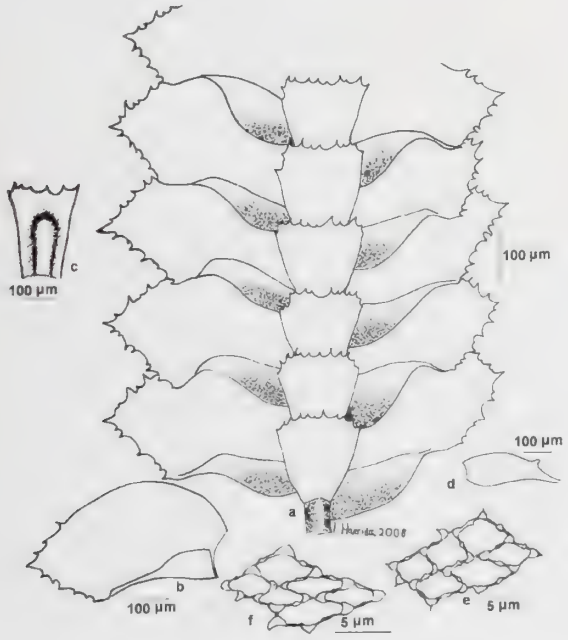

Figure 24. *Thysananthus minor* Verd. Shoot (a); leaf lobe (b); underleaf (c); lobule (d); cells of midleaf (e); cells of basal part of the lobe (f). Drawn from *Neervoort 1018*, BO.

Specimens examined: INDONESIA. **West Java**, Gn. Gede, above Cibodas, Geger Bentang, *ca* 1520-1700 m, *Neervoort 1112, 1018, 1088, Noerta & Soekar 1139* (BO!); G. Halimun Nat. Park, *ca* 1000 m, *Haerida 712* (BO!) *ibid.*, *ca* 1200 m, collector unknown (BIOT!); Gn. Cikurai, W slope, *ca* 1700 m *Verdoorn 59g, 59h* (BO!).

Distribution: Java, Sumatra, Papua New Guinea.

Notes: Diagnostic characters of *Thysananthus minor* are: 1) very small plant, less than 1 mm wide, 2) leaf lobe irregularly toothed towards the apex, 3) underleaves toothed towards the apex, 4) lobule with only 1 small tooth. *Thysananthus minor* is new to Java. This species grows at *ca* 1000-1710 m and is very similar to *T. spathulistipus* but differs by the smaller size. Possibly it is just a form of the latter species.

25. ***Thysananthus retusus*** (Reinw. *et al.*) B. Thiers & Gradst., Mem. N.Y. Bot. Gard. 52: 67 (1989); *Jungermannia retusa* Reinw *et al.*, Acta Phys.-Med. Acad. Caes. Leop. Carol. Nat. Cur. 12: 214 (1824); *Ptychanthus retusus* (Reinw. *et al.*) Nees var. α, in Gottsche *et al.*, Syn. Hepat. 292 (1845). –**Type**: Indonesia. Java, *Blume s.n.* (holotype, STR; isotype, W) – cf. Gradstein *et al.* (2002). –*Thysananthus planus* Sande Lac., Ned. Kruidk. Arch. 3, 4: 419 (1854).–Type: Indonesia. Java, *Junghuhn s.n.* (holotype, L; isotype, G) – cf. Gradstein *et al.* (2002).

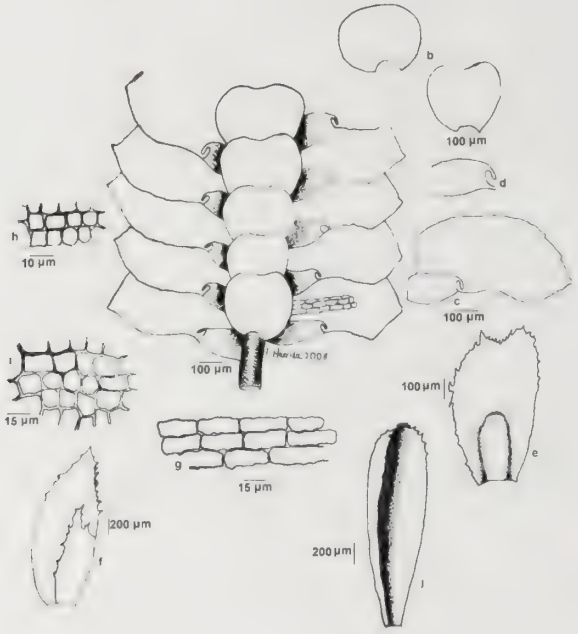

Figure 25. *Thysananthus retusus* (Reinw. *et al.*) B. Thiers & Gradst. Shoot (a); underleaves (b); leaf lobe (c); leaf lobule (d); female bracteole (e); female bract (f); vitta (g); cells of the margin of the leaf (h); cells of midleaf (i); perianth (j). Drawn from *Haerida 511*, BO.

Plants up to 2 cm long, 0.7-1 mm wide; pale green to brown in the dried condition. Branching *Lejeunea*-type. Stem diameter 100-120 µm. Leaves imbricate, convolute when dry, widely spreading. Lobe ovate to oblong, 740-840 µm long, 350-550 µm wide, margin entire, apex obtuse to acuminate; cells of lobe thick-walled, hyaline to light yellow, quadrangular to hexagonal,

trigones triangular, intermediate thickening scarce; marginal cells 6-8 × 3-5.5 µm, mid-leaf cells 8-15 × 7-10 µm, basal cells 13-19 × 5-8 µm, vittae consisting of 2-3 rows of rectangular cells, ending at 2/3 of the lobe length, 21-51 × 10-17 µm; oil bodies not seen. Lobule oblong-ovate 290-310 µm long, 140-150 µm wide, apex with 1 tooth consisting of 3-4 cells. Underleaves imbricate, orbicular, obdeltoid to subrectanglar sometimes recurved seemingly emarginate, 230-310 µm long, 290-390 µm wide, margins entire, apex rounded, sometimes with scattered small teeth towards the apex. Generative structures not seen.

Specimens examined: INDONESIA. **West Java**, Bogor Bot. Garden, *W. Meijer 55d1* (BO!); Gn. Salak, *ca* 2000 m, *Kurz s.n.* (BO!); Gn. Gede-Pangerango Nat. Park, Bodogol, *Haerida 851, 811* (BO!, GOET!); G. Pancar, *ca* 400 m, *Schiffner 287* (BO!); Geger Bentang, *ca* 1620 m, *Neervoort 1070* (BO!).

Distribution: Java, Philippines, West Irian, Papua New Guinea, Australia, Pacific Islands.

Notes: Diagnostic characters of *Thysananthus retusus* are: 1) small plant with flattened leaves, 2) leaf with a distinct vitta, and with isodiametric non-vitta cells, 3) apical tooth of leaf lobule 3-4 cells long. This species grows at ca 400-2500 m. By the vitta, the small, isodiametric leaf cells and the long, curved lobule tooth *T. retusus* is a very distinct species that cannot be confused with any other member of Ptychanthoideae.

26. ***Thysananthus spathulistipus*** (Reinw. *et al.*) Lindenb., in Gottsche et al., Syn. Hepat. 287 (1845); *Jungermannia spathulistipa* Reinw. *et al.*, Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 12: 212 (1824). –**Type**: Indonesia. Java, Bantam, Leback Mts., *Blume s.n.* (holotype, STR; isotypes, G, W) – cf. Gradstein *et al.* (2002).

Autoicous. Plants robust, up to 3 cm long, 0.5-1 mm wide, brownish green to dark brown in dried condition. Branching *Lejeunea*-type. Stem diameter 80-180 µm. Leaves imbricate, widely spreading. Lobe ovate-oblong, 820-1100 µm long, 320-630 µm wide, margin coarsely toothed towards the apex, apex acute; cells of lobe thick-walled, light yellow, rhomboidal, trigones cordate, intermediate thickening frequent, cell walls at the basal part sometimes with orange color; marginal cells 10-20 × 7-10 µm, mid-leaf cells 26-31 × 10-20 µm, basal cells 26-41 × 10-15 µm; oil bodies not seen. Lobule ovate, 240-330 µm long, 40-90 µm wide, inflated, apex truncate with 1 small tooth consisting of 1 cell. Underleaves imbricate, spathulate, 310-910 µm long, 350-480 µm wide, margin coarsely toothed towards the apex, apex truncate to sometimes

emarginate, insertion line almost straight. Androecia terminal on branches, bracts in 4-15 pairs, similar to leaves but lobules larger, bract lobule 2/3 of the bract lobe, bract lobe 270-370 µm long, 150-160 µm wide, hypostatic, bracteoles similar to underleaves in size and shape, 170-180 µm long, 200-230 µm wide. Gynoecia on short or long branches, with 1-2 lejeuneoid innovations, bract ovate 900-1000 µm long, 300-400 µm wide, crenulate towards the apex, apex acute, sinus up to 1/2 of lobe length; bracteole oblong to sub obovate 700-2200 µm long, 250-650 µm wide, margin crenate, apex truncate. Perianth oblong, about 2000 µm long, 550 µm wide, with 3 keels, margins toothed. Sporophytes and asexual reproduction not seen.

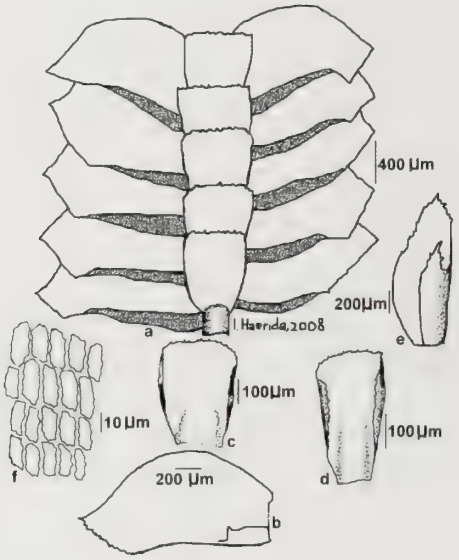

Figure 26. *Thysananthus spathulistipus* (Reinw. *et al.*) Lindenb. Shoot (a); leaf lobe (b); underleaf (c); female bracteole (d); female bract (e); cells of midleaf (f). Drawn from *Haerida 725*, BO.

Specimens examined: INDONESIA. **West Java**, Bogor Bot. Garden, *ca* 250 m, *Schiffner 281* (BO!); Cibodas Bot. Garden, *Verdoorn 20a, 20k, 30l, 30p, 30o, Neervoort 1506, 70* (BO!); Gn. Pangrango, *Meijer B895, B775, B286, B530, B447e, B519, B3339, B818c, B773a, B771a, B805, B811c, B811e, B385c, B752b, B753, B533c, B287b, B298b, B801a* (BO!); Gn. Gede, 1500-1900 m *Verdoorn 46m, 46l, 46j, 46h, 46g, 46f, Meijer B4093, Schiffner 291a, 289* (BO!); Gn. Gegerbentang, E slopes, 1500-2000 m, *Verdoorn 67f, 67e, 67g, Neervoort 1139, 1144, 1985, 1022, 1014, Noerta & Soekar 1144, 50/1089, Meijer B637a* (BO!); Gn. Halimun Nat. Park, *Gradstein s.n., Haerida 725* (BO!); Mt. Kendeng, *ca* 1060-1350 m, *Radhiah Zakaria 173c, 181c, 218c, 226c* (BIOT!); G. Malabar *Verdoorn 61g, 61f, 61e, 61d* (BO!); Gn. Guntur, "Kawah Kamodjan", 1500-1700 m, *Verdoorn 50f, 50e* (BO!); Gn. Cikurai, *ca* 1700 m, *Verdoorn 59l* (BO!).

Distribution: Java, Sumatra, Peninsular Malaysia, Borneo, Bali, Soembawa, Sulawesi, Moluccas, West Irian, Papua New Guinea, Australia, Solomon Is., Thailand, India, Sri Lanka, tropical Africa.

Notes: Diagnostic characters of *Thysananthus spathulistipus* are: 1) leaves and underleaves symmetrical, with toothed margins, 2) spathulate underleaves, 3) coarsely toothed female bracts and bracteoles. This species grows at *ca* 200-2000 m and is most common in the mountains. It differs from other Javanese species of *Thysananthus* by the rather large plant size, the symmetrical, toothed leaves without vitta, the lobule with a short, blunt tooth, and the often narrowly spathulate underleaves.

Discussion and conclusion

This study revealed the occurrence of 26 species of Lejeuneaceae subfam. Ptychanthoideae in West Java, in 8 genera: *Acrolejeunea* (Spruce) Schiffn. (3 species), *Archilejeunea* (Spruce) Schiffn. (1 species), *Lopholejeunea* (Spruce) Schiffn. (10 species), *Mastigolejeunea* (Spruce) Schiffn. (3 species), *Ptychanthus* Nees (1 species), *Schiffneriolejeunea* Verd. (2 species), *Spruceanthus* Verd. (2 species) and *Thysananthus* Lindenb. (4 species). Two species found in this study were new records of the Hepaticae in Java: *Mastigolejeunea indica* and *Thysananthus minor*. The record of *Mastigolejeunea indica* is based on a specimen collected by the Dutch Bryologist, W. Meijer, in Bogor Botanical Garden in 1951 and in Meru Betiri National Park, East Java, in 2005. Five additional species recorded from Java in the literature (*Acrolejeunea tjibodensis* Verd., *Dendrolejeunea fruticosa* (Lindenb. & Gottsche) Lacout., *Phaeolejeunea latistipula* (Schiffn.) Mizut. [doubtful record], *Spruceanthus sulcatus* (Nees) Gradst. and *Thysananthus comosus* Lindenb.) were not found in this study.

Based on the number of known localities in West Java the species of Ptychanthoideae can divided into several categories. Species with "wide distribution" are known from more than 5 localities, with "moderately wide distribution" from about 4, with "rather limited distribution" from about 3, with "limited distribution" from about 2, and "very limited distribution" from only one locality.

Lopholejeunea eulopha, *Lopholejeunea ceylanica*, *Lopholejeunea subfusca* and *Thysananthus spathulistipus* are the most common species in West Java, with a wide distribution. *Thysananthus spathulistipus* (200-1700 m) was found in Bogor Bot. Garden, Cibodas, Gede Pangrango Nat. Park and Halimun Salak Nat. Park, and on Mt. Guntur, Mt. Cikurai and Mt. Malabar; *Lopholejeunea eulopha* (200-1700 m) in Bogor Bot. Garden, Ujung

Kulon Nat. Park and Halimun Salak Nat. Park, and on Mt. Guntur and Mt. Megamendung; *L. ceylanica* (500-1700 m) in Bogor Bot. Garden, Cibodas, Gede Pangrango National Park, Telaga Warna and on Mt. Cikurai; and *L. subfusca* (500-2500 m) in Bogor Bot. Garden, Cibodas, Gede Pangrango National Park and on Mt. Cikurai and Mt. Papandayan.

Lopholejeunea nigricans, Lopholejeunea horticola and *Thysananthus retusus* have a moderately wide distribution. *Lopholejeunea nigricans* (200-1700 m) has been recorded from Bogor Bot. Garden, Mt. Pangrango, Mt. Guntur and Telaga Warna (Puncak Pass); *L. horticola* (800-2400 m) from Mt. Gede (including Cibodas), Mt. Guntur, Mt. Patuha and Mt. Malabar; and *Thysananthus retusus* (400-2500 m) from Bogor Bot. Garden, Mt. Gede, Mt. Halimun Salak Nat. Park and Mt. Pancar.

Archilejeunea planiuscula, Lopholejeunea herzogiana, L. wiltensii, Mastigolejeunea virens, Ptychanthus striatus, Spruceanthus semirepandus, Thysananthus convolutus and *Thysananthus minor* have a rather limited distribution in West Java. *Archilejeunea planiuscula* (200-1450 m) was found in Ujung Kulon Nat. Park and on Mt. Gede; *Lopholejeunea herzogiana* (1200-1500 m) in Bogor Bot. Garden, Gede Pangrango Nat. Park and Telaga Warna (Puncak Pass); *L. wiltensii* (1200-1900 m) in Gede Pangrango Nat. Park and on Mt. Guntur; *Mastigolejeunea virens* (200-1500 m) in Bogor Bot. Garden and on Mt. Gede and Mt. Megamendung; *Ptychanthus striatus* (1000-2400 m) in Gede Pangrango Nat. Park and on Mt. Megamendung; *Spruceanthus semirepandus* (1200-2300 m) on Mt. Gede, Mt. Cikurai and Mt. Malabar; *Thysananthus convolutus* (1300-2300 m) on Mt. Gede, Telaga Warna (Puncak Pass) and Mt. Malabar; and *T. minor* (1000-1700 m) on Mt. Gede, in Mt. Halimun Salak Nat. Park and on Mt. Cikurai.

Acrolejeunea fertilis, A. pycnoclada, Lopholejeunea applanata, Mastigolejeunea auriculata and *Schiffneriolejeunea tumida* var. *haskarliana* were found in an even more limited distribution. *Acrolejeunea fertilis* was only found in the lowlands (60-80 m) in Pulau Panaitan and Depok; *A. pycnoclada* only at Mt. Gede and Ciater (Subang), in rather high altitude (1500-1900 m) although the species has also been recorded from lowlands (e.g. Bogor Bot. Garden) in the literature; *Schiffneriolejeunea tumida* var. *haskarliana* (440-1500 m) only from Mt. Gede and Mt. Halimun Salak Nat. Park; *Lopholejeunea applanata* (*ca* 1200 m) only from Gede Pangrango Nat. Park; and *Mastigolejeunea auriculata* (200-500 m) only from Bogor Bot. Garden and Ujung Nat. Park. This condition may be due to inadequate collections from the area.

Acrolejeunea arcuata, Lopholejeunea recurvata, L. zollingeri, Mastigolejeunea indica, and *Schiffneriolejeunea pulopenangensis*, finally, had the most limited distribution and were found in only one location, i.e. *Acrolejeunea arcuata* only on Mt. Patuha at 2000 m, *Lopholejeunea recurvata* on Mt. Gede at *ca*

1450 m. *L. zollingeri* on Mt. Pangrango at *ca* 1600 m, and *Mastigolejeunea indica* and *Schiffneriolejeunea pulopenangensis* only in Bogor Bot. Garden at about 200 m. The records of the latter two species only from Bogor Botanical Garden emphasize the importance of this garden as a habitat for Ptychanthoideae in West Java. A searching for additional localities of the rare species in West Java is needed.

According to Gradstein (1991) the endemic genera of Asiatic Ptychanthoideae are largely restricted to the subtropical and temperate areas of Asia and some are also known as fossils in Eocenic amber of Europe. They are considered to be palaeoendemic, the relictual groups. Endemic genera of Asiatic Lejeuneoideae, however, occur mainly in the tropical rain forests of the Malesian archipelago, are often highly specialized, and are lacking in the fossil record. They probably have co-evolved in the Tertiary with the rain forest and are to be considered neoendemics.

Ptychanthoideae seem to be older than Lejeuneoideae and may already have existed in the Mesozoic before the break-up of Laurasia and Gondwanaland. The Mesozoic age was recently confirmed based on fossil evidence and DNA sequence analysis by Wilson *et al.* (2007), who found that Lejeuneaceae started to diversify in the Late Cretaceous, about 60-90 million years ago.

The geographical distribution and altitudinal ranges of Ptychanthoideae in West Java are shown in Table 1; the definition of the distribution types follows Ariyanti and Gradstein (2007). The geographical ranges of the species were determined based on collected specimens and literature (e.g., Mizutani, 1961; Gradstein and Terken, 1981; Menzel 1988; Gradstein *et al.*, 2002; Zhu and Gradstein, 2005; Ariyanti and Gradstein, 2007).

The data show that the species of Ptychanthoideae of West Java can be subdivided into 4 groups by their geographical distributions: Malesian species (8 spp.), tropical Asiatic species (10 spp.), palaeotropical species (tropical Asia – Africa; 3 spp.) and pantropical species (throughout the tropics; 4 spp.). It appears that the species are rather widespread; none of the species are endemic to Java or western Malesia. The widespread distribution of the species is probably due to their dispersal by spores, which may be easily carried by the wind over long distances (van Zanten and Gradstein, 1987). But also the rather old age of Ptychanthoideae (Gradstein, 1991; Wilson *et al.*, 2007) may play a role.

The majority of the species (about 20) are found at mid-montane elevations, at 1200-1500 m. Few species found below 100 m and above 2000 m. The data from West Java agree with the general pattern of altitudinal distribution reported for Lejeuneaceae. According to Gradstein (1995), the diversity of Lejeuneaceae decreases with elevation and accounts for about 45% of total hepaticae diversity in the lower montane forest

Table 1. Altitudinal and geographical distributions of the species of Ptychanthoideae recorded in West Java. Lowland: 0-1200 m. Montane: 1200-3000 m. A: Asiatic. M: Malesian. P: Pantropical. Pal: Palaeotropical (Asia, Africa). * species new to Java.

No.	Species	Altitudinal distribution		Geographical distribution
		Lowland	Montane	
1.	*Acrolejeunea arcuata*	-	+	M
2.	*Acrolejeunea fertilis*	+	-	M
3.	*Acrolejeunea pycnoclada*	+	+	Pal
4.	*Archilejeunea planiuscula*	+	+	A
5.	*Lopholejeunea applanata*	+	+	A
6.	*Lopholejeunea eulopha*	+	+	P
7.	*Lopholejeunea herzogiana*	-	+	M
8.	*Lopholejeunea nigricans*	+	+	P
9.	*Lopholejeunea ceylanica*	+	+	A
10.	*Lopholejeunea horticola*	+	+	A
11.	*Lopholejeunea recurvata*	+	+	M
12.	*Lopholejeunea subfusca*	+	+	P
13.	*Lopholejeunea wiltensii*	-	+	M
14.	*Lopholejeunea zollingeri*	-	+	A
15.	*Mastigolejeunea auriculata*	+	+	P
16.	*Mastigolejeunea indica**	+	-	M
17.	*Mastigolejeunea virens*	+	+	M
18.	*Ptychanthus striatus*	+	+	Pal
19.	*Schiffneriolejeunea pulopenangnesis*	+	-	M
20.	*Schiffneriolejeunea tumida var. haskarliana*	+	+	A
21.	*Spruceanthus polymorphus*	+	+	A
22.	*Spruceanthus semirepandus*	-	+	A
23.	*Thysananthus convolutus*	-	+	A
24.	*Thysananthus minor**	+	+	M
25.	*Thysananthus retusus*	+	+	A
26.	*Thysananthus spathulistipus*	+	+	Pal

(1000/1400-2000/2500 m), 30% in the upper montane forest (2000/2500-3000/4000 m) and 20% in the subalpine forest (above 3000/4000 m).

The members of the Ptychanthoideae of West Java are epiphytes and grow on the bark of trees, on treelets and shrubs. As indicated by Thiers and Gradstein (1989) and Gradstein *et al.* (2001), many species are rather xerotolerant epiphytes of trees at forest margins or in rather open vegetation. None of the species of West Java were found growing on living leaves, which are generally inhabited by tiny members of the subfamily Lejeuneoideae, and few species occur on small branches of shrubs, which are the habitat of the ramicolous bryophytes. Dendroid, feather or bracket-type mosses and liverworts, belonging to Neckeraceae, Hookeriaceae, Pterobryaceae, and Plagiochilaceae, as well as various tiny members of Lejeuneaceae are the specialists of this habitat (Gradstein and Pócs, 1989). A study of the ecology and optimum habitat conditions of the members of Lejeuneaceae subfam. Ptychanthoideae, including moisture and temperature rates, would be desirable. Such data might further improve our understanding of the distribution of the species of Ptychanthoideae in West Java.

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Phaius takeoi (Orchidaceae) Newly Recorded from Thailand and Myanmar

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Abstract

The occurrence of *Phaius takeoi* (Hayata) H.J. Su (Orchidaceae), previously only known in mainland China, Vietnam and Taiwan, is here reported for Thailand and Myanmar.

Introduction

In the course of floristic and taxonomic work on the orchids of Thailand and Myanmar three collections of a yellow and green-flowered *Phaius* species were made which did not match any currently known species (Seidenfaden, 1986; Kress *et al.*, 2003; Vaddhanaphuti, 2005; Kurzweil, 2010). The specimens are now positively identified as *P. takeoi* (Hayata) H.J. Su, currently only known in mainland China, Vietnam and Taiwan. The new record of this species in Thailand and Myanmar is reported below.

Phaius takeoi (Hayata) H.J. Su
Quart. J. Exp. Forest Natl. Taiwan Univ. 3 (1989) 77; Chen *et al.*, Fl. China vol. 25: 290 (2009); Su, in Digital Flora of Taiwan, http://www.efloras.org floratаxon.aspx flora_id =100&taxon_id =242413999, accessed January 12, 2010). –Basionym: *Calanthe takeoi* Hayata, Icon. Pl. Formosan. 9 (1920) 111. –**Typus**: Taiwan, Toyencho, Urai, Oct 1917, *Takeo Ito* s.n. (not found). **Plate 1.** –*Phaius longicruris* Z.H. Tsi, Acta Phytotax. Sin. 19 (1981) 505; Averyanov and Averyanova, Turczaninowia 5 (2002) 93. –Typus: China, Yunnan, Jinghong, in forest, 1400 m alt., Oct 1936, *Wang 79184* (holotype, PE).

Terrestrial **herbs**, vegetative parts entirely glabrous, basally pseudobulbous, to 1 m tall. **Roots** to 3 mm in diameter. **Pseudobulbs** elongate-clavate, 20-40 cm long and (1.3-)2-2.5 cm in diameter, slightly tapering upwards, with 3-5 nodes, internodes 2.5-10.7 cm long, green or dark green with green veins, glabrous.

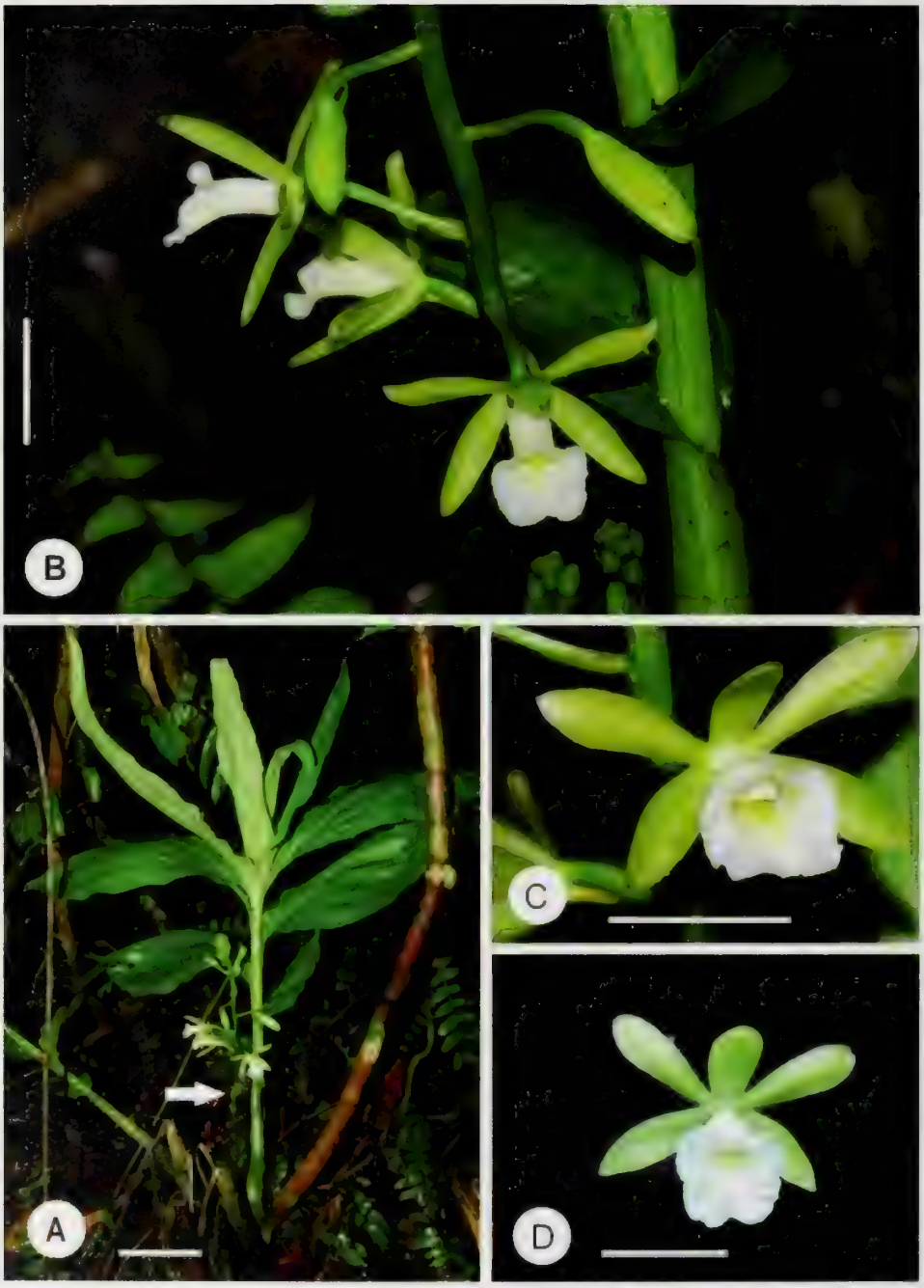

Plate 1. *Phaius takeoi* (Hayata) H.J. Su. A. Plant; B. Part of inflorescence; C & D. Flowers. All from *Watthana 3287* (Thailand, Tak); D flower photo from *Nyan Tun s.n.* (Myanmar, Shan State). Bars: A. 10 cm. B-D. 3 cm.

covered by pale green sheaths. **Leaves** 5-8, arising from the apical portion of the pseudobulbs, elliptic, elliptic-lanceolate or elliptic-oblong, (5.5-)12-40 × (2.5-)5.5-10(-14) cm, acuminate or long-acuminate, margin entire and slightly undulate, with 5-7 veins, green above, pale green underneath. **Inflorescences** arising from the lower nodes of the pseudobulbs, erect, up to 60 cm long and 0.4-0.8 cm in diameter, normally racemose but once observed with a side branch (in the specimen *Watthana* 3287), glabrous below, glabrous or sparsely hairy on the uppermost part of the rachis. Peduncles 30-50 cm long, with up to 9 sterile bracts 16-28 mm long. Rachis 10-13 cm long (rachis in all three examined specimens still elongating), with 4-15 flowers. Floral bracts persistent, ovate-lanceolate or narrowly lanceolate, the lower ones to 17 × 3.8 mm, acute, glabrous. **Flowers** 4-5 cm in diameter, opening widely; sepals and petals pale green or yellowish green and sometimes darker at the apex, lip white or cream and sometimes yellow-tinged. Pedicel plus ovary 2-3.2 cm long, sparsely pubescent or nearly glabrous. Sepals subequal, elliptic-oblong, obtuse or acute, 27-32(-35) × (7-)8-10.5 mm, 5-7-veined, abaxially sparsely hairy; laterals slightly oblique, somewhat decurved. Petals oblanceolate or oblanceolate-oblong, sometimes basally indistinctly clawed, obtuse or acute, 28-33 × 6-8 mm, 3-veined. Lip nearly orbicular, 30-34 × 24-26 mm (excluding spur), shallowly 3-lobed, glabrous for the most part but basal portion and inside of spur hairy, basally united with the column for 7-8 mm; midlobe orbicular-square or suborbicular, apex emarginate and sinus sometimes mucronate, margins undulate; side lobes ovate or elongate-ovate, strongly incurved and forming a wide open tube to embrace the column, apex broadly rounded, margins undulate; disc with three faint yellow and smooth ridges, the median one extending from the base of the lip to just below the apex of the midlobe, the lateral ones arising from the middle part of the lip to the base of the midlobe, spur elongate-conical with broad entrance, clavate, 6-9 mm long, greenish yellow. Column stout, 15-25 mm long, 6-7 mm broad, white, hairy on the front face below the stigma and continually into the spur, apex widened with very prominent lateral appendages.

Specimens examined: THAILAND. **Northern Region**. Phitsanulok Province, Phu Soi Dao, Sep 2008, *RMK* 671.51 (QBG, QBG spirit); Northern Region, Tak Province, Umphang, Jul 2009, *Watthana* 3287 (QBG). MYANMAR. Shan State, Taunggyi, Jul to Aug 2009, *Nyan Tun* s.n. (SING).

