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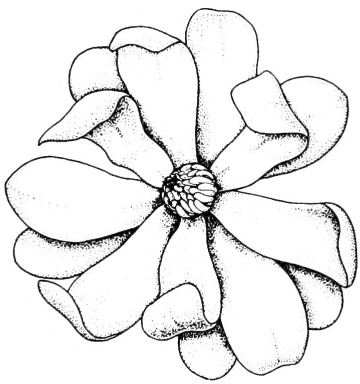

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THE GARDENS' BULLETIN
SINGAPORE

VOLUME 50

SINGAPORE BOTANIC GARDENS

Singapore Botanic Gardens
1998

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DATES OF PUBLICATION OF THE TWO PARTS WERE:

Part 1	Pp. 1–124	31 July 1998
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The Gardens' Bulletin

Singapore

VOL. 50 (Part 1) July 1998 ISSN 0374-7859

NATIONAL PARKS BOARD

Singapore Botanic Gardens Cluny Road Singapore 259569 Tel: 4741165 Telefax: 4754295

THE GARDENS' BULLETIN

The Gardens' Bulletin Singapore publishes papers on plant taxonomy (including revisions), horticulture, phytogeography, floristics, morphology, anatomy and related fields with emphasis on plants in the West Malesian region.

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The annual subscription for the Gardens' Bulletin is Singapore $100.00 including postage. Overseas subscribers are required to make payment in the form of bank drafts or international money orders in Singapore currency payable to *National Parks Board, Singapore.*

Instructions for contributing authors are found on the inside backcover.

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Date of Publication: 31 July 1998

Published by

National Parks Board
Singapore Botanic Gardens
Cluny Road
Singapore 259569

Printed by **Oxford Graphic Printers Pte Ltd**

Gardens' Bulletin Singapore **50** *(1998) 1–4.*

A New Species of *Aglaonema* Schott (Araceae) from Terengganu, Malaysia.

A. HAY

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Abstract

Aglaonema flemingianum is described as new from Terengganu State in Peninsular Malaysia. The new species is illustrated and fitted into a previously published key to the species of *Aglaonema*.

Introduction

Aglaonema Schott (Araceae) is a genus of about 22 species of rainforest herbs, several of which are much prized as ornamental foliage plants since they are often variegated in nature (Jervis, 1980). The genus occurs in Indochina and southwestern China (9 species), West Malesia (6 species) and Central Malesia (incl. Philippines; 6 species), with only one species, *A. marantifolium* Bl., extending into East Malesia. *Aglaonema* was revised by Nicolson (1969), who divided the genus into two sections based on vegetative architecture: Sect. *Chamaecaulon,* with creeping branched stems, very short leaf sheaths and cataphylls subtending each petiole, and Sect. *Aglaonema*, with erect stems, longer leaf sheaths and cataphylls rarely present among the petioles. The new species belongs to the latter group. Nicolson also discussed the great variability of several species, and their tendency to be rather poorly differentiated from one another at the extremes of their variation. This new plant, however, is vegetatively so distinct from others as to warrant recognition as a discrete species, though known only from a single collection.

***Aglaonema flemingianum* A. Hay sp. nov.** **Fig. 1.**

Ab aliis speciebus *Aglaonematis* petiolo brevissimo omnino vaginato, vagina apice ligulata ad marginem membranacea, laminae nervis primariis numerosissimis superne impressis, inferne prominentibus, pistillis paucis differt.

TYPUS: Cult. Hort. Reg. Bot. Sydney (Acc. No. 940284) originally collected from Malaysia, Terengganu, Sekayu, Ayer Terjun, *Hay et al. 9216* (NSW, holo).

Erect herb to c. 30 cm tall; stem 1–2 cm diam., internodes c. 1 cm long, dark green, smooth; leaves in a tight rosette, subtended by cataphylls only at the beginning of a sympodium module; cataphylls 2–?3 becoming progressively elongate, up to c. 7 cm long; petiole c. 4 cm long, c. 4 mm wide at the apex, sheathing throughout its length and clasping the stem more or less throughout; wing of sheath 6–8 mm wide, not or hardly tapering distally, membranous, the very margin eventually (in oldest leaves) becoming dry, brown and scarious, the apex of each wing extending free for c. 1 cm and overlapping the lower part of the leaf blade; leaf blade ovate to narrowly ovate, to c. 22 cm by c. 8 cm, widest at the middle, mid-green, not glossy; apex of blade acute to rounded and very shortly (c. 5–8 mm) acuminate and mucronate for c. 2 mm, the base tapering and narrowly rounded; midrib basally c. 5 mm broad and distally tapering, flat and slightly raised on the adaxial side, distally becoming flush and then impressed in the distal quarter, abaxially conspicuously raised and rounded in cross-section; primary lateral veins numerous, c. 12 on each side of the midrib, inserted c. 5 mm apart in the basal part of the midrib, further up c. 1 cm apart and distally c. 2 cm apart, diverging at c. 30° and gradually curving towards the leaf apex before running into the margin, adaxially impressed, abaxially prominent; secondary (interprimary) venation parallel to primary and flush ab- and adaxially; higher order venation forming an inconspicuous tessellate reticulum between the primary and interprimary veins; inflorescences to 2 together; peduncle concealed among leaf bases at anthesis, later extending somewhat to be exposed for c. 2 cm, subtended by short blunt cataphylls; spathe pale green, c. 3 cm long, broadly ovate, held boat-shaped at anthesis, c. 1.5 cm wide, open almost to the base, convolute in the lower 4 mm, inconspicuously keeled along the abaxial midline, the apex obtuse, mucronate for c. 2 mm; spadix somewhat exceeding the spathe, 3–5 cm long, stipitate for c. 5 mm at anthesis (elongating slightly afterwards), the stipe mostly adnate to the spathe, free in the upper 2 mm; female zone free, a single whorl of pistils; ovaries subcylindric, c. 2 mm tall, 1 mm diam.; stigma discoid, cap-like, sessile, c. 2 mm diam.; male zone 2.5 cm long, 8 mm wide at base, tapering in the upper half to a blunt tip, at the base with a whorl of incompletely fertile stamens; stamens not ostensibly arranged into male flowers, close-packed, irregularly 4-lobed, c. 2 mm diam.; fruit unknown.

Distribution and habitat: Endemic to Peninsular Malaysia and known only from the type collection from Terengganu, on the floor of wet lowland rain forest on slopes.

Notes: *Aglaonema flemingianum* can be incorporated into Nicolson's (1969) key to *Aglaonema* species thus:

Figure 1. *Aglaonema flemingianum. Hay et al. 9216.* a, habit; b, inflorescence; c, inflorescence with part of spathe removed; d, pistils and stamens. Scale bar to a = 4.5 cm; b = 2 cm; c = 1.3 cm; d = 5 mm.

12. Venation differentiated into primary and secondary veins.
    - 12a. Petiole about 1/5th the length of the blade, sheathing throughout; blade with 24 primary veins .... *A. flemingianum*
    - 12b. Petiole generally about or more than half the length of the blade, sheathing for about 1/2 to 4/5th its length; blade with 4-10 primary veins. .... 13 etc. as Nicolson (1969).

Some difficulty may be experienced with lead 6 in that key however, since *A. flemingianum* falls rather between the two alternatives there, though it nevertheless matches the second alternative (spadix cylindric; spathe elongate) better than it does the first (spadix clavate; spathe globose).

Insufficient material exists for the making, designation and distribution of isotypes. However, as soon as the plant from which the holotype was prepared flowers again, further material will be preserved for distribution to KEP, SING and other relevant herbaria.

The new species is named in grateful recognition of Conrad D. Fleming who has generously supported many expeditions by Araceae botanists working in tropical Asia.

Unlike many other *Aglaonema* species which are easily cultivated and fast growing, *A. flemingianum* is very slow-growing, but with very long-lived leaves. The dense rosette of almost sessile leaf blades may represent a useful feature for breeders of ornamental *Aglaonema* cultivars.

Acknowledgements

I thank Conrad D. Fleming for generous financial support of my fieldwork in Malaysia in 1994, when this species was first collected. I also thank Dr Jambari Hj. Ali, Head of the Department of Biology, Universiti Pertanian Malaysia, for allowing me to be affiliated with that department during my stay in Malaysia. Prof. Ruth Kiew, Mr Anthonysamy and Mr Roy Bangka provided generous hospitality and invaluable assistance with field work. I am indebted to Lesley Elkan for the botanical drawing, to Clare Herscovitch for technical assistance, Ian McLellan and nursery staff of the Royal Botanic Gardens Sydney for cultivating the living plants, and to Dr D.H. Nicolson for expert comment on the manuscript.

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Gardens' Bulletin Singapore ***50*** *(1998) 5–30.*

The Structure, Species Composition and Diversity of the Limestone Vegetation in Xishuangbanna, SW China

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Abstract

The limestone vegetation in Xishuangbanna, tropical southwest China, includes three main vegetation types, six formations, and nine communities, which are described in detail with enumerations of forest profiles and species composition. Species diversity is discussed based on Shannon-Wiener's indexes for each forest formation. Comparison between the limestone seasonal rain forests and the ones on non-limestone reveals that the limestone seasonal rain forest has a lower species diversity index value per unit area but higher community diversity than the rain forest on non-limestone.

Introduction

Limestone vegetation is one of the principal vegetation types in tropical Yunnan of southwest China. Because of the great diversity of habitat and topography, limestone vegetation is extremely diverse in community types and very rich in endemic taxa. However, limestone vegetation is even less well known than that not on limestone, owing to the rugged topography. About 19% (3600 km^2) of Xishuangbanna, the southern-most part of Yunnan, is limestone. Most of the limestone area is still covered by forests and although these have been studied (Liu, 1987; Xu et Jian 1987), little has been published in English. This paper is based mainly on three years' field work on plots and is a phytosociological study of the limestone vegetation.

General Geography

Location and topography

Xishuangbanna lies between 2109' and 2236' N, 9958' and 10150' E. The region, which borders Burma and Laos, is a mountainous area at the northern margin of mainland southeast Asia and the southern end of the Hengdwan Mountains (part of the Himalayas). Basically, the area has a mountain-valley topography with the mountains running north-south with lower elevations towards the south. Altitude varies from 480 m at the bottom of the lowest valley in the south to 2429 m at the top of highest mountain in the north.

The limestone occurs mainly in the south-eastern part of Xishuangbanna as a basically north-south-trending tract and ranges in altitude from 600 m to 1600 m (Fig. 1). There are two main types of limestone topography. One is typical karst hills, which have rocky tops without soil, and slopes partially covered by thin soil. The other is usually much bigger mountains, which also have rocky tops without soil, but have slopes, especially the lower ones, covered by thick soil with fewer limestone outcrops. Because of the diversity of topography and the great site to site variance of soil depth and cover of outcrops, there is a wide range of micro-habitats, i.e. there is a great spatial heterogeneity in the limestone.

Climate

The region of Xishuangbanna has a typical tropical monsoon climate. In the limestone area, climatic change with altitude is conspicuous. The annual mean temperature is 22°C (600 m alt.) to 18.4°C (1600 m), and the annual temperature accumulation (the sum of daily temperature means where they are > 10°C) is 8000°C (600 m) to 6600°C (1600 m); the monthly mean temperature is 15.9°C (600 m) to 12.3°C (1600 m) for the coldest month and 25.7°C (600 m) to 22°C (1600 m) for the hottest month. The annual precipitation varies from 1200 mm to 1556 mm of which more than 80 percent falls during the rainy season which starts in May and lasts till the end of October.

The Hengdwuan Mountains to the north of the region act as a huge barrier keeping out the cold air from the north in winter. Dense fog always exists for the whole of the dry season on the lower hills and in the valleys (average 146 foggy days per year and 1 mm precipitation per foggy day recorded in Mengla County in the south of the region), which compensates for the insufficient precipitation, so that a tropical moist climate occurs locally in spite of the fact that the region is controlled by strong monsoon climate and at a relatively high latitude and elevation.

Methods

Limestone vegetation is extremely diverse, especially because there are many communities, which are in different stages of succession. After initial floristic investigation (Zhu *et al*., 1996), the main and representative primary forest types (which occupied relatively large areas and are climax communities judged by field observation) were selected for establishing plots. For each selected forest type, one to several plots were laid out. The number of plots (or the total sampling area) for a forest type was

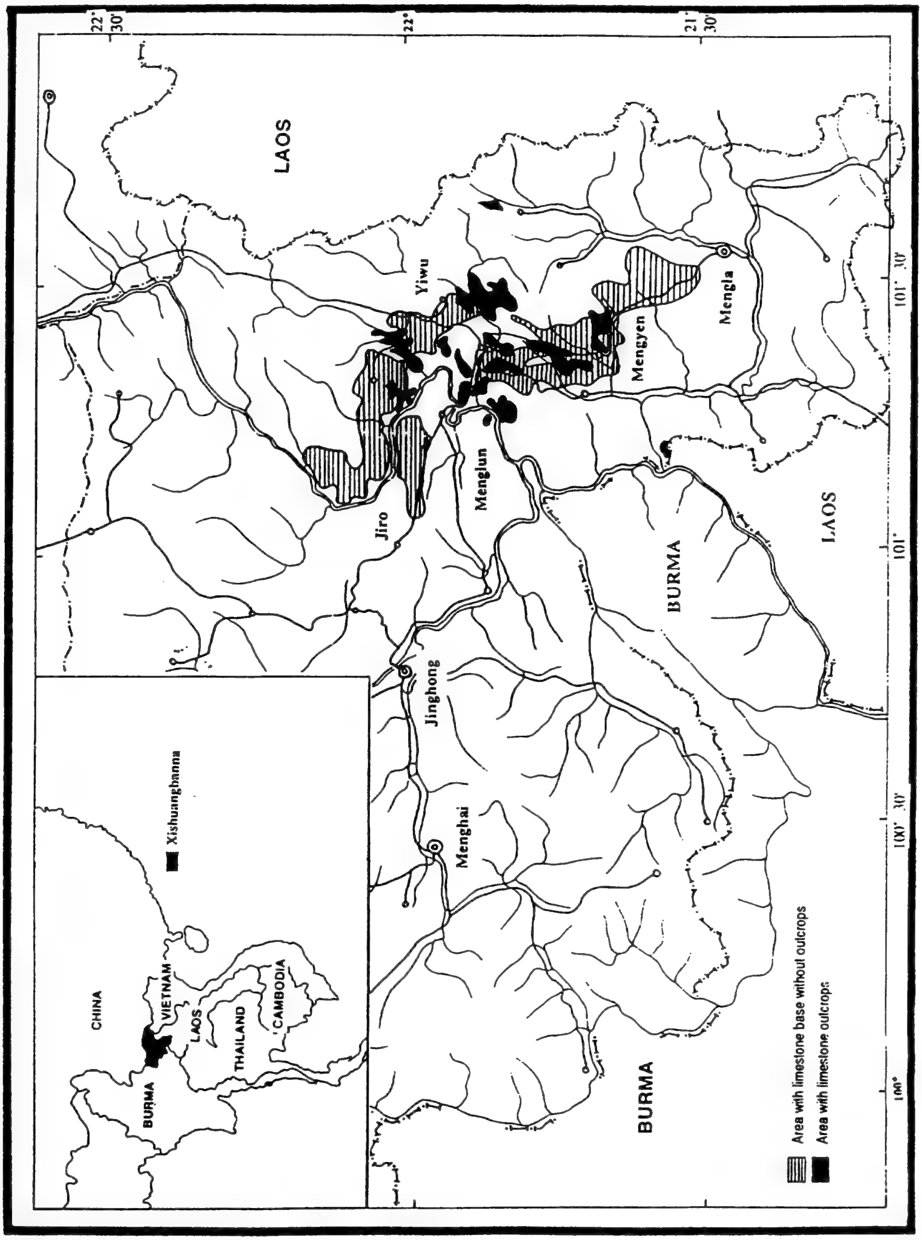

Figure 1. Distribution of limestone in Xishuangbanna, SW China.

determined mainly depending on floristic variance of the forest type. Sixteen plots were used for the analysis described in this paper. Different sized plots were used for different forest types in different topographical sites owing to considerations of phytocoenological minimal area and in some situations for facilitating field work. Plots were basically 2000–2500 m^2 for seasonal rain forest (7 plots), 500–2000 m^2 for seasonal moist forest (7 plots) and 100 m^2 for dwarf forest (2 plots) on tops of hills or mountains. (It is difficult to fix plot size even for the same forest type because of the very rugged topography).

In each plot, all trees were identified and their dbh. (minimum 5 cm), height and crown coverage measured. Each plot was roughly divided into 5 strips so that frequency of tree species could be calculated (except plots 102–16 and 102–15 in Tables 1 and 7, which were investigated by another botanist's group without subdivision of the plots). Furthermore, in 3–5 subplots (in each plot) of 5 x 5 m (for seasonal rain forest) or 3 x 3 m (for others), saplings and shrubs were counted, and the cover of seedlings and herbaceous plants were estimated by Braun-Blanquet's degree of abundance (Braun-Blanquet, 1932). Epiphytes and lianas were identified and abundance estimated by eye. Importance value indexes (IVI) devised by Curtis & McIntosh (1951) were calculated and shown in tables from data of plots except for Tables 1 and 7 in which percentage of total dominant density (%Dens.) and percentage of total dominant breast area (%BA) were calculated from data of plots 102–16 and 102–15. Shannon-Wiener's indexes (Shannon-Wiener, 1949) for species diversity and Evenness Indexes of Pielou (1966) were calculated from data of plots. For all species in plots, specimens were collected and identified. Species authorities follow Flora Reipublicae Popularis Sinicae. Specimens are kept in the herbaria at KUN and HITBC as well as at SYS.

Structure and species composition

The primary limestone vegetation can be classified into three vegetation types i.e. tropical seasonal rain forest, tropical seasonal moist forest and tropical montane dwarf forest based on physiognomic, structural and floristic characters as well as habitats (Wang *et al.*, 1997). The tropical seasonal rain forest occurs mainly in wet valleys and on lower slopes below 850–900 m altitude. The tropical seasonal moist forest occurs mainly on middle slopes and tops of lower hills. However, the distribution of vegetation types is greatly affected and modified by local micro-habitats. Topography seems to have the stronger effect on distributional patterns of vegetation than elevation. For example, the tropical seasonal rain forest occurs occasionally on the upper valleys near 1000 m altitude in some particular sites because of the temperature inversion appearing in the mountain areas. The tropical montane dwarf forest occurs on the tops of hills or mountains. Each vegetation type is further subdivided into formations.

1. Tropical Seasonal Rain Forest

Like equatorial lowland rain forest, tropical seasonal rain forest has 3–4 indistinct tree layers. The top layer is mainly emergent trees more than 30 m tall (tallest up to 45 m) and has c. 30% of crown coverage; the second layer, up to 30 m tall with almost continuous crowns (70–80% coverage) and a greatest density of stems, is the main canopy layer; the third layer, 5–18 m tall, and with crown cover of c. 40%, consists of small trees and juveniles of species from the upper layers. In some sites, the third tree layer can be further divided into two sublayers: upper sublayer (10–18 m tall) and lower sublayer (5–9 m tall). Buttresses and cauliflory are common, and both big woody climbers and vascular epiphytes are abundant. The forest is mainly evergreen in spite of the fact that there are some deciduous trees in the emergent layer. This forest type occurs in wet valleys and lower slopes of hills or mountains and below 1000 m altitude.

Tropical seasonal rain forest contains two main formations:

1a. Ravine seasonal rain forest

This occurs in the wettest valleys and lower slopes as well as shaded slopes (usually northeast facing). It has fewer than 10% deciduous trees, either in number of species or in individuals and all exist in upper layer. Floristically the formation is characterized by *Pometia tomentosa* (Fig. 2). The similar forest type, which occurs on non limestone habitats in the region, was called “wet seasonal rain forest” in early Chinese botanical references (Qu, 1960), but the term “ravine seasonal rain forest” was preferred by recent authors owing to its valley habitat (Jin and Ou, 1997; Zhu *et al.*, 1998). There are 90 tree species, 16 shrub species, 32 herbaceous species, 26 liana and 5 epiphyte species in the plots (cumulative area of 7400 m^2). Two communities have been recorded:

(i) *Pometia tomentosa-Alphonsea monogyna* community. This community occurs in the wettest bottom of valleys or on lower slopes, with *Pometia tomentosa* as dominant species of the upper tree layer. Its canopy is usually 35–40 m tall. *Alphonsea monogyna* is the dominant species and *Pseuduvaria indochinensis* the sub-dominant species in second tree layer. *Horsfieldia pandurifolia* is the dominant in the upper sublayer of the third tree layer (9–20 m tall) and *Cleidion spiciflorum* is the dominant in lower sublayer of the third tree layer (5–10 m tall). The understorey, with a

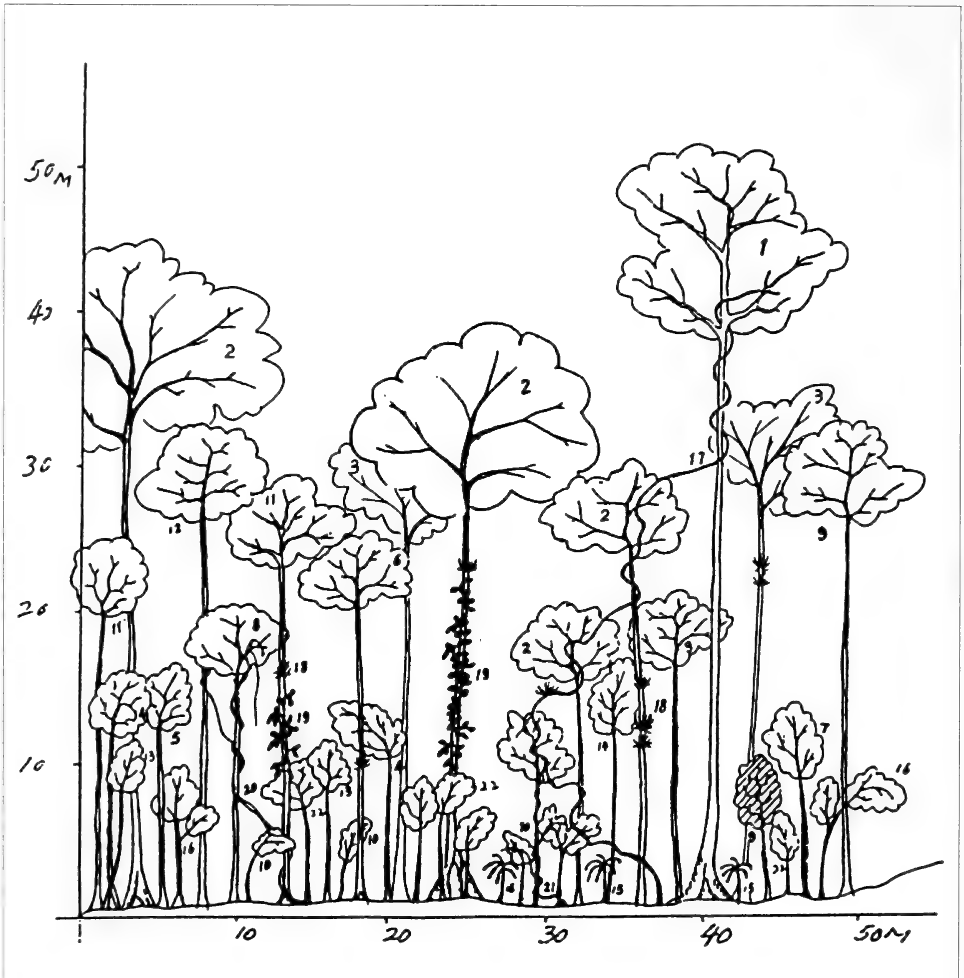

Figure 2. Forest profile of ravine seasonal rain forest

1. *Terminalia myriocarpa;* 2. *Pometia tomentosa;* 3. *Alphonsea monogyna;* 4. *Knema furfuracea;* 5. *Baccaurea ramiflora;* 6. *Garcinia cowa;* 7. *Syzygium latilimbum;* 8. *Barringtonia macrostachya;* 9. *Lasioccoca comberi* var. *pseudoverticillata;* 10. *Pittosporopsis kerrii;* 11. *Pseuduvaria indochinensis;* 12. *Pterospermum lanceaefolium;* 13. *Drypetes cumingii;* 14. *Horsfieldia pandurifolia;* 15. *Musa acuminata;* 16. *Trigonostemon thyrsoideum;* 17. *Ventilago calyculata;* 18. *Neottopteris nidus;* 19. *Rhaphidophora hongkongensis;* 20. *Combretum latifolium;* 21. *Fissistigma sp.;* 22. *Cleidion spiciflorum.*

cover of 30–40%, consists mainly of saplings and young woody lianas. *Pseuderanthemum polyanthum* and *Leea compactiflora* are the commonest shrub species. The herb layer is developed with a cover of 60%. The commonest species are the ferns *Ctenitopsis fusipes* and *Bolbites heteroclida,* the herb *Ophiopogon latifolius* and *Piper boemerifolium, and* the lianas *Derris cudatilimbum, and Strychnos nitida.* Its physiognomy and profile are almost exactly the same as those of wet seasonal rain forest on non-limestone in the region (Zhu, 1992, 1997). Most species of the community are also found in non-limestone seasonal rain forest, but the latter has many species not present on the limestone (Table 1).

Table 1. *Pomentia tomentosa-Alphonsea monogyna* community

Plot no.:102-16	Location: Meng-yue, Mengla
Altitude (m): 700-720	Area of plot (m): 80 x 30
Aspect: NE	Slope (degree): 0-5
Height of canopy: 40 m	Coverage of vegetation: >90%
No. of species (≥ 5 cm d.b.h.): 45	No. of stems: 140

Name of species	%Dens.	%BA	%Dens.+%BA
Pometia tomentosa	10.71	20.41	31.12
Amoora tetratepala	0.71	21.36	22.07
Alphonsea monogyna	15.00	2.76	17.26
Horsfieldia pandurifolia	6.43	5.71	12.14
Ficus altissima	0.71	9.98	10.69
Garuga floribunda var. *gamblei*	0.71	8.56	9.27
Cleidion spiciflorum	7.86	0.77	8.63
Diospyros hassellii	6.43	2.19	8.62
Pseuduvaria indochinensis	6.43	1.53	7.96
Glycosmis ferruginea	2.14	4.55	6.69
Litsea pierrei var. szemaois	2.86	3.25	6.11
Debregeasia squamata	3.57	0.85	4.42
Celtis timorensis	1.43	2.52	3.95
Prunus zippenliana	2.86	0.72	3.58
Picrasma javanica	2.14	0.74	2.88
Garcinia cowa	2.14	0.70	2.84
Erythrina stricta	1.43	1.33	2.73
Cryptocarya acutifolia	0.71	1.92	2.63
Macropanax dispermus	2.14	0.36	2.50
Canarium album	0.71	1.71	2.42
Litsea dilleniaefolia	1.43	0.75	2.18
Elaeocarpus austroyunnanensis	1.34	0.67	2.10
Lasiococca comberi var. *pseudoverticillata*	1.43	0.45	1.88

Cont:

Name of species	%Dens.	%BA	%Dens.+%BA
Diospyros nigrocortex	1.43	0.45	1.88
Antidesma montana	1.43	0.30	1.73
Tapiscia yunnanensis	0.71	0.94	1.65
Pterospermum lanceaefolium	1.43	0.20	1.63
Laportea sinuata	1.43	0.15	1.58
Tetrameles nudiflora	0.71	0.67	1.38
Semecarpus reticulatus	0.71	0.64	1.35
Macaranga indica	0.71	0.57	1.28
Toona ciliata	0.71	0.43	1.1
Dysoxylum lukii	0.71	0.40	1.11
Phaeanthus saccopetaloides	0.71	0.38	1.09
Dysoxylum binectariferum	0.71	0.27	0.98
Drypetes perreticulata	0.71	0.17	0.88
Canarium pimela	0.71	0.14	0.80
Phoebe puwenensis	0.71	0.11	0.82
Chisocheton sinensis	0.71	0.11	0.82
Trigonostemon thyrsoideum	0.71	0.11	0.82
Antidesma bunius	0.71	0.07	0.78
Sarcospermum arboreum	0.71	0.03	0.74
Sumbaviopsis albicans	0.71	0.02	0.73
Drypetes cumingii	0.71	0.02	0.73
Dichapetalum gelonioides	0.71	0.02	0.73
Total	100	100	200

(ii) *Pometia tomentosa-Celtis philippensis* var. *wightii* community. This community occurs near the bottoms of valleys and on lower slopes in somewhat less wet habitats, with rock outcrops usually covering more than 30% of the ground. It usually has *Celtis philippensis* var. *wightii and Lasioccoca comberi* var. *pseudoverticillata* as co-dominant species in the second tree layer and *Pometia tomentosa* as a dominant species in the upper tree layer. *Sumbaviopsis albicans* is the dominant in the upper sublayer of the third layer and *Cleidion spiciflorum* in the lower sublayer (Table 2). The understorey with a cover of 50% consists almost entirely of saplings. Only a few shrub species are recorded and the common ones are *Psychotria siamica, Sauropus macranthus* and *Miliusa tenuistipitata.* The herb layer has a cover of 30%, and the commonest are *Tectaria cordatum* (a fern), *Pilea balansae* and *Piper polysyphorum. Ventilago calyculata* var. *trichoclada* and *Loeseneriella lenticellata* are the commonest lianas. *Rhaphidophora hongkongensis* and *Pothos chinensis* are frequent epiphytes. This community is transitional toward lower hill seasonal rain forest in physiognomy and floristic composition.

Table 2. *Pometia tomentosa–Celtis philippensis* var. *wightii* community

Plot no.:	HW9203	HW9202	
Location:	Menglun	Menglun	
Altitude (m):	700	740	
Area of plot (m):	50 x 50	50 x 50	
Aspect:	NE	NE	
Slope (degree):	25	10	
Height of canopy (m):	35	30	
Coverage of vegetation (%):	100	100	
No. of tree species (≥5 cm DBH):	23	19	
No. of stems:	118	164	
Name of species	IVI[1)]	IVI	Average
Celtis philippensis var. *wighttii*	41.3	56.1	48.7
Lasiococca comberi var. *pseudoverticillata*	45.1	39.8	42.6
Cleidion spiciflorum	18.7	40.2	29.4
Sumbaviopsis albicans	24.7	30.7	27.7
Pometia tomentosa	11.8	18.5	15.1
Ficus altissima	27.2	–[2)]	13.6
Neonauclea tsiana	12.5	12.2	12.4
Caryota urens	14.3	11.4	12.8
Amoora tetrapetala	6.9	15.6	11.3
Drypetes perreticulata	12.7	8.2	10.4
Mitrephora maingayi	8.8	10.2	9.5
Tetrameles nudiflora	–	117.7	8.8
Terminalia bellerica	13.7	–	6.9
Garcinia xanthochymus	3.0	9.0	6.0
Mitrephora wangii	9.9	–	4.9
Duabanga grandiflora	8.7	–	4.3
Alphonsea monogyne	8.2	+[3)]	4.1
Chukrasia tabularis var. *velutina*	7.6	–	3.8
Dysoxylum hainanensis	+	7.7	3.8
Randia wallichii	5.9	+	2.9
Pterospermum lanceifolium	5.4	–	2.7
Pseudostreblus indica	+	5.6	2.8
Ficus benjamina	+	5.3	2.6
Morus macroura	4.0	–	2.0
Ficus glaberrima	3.2	–	1.6
Dysoxylum lenticellatum	3.2	–	1.6
Glycosmis ferruginea	–	3.0	1.5
Ficus cyrtophylla	–	3.0	1.5
Diospyros hassellii	–	3.0	1.5
Horsfieldia tetratepala	+	2.9	1.5
Laportea sinuata	2.9	–	1.4
Total	300	300	300

1) IVI=%Density + % Frequency + %Dominance
2) —: not recorded in the plot
3)+: only saplings (<5 cm d.b.h.) or seedlings were recorded in the plot

1b. Lower hill seasonal rain forest

Lower hill seasonal rain forest occurs in even less wet habitats mainly on lower hills and sometime on lower sun-facing (usually southwest) slopes. It has the same altitudinal range as formation 1a, but is never found in valleys. Deciduous trees make up 10–30% of the number of species or individuals and exist in upper layer and as emergents. The similar forest type occurs on non-limestone habitats in the region, and was also called "dry seasonal rain forest" (Qu., 1960), but the term "lower hill seasonal rain forest" was preferred recently considering its habitat.(Jin and Ou, 1997; Zhu *et al.*, 1998). It has a canopy about 30 m tall and relatively clear stratification. The upper layer with a crown cover of 40–50%, is 20–30 m tall. The second layer, which is the main canopy layer, has a crown cover of 70–80% and 10–20 m tall. The third layer with a cover of c. 50–60% is 3–10 m tall. There are some scattered emergents such as *Chukrasia tabularis* var. *velutina, Tetrameles nudiflora* and *Garuga floribunda* var. *gamblei* (Fig. 3). There are 67 tree species, 12 shrub species, 13 herbaceous species, 32 liana and 4 epiphyte species in the plots (cumulative area of 7400 m^2).

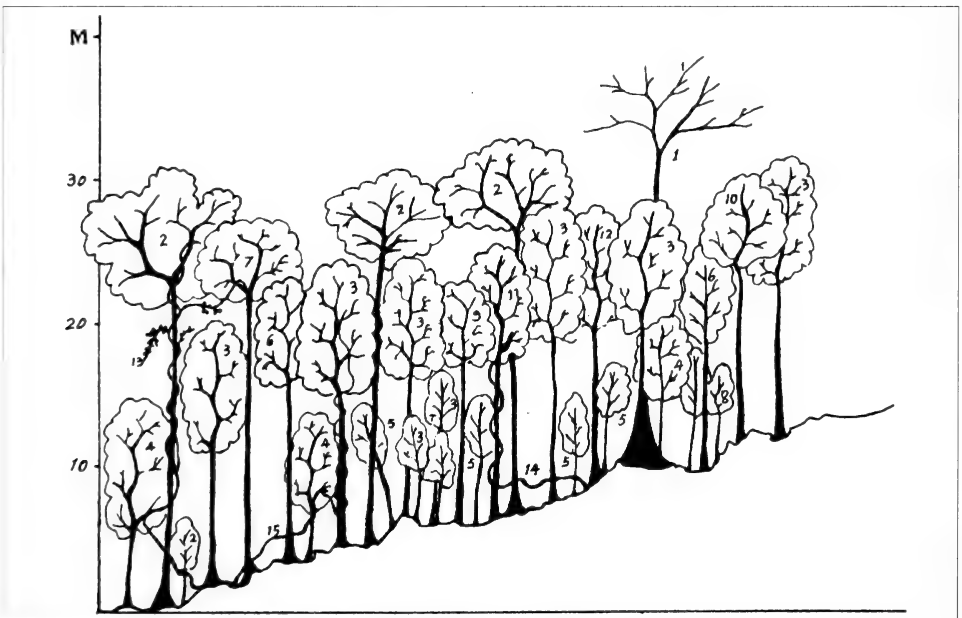

Figure 3. Forest profile of lower hill seasonal rain forest

1. *Tetrameles nudiflora;* 2. *Celtis philippensis* var. *wightii;* 3. *Lasioccoca comberi* var. *pseudoverticillata;* 4. *Sumbaviopsis albicans;* 5. *Cleidion spiciflorum;* 6. *Alphonsea mollis;* 7. *Amoora tetrapetala;* 8. *Tarenna sylvestis;* 9. *Garcinia bracteata;* 10. *Metadina trichotoma;* 11. *Alphonsea monogyna;* 12. *Beilschmiedia yunnanensis;* 13. *Combretum latifolium;* 14. *Ventilago calyculata;* 15. *Tetrastigma henryi.*

There are several other communities that occur on non limestone habitats in the region but only one community was recorded in the limestone:

Celtis philippensis var. *wighti*—*Lasiococca comberi* var. *pseudoverticillata* community. This is the commonest community on lower slopes of limestone. The upper tree layer is dominated by *Celtis philippensis* var. *wightii,* with some scattered deciduous emergents. *Lasiococca comberi* var. *pseudoverticillata* is the dominant in the second layer. *Sumbaviopsis albicans* and *Cleidion spiciflorum* are still the dominants in the third layer (Table 3). The understorey with a cover of 30–50%, consists of saplings. Fewer true shrub species were recorded. The herb layer is very undeveloped and consists of seedlings and a lot of creeping lianas. The commonest creeping lianas are *Derris caudatilinba* and *Loeseneriella yunnanensis.* Big woody lianas, such as *Combretum* spp., *Tetrastigma* spp. *Ventilago* spp. etc., are frequent. Epiphytes are less frequent than in the ravine seasonal rain forest.