Habitat and flowering time: This species is found in moist, broad-leaved primary or secondary forest. The Thai specimens were found in a marshy spot in evergreen forest, while the Myanmar specimen was collected in moist soil near streams. Populations were quite sizeable in the Myanmar plant where several dozen individuals were found on a hill slope, but very small

with under 20 individuals in the two Thai specimens'. Altitudes were not recorded in the Thai and Myanmar specimens reported here, but elsewhere the species is found at 500-1400 m (Averyanov and Averyanova, 2002; Tsi, 1981; Chen *et al.*, 2009; Su, no date, Digital Flora of Taiwan). Flowering occurs between July and September, and has elsewhere been reported between October and December. In Taiwan and Vietnam the species is said to be uncommon (Averyanov and Averyanova, 2002; Su, no date, Digital Flora of Taiwan).

Distribution: China (Yunnan), Taiwan, Vietnam, Thailand, Myanmar.

Notes: Among the Thai and Myanmar *Phaius* congeners, this species is unmistakable with its habit and the yellow-green flowers.

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Curcuma vitellina (Zingiberaceae), a New Species from Vietnam

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Abstract

Curcuma vitellina, a new species of Zingiberaceae from Tây Nguyên, Vietnam, is described, illustrated and compared to its closest ally, *C. pierreana*.

Introduction

Cambodia, Laos and Vietnam reportedly form a diversity hotspot for the family Zingiberaceae, although detailed data are lacking because the most recent comprehensive account of the family there is over a century old (Gagnepain, 1908). The main centres of diversity of the genus *Curcuma* are usually said to be India, Burma and Thailand (e.g. Leong-Škorničková *et al.* 2008), but our recent explorations of Zingiberaceae for the *Flora of Cambodia, Laos and Vietnam* indicate that these countries are at least as rich in *Curcuma* and other Zingiberaceae.

Three *Curcuma* species, *C. bicolor* Mood & K. Larsen, *C. glans* K. Larsen & Mood from Thailand and *C. rhomba* Mood & K. Larsen from Vietnam were described in 2001 (Mood & Larsen 2001). As a revision of *Curcuma* in Cambodia, Laos and Vietnam progresses, specimens collected at two localities in Vietnam have been shown to represent a new species which is described and illustrated here. Like the species described by Mood and Larsen, this new one lacks a clear distinction between fertile and coma bracts, but differs in overall shape and coloration of the flower as well as anther morphology.

Curcuma vitellina Škorničk. & H. Đ. Trần, *sp. nov.*
Curcumae pierreanae *comae absentia, bractearum formae, anthera basi calcaribus filamentaceis 2 similis, sed rhizomate ramis lanceolatis verticaliter fasciculatis (contra rhizomate ramis horizontaliter repentibus), corollae lobis*

dilute luteis (contra albis), labello staminodiisque lutee aurantiacis (contra albis vel albis apicibus profunde rosee purpurascentibus), lamina tenui valide plicata basi rotundata (contra coriacea venis principalibus minus prominentibus, basi cuneata ad attenuata) differt. –**Typus**: Vietnam, Lâm Đồng Prov., Pongour waterfall; 11° 41' 07.0" N, 108° 16' 06.1" E; 787 m; 23 Jun 2008, *Trần et al. 70* (holotype, SING incl. spirit; isotype, E, P, VNM, National University of Laos).

Rhizome ovoid, *ca* 2.5-5 × 1.5-3 cm, with lanceolate to narrowly lanceolate branches held upright, 3-8 × 1-1.5 cm, brown externally, light yellow internally, slightly aromatic, root tubers elliptic, 2-4 cm long, light brown externally, cream white internally, at 5-15 cm from rhizome. **Pseudostem** to 15 cm long, green, composed of leaf sheaths and enclosed by 2 sheathing bracts, ligule to 5 mm long, bilobed, hyaline, greenish white, translucent, turning papery with age, hairy at the apex, hairs *ca* 0.3 mm long; **leafy shoot** to 70 cm tall with up to 5-6 leaves when flowering; petiole 5-20 cm long (petiole of first leaf shortest, innermost leaves longest), green, glabrous; lamina elliptic to elliptic-ovate, 20-45 × 8-15 cm, glabrous on both surfaces, prominently plicate, adaxially bright green, shiny, abaxially lighter green, shiny; midrib glabrous, green; base rounded, margin hyaline, translucent white, *ca* 0.5 mm wide, glabrous; apex acute, shortly hairy. **Inflorescence** central, many flowered. Peduncle 4-20 cm long, up to 1 cm diam., greenish-white, puberulent, embedded within pseudostem. Spike 8-15 cm long, *ca* 4-5 cm diam. at the middle, without coma. Fertile bracts 15-60, larger at the base of the inflorescence, *ca* 3.5-4.5 × 2.5-3.5 cm, ovate to trullate, smaller and ovate at the apex, cream white or pale greenish, sometimes with slight pinkish tinge, both sides shortly densely pubescent, connate in the lower 1/3 to 1/4. Cincinni with 4-6 flowers at the base of the inflorescence, 2-3 flowers at the top. Bracteoles one per flower, ovate, boat-shaped, *ca* 7 × 4 mm to 15 × 7 mm (outer ones larger, inner ones are gradually smaller), hyaline, translucent white, glabrous, but for the apex, upper part and margins sparsely hairy. **Flowers** 5-5.5 cm, exserted from bracts. Calyx *ca* 17 mm long, teeth 3, unilaterally split *ca* 7 mm, translucent white, sparsely hairy on the three main veins leading from the tooth to the base. Floral tube *ca* 3 cm long, narrowly cylindrical at base for *ca* 2 cm above the ovary, funnel-shaped at apex, externally white turning pale yellowish towards the apex, with glandular hair, internally white with dorsally placed groove holding the style; dorsal corolla lobe *ca* 20 × 11 mm, triangularly ovate, concave, glabrous, cream white with pale yellowish apex, apex mucronate, mucro less than 1 mm long with a few short hairs; lateral corolla lobes *ca* 18 × 9 mm, triangular with a rounded, slightly concave apex, cream white with pale yellowish apex, glabrous. Lateral staminodes obovate, *ca* 18 × 11 mm, light yellow at base, yellow-orange towards the apex, glandular

hairs present on the raised middle portion facing the centre of the flower. Labellum *ca* 21 × 20 mm, obscurely trilobed, lateral lobes folding upwards, middle lobe emarginate with an incision up to 8 mm long, which splits at the apex of the lobe as flowering progresses, cream white at base, yellow at apex with deep yellow-orange band running through the centre (golden median band). Filament 4-6 mm long, pale yellowish, 4.5 mm at base, 2 mm at apex, with glandular hair at the back. Anther spurred, connective densely covered with short glandular hairs, anther spurs *ca* 0.5 mm long, filamentous, cream white, anther crest present, 1-1.5 × *ca* 2 mm, deep yellow, anther thecae 5 mm long, white, dehiscing along their whole length. *Style* white, glabrous, stigma *ca* 1 mm wide, white, ostiole facing upwards, ciliate. Epigynous glands two, cream, 4 × 0.8 mm, with blunt apex. Ovary 3 × 2 mm, trilocular, hairy, hairs *ca* 0.2 mm long. **Fruits** not seen.

Flowering: June to August.

Distribution & habitat: So far known only from two localities (Bảo Lộc Pass and Pongour Waterfall) in Lâm Đ'ông province, Tây Nguyên, Vietnam. It grows among rocks in open and semi-open shrubby vegetation.

Vernacular names & uses: None so far recorded.

Etymology: Medieval Latin *vitellinus*, from Latin *vitellus*, egg yolk, referring to the deep yellow colour of the flowers.

Other specimens examined: Among the vast amount of *Curcuma* herbarium material revised and digitised by the first author, we have found only one collection from Pongour (24 Aug 1924, *Evrard 1193* × 2, P), which can be identified with certainty as *C. vitellina*. There are a few other specimens collected within a radius of 100 km of Pongour, which might represent *C. vitellina* (e.g. *Poilane 30582*, P and *Poilane 5031* × 2, P), but the condition of the specimens and poor accompanying notes do not allow a definite identification to be made.

IUCN preliminary assessment: Endangered (E): B2 ab (iii). The area of occupancy is estimated to be less than 500 km^2. The species is known to exist at only two locations with continuing decline in extent and quality of habitat, which is disturbed by erosion and development for tourism.

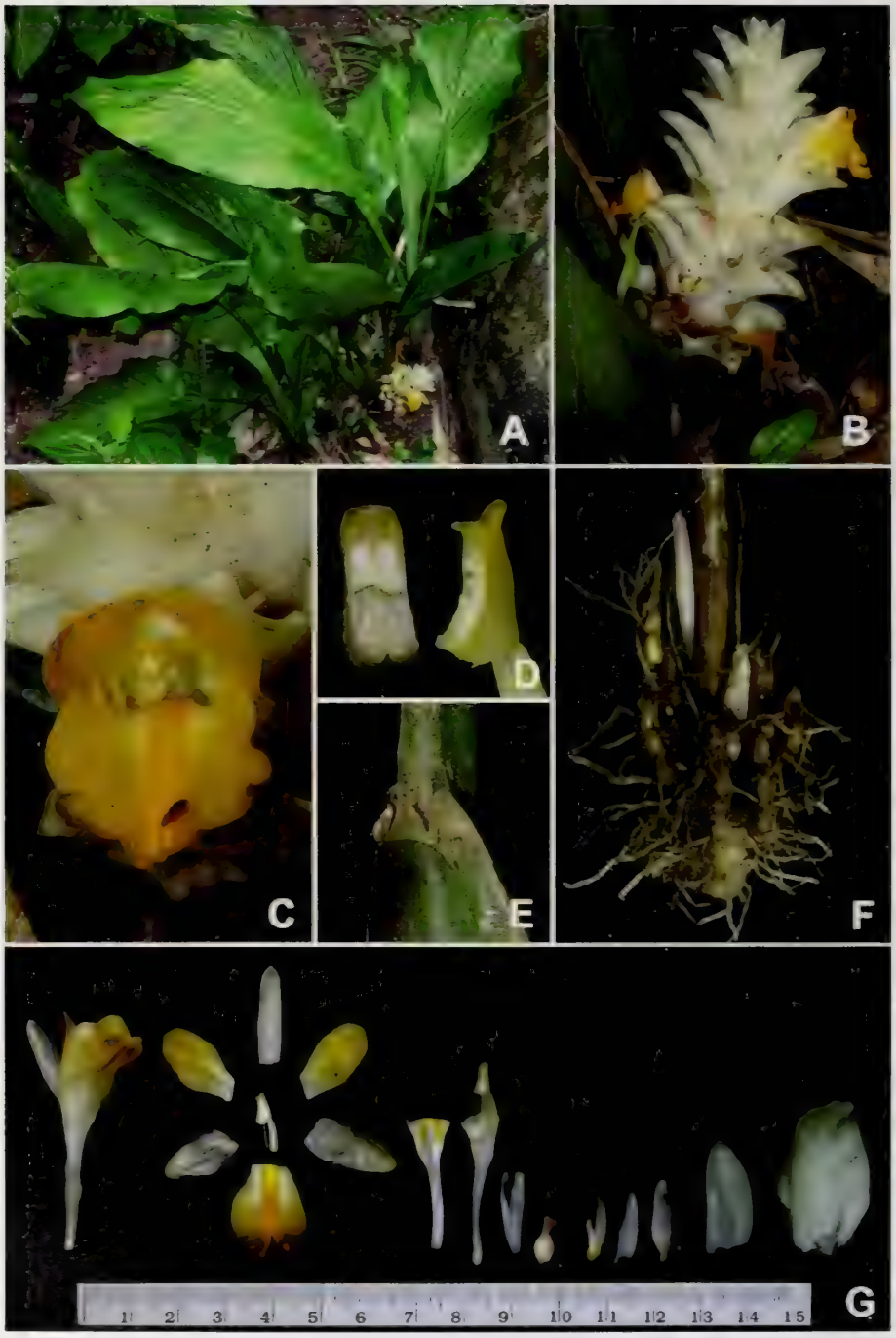

Figure 1. *Curcuma vitellina*, sp. nov. A. Habit; B. Inflorescence; C. Flower (front view); D. Detail of anther (front and side view); E. Ligule; F. Rhizome and base of leafy shoot; G. Dissected flower. Photographs by J. Leong-Škorničková taken from *Trần et al. 70*.

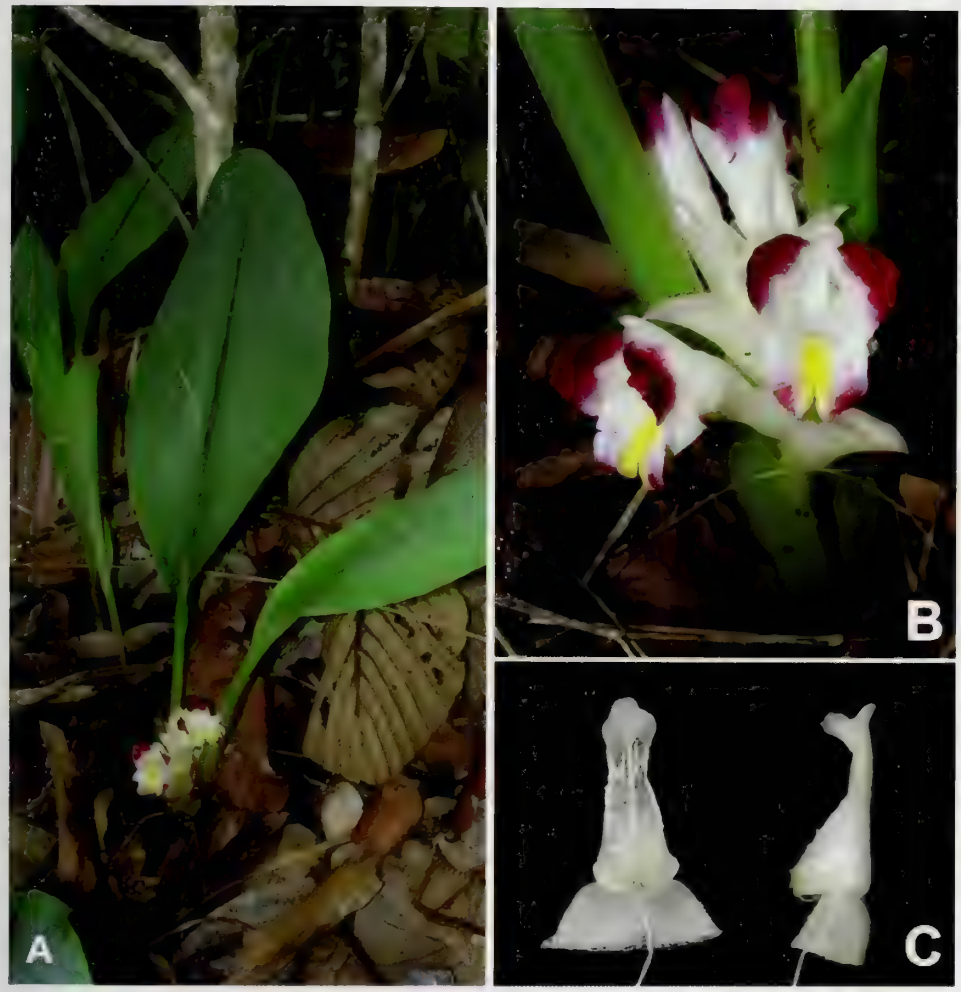

Figure 2. *Curcuma pierreana* Gagnep. A. Habit; B. Inflorescence; C. Anther (front and side view) Photographs by J. Leong-Škorničková from *Trần et al. 26.*

Notes: It is expected that *Curcuma vitellina* will be a seed-setting species as the presence of young seedlings in natural populations has been observed. *Curcuma vitellina* is similar to *C. pierreana* by its inflorescence composed of cream or greenish flower bracts (which may be tinged pink), reflexed at the tips and lacking a distinct coma (the inflorescence of *C. vitellina* is more robust and with more bracts than that of *C. pierreana*). The anthers of both species have a well-developed crest and two filamentous spurs at the base, but the overall shape of the anther is different (see Figs. 1-3). The two species differ in their rhizomes, the branches of which are narrowly

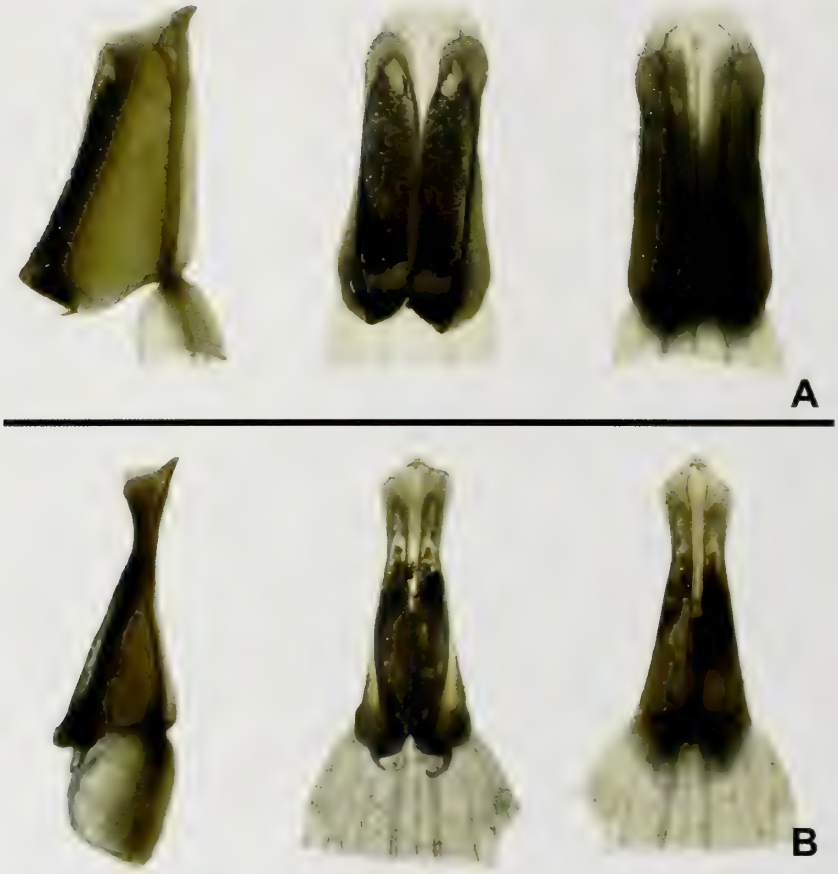

Figure 3. Anthers in side, front, and back view. A. *Curcuma vitellina* (*Trần et al. 70*); B. *Curcuma pierreana* (*Trần et al. 26*). Photographs by H.Đ. Trần.

lanceolate and vertically clustered in *C. vitellina*, but creep horizontally in *C. pierreana*. The lamina in *C. vitellina* is thin, prominently plicate, glabrous on both sides and has a rounded base, whilst it is rather leathery with dense, short hairs abaxially, with less prominent venation, and with a cuneate to attenuate base in *C. pierreana*. The flowers are yellow to yellow-orange in *C. vitellina*, while *C. pierreana* has white flowers with a yellow band on the labellum and dark maroon tips to the labellum and lateral staminodes.

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Centre at the Royal Botanic Garden Edinburgh (http://elmer.rbge.org.uk/ZRC/) for providing protologues and related references. We are grateful to Prof. Lê Công Kiệt and Dr. Trần Triết for their support during our fieldwork in Vietnam, and to Dr. J.F. Veldkamp (L) for translating the diagnosis into Latin. The second author thanks Singapore Botanic Gardens for granting an SBG Fellowship to work on the Zingiberaceae of Cambodia, Laos and Vietnam. The fundings by Sud Expert Plantes, France [SEP project 350], by the National Parks Board (Singapore), and by the Czech Science Foundation, GAČR [grant numbers 521/09/0202 and P506/10/0623] are gratefully acknowledged.

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New Combinations in *Haplopteris* (Adiantaceae) for the Flora of Peninsular Malaysia

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Abstract

Two new combinations are made here: *Haplopteris hirta* (Fée) S.Linds. and *Haplopteris angustissima* (Holttum) S.Linds.

In preparation for the account of the Adiantaceae for the Flora of Peninsular Malaysia new combinations are necessary in the genus *Haplopteris* C.Presl. The family delimitation to be used in the Flora account is modified from Smith *et al.* (2006, 2008) who recognized a broadly delimited Pteridaceae but acknowledged that there are five monophyletic groups within the family that could be raised back to family level. The Adiantaceae, comprising *Adiantum* L. and all members of the former family Vittariaceae, is one of these monophyletic groups.

As so defined, the Adiantaceae in Peninsular Malaysia consists of the five genera *Adiantum* L., *Antrophyum* Kaulf., *Haplopteris* C.Presl, *Monogramma* Comm. ex Schkuhr., and *Vaginularia* Fée. The generic delimitation of the Vittarioid genera in the Flora account will largely follow Crane (1998). In this work it was shown that the Old and New World *Vittaria* species did not form a monophyletic group. All *Vittaria* species in Peninsular Malaysia (see Holttum, 1955) now belong in the genus *Haplopteris*. Crane (1998) and Zhang (2003) made most of the necessary name changes but two new combinations are still required.

Haplopteris hirta (Fée) S.Linds. *comb. nov.*
Basionym: *Vittaria hirta* Fée, Mém. Foug. 10 (1865) 12. –**Type**: *Wallace* s.n., Borneo (holotype, BM).

Haplopteris angustissima (Holttum) S.Linds., *comb. nov.*
Basionym: *Vittaria angustissima* Holttum, Gard. Bull. Singapore 11 (1947) 274. –**Type**: *C.E.Carr* s.n., Pahang, Fraser's Hill, alt. 4000 ft. March 1929 (holotype, SING).

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A New Species of *Alocasia* (Araceae-Colocasieae) From Cambodia

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Abstract

Alocasia jiewhoei V.D.Nguyen, a new species from Cambodia, is described and illustrated.

Introduction

The genus *Alocasia* (Araceae-Colocasieae) includes about 75 species distributed mainly in tropical Asia, Malesia, Australia and Melanesia (Govaerts and Frodin, 2002). In Indo-China, eleven species have been recorded in the *Flore Général de l'Indo-Chine* by Gagnepain (1942). In 2007, during fieldwork in Cambodia, V.D. Nguyen's group found a new species of *Alocasia* growing on dry leaf litter in forest in Kulen National Park of Siem Riep Province. The plant does not match any known species in the genus (Boyce, 2007, 2008; Hay, 1998, 1999; Hay and Wise, 1991; Medecilo *et al.*, 2007; Wang *et al.*, 2005).

A comparison of morphological characters with other species in the genus showed the species resemble *A. odora* (Lindl.) K.Koch and *A. navicularis* (K.Koch & C.D.Bouché) K.Koch & C.D.Bouché, in having peltate, cordate-ovate leaf blades, 5-10 pairs of lateral veins, the greenish spathe and conical appendices. However, it is distinguished from *A. odora* and *A. navicularis* by its smaller size, slender petioles, stolons with bulbils at the apex, conspicuous styles and prominently lobed stigmas (Table 1). It closely resembles *A. navicularis* in having erect, cymbiform spathes.

Alocasia jiewhoei V.D. Nguyen, *sp. nov.*
Alocasiae odorae *similis in folii lamina peltata et spathae lamina dilute viridi, sed spathae lamina cymbiformi, stylis longis, stigmatibus longe lobatis differt.*–**Typus**: Cambodia, Siem Riep Province, Phrom Ku Len National Park, 13°36'58.1" N 104°02'20.4" E, 150 m alt., *V.D. Nguyen & Rattana CB-VN 212* (holotype, HN; isotypes, K, P, MO). **Fig. 1 & Plate 1.**

Table 1. A comparison of *Alocasia jiewhoei* and closely related species.

Characters	*A. odora*	*A. navicularis*	*A. jiewhoei*
Plant height	40 to >250 cm	50 to150 cm	30 to 70 cm
Rhizome internal colour	Light green and white	Light green and white	Light yellow
Petiole	Stout	Stout	Slender
Bulbils on the stolons	None	None	At the apex
Style	Very short or inconspicuous	Very short or inconspicuous	Conspicuous, 1-1.5 mm long
Spathe limb - shape - colour	 Hooked cymbiform Green to dull green	 Erect cymbiform Dull yellow	 Erect cymbiform Medium green
Stigma	Shallowly lobed	Shallowly lobed	Prominently lobed
Habitat	Wet, evergreen forest	Wet, evergreen forest	Dry, deciduous forest

Rhizomatous plants, *ca* 70 cm tall. **Rhizomes** decumbent, slender to stout, aerial parts 10-15 cm long, 1-4 cm in diameter, internodes 1.5-3 mm long, grey to dark brown externally, light yellow internally, covered by traces of decayed cataphylls. **Roots** stout, 10-15 cm long, not branched. **Stolons** several, subterranean, apex aerial, bearing bulbils at the apex; bulbils obovate, winged, six-angular in cross section, 1.5 cm long, *ca* 1 cm in diameter, oblong at base, abruptly acuminate, covered by several brown, small triangular scales. **Leaves** peltate, 4-7 together; petioles slender, 40-70 cm long, sheathed up to >1/3 of the length, green with dull dark green veins sunk below the surface; leaf blades ovate, 22-50 cm long, 17-30 cm at widest point, basal lobes broadly triangular, 7-16 cm long, 6-13 cm wide at base, apices obtuse, connection between 2 lobes 5-8 cm wide from petiole apex, dark green

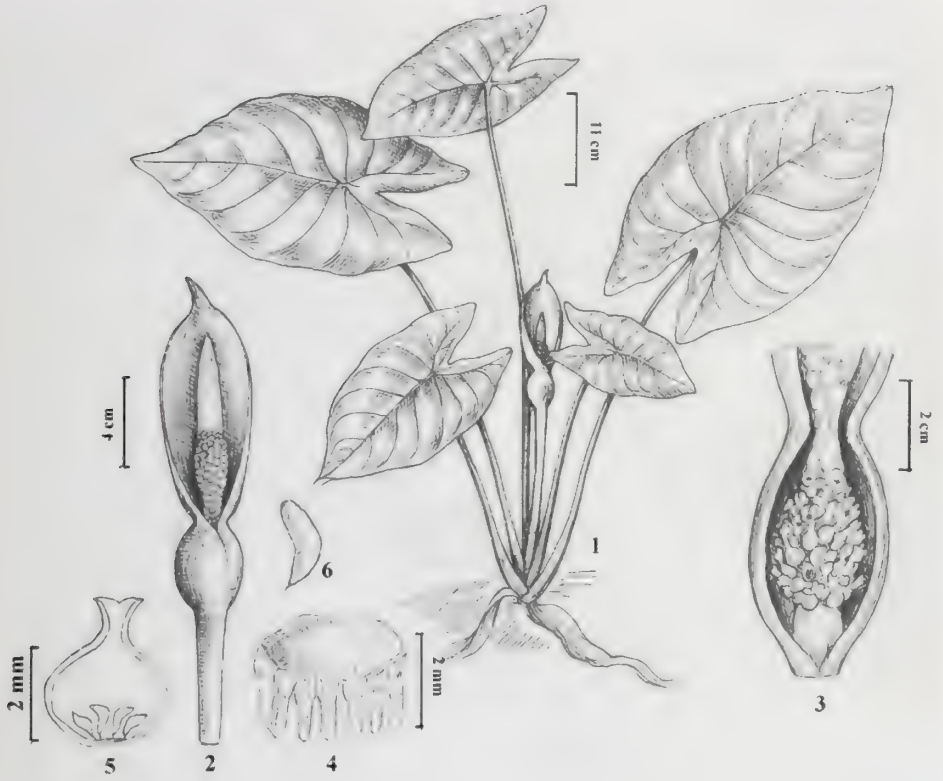

Figure 1. *Alocasia jiewhoei* V.D. Nguyen. 1. Habit; 2. Inflorescence; 3. Detail of female flower zone; 4. Male flower; 5. Ovary in longitudinal section; 6. Ovule.

and glossy above, dull green beneath; lateral veins 7-8 pairs in anterior lobes, 2-3 veins in posterior lobes, pronounced above, prominent beneath, secondary veins originating from lateral veins and midrib, run parallel and ascend towards leaf margins, connected by reticular veins. **Inflorescences** one per axil, several per plant; peduncles slender, 25-30(-45) cm long, 7-10 mm in diameter, expanded at top, green, covered by a thin white chalky layer; **spathes** 11-12 cm long, constricted about 1/5 of the way from the base; lower part ellipsoid or subglobose, green; limb 8.3-10 cm long, *ca* 4 cm wide, cymbiform, green when young, medium green at anthesis; **spadices** 8.5-10 cm long; female zones cylindrical, 0.8-1 cm long, **female flowers** congested, light yellow; ovaries subglobose in general, shallowly concaved into three lobes, 2 mm in diameter, green; styles 1 mm long, white; stigmas three lobed, 1-1.2 mm wide, white; ovules *ca* 10, placentation basal; sterile interstice conical at lower part, constricted near apex then slightly expanded at apex, 1.8-2.3 cm long, 9 mm in diameter at base, 3-4 mm at the constriction and 4-5 mm at apex, bearing 2 whorls of white, acute-ovate, flattened sterile flowers in

Plate 1. *Alocasia jiewhoei* V.D.Nguyen. A. Plant habit; B. Appendix and male portion; C. Staminodes and female portion in detail. (Photos: V.D. Nguyen).

upper part; base covered by 2 rows of sterile flowers, columnar or ring-like; male zones cylindrical, 1.8-2.3 cm long, 8-10 mm in diameter, oblong to base, white; appendices conical, 3.5-4.8 cm long, smaller in diameter than male zone, acute at apex, very shallowly concaved on surface, without veins, dull white; **male flowers** sub-rectangular, 3 mm long, *ca* 2 mm wide, bearing 4-6 stamens. **Berries** subglobose, 3-4 mm in diameter; **seeds** 2-3.

Ecology: Dry seasonal forest, altitude 0-500 m.

Distribution: Endemic in Cambodia.

Vernacular name: None recorded.

Uses: None recorded. However the new species has potential as an ornamental plant.

Etymology: The plant is named in honour of Tan Jiew Hoe of Singapore.

Conservation status: The plant is found in the Phrom Ku Len National Park of Siem Riep Province where the forest is protected. Although the new species is rare, there is little data to show if it is threatened.

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New Combinations in Malaysian Staphyleaceae

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Abstract

New combinations are made for the seven species of *Dalrympelea* (Staphyleaceae) from Malaysia that were previously included in *Turpinia*. *Dalrympelea pomifera* Roxb. is distinct from *D. sphaerocarpa* (Hassk.) A.T.Nor-Ezzawanis and does not occur in Malaysia and *Turpinia ovalifolia* Elmer from the Philippines is distinct from *D. trifoliata* (Ridl.) A.T.Nor-Ezzawanis.

Introduction

Staphyleaceae currently includes two genera, *Dalrympelea* Roxb. and *Staphylea* L. (Simmons, 2007; Stevens, 2010), that can be distinguished by the following morphological characters: stoloniferous shrubs (2 m) to upper canopy trees of 25-30 m in *Dalrympelea*, and small trees reaching 15 m in *Staphylea*; the bark ranges from creamy yellow and flaky to smooth grey in *Dalrympelea*, and grey to black and somewhat mottled, with or without lenticels in *Staphylea*; the stipules of opposed leaves are fused and sometimes becoming bifid at the apex, often having a colleter in *Dalrympelea*, and the stipules are free and multi-veined in most species of *Staphylea*. The former occurs in the Old World and the latter in both the Old and New Worlds.

Based on molecular analysis using nuclear and chloroplast markers, Staphyleaceae divides into two clades that are treated as distinct at the generic level (Simmons & Panero, 2000; Simmons, 2007). One clade, *Staphylea*, includes all species of *Staphylea*, all New World species of the *Turpinia* Raf., and one Asian species, *Turpinia cochinchinensis* (Lour.) Merr. and the monotypic *Euscaphis japonica* (Thunb.) Kanitz (Simmons, 2007).

The other clade includes the Old World *Turpinia* species, except for *Turpinia cochinchinensis*. Members of this latter clade are generally characterized by being evergreen trees with fused stipules (at least at the base), coriaceous leaves and a berry with a thickened pericarp (Simmons, 2007). Because the type species of *Turpinia* is *T. cochinchinensis*, which is now included in *Staphylea*, the name *Turpinia* cannot be applied to the Asian species. The earliest name for this clade is *Dalrympelea* Roxb. (Roxburgh,

1819). The revision of the family for the Flora of Peninsular Malaysia necessitates making new combinations for local *Turpinia* species besides reassessing the status of some species. New combinations are also provided for species in the Malaysian states of Sabah and Sarawak in Borneo that were revised by Pereira (1995).

DALRYMPELEA Roxb.
Hort. Beng. (1814) 17, *nomen*, Pl. Corom. 3 (1819) 76, *t.* 279; Simmons *in* Kubitzki, Fam. Gen. Vasc. Pl. 9 (2007) 443. Type species: *Dalrympelea pomifera* Roxb., Pl. Corom. 3 (1819) 76. *t.* 279.
Synonym: *Turpinia* Vent., Choix (1803) 31, *t.* 31, *p.p.* excl. New World species and *T. cochinchinensis*; Ridley, Fl. Malay Pen. 1 (1922) 511; Linden, Fl. Malesiana 1, 6 (1960) 51; Whitmore, Tr. Fl. Malaya 1 (1972) 447; Pereira, Tr. Fl. Sabah & Sarawak (1 (1995) 454.

Evergreen shrubs to large trees to 30 m tall, sometimes with buttresses. **Leaves** pinnately (1- or 3-) or 5-15-foliolate, coriaceous; stipules interpetiolar, basally connate to fused along their length. **Inflorescences** terminal or axillary panicles with more than 100 flowers. **Flowers** with sepals free, shorter than the pink, cream, yellow or green-white petals; stamens arising between the lobes of the nectary disc; ovary (2-)3(-4)-locular, sometimes partially imbedded in the disc, more or less syncarpous, with 2-8 ovules per locule. **Fruit** an ellipsoid, nearly globose or trilobed berry, fleshy or leathery, usually green to purple; exocarp thick and fleshy to woody. **Seeds** 1-6 per fruit.

Distribution: About 20-25 species from Sri Lanka and S India to China and Japan and southwards to New Guinea (Simmons, 2007) with 8 species in Malaysia (2 species in Peninsular Malaysia and 6 species and 1 variety in Sabah and Sarawak).

New Combinations for Malaysian Species

1. ***Dalrympelea borneensis*** (Merr. & L.M.Perry) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia montana* var. *borneensis* Merr. & L.M.Perry, J. Arnold Arbor. 22 (1941) 553. -Homotypic synonym: *Turpinia borneensis* (Merr. & L.M.Perry) B.L.Linden, Fl. Malesiana 1, 6 (1960) 56; Pereira, Tr. Fl. Sabah & Sarawak 1 (1995) 456. –**Type**: Borneo, Sabah [British North Borneo], Gunung Kinabalu, Tenompok, *J. & M.S. Clemens 29391* (holotype, UC; isotypes, BO, K).

Distribution: Borneo (Kalimantan and Sabah) and the Philippines.

2. ***Dalrympelea calciphila*** (J.T.Pereira) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia calciphila* J.T.Pereira, Sandakania 5 (1994) 18, fig. 1; Tr. Fl. Sabah & Sarawak 1 (1995) 457. –**Type**: Borneo, Sarawak, Miri Division, Gunung Api, *Anderson S 4710* (holotype, SAR; isotypes, BO, K, L, SING).

Distribution: Endemic in Sarawak, Borneo – Kuching Division near Bau (Bukit Buan and Bukit Gebung) and Miri Division (Gunung Api and Gunung Buda).

3. ***Dalrympelea grandis*** (B.L.Linden) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia grandis* B.L.Linden, Fl. Malesiana 1, 6 (1960) 55; Pereira, Tr. Fl. Sabah & Sarawak 1 (1995) 457. –**Type**: E Borneo, W Koetai, Kiau River, *Endert 4669* (holotype, L; isotypes, BO, K).
Distribution: Endemic in Borneo (Kalimantan, Sabah and Sarawak).

4. ***Dalrympelea nitida*** (Merr. & L.M.Perry) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia nitida* Merr. & L.M.Perry, J. Arnold Arbor. 22 (1941) 549; Linden, Fl. Malesiana 1, 6 (1960) 58; Pereira, Tr. Fl. Sabah & Sarawak 1 (1995) 459. –**Type**: Borneo, Sabah [British North Borneo], Gunung Kinabalu, Penibukan, *J. & M.S. Clemens 30840* (holotype, UC; isotypes, BO, K).

Distribution: Endemic in Sabah, Borneo (Ranau, Sandakan, Kudat and Lahad Datu Districts).

5. ***Dalrympelea sphaerocarpa*** (Hassk.) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia sphaerocarpa* Hassk., Flora 25, 2 (1842) Beibl. 1, 42; Ridley, J. Str. Br. Roy. As. Soc. 82 (1920) 179; Linden, Fl. Malesiana 1, 6 (1960) 49; Whitmore, Tr. Fl. Malaya 1 (1972) 448; Pereira, Tr. Fl. Sabah & Sarawak 1 (1995) 460-Homotypic synonym: *Turpinia pomifera* (Roxb.) DC. var. *sphaerocarpa* (Hassk.) King, J. As. Soc. Beng. 65 (1896) 453. –**Type**: Java, *sine coll., s.n., Herb. Reinwardtianum* (holotype, L, acc. no. *908272875*).
Heterotypic synonyms: *Turpinia latifolia* Wall. *ex* Ridl., J. Str. Br. Roy. As. Soc. 82 (1920) 178, Fl. Mal. Pen. 1 (1922) 512.–**Type**: Singapore, *Wallich 4939* (lectotype, K, isotype, CAL). -*Turpinia laxiflora* Ridl., J. Str. Br. Roy. As. Soc. 82 (1920) 179, Fl. Malay Pen. 1 (1922) 512; Linden, Fl. Malesiana 1, 6 (1960) 57. –**Type**: Peninsular Malaysia, Perak, Larut, *Kunstler 2824* (holotype, K).

Taxonomic notes: Wallich (1828) in his Catalogue named *Wallich 4939* as '*Turpinia ?latifolia*'. Hiern (1875) included *Turpinia latifolia* as a synonym of *Turpinia pomifera* (Roxb.) DC. with *Wallich 4939* as the only specimen cited for Malaya.

King (1896) described two varieties of *Turpinia pomifera* from Peninsular Malaysia. The typical variety was represented by a single specimen, *Kings' Collector 4243* from Perak, and *Turpinia pomifera* var. *sphaerocarpa* (Hassk.) King was described as 'the common form in the Malayan Provinces'. King cited *T. latifolia* based on *Wallich 4939* as a synonym of var. *sphaerocarpa*.

Turpinia sphaerocarpa Hassk. was originally described from Java and has small fruits 0.5-1.8 cm diameter with a thin pericarp 1-4 mm thick as compared with *Turpinia pomifera* from Continental Asia that Linden (1960) described as having larger fruits 2.5-3.7 cm diameter with a pericarp 5 mm thick. Re-constructing the fragments of the fruit on *Kings' Collector 4243* shows that it has a small fruit about 1.5 cm diameter with a pericarp *ca* 3 mm thick showing conclusively that it is not a specimen of *Turpinia pomifera*, but is typical of *Turpinia sphaerocarpa*. Ridley (1920) was not able to examine *Kings' Collector 4243* (there is apparently no specimen at Kew) but considered it was unlikely to be the same as the *Turpinia pomifera* and instead he used Wallich's original name, *T. latifolia* Wall. *ex* Ridl., to describe this common species in Peninsular Malaysia. (Incidentally, he gave Penang Hill as the locality for *Wallich 4939* but in fact Wallich collected it from Singapore). Ridley's description mentioned the fruit diameter as *ca* 1.3 cm (within the *Turpinia sphaerocarpa* range), but unfortunately he did not record pericarp thickness. Linden (1960) too was doubtful that *Turpinia pomifera* occurred in Peninsular Malaysia and considered *Kings' Collector 4243* as "too inadequate" for identification. He therefore reinstated *Turpinia sphaerocarpa* to specific rank with *Turpinia pomifera* var. *sphaerocarpa* and *T. latifolia* as synonyms. Whitmore (1972) noted that *Turpinia pomifera* was based 'on one doubtful collection', namely *Kings' Collector 4243*. It is therefore now clear that *Turpinia pomifera* does not occur in Peninsular Malaysia.

Of the three type specimens at L (acc. nos. *908272875*, *908272863* and *908272865*), sheet number *908272875* is chosen as the lectotype because it is the most complete specimen with more fruits and it is from Herbarium Reinwardtianum.

Ridley (1920) described a new species of *Turpinia*, *T. laxiflora* Ridl., but without a description of the fruit. In his Flora (Ridley, 1922), he distinguished it from *T. latifolia* by panicle size: 20 cm [8 in] long in *T. latifolia* as opposed to 38 cm [15 in] in *T. laxiflora*. Linden (1960) followed Ridley in retaining *T. laxiflora* as a distinct species noting that it differed from *T. sphaerocarpa* in its wider leaflets (8-24 × 3.5-12 cm as opposed to 3-18 × 2-10 cm in *T. sphaerocarpa*), larger panicles (to 45 cm vs. to 30 cm long), narrower petals (2.25-2.5 × 1-1.25 mm vs. 2.5 × 1.5 mm), shorter filaments (1.5-1.75 mm vs. 2-2.5 mm long), smaller fruits (0.5-1 cm vs. 1-1.5 cm diameter) and very thin pericarp (0.2-0.9 mm thick vs. 1-3 mm thick in *T. sphaerocarpa*). However, Whitmore (1972) synonymised *T. laxiflora* with *T. sphaerocarpa* but without giving a reason for his decision.

Examination of specimens from Peninsular Malaysia identified as *T. latifolia*/*T. sphaerocarpa* and *T. laxiflora* show that the characters listed by Linden (1960) are not mutually exclusive. For example, *Corner 28690* (KEP) has a panicle *ca* 21 cm long, which falls within *Dalrympelea sphaerocarpa*, but the petals measure *ca* 2 × 1.25 mm and filaments *ca* 1.25-1.5 mm long and so fall within the range for *T. laxiflora*. Similarly, *Jaamat 10275* (KEP) has a fruit *ca* 1.2 cm diameter with a pericarp *ca* 4 mm thick that fits *D. sphaerocarpa* but the petals measure *ca* 2 × 1 mm and the filaments are *ca* 1.5 mm long that fall within the range of *T. laxiflora*. Linden (1960) also mentioned colour of the dried leaf as a distinguishing characters (brown on both surfaces in *T. laxiflora*, but discolorous in *D. sphaerocarpa*), but again it was found that this character did not distinguish these two taxa. There being no constant character or combination of characters to keep *T. laxiflora* apart, it is here treated as a synonym of *D. sphaerocarpa*.

Burkill (1966) confused the picture by recognizing *Turpinia pomifera* and treating both *T. latifolia* and *T. laxiflora* as synonyms of it. He described *T. pomifera* as a "fairly large tree in the lowlands" which indicates that he was probably referring to *Dalrympelea sphaerocarpa*.

Pereira (1994) recognized a second variety, var. *microcerotis*, from Borneo, which differs from var. *sphaerocarpa* in having shorter leaf rachises (2-8 cm vs. 10-18 cm long), shorter leaflets (5-10 cm vs. 7-19 cm long) and a slightly trilobed fruit with three apical horns compared with the globose, hornless fruit of var. *sphaerocarpa*.

Distribution: Sumatra, Peninsular Malaysia, Singapore, Borneo, Java, Lesser Sunda Islands (Bali, Flores), Sulawesi, the Philippines and Maluku (Ceram, Ambon).

5a. ***Dalrympelea sphaerocarpa*** (Hassk.) A.T. Nor-Ezzawanis var. ***microcerotis*** (J.T. Pereira) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia sphaerocarpa* Hassk. var. *microcerotis* J.T. Pereira, Sandakania 5 (1994) 21, fig. 2; Tr. Fl. Sabah & Sarawak 1 (1995) 461. – **Type**: Borneo, Sabah [British North Borneo], Ranau, Gunung Kinabalu, Tenompok, *J. & M.S. Clemens 28707* (holotype, SING; isotypes, BO, K).

Distribution: Endemic in Borneo (Sabah and Kalimantan).

6. ***Dalrympelea stipulacea*** (B.L.Linden) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia stipulacea* B.L.Linden, Fl. Malesiana 1, 6 (1960) 55; Pereira,Tr. Fl. Sabah & Sarawak 1 (1995) 461.–**Type**: Borneo, Sabah, Gunung Kinabalu, near Tibabah River, *Carr SFN 27516* (holotype, SING).
Distribution: Endemic to Sabah (Ranau district only).

7. ***Dalrympelea trifoliata*** (Ridl.) A.T.Nor-Ezzawanis, *comb. nov.*
Basionym: *Turpinia trifoliata* Ridl., J. Str. Br. Roy. As. Soc. 82 (1920) 178, Fl. Malay Pen. 1 (1922) 511, fig. 50. –**Type**: Peninsular Malaysia, Melaka, Nyalas, *Goodenough 1771* (lectotype, SING, here chosen).
Heterotypic synonym: *Turpinia ovalifolia* Elmer, Leafl. Philip. Bot. 2 (1908) 490, *auct. non*: Linden, Fl. Malesiana 1, 6 (1960) 58; Whitmore, Tr. Fl. Malaya 1 (1972) 448.–**Type**: Philippines, Luzon, Lucban Tayabas, *Elmer 8088* (SING).

Taxonomic notes: Some authors (Linden, 1960; Whitmore, 1972) considered this species in Peninsular Malaysia to be conspecific with *Turpinia ovalifolia*. However, careful comparison between Peninsular Malaysian specimens and the type specimens of both *T. ovalifolia* and *T. trifoliata* show that the Malaysian specimens previously identified as *T. ovalifolia* in fact belong to *T. trifoliata*. *Turpinia ovalifolia*, known only from the type specimen, is characterized by its small leaves *ca* 4 × 2.5 cm with a more-or-less entire margin. In contrast, *T. trifoliata* specimens cited by Ridley (1920), namely *Goodenough 1771* and *Ridley 15906*, are characterized by larger leaves *ca* 7-14 × 3.5-7 cm with a crenate margin with fine, dark brown (when dry) callous points. These characters are shared by more recently collected specimens from Malaysia and indeed some have even larger leaves up to *ca* 9.5-20 × 4-9.5 cm. Therefore it is concluded that *T. ovalifolia* does not occur in Peninsular Malaysia.

Ridley (1920) cited two specimens in his original description of the species. *Goodenough 1771* is here chosen as the lectotype because it is a more complete specimen and the sheet has Ridley's description of the flower (in his handwriting) and is named '*Turpinia trifoliata*'.

Distribution: Peninsular Malaysia (Perak, Selangor, Negeri Sembilan, Pahang and Johor).

Acknowledgements

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A New Species of Costaceae from Borneo

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Abstract

A new species, *Cheilocostus borneensis*, is described. Specimens were collected in Sarawak in 1987 and Kalimantan in 2000, but only intensified surveys of gingers in Sarawak in 2002-2004 provided sufficient collections to recognize the new species, which is here described and illustrated. It is closely related to the widespread *C. globosus* from which it differs by the chocolate-brown sheaths, absence of axillary shoots on vegetative stems, larger leathery leaves, and by its calyx that is not prickly.

Introduction

Members of Bornean Costaceae were previously placed in the genus *Costus* L. (Maas, 1979), which is now circumscribed as a clade comprising only African and neotropical species based on phylogenetic analyses of morphological and molecular data (Specht and Stevenson, 2006). Following this evaluation of the generic circumscription of Costaceae, only two genera, *Cheilocostus* C. Specht and *Paracostus* C. Specht, are native to Borneo where seven species of Costaceae are presently known (Maas, 1979; Meekiong *et al.*, 2006; Meekiong *et al* , 2008). The exact generic placement has not been established for all Bornean species and an updated revision for both *Cheilocostus* and *Paracostus* is pending and will likely include other recently discovered and described species.

The genus *Cheilocostus* is easily distinguished from *Paracostus* by consisting of larger plants (> 1.5 m high) with erect shoots, and a condensed inflorescence with conspicuous bracts, each subtending a single flower. *Paracostus*, in contrast, is characterized by smaller plants (< 1.5 m), prostrate stems with few leaves, and inflorescences with few flowers supported by inconspicuous bracts. *Cheilocostus* is closely related to the genus *Tapeinochilus* Miq. which is only found east of Sulawesi into New Guinea, Australia and the Pacific (Gideon, 1996; Poulsen *et al.* 2010).

During expeditions targeting gingers in Sarawak in 2002-2004, the first author collected, with Malaysian collaborators, new material of several species of Costaceae. One of these had already been collected several times, and specimens were deposited in several herbaria but without pickled flowers essential for its description. The material now being available, the species is described below.

Cheilocostus borneensis A.D. Poulsen, *sp. nov.*
Cheilocostus borneensis *in inflorescentia radicali* C. globoso *similis est sed ab eo foliis ad apicem caulis aggregatis plerumque majoribus et calyce molliter acuto (haud pungenti nec aculeato) differt.* –**Typus**: Malaysia, Borneo, Sarawak, Batang Ai, Sungai Senkabang, small stream connecting to Sg. Delok opposite of Ng. Sumpa longhouse, 1°12'S 112°3'E, 130 m, flowering 8 Dec 2002, *A.D. Poulsen & Bakir Raymond 1964* (holo, SAR; iso, AAU, Sarawak Biodiversity Centre Flora Depository). **Figs. 1 & 2.**

Figure 1. *Cheilocostus borneensis* photographed by A.D. Poulsen (*Poulsen 2696*, cultivated).

Terrestrial, perennial **herb**. **Leafy shoots** in a dense clump, 1.5-2 m tall. Base of leafy shoot to 3 cm diam., pale yellow-green when fresh, covered by reddish brown sheaths. **Stem** leafless in lower *ca* 1.4 m, sheaths reddish chocolate-brown (uppermost yellow-green), glabrous, with 6-10 leaves consistently clustered toward the shoot apex. Ligule 1-2 mm long, ± truncate, slightly longer laterally to the petiole. Petiole 5-12 mm long, swollen, pale yellowish, slightly canaliculate, glabrous. Lamina to 27-42 × 9-16(-20) cm, narrowly obovate, mid-green above, pale green beneath, coriaceous, slightly plicate, glabrous throughout, base narrowly cuneate, apex acuminate, *ca* 1 cm long. **Inflorescence** radical (i.e. at the base of the plant terminating a separate leafless shoot that emerges directly from the rhizome), 12-21 cm long (bracts only), lax. Peduncle horizontal to ascending, 6-12 cm long, sheaths ± tubular, brown, glabrous, margin ragged. Spike 4-12 × 5-8 cm (bracts only). Fertile bracts to 3.2-3.5 × 2-2.5 cm, elliptic, cucullate, margin membranous, apex ± emarginate, softly mucronate, dark brown to greenish or pale reddish brown, glabrous. Rachis (distance from base of lowermost ovary to base of uppermost ovary) 2 cm long extending with age to 7(-9) cm, with 40-80 flowers, 1-2 open at a time. Bracteole 2-2.5 cm long, split to base adaxially, reddish brown, glabrous, apex rounded with one minute mucro, 1-lobed developed laterally, cucullate, not closely adhering to calyx, sometimes with a second shorter lobe without mucro. **Flower** 8.5-10 cm long, exerted *ca* 5 cm above the supporting bract. Calyx 3-3.2 cm long, tubular, dark reddish brown, glabrous, apex 3-lobed, lobes 0.7-1 cm long, slightly involute, apex acute to mucronate, soft (not pungent). Corolla tube (from apex of ovary to base of divergence of labellum and stamen) 2.5-3.2 cm long, fused solid with style in lowest 1-1.5 cm, white at base; lobes 3.5 × 1.5 cm, narrowly obovate, translucent white, glabrous, apex rounded, finely apiculate to 1 mm long. Labellum tube (from insertion of dorsal corolla tube to base of divergence of labellum and stamen) 1.1-1.3 cm long with coarse yellow hairs inside and outside. Labellum 5-5.3 × 5.2-6 cm, broadly obovate, thickened in centre with course, short hairs, white with yellow center, margin finely undulating, glabrous. Stamen *ca* 2.5 cm long (*ca* 3.2 cm when crest flattened), *ca* 1 cm wide, petaloid, white. Anther crest slightly or irregularly 3-lobed, recurved, 1.1-1.2 cm long, with yellow spot in lower centre, coarse hairs at margin. Thecae 0.7-0.8 cm long, 0.3-0.4 cm across both, dehiscing for their entire length. Ovary 1 × 0.6 cm, flattened ellipsoid, glabrous. Style 3.5-3.7 cm long (free part), glabrous. Stigma *ca* 0.3 cm wide, fan-shaped, flattened 2-lobed, lobes overlapping, one larger than the other, hairy, pale yellow. **Infructescence** head to 12 × 8 cm, often still flowering at apex, with persistent bracts, bracteoles and, calyces. **Fruit** 0.9-1 × 0.8-0.9 cm, obovoid, flattened-triangular, with an apical column (base of calyx and corolla tube), 3-locular, glabrous, cream to pale green. **Seeds** 1.5-1.7 × 1-1.2 mm, irregularly barrel-shaped, black, aril white, basal and not enclosing the seed.

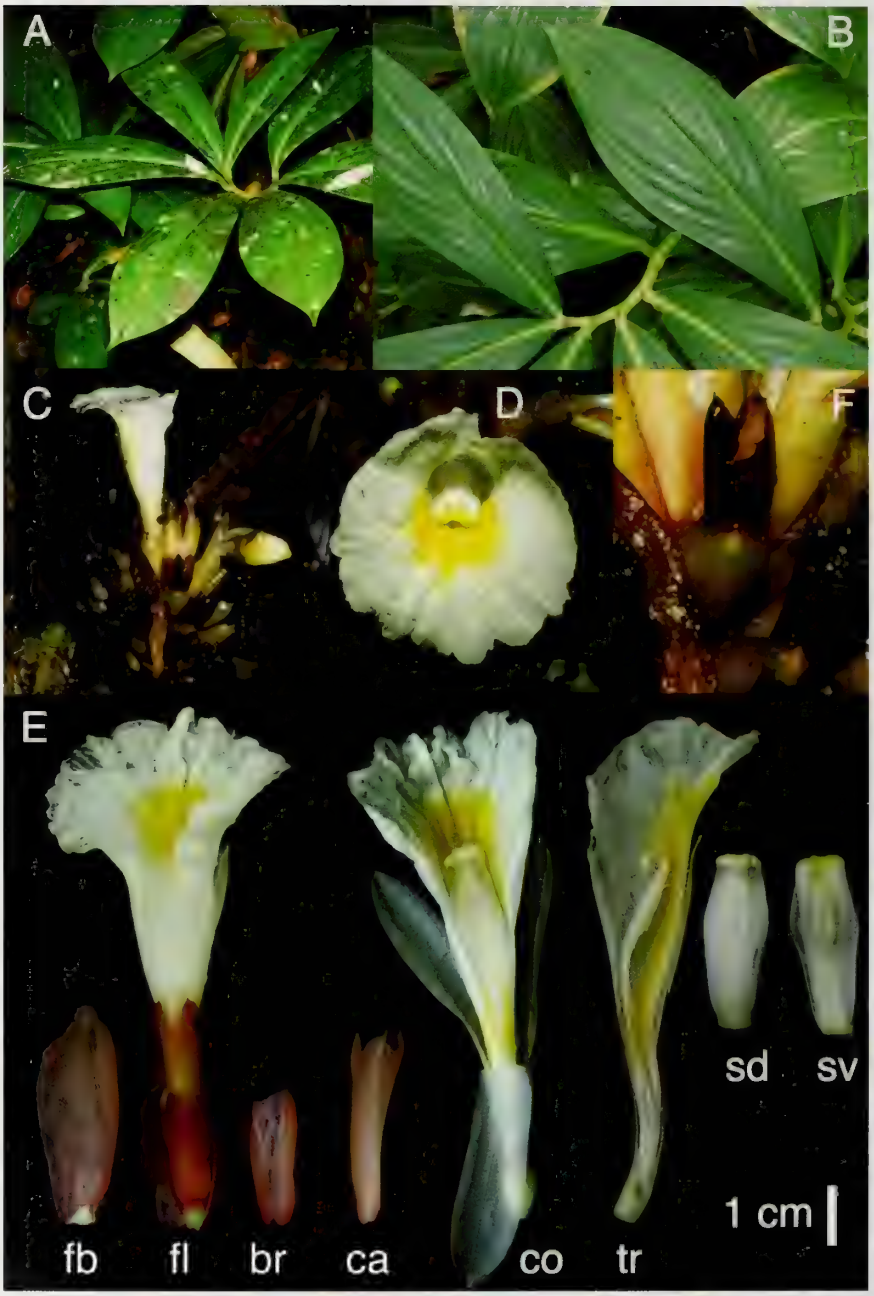

Plate 1. *Cheilocostus borneensis*. A. Habit; B. Leaves; C. Infructescence with flowers at apex; D. Close up of labellum and stamen; E. fb = fertile bract, fl = fertile bract with single flower, br = bracteole, ca = calyx, co = flower with bracteole and calyx removed, tr = longitudinal section of flower, sd = stamen, dorsal view, sv = stamen, ventral view; F. Fruit with semipersistent calyx. Photographs by A.D. Poulsen, A, C–D, F of *Poulsen & Bakir Raymond 1964* (the type); B, E of *Poulsen 2696* (cultivated).

Additional materials examined: INDONESIA. **Borneo**. West Kalimantan, Camp Betung Kerihun NP, Putussibau, 0°56'N 113°19'E, 150 m, fruiting 28 Feb 2000, *Ambriansyah, Kade Sidiyasa & Albertus AA 2238* (BO, L, WAN). MALAYSIA. **Borneo**, Sarawak: Batang Ai, Sungai Senkabang, small stream connecting to Sg. Delok opposite of Ng. Sumpa longhouse, 1°12'S 112°3'E, 130 m, flowering 3 Jun 1993, *Christensen & Poulsen 1997* (AAU); Gunung Mulu National Park, R. Ubong, between Mulu N.P. and logging concession, near Base Camp, 200 m, flowering, 7 Nov 1990, *Warwick MW177* (E bar code E00128356); Kapit, Balleh, Ulu Sungai Mengiong, Wong Kijang, flowering 26 Oct 1988, *Othman et al. S.56077* (SAR); Kapit, Balleh, Ulu Sungai Mengiong, Nanga Sebaning, 1°25'N 113°25'E (indicated approximately on map on rear side of label), flowering 1 Nov 1988, *Othman et al. S.56464* (AAU, E, K n.v.); Kapit, Batang Baleh, Sungai Mengiong, Sungai Entulu, 18 Jul 1987, *Bernard Lee. S. 54624* (AAU, E (bar code E00320502; bar code E00304605), K n.v.); Cultivated at Royal Botanic Garden Edinburgh, Accession number and qualifier: *20040728*A*, collected 16 Aug 2007, *Poulsen 2596* (E, SING), origin *Poulsen & Bakir Raymond 1964* (the type).

Distribution: Endemic to Borneo where it is known from three main areas in Sarawak (one being three collections from the Kapit area) and one in Kalimantan. The furthest localities are about 450 km apart.

Local names and uses: *Pa'bu* (Iban language; *Poulsen & Bakir Raymond 1964*). The plant was used in the past by Iban people but it is not certain for what purpose; *pasat baju* (Iban; *Othman et al. S.56077*).

Etymology: The epithet refers to the species being endemic to Borneo.

Ecology and habitat: Lowland primary or secondary (logged) mixed dipterocarp forest, along riverbanks, at 130-200 m.

Conservation status: *C. borneensis* is found at the foot hills of the central mountain range of Borneo in an area covering at least 2200 km^2 but with fewer than 10 localities. Also its sexual reproduction seems dependent on natural pollinators that may not persist in degraded habitats (see Notes below). Currently we propose the category of Vulnerable (Vu B1ab(iii); IUCN, 2001), but because of the logging activities and land use is changing rapidly in Borneo, this category could soon change to "Endangered".

Notes: *Cheilocostus borneensis* deviates from the generic description (Specht and Stevenson, 2006) by not having axillary branching of the vegetative

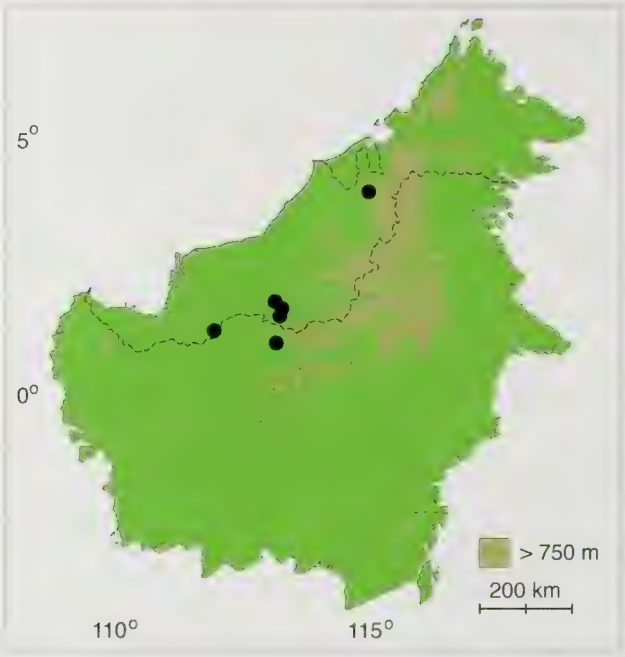

Figure 2. Distribution of *Cheilocostus borneensis* presently known from Sarawak (Malaysia) and West Kalimantan (Indonesia).

shoots. Vegetative branching is shared by *Cheilocostus* and *Tapeinochilos* but is lost in some *Tapeinochilos* species and, similarly, may have been lost in *C. borneensis*. Molecular evidence using four gene regions (ITS, ETS, rpb2 and trnL-F) and samples from a single accession (the type) places this species in *Cheilocostus*, sister to *C. globosus* (Blume) C. Specht.

Cheilocostus borneensis is similar to *C. globosus* in having a radical inflorescence, but is easily distinguished by having distinctly chocolate-brown sheaths on the stem (also obvious in herbarium specimens), having few larger leaves congested at the top of the stem, the leathery almost plastic-like texture of the leaves, and by not having axillary branching. As the flowers of *C. globosus* vary in colour of the labellum from white to yellow, dark orange to red, this character by itself is not always conclusive in separating the two. A more useful floral character to separate the two species is the apex of the calyx: *C. borneensis* is soft, whereas *C. globosus* has rigid points that, if touched, will easily make you bleed (i.e. pungent).

Recently, *Costus mulus* Meekiong, Ipor & Tawan was described from Sarawak (Meekiong *et al.*, 2008). This species also has a radical inflorescence containing flowers with a white labellum but the yellow patch is confined to a dot at the terminal margin of the labellum. Even though the description leaves many questions open and we have not been able to examine the type

material, this species has smaller leaves (13-21 × 6.5-9.5 cm vs. 27-42 × 9-15 cm) with a rounded to cordate base (not narrowly cuneate) and thus is clearly distinct from *Cheilocostus borneensis*.

The northernmost locality presently known of *C. borneensis* is Mulu National Park in Sarawak. Despite Smith's inventory (1984) on the richness of gingers of this area, no material was collected during her studies. Thus, she only reported *Paracostus paradoxus* (K. Schum) C. Specht and *Cheilocostus speciosus* (J. König) C. Specht from this area. The collection from Mulu, *Warwick MW177*, is a convincing match to the other collections, but the mucro on the bracts are exceptionally prominent.

In nature, the spike of *Cheilocostus borneensis* may have mature fruits in the lower bracts while simultaneously flowering towards the apex (Plate 1C). In cultivation mature fruits were never observed to develop and it is likely that manual pollination is needed to produce seeds. This may indicate that *C. borneensis* is only able to set fruits in habitats where the natural pollinator is present.

On 11 Dec 2002, at Sungai Rirang near the type locality, a plant of *Cheilocostus borneensis* with normal leafy shoots was seen bearing an erect, 54 cm long peduncle that was similar in appearance to the chocolate-brown sheathed stem of a leafy shoot, but instead of bearing leaves it terminated in a spike. This aberrant inflorescence has only been seen this once, never occurred in cultivation, and is apparently a rare phenomenon.