Table 3. *Lasiococca comberi* var. *pseudoverticellata*–*Celtis philippensis* var. *wightii* community

Plot no.:	94-03-01	93-12-03	9203	102-13		
Location:	Mengyen	Yingchan	Yingchan	Mengyen		
Altitude (m):	800	1000	1060	825		
Area of plot (m):		50 x 50	20(10 x 10)	5(10 x 10)	40 x 60	
Aspect:	SW	NW	SW	W		
Slope (degree):		40	5-15	10	10	
Height of canopy (m):		30	30	30	25	
Coverage (%):		>90	90	95	90	
No. of species (≥5cm d.b.h.)		27	23	12	11	
No. of stems	102	271	44	142		
Name of species		IVI	IVI	IVI	IVI	Average
Lasiococca comberi var. *pseudoverticellata*		67.12	126.1	101	151.1	111.3
Celtis philippensis var. *wightii*		23.64	44.18	30.37	97.2	48.85
Chukrasia tabularis var. *velutina*		15.37	11.42	30.24	–	14.26
Garuga floribunda var. *gamblei*		9.66	32.16	8.97	–	12.70
Tetrameles nudiflora		40.67	–	–	–	10.17
Sumbaviopsis albicans		11.81	9.33	7.64	6.39	8.8
Cleidion spiciflorum		10.67	6.67	7.57	9.3	8.55

Cont:

Name of species	IVI	IVI	IVI	IVI	Average
Alphosea mollis	10.81	–	18.42	–	7.3
Tarena sylvestis	–	14.1	7.57	–	5.42
Bombax insignis	17.00	–	–	–	4.25
Metadina trichotoma	–	2.27	13.85	–	4.03
Amoora tetrapetala	–	4.99	8.34	–	3.33
Laportea sinuata	5.84	7.55	–	–	3.35
Syzygium szemaoensis	–	–	–	12.8	3.2
Fortunella polyandra	–	12.7	+	–	3.14
Garcinia bracteata	9.91	2.11	+	–	3.01
Polyalthia cheliensis	11.71	–	+	–	2.93
Alphonsea monogyna	6.31	3.45	–	–	2.44
Croton crassifolium	3.09	–	–	6.23	2.33
Symphyllia silhetiana	–	–	–	8.9	2.23
Beilschmiedia yunnanensis	6.66	2.12	–	–	2.20
Caryota urens	–	–	8.42	–	2.11
Walsura robusta	–	–	7.57	–	1.89
Ficus conccina	6.24	–	–	–	1.56
Celtis bodinieri	5.95	–	–	–	1.49
Lagerstroemia tomentosa	5.79	–	–	–	1.45
Dracaena cochinchinensis	4.02	1.68	–	1.43	
Ficus racemosa	5.34	–	–	–	1.34
Murraya tetramera	–	5.10	+	–	1.28
Ficus glaberrima	2.96	2.14	–	–	1.28
Ficus virens 4.59	–	–	–	1.15	
Vitex quinata var. *puberula*	3.14	–	–	–	0.79
Syzygium melanophylla	–	–	–	3.0	0.75
Dysoxylum lenticellata	2.94	–	–	–	0.74
Mitrephora thorelii	2.94	–	–	–	0.74
Wrightia tomentosa	2.90	–	–	–	0.73
Ehretia tsangii	2.89	–	–	–	0.73
Mitrephora maingayi	–	2.38	–	–	0.6
Derris robusta	–	–	–	2.21	0.55
Diospyros yunnanensis	–	1.75	–	–	0.44
Mitrephora wangii	–	1.71	–	–	0.43
Amoora calcicola	–	1.68	+	–	0.42
Aglaia testicularis	–	1.66	–	–	0.42
Randia acuminatissima	+	–	–	1.55	0.39
Xeromphis spinosa	–	–	–	1.40	0.35
Total 300	300	300	300	300	

2. Tropical Seasonal Moist Forest

Tropical seasonal moist forest was recognized as a vegetation type based on its profile and its occurrence mainly on the middle and upper slopes ranging from 650–1300 m altitude on limestone. It usually has two distinct tree layers with the canopy 20–25 m tall although some scattered big trees can reach more than 30 m tall in some sites. Woody lianas are abundant and vascular epiphytes with small, thick leaves are common. Buttresses and cauliflory are relatively rare. This forest type is somewhat diverse in physiognomy and floristic composition because of the great diversity of micro-habitats on the mid and upper slopes of the limestone. This vegetation type was called "monsoon forest" in Chinese botanical references (Liu, 1987). The term seasonal moist forest is preferred because the forest is not equivalent to Schimper's monsoon forest in many ways in spite of the fact that it is affected by seasonal dryness and contains a variable percentage of deciduous trees.

Two main formations can be recognized:

2a. Tropical seasonal evergreen moist forest

This formation occurs on upper slopes, shady slopes or tops of lower hills with more than 90% of rock outcrops from 650 m to 1300 m alt. The forest is evergreen, with two distinct tree layers. The upper layer with a crown cover of 40–60% is 15–25 m tall and the second layer with a crown cover of 70–80% is 3–15 m tall. Woody climbers are very abundant. Vascular epiphytes with small, thick leaves are frequent. There are 50 tree species, 8 shrub species, 10 herbaceous species, 10 liana and 11 epiphyte species in the plots (cumulative area of 3500 m^2). It is intermediate between lower hill seasonal rain forest and montane dwarf evergreen forest.

Two main communities have been recorded:

(i) *Osmanthus polyneurus–Dracaena cochinchinensis* community. This community usually occurs on the upper slopes of mountains or hills above 1000 m altitude (Fig. 4). *Osmanthus polyneurus* is the dominant species in the top layer and *Dracaena cochinchinensis* is usually the dominant in the second layer (Table 4). The understorey consists of saplings and creeping lianas. The commonest lianas are *Loeseneriella yunnanensis* and *Hiptage benhalensis.* Herbaceous species of the family Urticaceae, such as *Procris crenata, Elatostema* spp. and *Pilea* spp., are abundant. Lithophytes are also frequent.

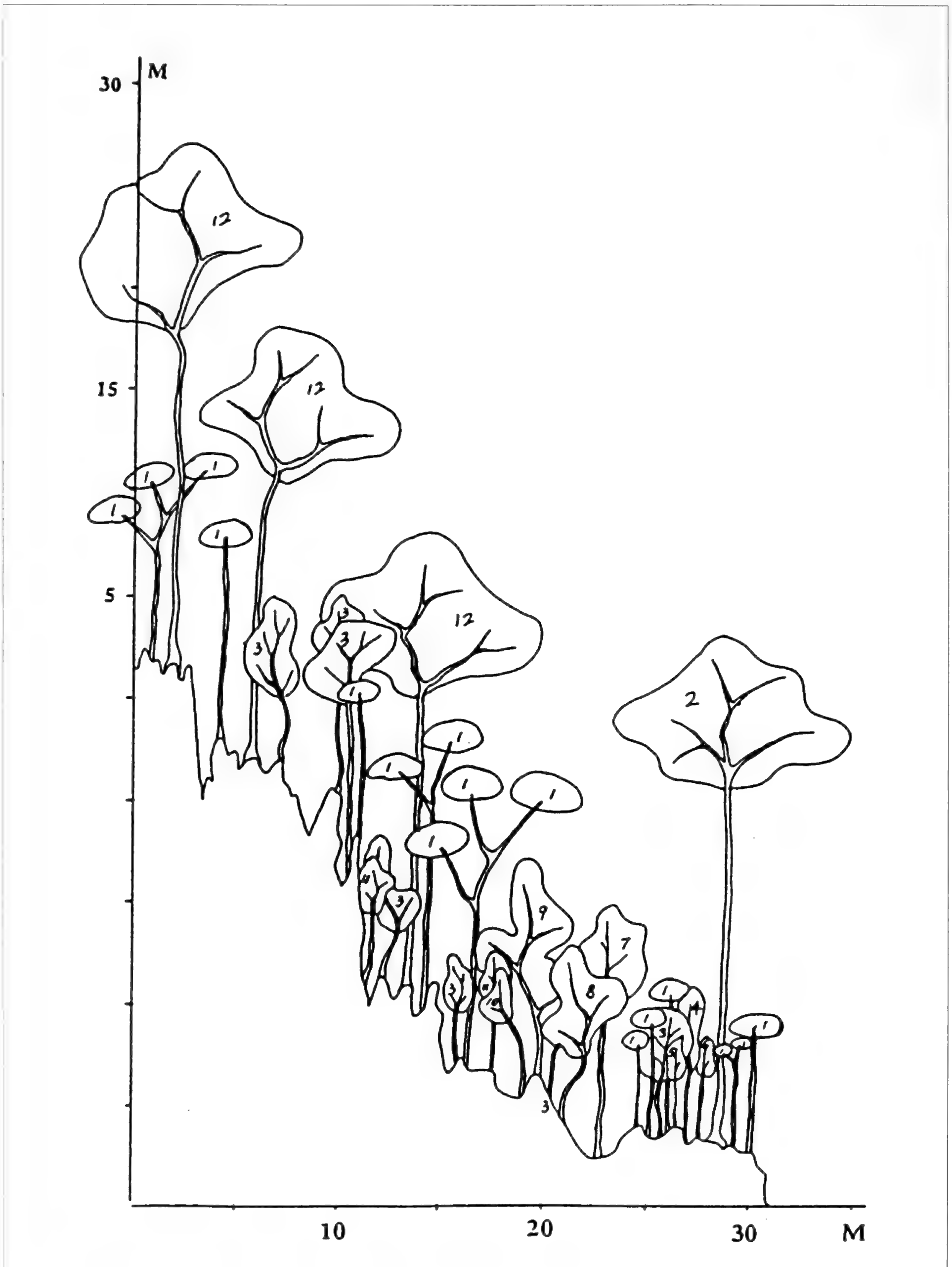

Figure 4. Forest profile of Osmanthus–Dracaena community

1. *Dracaena cochinchinensis;* 2. *Amoora tetrapetala;* 3. *Tarenna sylvestris*; 4. *Garcinia bracteata*; 5. *Mallotus philippinensis;* 6. *Diospyros yunnanensis*; 7. *Syzygium balsameum*; 8. *Photinia angusta* var. *hookeri*; 9. *Alphonsea mollis*; 10. *Engelhardtia spicata*; 11. *Clausena excavata*; 12. *Osmanthus polyneurus*

Table 4. *Osmanthus polyneurus–Dracaena cochinchinensis* community

Plot no.:	9207	9208	
Location:	Long-pa, Mengla	Long-pa, Mengla	
Altitude (m):	1320	1420	
Area of plot (m):	25 x 20	25 x 20	
Aspect:	E 30	NW	
Slope (degree):	40	25	
Height of canopy (m):	20	20	
Coverage of vegetetion (%):	85	90	
No. of tree species (>5 cm d.b.h.):	15	21	
No. of stems:	37	42	
Name of species	IVI	IVI	Average
Osmanthus polyneurus	74.83	90.86	82.84
Dracaena cochinchinensis	106.49	+	53.25
Tarenna sylvistris	24.14	11.53	17.75
Syzygiun sp.	–	24.22	12.11
Wightia tomentosa	7.79	14.9	11.35
Sterculia villosa	–	19.75	9.88
Murraya tetramera	6.99	11.07	9.03
Schefflera glomerulata	–	16.31	8.16
Mitrephora calcarea	9.56	5.99	7.82
Engelhardtia spicata	6.96	7.46	7.3
Alphonsea mollis	7.31	6.55	6.93
Myrsine semiserrata	+	13.52	6.76
Mallotus philippinensis	7.08	5.62	6.35
Garcinia bracteata	+	12.3	6.15
Celtis timorensis	+	11.74	5.87
Ficus curtipes	–	9.34	4.67
Garruga pinnata	9.27	–	4.64
Ficus orthoneura	9.26	–	4.64
Kopsis officinalis	–	8.18	4.09
Photinia arguta var. hookeri	8.08	–	4.04
Eriolaena kwangsiensis	7.79	–	3.9
Micromelum integerrimum var.*mollisimum*	7.34	–	3.67
Diospyros yunnanensis	–	7.1	3.55
Clausena excavata	6.96	+	3.5
Ulmus lanceifolia	+	6.7	3.35
Fortunella polyandra	–	5.89	2.95
Schoepfia fragrans	–	5.85	2.93
Wrightia laevis	–	5.62	2.81
Total	300	300	300

(ii) *Lasiococca comberi* var. *pseudoverticillat–Cleistanthus sumatranus* community. This occurs only on dry slopes and the tops of lower hills in Menglun between altitudes 650–800 m. There are two tree layers, of which the upper layer is 16 to 23 m tall and has a coverage of 50%; the lower layer is 5–16 m tall and has a coverage more than 70 %. *Lasiococca comberi* var. *pseudoverticillata* is the predominant species in the upper tree layer and *Cleistanthus sumatranus* in the lower tree layer (Fig. 5). It abuts lower hill seasonal rain forest, which is on the lower slopes and in valleys. Some deciduous emergent trees, such as *Tetrameles nudiflora, Garuga pinnata,* and *Chukrasia tabularis,* are sparsely dotted through the forest (Table 5). The understorey is similar to the former community.

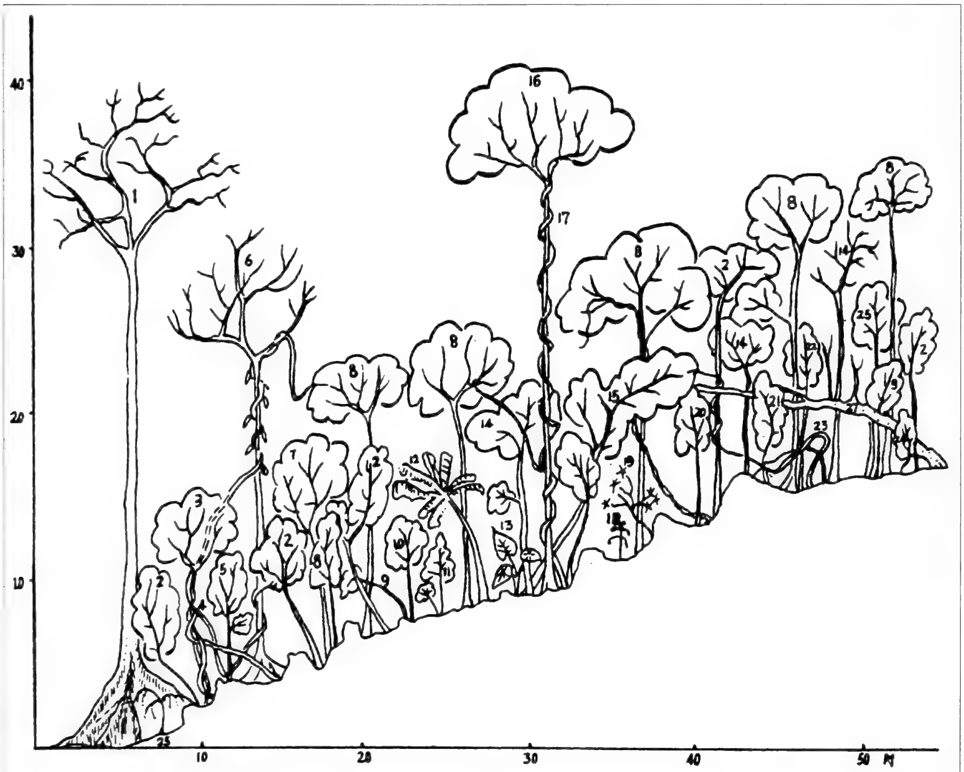

Figure 5. Forest profile of Lasiococca–Cleistanthus community

1. *Tetrameles nudiflora;* 2. *Cleistanthus sumatranus;* 3. *Laportea urentissima;* 4. *Pothos repens;* 5. *Sumbaviopsis albicans;* 6. *Garruga floribunda var. gamblei;* 7. *Mallotus paniculata;* 8. *Lasioccoca comberi* var. *pseudoverticillata;* 9. *Cleidion spiciflorum;* 10. *Sterculia lanceolata;* 11. *Murraya tetramera;* 12. *Musa acuminata;* 13. *Alocasia macrorhizza;* 14. *Colona floribunda;* 15. *Unknown;* 16. *Celtis philippensis* var. *wightii;* 17. *Santaloides roxburghii;* 18. *Sumbaviopsis albicans;* 19. *Dracaena cochinchinensis;* 20. *Aglaia parviridis;* 21. *Saurauia tristyla;* 22. *Mitrephora thorelii;* 23. *Salacia polysperma;* 24. *Leea crispa;* 25. *Mallotus philippinensis;* 26. *Caryota monostachya;* 27. Dead tree.

Table 5. *Lasiococca comberi* var. *pseudoverticellata–Cleistanthus sumatranus* community

Plot no.: 950506		Location: Menglun		
Altitude (m): 750		Area of plot (m): 50 x 50		
Aspect: NW		Slope (degree): 30		
Height of canopy: 22 m		Coverage of vegetation: >95%		
No. of species (≥5 cm DBH): 29		No. of stems: 445		
Name of species	%Dens.	%Freq.	%B.A.	IVI
Cleistanthus sumatranus	45.6	7.8	12.66	66.1
Croton crassifolius	8.5	7.8	37.5	53.9
Lasiococca comberi var. *pseudoverticellata*	27.19	7.8	4.9	39.9
Celtis philippensis var. wightii	4.7	6.3	21.3	32.3
Garuga pinnata	2.0	7.8	6.9	16.8
Tetrameles nudiflora	0.2	1.6	11.7	13.5
Glycosmis ferruginea	1.8	6.3	0.5	8.6
Mayodendron igneum	1.34	6.26	0.95	7.96
Tarena sylvestris	1.35	4.69	0.27	6.31
Alphonsea monogyna	0.67	4.69	0.79	6.15
Cipadessa baccifera	1.12	4.69	0.19	6.0
Beilschmeidia yunnanensis	0.67	3.13	0.29	4.09
Trigonostemon lyi	0.67	3.13	0.04	3.84
Ehretia tsangii	0.45	3.13	0.09	3.67
Syzygium cuminii	0.45	3.13	0.04	3.62
Amoora tetrapetala	0.22	1.56	1.14	2.92
Ficus orthoneura	0.22	1.56	0.66	2.44
Wrightia tomentosa	0.22	1.56	0.13	1.91
Amoora stellata	0.22	1.56	0.10	1.88
Zanthoxylum planispinum	0.22	1.56	0.1	1.88
Ficus concinna	0.22	1.56	0.07	1.85
Laportea basirotunda	0.22	1.56	0.07	1.85
Amoora calcicola	0.22	1.56	0.17	1.95
Mitrephora calcarea	0.22	1.56	0.03	1.81
Murraya microphylla	0.22	1.56	0.02	1.8
Lagestroemia tomentosa	0.22	1.56	0.01	1.79
Harpullia cupanioides	0.22	1.56	0.01	1.79
Stereospermum tetragonum	0.22	1.56	0.01	1.79
Lepisanthes sp.	0.22	1.56	0.01	1.79
Total	100	100	100	300

2b Tropical seasonal semi-evergreen moist forest

This formation occurs on much drier lower and middle slopes and in wide valleys within the range of 600–1200 m altitude. The forest is semi-evergreen with deciduous trees making up 30–60 % of the number of species and 35–70 % of the sum of cumulative importance value index (from plot data in Tables 6 and 7). The upper layer trees are usually deciduous with umbrella crowns and rough and thicker bark. The dominant species in the upper layer is usually *Bombax insignis,* but in some sites *Colona floribunda, Tetrameles nudiflora* or *Erythrina lithosperma* are either dominant or co-dominant. The second tree layer is evergreen. Small woody climbers are abundant but vascular epiphytes are less frequent. There are 80 tree species, 12 shrub species, 21 herbaceous species, 25 liana and 10 epiphyte species in the plots (cumulative area of 6150 m^2).

Two communities have been recorded:

(i) *Bombax insignis-Colona floribunda* community. This occurs on lower and middle dry slopes and covers a relatively large area. *Bombax insignis* is dominant. In some sites *Colona floribunda, Erythrina lithosperma* are co-dominant species in the top layer. *Pistacia weinmanifolia* is usually dominant in the second layer (Table 6). The understorey consists of saplings, lianas and shrubs. Common shrub species are *Murraya koenigii, Colebrookea oppositifolia* and *Allophylus hirsutus.* Common lianas are *Amalocalyx yunnanensis, Porana spectabilis* and *Acacia pinnata.* Epiphytes are rare.

Table 6. *Bombax insignis–Colona floribunda* community

Plot no.:	HW9201	93-12-01	94-03-02	
Location:	Huiwa	Yingchan	Mengyen	
Altitude (m):	980	1200	1000	
Area of plot (m):	30 x 30	25 x 30	40 x 50	
Aspect:	SW	SE	SW	
Slope (degree):	37	10	45	
Height of canopy (m):	20	20	22	
Coverage of vegetetion (%):	95	95	75	
No. of spp.(≥5 cm D.B.H.)	19	2	16	
No. of stems	70	38	57	
Name of species	IVI	IVI	IVI	Average
Bombax insignis	22.82	–	98.89	40.57
Colona floribunda	36.36	67.23	6.25	36.61
Erythrina lithosperma	25.20	40.14	–	21.78

Cont:

Name of species	IVI	IVI	IVI	Average
Lagerstroemia venusta	64.28	–	–	21.43
Pistacia weinmannifolia	43.48	–	19.26	20.91
Dracaena cochinchinensis	–	–	41.27	13.76
Hymenodictyon excelsum	10.84	–	23.41	11.42
Kydia calycina	–	27.13	–	9.04
Schima wallichii	–	9.08	–	9.02
Celtis philippensis var. *wightii*	–	–	25.97	8.66
Mallotus philippinensis	10.95	12.9	–	7.95
Spondias pinnata	–	19.07	–	6.36
Ehretia tsangii	–	7.29	9.0	5.43
Phyllanthus embelica	–	14.79	–	4.93
Millettia tetraptera	–	–	14.05	4.68
Ficus orthoneura	–	–	12.44	4.17
Grewia eriocarpa	11.75	–	–	3.92
Premna fulva	11.37	–	–	3.79
Sarcosperma kachinensis	–	11.26	–	3.75
Derris robusta	10.87	–	–	3.62
Lithocarpus microspermus	–	10.27	–	3.4
Helicia cochinchinensis	–	9.69	–	3.23
Litsea glutinosa	9.32	+	–	3.1
Sterospermum tetragonum	–	9.3	–	3.1
Tetrasmeles nudiflora	–	–	9.23	3.08
Sterculia villosa	–	–	9.15	3.05
Lepisanthes senegalensis	–	–	8.94	2.98
Eriolaena kwangsiensis	–	8.86	–	2.95
Melia toosenden	–	8.86	–	2.95
Engelhartia roxburghiana	–	8.65	–	2.88
Alphonsea mollis	–	–	8.0	2.67
Ficus hispida	–	7.74	–	2.56
Toona ciliata	–	7.73	–	2.48
Wrightia tomentosa	7.07	–	–	2.36
Acrocarpus fraxinifolius	–	6.71	–	2.24
Ulmus lanceifolius	+	6.54	–	2.18
Phoebe puwensis	–	6.63	–	2.12
Cipadessa baccifera	6.18	–	–	2.06
Croton crassifolius	5.40	–	–	1.80
Cratoxylon cochinchinensis	5.02	–	–	1.70
Mayodendron igneum	4.94	–	–	1.66
Zanthoxylum planispium	4.76	+	–	1.59
Dolichandrone stipulata	4.74	–	–	1.58
Radermachera microcalyx	4.62	–	–	1.54
Elaeocarpus varunum	–	–	4.61	1.54
Beilschmiedia yunnanensis	+	–	4.61	1.54
Ficus glaberrima	–	–	4.61	1.54
Total	300	300	300	300

(ii) *Bombax insignis-Garcinia bracteata* community. This occurs on lower drier gentle slopes or in wide valleys. *Bombax insignis* as emergent trees reaches up to 35 m tall. *Garcinia bracteata* and *Dracaena cochinchinensis* are co-dominant species in the second layer (Table 7). The understorey is similar to the former community.

Table 7. *Bombax insignis–Garcinia bracteata* Community

Plot no.: 102-15	Location: Mengyen, Mengla		
Altitude (m): 800	Area of plot (m): 50 x 50		
Aspect:	Slope (degree): 8-12		
Height of canopy: 40m	Coverage of vegetation: >90%		
No. of species (≥5 cm d.b.h.): 27	No. of stems: 115		
Name of species	%Dens.	%BA	%Dens. + %BA
Bombax insignis	7.83	23.08	30.91
Garcinia bracteata	14.78	7.92	22.70
Dracaena cochinchinensis	11.30	9.02	20.32
Laportea sinuata	10.43	6.87	17.30
Tetrameles nudiflora	2.61	12.43	15.04
Glycosmis ferruginea	8.69	5.69	14.38
Celtis bodinieri	5.22	5.81	11.03
Sumbaviopsis albicans	6.09	2.73	8.82
Dysoxylum lukii	4.35	3.45	7.80
Phaeanthus saccopetaloides	4.35	3.36	7.71
Vitex quinata var. *puberula*	2.61	3.35	5.96
Ficus racemosa	2.61	2.70	5.31
Cleidion spiciflorum	3.48	1.42	4.90
Tarenna sylvestris	2.61	2.09	4.70
Wrightia tomentosa	2.61	2.00	4.61
Wrightia pubescens	0.87	1.36	2.23
Ficus virens	0.87	0.95	1.82
Diospyros yunnanensis	0.87	0.90	1.77
Garuga floribunda var *gamblei*	0.87	0.82	1.69
Clausena excavata	0.87	0.82	1.69
Croton crassifolius	0.87	0.78	1.65
Hymenodictyon excelsum	0.87	0.68	1.55
Garuga pinnata	0.87	0.49	1.36
Alphonsea mollis	0.87	0.34	1.21
Unknown sp.	0.87	0.34	1.21
Cipadessa baccifera	0.87	0.27	1.14
Polyalthia cheliensis	0.87	0.27	1.14
Total	100	100	200

3. Montane Dwarf Forest

Tropical montane dwarf forest occurs on the tops of hills and summits of mountains at an altitude range between 900–1600 m. The forest has only one dwarf tree layer with canopy height of 7–15 m. Epiphyte ochids and non-vascular epiphytes are abundant. Small woody climbers are also abundant in some sites. The forest is usually characterized by *Agapetes burmanica,* which has swollen roots for water storage.

Two formations were recognised.

3a. Montane evergreen dwarf forest

This occurs on shady tops of hills and summits of relatively higher mountains above 1000 m altitude. *Pistacia weinmannifolia* and *Myrsine semiserrata* are usually dominant or co-dominant. Lithophytic orchids are very abundant on rocks; creeping climbers are also abundant. Only a representative community was plotted and analysed because of difficult field work in the very rugged topography.

Photinia angusta—Pistacia weinmannifolia community. This occurs mainly on limestone summits above 1200 m altitude. *Photinia angusta* and *Pistacia weinmannifolia* are co-dominant species (Table 8).

Table 8. *Photinia angusta-Pistacia weinmannifolia* community

Plot no.: 93-12-02	Location:Ying-chan,Mengla
Altitude (m): 1380	Area of plot (m): 10 x 10
Aspect: SW	Slope (degree): 20
Topography: on top of a hill	Height of canopy: 7 m
Coverage of vegetation: 95%	
No. of species (≥5 cm d.b.h.): 4	No. of stems: 6

Name of species	%Dens.	%Freq.	%BA	IVI
Photinia arguta var. *hookeri*	33.33	33.33	43.72	110.38
Pistacia weinmanifolia	33.33	33.33	43.72	110.38
Myrsine semiserrata	16.67	16.67	8.69	42.03
Pterospermum proteum	16.67	16.67	3.87	37.21
Total	100	100	100	300

Understorey	*Abund.	Freq.	Understorey	Abund.	Freq.
Agapetes burmanica	3.2	80	*Derris caudatilimbum*	+	40
Eria hainanensis	2.2	100	*Peperomia heyniana*	+	20
Hedychium villosum	+	80	*Bauhinia carcinophylla*	+	20
Fagopyrum tataricum	+	80	*Kalanchoe laciniata*	+	20
Tetrastigma delavayi	2.1	40	*Pyrrosia adnascena*	+	20
Pilea platanifolia	+	40	*Eria javanica*	+	20
Clematis kerrii	+	40	*Campylotropsis pinatorum*	+	20

* Braun-Blanquet's degree of abundance

3b. Montane semi-evergreen dwarf forest

The formation occurs only on some dry tops of hills. Deciduous trees make up 40 % of the number of species and 60 % of the sum of cumulative importance value index. Epiphytes are rare but woody climbers are still abundant. Also only a representative community was plotted and analysed.

Ficus neriifolia—Dracaena cochichinensis community. This occurs on dry and gentle tops of hills with an altitude of 900–1200 m. Deciduous species *Ficus neriifolia* is dominant (Table 9).

Table 9. *Ficus neriifolia-Dracaena cochichinensis* community

Plot no.: 93-12-04	Location: Yingchan,Mengla
Altitude (m): 930	Area of plot (m): 10 x 10
Aspect: S	Slope (degree): 15
Height of canopy: 15m	Coverage of vegetation: 85%
No. of species (≥5 cm d.b.h.): 5	No. of stems: 14

Name of species	%Dens.	%Freq.	%BA	IVI
Ficus neriifolia var. *trilepis*	42.86	40.00	44.50	127.36
Sterculia villosa	14.29	20.00	21.14	55.43
Dracaena cochinchinensis	28.57	20.00	3.78	52.35
Celtis philippensis var. *wightii*	7.14	10.00	20.23	37.37
Pistacia weinmannifolia	7.14	10.00	10.32	27.46
Total	100	100	100	300

Understorey	*Abund.	Freq.	Understorey	Abund.	Freq.
Schefflera glomerulata	2.2	80	*Phymatodes cuspidata*	+	80
Combretum punctatum	2.2	60	*Bauhinia carcinophylla*	+	40
Boehmeria siamensis	2.2	80	*Peperomia dindygulensis*	+	40
Pilea platanifolia	+	100	*Hedychium villosum*	+	20
Hoya pottisii	+	80			

* Braun-Blanquet's degree of abundance

Species diversity

From the data, tree species diversity indexes were calculated and results presented in Table 10. The highest value of diversity index is for the *Pometia-Alphonsea* community of ravine seasonal rain forest, which occurs mainly on bottoms of wet valleys, while the lowest value appears in the communities of the montane dwarf forest, which occurs on upper slopes

Table 10. Species diversity of limestone vegetation

Forest type	Plot	Area (m^2)	Alt. (m)	Habitat	Sl (°)	NS	NI	H'	E
I. Tropical seasonal rain forest									
a. Ravine seasonal rain forest									
a1 *Pometia-Alphonsea* Com.	102-16	2400	700	Wet valley terrace	0-5	45	140	3.2627	0.8571
a2 *Pometia- Celtis* Com.	HW9203	2500	700	Wet slope	25	23	118	2.4269	0.774
	HW9202	2500	740	Shade lower slope	10	19	164	2.0464	0.693
b. Lower hill seasonal rain forest									
b1 *Lasiococca-Celtis* Com.	940301	2500	800	Shade slope	40	27	102	2.5277	0.7669
II. Tropical seasonal moist forest									
a. Evergreen moist forest									
a1 *Lasiococca-Cleistanthus* Com.	*950506*	*2500*	*750*	*Sun-facing* Slope	*30*	*29*	*445*	*1.7393*	*0.5165*
b. Semi-evergreen moist forest									
b1 *Bombax-Garcinia* Com.	102-15	2500	800	Light slope	8-12	27	115	2.8613	0.8682
III. Montane dwarf forest									
a. Evergreen dwarf forest	931202	100	1380	Top of hills	20	4	6	1.3297	0.9592
b. Semi-evergreen dwarf forest	931204	100	930	Upper hill slope	15	5	17	1.3761	0.855

Sl : Slope; NS : Number of species (≥5 cm dbh); NI: Number of individuals (≥5 cm dbh); H': Shannon-Wiener's diversity indices (Shannon-Wiener, 1949); E: Evenness indices of Pielou (1966)

and tops of hills. The communities on sun-facing steep slopes, which are usually consociations or associations with co-dominant species, such as the *Lasiococca comberi* var. *pseudoverticillat -Cleistanthus sumatranus* community, have relatively lower diversity index values than the communities on sun-facing gentle slopes.

Compared with seasonal rain forests on non-limestone, the limestone seasonal rain forests show lower index values (Table 11) and this agrees with Cao's results (Cao and Zhang, 1997). The communities of seasonal

Table 11. Comparison of species diversity between the limestone seasonal rain forest and the seasonal rain forest on non-limestone

Forest type	Plot	Area (m^2)	Alt. (m)	Habitat	Sl (°)	NS	NI	H'	E
1. Tropical seasonal rain forest on limestone									
a. Ravine seasonal rain forest	102-16	2400	700	Wet valley terrace	0-5	45	140	3.2627	0.8571
	HW9203	2500	700	Wet slope	25	23	118	2.4269	0.774
	HW9202	2500	740	Shade lower slope	10	19	164	2.0464	0.693
b Lower hill seasonal rain forest	940301	2500	800	Shade slope	40	27	102	2.5277	0.7669
Tropical seasonal rain forest on non-limestone									
a. Ravine seasonal rain forest	940102	2500	650	Wet valley slope	5-10	49	108	3.586	0.9263
	940103	2500	675	Wet valley slope	30	57	194	3.573	0.8727
	940101	2500	700	Wet valley slope	25	48	96	3.599	0.9297
b Lower hill seasonal rain forest	931206	2500	650	Lower hill slope	10	52	182	3.3765	0.8545
	9201	2500	680	Lower hill slope	30	46	207	3.1594	0.825

Sl: slope; NS : Number of (≥5 cm dbh); NI: Number of individuals (≥5 cm dbh); H': Shannon-Wiener's diversity indices (Shannon-Wiener, 1949); E: Evenness indices of Pielou (1966)

rain forest on non-limestone have almost identical values for diversity index and evenness, while the communities of limestone seasonal rain forest show a clear disparity in the values. This implies that the limestone seasonal rain forest has higher community diversity than the rain forest on non-limestone substrates.

Acknowledgements

This project was funded by the Chinese Academy of Sciences (part of the project KZ951-A1-104-03) and the Yunnan Science & Technology Committee. I thank Prof Xu Zaifu, Director of Xishuangbanna Tropical Botanical Garden and Prof Wu Zheng-yi, Prof Zhang Hong-da, my academic advisors, and my colleagues Mr Cao Min and Mr Zhang Jianhou for their great help with my research. I also wish to acknowledge the

Department of Plant Sciences, University of Cambridge and especially the Ecology Group in the Department for help of various kinds. I particularly thank Dr E. Tanner and Dr P.Grubb for their great help in analyzing my data and writing this paper during my year's stay at the University of Cambridge as a visiting scholar. Finally, I particularly thank Dr T.C.Whitmore who has greatly supported and helped me in my research .

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Gardens' Bulletin Singapore **50** *(1998) 31–34.*

Codiaeum variegatum var. *cavernicola* var. nov. (Euphorbiaceae), the second *Codiaeum* from Borneo

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Abstract

Codiaeum variegatum (L.) Blume var. *cavernicola*, a cave dwelling shrub, is described from two limestone hills (Dulong Lambu and Madai) in Sabah, Malaysia.

Introduction

Merrill (1926) had already noted that *Codiaeum* is extremely poorly represented in Borneo; in his time there being a single wild species, *C. affine* Merrill. *C. affine* is still known only from the type collection from Banggi Island, Sabah.

A second taxon is described here. It differs from *C. affine* in its broader leaves 5.5–8.5 cm wide, with longer petioles 9–13 cm long (as opposed to *C. affine* with leaves 4 cm wide and petioles 5–7 cm long), fewer stamens (25 versus about 50 in *C. affine*), and trifid style (bifid in *C. affine*).

Merrill (1926) considered *C. affine* to belong to a group of Philippine species that have bifid styles, e.g. *C. luzonicum* Merr. and *C. palawanense* Elmer. The latter two have much larger laminas (up to 45 by 10 cm) than *C. affine* (15–25 by 4–6 cm). According to Merrill the main difference between *C. affine* and the other two is in the presence in *C. affine* of an upper sessile leaf subtending the inflorescence, which seems to be present in at least some specimens (called bract in our description), and absent from *C. luzonicum* and *C. palawanense*. This bract in *C. affine* is c. 9 by 4 cm, much larger than the one in the variety we describe here (up to 3.25 by 2.5 cm in *C. variegatum* var. *cavernicola*).

In the trifid style, fewer stamens and the five disc glands of the staminate flower, the new taxon is closer to wild plants of *C. variegatum* (L.) Blume, which is a species of the W. Pacific and Polynesian islands reaching its most northerly limit on the coasts of E. Java. It is not known wild in Borneo, although cultivated forms of *C. variegatum* are widely planted. The new variety differs from other wild populations of *C. variegatum*, which have shorter petioles (0.5–5 cm long), longer pedicels (3 cm long at the staminate flower and short, thick styles. These distinctions, coupled with its unique habitat, warrant its recognition as an ecovariety of the widespread *C. variegatum.*

Codiaeum variegatum (L.) Blume var. ***cavernicola*** Kiew & Welzen **var. nov.**

Typus: *Kiew & Lim BDL-1*, 29 Oct 1996 (staminate plant) - holo SING.

A *Codiaeo affini* foliis latioribus et staminibus paucioribus. a *C. variegato* pedicellis masculinis brevioribus, ab ambobus petiolis longioribus differt.