Acknowledgements

The first author thanks his adopted family at Nanga Sumpa for help with the fieldwork during which this species was discovered, Sarawak Biodiversity Centre and the National Parks and Nature Reserves of Sarawak for processing permits, HRH Crown Prince Frederik's Foundation for sponsorship of fieldwork, and Paul and Hiltje Maas for confirming the species as new during a visit to Utrecht in 2003. We thank Robert Mill and Philip Oswald for help with the Latin diagnosis and John Mood, as well as two anonymous reviewers, for critically reading an earlier version of the manuscript.

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Three New Species of *Begonia* Sect. *Platycentrum* from Nepal

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Abstract

Three new species of *Begonia* (Begoniaceae) are described from Nepal. All three species (*Begonia nuwakotensis* S. Rajbhandary, *Begonia panchtharensis* S. Rajbhandary and *Begonia taligera* S. Rajbhandary) belong to *Begonia* section *Platycentrum*, and they increase the number of *Begonia* species known from Nepal to 22. All are considered to belong to the IUCN threat category VUD2.

Introduction

Begonia inhabits moist, shady locations in humid lowland to upland forests. The greatest number of species is found in mid-elevations ranging between 1200-2500 m, growing in cloud forest habitats in rock crevices and on moist boulders and moss-covered tree trunks. *Begonia picta* Sm. and *Begonia dioica* Buch.-Ham. *ex* D. Don are the most common species in Nepal, found growing from 150-2700 m altitude. The genus was previously represented by 18 species in Nepal (Hara *et al.*, 1978; Doorenbos *et al.*, 1998; Press *et al.*, 2000) and one new record (Rajbhandary and Shrestha, 2009) bringing this total to 19. These are placed within five different sections, *Diploclinium* (Lindl.) A.DC., *Monopteron* (A. DC.) Warb., *Platycentrum* (Klotzsch) A.DC, *Putzeysia* (Klotzsch) A.DC and *Sphenanthera* (Hassk.) Warb. (Smith *et. al.* 1986; Doorenbos *et al.* 1998). There are four endemic species, *Begonia tribenensis* C.R. Rao, *Begonia minicarpa* H. Hara, *Begonia flagellaris* H. Hara and *Begonia leptoptera* H. Hara.

Section *Platycentrum* (Klotzsch) A.DC. includes about 110 species from India through central China to Southeast Asia, and is one of the largest sections of the genus *Begonia* (Shui *et al.*, 2002; Ye *et al.*, 2004). This section is comprised of relatively large and robust species, characterised by a large

androecium on a distinct column, anthers with an extended connective, two highly convolute or spiralled styles and two-locular, drooping fruits with three unequal wings, one of which is considerably lengthened. During botanical expeditions from 2006-2008 to different parts of Nepal three new species of *Begonia* belonging to section *Platycentrum* were discovered, which are described and illustrated here, bringing the total number of *Begonia* species known from the country to 22.

Species descriptions

Begonia nuwakotensis S. Rajbhandary, *sp. nov.* [§ *Platycentrum*]
Begoniae palmatae *similis sed foliis basalibus longe petiolatis, laminae base cum lobis superpositis et in margine sine lobis vel dentibus longis curvatis, flore femineo tepalis exterioribus 4 similibus et tepalo interiore uno parvo, placentis trilamellatis et fructu cum ala laterali lata oblonga differt.* –**Typus**: Central Nepal, Nuwakot, Kakani, Doman, 1700 m, 9 Aug 2007, *S. Rajbhandary, S. Ranjitkar, K. P. Thapa and S. R. Bista S31* (holotype, E; isotype, KATH). **Plate 1.**

Perennial, monoecious, rhizomatous, creeping **herb**, 14-30 cm tall. **Stems** rhizomatous at base, to 2 cm in diameter; erect portions semi-woody, reddish brown, becoming procumbent, tomentose, trichomes soft red. Stipules persistent, membranous, ovate, 16-21 × 8-10 mm, green to scarlet, with an abaxially prominent midrib forming a thin, long appendage at the apex, margin entire, outer surface sparsely hairy on the midrib, trichomes red, inner glabrous and glossy. **Leaves** cauline, petiole 6-24 cm long, green, villose, trichomes, red, multicellular up to 2 mm long; lamina asymmetric, broadly ovate or oblate-orbicular, 5-22 × 5-19 cm, base slightly oblique, cordate, with overlapping lobes 1.5-3 cm long, margin remotely and shallowly denticulate, distinctly divided into short 0.5-2 cm long lobes, apex acute to acuminate; upper surface green strigulose/sericeous, trichomes small and white, lower surface pale green, densely pilose, trichomes red and long; palmately veined, 7-8 veins. Inflorescences bisexual, axillary, cymose, few flowered, protandrous; peduncle 10-25 cm long, green, villose, trichomes red, multicellular. Bracts caducous, membranous, cymbiform, ovate, 12-15 × 8-11 mm, pale green to scarlet, glossy and pubescent, trichomes red, margin ciliate, apex acute. **Male flowers**: pedicel 1-2.3 cm, green, hairy, trichomes multicellular, red; tepals 4-5, white, outer 2 tepal orbicular, 13-15 × 13-20 mm, abaxially pilose, trichomes red, base cordate, margin ciliate, apex rounded to acute; inner 2-3 tepals obovate, 12-17 × 8-12 mm, smallest innermost 10-12 × 5-6 mm, white, glabrous, base cuneate, apex acute or sometimes rounded; androecium receptacle flat, free filaments almost equal, but slightly longer in the middle of the androecium, stamens *ca* 100, filaments 1-2 mm; anthers narrowly

Plate 1. *Begonia nuwakotensis* S. Rajbhandary. A. habit; B. Male flower; C. Stamens; D. Androecium; E. Upper leaf surface; F. Lower leaf surface; G. Bracts; H. Female flower; I. Stigma; J. Ovary; K. Prostrate stem; L. Fruits; M. Transverse section of fruit; N. Pollen; O. seed.

globose, on a small column, 6-10 mm diameter, yellow, symmetrical, obovoid, 1.2-1.5 mm long, anthers towards the outside are longer than the filaments and those at the centre are shorter than the filaments, dehiscing through unilateral slits as long as the anther, connective slightly extended. **Female flowers**: pedicel 1-2 cm, hairy, trichomes red, multicellular; tepals 5, white, unequal, four outer tepals are orbicular, 20-22 × 18-22 mm, innermost tepal smallest, ovate, 13-15 × 7-8 mm, except for the innermost all the tepals are abaxially pubescent, margin entire, base rounded, apex rounded, acute in the innermost tepal; styles 2, deciduous, 3-6 mm long, fused at the base and ends into a broad wide apex, yellowish green; stigma green, a papillose band, strongly spiralled over the broad apex of the style and twisted at two ends; ovary green, pubescent, trichomes red, 2 locular; placentation axile, trilamellate. **Fruits** with pedicel 15-25 mm long, glabrous; 17-25 × 10-12 mm, nodding or pendulous, unequally 3-winged, with one larger wing and two narrow wings, larger wing oblong, 12-20 mm; lateral wings much smaller, 5-6 mm, small wings recurved; capsule obovoid, *ca* 10-12 × 6-10 mm, green and hairy when young and dark brown when mature, glabrous; drying dark brown, dehiscing along the sutures between the two smaller wings.

SEM studies: **Pollen**: large, perprolate with slightly concave sides and slightly pointed poles, irregular striate ornamentation with few scattered pores, P 22-22.5 µm, E 7.6-8.4 µm, P/E 2.6-2.9, the endoporus elliptical with costae, margo distinct, narrow. **Seeds**: ellipsoidal to obovoid, mean size 325 × 240 µm; collar cells elongated, testa cells polygonal with straight or slightly curved anticlinal walls; anticlinal walls of testa cells thin and slightly raised; operculum short, flat and nipple-shaped; cuticular pattern consisting mainly of short linear zigzag striate ornamentation.

Distribution: Known only from the type locality (Fig. 1).

Ecology: Growing on wet shady slopes by the side of waterfalls, at *ca* 1700 m.

Notes: This species is similar to *Begonia palmata* but differs in lacking long and curved lobes or teeth in the leaf margin. It also differs in having female flowers with 4 similar outer tepals and one small inner tepal, trilamellate placentae, and a fruit with a broad oblong wing. It is known only from the type locality and so it is named after the place of its collection. The population at the moment is healthy and reproducing well. However, as the single locality is not under protection and the capability of the species to cope with less shade and moisture is not likely to be good, we consider it to belong to the IUCN threat category VUD2.

Figure 1. Distribution of *Begonia taligera*, *Begonia nuwakotensis*, *Begonia panchtharensis* in Kaski, Nuwakot and Panchthar Districts, Nepal.

Begonia panchtharensis S. Rajbhandary, *sp. nov*. [§ *Platycentrum*]
Begoniae sikkimensi *similis sed foliis solum basalibus praesentis eis magnis suborbicularibus profunde lobatis longe petiolatis et fere glabris, floribus femineis 6-tepalis et fructu cum ala laterali lata falcata differt*. –**Typus**: Cultivated plant grown from Eastern Nepal, Panchthar, Tinubote, Sisire, Prangbung, VDC, 2240-2300 m, 2 x 2007, *U. Thamsuhang s.n.*, vouchered as *S. Rajbhandary S74* (holotype, E, isotype, KATH). **Plate 2.**

Perennial, monoecious, rhizomatous **herb**, 50-60 cm tall. **Stem** rhizomatous, 8-12 cm long, 20-30 mm in diameter, covered with long roots. Stipules caducous, membranous, cymbiform, broadly ovate, 18-25 × 8-10 mm, pink with a light green tinge, glabrous with red spots on the abaxial surface, margin entire, apex acuminate. **Leaves** several, arising from the rhizome, petiole 33-46 cm long, succulent, glabrous, grooved, yellowish green with red linear dots; lamina slightly asymmetric, suborbicular and deeply lobed, 24- 40 × 36-48 cm, base deeply cordate; margin irregularly serrulate or deeply dentate, distinctly divided to 2/3 of leaf length; lobes 6-8, apex acuminate, dark green above and pale green below, adaxially sparsely hirsute more so on the periphery, trichomes small, multi-cellular, crimson or whitish transparent, abaxially glabrous except for sparse hairs on the veins near the periphery, palmately veined, 6-8 veins. **Inflorescences** bisexual, axillary, cymose, dichotomously branched, protandrous; peduncle 42-50cm long, glabrous, grooved, sub-woody, yellowish green with red linear dots. Bracts caducous, in unequal pairs, membranous, cymbiform, elliptic to broadly elliptic, 25-30 × 15-18 mm, green, narrowly ridged abaxially and with linear or circular red granules, papery, margin entire, apex acuminate.

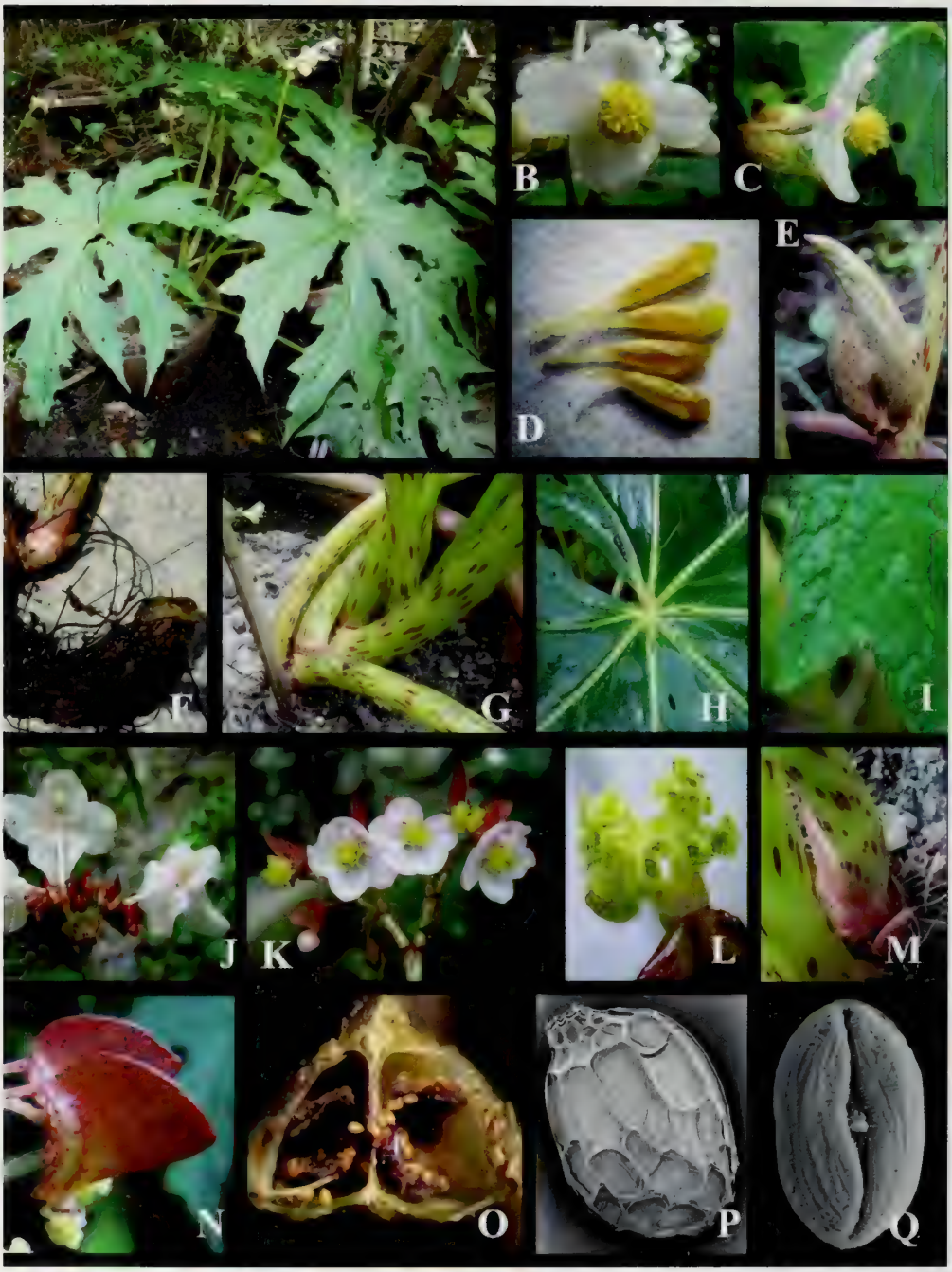

Plate 2. *Begonia panchtharensis* S. Rajbhandary. A. Habit; B. Male flower; C. Androecium; D. Stamens; E. Bracts; F. Rhizome; G. Petioles; H. Leaf venation; I. Leaf surface; J. & K. Inflorescence; L. Style and stigma; M. Stipule; N. Fruits; O. Transverse section of fruit; P. Seed; Q. Pollen.

Male flowers: pedicel 1-8 cm, light pink with linear red spots, glabrous; tepals 4, white to pink; outer 2 tepals broadly ovate, 1.2-1.8 × 0.9-1.2 cm, abaxially glabrous, with a pink tinge near the tip and the margin, base truncate, margin entire, apex acute; inner 2 tepals oval to narrowly oval, 1.5-1.8 × 0.8-1.3 cm; white, glabrous, base cuneate, apex retuse; androecium globose, on a small column, 9-12 mm long, yellow, symmetrical, receptacle slightly raised; stamens 125-141, filaments 0.5-2.5 mm long; anthers oblong, 1-1.5 mm, anthers towards the outside are longer than the filaments and those at the centre are shorter than the filaments, dehiscence through long straight slits which are slightly curved at the tip, connectives extended, acute. **Female flowers**: pedicel 1.5-2 cm, glabrous; tepals 6-8, outermost tepals pink, innermost white, symmetrical, oval 9-11 × 8-11 mm, glabrous, base rounded, margin entire, apex acute; styles 2, persistent, 2.5-6 mm long, fused at the base, greenish yellow, stigmatic surface spirally convolute, papillose; ovary oblong and slightly curved, locular part 10-13 × 3-4 mm, glabrous with red circular or linear granules, with three unequal wings; largest wing oblong with a rounded tip and two smaller more or less equal rim-like blunt wings; 2-locular, placentae axile, bilamellate. **Fruits**: pedicel 2.5-3 cm, glabrous; 10-25 × 10-15 mm, nodding or pendant, falcate, unequally 3-winged; longer wing obovoid–oblong, 9-25 × 10-15 mm, lateral wings smaller, 1 mm long, wings red, capsule oblong, 10-15 × 2-4 mm, light greenish yellow when young becoming brownish green when mature, glabrous; drying dark brown with green tinge, dehiscing along the sutures between the two smaller wings.

SEM studies: **Pollen**: large, perprolate with smooth convex sides and rounded poles, faint striate ornamentation with pores, P 16.8-21 µm, E 8-10 µm, P E 2.1, the endoporus elliptical with costae, margo present, the grains not syncopate. **Seeds**: ellipsoidal, 325-345 × 215-240 µm; collar cells elongated with straight and slightly curved anticlinal walls; testa cells polygonal with straight anticlinal walls; operculum long nipple-shaped with layers of cells; anticlinal boundaries broad and flat; the cuticle on the testa consisting mostly of patches without orientation while in the collar and operculum the cuticule has a long linear loose striate ornamentation.

Distribution: Known only from the type locality (Fig. 1).

Ecology: Growing on shady river banks and edge of the forest near rivers at ca. 2240-2300 m.

Notes: This distinct species is somewhat similar to *Begonia sikkimensis* A. DC. in leaf shape but differs in having only basal, large and almost glabrous leaves, female flowers with six tepals, and broad falcate winged fruit. As it is

known only from the type locality, the species is named after the place of its collection. As the single locality is not under protection and the capability of the species to cope with less shade and moisture is not likely to be good, we consider it to belong to the IUCN threat category VUD2.

Begonia taligera S. Rajbhandary, *sp. nov.* [§ *Platycentrum*]
Begoniae hatacoa *affinis sed folii margine subintegro usque remote triangulari-serrulato dentibus interdum attenuatis, floribus haud lineatis, stigmate spiraliter torto, fructu cum ala laterali longa lataque apice rotundato et in petiolis radicibus ubi e planta separatis effractisve crescentibus recedit.* –**Typus**: Central Nepal, Kaski, Bharat Pokhari, near Pokhara 700-740 m, 5 Sep 2007, *S. Rajbhandary and S Adhikari S52* (holotype, E; isotype, KATH). **Plate 3.**

Perennial, monoecious, caulescent **herb**, 30-70 cm tall. **Stem** rhizomatous at base, subwoody, 3.5 cm in diameter, covered with long roots; erect portions terete, 17-32 cm long, dark brownish red, branched, hairy. Stipules persistent, membranous, lanceolate, 6-11 × 7-13 mm, cymbiform, greenish white, transparent, abaxially glabrous, glossy, apex acuminate. **Leaves** cauline, petiole 6-10 (-32) cm long, succulent, densely covered with brown scales or multicellular two-armed short stalked trichomes, dark reddish brown at the base becoming ruby red adaxially near the top, readily forming adventitious roots when detached or broken; lamina asymmetric, cordate, ovate-lanceolate to elliptic-lanceolate, 10.5-23 × 5.5-18 cm, base slightly asymmetric, rounded or shallowly cordate, margin entire to attenuate-dentate, apex long-acuminate to attenuate, deep green adaxially, glossy, glabrous, yellowish-green abaxially, hairy with veins being covered densely with brown multicellular two-armed stalked trichomes, palmately veined, 5-7 veins. **Inflorescences** bisexual, axillary, branched cymose, protandrous, peduncle glabrous 6-20 cm long, red, bearing few terminal flowers. Bracts: caducous, in unequal pairs, membranous, cymbiform, long elliptic to lanceolate, 5-8 × 1.5-3.5 mm, light green, transparent, apex acuminate, margin entire, glabrous, glossy. **Male flowers**: pedicel 1.5-3.5 cm, white to brownish green, glabrous; tepals 4, outer 2 tepals broadly oval, 9-17 × 7-12 mm, abaxially glabrous and glossy with a green or pinkish tinge more on the upper tepal, base rounded, margin entire, apex acute; inner 2 tepals oval, 9-18 × 7-10 mm, white, glabrous, base rounded, apex obtuse or retuse; androecium a loose sessile globose cluster, 7-9 mm long, golden yellow, symmetrical, receptacle slightly raised; stamens 90-95, filaments 1-2 mm long and free; anthers narrowly obovate, 2-2.5 mm, longer than the filaments, dehiscence through long straight slits, connectives extended, round or acute. **Female flowers**: pedicel 1-2 cm, glabrous; tepals 5, white, outer 2 tepals broadly ovate, 1-13 × 1-12 mm, glabrous, glossy, base rounded, margin entire,

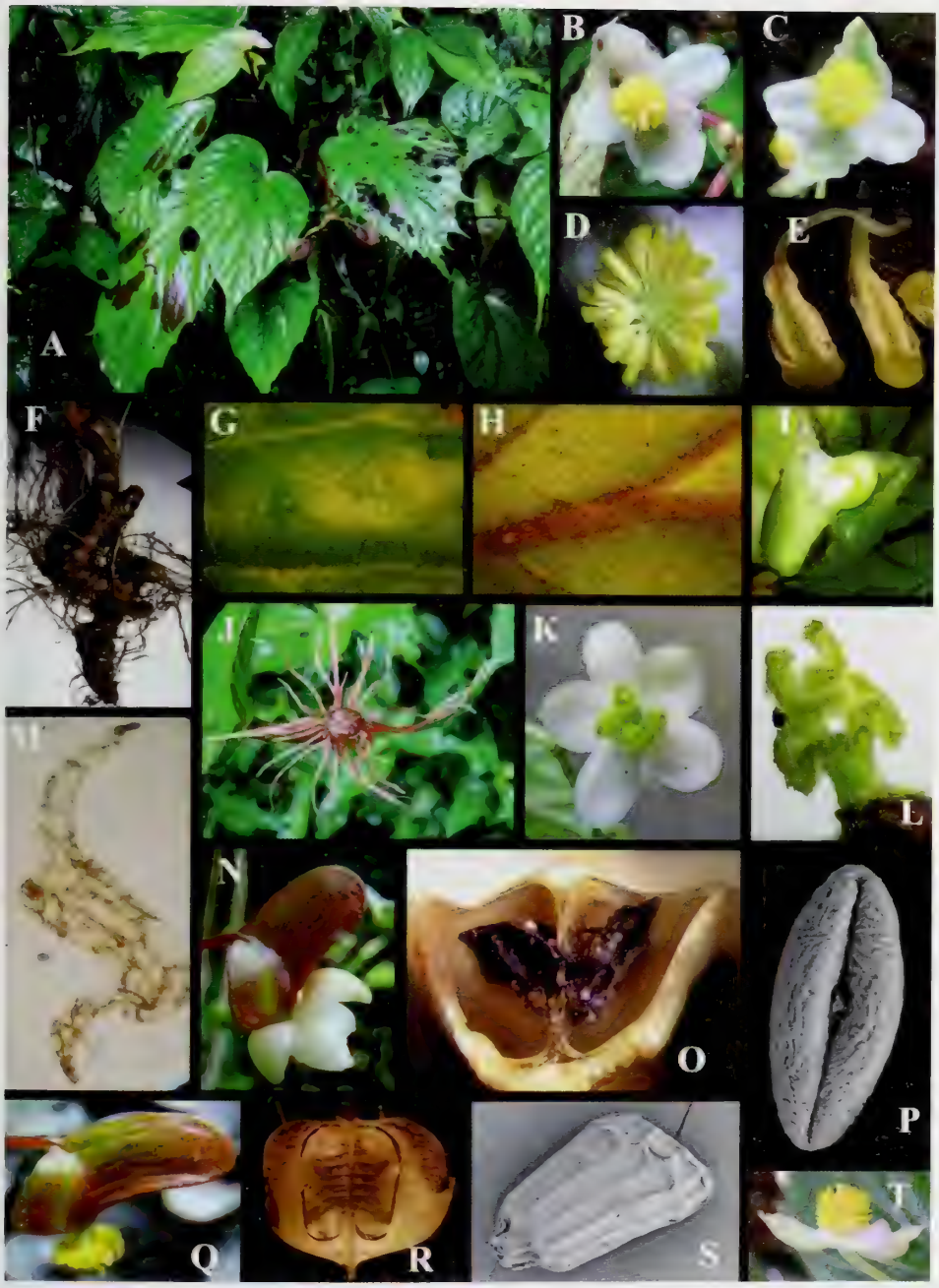

Plate 3. *Begonia taligera* S. Rajbhandary. A. habit; B. Male flower; C. & D. Androecium; E. Stamens; F. Rhizome; G. Upper leaf surface; H. Lower leaf surface; I. Bracts; J. Broken petiole with adventitious roots; K. Female flower; L. Style and stigma; M. Two-armed trichome; N. Ovary; O. Transverse section of fruit; P. Pollen; Q. Fruit; R. Recurved small wings of the fruit; S. Seed; T. Androecium.

apex obtuse or rounded, the inner 3 oblong or lanceolate, 1.5-2 × 6-7 mm, apex obtuse to acute, but sometimes all the tepals are either broadly ovate or all oblong; styles 2, sometimes 3-4, persistent, 0.4-0.5 mm long, free, each style ending into a broad apex and connate at the base, green when young and becoming more yellow when mature; stigmas bifid, spirally tortuous and papillose all over; ovary oblong, 9-12 mm long, glabrous and glossy, unequally 3-winged, 2-locular, placentae axile, bilamellate. **Fruits**: pedicels 1.2-2 cm long, glabrous; 19-25 × 9-15 mm, pendulous, with 3 unequal wings, the largest wing broadly falcate, 15-25 × 9-14 mm, apex rounded, the other 2 wings smaller and narrow, *ca* 4-5 mm long with rounded tips, capsule oblong, 10-15 x 3-4 mm, reddish brown when young and pale brown when mature, glabrous; drying pale brown, dehiscing along the sutures between the two smaller wings.

SEM studies: **Pollen**: large, perprolate, pollen grain with smooth convex sides, rounded poles, compact irregular striate ornamentation with pores in-between, P 17.4-20 μm, E 8 μm, P/E 2.1-2.5, elliptical endoporus with costae, margo present around the endoporus, the grains are not syncolpate. **Seeds**: ellipsoidal, mean size 392 × 228 μm; collar cells elongated with straight anticlinal walls; testa cells polygonal with straight and slightly curved anticlinal walls; operculum very short, flat nipple-shaped with a layer of flat elongated cells; anticlinal boundaries thin and slightly elevated; the cuticule with long linear striate ornamentation.

Distribution: Known only from the type locality (Fig. 1).

Ecology: Growing on moist shady rock ledges near streams at ca. 700-740 m.

Notes: Allied to *Begonia hatacoa* Buch.-Ham. ex D. Don but differs in having an entire to attenuate-dentate leaf margin, while in *B. hatacoa* the leaf margin is usually always entire or only slightly dentate. *Begonia taligera* also lacks striped flowers, the stigma is spirally tortuous, the lateral long wing of the fruit is more broad with a rounded tip, and in the pollen the ornamentation of the testa cells is compact with irregular striate with pores in-between and margo present. One of the characteristic features of this species is the development of roots when a petiole is broken or detached from the main stem. The epithet *taligera* is derived from the Latin *talea*, and means producing cuttings for propagation. The population is currently healthy and reproducing well. However, as the species is restricted to a single locality, which is not under formal protection, and the capability of the species to cope with less shade and moisture is not likely to be good, we consider it to belong to the IUCN threat category VUD2.

Acknowledgement

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Genetic Variation of Populations of *Scutellaria slametensis* and *S. discolor* (Lamiaceae) on Gunung Slamet, Jawa Tengah (Indonesia)

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Abstract

Genetic variation within and between populations of *Scutellaria slametensis* Sudarmono & B.J.Conn and *S. discolor* Colebr. on Gunung Slamet (Jawa Tengah, Indonesia) are evaluated by allozyme electrophoresis. Gels stained by 4 enzyme systems, namely, *Aspartate aminotransferase* (Aat), *Esterase* (Est), *Malate dehydrogenase* (Mdh) and *Peroxidase* (Per), were used to evaluate the number of polymorphic loci. The mean of total number of observed alleles per locus (A), mean of total number of effective alleles per locus (A_e), percentage of polymorphic loci (Pp%), and expected genetic heterozygosity (H_e) have been generated as parameters of genetic variation. The interpopulation genetic differentiation (F_{ST}) and estimated geographic distance between populations were used to evaluate the correlation between genetic differentiation and geographic effect. It was found that *S. slametensis* is genetically distinct from *S. discolor* (D = 1.4572). The mean genetic variation of *S. slametensis* (Pp = 75 %, A = 2.00, H_E = 0.450) is greater than that of *S. discolor* (Pp = 25 %, A = 1.25, H_E = 0.125). Almost all loci of the latter species are monomorphic and homozygotic, especially population 9 near Baturaden (Pp = 0%; H_E = 0; Allele frequencies all = 1). There is a moderately high degree of variation between populations of these two species (F_{ST} = 0.585, SE ± 0.092), whereas within-population variation is low (1–F_{ST} = 0.415). Both species are out-breeding (at subpopulation level: F_{IS} = -0.973, SE ± 0.015; and population level: F_{IT} = 0.180, SE ± 0.183), with low levels of gene flow within and between populations (N_m = 0.249, SE ± 0.065). The chromosome number of *S. slametensis* and *S. discolor* is 2n = 24.

Introduction

Scutellaria (Lamiaceae) is the largest genus of the family with about 360 species (Huang, 1994; Paton, 1990, 2004). The genus is widespread, subcosmopolitan, but poorly represented in moist tropical lowlands. There are currently four known species in Indonesia, namely, *S. discolor* Colebr., *S. indica* L., *S. javanica* Jungh. and *S. slametensis* Sudarmono & B.J.Conn (Backer and Backhuizen van den Brink Jr, 1965; Keng, 1978; Steenis van, 1972; Sudarmono and Conn, 2010). The Indonesian species are all members of subgenus *Scutellaria* sect. *Scutellaria* (Paton, 1990) and are informally classified by Paton into several 'species-groups:' '*S. discolor* species-group' (including *S. discolor* and probably *S. slametensis*); '*S. humilis* species-group' (including *S. javanica*); '*S. violacea* species-group' (including *S. indica*).

Allozymes have provided the most abundant source of information regarding genetic variation in natural populations (Hamrick and Godt, 1990). Genetic variation parameters such as amount of interbreeding between populations, allele heterozygosity, genetic diversity, genetic differentiation and the amount of gene flow can indicate the level of gene mutation, genetic drift, genetic 'bottle necks', and even the possible level of vulnerability of endangered populations. These parameters are equally useful for assessing genetic variation within and between populations of a species as they are between species (Hamrick and Godt, 1990). Maki (1972) and Luzuko *et al.* (2000) found that there was a significant correlation between low gene flow and geographic distance or isolation by distance. Wright (1943) was the first to describe the genetic process of isolation by distance that may operate when populations conform to a 'stepping stone' model, where gene flow occurs only between adjacent populations. He demonstrated that random genetic drift within localized populations, combined with limited migration among populations, can result in increased genetic differentiation with increasing spatial distance between populations.

Grant (1981) concluded that geographic isolation was an important factor that may result in allopatric speciation with reproductive isolation playing an important role in sympatric speciation. Both of these speciation phenomena might occur within populations of *Scutellaria* on Gunung Slamet. *Scutellaria slametensis* occurs at elevations of more than 1,000 metres, whereas *S. discolor* occurs at elevations of less than 800 m. Chromosome numbers were recorded and within-population allozyme variation was analyzed for both species.

Materials and methods

Sample collections

Samples of *Scutellaria slametensis* were collected from six populations on Gunung Slamet (Jawa Tengah, Indonesia, Fig. 1). These populations occur at different elevations. Populations 1 (elevation 1,980 m) and 3 (1,802 m) occurring on the southwestern slopes, along the Kaligua and Brebes route in the Perseroan Terbatas Perkebunan Nusantara (PTPN) IX National Tea Plantation (in Paron and Sokarata Blocks of the Protected Forest, respectively), Forest Holding Unity Division – Balai Kesatuan Pemangku Hutan (BKPH), with population 2 occurring closer to the summit of Gunung Slamet (at 2,002 m) (Table 1). Populations 4-6, from the southern part of Gunung Slamet, on the Baturaden climbing track occur between elevations of 1,390 and 2,215 m (Table 1), on the eastern and southeastern slopes. Samples of three populations of *S. discolor* were collected at elevations less than 800 m, from the Baturaden area of Gunung Slamet (Table 1: populations 7-9). Although Keng (1978) concluded that *S. discolor* occurred over a wide range of elevations, from 500-2,400 m, this species was not found above 800 m. on Gunung Slamet. Ten individual plants were sampled from each population. Collections of all populations of both species were cultivated at Kebun Raya Bogor (Indonesia) and dried herbarium vouchers lodged at Herbarium Bogoriense (BO), Herbarium of Kebun Raya Bogor (KRB) and National Herbarium of New South Wales (NSW).

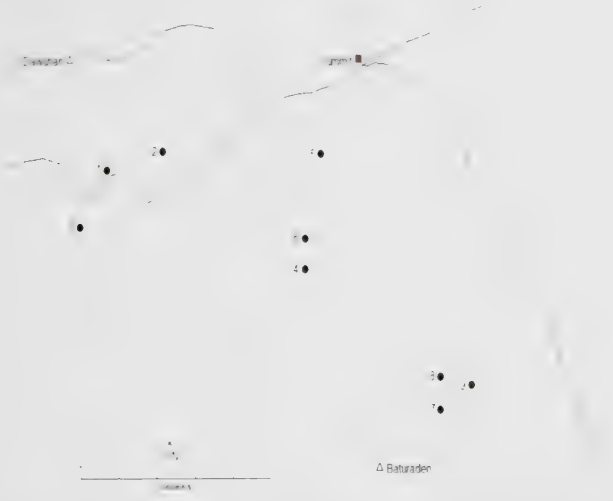

Figure 1. Distribution map of populations of *Scutellaria* included in this study on Gunung Slamet, Jawa Tengah, Indonesia. Populations 1-6 = *S. slametensis*; 7-9 = *S. discolor*; red square = summit of Gunung Slamet, elevation 3,428m.

Chromosome observation

Growing root tips were incubated in 0.05 % colchicine aqueous solution for 2 hours at 18°C. They were fixed with the fixative solution (ethanol: chloroform:glacial acetic acid = 2:1:1) for more than 45 minutes at 5°C. The root tips were then macerated with 1N HCl at 60°C for 18 seconds. The meristematic tissues were stained with 2% aceto-orcein for 5-10 minutes on a glass slide, one drop of 45% acetic acid was added and the tissue covered and squashed gently.

Allozyme analysis

Within-population allozyme variation was analyzed by enzyme systems for six populations of *Scutellaria slametensis* and compared to the within-population variation found within three populations of *S. discolor*, both occurring on Gunung Slamet (Jawa Tengah, Indonesia, Figure 1).

Leaf samples were prepared for allozyme electrophoresis by extracting 0.5 cm^2 samples of fresh leaf material. Young leaves were ground with 0.1 M Tris-HCl pH 7.5, 0.1% 2-mercaptoethanol, 0.001 M EDTA (tetrasodium salt). Extract was absorbed by filter paper (Whatmann No. 3) and run by 12% starch gel (4.5 hours, 300 volt; 45 mA). Four horizontal enzyme systems analyzed were Aspartate aminotransferase (*Aat*; EC 2.6.1.1), Esterase (*Est*; EC 3.1.1), Malate dehydrogenase (*Mdh*; EC 1.1.1.37) and Peroxidase (*Per*; EC 1.11.1.7). Staining procedure followed Soltis *et al.* (1983), with some modification in buffer pH and concentration (*Mdh* buffer with 1.5 M TRIS-HCl pH 8.0). The locus specifying the most anodally migrating isozyme was designated as 1, the next 2, and so on. Similarly, the most anodally of a gene was labeled 'a', the next 'b' and so on, as done by Shield *et al.* (1983) and Kephart (1990).

The genetic variation of populations is expressed as a percentage of polymorphic loci (*Pp* %), mean number of observed alleles per locus (*A*), and Nei's unbiased genetic diversity or expected heterozygocity (H_E), using POPGENE version 1.32 (Yeh *et al.*, 1999). Gene flow (N_m – the number of migrations per generation) for all loci was also estimated. The analysis of genetic identities (*I*) and genetic distance (*D*) for each pair-wise combination of populations were also estimated following Nei (1978). In this study, unbiased genetic identity was used to accommodate for the bias caused by small sample size (<50 individuals).

There are several indices used to evaluate genetic diversity, including total genetic diversity (H_T), genetic diversity within populations (H_S), genetic diversity among populations (D_{ST}), and the among populations genetic differentiation coefficient (G_{ST}). These statistics were generated using FSTAT program (Goudet, 2002). Total genetic diversity (H_T) was partitioned into within-population (H_S) and between-population (D_{ST}) components. H_T was estimated for each polymorphic locus from following

equations:

$$H_T = H_S + D_{ST}$$

$$H_S = \frac{1 - (\Sigma j_i)}{S}$$

Where, j_i is gene identity in sub-population and S is number of sub-populations. j_i was estimated by:

$$j_i = \Sigma x_{ik}^2$$

Where, x_{ik} is the frequency of the kth allele in ith sub-population

Genetic diversity between sub-populations (D_{ST}) was estimated by:

$$D_{ST} = (\Sigma_i \Sigma j \, D_{ij}) \, s^2$$

$$D_{ij} = \sum \frac{1}{2} (P_{ik} - P_{jk})^2$$

Where, P_{ik} is the frequency of the kth allele in ith sub-population, while P_{jk} is frequency of kth allele in jth sub-population.

Gene differentiation that occurs among populations (G_{ST}) was examined with Nei's genetic diversity indices (Nei, 1977, 1986). G_{ST} was expressed relative to total genetic variations among populations as:

$$G_{ST} = \frac{D_{ST}}{H_T}$$

Mean values of H_T, H_S, D_{ST} and G_{ST} were the average of all polymorphic loci within each group. All calculations were generated for each pair-wise comparison of populations and species using FSTAT program (Goudet, 2002).

The genetic structure of the studied populations was also analyzed in term of the following F-statistics: F_{IS} - fixation index related to non-random mating within populations; F_{IT} - mean inbreeding coefficient, F_{ST} - interpopulation genetic differentiation (following Weir and Cockerham, 1984).

Gene flow (N_m) for all loci was estimated:

$$N_m = \frac{(1 - G_{ST})}{4G_{ST}}$$

Assuming that populations have reached equilibrium between the effects of migration and random genetic drift, the degree of population subdivision was quantified using:

$$F_{ST} = \frac{1}{(4N_m + 1)}$$

Fst is the proportion of total genetic variance contained in subpopulation *S* relative to total genetic variance *T*. Unbiased data matrices (Nei, 1986) were generated using POPGENE (Yeh *et al.* 1999). It was also used to calculate mantel test (Sokal and Rohlf, 1995) for testing the null hypothesis of independence between genetic differentiation and geographic distances separating populations (Yeh *et al.*, 1999). Allozyme data were analyzed using UPGMA (Unweighted Pair-Group Method using Arithmetic Average) clustering techniques to construct a dendrogram to assist in the interpretation of these genetic data between species and populations. The dendrograms were generated using NTSYS (Rohlf, 2000).

Results

Chromosome analysis

Chromosome number of *Scutellaria slametensis* (Figs. 2A & B) and *S. discolor* (Figs. 2C & D) are both diploid 2n = 24. The length of mitotic metaphase chromosome of *S. slametensis* varies from 2-2.5 μm, whereas those of *S. discolor* are smaller (1.5-2 μm).

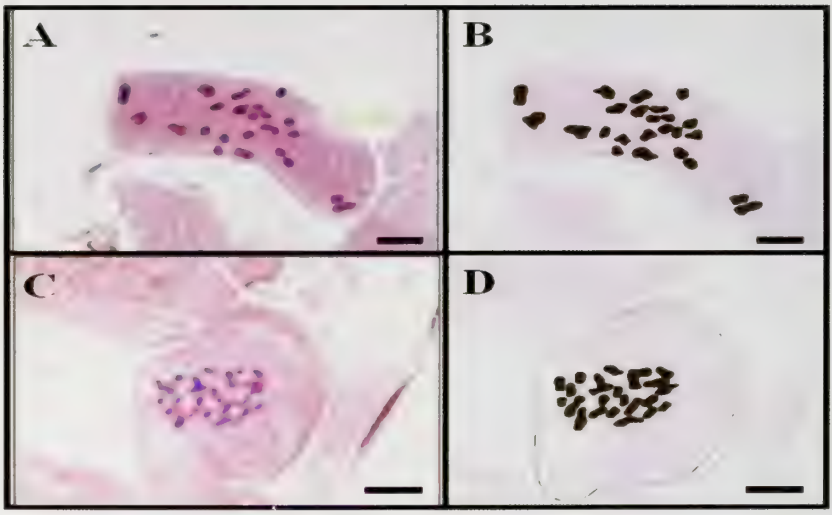

Figure 2. Mitotic metaphase chromosomes of *Scutellaria slametensis* (A, B) and *S. discolor* (C, D), both 2n=24. A & C, microphotographs; B & D, line-drawings of microphotographs. Scale bar = 5 μm.

Genetic Variation

Four loci were detected in all populations of both species of *Scutellaria* (Table 1). The four enzyme systems examined (namely, *Aat*, *Est*, *Mdh* and *Per*) were consistent for all nine populations studied. Populations 1, 4-6 (Table 1) are genetically highly variable with 75% of loci polymorphic (*Pp*). Population 4 has the highest mean number of alleles per locus (A = 2.00), with a high mean number of A=1.75 for populations 1, 5, 6 (Table 1). The expected heterozygosity is also regarded as high for these four populations (population 1: H_E = 0.375; 4: H_E = 0.401; 5: H_E = 0.375; 6: H_E = 0.375) (Table 1). In contrast, the lowest genetic variation occurs in population 9 (*Pp*= 0 %, A = 1.00, H_E = 0.000) (Table 1). Others populations that are regarded as having low genetic variation include: population 2 (*Pp* = 25 %, A=1.25, H_E = 0.139) and population 8 (*Pp* = 25 %, A = 1.25, H_E = 0.125).

Table 1. Mean genetic variation of populations of *Scutellaria slametensis* and *S. discolor* on Gunung Slamet (Jawa Tengah, Indonesia). Ten samples of each population (N) were examined. Populations 1-6 = *Scutellaria slametensis*; 7-9 = *S. discolor*. Percentage polymorphic loci (*Pp*), mean number of observed alleles per locus (A), mean of effective alleles per locus (*Ae*), mean of expected heterozygosity (H_E) (Nei, 1978). *Comparison of genetic variation categorized at regional geographic distributed means *Pp*=36.4 %, A=1.55, *Ae* =1.16 and H_E = 0.118 (Hamrick and Godt, 1990).

Pop. no.	Location	Altitude (m)	Geocode	*Pp%*	*A*	*Ae*	H_E	Category *
1	Protected forest block, Paron, Kaliwadas	1,980	7.2683° S 109.1584° E	75	1.75	1.75	0.375	high
2	Protected forest block, Sakub, Kaligua	2,002	7.2677° S 109.1456° E	25	1.25	1.25	0.139	Low
3	Protected forest block, Sokarata, Kaligua	1,802	7. 2829° S 109.1298° E	50	1.50	1.50	0.250	Low
4	Protected forest, Petak II	1,390	7.2834° S 109.2004° E	75	2.00	1.88	0.401	high
5	Protected forest, Post III, Baturaden	2,215	7.2668° S 109.2011° E	75	1.75	1.75	0.375	high
6	Protected forest, Post I, Baturaden	1,778	7.2668° S 109.2023° E	75	1.75	1.75	0.375	high
7	Camping ground, Baturaden	771	7.3119° S 109.2351° E	50	1.50	1.50	0.250	Low
8	Baturaden Botanic Garden	771	7.3052° S 109.2333° E	25	1.25	1.25	0.125	Low
9	Telaga Sunyi, Baturaden	777	7.3069° S 109.2427° E	0	1.00	1.00	0.000	low

Population structure and gene flow

Genetic diversity indices (Table 2) demonstrate that *Aat-1* and *Mdh* contain the highest total diversity (H_T) of those loci surveyed with 62.1% and 64.8%, respectively. The enzyme *Est*-1 contained the least genetic diversity (H_T = 44.4%). The mean of total genetic diversity (H_T) was 58% (SE ±0.030), whereas genetic diversity within populations (H_S) was 26.7% (SE ±0.058) and among populations (D_{ST}) 31.3% (SE ±0.034). There was no genetic diversity within-populations in the *Est-1* locus (H_S = 0%). Likewise, the genetic diversity within and among populations of *Aat-1* was low (H_S = 29.1% and D_{ST} = 35.1%, respectively). Although the genetic diversity within-populations of *Mdh* and *Per* were similar (both H_S = 38.9%), the among population genetic diversity was D_{ST} = 25.9% and D_{ST} = 19.8%, respectively. The mean genetic differentiation between populations (G_{ST}) is 57.1% (SE ± 0.095).

Table 2. Genetic diversity indices, *F*-statistic and estimation of gene flow between populations of *Scutellaria*. H_S, the genetic diversity within populations; D_{ST}, the genetic diversity among populations; H_T, the total genetic diversity; G_{ST}, the among populations gene differentiation coefficient; F_{IS}, the fixation index related to non random mating within populations; F_{IT}, the mean inbreeding coefficient of a set of a populations; F_{ST}, the interpopulation genetic differentiation; N_m, gene flow estimated from $F_{ST} = 0.25(1 - F_{ST})/F_{ST}$. SE, standard error.

Locus	Genetic diversity indices				*F*-statistic			Gene flow
	H_S	D_{ST}	H_T	G_{ST}	F_{IS}	F_{IT}	F_{ST}	N_m
Aat-1	0.291	0.351	0.641	0.547	-0.919	0.135	0.549	0.205
Est-1	0.000	0.444	0.444	1.000	****	1.000	1.000	0.000
Mdh	0.389	0.259	0.648	0.400	-1.000	-0.091	0.455	0.300
Per	0.389	0.198	0.587	0.337	-1.000	-0.326	0.337	0.492
Mean	0.267	0.313	0.580	0.571	-0.973	0.180	0.585	0.249
SE	0.058	0.034	0.030	0.095	0.015	0.183	0.092	0.065

The estimation of the genetic variation among and within populations indicates a moderately high degree of differentiation among populations (F_{ST} = 0.585; SE ±0.092), whereas variation within-populations (1-F_{ST}) represented 41.5% of the total variance. These species exhibit a considerable degree of out-breeding at both the subpopulation (F_{IS} = -0.973; SE ±0.015) and population levels (F_{IT} = 0.180; SE ±0.183), even though the estimate of mean gene flow was low (N_m = 0.249; SE ±0.065). However, the null hypothesis that these populations are at equilibrium is rejected because there is no correlation between pair-wise genetic differentiation values (F_{ST}) and geographic distance (r = 0.365; Mantel *t*-test= 2.259; $p < 0.01$) (Fig. 4).

Based on genetic distance (Nei 1978), two population-groups are differentiated (Fig. 3), representing *Scutellaria discolor* (populations 7-9) which is genetically distinct from all populations of *S. slametensis* (Genetic distance, D=1.4572). Within the populations of the latter species, populations 1 (Paron block, Brebes) and 5 (population in Post III, along walking track from base camp Baturaden to summit of G. Slamet) are genetically similar (Fig. 3). Likewise, populations 4 (Post II) and 6 (Post I) are also genetically similar and this latter population pair is genetically close to the previous pair. Populations 8 and 9 (*S. discolor*) are also genetically similar (Fig. 3).

Allele frequency of 9 populations and allele shared among species

Most alleles are relatively common within the sampled populations (occurring in at least 50% of loci) (Table 3). However, two alleles with low frequencies in population 4 are *Aat-1*^{c} with only 15% of chromosomes carry this allele and *Aat-1*^{b} (35%). Alleles *Aat-1*^{c}, *Mdh-1*^{a,b,c} and *Per*^{b} were shared between *S. slametensis* and *S. discolor*, whereas, *Aat-1*^{a,b}, *Est-1*^{a} and *Per*^{a} were specific to *S. slametensis*. Alleles *Est-1*^{b} and *Per*^{c} are specific to *S. discolor*.

Table 3. Allele frequency of 4 polymorphic loci in 9 populations of *Scutellaria*. Populations 1-6 = *S. slametensis*; 7-9 = *S.discolor*

Population	*Aat-1*^{a}	*Aat-1*^{b}	*Aat-1*^{c}	*Est-1*^{a}	*Est-1*^{b}	*Mdh-1*^{a}	*Mdh-1*^{b}	*Mdh-1*^{c}	*Per*^{a}	*Per*^{b}	*Per*^{c}
1	0.50	0.50		1.00		0.50	0.50		0.50	0.50	
2	1.00			1.00			1.00		0.50	0.50	
3	0.50		0.50	1.00		0.50	0.50		1.00		
4	0.50	0.35	0.15			0.50		0.50	0.50	0.50	
5	0.50	0.50		1.00		0.50	0.50		0.50	0.50	
6	0.50	0.50		1.00		0.50		0.50	0.50	0.50	
7			1.00		1.00		0.50	0.50		0.50	0.50
8			1.00		1.00	1.00				0.50	0.50
9			1.00		1.00	1.00				1.00	

Discussion

Paton (2004) noted that the chromosome numbers for *Scutellaria* are 2n=12-88, with most frequent numbers being 2n=20, 22, 24, 32 and 34. Chromosome numbers of *Scutellaria* subgenus *Scutellaria*, which includes all Indonesian species, are 2n=24-34 (Paton, 1990). Since the chromosome numbers of *S. discolor* and *S. slametensis* are both 2n=24, these two species are possibly closely related. Both of these species have small chromosomes, less than 5 µm long.

Allozymes have been successfully used to compare mating system, migration and local differentiation within and between populations (Brown,

1990). Factors such as, regional distribution of a taxon, geographic range, breeding system, seed dispersal mechanisms and successional status have been associated with differences in the percentages of polymorphic loci (*Pp*%), mean number of observed alleles per locus (*A*), and genetic diversity within-populations (H_E) (Hamrick and Godt, 1990). Values of *Pp*%, *A* and H_E obtained for *S. discolor* and *S. slametensis* are very similar to those obtained for out-breeding plants, wide-spread species, and for those with seeds that are dispersed by gravitational forces.

Scutellaria slametensis is a species with a restricted distribution and has mean genetic variation (*Pp*= 75 %, *A* = 2.00, H_E = 0.450) equivalent to that of *S. montana* (*Pp* = 75.42 %, *A* = 2.21, H_E = 0.19; see Cruzan, 2001), a species restricted to parts of Georgia and Tennessee (U.S.A.) (Cruzan, 2001). *Scutellaria slametensis* exhibits greater genetic variation than plants of *S. discolor* sampled from G. Slamet. Almost all loci of the latter species are monomorphic and homozygotic, especially population 9 (*Pp* = 0 %; H_E = 0; Allele frequencies all=1).

The value of allozyme electrophoresis in delimiting taxa has been found to be useful by several researchers (such as, Coates and Hnatiuk, 1990; Crawford, 1985; Gottleib, 1984). Although all populations of *S. discolor* and *S. slametensis* are relatively close geographically, they are genetically distant based on allozyme divergence. This is possibly a result of the steep mountainous terrain restricting the potential pollinators to small geographical areas within the region (Tyler, 2003). Within *S. slametensis*, populations 4 and 6 are genetically and geographically close. Population 5 is unexpectedly genetically close to population 1 even though the two are not geographically close. Together, populations 1 and 5, and 4 and 6 form a genetically distinct grouping (Fig. 3). Although the two high altitude populations, 5 (elevation at 2,215 m) and 2 (2,002 m) are geographically relatively close, these two populations are genetically distant (Fig. 3). Although population 1 is located in between populations 2 and 3, the genetic variation, hence gene flow, within the latter two populations is low suggesting that they do not share a common population of pollinators. Contrary to this, within-population variation in the population group 1 and 4-6 is high, representing high gene flow between these populations (Table 1). The three populations of *S. discolor* (populations 7-9) are both geographically close and genetically similar. Species characterized by a low level of gene-flow, such as *S. discolor* (Table 1), or a low level within or between populations, such as populations 2 and 3 (*S. slametensis*), may indicate high levels of selfing. Cruzan (2001) hypothesized that the smaller fragmentation threshold may reflect higher levels of selfing in isolated populations because of the absence of pollinators. Unpublished results from observations of floral behaviour and crossing tests of *S. slametensis* clearly demonstrate that this species is mostly self-

compatible as has been found in *S. indica* (Sun, 1999). However, within the current study, the low overall proportion of total genetic variance within a subpopulation relative to total genetic variance (F_{ST} = -0.9769) implies a low level of differentiation among populations, suggesting that *S. discolor* and *S. slametensis* are out-breeding. The low level of gene flow (mean N_m = 0.1988) observed suggests that although these populations are geographically close, they are relatively isolated genetically. Slatkin (1987) concluded that values of $N_m < 1$ mean that genetic drift will result in substantial differentiation between populations. This is possibly a consequence of pollinators only visiting flowers within a restricted area, hence mostly visiting plants in closely adjacent areas (such as, between populations 4 and 6, and between 8 and 9). However, this does not explain the lack of genetic distance between populations 1 and 5 (D = 0.000).

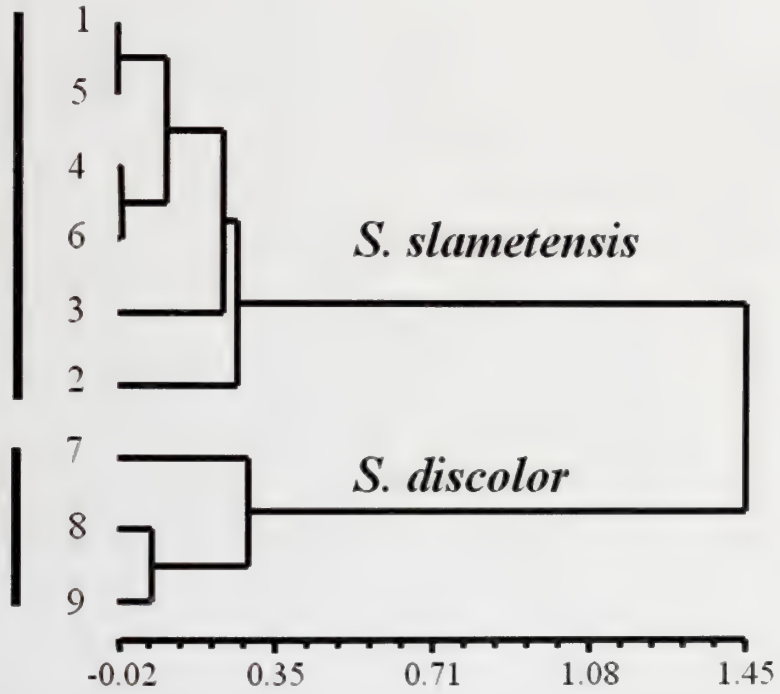

Figure 3. Dendrogram of Nei's genetic distance (Nei, 1978) between six populations of *Scutellaria slametensis* and three populations of *S. discolor* on Gunung Slamet, Jawa Tengah, Indonesia.

Mean total genetic diversity (H_T) showed majority of partitioning occurred among populations (D_{ST} = 31.5%) rather than within populations (H_S = 0.267). The large amount of genetic differentiation among populations

(G_{ST} = 0.571; F_{ST} = 0.585) indicate strong genetic differentiation between these populations (Table 3). *F*-statistics have similar values and indicate that populations of *S. discolor* and *S. slametensis* are genetically structured (Table 2). High levels of genetic structure within-populations are supported by the *Est-1* locus but with low levels of gene flow (*Nm*) (Table 2). High levels of pollen transfer indicate movement of pollinators that will naturally lead to increased genetic differentiation but decreased gene flow (Ellstrand and Elam, 1993). If genetic variation within species is predominantly affected by shared alleles, then there may be a significant correlation between shared alleles and the local geographical distribution pattern of the species. An understanding of nature of shared allele may be used to understand conservation implication for future.

Throughout this study we have assumed a 'stepping-stone' model (Kimura, 1953) of population structure among these plants whose dispersal ability is constrained by distance such that gene flow is most likely to occur between neighbouring populations (Hutchinson and Templeton, 1999). Consequently, it would be expected that adjacent populations tend to be more genetically similar than more distant populations. Therefore, assuming a 'stepping-stone' model of regional population structure, the null hypothesis that these regional populations are at equilibrium is rejected because there is no association between pair-wise genetic differentiation values (F_{ST}) and geographic distance (r = 0.365; Mantel *t*-test= 2.259; $p < 0.01$) (Fig. 4). In this study, the populations of *Scutellaria* on Gunung Slamet consist of mostly small, more or less isolated populations, such that allele frequency drifts independently of geographic distance between populations and is much more influential in determining the population structure than gene flow. These results are consistent with limited pollination events occurring between populations and/or the inhibition of dispersal in this mountainous terrain.

The dendrogram of the sampled populations (UPGMA – based on Nei's genetic distances; Nei, 1978) indicates a correlation between shared alleles and genetic distance (*D*) (Fig. 3). The topology of this dendrogram is congruent with morphological differences between *S. discolor* and *S. slametensis*. Based on allozyme data, the greatest genetic distance (*D* =1.45) was found between *S. discolor* and *S. slametensis*. There are several morphological features that distinguish *S. discolor* and *S. slametensis* (Sudarmono and Conn, 2010). The shape of the leaf, height of stem and number of flowers at inflorescence nodes of *S. discolor* are very different from those of *S. slametensis*. *Scutellaria discolor* has flowers with corolla purple, whereas, *S. slametensis* has corollas that are white basally, pink distally (populations 1 & 2) or purple distally (populations 3-6). *Scutellaria slametensis* has obovate leaves, whereas those of *S. discolor* are ovate. The former species has two flowers at each node of the inflorescence, whereas *S. discolor* has four flowers per node.

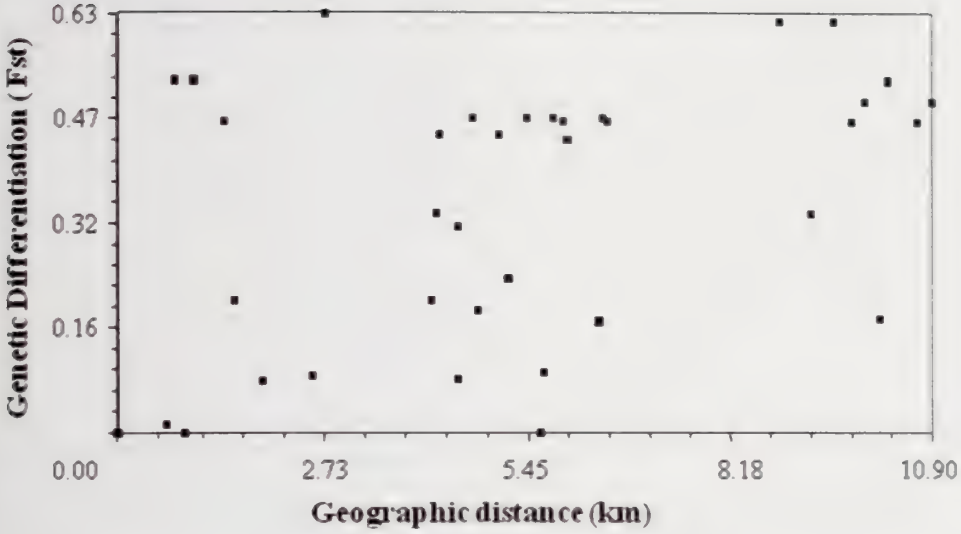

Figure 4. Correlation between geographic distance (km) and genetic differentiation (F_{st}) of nine populations of *Scutellaria discolor* and *S. slametensis* on Gunung Slamet. r=0.365; Mantel *t* test = 2.259; $p < 0.01$.

Conclusion

Scutellaria discolor and *S. slametensis* are morphologically and genetically distinct. Genetic variation within populations 1, and 4-6 are high (*S. slametensis*), whereas within populations 2, 3 (both *S. slametensis*), and 7-9 (*S. discolor*) are low. Although the genetic diversity within *S. slametensis* is partitioned, with one group with high genetic variation (populations 1, 4-6) and one with low values (populations 2 and 3), overall this species has a high level of genetic heterozygosity that makes it a species with a high frequency of heterogamy. Consequently, from a conservation point of view, this species is probably a low-risk species (Fracaro and Echeverrigaray, 2006). Even though the two species at the subpopulation level (F_{IS} = -0.973; SE ±0.015) and population level (F_{IT} = 0.180; SE ±0.183) are out-breeding, the mean gene flow was low (N_m = 0.249; SE ±0.065). Historically, genetic drift has affected the overall structure of the populations of this species, rather than gene flow. However, within the distribution of *S. slametensis*, the mean gene flow was high for the local populations 1, 4-6. Since this species is only known by a limited number of individuals in a restricted locality, it may prove to be vulnerable (IUCN, 2001) should the populations become more isolated, resulting in the level of gene flow and hence, heterozygosity becoming further reduced.

Although *S. discolor* is a widespread species, all loci of the plants sampled on Gunung Slamet are monomorphic and homozygotic. An assessment of the genetic variability of this species throughout its range is required. Even though a species may be widespread, an increased homozygosity may result in a reduction of the vigor of individuals, expression of deleterious characters, increased seed abortion, reduced fertilization and germination rates. These are factors that may lead to the disappearance of the populations (Dubash and Fenster, 2000).

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A New Species of *Polyalthia* (Annonaceae) from Sabah

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Abstract

Polyalthia lasioclada I.M. Turner, *sp. nov.* is described. It is a small tree known from the Mount Kinabalu area of Sabah.

When looking through some Annonaceae specimens recently collected from the Kinabalu Park area of Sabah, I realised several were the same thing as an odd specimen I had tentatively placed in *Polyalthia microtus* Miq. The leaves drying greyish with auriculate bases and orange-red corollas clearly pointed to membership of the informal '*Polyalthia insignis* species-group' of Johnson and Murray (1999). The unusual feature of the specimens was the villose twigs reminiscent of *Polyalthia borneensis* Merr. and *P. bullata* King rather than typical *P. microtus*. The availability of more collections confirmed that there were some consistent differences in flower and fruit form that separated the shaggy-twigged plant and therefore I here describe it as a new species.