Erect shrub 0.5–2 m tall. *Stem* glabrous, slender up to 4–5 mm thick in dried state. *Leaves* spiral, thinly subcoriaceous, glabrous, matt above: petiole slender, 9.25–13.25 cm long, lamina slightly oblanceolate to broadly oblong, 17.5–25 cm by 5.5–8.5 cm, index 2.9–3.2, base cuneate, margin entire, apex bluntly acuminate, midrib plane above, prominent beneath, veins 9–14 pairs, scarcely prominent above and beneath, perpendicular to midrib and margin, looped and closed near the margin, tertiary venation faint. Bracts foliaceous, sessile, broadly oval, 2.5–3.25 by 2.3–2.5 cm, bracteoles c. 1 mm long. *Inflorescences* axillary racemes, slender, erect, glabrous, one per axil. unbranched, 5-merous. Staminate inflorescences 12–15 cm long, of which the peduncle 0.75–5.5 cm long. *Staminate flowers* in clusters of up to 3 spaced 1–3 mm apart with the flowers developing in succession: mature buds globose, 3 mm diam.; pedicels slender, up to 10 mm by 0.75 mm; in open flower calyx lobes strongly reflexed. calyx c. 5 mm long, lobes c. 2.5 by 2.5 mm, margin recurved; corolla thin and delicate, c. 2 mm long with narrow base, broadening distally to 3 mm wide, apex shallowly bilobed and reflexed; disc glands 5, fleshy, c. 1 by 1.25 mm, grooved above; stamens c. 25, filament 1.5–4 mm long, anther spathulate, c. 1 by 1 mm, connective broad; pistillode absent. Pistillate inflorescences 17–36.5 cm long, of which the peduncle 7–20 cm. *Pistillode flowers* solitary, 3–13 mm apart, sessile or with pedicel up to 3 mm long, calyx orbicular-ovate, glabrous. c. 1.5 by 1 mm; corolla absent: disc absent; ovary glabrous. columnar with 3 longitudinal grooves corresponding to 3 locules. 3–4 mm by 2–2.5 mm, 1 ovule per locule, style trifid, filiform, c. 6 mm long. *Fruit* a regma, apex and base flattened, c. 8 by 10 mm, glabrous, septicidal, splitting into 3 cocci, later twisting and falling from central column on drying; pedicel elongating to 4 mm long and stout, c. 1.5 mm thick; calyx and style base persistent, epicarp fleshy, c. 0.3 mm thick; mesocarp fibrous, c. 0.75 mm thick. *Seeds* ovoid, c. 6 mm long, 4.5 mm wide and 5.5 mm thick; testa smooth and hard, c. 0.5 mm thick, brown and minutely speckled black; endosperm copious.

Distribution: Borneo, variety endemic to Sabah (Dulong Lambu and Madai). Bulit Dulong Lambu is commonly, though incorrectly, referred to as Gomantong Cave (Lim and Kiew, 1997).

Codiaeum variegatum is distributed from the Pacific Islands to E. Java, the two Sabah populations represent the species' most northerly limit of geographical distribution. In E. Java, wild populations of *C. variegatum* are found only in coastal areas in Nusa Burung. Since coastal areas are relatively well collected, its absence from this habitat in Borneo is not due to an artefact of botanical collection.

Ecology: Elsewhere *Codiaeum variegatum* grows in open areas but in Sabah the new variety is restricted to limestone, where it grows inside caves.

Specimens examined: BORNEO: Sabah - Bukit Dulong Lambu, Simud Hitam Cave *Kokawa & Hotta 533* 31 October 1968 (SAN), *Meijer SAN 136164* 21 June 1992 (unicate SAN); *Kiew & Lim BDL-1* 29 October 1996 (unicate SING), *BDL-2* (unicate L); Madai Cave *A. Berhaman et al. AB 90* 10 June 1996 (SAN. SING).

Notes: *Codiaeum variegatum* var. *cavernicola* is presently known from two localities, both on limestone, and brings to eight the number of Bornean euphorbs restricted to limestone (Airy Shaw, 1975), of which four are endemic to Borneo (three from Sarawak and *C. variegatum* var. *cavernicola* from Sabah). The varietal epithet reflects its cave-dwelling habitat. The two caves from which it is known are famous for their bird's nests. The annual harvest from the Simud Hitam Cave is estimated at about one million Malaysian dollars.

That it is not widespread is probably due to its extremely specialised niche. It grows within caves on limestone rubble rooted in guano, where light reaches the floor of the cave. In the case of Simud Hitam Cave, collapse of a large part of the upper cave wall has opened a 'window' through which skylight penetrates to the cave floor. In this cave, var. *cavernicola* forms a dense shrubby thicket but does not extend into areas with a soft, deep layer of guano. This habitat has not so far been encountered on other limestone hills in Sabah, which perhaps accounts for its absence elsewhere.

These two isolated populations exhibit some differences. The Madai Cave population includes plants with leaves with a large number of veins (13 or 14 pairs as opposed to 9–11 in leaves of the Simud Hitam Cave population) and longer pistillate inflorescences (up to 36.5 cm versus 17 cm in Simud Hitam Cave plants) with longer pedicels (up to 3 mm versus sessile in Simud Hitam Cave plants).

Acknowledgements

The first author thanks the Ministry of Science, Technology and the Environment, Malaysia, for funding field work under IRPA research grant 52858 and to Universiti Putra Malaysia for research leave to visit European herbaria, to A. Berhaman, Lim S. P. and staff of the Forest Research Centre, Sandakan for help and support in the field and to the Keepers of the Herbaria at BM, K, L and SAN for permission to examine specimens in their care. The second author would like to thank M. M. J. van Balgooy for his help in genus identification of the plant. The pertinent comments of A. Radcliffe-Smith on the manuscript are much appreciated.

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Gardens' Bulletin Singapore **50** *(1998) 35–37.*

The Angiosperm Flora of Singapore Part 8 Cannaceae

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Canna L.

Sp. pl. 1 (1753) 1; Woodson & Schery, Ann. Mo. bot. Gdn 32 (1945): 74–80.

Erect, perennial herbs. *Leaves* alternate, distichous, the sheaths opening gradually and passing into a petiole and a large, oblong, acute or acuminate lamina with a distinct midrib. *Inflorescence* a terminal raceme. *Flowers* bisexual, asymmetrical; petals 3, basally connate with the innermost staminode (labellum), style and 1 petaloid stamen with a 1-celled anther attached to its margin; sepals 3, free, imbricate; staminodes excluding labellum 2–3; ovary inferior, trilocular, containing many anatropous ovules, subglobose. *Capsule* globose to ovoid, conspicuously warty, crowned by the persistent sepals. *Seeds* many per fruit.

Distribution — Native of South America, now naturalized or cultivated in the tropics and subtropics. Only *C. indica* is naturalized in Singapore.

Ecology — Most species inhabit forest margins, open fields or along streams and disturbed areas.

Uses — *C. edulis* and its allies are cultivated for their starchy rhizomes in the tropics. In Vietnam, noodles are made from the rhizome starch of *C. discolor.* In Middle America the leaves and raw tubers are fed to pigs (Morton, 1981). In W. Africa a fibre can be extracted from *Canna* species and is of a quality to substitute jute in the making twine and sacking. (Burkill, 1985). *Canna* spp. and hybrids are also commonly cultivated in the tropics and subtropics as ornamentals. *C. glauca* is also cultivated as an ornamental aquatic.

1. *Canna indica* L.

Sp. pl 1 (1753) 1; Ridl., J. Straits Brch R. Asiat. Soc. 33 (1900) 166;

H.T.W.Tan *et al.*, Gdns' Bull., Singapore 44 (1992) 128; I.M.Turner, Gdns's Bull., Singapore 45 (1993) 49; I.M. Turner, Gdns' Bull., Singapore 47 (1995) 515.

C. orientalis Roscoe, Monandr. pl. Scitam. (1826) t. 12; Ridl., Fl. Malay Penins. 4 (1924) 291.

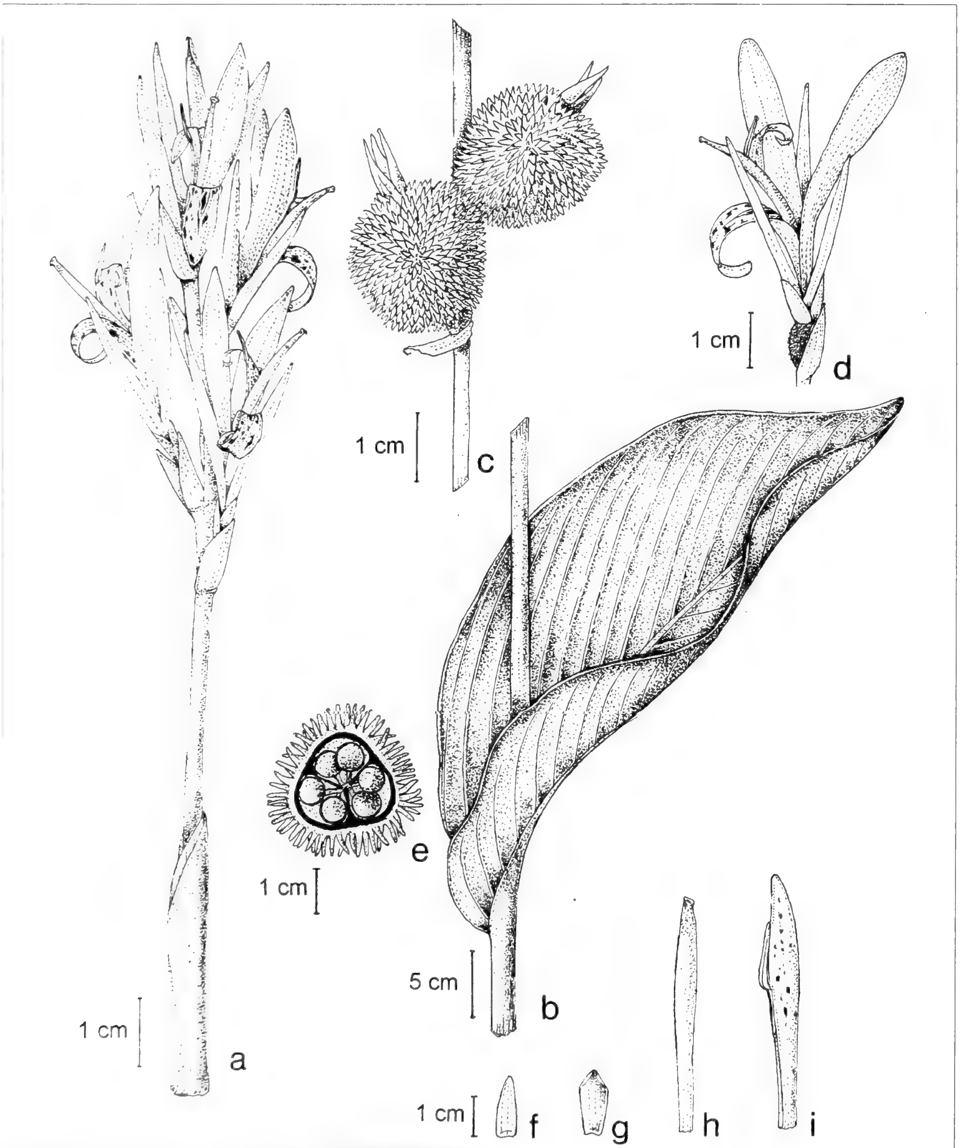

Figure 1. ***Canna indica*** L. a. Inflorescence. b. Leaf and part of stem. c. Two capsules on part of rachis. d. Flower. e. Cross section of ovary. f. Sepal. g. Floriferous bract. h. Style and stigma. i. Stamen.

Plants 1.5–2.0 m tall. *Laminas* green and glaucous on both surfaces, oblong to oblong-elliptic, 30–60 cm long, 15–25 cm wide, acute to shortly acuminate, margin membranous, gradually sheathing to the stem. *Inflorescence* spike-like. *Flowers* usually solitary, sometimes paired; petals 3, erect, red to reddish white, oblong-lanceolate, 4.0–4.5 cm long, narrowly acuminate; sepals 3, pale green, sometimes reddish or white, oblong-lanceolate, c. 1 cm long, glaucous; floriferous bracts green, sometimes reddish, oval-orbicular, 1.0–1.5 cm long, glaucous, persistent; staminodes 2–3, obovate to spathulate, 5.0–6.0 cm long; labellum reflexed, red-spotted yellow towards the base, often dentate at the apex; style yellowish basally, narrowly oblanceolate. *Capsules* green when unripe, subglobose, 3.0–3.5 cm long, 2.0–2.5 cm wide, conspicuously warty. *Seeds* black, globose, c. 5 mm in diam., hard; radicle dark brown to black.

Distribution — Singapore: naturalized along roadsides; Ponggol Road, Sungei Buloh Nature Park, Upper Thomson Road, Woodlands Road, etc. Thailand, Peninsular Malaysia, Borneo, Java, Japan, etc.

Ecology — In open field and forest margins.

Uses — Cultivated in beds as an ornamental. In Africa, the seeds are made into necklaces and rosaries (Purseglove, 1972) and also yield an attractive, evanescent purple dye (Burkill, 1985). In India, the stalks are chopped up and boiled in rice-water with pepper and fed to cattle as an antidote after eating poisonous grasses. The leaves are commonly used to wrap parcels (Burkill, 1985).

Acknowledgements

This work was supported by the Overseas Scholarship of Graduate Student of Nihon University.

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Nomenclatural Changes for Four Malayan Species in *Phrynium* (Marantaceae), *Solanum* (Solanaceae), *Stachyphrynium* (Marantaceae) and *Boesenbergia* (Zingiberaceae)

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Abstract

A new name is provided to substitute for a later homonym in Marantaceae. *Phrynium venustum* I.M. Turner, *nom. nov.*, replaces *Phrynium gracile* Holttum. *Solanum maingayi* Kuntze (Solanaceae) is shown to be the correct name for what has generally been referred to as *Solanum sarmentosum* Nees. *Stachyphrynium cylindricum* K. Schum. (Marantaceae) and *Boesenbergia flava* Holttum (Zingiberaceae) have to be considered new names because they were published as new combinations based on later homonyms. These illegitimate names, *Phrynium cylindricum* Ridl. and *Gastrochilus flavus* Ridl., are lectotypified.

A new name for a Malayan *Phrynium*

In his monograph of the Malayan Marantaceae, Holttum (1951) described a new species from the freshwater swamp forests of Johore as *Phrynium gracile*. Unfortunately, this combination had already been employed by Schumann for a species from New Guinea. A new name is provided for the Malayan plant.

Phrynium venustum I.M. Turner, *nom. nov.*
Phrynium gracile Holttum, Gard. Bull., Singapore 13 (1951) 282, *nom. illegit., non* K. Schum. (1905). *Type*: Peninsular Malaysia, S.E.JOHORE, Mawai-Jemaluang Road, Sungai Kayu Ara, *E.J.H. Corner S.F.N. 29981*, 5 January 1935 (holotype, SING!; isotype, K!).

Holttum *loc. cit.* gives the collecting locality of the type (*Corner S.F.N. 29981*) of this species as an uncertain site in Southeastern Johore, and refers to another, unnumbered, Corner collection from Sungei Kayu Ara. However, *S.F.N. 29981* specimens at SING and K are both clearly labelled as originating from Sungei Kayu Ara. This anomaly is not easily explained.

The correct name for *Solanum sarmentosum*

The prickly, prostrate Malayan nightshade generally known as *Solanum sarmentosum* Nees cannot correctly be referred to as such, as the combination was used earlier by Lamarck. Ridley, in his *Flora of the Malay Peninsula* synonymized *Solanum maingayi* Kuntze to *S. sarmentosum* Nees. Inspection of the type of Kuntze's species at Kew confirmed the correct placement by Ridley, and hence means that the Malayan plants must be referred to as *Solanum maingayi.*

Solanum maingayi Kuntze, Rev. Gen. Pl. 2 (1891) 454. *Type*: Peninsular Malaysia, MALACCA, *A.C. Maingay 1158*, 1867 (holotype, K!).
Solanum sarmentosum Nees, Trans. Linn. Soc. London 17 (1837) 58, *nom. illegit., non* Lam. (1794).

The correct citation for *Stachyphrynium cylindricum*

Stachyphrynium cylindricum is a member of the Marantaceae found growing on limestone in the Malay Peninsula (Holttum 1951). The combination was published by Schumann based on Ridley's *Phrynium cylindricum.* However, this is an illegitimate later homonym. The International Code for Botanical Nomenclature Article 58.1 allows a new combination based on a later homonym to be considered as an avowed substitute (*nomen novum*) or a new name. As Schumann clearly intended to make a new combination based on the type of *Phrynium cylindricum* Ridl., *Stachyphrynium cylindricum* should be considered a *nomen novum* for the former. Ridley did not designate a holotype from among the two collections of *Phrynium cylindricum* he cited. I therefore take this opportunity of lectotypifying the species.

Stachyphrynium cylindricum K. Schum., *nom. nov.*, Pflanzenr. 4 (1902) 49; Holttum, Gard. Bull., Singapore 13 (1951) 278.
Phrynium cylindricum Ridl., J. Straits Branch Roy. Asiat. Soc. 32 (1899) 178, *nom. illegit., non* Roscoe (1828). *Syntypes*: Peninsular Malaysia, Perak, Ipoh, *C. Curtis 3318*, August 1898 (SING!, 2 sheets); Kwala Dipang, *H.N. Ridley 9787*, 1898 (lectotype, selected here, K!).

The correct citation for *Boesenbergia flava*

An identical nomenclatural circumstance to the previous example surrounds the Malayan endemic ginger *Boesenbergia flava.* Holttum transferred the species from its original position in *Gastrochilus*, where it was a later homonym. Therefore, the combination must be considered a *nomen novum* with the same epithet as the illegitimate basionym. *Gastrochilus flavus* Ridl. is lectotypified.

Boesenbergia flava Holttum, *nom. nov.*, Gard. Bull. Singapore 13 (1950) 113.
Gastrochilus flavus Ridl., Fl. Malay. Penins. 4 (1924) 248, '*flava*', *nom. illegit.*, *non* (Hook.*f.*) Kuntze (1887). *Syntypes*: Peninsular Malaysia, PERAK, Batang Padang, *C. Curtis s.n.* (lectotype, selected here, K!); Bujong Malacca, *H.N. Ridley s.n.,* September 1898 (SING!); Bukit Kepaiyang, *H.N. Ridley s.n.*, February 1904 (SING!).

Acknowledgements

The Director of the Singapore Botanic Gardens and the Keeper of the Herbarium, Royal Botanic Gardens Kew, kindly allowed the author access to the collections in their respective herbaria. Martin Cheek, Jill Cowley and Alan Paton are thanked for their help at Kew. An anonymous reviewer and Dr K. Gandhi provided invaluable assistance with nomenclature.

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Gardens' Bulletin Singapore **50** *(1998) 43–48.*

Begonia lazat (Begoniaceae), a New Culinary Begonia from Borneo

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Abstract

A striking new large-fruited begonia is described from the floodplain forest in the lower reaches of the Kinabatangan River, Sabah. Although rare, this begonia is known by some older local residents as a culinary delicacy when eaten with prawns and chilli.

Introduction

At just over 560 km long, the Kinabatangan River is the largest river in Sabah and, where it begins its lower course, flows through a floodplain that remains one of the largest forested floodplains in Malaysia (Figure 1). This floodplain is one of the most important conservation areas in Sabah as well as being a major nature tourist destination where the proboscis monkey, a Bornean endemic, is reliably and highly visible along some of its tributaries.

Besides supporting a variety of wildlife, the Kinabatangan floodplain also includes an array of lowland habitats - remnant dipterocarp forest, freshwater swamp forest and open swamps, riverine forest, ox-bow lakes and limestone outcrops (Reza Azmi, 1996). In addition, a truly bewildering richness of natural resources characterises this vast floodplain. Reza Azmi (1996) recorded over a hundred useful plants with 22 species used for structural purposes (house and boat building, fencing, etc.), 12 for firewood, 35 as food, 73 in traditional medicine, and a further 27 species for miscellaneous uses (making fish-traps, *parang* (Malay=machete) handles, for ceremonial or pagan practices, etc.).

There is, however, increasing pressure for forest conversion from the expansion of agricultural estates (Payne, 1989). The vulnerability of the floodplain region has prompted the Sabah Government to recognise the Kinabatangan floodplain region as one of the highest priority habitats for conservation.

These floodplain habitats were surveyed by WWF-Malaysia in 1994. With the help of local residents, an initiative was started to document the uses of local plants by village residents living near the remnant floodplain

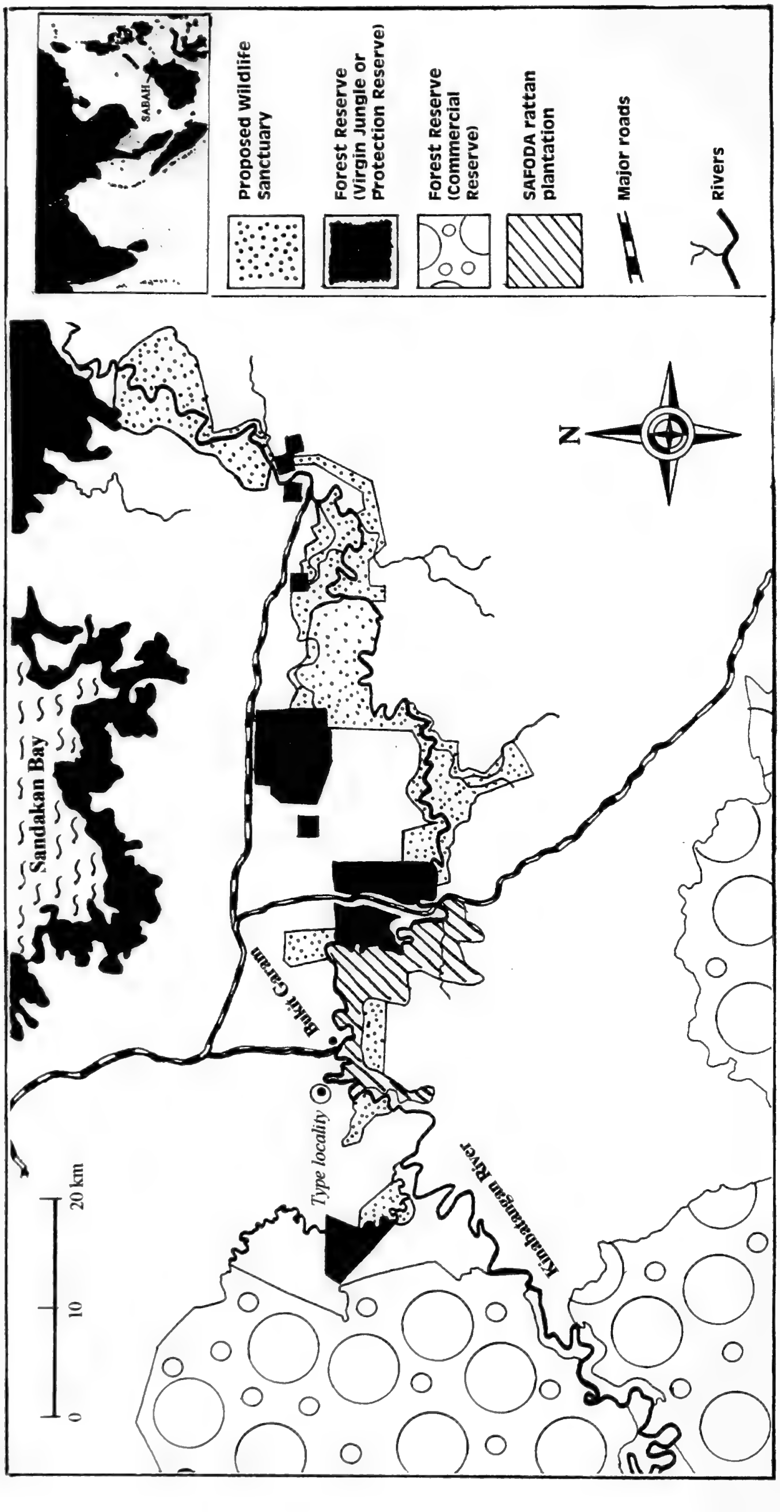

Figure 1. The lower Kinabatangan region showing the location of the type locality and major protected areas.

forests (Reza Azmi, 1996). The new begonia described here was discovered during this study with the help of two knowledgeable elders from Buang Sayang village, which lies near the banks of the lower Kinabatangan River (Figure 1). The wife of one of our local collectors recounted how leaves of this plant are used as a vegetable and that it is delicious when cooked with prawns and chilli.

Despite this begonia being known to the informants, attempts to relocate the plant or other individuals of it a year later proved fruitless and no other specimens have been discovered since the first collection. It is possible that this species may have a narrow habitat preference as it appears to be restricted to early secondary growth of indundated forest, the habitat where it was first discovered.

Begonia lazat Kiew & Reza Azmi **sp. nov.**

Holotype: *Reza Azmi RA206* near Kampung Buang Sayang, Kinabatangan District, Sabah, Borneo (SAN, unicate, fruits in spirit).
Figure 2.

Ab aliis speciebus Begoniae Borneensibus in sectione Petermannia fructibus magnis bene distincta, sed combinatione petiolis longitudine laminis aequante, laminis latioribus quam longioribus et textura in sicco tenuissimis, inflorescentia compacta et fructu basi attenuatis.

Cane-like glabrous begonia branching from base. *Stems* erect, reddish, slightly fibrous, 75–100 cm tall, 0.4 mm thick in dried state. *Leaves* alternate. Petiole as long as lamina, 9.5–12 cm long in fully grown leaves, dark red. Lamina of young leaves ovate (longer than broad) and almost symmetrical becoming suborbicular and slightly unequal when fully expanded, 9.5–12 by 12–12.5 cm, basal lobes rounded, 4–4.5 cm long (not overlapping), margin minutely serrulate, apex shortly acuminate, main veins 5, radiating from base, bifurcating two to three times before reaching the margin with up to 2 minor veins in basal lobes, veins impressed above and prominent beneath, in life glossy dark green with large and small silvery blotches arranged more or less in a line between veins, pale green beneath, succulent in life, drying tissue-paper thin and transparent. Stipules pale green, elliptic, up to 20 by 8 mm, entire, apex apiculate, drying thinly papery, caducous on the lower nodes. *Inflorescence* axillary, bisexual, a compact panicle with total length c. 2.25 cm, peduncle stout 1.5–7 mm long with 2–3 female flowers at base, male rachis erect c. 12–18 mm long lateral branches up to 3 mm long with dense clusters of male flowers. Bracts pale green, broadly ovate, 14 by 10 mm, partially enclosing the inflorescence, bracteoles similar in shape and decreasing in size towards apex of inflorescence. *Female flowers*: pedicel in flower 3 mm long, straight with the flower held horizontally, in fruit 5–7 mm becoming thickened and recurved so the fruit is pendant; ovary pale green, cylindric, c. 10 mm long and 5 mm wide, 3-loculate, placentas bilamellate, wings 3 and isomorphic; tepals white, 5, broadly elliptic, the largest 8.5 by 5 mm, apex rounded, entire; styles 3, bifid, falling in fruit. *Male flowers*: numerous, small, pedicels slender up to 11 mm long; tepals 2, glabrous, isomorphic, rosy red outside, broadly oblong, 6.5–8 by 5–5.5 mm,

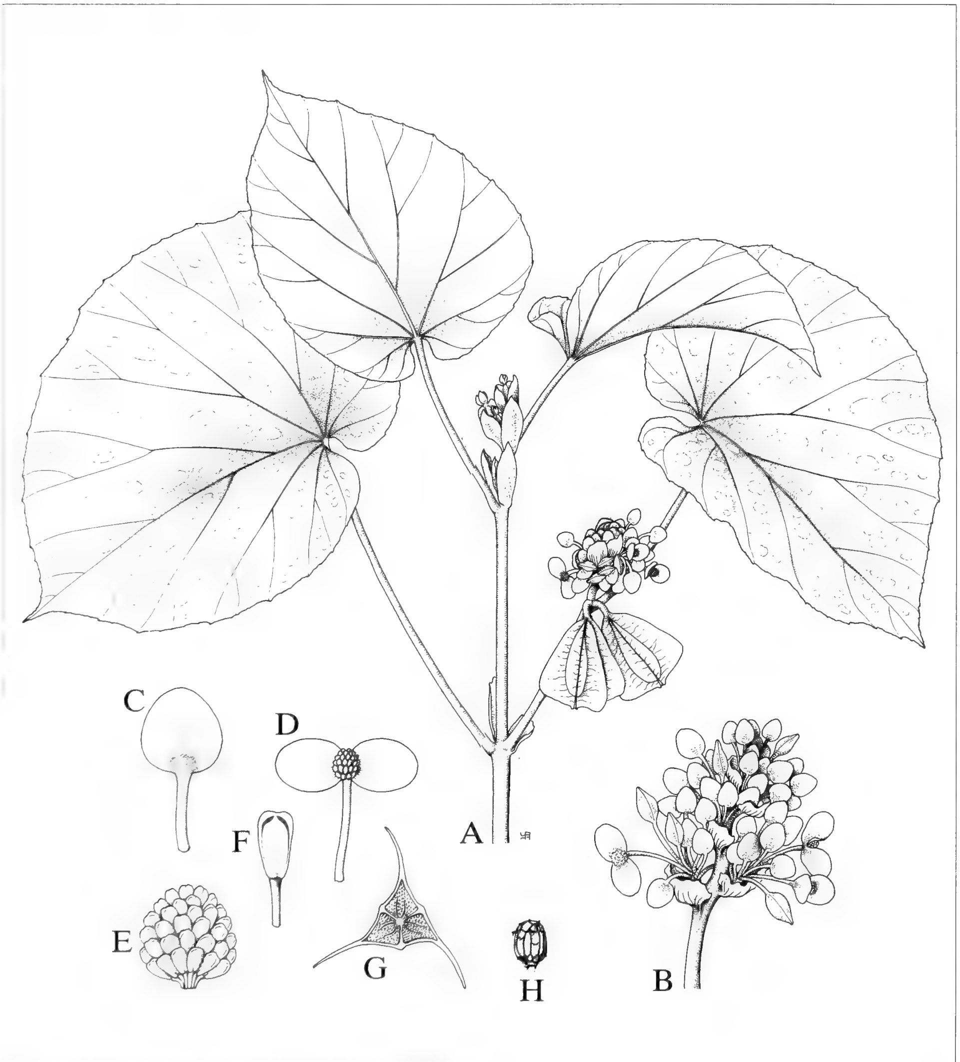

Figure 2. *Begonia lazat.*
A Habit (x 0.3), B Inflorescence with male flowers (x 0.6), C Male bud (x 2), D Open male flower (x 1.3), E Androecium (x 3.3), F Stamen (x 7), G T.S. Ovary (x 0.6), H Seed (x 13).

entire, apex rounded; androecium c. 50 stamens, sub-spherical, staminal column c. 4 mm long, filaments c. 1 mm long, anthers narrowly oblanceolate, 1 by 0.5 mm, apex truncate. *Capsule* pale green ripening brown and papery, obconic, 3.5 cm long and 2.75 cm wide, wings thin c. 9 mm wide, base narrowing into pedicel, apex truncate by the rounded wing angle. *Seeds* broadly oblong, less than twice as long as broad, c. 0.3 mm long.

Distribution: Known only from type locality at Kampung Buang Sayang (5°30'N 117° 50'E).

Habitat: Growing on a lightly shaded, low earth bank in disturbed seasonally innundated forest close to Kinabatangan River, not common. Apparently intolerant of competition as it is eliminated by subsequent growth of a shrubby layer.

Notes: *Begonia lazat* is one of several cane-like *Begonia* species with large fruits 3.5 cm long, such as *B. erythrogyna* Sands and *B. tawaensis* Merr., which belong to section Petermannia. Like *B. erythrogyna*, it is atypical of this section in the male flower possessing two instead of four tepals. However, it is unique among Bornean begonias in possessing the following combination of characters: large fruits, which narrow towards the base and have a short stalk; extremely thin glabrous leaves, which are broader than long; petioles as long as the lamina; and inflorescences where the terminal part with small male flowers is extremely short.

'Lazat' (Malay=delicious) indicates the use of its leaves as a sourish vegetable, which together with chilli are cooked with prawns. It is not unique in this respect as several other Malesian begonia species, which have glabrous, tender leaves, are also used, particularly for flavouring fish and prawn dishes.

Acknowledgements

The field work, which led to the discovery of this species, was conducted under WWF-Malaysia Project MYS304/94 entitled 'Conservation of the Kinabatangan Floodplain Flora, Habitats and the Role of Local Communities'. RA wishes to thank the Forest Research Centre, Sepilok, and SAN, who freely provided facilities to WWF during the period of study. RK thanks the Curators of the herbaria at BM, E, K, SAN and SING for permission to examine specimens in their care and for funding from the Ministry of Science, Technology and the Environment under IRPA Programme grant 08-02-04-025. The authors also thank Mdm P.H. Yap for the accomplished drawing.

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Gardens' Bulletin Singapore ***50*** *(1998) 49–57.*

The Types and Original Specimens of Published Names of Mosses Preserved in the Herbarium of Singapore Botanic Gardens (SING)

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Abstract

A total of 51 types and original specimens of published names of mosses, mostly collected from West Malesia, are preserved at the herbarium of Singapore Botanic Gardens (SING). Information about the locality, collector and collector's number, date of collection, nomenclatural status, and the currently accepted name, for each of the types and original specimens are presented.

Introduction

The well known herbarium of Singapore Botanic Gardens (SING) has a small, less known and little used collections of bryophytes. The specimens were collected mainly from Peninsular Malaya, Singapore, Sabah formerly British North Borneo and Sarawak. The entire bryophyte collections consist of about 10,000 packets, of which 51 are types and original material of published names of moss taxa. In addition, there are 13 moss specimens with unpublished herbarium names and marked as new species by the eminent English muscologist, Mr. H. N. Dixon, who also identified many of the moss collections at SING. Furthermore, a nearly equal number of specimens were indicated to be types of various hepatic taxa. The information on the hepatic types at SING will be dealt with in a separate report.

In preparing the list of moss types kept at SING, I have endeavored to confirm the nomenclatural status of all the specimens marked as types. Because many of the new species were described by Dixon, the holotypes are, presumably, with The Natural History Museum in London (BM) where the herbarium of Dixon was relocated after his death in 1944. The duplicate specimens at SING, even though represented by a larger quantity in several instances, can only be the isotypes or isoparatypes. It is interesting to note that some type packets at SING include handwritten field data not published in the species' protologue.

I also include in the present listing original materials of a handful of *nomina nuda* inadvertently published by Dixon based on the moss collections at SING. Often, this original material is needed to elucidate the intent of the author or to resolve the taxonomic enigma of a "nomen nudum". Some have subsequently been shown to represent distinct species.

Lastly, to help users of the type collections at SING, I have indicated the currently accepted name as a note under the binomial of the moss taxon concerned.

Catalogue of Species

Acroporium macroturgidum Dix.
[Isotype] Malaysia, Pahang, G. Tahan, 28 Aug 1928, *RE Holttum 20920.*

Acroporium surculare Dix.
[Isolectotype] Malaysia, Perak, Bidor Road, Tapah, Nov 1908, *HN Ridley 153.*
Note: Recombined as *Isocladiella surcularis* (Dix.) B.C. Tan and H. Mohamed, the name of this species was lectotypified by Tan and Mohamed (1990).

Breutelia kinabaluensis Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, 9000 ft, 16 Nov 1931, *RE Holttum 25337.*

Calymperes carrii Dix.
[Isotype] Papua New Guinea, Kanosia, Feb 1935, *CE Carr 11473.*
Note: This taxon was treated as a synonym of *Calymperes crassinerve* (Mitt.) Jaeg. in Reese *et al.* (1986). The isotype was distributed as a number of *Musci Selecti et Critici, Ser.* III , 1936.

Chionoloma latifolium Dix.
[Isotype] Malaysia, Langkawi, Pulau Dayang Bunting, 23 Aug 1925, *RE Holttum 15130.*

Cladopodanthus microcarpus Dix.
[Isotype] Malaysia, Sarawak, Mt. Dulit, Ulu Koyan, 22-25 Sep 1932, *PW Richards M2034.*

Clastobryella asperrima Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, Pakka, 15 Nov 1931, *RE Holttum 25646.*

Dicranoloma angustifrondeum Dix.
[Isotype] Malaysia, Sabah, Tenompok, 4000 ft, 17 Jun 1925, *CM Enriquez 18111.*
Note: A synonym of *Dicranoloma braunii* (Dozy & Molk.) Par. (Tan 1989).

Dicranoloma brevicapsularis Dix.
[Isotype] Malaysia, Pahang, G. Tahan, 12 Jun 1922, *Mohd. Haniff Nur 7915a.*
Note: A synonym of *Dicranoloma billarderi* (Brid. Ex Anon.) Par. (Tan 1989).

Dicranoloma euryloma Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, Tenompok, Lumu-Lumu, 12 Nov 1931, *RE Holttum 25633.*
[Isoparatype] Malaysia, Sarawak, Mt. Dulit, Ulu Koyan , 15 Sep 1932, *PW Richards M1853.*
Note: A synonym of *Dicranoloma assimile* (Hampe) Ren. (Tan 1989).