Polyalthia lasioclada I.M. Turner, *sp. nov.*
Polyalthiae microtus ramulis petiolisque villosis, sepalis minoribus, monocarpiis globosis vix cylindricis, in sicco aureobrunneis laevibus vix brunneis verruculosisque differt. –**Typus**: Malaysia. Borneo, Sabah, Ranau District, west of Kg Takutan, 2500 ft, 25 May 1973, G. Shea & Aban, SAN *77174* (holotype, SING; isotypes, K, L). **Plate 1.**

Small tree. **Twigs** drying dark grey or grey-brown with shallow longitudinal grooves and some cracking, youngest parts brown or reddish brown densely covered with long (3-4 mm) more or less straight golden brown hairs. **Leaves** chartaceous to subcoriaceous, drying grey or grey-brown above, brown beneath, glabrous except for long straight hairs on midrib below, densest near base, midrib and lateral nerves immersed above, prominent beneath, lamina elliptic to elliptic-obovate, 4.5-20 × 1.5-7.7 cm, apex acute to shortly acuminate, base auriculate, lateral veins 15-19 pairs, angled or arching forward, looping distinctly via a distinct intramarginal, tertiary venation reticulate. Petioles 1-

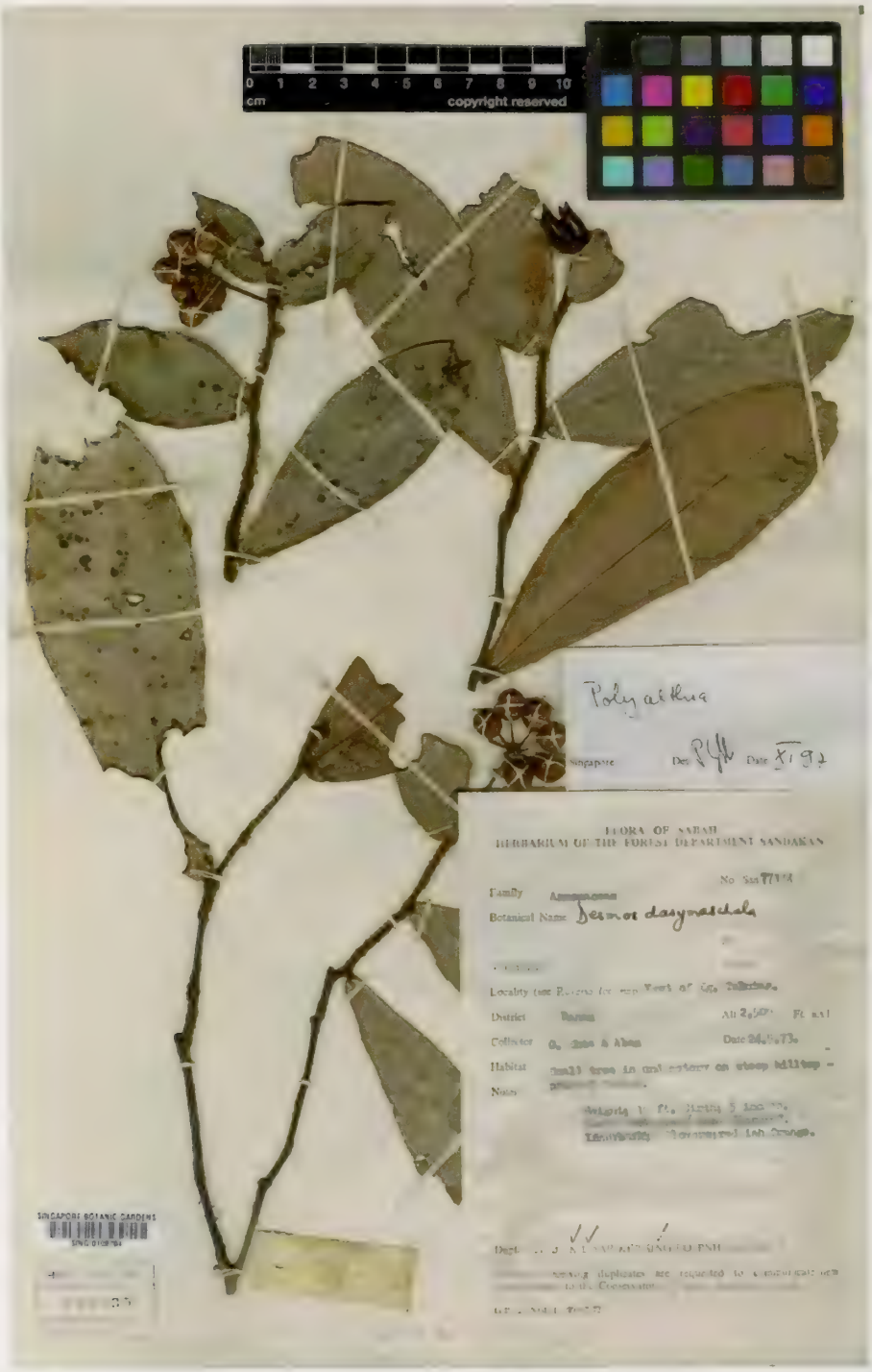

Plate 1. Photograph of the holotype of *Polyalthia lasioclada* I.M. Turner, *sp. nov.*

5 mm long, 1-3 mm thick, densely villose. Inflorescences single-flowered, intranodal. **Flowers** with pedicel 12-24 mm long, less than 1 mm wide, drying red brown with scattered pale hairs, faintly wrinkled longitudinally, sepals ovate or triangular 1-2 × 2-3 mm, drying brown with pale hairs externally, glabrous within, petals lanceolate 15-30 mm long, orange-red, outer slightly wider than inner, 5 vs 3-4 mm, drying dark brown or almost black, outside slightly wrinkled longitudinally, minutely pimpled near the base with sparsely scattered short white hairs, inside smoother with hairs confined to the apex. stamens many *ca* 2 mm long, connective apex truncate, carpels *ca* 12, *ca* 1.5 mm long, densely pale hairs. **Fruits** with pedicel *ca* 18 mm long, 1 mm wide, drying reddish brown, monocarps *ca* 12, globose, 8-10 mm diameter, apex apiculate, drying golden brown, sparsely adpressed pale hairy, drying relatively smooth, stipe 5-8 mm long, 1 mm thick. **Seeds** 1-2, drying pale brown.

Specimens seen: MALAYSIA. **Sabah**, Kota Marudi District, Kampung Monggis, 4 batu dari pusat Kampung Monggis Utara, 9 Apr 1996, *Matamin Rumutom 186* (K); Kampung Kawasan Taman 100 m dari Sungai Mokodon, 8 Mar 1996, *Daim Andau 344* (K); Kampung Kawasan Taman, Jalan ke Palu Agayo, 16 May 1995, *Kinsum Bakia 441* (K); Ranau District, Kampung Nalumad 2 batu from Kg Nalumad, 3 Oct 1998, *Daim Andau 1020* (K); Ranau District, Kampung Nalumad 5 batu dari Kg Nalumad, 9 Oct 1996, *Daim Andau 855* (K).

Notes: The chosen specific epithet is derived from Greek (*lasios* = shaggy, woolly, *clados* = branch, shoot) and reflects the characteristic villose twigs of the species.

Polyalthia lasioclada is similar to the widespread and rather variable *Polyalthia microtus*, particularly in flower form. The sepals of *P. lasioclada* are generally smaller than those of *P. microtus* (1-2 × 2-3 mm versus 4-6 × 4-6 mm). The monocarps of *P. lasioclada* are dry globose, relatively smooth and a golden brown, whereas those of *P. microtus* are more cylindrical, dry with the surface minutely warty and dark brown.

The villose twigs of *Polyalthia lasioclada* are similar to those of *P. borneensis* and *P. bullata*. However these species both have cream to yellow flowers with short villose pedicels rather than the orange-red corollas and relatively long, sparsely hairy pedicels of *P. lasioclada*. The many-nerved leaves of *P. bullata* (25-40 pairs) are unlikely to be confused with *P. lasioclada* (15-19 pairs).

Acknowledgements

Many thanks to Dr J.F. Veldkamp (L) for translating the Latin diagnosis. Support for this reasearch from the Arnold Arboretum, Forest Research Institute Malaysia, Singapore Botanic Gardens and Royal Botanic Gardens Kew is gratefully acknowledged.

References

Johnson, D. M.and N.A. Murray. 1999. Four new species of *Polyalthia* from Borneo and their relationship to *Polyalthia insignis*. *Contributions from the University of Michigan Herbarium* **22**: 95-104.

Studies on Schismatoglottideae (Araceae) of Borneo XIII: A Revision of the *Schismatoglottis nervosa* Species Complex

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Abstract

A revision of the *Schismatoglottis nervosa* Ridl. species complex is presented. Ten species are recognized, of which three species are pre-existing (*S. nervosa*, *S. elegans* A.Hay, and *S. brevicuspis* Hook.f.) and seven are novel and described here (*Schismatoglottis adoceta* S.Y.Wong, *S. linae* S.Y.Wong, *S. matangensis* S.Y.Wong, *S. simonii* S.Y.Wong, *S. tessellata* S.Y.Wong, *S. turbata* S.Y.Wong, and *S. ulusarikeiensis* S.Y.Wong.) The *S. nervosa* species complex is readily delimitated by the pungent terpenoid smell when the vegetative tissues are crushed, and by the presence of longitudinally ridged petioles. A key to the *S. nervosa* species complex is presented and all species are illustrated.

Introduction

Schismatoglottis is a genus of in excess of 150 species of terrestrial, lithophytic, and rheophytic herbs occurs within Malesia, but mainly in Borneo. Hay & Yuzammi (2000) presented an alpha-taxonomic revision of the Malesian species, one of the results of which was the recognition of six informal species groupings based primarily on shoot architecture and the senescence mechanics of the upper spathe: Asperata Group, Calyptrata Group, Corneri Group, Multiflora Group, Rupestris Group and Tecturata Group. However, *Schismatoglottis* has been proven as a polyphyletic assemblage (Wong *et al.*, 2010), and this has resulted in the removal of the Rupestris Group into a resurrected genus, *Apoballis* (Wong & Boyce, 2010). Further molecular analysis is being undertaken and will form the basis of further paper (Ting et al., in prep.).

Hay and Yuzammi (2000) placed *S. nervosa* and *S. elegans* (both from Sarawak) in the Asperata Group based on the combination of pleionanthic shoots, the leaf sheath open and nearly always fully attached and persistent, and by the spathe limb opening more-or-less wide and then crumbling-

deliquescent. One species, which occurs in West Malaysia, *Schismatoglottis brevicuspis* Hook.f also belongs to this complex. In addition to these species, a further 7 species, all novel, are recognized here from Sarawak: *Schismatoglottis adoceta* S.Y.Wong, *S. linae* S.Y.Wong, *S. matangensis* S.Y.Wong, *S. simonii* S.Y.Wong, *S. tessellata* S.Y.Wong, *S. turbata* S.Y.Wong, and *S. ulusarikeiensis* S.Y.Wong. The *S. nervosa* species complex is clearly distinguished within the Asperata Group by a pungent terpenoid smell when crushed (tissues odourless when crushed in Asperata Group *s.str.*, i.e., *sensu* Wong), coriaceous to thinly coriaceous ± elliptic leaves with veins prominent abaxially (leaves thinly sub-succulent and fragile with veins obscure to invisible abaxially in Asperata Group *s. str.*), and longitudinally ridged petioles (petioles asperous to puberulent or hispid in Asperata Group *s. str.*), supporting the recognition as a distinct species complex within the group.

The *S. nervosa* species complex comprises terrestrial forest-dwelling herbs commonly on steep soil banks or occurring as obligate or facultative lithophytes on limestones, shales, sandstones and granite. *Schismatoglottis nervosa* and *S. elegans* are restricted to Karst limestones; *Schismatoglottis matangensis* and *S. turbata* to sandstones, and *S. adoceta*, *S. tessellata* and *S. ulusarikeiensis* to shales, *S. simonii* to both limestones and sandstones, and *S. linae* and *S. brevicuspis* to granite.

Allied taxa

There are additional species in the *S. asperata* group that possess longitudinally and/or puberulent ridged petioles and/or are weakly (not pungently) terpenoid smelling when crushed, of which one, *Schismatoglottis latevaginata* Alderw., described and numerous other species are awaiting formal description. Based on initial observations of the spathe senescence mechanics (spathe at least partially circumscissile before shedding in large pieces) and leaf shape (lamina oblongo-ovate on a disproportionately long petiole), these species are morphologically more closely related to one another than any of them are to species of the *S. nervosa* species complex, and will be the subject of a subsequent paper.

Schismatoglottis nervosa species complex

Small to robust **herbs**, 40-70 cm tall, occasionally up to *ca* 1 m tall, with vegetative tissues emitting a pungent aromatic (terpenoids) smell when crushed. **Stem** epigeal, pleionanthic, erect to decumbent, sometimes ascending and then rooting ('terrestrial climber' *sensu* Boyce), 30-50 cm

long x 2-4 cm thick, adventitiously branched from older portions, rooting along entire length on contact with ground, roots often penetrating petiole bases; leaf scars prominent. **Leaves** few to many (5-15) together; innovations yellowish green; senescent lamina sometimes rotting and falling together with distal portion of petiole to leave the lower portion of the petiole attached to plant, this rotting and falling at a later stage; petioles terete, *ca* 30-40 cm long, sometimes, up to *ca* 70 cm long, adaxially channelled or D-shaped in cross section, weakly to strongly longitudinally ridged (resembling celery - *Apium graveolens* - Apiaceae) especially abaxially, minutely (strong lens required) and densely verruculate or glabrous; petiole sheathing in the lower ⅓ - ½, sheaths fully attached, thinly coriaceous, sometimes leathery, marcescent or persistent, tapering, closed or less often wide open, sometimes with a short rounded free ligular portion; lamina broadly ovate to oblongo-ovate to elliptic, coriaceous or thinly coriaceous, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate, adaxial surface semi-matte, bright deep to medium green, always slightly bullate, abaxial surface paler green, often glaucous, drying strongly discolorous; midrib adaxially flush with lamina, abaxially very prominent; primary venation impressed adaxially, sometimes flush with lamina, strongly raised abaxially, alternating with lesser interprimaries, interprimaries occasionally arising from the bases of the primary veins, both diverging at 45°- 90° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary venation mostly arising from the midrib, occasionally from near the bases of the primary veins, prominent abaxially; tertiary venation forming an obscure to prominent tessellate pattern, variously prominent adaxially and abaxially. **Inflorescences** up to three together (rarely 4), erect, white, moderately fragrant (esterase) at female anthesis; peduncle to *ca* 2 cm long, concealed by leaf bases, prophylls, and cataphylls at flowering, slightly exserted in fruit; **spathe** interior glossy, exterior semi-glossy; lower spathe differentiated from the limb by a weak constriction correlating with spadix interstice; limb oblongo-lanceolate, white to partially green, weakly coriaceous to somewhat spongy, semi-truncate to shortly to strongly acuminate (to *ca* 5 mm long), apex mucronate (to *ca* 2 mm), limb either caducous by crumbling at or just after male anthesis, with remaining fragments deliquescing, or briefly persistent until end of anthesis and thence deliquescent; spadix sessile, isodiametrically adnate on the lower abaxial side relative to the spathe opening; **female zone** conic-cylindric; pistils numerous, close-packed or laxly arranged; stigma sessile, punctiform, minute to large but always smaller in diameter than ovary; interpistillar staminodes confined to a more-or-less single ring at the base of the female zone (rarely among the pistils); sterile interstice present, supra-pistillate pistillode zone often constricted; pistillodes half to twice the diameter of

ovary, close-packed or laxly arranged and followed by a whorl of staminodes, this zone often constricted; **male zone** contiguous with interstice staminodes, cylindric; stamens close-packed, the whole butterfly or dumbbell-shaped from above; pores oblong to C-shaped, deep to shallow; appendix sub-cylindric, white or yellow when fresh, distally tapering to a blunt or sharp point, basally merging with the male zone or weakly or distinctly wider and slightly truncate; appendix staminodes small to rather large, densely packed, flat-topped to slightly impressed, irregularly polygonal.

Key to *Schismatoglottis nervosa* species complex

1. Petiole longitudinally ridged; vegetative tissues pungently aromatic (terpenoids) when crushed; leaves ± elliptic, thickly to thinly coriaceous with veins prominent abaxially.....**2**
1. Not the above combination ..... remainder of genus (see Hay and Yuzammi, 2000; Hay, 2002)

2. Spathe hardly opening; upper part of spathe limb remaining green during anthesis; stigma green when fresh.....**3**
2. Spathe opening wide; upper part of spathe turns to white during anthesis; stigma white when fresh (except for *S. tessellata*).....**4**

3. Petiolar sheath persistent, opening wide; lamina longer and narrower (ratio ≥3:1); primary venation adaxially flush with surface and with less than 10-15 on each side. Central Sarawak: Sarikei.....***S. ulusarikeiensis***
3. Petiolar sheath marcescent, opening narrow; lamina shorter and wider (ratio < 3:1); primary venation adaxially sunken with surface and with 15-20 on each side. West Malaysia: widespread..... ***S. brevicuspis***

4. Appendix white when fresh; petioles puberulent, densely (sometimes minutely) verruculate, longitudinal ridges prominent; leaf apex shortly acuminate to *ca* 1 cm.....**5**
4. Appendix yellow when fresh; petioles glabrous, not verruculate, longitudinal ridges not prominent; leaf apex strongly acuminate to *ca* 3 cm.....**9**

5. Tertiary venation obscure-tessellate; female zone exceeding male zone, pistils laxly arranged, stigma small, 1/5 of ovary diam., turning yellow in alcohol; spadix interstice sharply constricted. West Sarawak: Matang.....***S. matangensis***
5. Tertiary venation prominent tessellate; male zone exceeding female zone, pistils crowded, stigma large, 1/3 to ½ of ovary diam., remaining white in alcohol; spadix interstice weakly constricted. Plants of limestone, sandstone and granite. West Sarawak except Matang **6**

6. Male zone irregularly arranged with uneven surface, male flowers round; appendix markedly wider than male zone and slightly truncate basally in diameter. Plants of sandstone..... ***S. turbata***
6. Male zone evenly arranged with smooth surface, male flowers butterfly shape or dumbbell shape; appendix contiguous with male zone. Plants on a variety of substrates..... **7**

7. Spathe limb splitting into longitudinal strips before deliquescing. Plants of sandstone..... ***S. linae***
7. Spathe limb deliquescent in a whole piece. Plants of limestone..... **8**

8. Stamen pores narrowly C-shaped, deep, connective narrow, rims not alate; stigma ½ ovary diam.; secondary and tertiary venation not strongly pronounced. Plants weak to robust, sometimes colony forming. Always lithophytic in soil collected in crevices and sinkholes in limestone. Full shade, less than 200 m asl. West Sarawak: Bau..... ***S. nervosa***
8. Stamen pores oblong, shallow, connective broad, rims widely alate; stigma 1/3 ovary diam.; secondary and tertiary venation pronounced. Plant robust, always colony forming. Always terrestrial in deep soil on limestones and sandstones. Sometimes in full sun, less than 600 m asl. West Sarawak: Padawan/Serian..... ***S. simonii***

9. Leaf lamina thinly coriaceous, occasionally with grey stripe, adaxially glossy; tertiary venation more tessellate adaxially than abaxially; female flowers green; appendix 1/6 of spadix length. Central Sarawak: Kapit..... ***S. tessellata***
9. Leaf lamina coriaceous, never variegated, adaxially semi-matte; tertiary venation more tessellate abaxially than adaxially; female flowers white; appendix ½ to 1/3 of spadix length..... **10**

10. Petiolar sheath leathery; leaf lamina glaucous abaxially, leaf apex shorter (to *ca* 2 cm); stigma large (½ of ovary diameter), staining yellow in alcohol; connective narrow, pore oblong. Plants of shales in central and northeast Sarawak..... ***S. adoceta***
10. Petiolar sheath coriaceous; leaf lamina not glaucous abaxially, leaf apex longer (to *ca* 3 cm); stigma small (1/5 of ovary diameter), remaining white in alcohol; connective broad, pore C-shaped. Plants of limestones in northwest Sarawak ..... ***S. elegans***

1. ***Schismatoglottis adoceta*** S.Y.Wong, *sp. nov.*
Ab Schismatoglottis elegans *foliis subtus glaucis, laminae foliae apice acuminata breviore (ad 2 cm longa), stigmatibus maioribus (quam ovaria ca ½ diametro vs. 1/5 in* S. elegans*) et cum alcoholis flavescente (stigmatii* S. elegansii *sum alcoholis alba remenans). Connectivo antherae anguste, poris*

oblongo (vs. connectivo antherae crasso, poris hippocrepiformis: S. elegans*) distinguitur.* Schismatoglottis adocetae *in habitu saxa shaleiaca restrictus est (*S. elegans *in habitu calcicola unica).*–**Typus**: Malaysia, Sarawak, Kapit Division, Belaga, km 10 Bakun-Bintulu-Miri road junction, 02° 50' 51.7"; 114° 01' 57.6", 182 m asl, 11 Oct 2005, *P.C.Boyce et al. AR-1408* (holo, SAR). **Plate 1.**

Leaf petioles glabrous, slightly channelled and carinate adaxially in cross section; sheathing in the lower 1/5 to ½, sheath fully attached, closed, tapering, leathery, persistent; lamina broadly ovate to oblongo-ovate, more-or-less elliptic, thinly coriaceous, slightly bullate, 7-9 cm wide x 13-23 cm long, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate to *ca* 2 cm, adaxial surface semi-matte mid-green, abaxial surface paler green, glaucous, drying strongly discolorous, midrib adaxially flush with lamina, abaxially prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially with 17-22 primary lateral veins on each side, alternating with lesser interprimaries, frequently with a few branches from near the base, both diverging at 45°- 60° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary venation, arising from the midrib and the primary veins; tertiary venation obscure tessellate adaxially and abaxially in both living plants and dry specimens. **Inflorescences** up to three in quick succession alternating with foliage leaves *ca* 5 cm long, (i.e. not forming a true synflorescence), fragrant (esterase) at female anthesis; peduncle to *ca* 1 cm, not exserted from leaf bases, slightly exserted in fruit; **spathe** interior glossy, exterior semi-glossy, coriaceous, *ca* 7.5 cm long, lower spathe narrowly ovoid, green when fresh, *ca* 2.5 cm long × 1 cm diam., differentiated from the limb by a weak constriction; limb sub-truncate, white, *ca* 5 cm long, coriaceous, opening wide except for convolute base, at first over-arching, then reflexed, finally more or less twisted and then caducous-crumbling, apex mucronate *ca* 4 mm long, green when fresh; spadix sessile, adnate isodiametrically to the spathe in the lower 1/2 of female zone, whitish, to *ca* 5.5 cm long, less than the length of spathe; **female zone** *ca* 1.7 cm long, 1/3 of spadix length; pistils many, crowded, round to slightly rhomboid, with weakly bisulcate longitudinal ridges, *ca* 0.5 mm diam. × 0.45 mm long; stigma large, bun-shaped, to *ca* 0.3 mm diam., 1/2 of ovary, punctiform, papillate, yellow in alcohol; interpistillar staminodes very occasional among the pistils, crowded into a row along the spathe/spadix adnation, stalked, clavate and flat-topped, *ca* 0.5 mm diam., similar size to pistils; sterile interstice strongly narrowed, *ca* 1.4 mm diameter in the middle, (2.5-) *ca* 7 mm long which is 1/8 of spadix length, basally more or less covered with inflated abortive pistils (reduced stigmas), twice the diameter of ovary, transversely sulcate, apically covered with two rows of sterile stamens, irregular shape, slightly wider than stamens; **male**

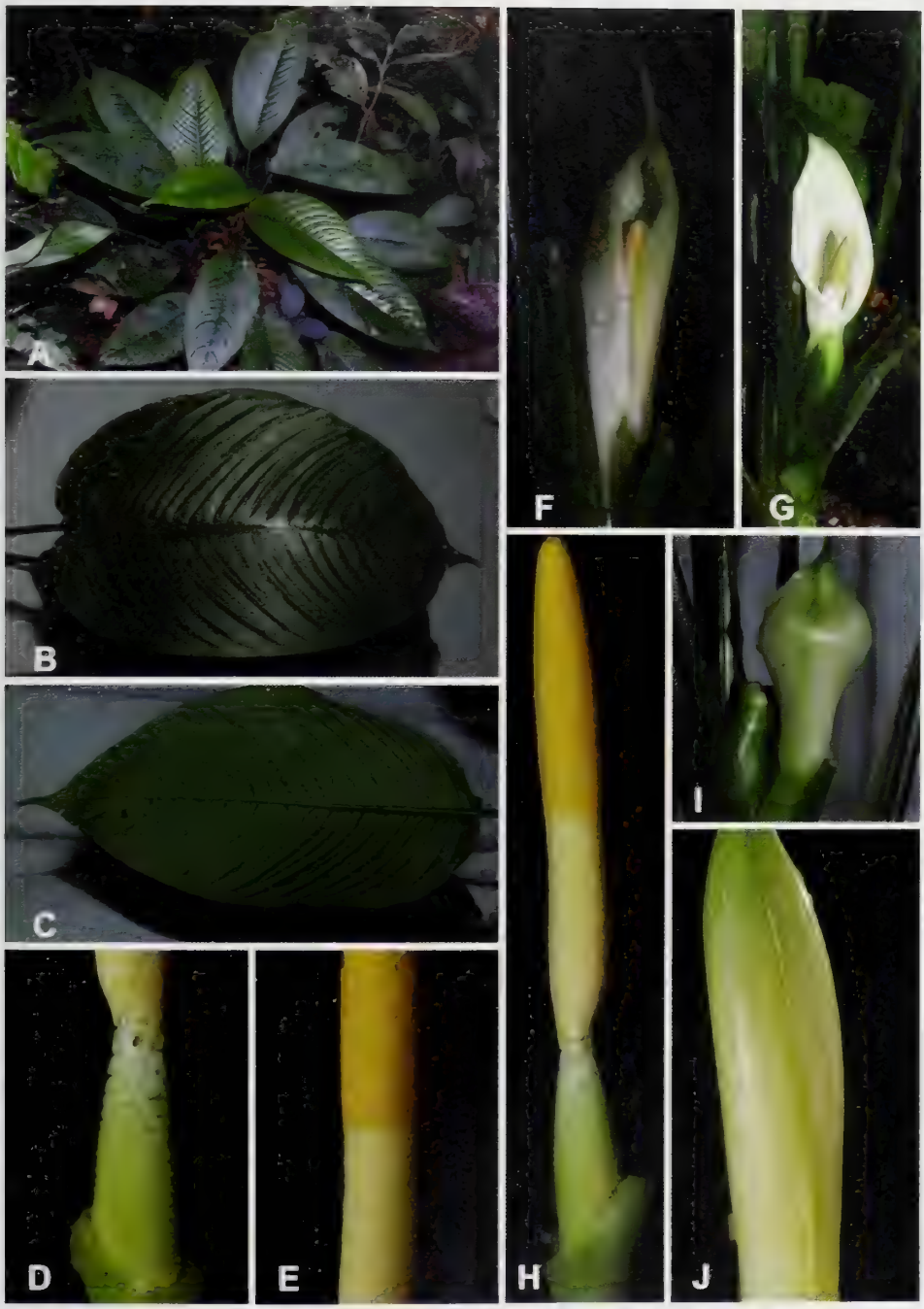

Plate 1. *Schismatoglottis adoceta* S.Y.Wong. A. Whole plant; B. Leaf lamina adaxially; C. Leaf lamina abaxially; D. Female zone; E. Male zone and yellow appendix; F. Inflorescence during female anthesis; G. Inflorescence during male anthesis; H. Spadix with the spathe artificially removed; I. Spathe at male anthesis; J. Spathe prior to female anthesis. Images © P.C. Boyce

zone cylindric, *ca* 3.6 mm diam. × 1.2 cm long, 1/3 of spadix length, marked increased in diameter from interstice; stamens crowded, truncate, *ca* 0.4 mm across, dumbbell-shaped with the connective not elevated above the thecae, connective narrow, pore oblong and deep; appendix sub-cylindric, *ca* 1.8 cm long, 1/3 of spadix length, yellow when fresh, turning white in alcohol, frequently chewed by beetles, tapering to a sharp point, basally more or less not isodiametric with top of male zone; staminodes of appendix more or less columnar, irregularly polygonal, flat-topped, *ca* 0.5-1 mm diameter.

Other specimens seen: SARAWAK. Bintulu Division: Bintulu, Bk. Satiam, 02° 59' 33.0"; 112° 56' 01.4", 18 m asl, 12 Aug 2004, *P.C.Boyce & Jeland ak Kisai AR-632.1* (SAR); Bk. Merairi, 02° 46' 26.9"; 113° 39' 19.8", *JS/LC-24 AR-1284* (SAR).

Distribution: Central and northeast Sarawak, Kapit and Bintulu Divisions.

Habitat: Lithophytic on shale (Bintulu and Kapit Divisions), 18-180 m asl.

Notes: *Schismatoglottis adoceta* is clearly distinguished from the rest of the *S. nervosa* complex by having leathery petiolar sheath (coriaceous petiolar sheath in the rest of the complex). *S. adoceta* is most similar to *S. elegans* although readily distinguished by the leaf laminae abaxially glaucous, the leaf apex much shorter-acuminate (to *ca* 2 cm), larger stigma (*S. adoceta* 1/2 of ovary diameter vs. *S. elegans* 1/5 of ovary diameter) staining yellow in alcohol (remaining white in *S. elegans*), anthers with a narrow connective and oblong pore (*S. adoceta*) whereas anthers in *S. elegans* have a broad connective and a C-shaped pore. *Schismatoglottis adoceta* is restricted to shales as compared to *S. elegans* endemic on limestones. *Schismatoglottis adoceta* differs from *S. tessellata* (also of shales) by coriaceous leaf laminae with the adaxially much less pronounced tertiary venation and the spadix appendix in *S. adoceta* much longer and narrower.

Etymology: The specific epithet is derived from the Greek '*adocetus*', unexpected, in allusion to the realization late in the preparation of this manuscript that several elements of *S. elegans* sensu Hay and Yuzammi required a specific recognition.

2. ***Schismatoglottis brevicuspis*** Hook.f.
Fl. Brit. Ind. 6 (1894) 537; Ridl. Materials Fl. Mal. Pen. 3 (1907) 33 & J. Straits Branch Roy. Asiat. Soc. 57 (1910) 113 & Fl. Mal. Pen. 5 (1925) 113; Engl. & Krause, Pflanzenr. 55 (IV.23Da) (1912) 98, *pro parte excl. specim. cit.* Curtis (Penang, Waterfall), Ridley (Selangor, Petaling; Pahang, Tahan River) [i.e. *S.*

brevipes Hook.f., q.v.]. –**Type**: Malaysia, Perak, *Scortechini* 612 (holo, K; iso, CAL, SING).

Other specimens seen: PENINSULAR MALAYSIA. **Johor**: Muar, Gunung Ledang F.R., Gunung Ledang, (Mt Ophir), 22 Jan 1994, (orig. coll. *Hay, A., Samy, A. & Ban Ka 9172*) sub. *C. Herscovitch NSW407380* (KEP 41490, L 0832670); Bukit Tunjok Laut, *Ngadiman 37088* (SING). **Melaka**: Base of G. Mering, *Ridley s.n.* (SING). **Pahang**: Pulau Tioman, Jason Bay, *Burkill 1042* (K, SING); Kemaman, Ulu Ayam, Bukit Kajang, *Corner 30249e* (SING); Raub–Bentong boundary, *Furtado 33097a* (SING). **Negeri Sembilan**: Beremban Forest Reserve, foot of Gunung Angsi, *Furtado s.n.* (SING). **Selangor**: Ulu Gombak, *Croat 53276* (K, MO); Gombak valley, 13 Jan 1994, *C. Herscovitch NSW407381* (KEP 41493); near Klang Gates Reservoir, *Nicolson 1140* (K); Genting Peras, *Ridley s.n.* (SING). **Perak**: Hulu Perak, Tasik Banding, n.d., *Baharuddin bin Sulaiman s.n.* (sub. *AR-2599*, living collection in Semenggoh Botanical Research, Kuching, Sarawak) (SAR, USM); Sungei Batang Padang, Tapah, *Furtado 33096* (SING); Larut, 14 Jan 1994, *Hay, A., Samy, A. & Ban Ka 9075* (L 0832668); Kuala Kangsar, Bubu F.R., foothills of Gunong Bubu, 18 Jan 1994, (orig. coll. *Hay, A., Samy, A. & Ban Ka 9130*; Cult. RBG Sydney, Acc. No. *940126* (KEP 41475, L 0832671). **Kelantan**: Gua Musang, Relai F.R. 5°02' N, 102°23' E, 1992, *Kiew, B.H. KBH10* (KEP 38211). **Kedah**: Gunung Bongsu, nr Terap, *Bogner 1692* (K). INDONESIA: **Sumatera**: Sibolangit, *Alston 14481* (BM); Sibolangit, Bukit Semiak, *Md Nur 7368* (K); Aceh, Middle Alas River (Lae Sauraya) area, *ca* 15 km N of Gelombang, S of Bengkong R., 21 Jul 1985, *de Wilde & de Wilde-Duyfjes 20188* (L 0239831).

Distribution: Malay Peninsula and Sumatra (North Sumatera and Aceh provinces)

Habitat: In wet gullies and among rocks by streams in lowland rain forest and lowland hill forest, to *ca* 900 m alt.

Notes: P.C. Boyce and the author saw a living collection of this species at Nancy Botanical Garden, France, and realised that this species belongs to the *S. nervosa* complex, although somewhat unusual in the spathe hardly opening and the spathe limb green, a character set otherwise shared only with *S. ulusarikiensis*. A later trip to the aroid garden in Universiti Sains Malaysia, Penang, which also has the living material of *S. brevicuspis* further confirmed the placement of this species.