Diphyscium rhynchophorum Dix.
[Isotype] Malaysia, Sarawak, Mt. Dulit, Ulu Koyan, 15 Sep 1932, *PW Richards M1868.*
Note: The specimen bears the annotation of M. Manuel in 1978 as an isotype. According to Hyvönen (1989a), this species is a synonym of *Diphyscium loriae* C. Muell.

Distichophyllum sinuosulum Dix.
[Isotype] Malaysia, Perak, Birch's Hill, 3 Mar 1924, *IH Burkill 12606.*
Note: A synonym of *Distichophyllum cirratum* Ren. & Card. (Mohamed and Robinson 1991).

Endotrichella formosa Dix., *nom. nud.*
[Original material] Malaysia, Pahang, Kota Gelanggi, 4 Aug 1929, *MR Henderson 22405.*
Note: A synonym of *Garovaglia elegans* (Dozy & Molk.) Bosch & Sande Lac. (Mohamed and Tan 1988).

Fissidens albolimbatus Dix.
[Isotype] Malaysia, Sarawak, Long Kapa, Mt. Dulit, Ulu Tinjar, 31 Aug 1932, *PW Richards M1587.*
Note: A synonym of *Fissidens ceylonensis* Dozy & Molk. *fide* Tan and Iwatsuki (1989).

Fissidens pachyphyllus Dix.
[Isotype] Malaysia, Sarawak, Mt. Dulit, Ulu Koyan, 22 Sep 1932, *PW Richards M2039.*

Fissidens perpellucidus Dix.
[Isoparatype] Malaysia, Sarawak, Mt. Dulit, Ulu Tinjar, 29 Aug 1932, *PW Richards M1589.*
Note: A synonym of *Fissidens pallidus* Hook. f. & Wils. *fide* Tan and Iwatsuki (1989).

Forsstroemia rigida Dix.
[Isotype] Papua New Guinea, above Port Moresby, Boridi, Nov 1935, *CE Carr 13559.*
Note: The specimen was distributed as a number of *Musci Selecti et Critici, Ser.* V, 1938. The species was synonymized with *Neolindbergia vitiensis* (Bartr.) Enroth by Akiyama *et al.* (1991) who also reported the Carr specimen at BM as the lectotype. However, only one specimen (*Carr 13559*) was mentioned in the protologue (Dixon 1943), so there is no need for lectotypification.

Hypnodendron copelandii Broth. var. *latifolium* Dix.
[Holotype] Malaysia, Sabah, Mt. Kinabalu, Lamu-Lamu, 5000 ft, 18 Jun 1925, *CM Enriquez 18146.*
Note: In the protologue, Dixon (1935: 96) indicated the holotype of his new variety to be at SING. The specimen was annotated by A. Touw in December of 1968 as *Hypnodendron diversifolium* Broth. & Geh. (Touw 1971).

Hypnodendron wrayi Broth. ex Dix., *nom. nud.*
[Original material] Malaysia, Perak, G. Batu Puteh, 4500 ft, *L Wray Jr. 301.*
Note: Specimen annotated by A. Touw in December of 1968 as *Hypnodendron diversifolium* Broth. & Geh. (Touw 1971).

Leptodontium kinabaluense Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, 13,400 ft, 14 Nov 1931, *RE Holttum 25685.*

[Isoparatype] Ibid, *RE Holttum 25688.*
Note: A synonym of *Leptodontium flexifolium* (Dicks.) Hampe (Zander 1993).

Leptodontiopsis orientalis Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, 1,500 ft, 14 Nov 1931, *RE Holttum 25668.*
[Isoparatype] Ibid, *RE Holttum 25689.*

Mastopoma papillatum Dix., *nom. nud.*
[Original material] Malaysia, Kelantan, G. Sitong, 2600 ft, 6 Mar 1924, *Mohd. Haniff Nur 12234.*
Note: The name was published invalidly by Dixon in 1926.

Macromitrium ochraceoides Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, between Kamborangah and Pakka, 7,200-10,200 ft, 13 Nov 1931, *RE Holttum 25481.*
[Isoparatype] Ibid, below Pakka, 10,200 ft, 15 Nov 1931, *RE Holttum 25663.*

Piloecium acroporioides Dix.
[Isotype] Malaysia, Sarawak, Marudi (Claudetown), 300 m, Nov 1932, *PW Richards M2672.*

Pogonatum euryphyllum Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, near Kamborangah, 7,200 ft, 13 Nov 1931, *RE Holttum 25644.*
[Isoparatype] Ibid, Tenompok, 4,700 ft, 11 Nov 1931, *RE Holttum 25344.*
Note: A synonym of *Pogonatum cirratum* (Sw.) Brid. ssp. *macrophyllum* (Dozy & Molk.) Hyvönen (Hyvönen 1989b).

Pseudoracelopus borneensis Dix.
[Isotype] Malaysia, Sabah, Bettolan, near Sandakan, 21 Aug 1927, *CB Kloss 19171.*
Note: A synonym of *Pogonatum iwatsukii* Touw (Touw 1986).

Rhaphidostegium complanatulum Dix., *nom. nud.*
[Original material] Malaysia, Perak, Padang Rengas reservoir, 18 Jan 1925, *Mohd. Haniff Nur 14981.*
Note: The name was published invalidly by Dixon in 1926.

Rhaphidostichum aquaticum Dix.
[Isotype] Malaysia, Sarawak, G. Matang, 500 ft, 22 Jan 1930, *RE Holttum 23165.*

Note: The species is now known as *Papillidiopsis aquaticum* (Dix.) Buck and B.C. Tan.

Sclerohypnum riparium Dix.
[Isotype] Malaysia, Pahang, Tahan River, 24 Aug 1928, *RE Holttum 20089.*
Note: The species is now known as *Sclerohypnum littorale* (Hampe) B.C. Tan (Tan 1991).

Sphagnum cuspidatulum C. Muell. var. *trengganuense* A. Johnson
[Holotype] Malaysia, Trengganu, G. Padang, 4,000 ft, Jun 1937, *Moysey and Kiah 31023.*
Note: Eddy (1977) listed this trinomial under the synonymy of *Sphagnum cuspidatum* Hoffm. subsp. *subrecurvum* (Warnst.) Eddy.

Sphagnum flaccidifolium Dix. *ex* A. Johnson
[Holotype] Malaysia, Selangor, Telok Forest Reserve, 7th Milestone Klang, *Carrick 500.*
[Paratypes] Malaysia, Selangor, Telok Panglima Garang, May 1933, *RE Holttum 28317*; Indonesia, Sumatra, near Palan Borae, 24 Feb 1933, *RE Holttum 28127.*
Note: Annotated by A. Eddy in 1968 as *Sphagnum subrecurvum* var. The taxon is subsequently treated by Eddy (1977) as *Sphagnum cuspidatum* Hoffm. ssp. *subrecurvum* (Warnst.) Eddy var. *flaccidifolium* (A. Johnson) Eddy.

Sphagnum holttumii Dix. *ex* A. Johnson
[Holotype] Malaysia, Pahang, G. Tahan, 5,000 ft, 30 Aug 1928, *RE Holttum 20906.*
[Paratypes] Malaysia, Pahang, G. Tahan, ca 5,000 ft, 30 Aug 1928, *RE Holttum 20908*; ibid, ca 6,000 ft, 31 Aug 1928, *RE Holttum 20909*; ibid, 6,000 ft, 31 Aug 1928, *RE Holttum 20910*; ibid, 3500-4500 ft, 28 Aug 1928, *RE Holttum 20916*; Cameron Highlands. 4800 ft, 1 Apr 1930, *RE Holttum 23300*; Johore, G. Pantai, 1600 ft, 9 Jun 1930, *EJH Corner 23207.*
Note: All the above mentioned specimens bear the unpublished herbarium name, *Sphagnum kedahense* Dix. The species is treated as a synonym of *Sphagnum perichaetiale* Hampe (Eddy 1977).

Sphagnum roseotinctum A. Johnson
[Holotype] Malaysia, Kelantan State, G. Sitong, 2,600 ft, 6 Mar 1924, *Mohd. Haniff Nur 12244.*
Note: The specimen was first reported by Dixon in 1926 as *Sphagnum kelantanense*, a *nomen nudum*. Johnson (1958) described it as a new species

and Eddy (1977) reduced it to one of the many synonyms of *Sphagnum perichaetiale* Hampe. In the protologue (Johnson 1958), two paratype specimens of *S. roseotinctum* collected by Spare (no. *1439* and *1430*) were mentioned, but I cannot find these two specimens at SING at present.

Stephanodictyon borneensis Dix.
[Isotype] Malaysia, Sabah, Mt. Kinabalu, Lobang, 19 Nov 1931, *RE Holttum 25637.*
Note: The genus was combined with *Trichostomum* by Zander (1993) and the species is now known as *T. borneensis* (Dix.) Zand.

Symphyodon complanatus Dix.
[Isotype] India, Assam, watershed of Egar to Serpo, 5500 ft, 23 Jan 1912, *IH Burkill 36208* (ex Herb. Hort. Bot. Calcuttensis).

Syrrhopodon perakensis Dix.
[Isotype] Malaysia, Perak, Lumut, Dindings, 1896, *HN Ridley 449.*
Note: Annotated by H. Mohamed in September of 1983 as *Syrrhopdon fallax* Lac., a synonym of *Syrrhopodn aristifolius* Mitt. As a synonym, this taxon was not mentioned by Mohamed and Reese (1985) in their taxonomic revision of the genus for Malaysia and adjacent regions.

Taxithelium bilobatum Dix.
[Isotype] Malaysia, Perak, Bujang, Malacca, 1891, *HN Ridley 739.*
Note: The species is now known as *Glossadelphus bilobatus* (Dix.) Broth. The isotype packet at SING has the collection number written as *Holttum 739*, probably an error. In the protologue, the holotype was indicated to be at Mitten Herbarium (Dixon 1924)

Tayloria borneensis Dix.
[Isotype] Malaysia, Sabah, Tenompok, 11 Nov 1931, *RE Holttum 25329.*

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The Botany of the Islands of Mersing District, Johore, Peninsular Malaysia. 2. The Floras of Pulau Aur and Pulau Pemanggil, with Notes on the Smaller Islands

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Abstract

All the records for vascular plants found growing on Pulau Aur, its small neighbour Pulau Dayang, and Pulau Pemanggil, islands in the Mersing District of Johore, Peninsular Malaysia are collated and listed. Notes on the botany of some of the smaller islands in the vicinity are also presented. A total of more than 180 species are listed for Pulau Aur. It is notable as the only Malaysian locality for the rubiaceous tree *Zuccarinia macrophylla*. Other rare species recorded from the island include *Selaginella plana* (Selaginellaceae), *Operculina riedeliana* (Convolvulaceae), *Thrixspermum carinatifolium* (Orchidaceae), *Rauvolfia sumatrana* (Apocynaceae), *Canarium hirsutum* (Burseraceae) and *Hymenodictyon orixense* (Rubiaceae). A list of the 172 vascular plant species recorded as growing on Pulau Pemanggil is presented. Notable collections include *Lasianthus barbellatus* (Rubiaceae), *Didymocarpus tiumanicus* (Gesneriaceae), *Mallotus moritzianus* (Euphorbiaceae) and *Margaritaria indica* (Euphorbiaceae). Pulau Sibu is relatively well-known botanically. Details of some recent collections from Pulau Besar are given. Pulau Tengah is notable for records of *Argusia argentea* (Boraginaceae) and *Schizachyrium sanguineum* (Gramineae).

PULAU AUR

Introduction

Pulau Aur (104° 32' E 2° 27' N) is the most remote of the Johore islands (Fig. 1), lying some 62 km from the Johore coast, about 74 km due east of Mersing. Aur covers about 19 km^2, and the nearby Pulau Dayang about

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1.8 km^2 (Fig. 2). The first botanical collections were made on Pulau Aur more than a century ago when J. Feilding visited the island in 1892. In April-May 1927, M.R. Henderson visited Pulau Aur, Pulau Dayang and Pulau Tioman. Henderson (1930) reported that the human population numbered about 400, which was a considerable reduction compared to a mid-nineteenth century estimate of 1400. Much of the native vegetation was cleared for cultivation when Aur was heavily populated, but since then secondary forest has developed on many areas away from the coasts. Except for a short note on some common plants (Marchette 1964), there has been no publication on the flora of Pulau Aur since Henderson's paper. In this paper we collate all vascular plant records for Aur and Dayang that we have been able to verify from material in various herbaria (SING, SINU and UKMB) in Malaysia and Singapore. Recent collecting trips were made by a group from Universiti Kebangsaan Malaysia in January 1988, and by Boo, Chen and Choo in August 1996.

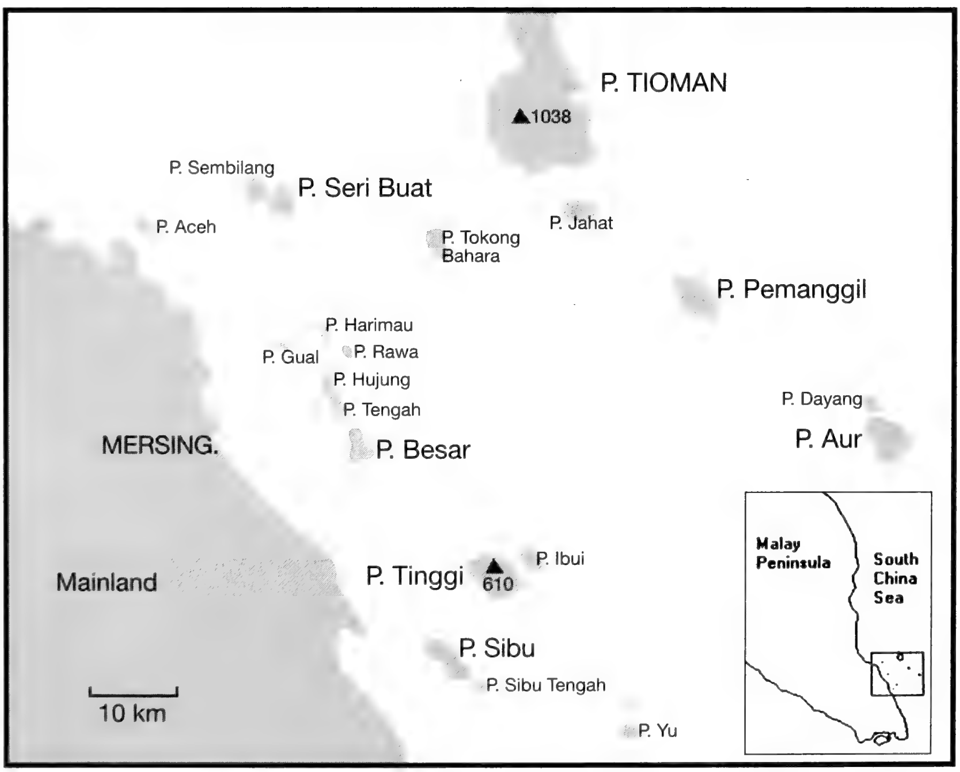

Figure 1. Map of the islands off the east coast of Johore. P. = Pulau, spot heights in metres.

Literature Records

There are a few records for plants from Aur for which specimens have not been located recently. *Balanophora abbreviata* Blume was reportedly collected by Feilding on Aur (Ridley 1924, as *Balanophora insularis*), but the specimen seems to have eluded all recent authors. All other collections of this parasitic herb from Peninsular Malaysia come from Perak (Kiew 1978). Feilding's Johore grass collections were written up for publication by Rendle (1894), probably based on specimens deposited in the Kew herbarium. Feilding is reported to have collected five species from Pulau Aur, probably *Centotheca lappacea* (L.) Desv., *Coix lacryma-jobi* L., *Dactyloctenium aegyptium* (L.) Willd., *Panicum sarmentosum* Roxb. and *Setaria* sp., but without reference to the specimens it is not possible to be absolutely certain.

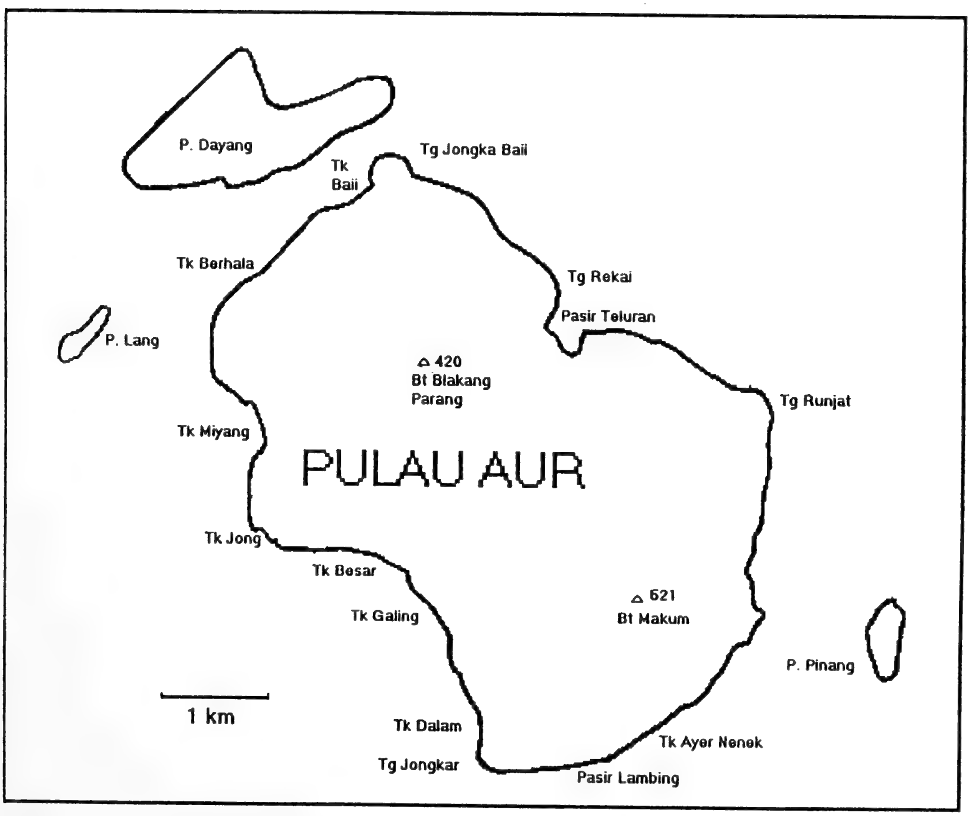

Figure 2. Map of Pulau Aur and its neighbouring islands. P. = Pulau, Tg = Tanjung, Tk = Telok, Bt = Bukit, spot heights in metres.

Collections of Interest

We have amassed records of over 180 species from Pulau Aur. These are listed in Appendix 1. Nomenclature follows Turner (1995) where possible. Probably the most important is that of *Zuccarinia macrophylla*, which is the only collection of this species (and genus) from Malaysia (Wong 1989). It is a small rubiaceous tree from lowland forest, and has not been recollected recently from Aur. Other very rare plants found on Aur include *Selaginella plana* (Wong 1983), *Thrixspermum carinatifolium* (Seidenfaden & Wood 1992), *Canarium hirsutum* (Turner *et al.* 1993) and *Operculina riedeliana* (this study). The apocynaceous shrub *Rauvolfia sumatrana* was previously reported from Perak alone in Peninsular Malaysia (Markgraf 1984). Our recent record from Pulau Aur extends the species to Johore. Our discovery of *Hymenodictyon orixense* on Aur is also notable biogeographically being the first record of this species from the east coast of the Malay Peninsula.

PULAU PEMANGGIL

Introduction

Pulau Pemanggil is an island of about 12 km^2 (Fig. 3) lying between Pulau Tioman and Pulau Aur in the South China Sea, about 50 km from the Johore mainland (Fig. 1). Pulau Pemanggil is one of the botanically least well-known of the islands of Mersing district. It was the subject of a paper by Latiff (1982), but otherwise little has been published regarding the vascular plants found on the island. Md. Noor and Samsuri collected on the island in 1966. Latiff and his students visited in January 1980 and Boo, Chen and Choo collected there in August 1996. We have collated all the records for vascular plants collected from Pulau Pemanggil in herbaria available to us (KEP, SING, SINU and UKMB) and a list of 172 species is given in Appendix 1.

Notable Collections

Lasianthus barbellatus, *Didymocarpus tiumanicus* and *Mallotus moritzianus* are very rare species in Peninsular Malaysia that are recorded from Pulau Pemanggil. Henderson (1930) reported the first two species as endemic to Pulau Tioman, but both have subsequently been found on Pulau Pemanggil. *Didymocarpus tiumanicus* has also been recorded from Pulau Tinggi (Turner

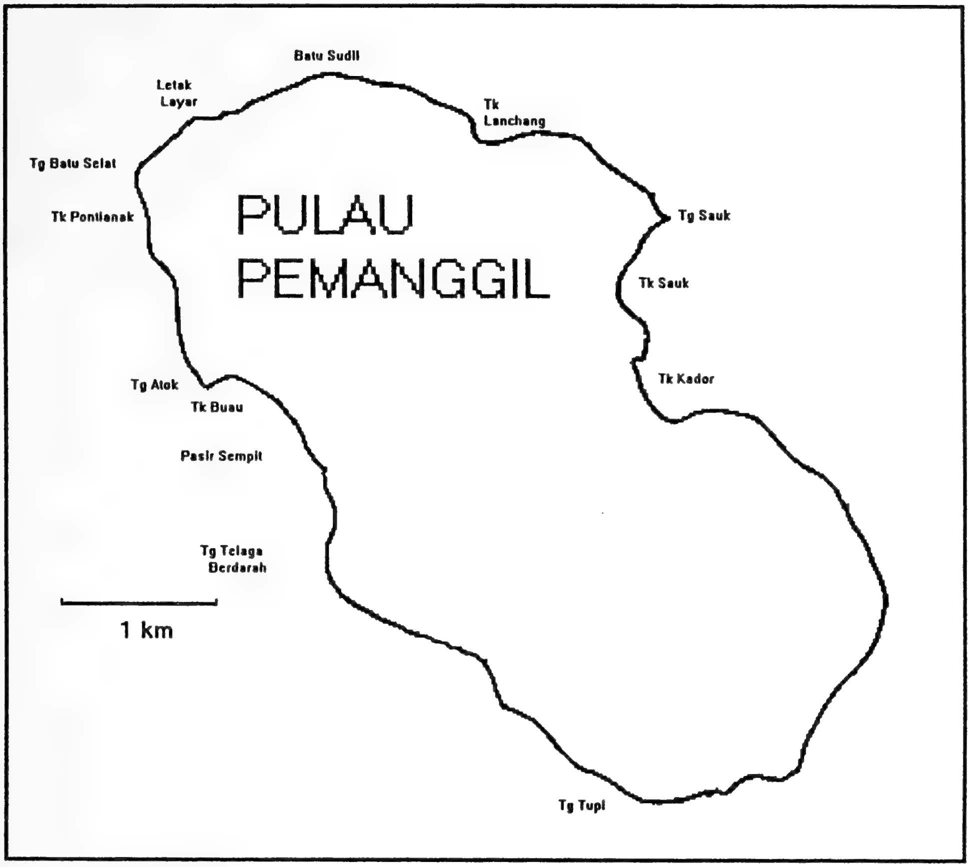

Figure 3. Map of Pulau Pemanggil. Tg = Tanjung, Tk = Telok.

et al. 1997). *Margaritaria indica* is confined to the Tioman island group in its Peninsular Malaysian range, having also been recorded from Pulau Sibu Tengah and two small islets to the northeast of Pulau Tioman. *Mallotus moritzianus* has been recorded from Trengganu as well as Pulau Pemanggil (Whitmore 1973).

Not quite so rare, but still notable are the occurrence of *Selaginella plana* (Wong 1982), *Aganosma wallichii* (Middleton 1996) and *Marsdenia acuminata* (Ridley 1923, as *Gymnema acuminatum*).

Deeringia polysperma is a species generally confined to limestone in Peninsular Malaysia (Chin 1979). Pemanggil does not have any limestone outcrops, and the presence of the species on the island is probably a reflection of the tendency to dry spells of the climate of Pulau Pemanggil and its neighbours, and the abundance of well-drained rocky substrates. Limestone, often being freely draining, tends to support species with ranges extending into drier climates.

THE SMALLER ISLANDS

Introduction

We have given accounts of the floras of Pulau Tinggi (Turner *et al.*, 1997) and Pulau Aur and Pulau Pemanggil. There are many other islands, though mostly much smaller than the three already covered, in the Mersing District. In this final section our knowledge of these islands, including some unpublished data, is summarized.

Pulau Sibu

Pulau Sibu is the best studied island in terms of its botany. A detailed account of the flora and vegetation was given by Turner *et al.* (1993). Pulau Sibu has little undisturbed inland vegetation remaining, but good examples of a number of coastal vegetation types. The peculiar shrubby heathland found on hills overlooking the sea on Pulau Sibu was the topic of a study by Turner *et al.* (1995).

Pulau Besar

There has been little published about this island. On a brief visit in June 1996, Dr C.L. Loh of the Malaysian Nature Society made some plant collections. A list of the species collected is given in Appendix 1. There are some seagrass meadows in the waters surrounding Pulau Besar. Japar (1994) reports the presence of *Cymodocea serrulata*, *Halodule uninervis*, *Halophila ovalis*, *Halophila spinulosa* and *Syringodium isoetifolium*.

Other Islands

E.J.H. Corner visited a number of the small islands in the Tioman group on various trips in the period 1932-1936. He reported his botanical findings nearly fifty years later (Corner 1985). Most of the islets he visited were in Pahang, but he did make collections on Pulau Setindan and Pulau Tengah. Notable collections from Pulau Tengah were the first record from the east coast of Peninsular Malaysia for the small coastal shrub *Argusia argentea* (*Messerschmidia argentea* in his paper) and the first record from the Peninsula for the grass *Schizachyrium sanguineum*. Japar (1994) lists the following seagrass species from Pulau Tengah: *Cymodocea serrulata*, *Halodule pinifolia*, *Halodule uninervis* and *Halophila ovalis*.

In the Herbarium of the Singapore Botanic Gardens there are a number of collections made by Mrs Betty Molesworth Allen in July 1955 from Pulau Yu, an island south of Pulau Tinggi. Her ten collections are listed in Appendix 1.

Acknowledgements

The Malaysian Nature Society are thanked for their support of studies of the plant diversity of the Johore Islands. We are particularly grateful to Dr C.L. Loh for making collections during his visit to Pulau Besar. Dr Ruth Kiew kindly contacted Mrs Molesworth Allen to confirm which Pulau Yu she visited more than forty years ago.

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Appendix 1. A List of the Plant Species Recorded from Islands in the Mersing District, Johore.

The species are listed with one representative collection for each. Where possible, for Pulau Aur, an indication of records from Pulau Aur and/or Pulau Dayang is given in brackets after each species. A 'c' in the margin next to an entry indicates a species only found in cultivation.

Pulau Aur

Pteridophyta

Aspleniaceae

Asplenium nidus L. - Boo, Chen & Choo 399 [P. Aur] (SINU)

Cyatheaceae

Cyathea squamulata (Blume) Copel. -Boo, Chen & Choo 386 [P. Aur] (SINU)

Dennstaedtiaceae

Lindsaea cultrata (Willd.) Sw. - Boo, Chen & Choo 384 [P. Aur] (SINU)

Dryopteridaceae

Tectaria singaporeana (Hook. & Grev.) Copel. - Boo, Chen & Choo 420 [P. Aur] (SINU)

Hymenophyllaceae

Cephalomanes javanicum (Blume) Bosch - Boo, Chen & Choo 286 [P. Aur] (SINU)

Marattiaceae

Angiopteris evecta (G. Forst.) Hoffm. - Boo, Chen & Choo 383 [P. Aur] (SINU)

Oleandraceae

Nephrolepis acutifolia (Desv.) H. Christ. - Boo, Chen & Choo 382 [P. Aur] (SINU)

Nephrolepis auriculata (L.) Trimen - Boo, Chen & Choo 217 [P. Dayang] (SINU)

Polypodiaceae

Pyrrosia angustata (Sw.) Ching - Boo, Chen & Choo 402 [P. Aur] (SINU)

Pyrrosia lanceolata (L.) Farwell - Boo, Chen & Choo 257 [P. Aur & P. Dayang] (SINU)

Pteridaceae

Pteris ensiformis Burm.*f.* - Boo, Chen & Choo 186 [P. Aur] (SINU)

Schizaeaceae

Lygodium circinnatum (Burm.*f.*) Sw. - M.R. Henderson, S.F.N. 18247 (SING)

Selaginellaceae

Selaginella plana (Desv.) Hieron. - M.R. Henderson, S.F.N. 18365 (BM)

Thelypteridaceae

Pronephrium repandum (Fée) Holttum - Boo, Chen & Choo 388 [P. Aur] (SINU)

Vittariaceae

Vittaria ensiformis Sw. - Boo, Chen & Choo 379 [P. Aur] (SINU)

Spermatophyta

Acanthaceae

c *Justicia gendarussa* Burm.*f.* - Boo, Chen & Choo 195 [P. Aur] (SINU)

Alangiaceae

Alangium kurzii Craib - Boo, Chen & Choo 280 [P. Aur & P. Dayang] (SINU)

Amaranthaceae

Cyathula prostrata (L.) Blume - Boo, Chen & Choo 294 [P. Aur] (SINU)

Amaryllidaceae

Crinum asiaticum L. - Boo, Chen & Choo 144 [P. Aur] (SINU)

Proiphys amboinensis (L.) Herb. - Boo, Chen & Choo 326 [P. Dayang] (SINU)

Anacardiaceae

c *Anacardium occidentale* L. - Boo, Chen & Choo 327 [P. Aur] (SINU)

Annonaceae

c *Cananga odorata* (Lam.) Hook.*f.* & Thomson - A. Latiff & A. Zainudin 2708 [P. Aur] (UKMB)

Meiogyne virgata (Blume) Miq. - M.R. Henderson, S.F.N. 18360 (SING)

Friesodielsia affinis (Hook.*f.* & Thomson) D. Das - A. Latiff & A. Zainudin 2699 [[P. Aur] (UKMB)

Friesodielsia kingii (J. Sinclair) Steenis - M.R. Henderson, S.F.N. 18235 (SING)

Polyalthia cinnamomea Hook.*f.* & Thomson- M.R. Henderson, S.F.N. 18216 (SING)

Apocynaceae

Catharanthus roseus (L.) G. Don - Boo, Chen & Choo 248 [P. Aur & P. Dayang] (SINU)

Cerbera manghas L. - A. Latiff & A. Zainudin 2668 [P. Aur] (UKMB)

Cerbera odollam Gaertn. - Boo, Chen & Choo 314 [P. Dayang] (SINU)

Rauvolfia sumatrana Jack - Boo, Chen & Choo 159 [P. Aur] (SINU)

Araceae

Aglaonema simplex Blume - M.R. Henderson S.F.N. 18221 (SING)

Rhaphidophora korthalsii Schott - Boo, Chen & Choo 380 [P. Aur] (SINU)

c *Syngonium podophyllum* Schott - Boo, Chen & Choo 284 [P. Aur] (SINU)

Araliaceae

Arthrophyllum diversifolium Blume - M.R. Henderson, S.F.N. 18362 (SING)

Schefflera elliptica (Blume) Harms - A. Latiff & A. Zainudin 2701 [P. Aur] (UKMB)

Schefflera heterophylla (Wall. *ex* G. Don) Harms - M.R. Henderson, S.F.N. 18238 (SING)

Aristolochiaceae

Aristolochia tagala Cham. - M.R. Henderson, S.F.N. 18226 (SING)

Asclepiadaceae

Dischidia bengalensis Colebr. - Feilding *s.n.* (SING)

Hoya verticillata (Vahl) G. Don - Boo, Chen & Choo 289 [P. Aur] (SINU)

Boraginaceae

Ehretia timorensis Decne. - M.R. Henderson, S.F.N. 18203 (SING)

Bromeliaceae

c *Ananas comosus* (L.) Merr. - Boo, Chen & Choo 222 [P. Dayang] (SINU)

Burseraceae

Canarium hirsutum Willd. - M.R. Henderson, S.F.N. 18242 (SING)

Cactaceae

Opuntia monacantha Haw. - Boo, Chen & Choo 238 [P. Dayang] (SINU)

Cannaceae

c *Canna edulis* Ker Gawl. - Boo, Chen & Choo 213 [P. Dayang] (SINU)

Capparaceae

Cleome viscosa L. - Boo, Chen & Choo 151 [P. Aur & P. Dayang] (SINU)

Cecropiaceae

Poikilospermum suaveolens (Blume) Merr. - A. Latiff & A. Zainudin 2705 [P. Aur] (UKMB)

Combretaceae

Quisqualis indica L. - M.R. Henderson, S.F.N. 18227 (SING)

Commelinaceae

Commelina diffusa Burm.*f.* - Boo, Chen & Choo 269 [P. Aur] (SINU)

Murdannia nudiflora (L.) Brenan - Boo, Chen & Choo 163 [P. Aur & P. Dayang] (SINU)

Compositae

Elephantopus scaber L. - Boo, Chen & Choo 150 [P. Aur] (SINU)

Vernonia cinerea (L.) Less. - Boo, Chen & Choo 179 [P. Aur] (SINU)

Vernonia patula (Dryand.) Merr. - Boo, Chen & Choo 257 [P. Aur] (SINU)

Wollastonia biflora (L.) DC. - Boo, Chen & Choo 220 [P. Dayang] (SINU)

Convolvulaceae

Ipomoea pes-caprae (L.) R.Br. - Boo, Chen & Choo 233 [P. Dayang] (SINU)

Ipomoea pes-tigridis L. - Boo, Chen & Choo 265 [P. Aur] (SINU)

Operculina riedeliana (Oliv.) Ooststr. - Boo, Chen & Choo 409 [P. Aur] (SINU)

Crassulaceae

Kalanchoe pinnata (Lam.) Pers. - Boo, Chen & Choo 196 [P. Aur & P. Dayang] (SINU)

Cycadaceae

Cycas ?siamensis Miq. - Boo, Chen & Choo 305 [P. Dayang] (SINU)

Cyperaceae

Scleria lithosperma (L.) Sw. - Boo, Chen & Choo 373 [P. Aur] (SINU)

Dilleniaceae

Tetracera indica (Christm. & Panz.) Merr. - Boo, Chen & Choo 168 [P. Aur] (SINU)

Dracaenaceae

Dracaena elliptica Thunb. - Boo, Chen & Choo 419 [P. Aur] (SINU)

Ebenaceae

Diospyros cauliflora Blume - M.R. Henderson, S.F.N. 18276 (SING)

Escalloniaceae

Polyosma integrifolia Blume - Boo, Chen & Choo 421 [P. Aur] (SINU)

Euphorbiaceae

Claoxylon indicum (Reinw. *ex* Blume) Hassk. - Boo, Chen & Choo 279 [P. Aur] (SINU)

Cnesmone javanica Blume - Boo, Chen & Choo 393 [P. Aur] (SINU)

c *Jatropha curcas* L. - Boo, Chen & Choo 272 [P. Aur] (SINU)

Macaranga gigantea (Rchb.*f.* & Zoll.) Müll.Arg. - Boo, Chen & Choo 353 [P. Aur] (SINU)

c *Manihot esculenta* Crantz - Boo, Chen & Choo 245 [P. Aur] (SINU)

Melanolepis multiglandulosa (Reinw. *ex* Blume) Rchb.*f.* & Zoll. - Boo, Chen & Choo 278 [P. Aur & P. Dayang] (SINU)

c *Pedilanthus tithymaloides* Poit. - Boo, Chen & Choo 293 [P. Aur] (SINU)

Phyllanthus pulcher Wall. *ex* Müll.Arg. - Boo, Chen & Choo 189 [P. Aur] (SINU)

Flacourtiaceae

c *Flacourtia jangomas* (Lour.) Raeusch. - Boo, Chen & Choo 405 [P. Aur & P. Dayang] (SINU)

Flacourtia rukam Zoll. & Moritzi - A. Latiff & A. Zainudin 2665 [P. Aur] (UKMB)

Flagellariaceae

Flagellaria indica L. - Boo, Chen & Choo 172 [P. Aur] (SINU)

Gnetaceae

c *Gnetum gnemon* L. - Boo, Chen & Choo 331 P. Dayang

Gnetum latifolium Blume var. *funiculare* (Blume) Markgr. - Boo, Chen & Choo 290 [P. Aur] (SINU)

Gnetum macrostachyum Hook.*f.* - M.R. Henderson, S.F.N. 18250 (SING)

Goodeniaceae

Scaevola taccada (Gaertn.) Roxb. - Boo, Chen & Choo 231 [P. Dayang] (SINU)

Gramineae

Cyrtococcum oxyphyllum (Steud.) Stapf - M.R. Henderson, S.F.N. 18225 (SING)

Guttiferae

Calophyllum inophyllum L. - Boo, Chen & Choo 219 [P. Dayang] (SINU)

Garcinia parvifolia Miq. - Boo, Chen & Choo 365 [P. Aur] (SINU)

Hypoxidaceae

Molineria latifolia (Dryand.) Herb. - Boo, Chen & Choo 374 [P. Aur] (SINU)

Labiatae

Leucas zeylanica (L.) R.Br.- Boo, Chen & Choo 339 [P. Dayang] (SINU)

Leeaceae

Leea indica (Burm.*f.*) Merr. - Boo, Chen & Choo 162 [P. Aur & P. Dayang] (SINU)

Leguminosae

Abrus precatorius L. - Boo, Chen & Choo 239 [P. Dayang] (SINU)

Bauhinia integrifolia Roxb. - M.R. Henderson, S.F.N. 18233 (SING)

Canavalia cathartica Thouars - Boo, Chen & Choo 226 [P. Dayang] (SINU)

Crotalaria pallida Aiton - Boo, Chen & Choo 267 [P. Aur & P. Dayang] (SINU)

Crotalaria retusa L. - Boo, Chen & Choo 270 [P. Aur] (SINU)

Crudia lanceolata Ridl. - Boo, Chen & Choo 410 [P. Aur] (SINU)

Derris scandens (Roxb.) Benth. - Boo, Chen & Choo 341 [P. Dayang] (SINU)

Desmodium gangeticum (L.) DC. - Boo, Chen & Choo 360 [P. Aur] (SINU)

Desmodium heterocarpon (L.) DC. - Boo, Chen & Choo 381 [P. Aur] (SINU)

Desmodium velutinum (Willd.) DC. - Boo, Chen & Choo 281 [P. Aur] (SINU)

Flemingia strobilifera (L.) Roxb. - M.R. Henderson, S.F.N. 18240 (SING)

Mimosa pudica L. - Boo, Chen & Choo 164 [P. Aur] (SINU)

Mucuna biplicata Teijsm. & Binn. *ex* Kurz - Boo, Chen & Choo 425 [P. Aur] (SINU)

Pueraria phaseoloides (Roxb.) Benth. - Boo, Chen & Choo 274 [P. Aur] (SINU)

Senna alata (L.) Roxb. - Boo, Chen & Choo 145 [P. Aur] (SINU)

Senna occidentalis (L.) Link - Boo, Chen & Choo 173 [P. Aur] (SINU)

Loganiaceae

Fagraea auriculata Jack - Boo, Chen & Choo 325 [P. Aur] (SINU)

Malvaceae

Hibiscus tiliaceus L. - A. Latiff & A. Zainudin 2 [P. Aur] (UKMB)
Sida cordifolia L. - Boo, Chen & Choo 362 [P. Aur] (SINU)
Sida rhombifolia L. - Boo, Chen & Choo 263 [P. Aur] (SINU)
Urena lobata L. - Boo, Chen & Choo 304 [P. Dayang] (SINU)

Melastomataceae

Clidemia hirta (L.) D. Don - Boo, Chen & Choo 404 [P. Aur] (SINU)
Melastoma malabathricum L. - Boo, Chen & Choo 193 [P. Aur & P. Dayang] (SINU)
Memecylon caeruleum Jack - Boo, Chen & Choo 143 [P. Aur & P. Dayang] (SINU)

Meliaceae

Chukrasia tabularis A. Juss. - Boo, Chen & Choo 275 [P. Aur] (SINU)
Dysoxylum cauliflorum Hiern - M.R. Henderson, S.F.N. 18354 (SING)

Menispermaceae

Fibraurea tinctoria Lour. - Boo, Chen & Choo 424 [P. Aur] (SINU)
Pericampylus glaucus (Lam.) Merr. - Boo, Chen & Choo 198 [P. Aur & P. Dayang] (SINU)
Tinospora crispa (L.) Hook.*f.* & Thomson - Boo, Chen & Choo 275 [P. Dayang] (SINU)

Monimiaceae

Kibara coriacea (Blume) Tul. - Boo, Chen & Choo 422 [P. Aur] (SINU)
Matthaea sancta Blume - Boo, Chen & Choo 418 [P. Aur] (SINU)

Moraceae

Ficus aurantiacea Griff. - A. Latiff & A. Zainudin 2677 [P. Aur] (UKMB)
Ficus recurva Blume - Boo, Chen & Choo 375 [P. Aur] (SINU)
Ficus superba (Miq.) Miq. - Boo, Chen & Choo 272 [P. Aur] (SINU)

Myristicaceae

Knema curtisii (King) Warb. - M.R. Henderson, S.F.N. 18220 (SING)
Knema globularia (Lam.) Warb. - M.R. Henderson, S.F.N. 18244 (SING)

Myrsinaceae

Ardisia elliptica Thunb. - Boo, Chen & Choo 320 [P. Dayang] (SINU)
Ardisia lanceolata Roxb. - Boo, Chen & Choo 174 [P. Aur] (SINU)
Ardisia lurida Blume - Boo, Chen & Choo 200 [P. Aur] (SINU)
Ardisia solanacea Roxb. - M.R. Henderson, S.F.N. 18232 (SING)

Myrtaceae

c *Psidium guajava* L. - Boo, Chen & Choo 170 [P. Aur & P. Dayang] (SINU)
Syzygium grande (Wight) Walp. - Boo, Chen & Choo 300 [P. Dayang] (SINU)
c *Syzygium jambos* (L.) Alston - Boo, Chen & Choo 201 [P. Aur] (SINU)
Syzygium pseudoformosum (King) Merr. & L.M. Perry - Boo, Chen & Choo 397 [P. Aur] (SINU)

Nyctaginaceae

Boerhavia diffusa L. - Boo, Chen & Choo 214 [P. Dayang] (SINU)

Orchidaceae

Cirrhopetalum puguahaanense (Ames) Garay *et al.* - Boo, Chen & Choo 429 [P. Aur] (SINU)
Thrixspermum caranatifolium (Ridl.) Schltr. - J. Fielding s.n., 1892 (SING)

Palmae

Arenga westerhoutii Griff. - Boo, Chen

& Choo 356 [P. Aur] (SINU)

Daemonorops melanochaetes Blume - M.R. Henderson S.F.N. 18358 (SING)

c *Metroxylon sagu* Rottb. - Boo, Chen & Choo 205 [P. Aur] (SINU)

Pandanaceae

Freycinetia imbricata Blume - Boo, Chen & Choo 408 [P. Aur] (SINU)

Passifloraceae

Passiflora foetida L. - Boo, Chen & Choo 251 [P. Aur & P. Dayang] (SINU)

Piperaceae

c *Piper betel* L. - Boo, Chen & Choo 376 [P. Aur] (SINU)

Portulacaceae

Portulaca oleracea L. - Boo, Chen & Choo 192 [P. Aur] (SINU)

Portulaca quadrifida L. - Boo, Chen & Choo 309 [P. Dayang] (SINU)

Rosaceae

Eriobotrya bengalensis (Roxb.) Hook.*f.* - M.R. Henderson, S.F.N. 18211 (SING)

Rubus moluccanus L. var. *angulosus* Kalkman - A. Latiff & A. Zainudin 2692 [P. Aur] (UKMB)

Rubiaceae

Borreria laevicaulis (Miq.) Ridl. - Boo, Chen & Choo 229 [P. Aur & P. Dayang] (SINU)

Geophila repens (L.) I.M. Johnst. var. *asiatica* (Cham. & Schldtl.) Fosberg - Boo, Chen & Choo 359 [P. Aur] (SINU)

Hedyotis capitellata Wall. *ex* G. Don - M.R. Henderson, S.F.N. 18356 (SING)

Hedyotis dichotoma Koenig *ex* Roth - Boo, Chen & Choo 371 [P. Aur] (SINU)

Hedyotis tenelliflora Blume - Boo, Chen & Choo 361 [P. Aur] (SINU)

Hedyotis vestita R. Br. *ex* G. Don - M.R. Henderson, S.F.N. 18364 (SING)

Hymenodictyon orixense (Roxb.) Mabb. - A. Latiff & A. Zainudin 2706 [P. Aur] (UKMB)

Ixora javanica (Blume) DC. - M.R. Henderson, S.F.N. 18218 (SING)

Ixora nigricans Wight & Arn. - M.R. Henderson, S.F.N. 18212 (SING)

Ixora pendula Jack - Boo, Chen & Choo 202 [P. Aur] (SINU)

Ixora umbellata Koord. & Valeton - M.R. Henderson, S.F.N. 18219 (SING)

Kailarsenia tentaculata (Hook.*f.*) Tirveng. - ?Feilding 4082 (SING)

Morinda citrifolia L. - Boo, Chen & Choo 247 [P. Aur] (SINU)

Morinda elliptica (Hook.*f.*) Ridl. - M.R. Henderson, S.F.N. 18363 (SING)

Morinda umbellata L. - M.R. Henderson, S.F.N. 18210 (SING)

Ophiorrhiza discolor R.Br. - Boo, Chen & Choo 407 [P. Aur] (SINU)

Paederia foetida L. - Boo, Chen & Choo 372 [P. Aur] (SINU)

Pavetta naucleiflora R.Br. *ex* G. Don - M.R. Henderson, S.F.N. 18245 (SING)

Tarenna costata (Miq.) Merr. - M.R. Henderson, S.F.N. 18375 (SING)

Timonius wallichianus (Korth.) Valeton - Boo, Chen & Choo 391 [P. Aur] (SINU)

Zuccarinia macrophylla Blume - M.R. Henderson, S.F.N. 18213 (SING)

Rutaceae

c *Citrus maxima* (L.) Merr. - Boo, Chen & Choo 149 [P. Aur] (SINU)

Glycosmis chlorosperma Spreng. - Boo, Chen & Choo 157 [P. Aur] (SINU)

Glycosmis mauritiana (Lam.) Tanaka - Boo, Chen & Choo 313 [P. Dayang] (SINU)

Glycosmis pentaphylla (Retz.) DC. - A. Latiff & A. Zainudin 2707 [P. Aur] (UKMB)
Murraya paniculata (L.) Jack - Boo, Chen & Choo 207 [P. Aur] (SINU)
c *Triphasia trifolia* (Burm.*f.*) P. Wilson - Boo, Chen & Choo 167 [P. Aur] (SINU)

Sapindaceae
Allophylus cobbe (L.) Raeusch. - M.R. Henderson, S.F.N. 18369 (SING)
Cardiospermum halicacabum L. - Boo, Chen & Choo 161 [P. Aur] (SINU)
Lepisanthes rubiginosa (Roxb.) Leenh. - M.R. Henderson, S.F.N. 18205 (SING)
Lepisanthes tetraphylla (Vahl) Radlk. - M.R. Henderson, S.F.N. 18372 (SING)

Scrophulariaceae
Lindernia crustacea (L.) F. Muell. - Boo, Chen & Choo 175 [P. Aur & P. Dayang] (SINU)

Simaroubaceae
Brucea javanica (L.) Merr. - M.R. Henderson, S.F.N. 18207 (SING)
Eurycoma longifolia Jack - Boo, Chen & Choo 364 [P. Aur] (SINU)

Solanaceae
c *Datura metel* L. - Boo, Chen & Choo 142 [P. Aur] (SINU)
Solanum erianthum D. Don - M.R. Henderson, S.F.N. 18201 (SING)

Sterculiaceae
Leptonychia caudata (Wall. *ex* G. Don) Burret - M.R. Henderson, S.F.N. 18355 (SING)

Taccaceae
Tacca palmata Blume - Boo, Chen & Choo 306 [P. Dayang] (SINU)

Tiliaceae
Triumfetta rhomboidea Jacq. - Boo, Chen & Choo 268 [P. Aur] (SINU)

Umbelliferae
Centella asiatica (L.) Urb. - Boo, Chen & Choo 335 [P. Dayang] (SINU)

Urticaceae
Pouzolzia zeylanica (L.) Benn. - Boo, Chen & Choo 190 [P. Aur] (SINU)

Verbenaceae
Callicarpa candicans (Burm.*f.*) Hochr. - M.R. Henderson, S.F.N. 18202 (SING)
Callicarpa longifolia Lam. - Boo, Chen & Choo 155 [P. Aur & P. Dayang] (SINU)
Clerodendrum laevifolium Blume - Boo, Chen & Choo 208 [P. Aur] (SINU)
Gmelina elliptica Sm. - M.R. Henderson, S.F.N. 18209 (SING)
Lantana camara L. - Boo, Chen & Choo 188 [P. Aur] (SINU)
Peronema canescens Jack - Boo, Chen & Choo 153 [P. Aur] (SINU)
Premna serratifolia L. - Boo, Chen & Choo 244 [P. Aur] (SINU)
Stachytarpheta indica (L.) Vahl - Boo, Chen & Choo 221 [P. Dayang] (SINU)
Vitex trifolia L. - Boo, Chen & Choo 227 [P. Dayang] (SINU)

Violaceae
Rinorea horneri (Korth.) Kuntze - M.R. Henderson, S.F.N. 18217 (SING)

Vitaceae
Cayratia japonica (Thunb.) Gagnep. - Boo, Chen & Choo 253 [P. Aur] (SINU)
Cayratia mollissima (Wall.) Gagnep. - M.R. Henderson, S.F.N. 18206 (SING)
Cayratia trifolia (L.) Domin - A. Latiff & A. Zainudin s.n. [P. Aur] (UKMB)

Cissus repens Lam. - Boo, Chen & Choo 181 [P. Aur & P. Dayang] (SINU)
Tetrastigma leucostaphylum (Dennst.) Alston *ex* Mabb. - Boo, Chen & Choo 392 [P. Aur] (SINU)
Tetrastigma pisicarpum (Miq.) Planch. - A. Latiff & A. Zainudin 2698 [P. Aur] (UKMB)

Zingiberaceae
c *Alpinia galanga* (L.) Sw. - Boo, Chen & Choo 258 [P. Aur & P. Dayang] (SINU)
Alpinia mutica Roxb. - M.R. Henderson, S.F.N. 18228 (SING)
Amomum uliginosum J. König - Boo, Chen & Choo 369 [P. Aur] (SINU)

Pulau Pemanggil

PTERIDOPHYTA

Aspleniaceae
Asplenium affine Sw. - A. Latiff & A. Zainudin s.n. (UKMB)
Asplenium polyodon G. Forst. - A. Latiff & A. Zainudin s.n. (UKMB)
Asplenium robustum Blume - A. Latiff & A. Zainudin s.n. (UKMB)

Dryopteridaceae
Pleocnemia irregularis (C. Presl) Holttum - Boo, Chen & Choo 95 (SINU)

Lycopodiaceae
Huperzia phlegmaria (L.) Rothm. - Md. Noor & Samsuri 24 (SING)

Marratiaceae
Angiopteris evecta (G. Forst.) Hoffm. - Boo, Chen & Choo 84 (SINU)

Oleandraceae
Nephrolepis acutifolia (Desv.) H. Christ - Boo, Chen & Choo 127 (SINU)
Nephrolepis cordifolia (L.) C. Presl - R. Jaman 480 (UKMB)
Nephrolepis hirsutula (G. Forst.) C. Presl - Boo, Chen & Choo 55 (SINU)

Pteridaceae
Acrostichum aureum L. - Boo, Chen & Choo 112 (SINU)
Pteris ensiformis Burm.*f.* - Boo, Chen & Choo 126 (SINU)
Pteris venulosa Blume - R. Jaman 474 (UKMB)

Selaginellaceae
Selaginella plana (Desv.) Hieron. - Boo, Chen & Choo 77 (SINU)
Selaginella willdenowii (Desv.) Baker - R. Jaman 479 (UKMB)

Thelypteridaceae
Amphineuron terminans (Hook.) Holttum - Boo, Chen & Choo 77 (SINU)

Vittariaceae
Vittaria angustifolia Blume - A. Latiff & A. Zainudin s.n. (UKMB)

SPERMATOPHYTA

Amaranthaceae
Deeringia polysperma (Roxb.) Moq. - Md. Noor & Samsuri 49 (SING)

Amaryllidaceae
c *Hippeastrum reticulatum* (L'Hér.) Herb. - Shafiee Daud s.n. (UKMB)

Ancistrocladaceae
Ancistrocladus tectorius (Lour.) Merr. - Shafiee Daud s.n. (UKMB)

Annonaceae

c *Cananga odorata* (Lam.) Hook.*f.* & Thomson - Boo, Chen & Choo 76 (SINU)

Apocynaceae

Aganosma marginata (Roxb.) G. Don - Boo, Chen & Choo 66 (SINU)

Aganosma wallichii G. Don - Md. Noor & Samsuri 54 (SING)

Catharanthus roseus (L.) G. Don - Saidah Mamat s.n. (UKMB)

Araceae

Aglaonema nitidum (Jack) Kunth - Ramli Khamis s.n. (UKMB)

Aglaonema simplex Blume - Ramli Khamis s.n. (UKMB)

Epipremnum giganteum (Roxb.) Schott - A. Latiff & A. Zainudin 156 (UKMB)

Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi - Boo, Chen & Choo 94 (SINU)

Scindapsus beccarii Engl. - Boo, Chen & Choo 38 (SINU)

Araliaceae

Schefflera elliptica (Blume) Harms - Boo, Chen & Choo 16 (SINU)

Schefflera oxyphylla (Miq.) R. Vig. - Boo, Chen & Choo 57 (SINU)

Asclepiadaceae

Hoya diversifolia Blume - Md. Noor & Samsuri 32 (SING)

Marsdenia acuminata (Roxb.) I.M. Turner - Boo, Chen & Choo 120 (SINU)

Cecropiaceae

Poikilospermum suaveolens (Blume) Merr. - Md. Noor & Samsuri 38 (SING)

Celastraceae

Loesneriella macrantha (Korth.) A.C. Sm. - Md. Noor & Samsuri 19 (SING)

Microtropis valida Ridl. - Md. Noor & Samsuri 41 (SING)

Combretaceae

Combretum tetralophum C.B. Clarke - Boo, Chen & Choo 13 (SINU)

Quisqualis indica L. - Boo, Chen & Choo 46 (SINU)

Terminalia catappa L. - Boo, Chen & Choo 106 (SINU)

Commelinaceae

Belosynapsis ciliata (Blume) R.S. Rao - Boo, Chen & Choo 48 (SINU)

Commelina diffusa Burm.*f.* - Boo, Chen & Choo 70 (SINU)

Compositae

Blumea balsamifera (L.) DC. - Md. Noor & Samsuri 59 (SING)

Complaya trilobata (L.) Strother - Boo, Chen & Choo 122 (SINU)

Conyza bonariensis (L.) Cronquist - Md. Noor & Samsuri 55 (SING)

Vernonia cinerea (L.) Less. - Boo, Chen & Choo 40 (SINU)

Wollastonia biflora (L.) DC. - Boo, Chen & Choo 20 (SINU)

Convolvulaceae

c *Ipomoea batatas* (L.) Lam. - Arishah Hashim s.n. (UKMB)

Ipomoea mauritiana Jacq. - Boo, Chen & Choo 45 (SINU)

Ipomoea pes-caprae (L.) R.Br. - Boo, Chen & Choo 123 (SINU)

Crassulaceae

c *Kalanchoe laciniata* (L.) DC. - Boo, Chen & Choo 41 (SINU)

Kalanchoe pinnata (Lam.) Pers. - Boo, Chen & Choo 102 (SINU)

Cycadaceae

Cycas rumphii Miq. - Boo, Chen & Choo 141 (SINU)

Dilleniaceae

Tetracera indica (Christm. & Panz.) Merr. - Boo, Chen & Choo 98 (SINU)

Dracaenaceae

Dracaena maingayi Hook.*f.* - Boo, Chen & Choo 61 (SINU)

Euphorbiaceae

Actephila excelsa (Dalzell) Müll.Arg. var. *javanica* (Miq.) Pax & K. Hoffm. - Md. Noor & Samsuri MN14 (SING)

Antidesma cuspidatum Müll.Arg. - Boo, Chen & Choo 85 (SINU)

Antidesma japonicum Siebold. & Zucc. - Rahim Hamid s.n. (UKMB)

Breynia reclinata (Roxb.) Hook.*f.* - Boo, Chen & Choo 26 (SINU)

Breynia vitis-idaea (Burm.*f.*) C.E.C. Fisch. - Md. Noor & Samsuri 9 (SING)

Mallotus moritzianus Müll.Arg. - Md. Noor & Samsuri 17 (SING)

Mallotus paniculatus (Lam.) Müll.Arg. - Saidah Mamat s.n. (UKMB)

Mallotus philippensis (Lam.) Müll.Arg. - Shafiee Daud s.n. (UKMB)

c *Manihot esculenta* Crantz - Boo, Chen & Choo 81 (SINU)

Margaritaria indica (Dalzell) Airy Shaw - Boo, Chen & Choo 18 (SINU)

Melanolepis multiglandulosa (Reinw. *ex* Blume) Rchb.*f.* & Zoll. - Boo, Chen & Choo 72 (SINU)

Phyllanthus pulcher Wall. ex Müll.Arg. - Boo, Chen & Choo 113 (SINU)

Suregada multiflora (Juss.) Baill. - A. Latiff & A. Zainudin 148 (UKMB)

Flacourtiaceae

c *Flacourtia jangomas* (Lour.) Raeusch. - Boo, Chen & Choo 111 (SINU)

Flagellariaceae

Flagellaria indica L. - Boo, Chen & Choo 116 (SINU)

Gesneriaceae

Didymocarpus tiumanicus (Ridl.) B.L. Burtt - Md. Noor & Samsuri MN72 (SING)

Gnetaceae

c *Gnetum gnemon* L. - Boo, Chen & Choo 90 (SINU)

Gnetum latifolium Blume var. *funiculare* (Blume) Markgr. - Md. Noor & Samsuri MN68 (SING)

Goodeniaceae

Scaevola taccada (Gaertn.) Roxb. - Boo, Chen & Choo 105 (SINU)

Gramineae

Centotheca lappacea (L.) Desv. - Boo, Chen & Choo 69 (SINU)

Oplismenus compositus (L.) P. Beauv. - Md. Noor & Samsuri 50 (SING)

Guttiferae

Calophyllum inophyllum L. - Boo, Chen & Choo 107 (SINU)

Garcinia hombroniana Pierre - Md. Noor & Samsuri 25 (SING)

Joinvilleaceae

Joinvillea ascendens Brongn. & Gris. ssp. *borneensis* (Becc.) Newell - Arishah Hashim 43 (UKMB)

Labiatae

Leucas zeylanica (L.) R.Br. - Boo, Chen & Choo 34 (SINU)

Ocimum tenuiflorum L. - Boo, Chen & Choo 23 (SINU)

c *Solenostemon scutellarioides* (L.) Codd - Shafiee Daud s.n. (UKMB)

Lauraceae

Cassytha filiformis L. - Boo, Chen & Choo 25 (SINU)

Litsea glutinosa (Lour.) C.B. Rob. - Md. Noor & Samsuri 6 (SING)

Lecythidaceae

Barringtonia asiatica (L.) Kurz - Boo, Chen & Choo 346

Leeaceae

Leea indica (Burm.*f.*) Merr. - Md. Noor & Samsuri 4 (SING)

Leguminosae

Abrus precatorius L. - Boo, Chen & Choo 117 (SINU)
Archidendron jiringa (Jack) I.C. Nielsen - Arishah Hashim 60 (UKMB)
Bauhinia integrifolia Roxb. - Boo, Chen & Choo 9 (SINU)
Canavalia cathartica Thouars - Md. Noor & Samsuri 60 (SING)
c *Cassia fistula* L. - Saidah Mamat 32 (UKMB)
Crotalaria pallida Aiton - Boo, Chen & Choo 29 (SINU)
Derris scandens (Roxb.) Benth. - Boo, Chen & Choo 118 (SINU)
Desmodium velutinum (Willd.) DC. - Boo, Chen & Choo 6 (SINU)
Flemingia strobilifera (L.) Roxb. - Boo, Chen & Choo 133 (SINU)
Mucuna biplicata Teijsm. & Binn. *ex* Kurz - Arishah Hashim 73 (UKMB)
c *Psophocarpus tetragonolobus* (L.) DC. - Rahim Hamid s.n. (UKMB)
Pueraria phaseoloides (Roxb.) Benth. - Boo, Chen & Choo 8 (SINU)
Vigna marina (Burm.) Merr. - Boo, Chen & Choo 10 (SINU)

Lythraceae

Pemphis acidula J.R. Forst & G. Forst. - Shafiee Daud s.n. (UKMB)

Malvaceae

c *Abelmoschus moschatus* Medik. - Zainal Mustaffa s.n. (UKMB)
Abutilon indicum (L.) Sweet - Rahim Hamid s.n. (UKMB)
Hibiscus tiliaceus L. - Boo, Chen & Choo 100 (SINU)
Sida acuta Burm.*f.* - Boo, Chen & Choo 24 (SINU)
Thespesia populnea (L.) Sol. *ex* Corrêa - Md. Noor & Samsuri 53 (SING)
Urena lobata L. - Boo, Chen & Choo 11 (SINU)

Melastomataceae

Medinilla crassifolia (Reinw. *ex* Blume) Blume - Zainal Mustaffa s.n. (UKMB)
Memecylon caeruleum Jack - Boo, Chen & Choo 47 (SINU)
Memecylon edule Roxb. - Boo, Chen & Choo 30 (SINU)
Pogonanthera pulverulenta (Jack) Blume - Boo, Chen & Choo 54 (SINU)

Menispermaceae

Pericampylus glaucus (Lam.) Merr. - Boo, Chen & Choo 32 (SINU)
Stephania capitata (Blume) Spreng. - Boo, Chen & Choo 80 (SINU)

Moraceae

Artocarpus lanceifolius Roxb. - A. Latiff & A. Zainudin 132 (UKMB)
Ficus callosa Willd. - Rahim Ahmad 65 (UKMB)
Ficus deltoidea Jack - Arishah Hashim 66 (UKMB)
Ficus drupacea Thunb. - Boo, Chen & Choo 63 (SINU)
Ficus hispida L.*f.* - Boo, Chen & Choo 52 (SINU)
Ficus schwarzii Koord. - A. Latiff & A. Zainudin 134 (UKMB)
Ficus superba (Miq.) Miq. - Boo, Chen & Choo 43 (SINU)
Ficus tinctoria G. Forst. ssp. *gibbosa* (Blume) Corner - Boo, Chen & Choo 7 (SINU)
Streblus ilicifolius (Vidal) Corner - Boo, Chen & Choo 92 (SINU)

Myristicaceae
Knema laurina (Blume) Warb. - Md. Noor & Samsuri 69 (SING)

Myrsinaceae
Ardisia elliptica Thunb. - Arishah Hashim 67 (UKMB)
Ardisia oxyphylla Wall. *ex* DC. - A. Latiff & A. Zainudin 1394 (UKMB)
Ardisia villosa Roxb. - Md. Noor & Samsuri 74 (SING)

Myrtaceae
c *Psidium guajava* L. - Boo, Chen & Choo 37 (SINU)

Nytaginaceae
Boerhavia diffusa L. - Boo, Chen & Choo 2 (SINU)

Onagraceae
Ludwigia hyssopifolia (G. Don) Exell - Boo, Chen & Choo 87 (SINU)

Opiliaceae
Lepionurus sylvestris Blume - Md. Noor & Samsuri 67 (SING)

Orchidaceae
Cymbidium finlaysonianum Lindl. - Md. Noor & Samsuri 28 (SING)
Dendrobium crumenatum Sw. - Boo, Chen & Choo 62 (SINU)
Eulophia spectabilis (Dennst.) Suresh - Boo, Chen & Choo 109 (SINU)
Phaius callosus (Blume) Lindl. - Md. Noor & Samsuri 26 (SING)

Palmae
Daemonorops angustifolia (Griff.) Mart. - Arishah Hashim s.n. (UKMB)
Daemonorops sabut Becc. - R. Jaman 484 (UKMB)
Daemonorops sepal Becc. - Shafiee Daud 49 (UKMB)
Nypa fruticans Wurmb - Boo, Chen & Choo 114 (SINU)

Pandanaceae
Pandanus dubius Spreng. - Boo, Chen & Choo 138 (SINU)

Passifloraceae
Passiflora foetida L. - Boo, Chen & Choo 71 (SINU)

Rhamnaceae
Gouania leptostachya DC. - A. Latiff & A. Zainudin 133 (UKMB)

Rubiaceae
Canthium glabrum Blume - A. Latiff & A. Zainudin 135 (UKMB)
Chasalia chartacea Craib - Ramli Khamis 41 (UKMB)
Hedyotis biflora (L.) Lam. - Boo, Chen & Choo 139 (SINU)
Hedyotis dichotoma Koenig *ex* Roth - Boo, Chen & Choo 130 (SINU)
Lasianthus barbellatus Ridl. - Md Noor & Samsuri 48 (SING)
Morinda citrifolia L. - Boo, Chen & Choo 101 (SINU)
Prismatomeris tetranda (Roxb.) K. Schum. ssp. *malayana* (Ridl.) J.T. Johanss. - Md. Noor & Samsuri 23 (SING)
Tarenna mollis (Wall. *ex* Hook.*f.*) B.L. Rob. - Shafiee Daud 47 (UKMB)

Rutaceae
Atalantia monophylla (L.) DC. - Boo, Chen & Choo 136 (SINU)
Glycosmis mauritiana (Lam.) Tanaka - Boo, Chen & Choo 119 (SINU)
Murraya paniculata (L.) Jack - Boo, Chen & Choo 110 (SINU)

Sapindaceae
Allophylus cobbe (L.) Raeusch. - Boo, Chen & Choo 51 (SINU)

Sapotaceae

Pouteria linggensis (Burck) Baehni - Md. Noor & Samsuri 35 (SING)

Simaroubaceae

Brucea javanica (L.) Merr. - Md. Noor & Samsuri 12 (SING)

Solanaceae

Physalis ?pubescens L. - Boo, Chen & Choo 49 (SINU)

Solanum nigrum L. - Boo, Chen & Choo 79 (SINU)

Solanum torvum Sw. - Md. Noor & Samsuri 15 (SING)

Stemonaceae

Stemona curtisii Hook.*f.* - Boo, Chen & Choo 104 (SINU)

Sterculiaceae

Leptonychia caudata (Wall. *ex* G. Don) Burret - Md. Noor & Samsuri 42 (SING)

Turneraceae

Turnera ulmifolia L. - Boo, Chen & Choo 5 (SINU)

Ulmaceae

Trema tomentosa (Roxb.) Hara - Md. Noor & Samsuri 5 (SING)

Verbenaceae

Callicarpa longifolia Lam. - Boo, Chen & Choo 15 (SINU)

c *Clerodendrum calamitosum* L. - Boo, Chen & Choo 4 (SINU)

Clerodendrum inerme (L.) Gaertn. - Boo, Chen & Choo 27 (SINU)

c *Clerodendrum serratum* (L.) Moon - Arishah Hashim 90 (UKMB)

c *Clerodendrum thomsonae* Balf.*f.* - Md. Noor & Samsuri 11 (SING)

Lantana camara L. - Boo, Chen & Choo 22 (SINU)

Vitex trifolia L. - Boo, Chen & Choo 108 (SINU)

Violaceae

Rinorea bengalensis (Wall.) Kuntze - Md. Noor & Samsuri 43 (SING)

Vitaceae

Ampelocissus cinnamomea (Wall.) Planch. - Saidah Mamat s.n. (UKMB)

Cissus nodosa Blume - A. Latiff & A. Zainudin 138 (UKMB)

Cissus repens Lam. - A. Latiff & A. Zainudin s.n. (UKMB)

Tetrastigma leucostaphylum (Dennst.) Alston *ex* Mabb. - A. Latiff & A. Zainudin 122 (UKMB)

Tetrastigma pedunculare (Wall. *ex* Lawson) Planch. - A. Latiff & A. Zainudin s.n. (UKMB)

Pulau Besar

PTERIDOPHYTA

Adiantaceae

Adiantum stenochlamys Baker - C.L. Loh PB-20 (SINU)

Blechnaceae

Blechnum finlaysonianum Wall. *ex* Hook. & Grev. - C.L. Loh PB-30 (SINU)

Stenochlaena palustris (Burm.) Bedd. - C.L. Loh PB-22 (SINU)

Oleandraceae

Nephrolepis auriculata (L.) Trimen - C.L. Loh PB-28 (SINU)

Schizaeaceae
Lygodium circinnatum (Burm.*f.*) Sw. - C.L. Loh PB-4 (SINU)

SPERMATOPHYTA

Anacardiaceae
c *Anacardium occidentale* L. - C.L. Loh PB-37 (SINU)

Apocynaceae
c *Thevetia peruviana* (Pers.) K. Schum. - C.L. Loh PB-16 (SINU)

Asclepiadaceae
Hoya verticillata (Vahl) G. Don - C.L. Loh PB-10 (SINU)

Cycadaceae
Cycas rumphii Miq. - C.L. Loh PB-41 (SINU)

Erythroxylaceae
Erythroxylum cuneatum (Miq.) Kurz - C.L. Loh PB-42 (SINU)

Euphorbiaceae
Antidesma cuspidatum Müll.Arg. - C.L. Loh PB-3 (SINU)
Breynia reclinata (Roxb.) Hook.*f.* - C.L. Loh PB-17 (SINU)
Macaranga heynei I.M. Johnst. - C.L. Loh PB-40 (SINU)
Phyllanthus oxyphyllus Miq. - C.L. Loh PB-23 (SINU)
Suregada multiflora (Juss.) Baill. - C.L. Loh PB-33 (SINU)

Guttiferae
Calophyllum inophyllum L. - C.L. Loh PB-36 (SINU)

Lecythidaceae
Barringtonia macrostachya (Jack) Kurz - C.L. Loh PB-26 (SINU)

Leguminosae
Dendrolobium umbellatum (L.) Benth. - C.L. Loh PB-9 (SINU)
c *Tamarindus indica* L. - C.L. Loh PB-19 (SINU)

Loranthaceae
Dendrophthoe pentandra (L.) Miq. - C.L. Loh PB-13 (SINU)

Malvaceae
Hibiscus tiliaceus L. - C.L. Loh PB-14 (SINU)

Moraceae
Ficus fistulosa Reinw. *ex* Blume - C.L. Loh PB-38 (SINU)

Moringaceae
c *Moringa oleifera* Lam. - C.L. Loh PB-12 (SINU)

Myrsinaceae
Ardisia elliptica Thunb. - C.L. Loh PB-1 (SINU)

Myrtaceae
Rhodomyrtus tomentosa (Aiton) Hassk. - C.L. Loh PB-45 (SINU)
Syzygium grande (Wight) Walp. - C.L. Loh PB-11 (SINU)

Oleaceae
Olea brachiata (Lour.) Merr. - C.L. Loh PB-31 (SINU)

Opiliaceae
Cansjera rheedei J.F. Gmel. - C.L. Loh PB-8 (SINU)

Polygalaceae
Polygala paniculata L. - C.L. Loh PB-46 (SINU)

Rubiaceae

Guettarda speciosa L. - C.L. Loh PB-18 (SINU)

Timonius compressicaulis (Miq.) Boerl. - C.L. Loh PB-2 (SINU)

Santalaceae

Dendrotrophe varians (Blume) Miq. - C.L. Loh PB-48 (SINU)

Sapindaceae

Guioa pleuropteris (Blume) Radlk. - C.L. Loh PB-7 (SINU)

Simaroubaceae

Brucea javanica (L.) Merr. - C.L. Loh PB-25 (SINU)

Theaceae

Gordonia multinervis King - C.L. Loh PB-5 (SINU)

Umbelliferae

Centella asiatica (L.) Urban - C.L. Loh PB-34 (SINU)

Verbenaceae

Vitex pinnata L. - C.L. Loh PB-29 (SINU)

Pulau Yu

PTERIDOPHYTA

Oleandraceae

Nephrolepis acutifolia (Desv.) H. Christ. - B. Molesworth Allen 2575 (SING)

SPERMATOPHYTA

Celastraceae

Salacia chinensis L. - B. Molesworth Allen s.n., 30 July 1955 (SING)

Guttiferae

Calophyllum soulattri Burm.*f.* - B. Molesworth Allen s.n., 30 July 1955 (SING)

Myrsinaceae

Ardisia elliptica Thunb. - B. Molesworth Allen s.n., 30 July 1955 (SING)

Rubiaceae

Gynochthodes sublanceolata Miq. - B. Molesworth Allen s.n., 30 July 1955 (SING)

Ixora javanica (Blume) DC. - B. Molesworth Allen s.n., 30 July 1955 (SING)

Timonius compressicaulis (Miq.) Boerl. - B. Molesworth Allen s.n., 30 July 1955 (SING)

Sapindaceae

Guioa pleuropteris (Blume) Radlk. - B. Molesworth Allen s.n., 30 July 1955 (SING)

Mischocarpus sundaicus Blume - B. Molesworth Allen s.n., 30 July 1955 (SING)

Verbenaceae

Premna serratifolia L. - B. Molesworth Allen s.n., 30 July 1955 (SING)

Gardens' Bulletin Singapore **50** *(1998) 83–98.*

Unravelling *Pinanga patula* (Palmae) *sensu* Scheffer, Beccari and Ridley *non* Blume.