3. ***Schismatoglottis elegans*** A.Hay
Telopea 9(1) (2000): 67. –**Type**: Cultivated in RBG Sydney Acc. No. *940510*,

ex Malaysia, Sarawak, Niah National Park, Niah Caves area, along path from Niah town (orig. coll. *Hay et al. 9359*), Feb 1996, *C. Herscovitch s.n.* (holo, SAR; iso, K, KEP, NSW, all + spirit). **Plate 2.**

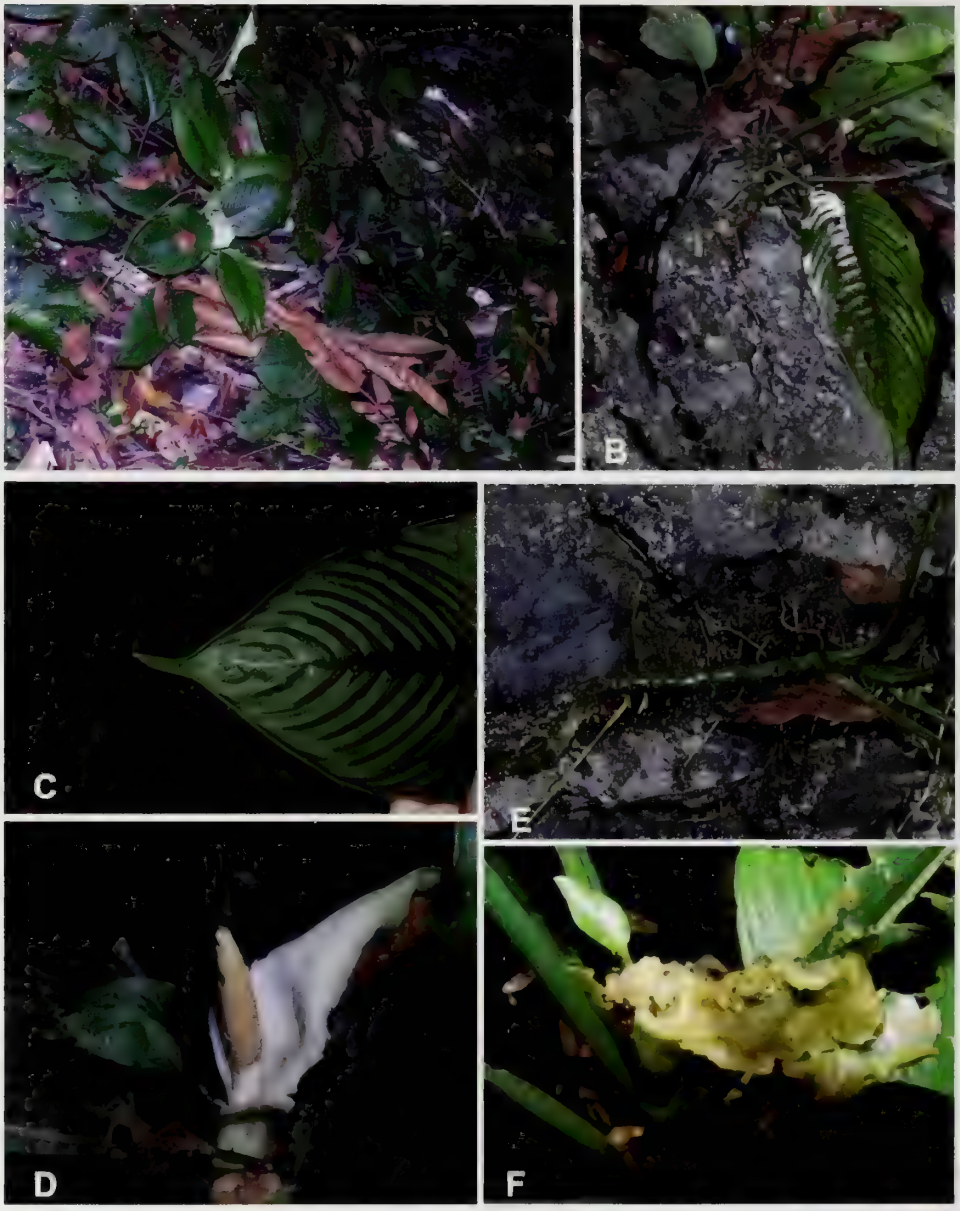

Plate 2. *Schismatoglottis elegans* A.Hay. A. Population in the wild, spreading across the floor, the base of a limestone hill; B. Whole plant occurs in deep litter on limestone; C. Leaf lamina apex (to c. 3 cm long); D. Inflorescence at male anthesis; E. Creeping rhizome; F. Inflorescence post anthesis showing the deliquescing spathe limb. Images © P.C. Boyce

Other specimens seen: MALAYSIA. **Sarawak**. Miri Division: Niah Suai, Niah National Park, trail to Great Cave, 03° 49' 09.9": 113° 46' 52.3", 46 m asl. 13 Oct 2005, *P.C.Boyce et al. AR-1428* (SAR); Niah Suai, Niah National Park, Madu Trail, 03°48' 57.9»; 113° 46'18.3», 34 m asl. 13 Jul 2006, *P.C.Boyce et al. AR-1877* (SAR + spirit); *P.C.Boyce et al. AR-1878* (SAR + spirit); Subis, Gua Sibau, Niah National Park, Trail from Rh. Chang, 24 Aug 2002, *Julaihi A. et al. S. 89319* (SAR).

Distribution: Sarawak. Miri Division, endemic to Niah area (Northeast Sarawak).

Habitat: Humus-filled crevices in limestone in wet to swampy lowland rainforest, 34-200 m asl.

Notes: *Schismatoglottis elegans* is distinguished from *S. nervosa* (in West Sarawak limestone) by leaf laminae not glaucous abaxially and the spadix appendix yellow when fresh. The tip of the leaf lamina acuminate up to *ca* 3 cm. Stamens of *S. elegans* are much rounder, with a broad connective and are the more dumbbell-shaped as compared to other species in the complex. Stamen pores are deepest as compared to other species in the complex. Hay and Yuzammi (2000) mentioned that the appendix staminodes dried with the stalk collapsed but the tops remaining expanded and tending to cohere in groups. However, inflorescence of *AR-1877* does not behave in this manner while some inflorescences of *S. nervosa* behave in the same manner suggesting that this is not a strong differentiating character. The spadix of *AR-1877* differs from other collections in that it has ovaries tetrasulcate with the stigma staining yellow and interstice staminodes and stamens turning darker yellow in alcohol. It is not clear if these are artefacts of the period (post anthesis) of preservation.

Schismatoglottis elegans resembles *S. tessellata* although aside from ecological differences (*S. tessellata* is restricted to shales) the latter also differs by having thinly coriaceous leaf laminae with the tesselate tertiary venation adaxially markedly more pronounced, a larger stigma and much shorter and broader spadix appendix.

Hay and Yuzammi (2000) noted that *S. elegans* is found in a variety of other localities in rainforest between 800 and 1300 m alt. However, there are considerable doubts about the four specimens cited and pending further investigation, the author suspect these observations represent morphologically similar but different species.

4. ***Schismatoglottis linae*** S.Y.Wong, *sp. nov.*
Schismatoglottis linae *simillima speciebus* S. nervosa *et* S. simonii *quae spathe senescens differt. Spathae laminorum findens longitidinalis ante*

deliquescens, staminis connectivo producto latus, poris antherae profundis (vs. staminis connectivo producto latus, poris non-profundis: S. simonii, *et staminis connectivo anguste et poris profundis:* S. nervosa*) distinguitur. Inter specibis Schismatoglottodorum grex nervosae habitu graniticola terrestri uniqus.* – **Typus**: Malaysia, Sarawak, Kuching Division, Lundu,Gunung Gading, below plank walk to swimming area, 01° 41' 31.0"; 109° 50' 44.5", 700 m asl, 14 Dec 2006, *P.C.Boyce et al. AR-2062* (holo, SAR). **Plate 3.**

Leaf petioles terete, obscurely longitudinally ridged (clearer under magnification), glabrous, up to *ca* 40 cm long, slightly channelled and carinate adaxially in cross section; sheathing in the lower 1/3 to ½, sheath fully attached, closed, tapering, coriouceous, marcescent; lamina broadly ovate to oblongo-ovate, more-or-less elliptic, thinly coriaceous, slightly bullate, 8-10 cm wide × 15-25 cm long, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate to *ca* 3 cm, adaxial surface semi-matte mid-green, abaxial surface paler green, glaucous, drying strongly discolorous, midrib adaxially flush with lamina, abaxially prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially with 18-22 primary lateral veins on each side, alternating with lesser interprimaries, frequently with a few branches from near the base, both diverging at 45°- 60° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary venation, arising from the midrib and the primary veins; tertiary venation obscure tessellate adaxially and abaxially in both living plants and dry specimens. **Inflorescences** up to three in quick succession alternating with foliage leaves *ca* 5 cm long, (i.e. not forming a true synflorescence), fragrant (esterases) at female anthesis; peduncle to *ca* 1 cm, not exserted from leaf bases, slightly exserted in fruit; **spathe** interior glossy, exterior semi-glossy, coriaceous, *ca* 13 cm long, lower spathe narrowly ovoid, green when fresh, *ca* 3.5 cm long × 1 cm diam., differentiated from the limb by a constriction; limb truncate, white, *ca* 8 cm long, coriaceous, opening wide except for convolute base, at first over-arching, then reflexed, finally more or less twisted and then caducous-crumbling in longitudinal stripes, delisquescent post male anthesis, apex mucronate *ca* 4 mm long; spadix sessile, adnate isodiametrically to the spathe in the lower ½ of female zone, whitish, to *ca* 10 cm long, less than the length of spathe; **female zone** *ca* 2.5 cm long, 1/3 of spadix length; pistils many, crowded, round to slightly rhomboid, with weakly bisulcate longitudinal ridges, *ca* 0.5 mm diam. × 0.5 mm long; stigma smaller than ovary, bun-shaped, to *ca* 0.3 mm diam., punctiform, papillate; interpistillar staminodes confined into a row along the spathe/spadix adnation, stalked, clavate and flat-topped, *ca* 0.5 mm diam., similar size to pistils; sterile interstice strongly narrowed, *ca* 0.4 cm diameter in the middle, *ca* 5 mm long, basally more

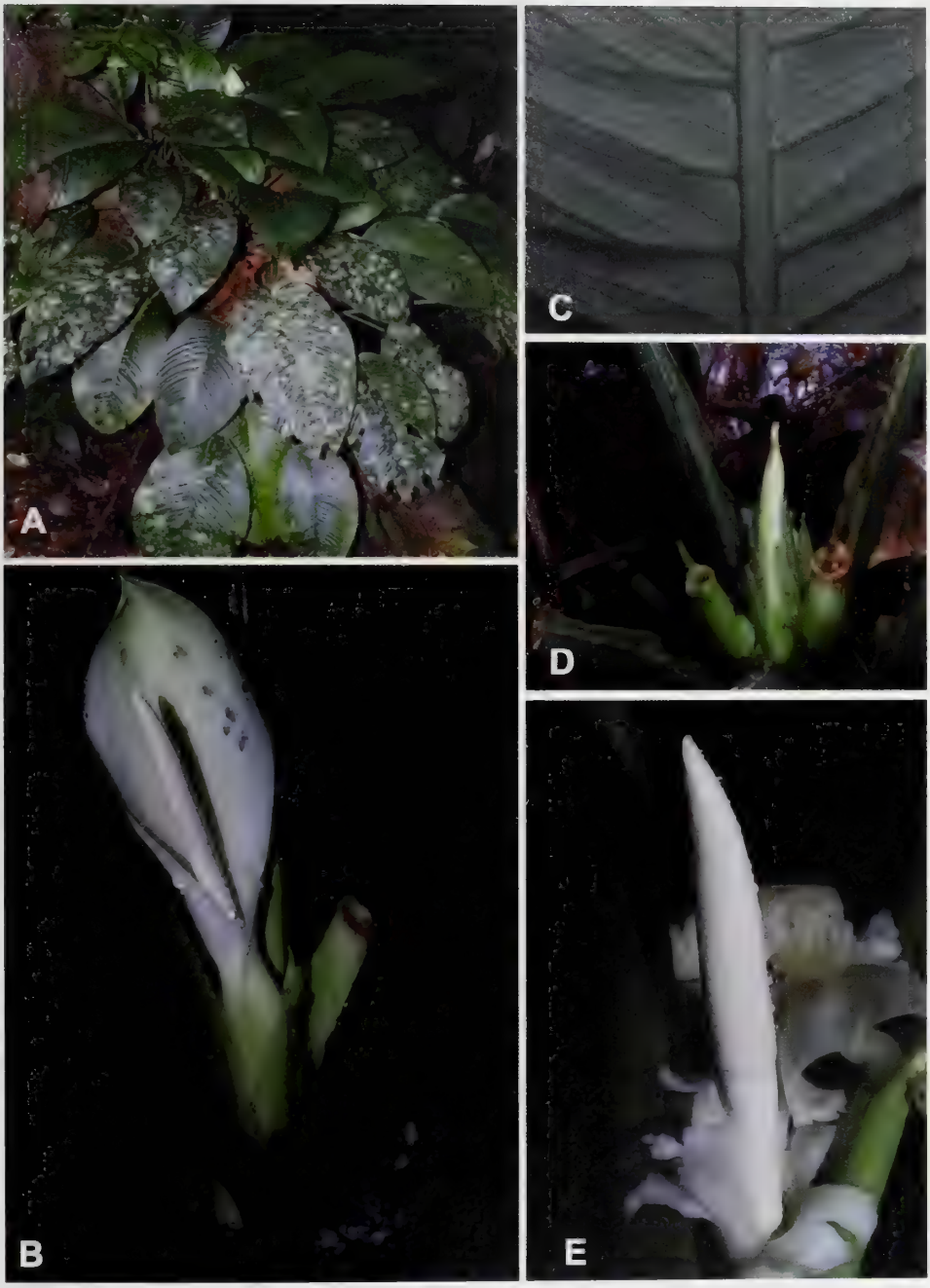

Plate 3. *Schismatoglottis linae* S.Y.Wong. A. Whole plant; B. Inflorescence at male anthesis with an infructescence on the right side; C. Leaf lamina abaxially; D. Emerging inflorescence with two infructescences; E. Inflorescence post anthesis showing the spathe limbs caducous in longitudinal stripes. Images © P.C. Boyce

or less covered with inflated abortive pistils (reduced stigmas), twice the diameter of ovary, transversely sulcate, apically covered with sterile stamens, irregular shape, slightly wider than stamens; **male zone** cylindric, *ca* 5 mm diam. × 3.5 cm long, ⅓ of spadix length, slightly increased in diameter from interstice; stamens crowded, truncate, *ca* 0.4 mm across, dumbbell-shaped with the connective not elevated above the thecae, connective broad, pore oblong and deep; appendix subcylindric, *ca* 3.5 cm long, ⅓ of spadix length, white when fresh and in alcohol, tapering to a sharp point, basally more or less not isodiametric with top of male zone; staminodes of appendix more or less columnar, irregularly polygonal, flat-topped, *ca* 0.5-1 mm diameter.

Distribution: Sarawak, Kuching Division, endemic to Gunung Gading, Lundu (West Sarawak).

Habitat: Terrestrial on pockets of loose soil in deep litter along the stream running through at the base of the granites (Kuching Division), 70 m asl.

Notes: *Schismatoglottis linae* resembles *S. nervosa* and *S. simonii* but is distinguished from these two species by the spathe limb senescence. The spathe limb splits into longitudinal stripes before deliquescing. The connective is broad but stamen pores are deep (broad connective and shallow pore in *S. simonii*, narrow connective and deep pore in *S. nervosa*). Plants are terrestrial along the stream in deep litter on granite surface (the only species in the complex on this geology).

Etymology: This species is named for Lin Jenkins who is an avid lover of tropical aroids.

5. ***Schismatoglottis matangensis*** S.Y.Wong, *sp. nov.*
Schismatoglottis matangensis cum *S. nervosa* confunditur sed inflorescentia femina quam inforescentia mascula excedens, pistillis sublaxis ordinatis, stigmate parva (quam ovaria *ca* ⅕ diametro) cum alcoholis flavescente, spadice cum interstitio sterile abrupte constricta et habitu lapis arenaricola restrictus differt. –**Typus**: Malaysia, Sarawak, Kuching Division, Matang, Kubah National Park, Waterfall Trail, 01°35' 40.2"; 110° 10'45.9", 190 m asl, 7 Jun 2006, *P.C.Boyce & S.Y.Wong AR-1830* (holo, SAR). **Plate 4.**

Leaf petioles terete, channelled canaliculate adaxially in cross section, 13-20 cm long, strongly longitudinally ridged (like celery) especially abaxially, very minutely (strong lens required) and densely verruculate, sheathing in the lower ⅓ - ½ with the sheaths tapering, closed, and fully attached, marcescent, sometimes with a short rounded ligular portion; lamina

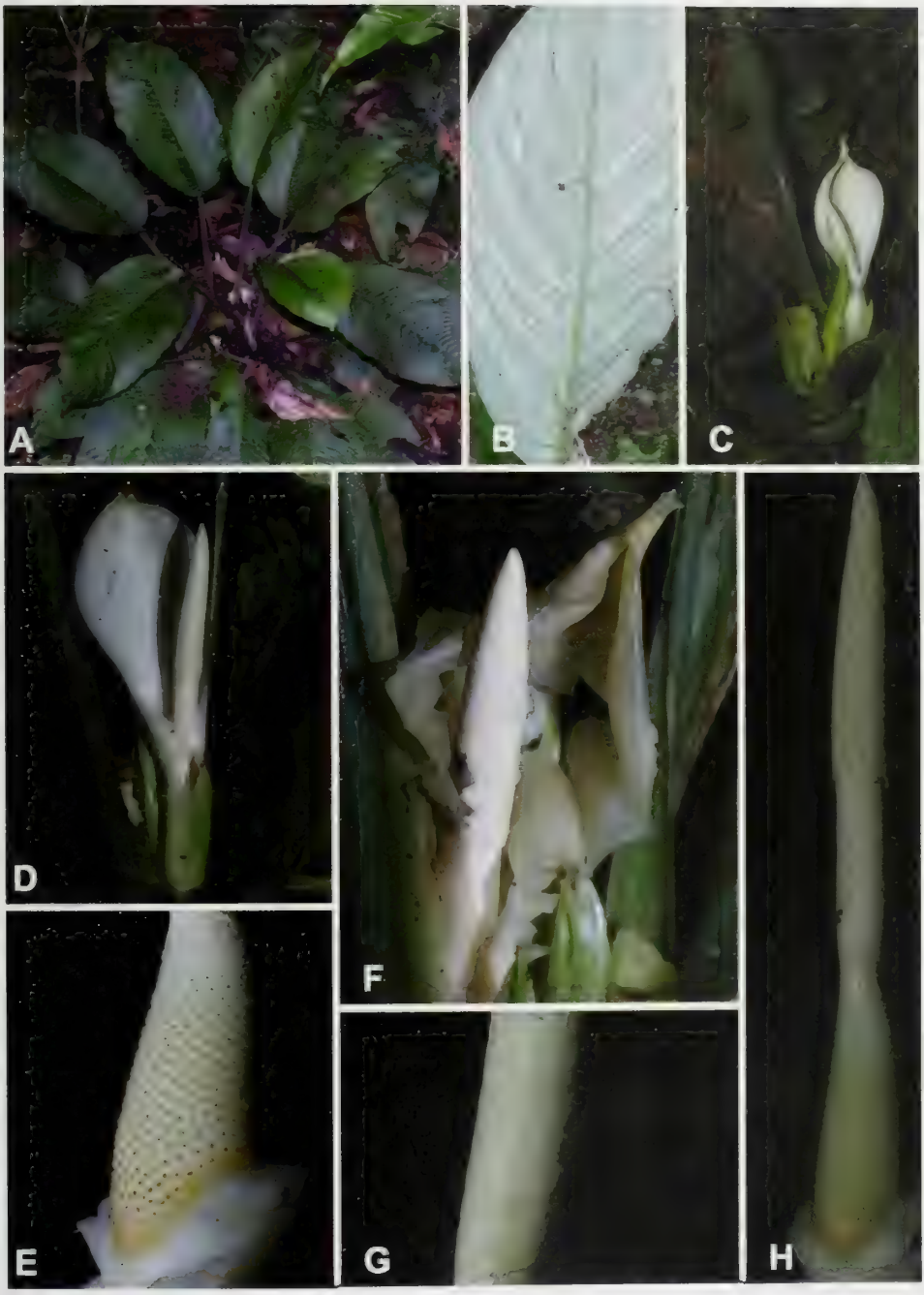

Plate 4. *Schismatoglottis matangensis* S.Y.Wong. A. Whole plant; B. Leaf lamina abaxially; C. Inflorescence at male anthesis with an infructescence on the left side; D. Inflorescense at male anthesis; E. Female zone, note the stigma in orange; F. Spathe limb deliquescent post male anthesis; G. Male zone; H. Spadix with the spathe artificially removed. Images © P.C. Boyce

broadly ovate to oblongo-ovate, not elliptic, coriaceous, 13-22 cm long x 7-11 cm wide, the base broadly rounded to slightly retuse, the apex acute and shortly acuminate to *ca* 1 cm, undulate along margin, adaxial surface matte deep green, always slightly bullate, abaxial surface glaucous, paler green, drying strongly discolorous; midrib adaxially flush with lamina but centrally channelled toward leaf base, abaxially very prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially, numerous, 15-22 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins, both diverging at 45°-90° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins; tertiary venation forming faint tessellate adaxially and abaxially. **Inflorescences** up to 3 together, erect, white, fragrant (esterases) smell at female anthesis, peduncle to *ca* 1.5 cm long, concealed by cataphylls deliquesing and adhering to spathe limb exterior, slightly exserted in fruit; **spathe**, interior glossy, exterior, semi-glossy, softly coriaceous, *ca* 9.5 cm long, lower spathe very pale green, *ca* 4 cm long × 1.3 cm width, differentiated from the limb by a faint constriction at interstice, narrowly ovoid; limb obovate, white, *ca* 5.5 cm long × 2.2 cm width, upper margin reflex, abruptly acuminate, *ca* 7 mm long and ultimately mucronate apex, *ca* 2 mm long, caducous by crumbling at or just after male anthesis; spadix adnate, isodiametrically attached to ¼ of female zone, subcylindric, 5.2 cm long, ½ of spadix length; **female zone**, conic-cylindric, ivory in fresh and alcohol, 1.6 cm long × 7 mm diam., ⅓ of spadix length; pistils many but laxly arranged, irregularly round to slight rhomboid from above, *ca* 0.46 mm diam. x 0.72 mm long, stigma, sessile, minute, *ca* 0.15 mm diam., ⅕ of ovary, punctiform, papillate, orange staining in alcohol, ovaries of on lower part zone tending to be bisulcate, ovaries of on upper part zone tending to be trisulcate or tetrasulcate; interpistillar staminodes confined to less than a single ring at the base of the female zone, similar or twice the size of female flower, flat-topped; sterile insterstice presents, ⅛ of spadix length, supra pistilate pistilode zone (*ca* 2.5 mm long), pistilode larger than pistil, irregularly round, 0.6 mm diam. transitioning into naked zone (1.5 mm long × 2.3 mm diam.) in *AR-1830* or contiguous with infra staminate staminodes zone (*ca* 2.5 mm long), irregularly polygonal, flat-topped, white when fresh but stained orange in alcohol (*AR-1830* & *AR-1865*), strongly narrow at the staminode zone corresponding with the spathe constriction; **male zone** cylindric, 10 mm long × 4 mm diam., ¼ of spadix length; stamens, butterfly-shaped from above, white when fresh, turning dirty yellow in alcohol (*AR-1830* & *AR-1865*), remaining white in alcohol (*AR-1864*), close-packed, 0.3 mm diam., anthers truncate (flat-topped), connective narrow and thecae large, pores small and

deep, C-shaped with the convex side innermost; appendix sub-cylindric, *ca* 1.9 cm long, ⅓ of spadix length, white when fresh and in alcohol, strongly tapering to a sharp end, middle slightly thicker than the base; staminodes of appendix densely packed, flat-topped, irregularly polygonal, *ca* 0.3-1 mm diam.

Other specimens seen: MALAYSIA. **Sarawak**. Kuching Division: Matang, trail to Indian Temple, 2 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-145.3* (SAR); Matang, Kubah National Park, Waterfall Trail, 01°35' 40.2"; 110° 10'45.9", 190 m asl, 7 Jun 2006, *P.C.Boyce & S.Y.Wong AR-1831* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1832* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1833* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1834* (SAR); *ibid.*, 11 Jul 2006, *P.C.Boyce & S.Y.Wong AR-1864* (SAR + spirit); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1865* (SAR + spirit); *ibid.*, *P.C.Boyce & S.Y.Wong, AR-1866* (SAR).

Distribution: Sarawak, Kuching Division, endemic to Matang (West Sarawak).

Habitat: Evergreen moist forest on Matang series sandstones where terrestrial in deep litter over exposed black soil, sometimes between sandstone rocks, 190-450 m asl.

Notes: *Schismatoglottis matangensis* is morphologically different from *S. nervosa* by characters of the inflorescence: female zone exceeding male zone, pistils laxly arranged [in marked contrast to most other species of the *S. nervosa* complex (except for *S. tessellata*) in which pistils are crowded] and minute (⅕ of ovary diam.) two-three lobed stigma staining yellow in alcohol. Other distinguishing characters for *S. matangensis* include a sharp constriction at the interstice, interstice staminodes staining orange in alcohol (*AR-1830* & *AR-1865*) and stamens staining orange in alcohol (*AR-1865*) although the remainder of the observed inflorescences have stamens remaining white in alcohol and these colour differences may be an artefact of inflorescence anthesis phase at preservation although stamens of *S. nervosa* always remain white in alcohol irrespective of the phase of the spadix. In robust inflorescences, the appendix displays a marked increase in diameter at the junction of the male zone, contiguous with the male but not isodiametrical.

The petiolar sheath is marcescent in *S. matangensis*. Primary venation of *S. matangensis* is more prominent than in *S. nervosa*, however, on average secondary and tertiary venation are less pronounced. *Schismatoglottis matangensis* is restricted to sandstones whereas *S. nervosa* are restricted to karst limestones.

Etymology: The specific epithet from the Matang Massif, the type locality and so far the only known site for this species.

6. ***Schismatoglottis nervosa*** Ridl.
Schismatoglottis nervosa Ridl., Journ. As. Soc. Straits 49 (1907) 50; Hay & Yuzammi, Telopea 9(1) (2000) 73. –**Typus**: Cult. in Singapore Botanic Gardens, ex Malaysia, Sarawak, Bau, Jan 1907, *H. N. Ridley* s.n. (holo, SING, 2 sheets). **Plate 5.**

Other specimens seen: MALAYSIA. **Sarawak**. Kuching Division: Bau, Bk. Krian, 28 May 1972, *J.A.R.Anderson S. 31966* (SAR); Bau, Krokong, Gua Peri-peri (Fairy Cave), 01° 22' 51.9"; 110° 07' 09.3", 30 m asl, 29 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-145.1* (SAR); Bau, Krokong, Kampung Tringgus, Sg. Bong, 01° 15' 32.2"; 110° 05' 37.2", 81 m asl, 21 Jul 2004, *P.C.Boyce & Jeland ak Kisai AR-525* (SAR); Bau, Gn. Bidi, 01° 23' 27.0"; 110° 07' 07.6", 50 m asl, 6 Jan 2005, *P.C.Boyce & Jeland ak Kisai AR-944* (SAR + spirit); Bau, Kampung Bogag, Gn. Tibugai, 01° 21' 31.1"; 110° 03' 48.7", 80 m asl, 6 Jan 2005, *P.C.Boyce & Jeland ak Kisai AR-950* (SAR); Bau, Krokong, Gua Peri-Peri (Fairy Cave), 01° 22' 51.9"; 110° 07' 09.3", 30 m asl, 25 May 2006, *P.C.Boyce & S.Y.Wong AR-1823* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1824* (SAR); Ibid., *P.C.Boyce & S.Y.Wong AR-1825* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1826* (SAR + spirit); Ibid., *P.C.Boyce & S.Y.Wong AR-1827* (SAR + spirit); Bau, Kampung Jugan, 01° 28' 46.4"; 110° 05' 08.5", 72 m asl, 25 Jun 2004, *P.C.Boyce et al. AR-491* (SAR); Bau, Gn. Singai, 17 Nov 2004, *P.C.Boyce et al. AR-752* (SAR); Bau, Krokong, Kampung Tringgus, 01° 15' 40.2"; 110° 05' 35.9", 80 m asl, 19 Feb 2005, *P.C.Boyce et al. AR-992* (SAR); Bau, Gn. Juita, 01° 23' 48.7"; 110° 08' 07.2", 35 m asl, 28 Oct 2005, *P.C.Boyce et al. AR-1499* (SAR); Bau, Segong, Gn. Opar, 01° 27' 07.3"; 110° 04' 00.5", 79 m asl, 9 Nov 2005, *P.C.Boyce et al. AR-1502* (SAR); Bau, Krokong, Kampung Tringgus, 01° 15' 40.2"; 110° 05' 35.9", 81 m asl, 27 Jun 2006, *P.C.Boyce et al. AR-1845* (SAR + spirit); Bau, Gn. Lanyang, 10 Apr 2002, *Connie, G et al. SBC 2807* (SAR); Bau, Kampung Jugan, 19 Jun 2004, *Jeland ak Kisai & Jipom ak Tisai AR-474* (SAR); Bau, Gn. Poing, 23 Sep 2001, *Julia, S. et al. SBC 345* (SAR); locality not recorded, 26 Feb 2002, *Julia, S. et al. SBC 2155* (SAR); Bau, Bk. Jebong, 6 Jul 1970, *P.F.Lehmann S. 30136* (SAR); Bau, Jambusan, Gn. Batu, 19 Feb 2002, *K. Meekiong et al. SBC 1662* (SAR); Bau, Jambusan, Gn. Batu, 19 Feb 2002, *K. Meekiong et al. SBC 1929* (SAR); Bau, Jambusan, Gn. Jebong, 5 Mar 2002, *K. Meekiong et al. SBC 1953* (SAR); Bau, Bengoh range, Pangkalan Tebang, logging road, 6 Jul 1996, *M. Mohizah S 73890* (SAR); 2 miles east of Bau, 6 Aug 1961, *D. H. Nicolson* (SAR, US); Bau, Krokong, Gua Peri-Peri (Fairy Cave), 22 Mar 1999, *Patsipun et al. S. 79985* (SAR); Bau, Gn. Tabai, 13 Mar 2002, *Shaevy W. et al. SBC 2298* (SAR).