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Abstract

Preparatory to a revision of the genus *Pinanga* Blume as found in Peninsular Malaysia, three taxa hitherto related to *P. patula* Blume by Scheffer, Beccari, and Ridley are discussed in the light of uncertainties pertaining to Blume's species. The paper presents fresh nomenclatural notes on *P. riparia* Ridley, and describes *P. auriculata* Becc. var. *merguensis* Becc. as a new combination, and a new variety, *P. auriculata* Becc. var *leucocarpa..*

Introduction

In 1838, Blume (*Bull. Neerl.* 1:65) introduced the genus *Pinanga* and described a number of new species, including *P. patula* Blume, based on specimens from the interior mountains of Sumatra collected by his friend Praetorius. The type location of *P. patula* has yet to be identified. From the text and illustration in his subsequent publication (*Rumphia* ii, 86, 87, t.115), the taxon was clearly characterised by having four to seven pairs of leaflets, and inflorescences having two rachillae. The herbarium specimens at Leiden (lectotype: *Herb. Lugd. Bat. 900-182-241*, L; syntype: *900-182-241*, L) display pinnate leaves with up to five pairs of leaflets, "spreading, falcate-lanceolate, acuminate" on laminas small enough to lie comfortably within the dimensions of a herbarium sheet (Plate 1), and are thus smaller than those of the taxa subsequently considered to be conspecific or varieties.

Contemporaneously, Martius held a different view of Blume's genus, and placed the new taxa under *Seaforthia* in his publication *Historia Naturalis Palmarum* (1837-1850). Later, in 1855, Miquel also disregarded *Pinanga* and relisted the lot under *Ptychosperma*, redescribing *Ptycosperma patula* (*Flora van Nederlandsch Indie.**3***:26) presumably using the same original specimens, but in greater detail, indicating that the stem was three to four feet tall. As with Blume, he was silent on whether the taxon was solitary or clustering.

Scheffer, then Director at Hortus Botanicus Buitenzorg (now Kebun Raya Bogor), subsequently revised Miquel's account, reinstating *Pinanga*, including *P. patula* and the other Blume species with further descriptions (*Natuurkundig Tjidschrift voor Ned. Indie.* ***32***, 1871), freshly indicating that *P. patula* was stoloniferous (as distinct from being caespitose). He, however, appears to have added further cloudiness by reference to other taxa he considered to be conspecific or related, including *P. inaequalis* Blume, *P. minor* Blume, *P. furfuracea* Blume, and *P. junghuhnii* Blume. In 1876, he elaborated further on his *Pinanga* listing, and published photographs of the palms growing at Buitenzorg, including the clump labelled "*P. patula*", which might well be the same still to be seen at present-day Bogor. I believe, however, that it is not the same as the Blume taxon, as will be explained below, and it can be suggested that Scheffer had not been familiar with the original species from the type location, and has misled Beccari and others in this identification.

Beccari made three visits to Bogor, first meeting Scheffer on his way to New Guinea in 1871, and in 1874 when he became acquainted with the Javan flora. During these visits, he had so accepted *P. patula sensu* Scheff. as a distinct and stoloniferous species that during his third trip in 1878, when he travelled to Padang Pajang and Gunung Singalang he did not appear to have tried to find the Blume species. In 1885, after Scheffer's death, he wrote up *Reliquiae Schefferianae,* obviously accepting *P. patula* *sensu* Scheff., and in *Malesia 3*, reconfirmed his concept of the taxon and its variety, *P. patula* var. *junghuhnii* Scheff., describing the latter as a "mountain form" of the species (citing his own specimen from Lubu-Raja, at 3000–4000 ft altitude).

It would appear that after Praetorius, there had been no subsequent collections over the next 30 years or so; specimens by Korthals at Leiden are undated and without location notes. Collections from locations near Palembang were later made by Grashof (c. 1915), and by Teysmann probably earlier. In 1971–73, Dransfield collected from Gunung Tujuh and G. Kerinci at 1400–1900 m, but labelled his specimens (e.g. *JD2689,* K) tentatively "aff. *P. patula*"; whereas his specimen from Jambi (*JD2555*, BO, K) from a peat swamp were called "*P. patula*", but they resemble more closely *P. patula sensu* Scheff. (as will be discussed later).

In Sarawak, Beccari had begun to find innumerable new species, including the solitary and distinctive *P. auriculata* Becc. (Malesia. **3**, 1886: 134–135), which he clearly considered to be distinct from the clustering *P. patula sensu* Scheff.. Viewing Beccari's own collections in Florence, we can observe interesting but curiously variable determinations of specimens sent to him between 1866 and 1892, and later, with particular reference to the Malayan ones. Several, which he labelled as *P. patula* have to be regarded as incorrect or dubious. He also began to coin new varieties, which were not published, as far as I have been able to discover, e.g. "var. *kalamantanica*", "var. *lianggagangensis*", and "var. *borneensis*". The last-named was presented as *P. patula* Blume forma *borneensis* by Winkler

(1913), together with *P. patula* Blume var. *microcarpa* Becc., also from Borneo.

Following Beccari's wishes, posthumously Martelli published *P. patula* Blume var. *merguensis* Becc. (in Martelli, 1934), and in 1935 relisted: *P. patula* var. *celebica* Scheff. (which he proposed to be synonymous with *P. inaequalis, P. minor*, and *P. furfuracea* - a three-way puzzle to be resolved elsewhere), *P. patula* var. *gracilis* Scheff. (synon. of *P. gracilis* Blume), *P. patula* var. *junghuhnii* Scheff. from Sumatra, and introduced *P. patula* Blume var. *riparia* Becc. in Martelli, the last-named being a reduction of *P. riparia* Ridley – which will be discussed later.

Plate 1. *Pinanga patula* Blume (lectotype: *Praetorius, Herb. Lugd. Bat. 900-182-241*, L). By courtesy of Rijksherbarium, Leiden.

Plate 2. *Pinanga riparia* Ridley, cultivated in Singapore Botanic Gardens, c.1934. By courtesy of Singapore Botanic Gardens.

Plate 3. *Pinanga paradoxa* (Griff.) Scheff., leaves (**H0942*).

Plate 4. *Pinanga riparia* Ridley, leaves.

Significantly, especially in the context of this account, Beccari determined the specimen *Ridley 3158* from Kuala Tenok, Pahang collected in 1891 as *P. patula* Blume, thus "importing" the nomenclature into Peninsular Malaysia. Another specimen collected in 1892 from Ulu Bubong, Perak (*King's Collector 10702,* K, FI and CAL) was similarly cited by Beccari and J.D. Hooker (and propagated as such by a fine drawing in the Bentham Trust) further contributed to the spread of this error. I am positive, however, that this is a specimen of *P. pectinata* Becc. & J.D. Hooker, which is distinct, as will be discussed more fully in my revision (in prep.) of *Pinanga* in Malaya.

Hooker had asked Beccari to collaborate on the palm section of *Flora of British India* but, although identified as precedent co-author, it is believed that Beccari had not responded to the invitation. From the correspondence between the two, it emerges that in 1886, Hooker had wanted Beccari (who was then preoccupied with the third volume of his own *Malesia*) to go to Kew to work on the Scortechini material; in September 1891, he offered Beccari 15 pounds sterling to provide diagnoses and descriptions of the Indian species. In the above-mentioned *Flora* itself, J.D. Hooker published *P. pectinata* based on *King's Collector 4393* together with other *Pinanga* taxa, but called *P. patula* Blume "a doubtful species"!

Ridley, in *Materials for a Flora of the Malay Peninsula* (1907) and *Flora of the Malay Peninsula* (1925) reinstated *P. patula* as a Malayan species, citing his own Kuala Tenok collection, and the Ulu Bubong one mentioned above, thus leaning on Beccari's authority. Here, *sensu* Ridley, three different taxa are being confused. Although his Pahang specimen was of a <u>solitary</u> species, Ridley described the lot as "tufted". He, however, chose to ignore Beccari's efforts to sink his *P. riparia* (1905), but in this paper, *P. patula* var. *riparia* (1935) will revert to being a synonym. This also contradicts Whitmore's taxonomic note (*Principes.* (1970) ***14***:125), where he incorrectly deemed *P. riparia* to be synonymous with *P. pectinata*, but suggested that *P. patula sensu* Ridley was distinct.

It is obviously urgent and desirable to seek out the "real" *P. patula* and to collect fresh herbarium and live specimens (for propagation) from the probable type location in Sumatra, on the mountains. The prominent clumps labelled as this taxon in Kebun Raya Bogor and also those previously in the Singapore Botanic Gardens (Plate 2) - as shown in a photograph c.1934 by a Captain Johnstone, which correspond with herbarium specimens originally labelled "*P. disticha*", but determined by Furtado in 1929 as "*P. patula* var." are indistinguishable from *P. riparia* Ridley, which is a stoloniferous species found in low and wet places, and should now be recognised as such. It appears to adapt well to garden conditions, as evidenced at Bogor, and is indeed a handsome horticultural attraction.

Dransfield (1974) believes that his specimen (*JD 3590,* BO, K, L, SING) from Bengkulu at 500 m altitude matches with the type; his, however, has larger leaves and inflorescences with three or more branches. Another specimen (*JD 2679,* BO, K) collected at 800 m from Kepahiang, Bengkulu (which occupies six sheets), displays various forms of leaf dissection, including one that does seem similar to the Praetorius specimen at Leiden. I would be inclined, however, to defer a definitive verification of *P. patula* Blume until field visits to the "interior mountains of Sumatra" yield more conclusive results. My suspicion is that the elusive palm may prove to be closer in appearance to *P. paradoxa* (Griff.) Scheff. (Plate 3) and *P. salicifolia* Blume, from Peninsular Malaysia and Borneo respectively. The Praetorius specimens have slender stems of similar dimensions to these.

With regard to the species of relevance to Peninsular Malaysia, I propose to address the following three taxa: *P. riparia* (also found in Thailand, and probably once in Singapore), *P. patula* var. *merguensis* (now known to be widespread in South Thailand and in Perlis), and *P. patula sensu* Beccari and Ridley *non* Blume (in Thailand, Peninsular Malaysia and Singapore).

1. Pinanga riparia Ridley. *J. Roy. As. Soc. Str. Br.* ***44*** (1905) 201.
Type: Johor: Sg. Tebrau, 1903, *Ridley 11518* (SING – lectotype here chosen, K iso).

Synon **:** *P. patula* Blume var. *riparia* Becc. in Martelli. *Nuov. Giorn. Bot. Ital. NS* ***42*** (1935) 71**.** *Type*: Johor, Kukub, 1909, *Ridley 14170* (FI, SING).

Notes: Viewing the herbarium specimens in Leiden, I became convinced that Ridley's taxon is not related to *P. patula* Blume. Although they may both be clustering species, *P. riparia* is distinctly stoloniferous, and has laminas which are usually larger, have more numerous leaflets, and broader apical ones (Plate 4). From Ridley's accounts and field familiarity, I was also positive that the Bogor clump is *P. riparia* and not Blume's taxon, which, as conjectured above, neither Scheffer nor Beccari had the opportunity of verifying from live specimens.

The error becomes clear from Beccari's account of *P. patula* (*Malesia.* ***3***: 139-140), from which we learn that the Bogor live specimen had been collected from Banka by Teysman (and was similar to Beccari's own find at Sungai Bulu in Padang), both undoubtedly from riverine habitat. Beccari further commented on Teysman's Bornean collections from Kapuas and Sg. Landak, which he felt were varieties or other forms of *P. patula sensu* Scheffer. Presented with Ridley's specimen *14170* collected from Kukup in 1909, he obviously could only treat it as a variety of *P. patula sensu* Scheffer.

John Dransfield (pers. comm.) believes that in Borneo, there may be other swamp-dwelling, stoloniferous taxa which relate with *P. riparia*, and might even be conspecific; indeed, collections of *P. patula* var. *borneensis*, and other specimens from Kalimantan, Brunei and Sarawak have to be reexamined (also in relation to the puzzling *P. furfuracea*) - an interesting prospect for further research in that domain.

P. riparia is easily identifiable after acquaintance in the field; in its natural habitat, it is practically rheophytic. The shiny leaves vary not only in size, but also in number of pinnae, and the petiole and rachis are sometimes glaucous. The stolons arise often at a distance from the main plant, and the nodal sections of the stems are green, light or darker, and "unwoody", often to 4 m in height. The deflexed inflorescence has usually two rachillae distinctively purple (coral red initially), with elliptical light green drupes (Plate 10), turning red to black. Specimens in herbaria have sometimes been mislabelled as *P. singaporensis* Ridley (with which *P. riparia* is often sympatric in Johor), and which in turn has often been misidentified as *P. pectinata.*

Distribution: Thailand: Narathiwat (viz. Phengklai & Niyomdham, 1991); Peninsular Malaysia: Terengganu (Saw Leng Guan pers. comm.), Pahang, Selangor, Negri Sembilan, Johor; Indonesia: S. Sumatra, Banka.

Habitat: peat swamps, river banks; not rare, but endangered by habitat destruction.

Specimens examined: Thailand: Narathiwat, 1974, *Larsen 33092* (K); Peninsular Malaysia: Selangor, Tanjong Karang, 1937, *Nur 34126* (SING); Johor: Sg. Tebrau, 1903, *Ridley 11518* (Type, K, SING), 1906, *Ridley 13235* (K, SING), Kukub, 1909, *Ridley 14170* (Type of *P. patula* var. *riparia* Becc. in Martelli, FI, SING), Sg. Sedili, 1935, *Corner 29239* (K).

2. *Pinanga auriculata* Becc. **var. *merguensis*** (Becc. in Martelli) C.K. Lim **comb. nov.**

Synon.**:** *P. patula* Blume var *merguensis* Becc. in Martelli. *Atti. Soc. Toscana Scienze Naturali Res. Pisa Memorie* ***44*** (1934): 125,126; ("merguiensis": *Nuov. Giorn. Bot. Ital. NS* ***42*** (1935):71)**.**

Type: Myanmar: Mergui, Tarapon, 1911, *Meebold 14380* (two sheets), (WSRL).

Notes: From wider field observations and collections, this taxon is confirmed as widespread from Mergui and along the west coast of Peninsular Thailand – where indeed it had been collected by Kerr, Whitmore and others – and within Perlis, where it was collected in 1995 by L.G. Saw and C.K. Lim (*H1837, H1840* KEP), and noted as a new record for Peninsular Malaysia (Lim, *Principes* ***42***: 115). It is a solitary species clearly unrelated to the Sumatran taxon, *P. patula* Blume, as discussed earlier. Observing the striking similarity in habit and habitat of *P. auriculata* Becc. (1886), which Beccari collected at Kuching (holotype *PB589*, FI), I propose to transfer var. *merguensis* to varietal status under it.

Although I had felt an earlier hesitance and reluctance to "cross the Sunda shelf" to relate Peninsular Malaysian and Bornean *Pinanga* species, recent field trips to Sarawak have provided new perceptions. Furthermore, the two taxa display many features in common, and it would seem that *Pinanga* taxa with affinities to *P. auriculata* may be quite widespread in the western Malesian region. The bifid eophyll and juvenile leaves (Plate 6) are quite indistinguishable within the group (and similar also with *P. limosa* Ridley); the prophylls are also similar, and dry into papery tatters. Ligules or auricles subtending from the leafsheath, where the petiole splits away, are often variable even in *P. auriculata* var. *auriculata,* and may not always be prominent.

The leaflets of var. *merguensis* (and of another new variety to be described below) differ from those of *P. auriculata* var. *auriculata*, which are more numerous and longer; in the variety, these are more sigmoidal (Plates 7), with pinnae that may be closely or more distantly spaced. They both have inflorescences usually with four to six rachillae; in var. *merguensis* the infructescence, often profuse and abundant, has drupes which are distinctively shiny and almost translucent, wine-red, (Plate 11) before ripening black. Meebold's fine specimens (Plate 5) has been well curated at Wroclaw (earlier known as Braslav). Beccari, who designated the type in 1913, originally annotated it as "*P. patula* Bl. forma *merguensis* Becc.".

Distribution: Myanmar: Mergui; Thailand: Ranong, Trang, Surat Thani, Phuket, Satun; Peninsular Malaysia: Perlis.

Habitat: hill forests or lowland, riverine; not rare.

Specimens examined: Thailand: Ranong, 1918, *Kerr 16386* (K), 1927, *Kerr 11763* (K), Trang, Khao Chong Nat. Park, 1979, *Dransfield JD 5451* (K). Peninsular Malaysia: Perlis, Mata Ayer F.R., 1995, *C.K. Lim H1837, H1840* (KEP), *1996, C.K. Lim H1942**

Plate 5. *Pinanga auriculata* Becc. var. *merguensis* (Becc. in Martelli) C.K. Lim (holotype: 1911, *Meebold 14380*, WSRL). By courtesy of WSRL.

Plate 6. *Pinanga auriculata* var. *merguensis*, juvenile leaves.

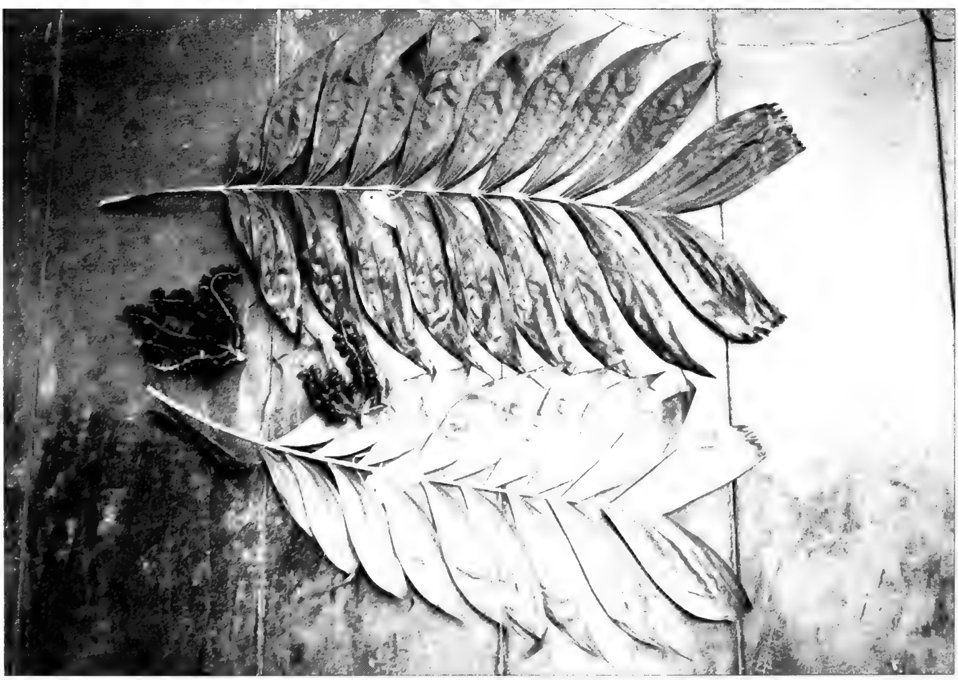

Plate 7. *Pinanga auriculata* var *merguensis*, leaves and fruit (**H1837*).

**Note: Within this account, as in my other taxonomic papers, certain specimens (prefix: H) currently kept in the Palm Search Malaysia collection are cited to supplement herbarium collections examined. Although it is intended eventually to deposit more specimens in the major reference herbaria, many items represent field records of the in situ conservation status, which the PSM project is in the process of monitoring.*

3. *Pinanga auriculata* Becc. **var *leucocarpa*** C.K. Lim **var. nov.**

A varietate typica fructibus albidis in statu immaturo distinguibilis.

Typus: Pahang, Kuala Tenok, 1891, *Ridley 3158* (holotypus, SING; isotypus, FI, K)

Synon nov.**:** ***P. patula*** *sensu* Ridley *non* Blume, Ridley. *Materials for a Flora of the Malay Peninsula.* ***2*** (1907) 143; ***P. bowiana*** Hodel. *The Palm Journal* ***134*** (1997) 35. (Type: Thailand: Narathiwat, 1997, *Hodel & Vatcharakorn 1608*, BK)

Stem, size and habit similar to *P. auriculata* var. *merguensis*; similarly, leaves divided with six to eleven pairs of leaflets, sigmoidal, with four nerves, sometimes bullate, glabrous, light or dark green, lighter on underside; prophyll drying papery; inflorescence infrafoliar, pendent, with two to six rachillae, usually light green; floral pits distichously arranged, flowers not examined; drupes globose, 6 x 8 mm, distinctively creamy white with green tips when immature, ripening red to black.

Geographical range: only along east coast of peninsular Thailand and Peninsular Malaysia, and Singapore.

Notes: As discussed in the Introduction, the specimen from Pahang collected by Ridley was incorrectly determined by Beccari, who may not have known that the Malayan taxon was distinctively solitary. Ridley had later described it as "tufted" or with "several" stems, and also confused it with *P. pectinata*. Whitmore (1973: 92) was obviously aware that Ridley's descriptions of *P. patula* were faulty, and from his field observations pointed out that it was a solitary species (Plate 8). In habit and leaf form, which are pronouncedly sigmoidal (Plate 9), it could sometimes be confused with *P. auriculata* var. *merguensis*, which it closely resembles, but can be distinguished by the fruit, which are more globose and creamy white (with green tips) when immature, or nearly mature (Plate 12) – hence the varietal epithet. The fruit is also reminiscent of those of *P. limosa*, which is a diminutive species

Plate 8. *Pinanga auriculata* Becc. var. *leucocarpa* C.K.Lim, at Merapoh, Pahang.

Plate 9. *Pinanga auriculata* var. *leucocarpa*, leaves and inflorescence (**H0583*).

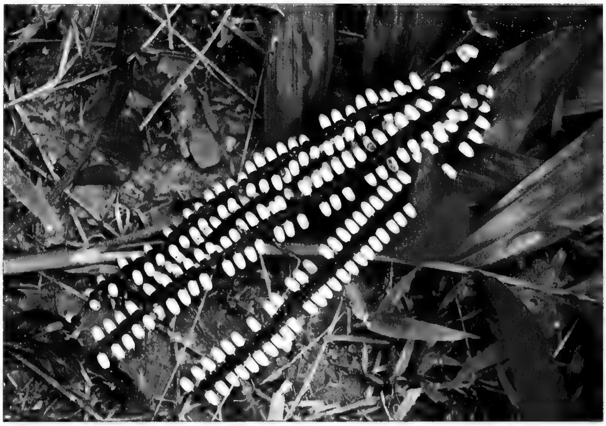

Plate 10. *Pinanga riparia*, inflorescence and fruit (**H0509*).

Plate 11. *Pinanga auriculata* var. *merguensis*, inflorescence and fruit (**H1837*).

Plate 12. *Pinanga auriculata* var. *leucocarpa*, inflorescence and fruit (**H1259*).

with spicate inflorescences. It should be noted that when dried, drupes tend to look quite similar to those of *P. limosa* but are more elliptical or fusiform, and no longer globose.

Both varieties of *P. auriculata* are quite variable in robustness and size – seen fruiting at heights varying from 2 to 4 m. In the inflorescence of var. *leucocarpa*, the rachillae are usually light green, but coral red variants have been observed, with immature drupes not the usual creamy colour, but red; this rare variation has also been noticed in *P. limosa*.

In an earlier paper (Lim, 1998), I determined that *P. bowiana* Hodel was conspecific with "*P. patula* Blume" – more correctly, with *P. patula sensu* Ridley *non* Blume. In the light of further research on the basionym, both will now be reduced to synonymity under *P. auriculata* var. *leucocarpa*,. In his account, Hodel did not seem aware of the many herbarium collections of the Malayan taxon, or of those collected previously in the Narathiwat area. His description also lacked the essential mention of the fruit and diagnostic colour of the drupes, but from familiarity with his collection sites, I feel sure that his specimen is of this particular variety.

The Ridley specimen from Pahang is for Malesian taxonomy important and historical, and has drawn with it numerous other collections designated similarly. For this reason, it continues to serve as the type for the new variety. The many herbarium specimens hitherto labelled *P. patula* by Ridley and others, however, may now have to be redesignated, and sorted out to differentiate var. *leucocarpa* from var. *merguensis,* the convenient initial guide being the collection site, and better, from clear evidence of the inflorescence and fruit.

As a result of more extensive field monitoring, territoriality becomes a useful indicator where it can be reasonably sure that certain taxa are localised. In geographical range, var. *leucocarpa* is widespread along the east coast of Peninsular Malaysia from Singapore and Johor to Kelantan, and in the Narathiwat area of Southern Thailand, but has so far not been found in the western side of the Peninsula where var. *merguensis* is common, from Perlis northwards.

Distribution: Thailand: Narathiwat; Peninsular Malaysia: Kelantan, Terengganu, Pahang, Johor; Singapore.

Habitat: hill forests or lowland, swamp; not rare in Peninsular Malaysia.

Specimens examined: Thailand: Narathiwat, 1997, *Hodel & Vatcharakorn 1608,* BK (Holotype of *P. bowiana* Hodel); Peninsular Malaysia: Terengganu, Kemaman, 1935, *Corner30165* (K, SING), Ulu Setiu, 1977, *J. Dransfield JD5175* (K), G. Padang, 1969, *T.C. Whitmore FRI 12749* (KEP), Sg. Kerbat, 1971, *T.C. Whitmore FRI 20222* (KEP), Kelantan, Bukit Batu

Papan, 1935, *Henderson 29525* (SING), Pahang, Temerloh, 1967, *Palmer 18* (SING), K. Kenyam, 1985, *J. Dransfield JD6224* (K); Singapore: Bukit Timah, 1902, *Ridley s.n.,* (SING).

Acknowledgements

To the Directors of the Herbaria at BK, BO, CAL, FI, K, KEP, L, SING and WSRL special thanks, and for permission to reproduce illustrations of types. For invaluable taxonomic advice, consultation and discussion: Dr. Chin See Chung, Dr. Ed de Vogel, Dr. John Dransfield, Dr. Ruth Kiew, Dr. C. Nepi, Dr. Saw Leng Guan, Dr. Wanda Stojanowska and Dr. Tim Whitmore. To the members of the Palm Search Malaysia crew, for their field efforts and support.

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ERRATA

Gardens' Bulletin Singapore 48 (1996)

Lim, C.K. Unravelling *Iguanura* Bl. (Palmae) in Peninsular Malaysia

Page 62: **Acknowledgements:** Third paragraph, lines 9 & 10:-
"Mr S. Nadarajah" should read "Mr D. Nadarajah"
"Ahmad Ismail" should read " Ismail Ahmad"
"Mohamad Noor Jamalulail" should read "Mohd Nor Jamalulail"

Lim, C.K. Palms in the Farquhar Collection of Natural History Drawings

Page 70: Item 7, line 2: "tunngal" should read "tunggal"
Page 72: Second paragraph, line 21: "Rottl." should read "Rottb"
line 25: "Findlaysonis" should read "Findlayson's"
Page 72: Fourth paragraph, line 11: after "mystery" insert: "had been"
Page 73: Plate 6: The illustration is erroneously that of "Nipah: *Nipa fruiticans*"

Gardens' Bulletin Singapore **50** *(1998) 99–114.*

Four New *Pinanga* Blume (Palmae) Species from Peninsular Malaysia

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with contributions by

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Abstract

Four new *Pinanga* species, all from Johor, are described: *P. jamariensis, P. johorensis, P. palustris* and *P. pantiensis*.

Introduction

Since 1989, the Palm Search Malaysia project has made innumerable and repeated trips around Peninsular Malaysia, gaining important field experiences and findings of new or forgotten species. Stimulated by fresh data, the genera *Iguanura* Blume and *Pinanga* Blume have been given priority for updating and revision – a process of "unravelling", especially because of historical uncertainties, inherent in the monumental and strenuous efforts of earlier collectors including H.N. Ridley and others, in the determination of some herbarium specimens. The *Iguanura* revision has since been published (Lim, 1996).

To facilitate the ongoing revision of *Pinanga* within Peninsular Malaysia, I decided to sort out certain vexatious aspects relating to *P. patula sensu* Scheffer, Beccari and Ridley *non* Blume (Lim, 1998), and now, for taxonomic convenience, to publish four new species, which have been in draft since 1994 or earlier. The taxa are all coincidentally from Johor: *P. jamariensis* C.K. Lim, *P. johorensis* C.K. Lim & L.G. Saw, *P. palustris* Kiew, and *P. pantiensis* J. Dransfield.

Saw Leng Guan had shared the discovery of *P. johorensis*, for which he is co-author. We gladly decided to honour the State of Johor by the epithet, as indeed it is quite widespread there (several previous collectors

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having considered it to be *P. malaiana* (Mart.) Scheff., e.g. *Whitmore FRI 0187*, SING). *P. jamariensis* and *P. pantiensis* are more localised in their known habitat, the latter being probably more seriously endangered by forest clearance at Linggiu and Gunung Panti, where an *in situ* conservation effort would be most desirable and urgent. *P. palustris*, although earlier thought to be localised to the Endau area, is now known to be quite widespread not only in Johor but also along the east coast of the Peninsula up to Terengganu. As with *P. johorensis*, with which it often shares its habitat, many early collections of this taxon have been labelled as *P. malaiana,* e.g. *Tan Ah King 23* from Mawai, 1959, SING (but note: *Tan Ah King 23A*, SING, collected contiguously is *P. johorensis*). It is also one of the few Malayan *Pinanga* species that appears to have an affinity with Sarawak ones, in particular, *P. mirabilis* Becc. (1886).

*Note: Within this account, as in my other taxonomic papers, certain specimens (prefix: *H) currently kept in the Palm Search Malaysia collection are cited to supplement herbarium collections examined. Although it is intended eventually to deposit more specimens in the major reference herbaria, many items represent field records of the in situ conservation status, which the PSM project is in the process of monitoring.*

1. *Pinanga jamariensis* C.K.Lim **sp. nov**

P. auriculatae var. merguensi similis sed foliis parvidissectis et glaucis bene distincta.

Typus: Johor: Bukit Jamari, 1993, *C.K.Lim H1456* (holotypus SING, isotypus KEP).
Plates 1–4.

Solitary, stilt-rooted; stem grey-brown, erect, 3–8.5m tall, slender, 2 cm diam., internodes 5–12 cm. Crown with eight or more leaves; leaf sheath c. 28 cm, distinctly glaucous, white, tinged pink within; petiole 5 mm diam. to 30 cm long, glaucous; lamina thick and fleshy, 65 x 40 cm, glaucous, darker green above, lighter below and white to silvery, sometimes prominently whitish along nerves; blade often entire in juveniles, later divided into three or more irregular pairs of leaflets, with three to five nerves, leaves sometimes (rarely, e.g. **H1460*) with serrated leaf edges. Inflorescence infrafoliar, pendent, with 3–4 branches; prophyll thin, papery, brown, often lingering though shrivelled; peduncle short c. 10 cm, 6 mm wide; rachillae slender, to 15 cm, reddish, with distichous floral pits. Staminate and pistillate flowers not seen. Fruit distichously borne, c. 24 pairs per rachilla; immature drupes light green with darker tips, ellipsoid, elongate and pointed, ripening to buff colour then blood red to black, broadening ellipsoid, c.12 x 10 mm; testa fibrous. Seedling leaf entire-bifid, acute, dark green, glabrous.

Notes: This handsome and elegant palm is relatively rare, found so far in Johor from Gunung Panti (where I first saw it) to Kahang, Mersing Forest Reserve, and at its type location in Bukit Jamari (Plate 3), which its epithet identifies. Its glaucousness is indeed quite diagnostic, and the thick white

Plate 1. *Pinanga jamariensis* C.K.Lim (holotype: 1993, *C.K.Lim H1456*, SING). By courtesy of SING.

Plate 2. *Pinanga jamariensis*, leaves and inflorescences (**H1455*).

Plate 3. *Pinanga jamariensis,* solitary palm at Bukit Jamari, Johor.

Plate 4. *Pinanga jamariensis,* young adult plant.

leaves with fewer and broad leaflets (Plates 2 & 4) tell it apart from *P. auriculata* Becc. var. *leucocarpa* C.K. Lim (synon: *P. patula sensu* Ridley *non* Blume, see Lim, 1998) found in the same areas, which, however, has leaves with more numerous leaflets that are glabrous and sigmoidal in shape, and fruits that are globose and creamy white when immature, resembling those of *P. limosa* Ridley. Juvenile stages of the new species may indeed also look similar to the diminutive *P. limosa*, which occasionally has glaucous leaves, entire or dissected, and similarly thick; the eophylls are practically indistinguishable, and suggest an affinity within what might be called the '*limosoid* group'. Curiously, in these two *Pinanga* taxa, serrations to leaf edges beyond the apical teeth have been observed (which I have also seen in *P. subintegra* Ridley), although as a rare occurrence.

Although compared with *P. auriculata* Becc. var. *merguensis* C.K. Lim (1998), the precedent variety, in the diagnosis (the habit and infructescence are similar), the drupes of that taxon are, however, different in colour, being distinctively shiny, wine-red, and its leaves (similarly with var. *leucocarpa*) are glabrous, and quite different in dissection and shape. Furthermore, their respective domains are geographically distant and disjunct. The new species is often sympatric with *P. auriculata* var. *leucocarpa,* as mentioned above, and also with *P. limosa, P. simplicifrons* (Miq.) Becc. and the other new species to be described in this paper, *P. johorensis*, and *P. singaporensis* Ridley in the Kahang area and at Gunung Panti.

It may be found fruiting at less than 2 m in height, contrasting with the surprisingly tall individuals towering at over 8 m, with disproportionately slender stems, able to endure in wind-sheltered habitat at Jamari, where *P. johorensis* and *Johannesteijsmannia altifrons* Reichenb.*f.* & Zoll. are also luxuriant. This new and attractive *Pinanga* can easily become endangered due to deforestation, as at Kahang, where it is already rare, and may require protection.

Distribution: Johor: Mersing F.R., Bukit Jamari, Kahang, Gunung Panti.

Habitat: lowland dipterocarp forest, to 50 m a.s.l., not common.

Specimens examined: Johor: Gunung Panti, 1990, *C.K.Lim *H0515*, Bukit Jamari, 1991, *C.K.Lim H1004* , 1992, *C.K.Lim H1149* , 1993, *C.K.Lim H1455,* 1993, *C.K.Lim H1457* (SING), *C.K.Lim H1402, H1459, H1460, H1526*, 1994, *C.K.Lim H1674, H1682*, 1995, *C.K.Lim H1895, H1923* , 1996, *C.K.Lim H195.*

2. *Pinanga johorensis* C.K.Lim & L.G.Saw **sp. nov**

A P. malaiana minor, rachillis plerumque 2-ramulis, longis stolonibus bene distincta.

Typus: Johor: Lenggor F.R., 1993, *L.G.Saw FRI 37435* (holotypus KEP, isotypus K).
Plates 5–7.

Clustering, pleonanthic, monoecious palm. Stem with basal suckers forming very loose clumps, stoloniferous with distant stems up to 3 m apart; stem to 7 m tall, slender to 3 cm diam.; nodal scars conspicuous, 1 cm wide, internode to 15 cm apart; stem surface green, sometimes sparsely lepidote, with brown scales. Crownshaft to c. 65 cm long, dark green, sometimes glaucous, conspicuously swollen in developing inflorescences. Leaves six to nine in crown; leaf sheath to 32 cm long, glaucous on freshly exposed parts, prominently lepidote on older parts; leaf with sheath to 1 m or longer; petiole to 38 cm long, c. 1 cm diam., slightly channelled adaxially, round abaxially, lepidote; leaflets acuminate, often five to seven regularly arranged on each side of rachis, broad with 4–5 nerves (sometimes with 17 to 22 pairs of leaflets, each with fewer nerves), the apical leaflets broader, very prominently toothed and deeply lobed; lamina up to 122 cm long by 75 cm wide, shiny green, coriaceous, drying dull greenish brown on upper surface, darker brown on abaxial surface. Inflorescence infrafoliar, pendulous; prophyll from immature inflorescence elliptic, strongly two-keeled, pink when fresh; peduncle short to 1.5 cm long, flattened, wide at the prophyll scar; rachillae two, rarely three, with floral triads arranged distichously. Immature staminate flowers asymmetrical, sessile; calyx with three free triangular unequal lobes, c. 2 mm long; corolla with three well-developed ovate lobes, joined shortly below; stamens c. 38. Immature pistillate flower sessile; globose, calyx with three triangular, ciliate-margined lobes, about the same size as calyx lobes; staminodes absent; ovary cylindrical to ovoid, c. 1.5 x 1 cm; stigma with short style c. 0.5 mm long, 0.5 mm wide; stigma irregularly lobed and flattened. Infructescence infrafoliar strongly reflexed, up to 22 cm long. Immature fruits buff coloured with pink tips, maturing to bright red and black, with black calyx and corolla, borne on coral red rachillae. Mature fruit ellipsoid to 3 x 1.5 cm, with a distinct low collar surrounding the apical stigmatic remains; epicarp smooth; endocarp with conspicuous longitudinal fibres; seed adhering to endocarp, 1.5 x 1.2 cm, attached basally; endosperm deeply and irregularly ruminate; embryo basal.

Plate 5. *Pinanga johorensis* C.K.Lim & L.G.Saw, stoloniferous palm at Bukit Jamari.

Plate 6. *Pinanga johorensis*, note toothed apical leaflets.

Plate 7. *Pinanga johorensis*, inflorescences and fruit, Kahang, Johor (**H0744*).