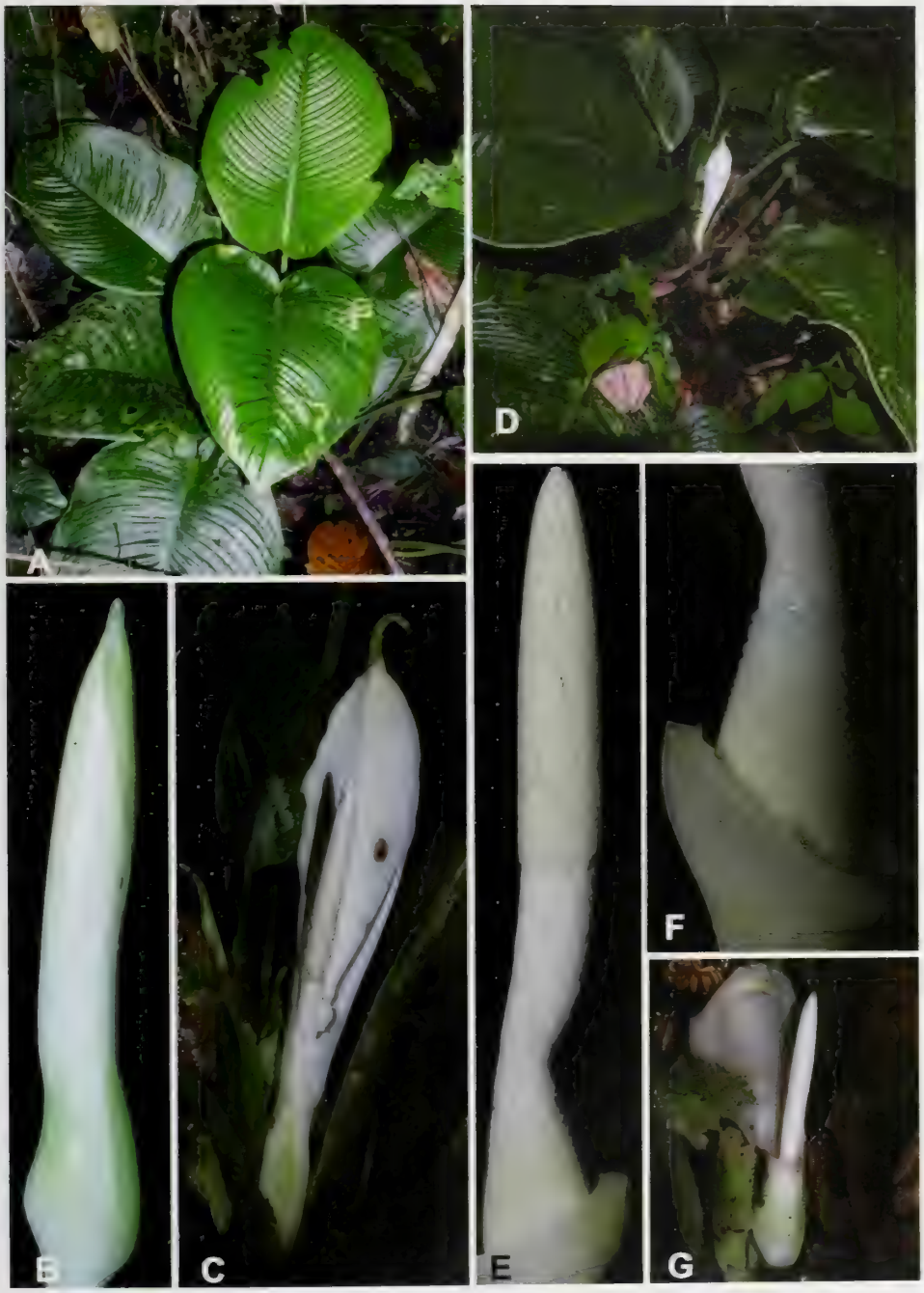

Plate 5. *Schismatoglottis nervosa* Ridl. A. Whole plant; B. Inflorescence prior to anthesis; C. Inflorescence at male anthesis; D. Whole plant with an inflorescence at male anthesis; E. Spadix with the spathe artificially removed; F. Female zone; G. Spathe limb deliquescent post anthesis. Images © P.C. Boyce

Distribution: Sarawak, Kuching Division, endemic to the Bau area (West Sarawak).

Habitat: Evergreen moist forest on karst limestone in the Bau area. Terrestrial in deep litter or lithophytic in soil collected in crevices and sinkholes in limestone; rarely along stream banks, 30-160 m asl.

Notes: Hay and Yuzammi (2000) were unclear whether the interstice was present or the fertile zones were contiguous. Based on the author's observation, the interstice is always present with pistillodes at the lower part and staminodes at the upper part and without the presence of naked zone. In the type specimen, the presence of the interstice is not clear due to damage to the spadix at the crucial area of the interstice. In all collections the female zone is shorter than the male zone, whereas *S. matangensis* has a longer female zone than male zone. Stigmas of *S. nervosa* are larger than those of *S. matangensis* and always remain white in alcohol.

In the type specimen, there are two types of staminodes on the appendix of the inflorescence. The lower staminodes are very irregularly rhomboid, smaller (*ca* 0.5 mm diam.) while the upper staminodes are regularly rhomboid and larger (0.5-1 mm diam.). A naked zone, which has dried black, is present at the tip of appendix.

7. ***Schismatoglottis simonii*** S.Y.Wong, *sp. nov.*
A Schismatoglottis nervosa *habitu robustis coloniis, veneris laminorum seconadariis et tertiariis plus prominentis, stigmate plus late, connectivo antherae crasso, poris oblongo, non profundus quam marginem late alatis differt.* –**Typus**: Malaysia, Sarawak, Samarahan, Serian, Kidadum, Sugun Karang, 01°06' 17.6"; 110° 29'04.5", 100 m asl, 29 Jun 2006, *P.C.Boyce et al. AR-1859* (holo, SAR). **Plate 6.**

Leaf petioles terete, channelled slightly canaliculate adaxially in cross section, 13-40 cm long, strongly longitudinally ridged (like celery) especially abaxially at the base, very minutely (strong lens required) and densely verruculate, sheathing in the lower ⅓ - ½ with the wings tapering, and fully attached, marcescent, sometimes with a short rounded ligular portion; lamina broadly ovate to oblongo-ovate, sometimes elliptic, 12-30 cm long x 6-20 cm wide, coriaceous, adaxial surface semi-glossy deep green, always slightly bullate, abaxial surface paler green, glaucous, drying strongly discolourous, the base broadly rounded to sub-truncate, slightly retuse to cuneate, the apex acute and shortly acuminate to *ca* 1 cm, undulate along margin; midrib

Plate 6. *Schismatoglottis simonii* S.Y.Wong. A. Whole plant; B. Inflorescence during male anthesis; C. Leaf lamina adaxially; D. Leaf lamina abaxially; E. Emerging inflorescence with three infructescense flanking on each side; F. Spadix with spathe artificially removed; G. Female zone; H. Spathe limb starting to deliquescent post male anthesis; I. Infructescence ripen to reveal the seeds.

adaxially flush with the lamina but centrally channelled toward the leaf base, abaxially very prominent raised canaliculate; primary venation impressed adaxially, strongly raised abaxially, numerous, 16-25 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins, diverging at 60°-90° and gradually curving towards the tip before reaching the intermarginal colllecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins; tertiary venation forming tessellate reticulum adaxially and abaxially, more notable abaxially. **Inflorescences** up to three together, erect, white, fragrant (esterases) smell at female anthesis; subtended by lanceolate cataphylls to *ca* 6 cm long; peduncle to *ca* 2.5 cm long, concealed by leaf bases and cataphylls at flowering, slightly exserted in fruit; **spathe**, interior glossy, exterior semi-glossy, softly coriaceous, *ca* 9 cm long; lower spathe, ovoid, pale green when fresh and white in alcohol, *ca* 2.5 cm long × 1.5 cm diam., differentiated from the limb by a faint constriction coinciding with interstice; limb oblongo-lanceolate, white when fresh and in alcohol, *ca* 5.5 cm long, apex, green when fresh, mucronate for *ca* 5.8 mm, caducous by disintegrating or crumbling at or just after male anthesis; spadix sessile, adnate isodiametrically to the spathe in the lower ⅙ of female zone, subcylindric, *ca* 7 cm long subequalling the spathe; **female zone** ovoid, ivory when fresh and in alcohol, 1.8 cm long × 0.8 cm diam., ⅓ of spadix length; pistils numerous and close-packed, rhomboid to round from above, *ca* 1.19 mm long × 0.56 mm diam.; stigma sessile, punctiform, large, 0.20 mm diam., ⅓ of ovary, raised; interpistillar staminodes confined to more or less a single ring at the base of the female zone, irregularly polygonal from above, about the same size as the ovaries shorter than pistils; sterile insterstice present, supra pistillate pistillodes zone, white, *ca* 1.8 mm long, 1/14 of spadix length, strongly narrow in the upper half of pistillodes zone corresponding with the spathe constriction, pistillodes irregularly polygonal, large, *ca* 1 mm diam., twice the size of ovary, centrally impressed; sometimes naked zone present; followed by a whorl of incompletely abortive stamens, *ca* 2.6 mm long, staminodes, irregularly squat-columnar, flat-topped, 0.62 mm diam.; **male zone** contiguous with interstice staminodes, cylindric, 1.3 cm long × 4.2 mm diam., slightly less than ⅓ of spadix length; stamens close-packed, irregular dumbbell-shaped from above and neighbouring anthers with their lobes interdigitating, white when fresh and remaining white in alcohol, *ca* 0.6 mm diam., anthers truncate, connective broad and elevated, thecae large; pores oblong and shallow, rims widely alate; appendix cylindric, 2.6 cm long × 4.8 mm diam., slightly less than ⅓ of spadix length, white when fresh and in alcohol, abruptly widen at base, distally tapering to sharp point; staminodes of appendix densely packed, flat-topped to slightly centrally impressed, irregularly polygonal, *ca* 0.5-1 mm diam.

Other specimens seen: MALAYSIA. **Sarawak**, Kuching Division: Padawan, Kampung Bengoh, Danu road, Gn. Temuang, Sg. Abang, 01° 15' 38.6"; 110° 15' 31.4", 50 m asl, 16 Feb 2006, *P.C.Boyce et al. AR-1707* (SAR); Padawan, 10 mi s.w. of main Kuching-Serian Highway, 01° 10'; 110° 20', 30 Sep 1981, *T. B.Croat 53179* (SAR); Siburan, Kampung Giam, Air Terjun Giam, 01° 19' 11.2"; 110° 16' 11.4", 37 m asl, 7 Feb 2006, *P.C.Boyce et al. AR-1693* (SAR); Samarahan Division: Serian, Mongkos, Kampung Batuh Mawang, Labak Ebang, Utak Samat, 5 Jan 2006, Simon Kutuh ak Paru AR-1666 (SAR); Serian, Gn. Ampungan, 01° 09' 08.2"; 110° 37' 21.2", 450 m asl, 21 Nov 2003, *P.C.Boyce & Jeland ak Kisai AR-92.4* (SAR); Serian, Pichin, Umon Murut, Tiab Belanting, 01° 08' 03.7"; 110° 27' 00.3", 90 m asl, 15 Jun 2005, *P.C.Boyce et al. AR-1215* (SAR); *ibid.*, 15 Jun 2005, *P.C.Boyce et al. AR-1220* (SAR + spirit); Serian, Mongkos, Kampung Batuh, Gn. Selabur, 00°57' 26.2"; 110° 30' 15.8", 100 m asl, 15 Mar 2006, *P.C.Boyce et al. AR-1724* (SAR); Serian, Kidadum, Sugun Karang, 01°06' 17.6"; 110° 29'04.5", 100 m asl, 7 Apr 2006, *P.C.Boyce et al. AR-1764* (SAR); Serian, Gn. Ampungan, 01° 09' 10.1"; 110° 37' 26.2", 568 m asl, 28 Aug 2006, *P.C.Boyce et al. AR-2003* (SAR + spirit); Serian, Pichin, Gunung Kedadum, Sugun Kerang, 13 Nov 2004, *Simon Kutuh ak Paru AR-750* (SAR); Serian, Pichin, Labu, Sg. Tiyab, 26 Jul 2005, *Simon Kutuh ak Paru AR-1299* (SAR); Serian, Kampung Selabi, Sg. Mawang, 2 Feb 2006, *Simon Kutuh ak Paru AR-1703* (SAR); Serian, Taman Rekreasi Rachan, 01° 08' 34.9"; 110° 35' 02.4", 57 m asl, 18 Oct 2006, *P.C.Boyce & S.Y.Wong AR-2038* (SAR).

Distribution: Sarawak, Kuching & Samarahan Divisions, endemic to the Padawan/Serian areas (West Sarawak).

Habitat: Always terrestrial in deep soil on limestones and sandstones, sometimes lithophytic on permanent wet areas of limestone but not in direct water flow, sometimes not in full shade. Large colony forming, 50-600 m asl.

Notes: *Schismatoglottis simonii* is clearly closely allied to *S. nervosa* but leaf laminae are wider in *S. simonii* than *S. nervosa* [length: width ratio (to 3:2 in *S. simonii*, to 2:1 in *S. nervosa*)]. Secondary and tertiary venations in *S. simonii* are more pronounced than *S. nervosa*. The zonation in the spadix of *S. simonii* is equally distributed among the female, male and appendix (⅓ each) as compared to *S. nervosa* (female zone, ¼; male zone ⅕; appendix ⅓). The stigma narrower in *S. simonii* as compared to *S. nervosa* while the stamens have a broad connective, with shallow oblong pores. *S. simonii* tends to form large colony and much more robust than *S. nervosa*.

Etymology: This species is named for Mr Simon Kutuh ak Paru, occasional member of our field team, who has so ably organise field trips to Padawan limestones.

8. ***Schismatoglottis tessellata*** S.Y.Wong, *sp. nov.*
Folii lamina tenuiter coriaceis, nervis tertiariis tessellatis abaxialiter et adaxialiter valde prominentibus quamquam veniis adaxialiter valde prominentibus, stigmate amplis globuliformis (quam ovaria ca ½ diametro); appendice crasso brevioribus, usque ad tertiam partem longitudinis spadice toto in complexus nervosae unica est. In habitu saxa shaleiaca restrictus. – **Typus**: Malaysia, Sarawak, Kapit, Taman Rekreasi Sebabai, 01° 56' 45.6"; 112° 54' 16.8", 50 m asl, 16 Mar 2005, *P.C.Boyce et al. AR-1087* (holo, SAR). **Plate 7.**

Leaf petioles, slightly D-shaped but slightly carinate channelled to the base of lamina adaxially in cross section, glabrous, longitudinal ridges only visible with magnification, long, 20-30 cm long; sheathing in the lower ⅓ to ½ with the sheaths tapering, fully attached, open, persistent to marcescent; lamina broadly ovate to oblong ovate, thinly coriaceous, 13-21 cm long × 5-10 cm wide, sometimes variegated with grey stripes on each side adaxially, the base cuneate to slightly retuse, the apex acute and strongly acuminate for *ca* 0.7-2 cm, adaxial surface semi-glossy deep green, abaxial surface paler green, always slightly bullate, glaucous, drying strongly discolourous; midrib adaxially flush with the lamina but centrally channelled at the leaf base, abaxially very prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially, numerous, 11-20 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins, diverging at 45°-60° and gradually curving towards the tip before reaching the intermarginal collecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins; tertiary venation forming distinctive tessellate adaxially and abaxially, more notable adaxially. **Inflorescences** up to three together, erect, white, fragrant (esterases) smell at female anthesis; concealed by oblongo-lanceolate cataphyll, *ca* 7 cm long, peduncle to *ca* 2 cm, slightly exserted in fruit; **spathe**, interior glossy, exterior semi-glossy, softly coriaceous, *ca* 9 cm long; lower spathe broadly ovoid, *ca* 1.7 cm diam. × 3.8 cm long, differentiated from the limb by a faint constriction coinciding with interstice; limb broadly lanceolate, rather coriaceous, caducous by crumbling at or just after male anthesis; spadix, sessile, isodiametrically attached to the spathe in the lower ⅓ of **female zone**, conic-cylindric, *ca* 5.9 cm long; female zone, conic-cylindric, white when fresh but very slightly yellow in alcohol, 1.4

Plate 7. *Schismatoglottis tessellata* S.Y.Wong. A. Whole plant on shales; B. Leaf lamina adaxially revealing the tessellate venation; C. Leaf lamina variation; D. Inflorescence at male anthesis; E. Spathe at male anthesis; F. Spadix with spathe artificially removed; G. Female zone, interstice and part of male zone. Images © P.C. Boyce

cm long × 7 mm diam., ¼ of spadix length; pistils numerous, laxly-arranged, elongate-ovoid to subcylindric, *ca* 1.70 mm long × 0.53 mm diam.; stigma sessile, large bun-shaped, *ca* 0.26 mm diam., ½ of ovary, raised, papillate; interpistillar staminodes confined to more or less a single ring at the base of the female zone, irregularly polygonal from above, twice the size of ovaries, flat-topped, shorter than pistils; sterile interstice presence, 1.2 cm long, ⅛ of spadix length, pistils transitioning gradually into laxly spirally arranged pistilode that are *ca* half to two times larger than pistil, irregularly round, white when fresh and in alcohol, *ca* 7 mm long, sharp constriction in between pistillode and staminode zones; staminodes, larger than stamens, irregular polygonal, flat-topped, white when fresh and turning yellow in alcohol, *ca* 5 mm long; **male zone**, cylindric, *ca* 2.2 cm long x 4.8 mm diam., ⅓ of spadix length; stamens close-packed, irregularly butterfly-shaped from above and neighbouring anthers with their lobes interdigitating, 0.5 mm diam., anthers truncate, connective broad and thecae large, pores large accounting of the entire top of the thecae and shallow, C-shaped, the rims narrowly alate; appendix conic-cylindric, 1.2 cm long x 5.3 mm diam., ⅛ of spadix length, yellow when fresh, turning white in alcohol, distally tapering to a very blunt point, basally slightly thicker than the male zone, middle thicker than basal; staminodes of appendix loosely arranged, large staminode, flat-topped, 0.7-1.2 mm across, squat-columnar.

Other specimens seen: MALAYSIA. **Sarawak**, Kapit Division: Nanga Gaat, Rejang Wood Concession, Sg. Piat, 01° 38' 09.1"; 113° 24' 09.9", 200 m asl, 14 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-103.1*; *P.C.Boyce & Jeland ak Kisai AR 103.2* (SAR); *ibid.*, 14 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-105* (SAR); Nanga Gaat, km 3.5 after heli-logging camp on road to Camp Gahada, Sg. Bereng, 01° 45' 36.0"; 113° 27' 54.7", 228 m asl, 15 Dec 2004, *P.C.Boyce et al. AR-888* (SAR); *ibid.*, 19 Apr 2006, *P.C.Boyce et al. AR-1792* (SAR); *ibid.*, 19 Apr 2006, *P.C.Boyce et al. AR-1794* (SAR).

Distribution: Central Sarawak (Kapit Division).

Habitat: Evergreen moist forest on shale where either on steep earth banks or lithophytic on muddy shale, 50-228 m asl.

Notes: This species is distinguishable by its thinly coriaceous leaves texture and tertiary venation strongly raised-tessellate in both surfaces of leaf, but more prominently adaxially. The pistils are laxly arranged with large (compared to ovary diameter) bun-shaped stigmas, while the appendix is shorter and broader (⅛ of spadix length) than other species of the *S. nervosa* species complex. *Schismatoglottis tessellata* bears some resemblance to *S.*

elegans but is readily separable by its thinly coriaceous leaf lamina, adaxially strongly prominent tessellate tertiary venation (hence the epithet) and shorter leaf apex. The stigma is large bun-shaped in *S. tessellata* as compared to small stigma in *S. elegans*. *Schismatoglottis tessellata* is restricted to shales, as observed so far. Occasionally, leaf laminae of *S. tessellata* are variegated with grey stripes on each side adaxially.

Etymology: The epithet reflects the prominently raised-tessellate venation that immediately distinguishes this species.

9. ***Schismatoglottis turbata*** S.Y.Wong, *sp. nov.*
Schismatoglottis turbata *ad alii specibis Schismatoglottodorum grex floribus masculinus parvus, rotundis, densiter irregularis dispositae, poris profunde differt. Appendice quam inflorescentiae masculae apicem sigillatim crassiore distinguitur.* –**Typus**: Malaysia, Sarawak, Kuching Division, Sempadi, Sg. Limau, Bukit Kankar, 01°39' 44.2"; 109°59'56.5", 41 m asl, 25 Aug 2007, *P.C.Boyce et al. AR-2143* (holo, SAR). **Plate 8.**

Leaf petioles terete, obscurely longitudinally ridged (clearer under magnification), glabrous, up to *ca* 30 cm long, slightly channelled and carinate adaxially in cross section; sheathing in the lower ⅓ to ½, sheath fully attached, closed, tapering, leathery, persistent; lamina broadly ovate to oblongo-ovate, more-or-less elliptic, thinly coriaceous, slightly bullate, 7-9 cm wide × 13-23 cm long, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate to *ca* 2 cm, adaxial surface semi-matte mid-green, abaxial surface paler green, glaucous, drying strongly discolorous, midrib adaxially flush with lamina, abaxially prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially with up to 20 primary lateral veins on each side, alternating with lesser interprimaries, frequently with a few branches from near the base, both diverging at 45°- 60° and gradually curving towards the apex before reaching the inter-marginal collecting vein; secondary venation, arising from the midrib and the primary veins; tertiary venation obscure tessellate adaxially and abaxially in both living plants and dry specimens. **Inflorescences** up to four in quick succession alternating with foliage leaves *ca* 5 cm long, (i.e. not forming a true synflorescence), fragrant (esterases) at female anthesis; peduncle to *ca* 1 cm, not exserted from leaf bases, slightly exserted in fruit; **spathe** interior glossy, exterior semi-glossy, coriaceous, *ca* 7.5 cm long, lower spathe narrowly ovoid, green when fresh, *ca* 2.5 cm long × 1 cm diam., differentiated from the limb by a weak constriction; limb sub-truncate, white, *ca* 5 cm long, coriaceous, opening wide except for convolute base, at first over-arching, then reflexed, finally more or less twisted and

Plate 8. *Schismatoglottis turbata* S.Y.Wong. A. Whole plant; B. Two emerging inflorescences with two infructescences; C. Inflorescence at male anthesis; D. Spadix with spathe artificially removed; E. Female flowers, interstice and part of male zone; F. Male zone and appendix; G. Spathe limb deliquescent post anthesis. Images © P.C. Boyce

then caducous-crumbling, apex mucronate *ca* 4 mm long, green when fresh; spadix sessile, adnate isodiametrically to the spathe in the lower ½ of female zone, whitish, to *ca* 5.5 cm long, less than the length of spathe; **female zone** *ca* 1.7 cm long, ⅓ of spadix length; pistils many, crowded, round to slightly rhomboid, with weakly bisulcate longitudinal ridges, *ca* 0.5 mm diam. × 0.45 mm long; stigma large, bun-shaped, to *ca* 0.3 mm diam., ½ of ovary, punctiform, papillate, yellow in alcohol; interpistillar staminodes very occasional among the pistils, crowded into a row along the spathe/spadix adnation, stalked, clavate and flat-topped, *ca* 0.5 mm diam., similar size to pistils; sterile interstice strongly narrowed, *ca* 1.4 mm diameter in the middle, (2.5-) *ca* 7 mm long which is ⅛ of spadix length, basally more or less covered with inflated abortive pistils (reduced stigmas), twice the diameter of ovary, transversely sulcate, apically covered with two rows of sterile stamens, irregular shape, slightly wider than stamens; **male zone** cylindric, *ca* 3.6 mm diam. × 1.2 cm long, ⅓ of spadix length, marked increased in diameter from interstice; stamens crowded, truncate, *ca* 0.4 mm across, dumbbell-shaped with the connective not elevated above the thecae, connective narrow, pore oblong and deep; appendix subcylindric, *ca* 1.8 cm long, ⅓ of spadix length, yellow when fresh, turning white in alcohol, frequently chewed by beetles, tapering to a sharp point, basally more or less not isodiametric with top of male zone; staminodes of appendix more or less columnar, irregularly polygonal, flat-topped, *ca* 0.5-1 mm diameter.

Other specimens seen: MALAYSIA. **Sarawak**, Kuching Division, Sempadi, Sg. Limau, 250 m asl, 26 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-271* (SAR).

Distribution: Southern Sarawak, Kuching Division.

Habitat: Lithophytic on sandstone (Kuching Division), 41-250 m asl.

Notes: *Schismatoglottis turbata* is clearly distinguished from the rest of the *S. nervosa* complex by having small and round male flowers with deep pores. The male zone is dense but irregularly arranged. The appendix is markedly increased in diameter than the male zone.

Etymology: The specific epithet is derived from the Latin '*turbatus*', exasperating, in allusion to the feeling on discovering yet another novel species in the *S. nervosa* complex.

10. ***Schismatoglottis ulusarikeiensis*** S.Y.Wong, *sp. nov.*
Ab alii speciebus grex nervosae Borneensibus spathae laminorum pro parte

majore viridis (non in toto albis) et per anthesin haud aperiens distinguitur. –**Typus**: Malaysia, Sarawak, Sarikei Division, Ulu Sarikei, 01° 55' 05.4"; 111° 29' 35.8", 59 m asl, 7 Dec 2005, *P.C.Boyce et al. AR-1588* (holo, SAR). **Plate 9.**

Leaves few together (to *ca* 5), innovations yellowish green, the lamina sometimes rotting and leaving behind portion of petiole, with this rotting away at a later stage; petioles terete, channelled slightly canaliculate adaxially in cross section, sometimes D-shaped in cross section, strongly longitudinally ridged, very minutely (strong lens required) and densely verruculate, 13-20 cm long, sheathing in the lower 1/3 to ½ with the sheaths tapering, fully attached, wide open persistent; lamina always oblongo-ovate, sometimes ovate, softly coriaceous, 13-21 cm long × 5-9 cm wide (ratio up to *ca* 3:1), the base broadly rounded to sub-truncate, slightly retuse to cuneate, the apex acute to *ca* 1 cm, adaxial surface semi-glossy mid green, abaxial surface paler green, always slightly bullate, glaucous, drying strongly discolourous; midrib adaxially flush with the lamina but centrally channelled at the leaf base, abaxially very prominent, raised canaliculate in cross section; primary venation prominent but flushed on adaxial surface, sometimes slightly impressed, strongly raised abaxially, numerous, 10-15 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins but only occur at the leaf bases, diverging at 60°- 80° and gradually curving towards the tip before reaching the intermarginal collecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins, obscure adaxially and abaxially; tessellate tertiary venation, obscure adaxially and prominent abaxially. **Inflorescences** up to three together, erect, white, 6.5 to 7 cm long, peduncle 1.5 to 2.5 cm, slightly exserted during fruiting; **spathe**, interior glossy, exterior semi-glossy, thickly coriaceous, *ca* 9 cm long; lower spathe broadly ovoid, *ca* 1.5cm diam. × 3.5 cm long, white when fresh, differentiated from the limb by a faint constriction coinciding with the upper part of interstice; limb lanceolate, thickly coriaceous, caducous by melting at or just after male anthesis, upper part of the limb green prior to anthesis; spadix, sessile, isodiametrically attached to the spathe in the lower 1/4 of female zone, cylindric, 5.5-6 cm long; **female zone**, cylindric, green when fresh but yellow in alcohol, 1.5-2.2 cm long × 7-10 mm diam., ¼ of spadix length; pistils numerous, tightly arranged, elongate-ovoid to subcylindric, *ca* 0.50 mm diam.; stigma sessile, large bun-shaped, *ca* 0.40 mm diam., overtopping ovary, raised, papillate; interpistillar staminodes confined to more or less a single ring at the base of the female zone, but sometimes in robust inflorescence, a few scattering towards the distal part of the female tzone, irregularly polygonal from above, twice the size of ovaries, flat-topped, shorter than pistils; sterile interstice presence, 0.6-1 cm long × 0.7-1 cm wide,

Plate 9. *Schismatoglottis ulusarikeiensis* S.Y.Wong. **A**. Whole plant: **B**. Petiolar sheath persistent and open: **C**. Inflorescence at just before female anthesis: **D**. Female zone, interstice and part of male zone: **E**. Spathe prior to anthesis: **F**. Spadix with spathe artificially removed: **G**. Inflorescence post male anthesis with the appendix and spathe limb deliquescent.

pistillodes that are c. half to two times larger than pistil, irregularly round, white when fresh and in alcohol, *ca* 7 mm long, sharp constriction in between pistillode and staminode zones; staminodes, larger than stamens, irregular polygonal, flat-topped, white when fresh and turning yellow in alcohol, *ca* 5 mm long; **male zone**, cylindric, *ca* 1.8-2.2 cm long × 7 mm diam., ⅓ of spadix length; stamens close-packed, irregularly butterfly-shaped from above and neighbouring anthers with their lobes interdigitating, 0.5 mm diam., anthers truncate, connective narrow and thecae large, pores large accounting of the entire top of the thecae and shallow, C-shaped, the rims narrowly alate; appendix cylindric, 2.1-2.3 cm long × 7 mm diam., ⅓ of spadix length, white when fresh and in alcohol, blunt point at distall, basally contiguous with the male zone; staminodes of appendix tightly arranged, large staminode, flat-topped, 0.7-1.2 mm across, squat-columnar, staminodes at the distal portion, sometimes forms slit. Fruits immature during observation.

Other specimens seen: MALAYSIA. **Sarawak**, Sarikei Division: Ulu Sarikei; 01° 55' 05.4"; 111° 29' 35.8"; 59 m asl, 7 Dec 2005, *P.C.Boyce et al. AR-1577* (SAR); *ibid.*, 7 Dec 2005, *P.C.Boyce et al. AR-1579* (SAR); *ibid.*, 7 Dec 2005, *P.C.Boyce et al. AR-1588* (SAR) ; *ibid.*, 7 Dec 2005, *P.C.Boyce et al. AR-1635* (SAR).

Distribution: Central Sarawak, Sarikei Division. Known only from the type locality.

Habitat: Evergreen moist lowland forest on shales, 59 m asl.

Notes: *Schismatoglottis ulusarikeiensis* is immediately distinguishable from the rest of the *S. nervosa* complex with primary venation adaxially flush with surface and with less than 10-15 on each side. Petioles are terete, strongly longitudinally ridged and without hyaline margin in *S. ulusarikeiensis*. The lamina is longer but narrower as compared to the rest of the species in the complex. The upper part of the spathe limb remains in green form prior to anthesis and this is unobserved in any other species in the complex. The spathe limb is barely open during anthesis and this is only observed in *S. brevicuspis*. The spadix is robust and forms a uniform width throughout the different zones. The female flowers are green when fresh and this is only observed in *S. tessellata*.

Etymology: The specific epithet is derived from the name of the type and only known locality.

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Book Review: B.S. Parris, R. Kiew, R.C.K. Chung, L.G. Saw & E. Soepadmo (eds). 2010. **Flora of Peninsular Malaysia, Series I. Ferns and Lycophytes. Vol. 1.** (Malayan Forest Records. No. 48). Forest Research Institute Malaysia, Ministry of Natural Resources and Environment, Malaysia, 249 pp. Price: RM80/USD60

A new flora useful to the study of Singapore pteridophytes is now available. The volume 1 of the new Flora of Peninsular Malaysia, Series 1, dealing with fern and lycophyte groups, has just been published.

The flora, according to the new publication, was initiated to document the indigenous plant diversity by providing reliable and accurate accounts of plant families, genera and species found in Peninsular Malaysia, with updated nomenclatures. It will consist of two series, with Series II dealing with gymnosperms and angiosperms.

The Vol. 1 of Series 1 of the new flora described 100 species in 21 genera and 9 families of ferns and lycophytes, representing about a sixth of the spore producing vascular flora of the peninsula. The families treated by various authors and included in vol. 1 are Selaginellaceae (K.M. Wong), Psilotaceae (R. Kiew), Equisetaceae (R. Kiew), Osmundaceaee (R. Jaman), Matoniaceae (R. Jaman & Y. Umi Kalsom), Schizaeaceae (R. Jaman & Y. Umi Kalsom), Cibotiaceae (A.T. Nor Ezzawanis), Loxogrammaceae (R. Jaman) and Grammitidaceae (B.S. Parris). All species are shown with a distribution map and provided with an assessment of their conservation status. But only selected species of each family are nicely and accurately illustrated with line drawings. However, each family is further illustrated with beautiful coloured photos of a few more representative species.

There is one nomenclatural novelty proposed in vol. 1 of the new flora, namely, *Tomophyllum callophyllum* (C.H. Wright) Parris, and no new species record is reported. The biggest taxonomical change is seen in the Family Grammitidaceae where several new generic concepts recently proposed based on molecular evidence are accepted.

Aside from the useful information on the taxonomy and nomenclature, the book includes also a conspectus of the orders, families and genera of ferns and lycophytes of Peninsular Malaysia, keys to the families, genera and species of the plant groups treated, a historical account of botanical collecting of ferns and lycophytes in Peninsular Malaysia, and interestingly, a chapter on the assessment and conservation of these plant groups in Peninsular Malaysia. A glossary and a separate index to the scientific names and vernacular/common names of the taxa conclude the volume.

I have one question in mind after browsing through the hundred pages of the flora. Figures A & B in Plate 2 represent two different species?

As a student of Malesian pteridophyte flora, I definitely look forward to the completion of the publication of Series 1 of this new flora. The authors of vol. 1 of Series 1 of the new flora are to be congratulated for this timely and well-done accomplishment.

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Medinilla alternifolia Blume, Mus. Bot. Ludg.-Bat. 1:1 (1849) 19.
Sterculia acuminatissima Merr., Philipp. J. Sci. 21 (1922) 524.

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