Notes: This smaller relative of *P. malaiana* (Mart.) Scheffer has undoubtedly been often confused with its larger kin, and perhaps many herbarium specimens still exist under that appellation. It can frequently be seen along the road from Kluang to Jamaluang, where it is under threat from forest clearance, and at Bukit Jamari (Plate 5). Apart from the two-, sometimes three-branched rachillae (Plate 7), it can be differentiated by the slender stems growing out of surprisingly distant stolons, and its fewer broad leaflets with the apical leaflets prominently toothed (Plate 6), although multi-pinnate forms with narrower leaflets can also be found. In the field, the swollen leaf sheaths have been observed to be penetrated by insects eager to ravage the inflorescence within; one rarely sees exposed flowers in anthesis. After abscission the prophyll may sometimes be erect, but are usually deflexed.

It is relatively widespread in Johor, justifying its epithet. From the Lenggor F.R. to Mersing, it grows sympatrically with *P.limosa, P. palustris* Kiew (see below), *Nenga grandiflora* Fernando, and *N. pumila* var. *pachystachya* (Blume) Fernando, *I. geonomiformis* Griff. ex Mart., *I. asli* C.K. Lim, and the rattans of the area including *Korthalsia echinometra* Becc., and *K. flagellaris* Miq.. Ridley's 1903 specimen indicates its presence in Singapore. Further research might possibly yield collections in Sumatra and the Riouw islands.

Distribution: Johor, Lenggor F.R., Mersing F.R., Bukit Jamari; Singapore.

Habitat: lowland dipterocarp forest, to 80 m a.s.l.; common palm.

Specimens examined: Johor: Kota Tinggi, Mawai, 1959, *Tan Ah King 23A* (SING), Kahang, Kg. Sri Lukud, 1990, *C.K.Lim *H0512*, 1991, *C.K.Lim H0745, H0970, H1051, H1057*, Bukit Jamari, 1991, *C.K.Lim H1003*, 1993, *C.K.Lim H1458* (SING), *H1400, H1525*, 1994, *C.K.Lim H1683*, 1995, *C.K.Lim H1896, H1924*, Labis F.R., 1966, *T.C.Whitmore FRI 0187* (SING), 1970, *T.C.Whitmore FRI 15618* (KEP), 1993, *C.K.Lim H1519* , Lenggor F.R., 1993, *C.K.Lim H1588, H1589* ; Singapore: Bukit Panjang, 1903, *Ridley 1841* (SING).

3. ***Pinanga palustris*** Kiew **sp.nov.**

A P. malaiana fructibus grandibus infructescentia erecta et interfoliacea differt.

Typus: Pahang: Sg. Kinchin, 1989.*R. Kiew RK2806* (holotypus KEP).
Plates 8–9.

Robust, clustering palm, clumps c.1 m across at the base, consisting of 10 or more stems with leafy canopy more than 3 m across. Majority of stems in clump either short and completely covered by leafsheaths, or are basal suckers with undivided leaves. Juvenile undivided leaf with lamina up to 50–80 cm by 14–17 cm with a deep apical notch, apical leaflet prominently toothed, petiole c. 65 cm long. Tallest stem in clump 1.5–3.5 m tall and 3 cm thick with whitish annuli 1–2 cm apart, and c. 1 cm wide. Individual stems with c. 3 leaves. Crownshaft c. 25 cm long, lower 1–2 leafsheaths dead and partially rotten. Leafsheath 15 cm long, reddish-brown, or stems yellow within sheath, persistent. Petiole 1.5 m long, yellowish-green, glabrous, channeled above. Lamina pinnately divided, up to 2.5 m long and 90 cm wide, with six to eight pairs, not constricted at insertion, mid-leaflets c. 60 cm by 5 cm, each with three to four veins, veins minutely furfuraceous on lower surface, distal leaflets 35–40 cm by c. 6 cm, with deeply serrate margin, with teeth 1.5–3 cm long. Inflorescences interfoliar, produced in lower leaf axils and only emerging through rotten leafsheath when in fruit, glabrous, stout, erect, peduncle flattened 2–3 cm by 1–1.5 cm, thickening and becoming 2 cm wide in infructescence; rachillae two to three (rarely four), 10 cm long and 5–10 mm wide, flattened, in infructescence yellowish with ruby red or crimson hue. Fruit scar circular, flat c. 10–12 mm across. Prophyll 9 cm by 3.5 cm, rosy red or white flushed at apex when immature. Flower triads alternate and distichous, 3–4 mm apart. Male flowers (from immature inflorescence) with perianth parts fleshy, more or less triangular, stamens 30 plus (to 44), and sessile with oblong anthers. Female flowers with three imbricate sepals, broadly ovate with minutely apiculate apex, 4 mm by 8 mm; petals three, apically valvate, basally imbricate, with acute apex, 8 mm by 5 mm, margin finely ciliate. Ovary with capitate stigma. Immature fruit ellipsoid and peachy-pink in colour, swelling when ripening, ovoid, 30–35 mm by 18 mm and rosy-red to black. Calyx persistent, black in fruit. Epicarp smooth and matt with apical "nose" 3 mm long, mesocarp spongy, endocarp fibrous. Seed deeply ruminate.

Notes: In Kiew and Dransfield (1987), this species was referred to as *Pinanga* aff. *mirabilis* and was subsequently listed as such in several checklists. The current epithet denotes its characteristic swamp and wet habitat. It does resemble the Bornean *P. mirabilis* Becc. not only in habit and habitat, but also in the large size of fruit (up to 25 x 12 mm in the latter). The new taxon is quite different from the other large *Pinanga*, *P. malaiana*, which has taller and distinct stems, although caespitose, not clumping, and having longer pendulous infructescences with red to shiny black drupes, which are not as large.

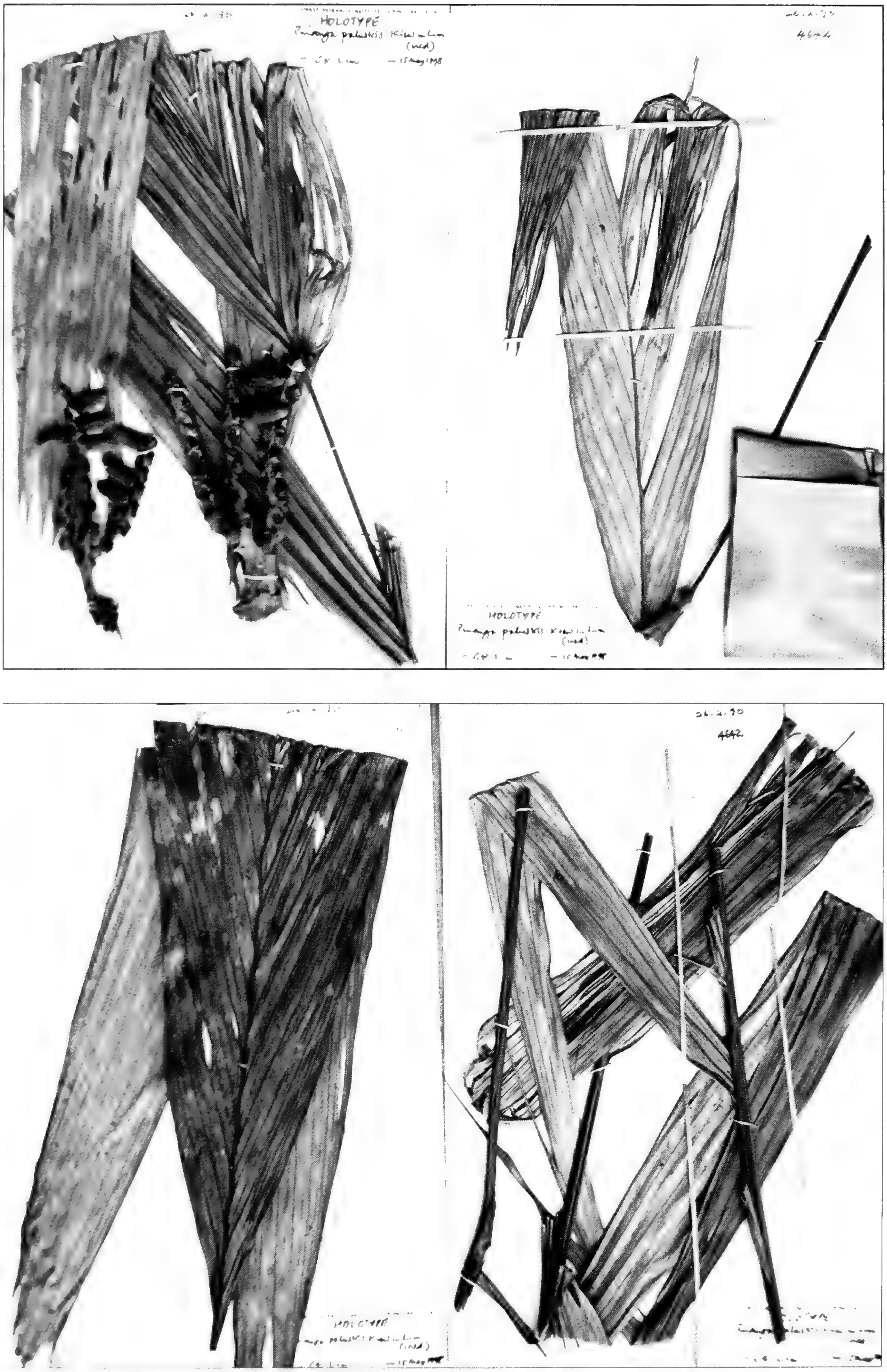

Plate 8. *Pinanga palustris* Kiew (holotype: 1989, *R. Kiew 2806* KEP). By courtesy of KEP.

Plate 9. *Pinanga palustris*, with leafsheaths stripped, at Kahang, Johor.

P. mirabilis has leaves which are usually entire, although pinnate plants are not uncommon and are sometimes sympatric (Dransfield, 1991); the stems are taller, up to 5 m, but usually 2–3 m, cleanly exposed by the abscissing leaves, which also reveal pendent or infrafoliar inflorescences, although some have been observed to be erect as at Lambir Hills; its fruits are different in colour when immature, a brownish-pink, whereas they are coral red in *P. palustris.* Again, the Malayan species has characteristic orange stems, when revealed by stripping the rotting leafsheaths (Plate 9), and so far, no large entire-leaf forms have been encountered, barring the juveniles.

As for *P. johorensis*, many herbarium specimens of this new taxon have been filed under *P. malaiana*. Furtado in his determinations (at SING) had noticed differences, and began to suggest comparisons with *P. malayana* (Griff.) Scheff. var. *sumatrana* Becc. or with *P. malayana* var. *baramensis* (*P. malaiana* (Griff.) Scheff. var. *barramenis* Becc. in Martelli), which are Sumatran and Bornean taxa respectively, the latter since reduced under *P. mirabilis* by Dransfield (1991).

Distribution: Johor: Ulu Endau, Lenggor F.R., Kahang, widespread, also Pahang: Rompin, Kedaik.

Habitat: usually along sides of streams, or in swampy places, sometimes on hills up to 300 m as observed at Ulu Endau on sandstone, growing among *Johannesteijsmannia altifrons*.

Specimens examined Johor: Mawai, 1935, *Corner & Furtado 29240* (K, SING), 1959, *Tan Ah King 23* (SING), Sg. Kayu, 1937, *Keah 32423* (SING), Gunung Panti East, 1892, *Ridley s.n.* (SING), 1973, *J. Dransfield JD3044* (SING), Ulu Endau, *Dransfield JD3548* (SING), *B.H. & R. Kiew RK1613* (KEP), 1977, *J. Dransfield & F.W. Fong JD5040* (K, KEP), Sg. Sempanong 1985, *R. Kiew RK1743* (KEP), Kuala Marong, 1985, *R. Kiew RK1761* (KEP), Kahang, 1990, *C.K.Lim *H0279, H0426, H0533*, Lenggor F.R., 1991, *C.K. Lim H0933*, *L.G. Saw et alia FRI 37439* (KEP), Ulu Sedili, 1991, *C.K. Lim H0929*; Pahang: Sg. Kinchin (see type), Endau-Rompin, 1985, *C.M. Low FRI 25900* (KEP), Kedaik, 1991, *C.K. Lim H1001*, Lesong F.R., 1992, *L.G. Saw FRI 37532* (KEP), 1993, *L.G. Saw FRI 38522* (KEP).

4. ***Pinanga pantiensis*** J.Dransf. **sp. nov.**

Inter species Malayanas rachillis luteis vel aurantiacis valde fractiflexis bene distincta, P. pachyphyllae, specie Borneensis, verosimiliter affinis sed textura et dissectione folii et rachillis fractiflexis differt.

Typus: Johor: Kota Tinggi, Gunung Panti.F.R., 1973, *J. Dransfield et alia JD3048* (holotypus SING).
Plates 10–13.

Clustering undergrowth palm to 6 m tall. Stem c. 20 mm diam., green with grey-brown leaf scars; internodes 40–50 mm long, with scattered caducous black scales when newly exposed. Crownshaft c. 35 cm long; sheaths pale green, c. 25 cm long, striate when dry, minutely dotted with small caducous scales. Leaves arcuate, to 2 m long; petiole c. 50 cm long, c. 5 mm diam. near base; rachis light orange-yellow when fresh; leaflets 10–16 on each side of the rachis, arcuate, diverging at angle of about 30 degrees from the rachis, the longest to 38 x 3 cm, very coriaceous, glossy green when fresh, acuminate and consisting of three to ten folds except for the apical two leaflets on each side, consisting of three to ten folds and lobed to a depth of 1 cm at the tips; transverse veins conspicuous, close, leaflet surfaces glabrous, ramenta absent. Inflorescence infrafoliar, known only in immature to mature fruiting state, to 15 cm long with three to five branches; prophyll 14 x 4 x 2 cm, thick, yellow green; peduncle c. 3 cm long, c. 8–10 mm wide at the base, tapering to 2 mm wide, rachillae conspicuously zig-zag, yellow to orange; rachilla bract triangular, c. 2–4 mm, flower scar 4 mm diam. Immature fruit green, mature fruit satiny-black, ovoid, 32–35 x 15–17 mm; epicarp minutely striate, pericarp c. 4 mm thick. Seed 10 x 20 mm, endosperm deeply ruminate; embryo basal. Seedling leaf coriaceous.

Notes: When Dransfield recognised this as a new taxon, after viewing herbarium records deposited by Corner as early as 1936, and from his own collections, it was thought to be localised and endemic to the unique flora of Gunung Panti, hence the epithet. The species has since been found in adjacent areas in Johor, especially at Linggiu where the recently constructed dam has diminished its population, further threatening what is undoubtedly a rare palm. On a recent collection trip to that locality, on the stems of the few residual plants the internodes were seen to vary from 13 cm at the base, to 4 cm at the upper end, providing an indication of effects on growth, perhaps due to ecological change and disturbance.

In appearance the taxon resembles *P. malaiana*, though it is not observed to be as tall or robust. Although clustering, it usually has one or two dominant stems (Plate 11). The pinnae are usually narrower and more widely spaced (than in *P. malaiana*), and are characteristically tough and stiff. The inflorescence is its striking feature (Plate 12), with zig-zag rachillae, often bright yellow in colour and glossy black fruit (Plate 13). The recently described palm from Khao Sok in Thailand, *P. fractiflexa* Hodel (1997), has wavy but green, and not so strongly fractiflexing rachillae.

Distribution: Johor: Linggiu, Kota Tinggi, Gunung Panti F.R.(east).

Habit: Hill slopes, ridge top, dipterocarp forest, to 250 m a.s.l.

Specimens examined: Johor: Linggiu, 1992, *C.K. Lim *H1343*, 1993, *C.K.Lim H1530,* 1998, *H2001;* Kota Tinggi, 1957, *T.C. Whitmore 63* (SING); G. Panti, Ulu Segun (300m alt) 1936, *Corner SFN 30659* (SING); G. Panti

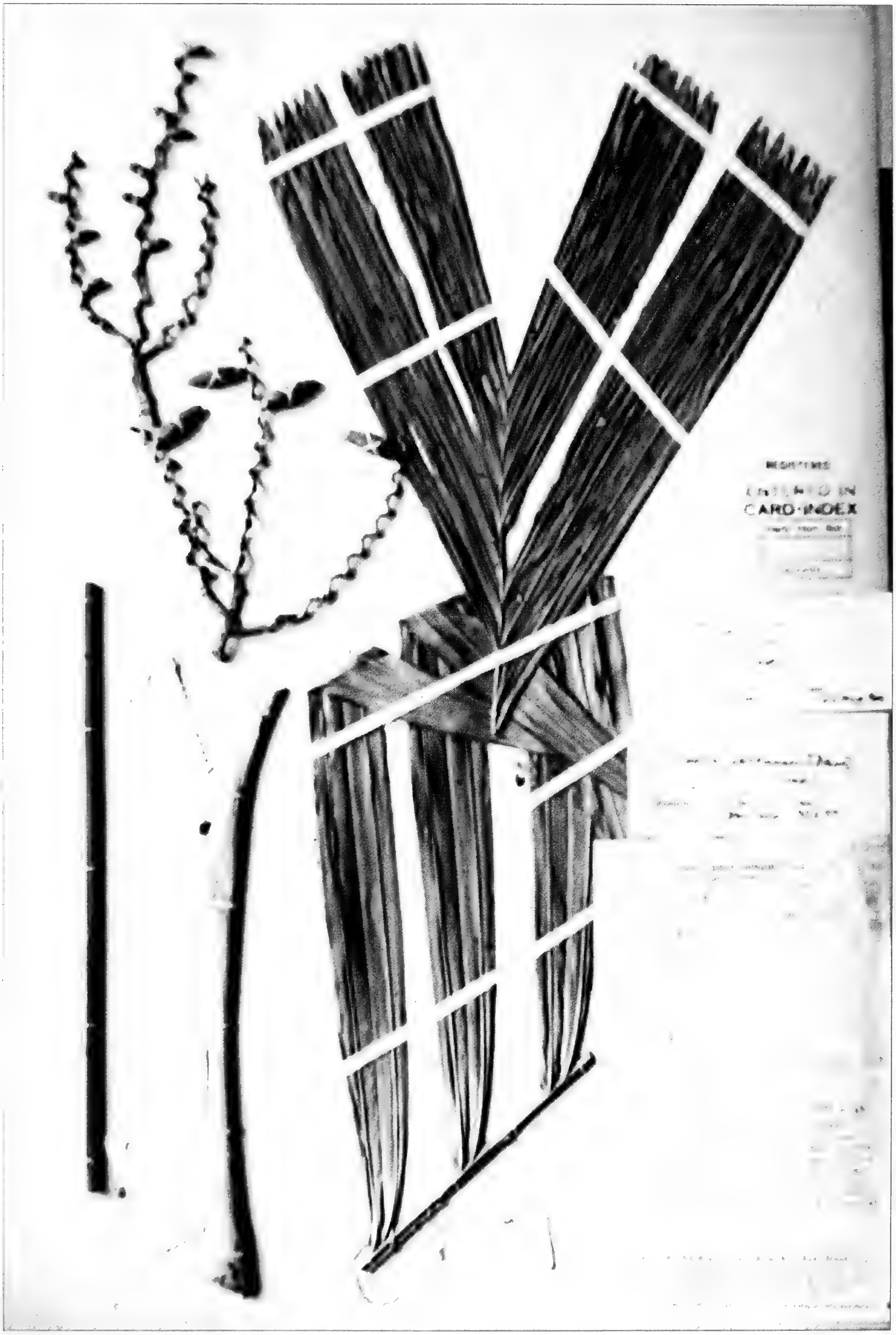

Plate 10. *Pinanga pantiensis* J.Dransfield (holotype: 1973, *JD3048* SING). By courtesy of SING.

Plate 11. *Pinanga pantiensis*, dominant stem in clump, at Linggiu, Johor.

Plate 12. *Pinanga pantiensis*, inflorescences infrafoliar.

Plate 13. *Pinanga pantiensis*, zig-zag rachillae, and fruit (**H1343*).

(forested eastern slope, 300m alt.) 1967, *T.C. Whitmore FRI 4515* (KEP), 1967, *Suppiah FRI 98978* (KEP); Ulu Sedili, 1991, *C.K. Lim H0926*;

Acknowledgements

Special thanks to Dr. John Dransfield, Dr. Ruth Kiew and Dr. Saw Leng Guan for generously contributing new species and collaboration, and to the Directors of the herbaria at L, K, KEP, SING and WSRL, and to friends at KEP, Dr. Lilian Chua, Kamarudin bin Salleh, Mat Asri bin Ngah Sanah, and at SING, Dr. Chin See Chung, Mohamad Shah bin Mohamad Noor, Ali Ibrahim, to my field collectors Adong Pandak, Alus Sarip, Hamid Busu, Adnan bin Yusuf, Busu Ngah, Mohamed Noh bin Muhamad, to Dr. Tim Whitmore for his ready help and advice, and to the Minister for Primary Industries, Malaysia, Datuk Seri Dr. Lim Keng Yaik, and the Departments in his portfolio for their assistance to the Palm Search Malaysia project.

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Gardens' Bulletin Singapore **50** *(1998) 115–119.*

'Some New Eastern Gingers' – a Paper by H.N. Ridley Containing Descriptions of Four Species Overlooked since their Publication in 1900

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Abstract

Attention is drawn to four Malesian species of ginger (*Alpinia pectinata*, *Alpinia celebica*, *Amomum terminale* and *Tapeinochilos koordersianus*) validly published by H.N. Ridley in 1900 that do not appear in *Index Kewensis*. We lectotypify *Alpinia pectinata* Ridl., a new synonym of *Alpinia eremochlamys* K. Schum. *Alpinia celebica* Ridl. pre-dates Schumann's use of the same combination.

Introduction

In the July 1900 issue of the *Journal of the Straits Branch of the Royal Asiatic Society*, there appeared on pages 97–99 a short, anonymous, paper entitled 'Some New Eastern Gingers' (Ridley 1900). The paper contained descriptions of four species named as *Alpinia pectinata*, *Alpinia celebica*, *Amomum terminale* and *Tapeinocheilus koordersiana*. The only one of these names to appear in *Index Kewensis* is *Alpinia celebica,* which is attributed to K. Schumann in a publication of 1899 (though this was a *nomen nudum* only validated in 1904). Therefore, if these are validly published names, they require to be circulated to prevent the unwitting adoption of later homonyms when new names or combinations are put forward.

Validity of the Four Species

It is first necessary to establish the author of these names. This is not difficult. At the time of the paper's publication, H. N. Ridley was Director of the Singapore Botanic Gardens and a well-known authority on the Scitamineae (Zingiberales) of tropical Asia. The first sentence of the paper states: 'The following new species of *Scitamineae* have passed through my hands since writing the paper published in Journal No. 32 and do not appear in Schumann's paper.' Ridley (1899) published a monograph of 'The Scitamineae of the Malay Peninsula' in the *Journal of the Straits Branch of the Royal Asiatic Society* No. 32, pp. 85–184, leaving no doubt that Ridley must be the author of the 'New Eastern Gingers'. The Schumann paper referred to is probably K. Schumann's '*Monographie der Zingiberaceae von Malaisien und Papuasien*' (Schumann 1899).

The species descriptions of the four gingers are written in English, which does not invalidate the names for a publication of this date. The descriptions are reasonably detailed, certainly sufficiently so, to make rejection of the names on such grounds untenable. Finally, there is the problem of typification. There is no specific mention of herbarium specimens directly associated with any of the species described. Instead after the diagnosis of each species there is a locality stated. For three of the species this is Celebes (the former name of Sulawesi), with the following extra information being given for *Alpinia pectinata*: 'at Gunong Klabat 1300 to 1600 metres elevation, fruiting in January.' The fourth species, *Amomum terminale*, is referred to as from 'Bismarck Archipelago (Micholitz.) Flowered in Botanic Gardens, Singapore, Feb. 1900.' Micholitz is known to have collected in the Bismarcks (van Steenis-Kruseman 1950), and presumably he sent live material to Singapore for Ridley to have cultivated in the Botanic Gardens. The final sentence of the paper may offer a clue to the identity of the collector of the specimens that Ridley was sent from Celebes. He writes: 'I have great pleasure in associating it [the new species of *Tapeinochilos*] with the name of Dr. Koorders, who made such fine collections of plants in Celebes recently.' Koorders collected on Celebes in 1894–95 and visited Gunong Klabat on 17–19 January 1895 (van Steenis-Kruseman 1950). It seems highly probable therefore that the three species from Celebes described by Ridley should be typified by Koorders' collections.

Identity of Alpinia pectinata Ridl.

Unfortunately, a thorough search of the herbarium of the Singapore Botanic Gardens (SING) has failed to locate any likely material to typify any of the four names. This may be accounted for by Ridley's opening reference to the new species as having 'passed through my hands.' Possibly, Koorders sent material to Ridley for naming but without sufficient duplicates, at least of some collections, for any material to be lodged at SING. The absence of any collections of the *Amomum terminale* grown in the Singapore Botanic Gardens is less easily explained.

A visit to Herbarium Bogoriense in Indonesia was more successful. A Koorders specimen exactly matching the collecting details indicated for *Alpinia pectinata* by Ridley was discovered. This we select as the lectotype for the species since it is determined '*Alpinia pectinata* Ridley' apparently in Ridley's hand and signed and dated by him 'Ridley 10.x.99.'

Smith (1990), in her synopsis of *Alpinia*, referred to *Alpinia pectinata* Ridl. as a *nomen nudum* first employed by Holthuis (in Holthuis & Lam 1942), who was given the name on material identified at Bogor. Smith identified the species as *Alpinia eremochlamys* K. Schum., which she claimed was only validly published in 1904, with the 1899 publication of the name representing a *nomen nudum*. We cannot agree with this conclusion. Name, diagnosis and type specimens are all included in the original protologue of *Alpinia eremochlamys*. We conclude that *Alpinia pectinata* Ridl. is valid, and represents a new synonym of *Alpinia eremochlamys* as summarized below:

Alpinia eremochlamys K. Schum., Bot. Jahrb. Syst. 27 (1899) 288. *Syntypes:* Sulawesi; Tomohon, *Sarasin 412,* 6 June 1894; Tondano, *A.B. Meyer s.n.,* May 1871; Kandari Peninsula, *Beccari,* May 1874.
Alpinia pectinata Ridl., J. Straits Branch Roy. Asiat. Soc. 34 (1900) 97 synon. nov.. *Type:* "Celebes at Gunong Klabat 1300 to 1600 metres elevation, fruiting in January," *Koorders 19650β*, 19 January 1895 (lectotype, selected here, BO!).

Three Unidentified Species

Type material for the three other Ridley names has yet to be found and we cannot therefore identify the species concerned with certainty, but we conclude that all three were validly published. However, it would be premature to propose any formal name changes or new synonyms. The full citation and Ridley's original diagnoses (with their idiosyncratic punctuation) of the three species are given below as an aid to others who may want to attempt to resolve the problem.

Alpinia celebica Ridl., J. Straits Branch Roy. Asiat. Soc. 34 (1900) 98. *Type:* "Celebes." [*non Alpinia celebica* K. Schum., Pflanzenr. 20 (1904) 362. *Type:* Sulawesi, Riedel s.n. (K!, lectotype, selected by Smith, 1990)].

'*A* (Hellenia) *Celebica* n. sp. A herb more than 18 inches tall with glabrous very long pointed lanceolate leaves, 8 inches long 1½ inch wide, petiole terete striolate graceful one inch long ochrea oblong truncate. Panicle graceful erect branches short many flowered five inches long. Bracts caducous. Flowers 1½ inch long. Calyx tubular truncate ½ inch long. Corolla tube twice as long, lobes oblong obtuse ½ inch long. Lip narrow shorter than corolla, deeply bifid, lobes spathulate emarginate. Staminodes narrow subulate. Stamen with a rather long filament, another [*sic*] oblong not crested. Style graceful.'

Amomum terminale Ridl., J. Straits Branch Roy. Asiat. Soc. 34 (1900) 98. *Type*: "Bismarck Archipelago (Micholitz.) Flowered in the Botanic Gardens, Singapore, Feb. 1900."

'*Amomum terminale* n. sp. Stems crowded slender about 2 feet tall, or much taller ¼ inch through. Leaves dark green, elliptic lanceolate acuminate thinly coriaceous pale beneath glabrous 7 inches long, 2 inches wide, petiole very short, ocrea [*sic*] ⅛ inch long rounded. Spike terminal or basal cylindric 4 inches long ⅜ inches through. Bracts ovate obtuse margins hairy ¾ inch long ½ inch wide red. Bracteole ¼ inch long oblong obtuse pink. Flowers in pairs. Calyx tubular dilated upwards trifid pink ¾ inch long. Corolla tube one inch long slender white, lobes lanceolate acute ½ inch long. Lip three lobed, two lateral lobes shorter curved outwards, acute, median obovate obscurely lobed, ½ inch long. Anther with a broad connective rounded crenulate.'

Ridley added after the diagnosis:

'The habit of this plant and its red bracts cause it to resemble some species of *Zingiber*, but it has not the long anther beak of that genus. It is abnormal among Amomums in having the spike terminal, but it is also said to produce basal spikes from the rhizome. It is indeed difficult to refer it to any genus but I am unwilling to make a distinct genus for it alone. In some respects it may be classed with an ornamental plant known as *Costus Zebrinus* of gardens, which however has no relationship with the genus *Costus* at all.'

Tapeinochilos koordersianus Ridl., J. Straits Branch Roy. Asiat. Soc. 34 (1900) 99, *sphalm. Tapeinocheilus koordersiana. Type*: "Celebes."

'*Tapeinocheilus Koordersiana* n. sp. A tall plant, 25 feet tall. Leaves broadly oblong nearly four feet long 8 inches wide, subcoriaceous pubescent or glabrous narrowed at the base. Spike subcylindric 8 inches long, 4 inches wide. Bracts stiff coriaceous not woody oblong or ovate cuspidate ribbed pubescent the larger ones 2½ inches long and one inch wide, the inner ones lanceate cuspidate pubescent longer. Bracteoles linear narrowed acute shorter than flowers. Calyx tube one inch long narrow little enlarged above, lobes lanceolate acute quite covered with silky hairs. Corolla tube hairy but little longer, lobes narrow acute. Lip oblong rounded hairy. Anther oblong hairy. Capsule an inch long obovate warted covered with brown wool.'

After is added:

'Another species of this grand Eastern island genus, allied to Miquel's *T. pungens* but with larger flowers and pubescent bracts.'

Acknowledgements

We are grateful to the directors of the Singapore and Bogor Herbaria for allowing us access to the material under their charge. D.J. Middleton kindly checked the Rijksherbarium for potential type material. R.K. Brummitt is thanked for valuable comments he gave on a draft of this paper.

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TREE FLORA OF PASOH FOREST

Kochummen, K.M. 1997. Tree Flora of Pasoh Forest. Malayan Forest Records No. 44. Forest Research Institute Malaysia, Kepong, 52109 Kuala Lumpur, Malaysia. xv + 416. Figs. 1-20, 29-42, coloured plates; figs 21-28 b&w line drawings. ISBN 983-9592-69-6. Hardbound. Price RM60.00. Available from the Director General, Forest Research Institute Malaysia.

Pasoh Forest Reserve, a patch of rain forest in Negeri Sembilan, Malaysia, has been made internationally known for the biological research carried out in it since 1970, first under the auspices of the International Biological Programme (IBP) and later by the Smithsonian Tropical Research Institute (STRI). The research station in the reserve is managed by the Forest Research Institute of Malaysia (FRIM).

In 1985 a joint research programme between STRI and FRIM, based on a 50 hectare plot, took off. All trees with a diameter of 1 cm and above were enumerated. The task of identifying all the 335,240 individuals (in 814 species, 290 genera and 78 families) was carried out by K.M. Kochummen and his team. As most individuals would not be flowering or fruiting at the time of sample, they had to be identified based on vegetative characters. This required a special skill of which Kochummen is the master practitioner and in this publication he has made available a useful summary of the work done.

This book, therefore, is not only the definitive account of the flora of the 50 hectare plot, but also a practical manual to the art and science of identifying southeast Asian rainforest trees using vegetative characters.

In the first part of the book, vegetative characters useful for the identification of trees are defined and, in many cases, illustrated.

The second part consists of three keys to species or genera. The first key identifies selected trees with "spot" characters, for example, those with large leaves at least 20 cm long and 10 cm wide, with latex from cut bark, or whose boles have thorns; the second key uses mainly bole and bark characters and the third, leaf characters. As each key is broken into several sub-groups each with a new numbering sequence, it would have been useful at the beginning of each key to have an index listing the sub-groups and the pages on which they begin. Keys two and three list the sub-groups, but do not provide the page numbers.

In the key using bole and bark characters, the bole surface is divided into four types, smooth or cracking, scaly, fissured, and dippled. However, in the illustrations on bole characters there are also lenticellate and cankered types; both of which appear more smooth than scaly, fissured or dippled. Where would they go in the key? As it turns out, *Parartocarpus bracteatus* (lenticellate bole), keys out under the sub-group "bole smooth or cracking." However, *Pterocymbium javanicum* (cankered) does not appear in the key using bole and bark characters.

The third, and major part of the book, is a description of the families, genera and species covered. Where there is more than one genus per family, a key to the genera is provided under each family. However, this is not always consistent, sometimes in place of a key to genera is a key to "genera and species" (Anacardiaceae) and sometimes there may be more than one key to the genera (Leguminosae, one generic key based on bole characters and another based on leaf characters). Following this, there is often a "forest key" to the species of the family. Again, there are some families in which this key is not provided. Subsequently each species is keyed under the respective genus.

The families, genera (except where there is only one species) and species are all described. It is explained that as there is already a *Tree Flora of Malaya*, this account, which covers about one quarter of that flora, gives only brief mention of flower and fruit characters. The distribution of each species in the 50-hectare plot is given.

A number of typographical errors are noted in passing, but these are minor and should not detract from the main achievement of this book as a major contribution to the use of vegetative characters in the identification of rainforest trees. The only disturbing feature to the reviewer is the use of slash characters (latex, colour and texture of inner bark). Although this is not essential to identification in most cases, slashing at boles has become a standard procedure for foresters and botanists in this part of the world. Over the years most trees in a place like the 50-hectare plot (which presumably would be heavily used for teaching) would run the risk of being slashed repeatedly. The growth and health of such trees could be affected.

This is a reasonably priced book that is of great practical use for students of Malesian botany and all who are interested in the identification of trees of the region.

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Gardens' Bulletin Singapore 50 (1998) 123–124.

BRYOPHYTES IN THAILAND compiled by Renoo Sornsamran and Obchant Thaitong, Office of Environmental Policy and Planning, Ministry of Science Technology and Environment. 19 colored photographs + One Map + 274 pp (1995). Free upon request from the Office of Environmental Policy and Planning of the Ministry of Science Technology and Environment at 60/1 Soi Pibulwattana Rama VI Road, Bangkok 10400, Thailand.

This nicely designed checklist of bryophytes of Thailand with good quality printing came to my attention in 1997 when an announcement of its existence was made public through the Bryonet listserve system.

According to the two authors, the checklist was compiled to help researchers in Thailand who have little access to references of Thai bryophytes. Yet, for reasons beyond my comprehension, the authors limit their reference sources to publications dated from 1900 to 1979. Prof. Z. Iwatsuki and I published in 1993 an updated checklist of the mosses of Indochina, Thailand included, in Vol. 74 of the widely circulated Journal of Hattori Botanical Laboratory. Our 1993 checklist and many monographs published in the 80's (e.g., Iwatsuki and Suzuki 1982; Mohamed and Reese 1985; Reese and Mohamed 1985) were not consulted by the compilers for nomenclatural update of their new checklist. As a result, this is the first checklist of mosses that I know which became outdated on the day it was published.

Since I study mainly mosses of East and Southeast Asia, I shall confine my review to the moss part of this new publication. The 1995 listing included 644 species of mosses for the entire country while Tan and Iwatsuki (1993) counted 563 species of mosses in Thailand. The increase in the number of mosses is not due to later discovery but is the result of extensive use of old and discarded synonyms, and even basionyms. Furthermore, the compilers of the checklist under review have not been careful and accurate in their bibliographical work. In a number of instances, the same binomial has been repeated on two different pages, thus, inflating further the total number of moss species. Misspelled names of taxa are not uncommon.

The new checklist of Thai bryophytes is done in a tabulated format consisting of four columns entitled Order/Family, Species, Site Found, and Reported by/year. Unfortunately, the arrangement of moss taxa is alphabetical by their ordinal names first, and then the families and genera. Most practising taxonomists, not to mention the students of bryophytes in general, may know well the genera and families of mosses, but will not know by heart the classification of various orders of mosses. This arrangement has made it a difficult reference from which to retrieve information. To aggravate the confusion, the arrangement of liverwort genera in the book is done in a different manner. The hepatic taxa are arranged alphabetically by family and genus after grouping them first under Marchantiales, and followed by Metzgeriales, Calobryales and Jungermanniales. This inconsistency of system of arrangement of taxa leaves the finding of a taxon only by way of the Index of Species that concludes the book.

Because of the limitation to references only from 1900 to 1979, the locality information of each species is neither complete nor up-to-date in coverage. However, for local consumption, the compilers are correct to include the names of mountains and other specific locations where the species had been reported in literature. Compared with the latest and electronic catalogue of Thai mosses prepared by the Missouri Botanical Gardens (http://www.mobot.org/MOBOT/moss/Thailand/ thailand.htm), this 1995 checklist, with its enumeration of localities under each province reported for a species, is more useful this way. In the MO's catalogue of Thai mosses, the locality information stops at the provincial level.

One other feature that I like about the new publication is the coloured pictures of a number of Thai bryophytes identified to genus. Unfortunately, the usefulness of this Thai checklist of bryophytes is handicapped by the outdated nomenclature and limited search of literature.

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

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The Gardens' Bulletin

Singapore

VOL. 50 (Part 2) December 1998 ISSN 0374-7859

SINGAPORE BOTANIC GARDENS

NATIONAL PARKS BOARD
Singapore Botanic Gardens Cluny Road Singapore 259569 Tel: 4741165 Telefax: 4754295

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The Gardens' Bulletin
Singapore

VOL. 50 (Part 2) December 1998 **ISSN 0374-7859**

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Date of Publication: 31 December 1998

Published by

National Parks Board
Singapore Botanic Gardens
Cluny Road
Singapore 259569

Printed by **Oxford Graphic Printers Pte Ltd**

Gardens' Bulletin Singapore **50** *(1998) 125–150.*

New Species and New Record of *Lithocarpus* Blume (Fagaceae) from Sabah and Sarawak, Malaysia

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Abstract

Eleven new species and one new record of *Lithocarpus* are described from Sabah and Sarawak. The new species are *L. brochidodromus, L. corneri, L. kalkmanii, L. keningauensis, L. kochummenii, L. melataiensis, L. muluensis, L. oblancifolius, L. sandakanensis, L. stonei,* and *L. tawaiensis*, and the new record is *L. hystrix*. Descriptions of the new taxa are provided.

Introduction

In his account of the Malesian Fagaceae, Soepadmo (1972) recognised 49 species of *Lithocarpus* in Sabah and Sarawak. Upon revision of the genus for the *Tree Flora of Sabah and Sarawak*, eleven new species and one new record are to be added, making the number of known species from the two eastern states of Malaysia 61. Of the eleven described new taxa, six occur in Sabah only, two in Sarawak only, two both in Sabah and Sarawak, and one in Sarawak and Brunei.

Description of the New Species

1. *Lithocarpus brochidodromus* S. Julia & Soepadmo, **sp. nov.** Fig.1
(Latin, *brochidodromus*=loop-veined; referring to the leaves)

Lithocarpo cooperto simillimus, sed foliis multo maioribus crassioribusque, venis lateralibus valide brochidodromis, glande ovoideo-globosa differt. ***Typus****: Dewol & Lideh SAN 105591,* Borneo, Sabah, Pensiangan, Sapulut, Sg. Saburan (*holotypus* SAN!).

Tree up to 20 m tall, 15–55 cm in diameter. Bark flaky, greyish or brownish; inner bark reddish or greyish or greenish. Sapwood brownish or whitish. *Twig* densely tomentose with appressed stellate and simple hairs, later subglabrescent, smooth or sparsely large-lenticellate, sometimes scaly. Stipules linear or ovate, 5–15 x 2–5 mm. *Leaves* coriaceous, rigid, sparsely appressed yellowish tomentose with simple and stellate hairs or rarely glabrous above, densely appressed yellowish tomentose below; blades broadly elliptic-oblong or ovate, 14–22(–32) x 5–9(–11) cm, base rounded or broadly acute, margin strongly recurved, apex acuminate, acumen 15–20 mm long; midrib broad, slightly raised above, strongly raised below, densely stellate-tomentose above, sparsely appressed, stellate-tomentose below; lateral veins thick, 7–12 pairs, lax, strongly impressed above, strongly raised below, clearly and strongly joining near the margin, forming an angle of 20°–30° with the midrib; intercostal veins scalariform or subscalariform, lax, prominent and impressed above, clearly prominent below; petioles 4–12 x 2–5 mm. *Inflorescences* male and female. *Male inflorescences* solitary in the axils of distal leaves or in subterminal, lax paniculate clusters on the new shoot, 6–10 cm long; bracts linear to acute, 1.5–3.5 x 1–2 mm; bracteoles linear, *c.* 1.7 x 0.6 mm. *Male flowers* solitary along the rachis; perianth 6-lobed, thick coriaceous, elliptic, 2.5–3 x 1–1.5 mm; stamens 12, filaments *c.* 2 mm long; pistillode subglobose, 1.5–2 mm in diameter. *Female inflorescences* in subterminal, lax paniculate clusters on the new shoot or solitary in the axils of distal leaves, 14–18 cm long; bracts acute, 2–2.5 x 1–1.7 mm; bracteoles linear-elliptic, *c.* 2 x 0.5 mm. *Female flowers* solitary along the rachis; perianth 6-lobed, thick coriaceous, acute-rounded, 0.4–0.7 mm across; staminodes 12; styles 3, conical, slightly recurved, 1.5–2.5 mm long. *Cupules* solitary along the rachis, *c.* 5-mm-stalked, deeply cup-shaped, 1.5–2.5 x 2–2.5 cm, densely appressed stellate-tomentose, scaly or set with spine-like appendages; wall bony, thick, enclosing the acorn completely or more than half of the acorn; scales distinct, sturdy, hook-like, set irregularly. *Acorn* ovoid-globose, 1.5–2 cm across, sparsely tomentose with simple hairs, brown, base flat, top rounded-acute; scar convex, *c.* 1 cm in diameter; wall woody, thin, greater parts free from the cupule.

Vernacular names: Sabah: *tikalod* (Dusun Ranau); Sarawak: *tekalat* (Murut).

Distribution: Endemic to Borneo. In Sabah, recorded from Sapulut in Keningau, Ulu Tungud in Beluran, and Sg. Timbulanan in Labuk Sugut area. In Sarawak, collected from Sg. Plieran, Belaga and Lambir NP in Miri.

Ecology: In primary to secondary forests, including riparian forest. Usually grow on hill slopes, up to 465 m.

Notes: A species closely allied to *Lithocarpus coopertus* but differs by its much bigger and thicker leaves with strongly looped lateral veins, and its ovoid-globose acorn.

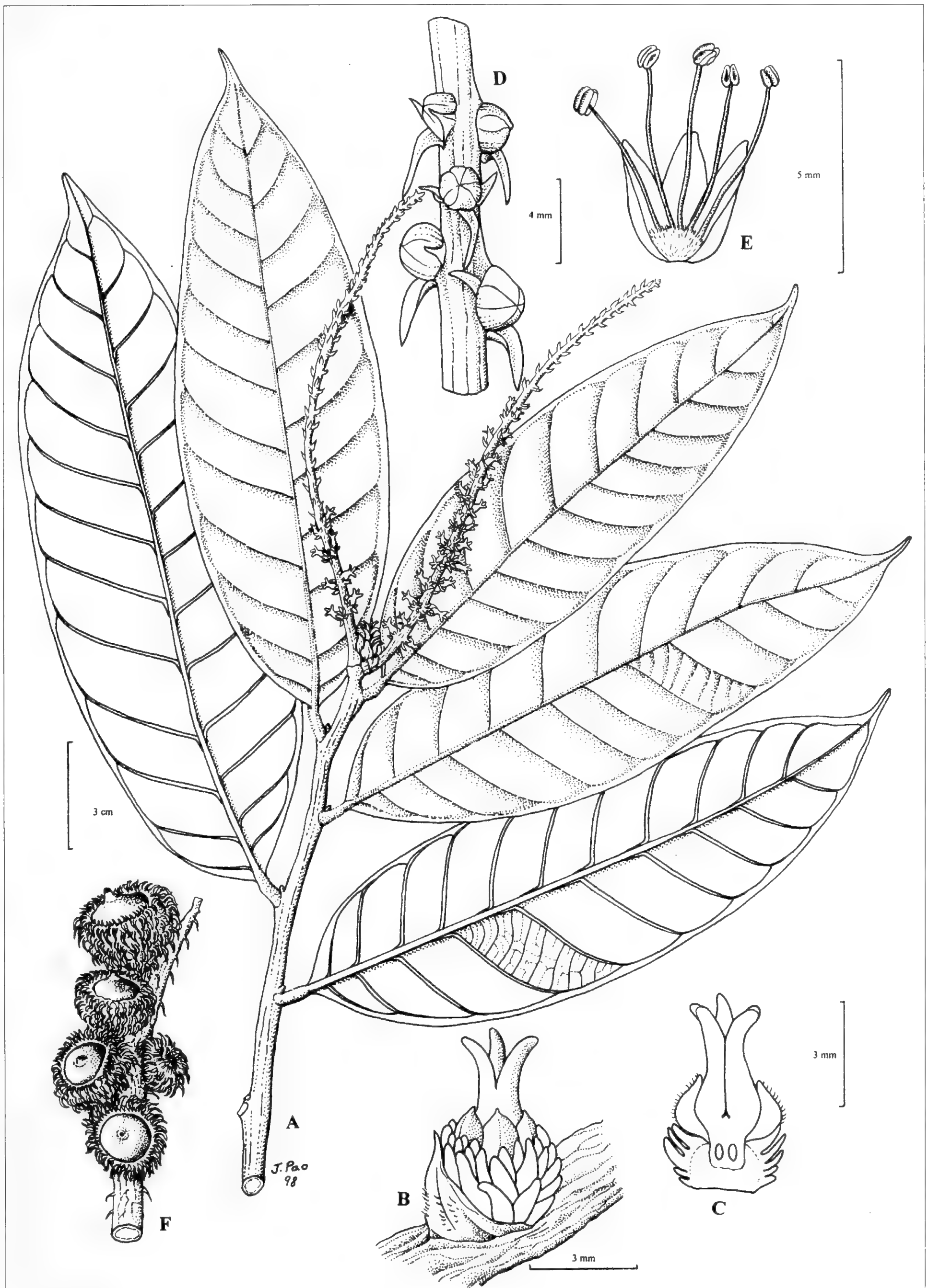

Figure 1. ***Lithocarpus brochidodromus*** S. Julia & Soepadmo, ***sp. nov.*** A, flowering (female) leafy twig; B, female flower; C, longitudinal section of female flower; D, part of male inflorescence; E, longitudinal section of male flower; F, infrutescence *(A–C* from *SAN 103647,* D–E from *S 24089, F* from *SAN 106929).*

Specimens Examined: BORNEO. SABAH: Labuk Sugut, Sg. Timbulanan, *Aban SAN 90489* (K, KEP!, L, SAN!, SAR!); Beluran, Ulu Tungud, Sg. Dual, *Joseph et al. SAN 96531* (K, KEP!, KLU!, L, SAN!, SAR!); Keningau, Sapulut FR, Sg. Tibou, *Sumbing & Soludi SAN 103647* (K, KEP!, L, SAN!); Nabawan, Sapulut, Sg. Saburan, RP. 474, *Dewol & Lideh SAN 105591* (SAN!); Sapulut, Sg. Saburan, *Fidilis & Omar SAN 106929* (SAN!); Keningau, Sapulut, East of Sg. Saburan RP. 474, *Leopold Madani SAN 119228* (K, KEP!, SAN!). SARAWAK: Miri, Lambir NP, *Chai S 24089* (KEP!, SAN!, SAR!); 7th Division, Belaga, Plieran Rapids, Sg. Pleieran, Murum, *Lai et al. S 67948* (SAR!); 7th Division, Belaga, Plieran Rapids, Sg. Pleieran, Murum, *Lai et al. S 67949* (SAR!).

2. *Lithocarpus corneri* S. Julia & Soepadmo, **sp. nov.** Fig.2
(E. J. H. Corner, 1906–1996, prominent former Professor of Tropical Botany, University of Cambridge, United Kingdom)

In folii characteris Lithocarpo ruminato simillimus, sed cupula glandeque obconica, foliis venis intercostalibus densis facile distinguendus. ***Typus:*** *Berhaman SAN 132620*, Borneo, Sabah, Tenom District, Lumaku FR (*holotypus:* SAN!; *isotypi* KEP!, L, SAR!).

Tree 10–15 m tall, 20–30 cm in diameter. Bark rough, brown. *Twig* sparsely tomentose, glabrescent, greyish brown, sparsely lenticellate, sometimes smooth. Stipules linear, 3–4 x 1 mm, persistent. *Leaves* thin coriaceous, sparsely appressed yellowish tomentose above, densely appressed yellowish tomentose below; blades elliptic, (6–)8–12 x 3–4.5 cm, base acute to broadly acute, margin recurved, apex acuminate, acumen 5–10 mm long; midrib raised on both surfaces, stronger above, sparsely appressed tomentose on both surfaces; lateral veins thin, 5–8 pairs, lax, flat above, slightly raised below, disappearing towards the leaf margin, forming an angle of 45°–60° with the midrib; intercostal veins scalariform or subscalariform, dense, obscure on both surfaces or slightly prominent below; petioles 5–10 x 2 mm. Inflorescences and flowers unknown. *Cupules* solitary along the rachis, sessile, obconical, 2.5–4.5 x 3.5–5.5 cm, base rounded-acute, top flat, densely appressed tomentose, lamellate; wall woody, 2–3 mm thick, completely enclosing the acorn except for an opening of 1–2 cm in diameter; lamellae distinct, entire, set in 12–15 regular lines, denser towards the top. *Acorn* obconical, 2–4 x 3–5 cm, densely tomentose with simple and stellate hairs, brown; wall woody, thick, greater parts adnate to the cupule.

Distribution: Endemic to Sabah, Borneo. So far collected from Lumaku FR, Tenom and Mark Pang logging area, Ranau.

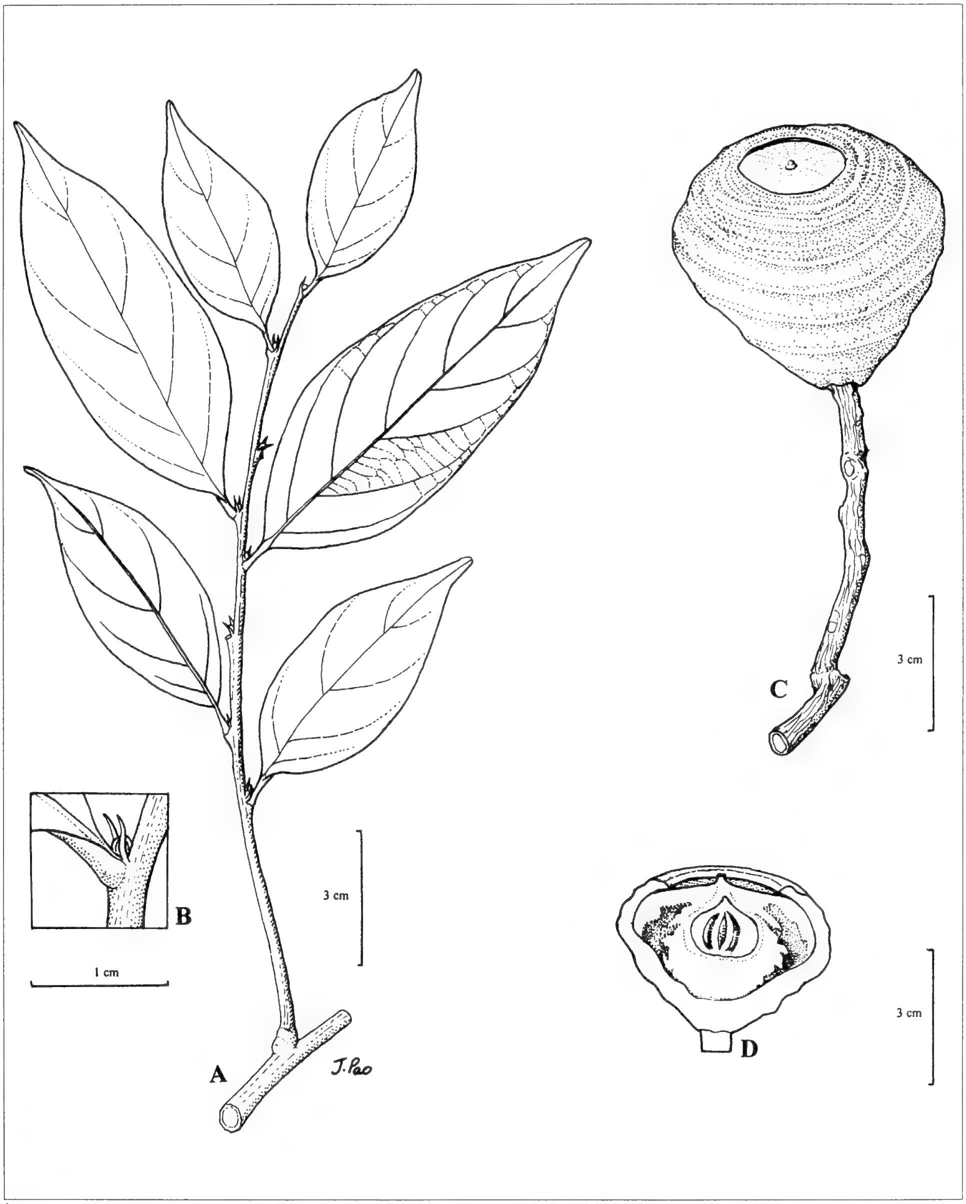

Figure 2. ***Lithocarpus corneri*** S. Julia & Soepadmo, ***sp. nov.*** A, leafy twig; B, stipules; C, mature cupule; D, longitudinal section of the cupule showing the acorn (A–C from *SAN 132620,* D from *SAN 110435).*

Ecology: In primary to disturbed forests on hillsides.

Notes: A species closely related to *Lithocarpus ruminatus* in leaf characters but can be easily distinguished by its obconical cupule and acorn, densely lamellate cupule, and leaves with dense intercostal veins.

Specimens Examined: BORNEO. SABAH: Ranau, Mark Pang Logging area, *Amin & Lideh SAN 110435* (SAN!); Tenom, Lumaku FR, *Berhaman et al. SAN 132620* (KEP, L, SAN!, SAR!); Tenom, Lumaku FR, *Maikin et al. SAN 132937* (K, KEP!, L, SAN!).

3. *Lithocarpus kalkmanii* S. Julia & Soepadmo, **sp. nov.** Fig.3
(C. Kalkman, 1928 - 1998, former Director of the Rijksherbarium, Leiden, the Netherlands)

In characteris cupulae Lithocarpo halleri simillimus et in folii Lithocarpo pulchro, sed ab Lithocarpo halleri foliis crassis coriaceis rigidis, venis lateralibus densis costa angulis 30°–40° abeuntibus, venis intercostalibus dense scalariformibus differt. Ab Lithocarpo pulchro cupula obovoideo-globosa lamellata glandem praeter aperturam c. 0.5 cm in parte apicali omnino tegenti distinguendus. ***Typus****: Meijer & Hendry SAN 42460,* Borneo, Sabah, Ranau, Kinabalu NP, W border, N of Sosopodon (*holotypus* SAN!; *isotypi:* AA, K, L).

Tree up to 30 m tall, 45–60 cm in diameter. Bark large-lenticellate or cracky, brownish or greyish; inner bark reddish brown. Sapwood yellowish. *Twig* sparsely brownish tomentose, later glabrescent, smooth or sparsely large-lenticellate. *Leaves* thick coriaceous, sometimes rigid, densely appressed yellowish tomentose above, densely appressed greyish brown tomentose below; blades broadly elliptic, 11–15.5 x 5–8 cm, base broadly acute, margin recurved, apex acuminate, acumen 5–12 mm long; midrib slightly raised above, strongly raised below, sparsely appressed tomentose on both surfaces; lateral veins thick, 12–14 pairs, dense, flat above, strongly raised below, disappearing near the margin, forming an angle of 30°–40° with the midrib; intercostal veins scalariform, dense, obscure above, slightly prominent below; petioles 15–20 x 2–3 mm. Inflorescences and flowers unknown. *Cupules* solitary along the rachis, sessile, obovoid-globose, 5–7 x 4–5.5 cm, base rounded, top flat, glabrous, lamellate; wall woody, thick, completely enclosing the acorn or with an opening of *c.* 0.5 cm in diameter; lamellae distinct, entire or minutely denticulate, especially the upper-most ones, set in 6–7 regular lines. *Acorn* obovoid-globose, 4.5–6 x 3–5 cm, densely tomentose, dark brown; scar deeply concave, *c.* 1 cm in diameter; wall woody, thick, greater parts adnate to the cupule.

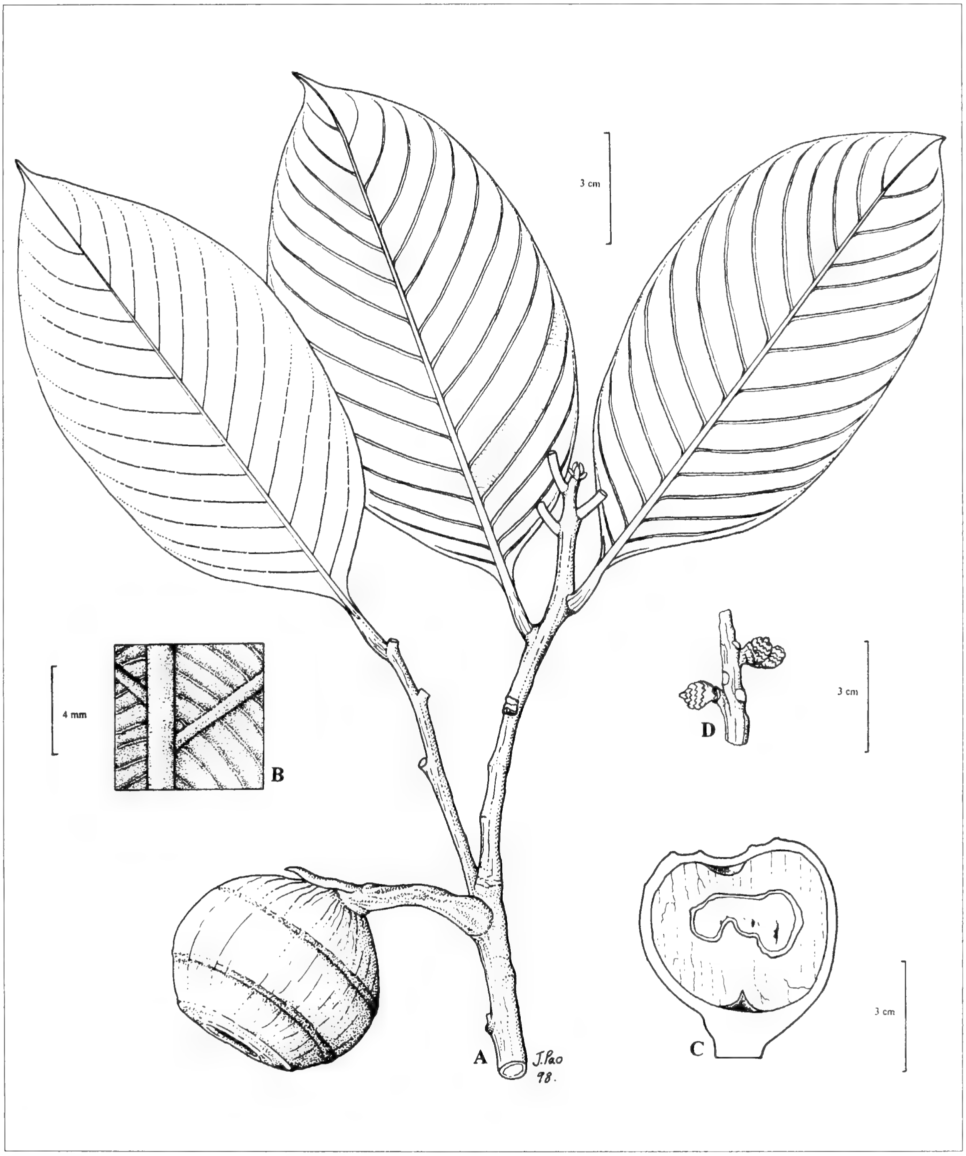

Figure 3. ***Lithocarpus kalkmanii*** S. Julia & Soepadmo, ***sp. nov.*** A, fruiting leafy twig; B, detailed of lower leaf surface; C, longitudinal section of cupule; D, young infructescence *(*A–B from *SAN 42460,* C–D from *SAN 56714).*

Distribution: Endemic to Sabah, Borneo. So far only found in the Kinabalu NP and Sosopodon FR in Ranau area and one collection from Nabawan.

Ecology: In primary upper hill mixed dipterocarp to submontane oak-laurel forests at altitude 1080–1500 m.

Notes: A species closely related to *Lithocarpus halleri* in cupule characters and to *Lithocarpus pulcher* in leaf characters but differs from *Lithocarpus halleri* by its thick coriaceous and rigid leaves, its dense lateral veins forming an angle of 30°–40° with the midrib and densely scalariform intercostal veins. From *Lithocarpus pulcher* it can be distinguished by its obovoid-globose, lamellate cupule, which completely encloses the acorn except for an opening of *c.* 0.5 cm on the apical part.

Specimens Examined: BORNEO. SABAH: Ranau, Kinabalu NP, W. border N. of Sosopodon, *Meijer & Henry SAN 42460* (AA, K, L, SAN!); Ranau, Kinabalu, Jalan Liwagu, *Francis Sadau SAN 42825* (SAN!); Ranau, Sosopodon FR, *Aban Gibot SAN 56714* (KEP!, K, L, SAN!); Nabawan, *Ignasius* SAN 139147 (SAN!).

4. *Lithocarpus keningauensis* S. Julia & Soepadmo, **sp. nov.** Fig.4
(Of Keningau, Sabah)

In folii characteris Lithocarpis meijeri luteo sericobalanoque simillimus, ab his cupula magna lignosa glandem omnino tegenti, lamellis etiam in iuventu arcte distinctis facile distinguiendus. ***Typus****: Amin SAN 95311,* Borneo, Sabah, Keningau, Bukit Kitau (*holotypus* SAN!; *isotypi* K!, KEP!, L, SAR!).

Tree 15–20 m tall, 25–60 cm in diameter. Bark fissured or scaly, brown or reddish; inner bark brown or reddish. Sapwood yellowish to brownish. *Twig* densely appressed tomentose, later glabrescent, slightly fissured or sparsely large-lenticellate or smooth. *Leaves* thick coriaceous, rigid, glabrous or densely appressed yellowish tomentose above, densely appressed yellowish or brownish tomentose below; blades elliptic or broadly elliptic, 12.5–16.5(–29) x 4.5–7(–12.5) cm, base acute, margin recurved, apex acuminate, acumen *c.* 10 mm long; midrib broad, slightly raised above, strongly raised below, densely appressed tomentose on both surfaces; lateral veins thick, 12–14 pairs, lax, slightly raised or flat above, raised below, disappearing near the margin, forming an angle of 35°–45° with the midrib; intercostal veins scalariform, dense, obscure above, slightly prominent below; petioles 10–15 x 3–5 mm. Inflorescences and flowers unknown. *Cupules* solitary along the rachis, sessile, obovoid, 7–11 x 5–6.5 cm, base acute, top flat, glabrescent, lamellate; wall woody, thick, completely

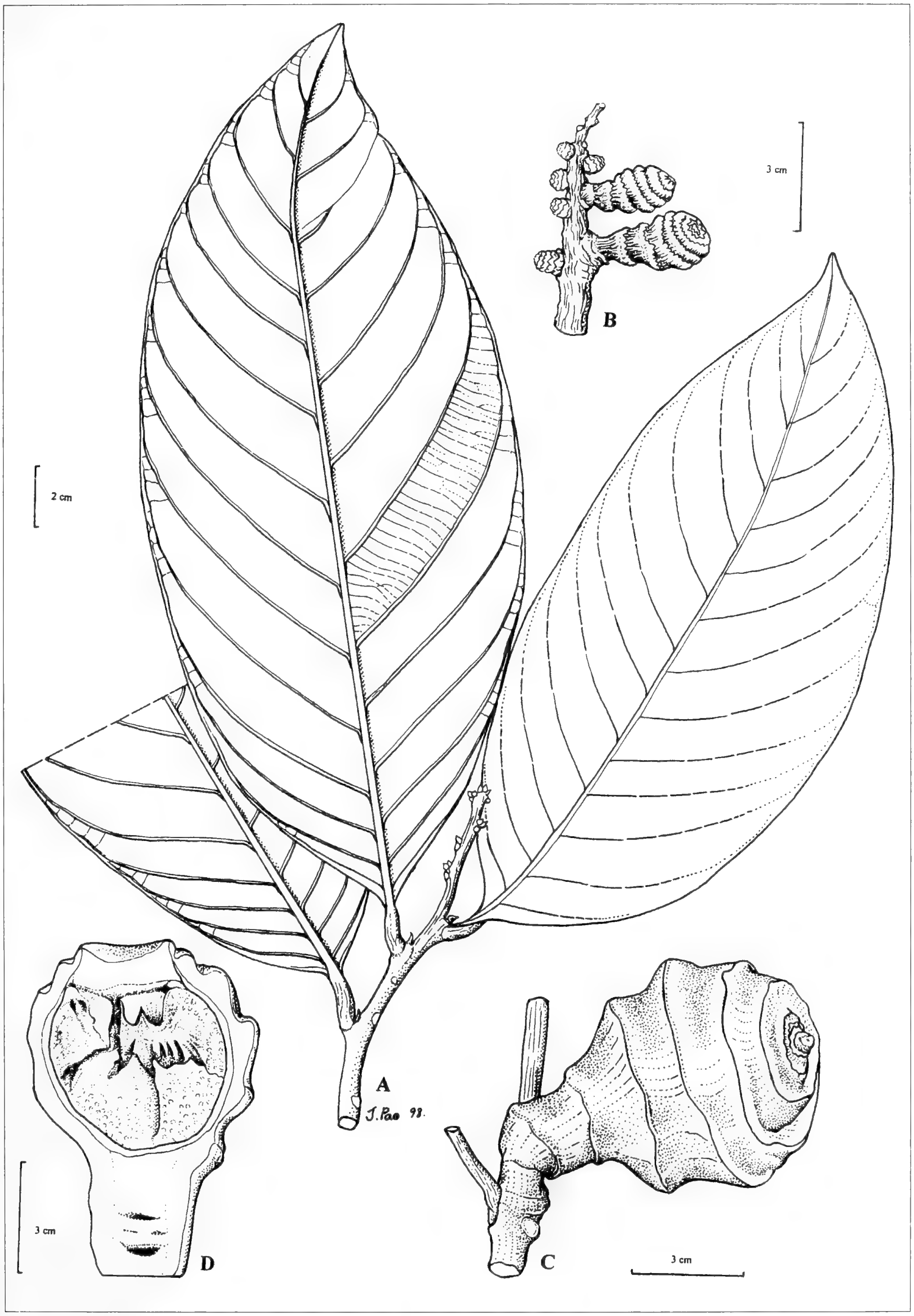

Figure 4. ***Lithocarpus keningauensis*** S. Julia & Soepadmo, ***sp. nov.*** A, leafy twig; B, young infructescence; C, mature cupule; D, longitudinal section of mature cupule (A & D from *SAN 50208*, B from *SAN 92174*, C from *SAN 95311*).

enclosing the acorn; lamellae strongly distinct even in the young cupule, folded inwardly, longitudinal groove entire or wavy at the top, set in 6–10 regular lines, protruding from the cupule surface. *Acorn* obovoid globose, 4.5–6 x 3–5 cm, densely tomentose, dark brown; scar deeply concave, *c.* 1 cm in diameter; wall woody, thick, greater parts adnate to the cupule.

Distribution: Endemic to Sabah, Borneo. Known only from Ulu Biah, Bukit Kitau and Keningau trail in Keningau, Sabah.

Ecology: In primary to disturbed forests on hill slopes, up to 300 m, on dark brown soils.

Notes: A species closely related to *Lithocarpus meijeri, Lithocarpus luteus* and *Lithocarpus sericobalanus* in leaf characters but can be easily distinguished from the three by its big and woody cupule, which is completely enclosing the acorn and by its strongly distinct lamellae even in the young cupule.

Specimens Examined: BORNEO. SABAH: Papar, Keningau trail, *Francis Sadau SAN 50208* (KEP!, SAN!, SAR!); Keningau, Ulu Biah, *Oikawa SAN 92174* (K!, KLU!, L, SAN!, SAR!); Keningau, Bukit Kitau, *Amin SAN 95311* (K!, KEP!, L, SAN!, SAR!).

5. *Lithocarpus kochummenii* S. Julia & Soepadmo, **sp. nov.** Fig.5
(K. M. Kochummen, senior forest botanist at the Forest Research Institute Malaysia, Kepong)

Lithocarpo cooperto simillimus, sed foliis maioribus crassioribus, venis lateralibus distincte brochidodromis, cupula maiore appendiculis validioribus spiniformibus differt. ***Typus**: Bernard Lee S 38884,* Borneo, Sarawak, Miri, Gunung Mulu NP (*holotypus* SAR!; *isotypi* K!, KEP!, SAN!).

Tree 15–30 m tall, 10–60 cm in diameter; stilt root up to 2 m high. Bark fissured or lenticellate, reddish brown. *Twig* densely tomentose, later glabrescent, sparsely to densely large-lenticellate. Stipules linear, 6–10 x 1 mm. *Leaves* thick coriaceous, rigid, sparsely appressed tomentose or glabrescent above, densely appressed brownish or yellowish tomentose below; blades broadly or rarely narrowly lanceolate or oblanceolate, (10–)14–18(–22) x (4–)5–7(–8.5) cm, base cordate or rounded, margin strongly recurved, apex sharply acute or acuminate, acumen 15–20 mm long; midrib broad, raised on both surfaces, stronger below, glabrescent or sparsely tomentose on both surfaces; lateral veins thick, (11–)14–18(–20) pairs, dense, strongly impressed or rarely flat above, strongly raised below, clearly joining

Figure 5. ***Lithocarpus kochummenii*** S. Julia & Soepadmo, ***sp. nov.*** A, fruiting leafy twig; B, part of female inflorescence; C, longitudinal section of female flower; D, longitudinal section of male flower; E, top view of cupule; F, side view of cupule; G, longitudinal section of cupule showing the free acorn (A from *S 4557,* B–D from *DK 964,* E–G from *S 38884).*

near the margin, forming an angle of 30°–40° with the midrib; intercostal veins thin, scalariform, rarely subscalariform, lax, obscure above, thinly prominent below; petioles 5–10 mm long. *Inflorescences* male, female or androgynous. *Male inflorescences* in lateral or subterminal, dense paniculate clusters on the new shoot or solitary in the axils of distal leaves, 5–13 cm long; bracts acute-linear, 1.5–1.7 x 0.8 mm; bracteoles oblong, *c.* 0.5 x 0.2 mm. *Male flowers* solitary along the rachis; perianth 6-lobed, thin coriaceous, elliptic, *c.* 1.2 x 1 mm; stamens 12, filaments 2–2.5 mm long; pistillode *c.* 1 mm in diameter. *Female or androgynous inflorescences* solitary in the axils of distal leaves or in terminal, lax paniculate clusters on the new shoots, 7–15 cm long; bracts acute, *c.* 1.2 x 0.6–1 mm; bracteoles acute, *c.* 1 x 0.8 mm. *Female flowers* solitary along the rachis; perianth 6-lobed, thick coriaceous, ovate-acute, *c.* 1.1 x 0.8 mm; staminodes 10–12; styles 3, conical, recurved, *c.* 2 mm long. *Cupules* solitary along the rachis, sessile, conical-ovoid, 2–2.5 cm across, densely tomentose with simple and stellate hairs, scaly or with spine-like appendages; wall woody, thin, enclosing the acorn completely; spine-like appendages distinct, broad and sturdy, straight or slightly recurved, set irregularly. *Acorn* conical, 1.5–2 cm across, densely tomentose with simple hairs, rarely glabrous, brown, base flat, top acute; scar deeply concave, 1.3–1.5 cm in diameter; wall woody, thin, greater parts free from the cupule.

Vernacular name: Sarawak: *salad* (Murut).

Distribution: Endemic to Borneo. Recorded from Gunung Mulu, Ulu Sg. Kayan in Belaga, Batu Lawi in Bario and Ulu Sg. Masia, Kota FR in Lawas, Sarawak. Also known from Bukit Tudal, Temburong, Brunei.

Ecology: In submontane, *kerangas* and riparian forests, at 900–1280 m.

Notes: Closely related to *Lithocarpus coopertus* but differs by its much larger and thicker leaves with clearly looped lateral veins, and larger cupule with sturdier spine-like appendages.

Specimens Examined: BORNEO. SARAWAK: Kalabit Highland, foot of Batu Lawi, a tributary of Sg. Tabun, *Nooteboom & Chai 2314* (K!, KEP!, SAR!). Baram, Gunung Mulu, path from Sg. Melinau Paku, *Anderson S 4557* (K!, SAN!, SAR!); Limbang, Lawas, along Sg. Masia at Maligan Range, *Ilias Paie S 32852* (KEP!, SAR!); Limbang, Lawas, Ulu Sg. Masia in Kota FR, *Tong & Jugah S 32911* (KEP!, SAR!); Miri, Gunung Mulu NP, *Martin S 38182* (K!, KEP!, SAN!, SAR!); Miri, Gunung Mulu NP, *Bernard Lee S 38884* (K!, KEP!, SAN!, SAR!); Kapit, Belaga, Dulit Range, Ulu Sg. Kayan, *Dayang Awa & Yii S 46836* (K!, KEP!, SAR!); BRUNEI: Temburong subdistrict Amo, Bukit Tudal, *Kirkup 964* (BRUN, K!, KEP!).

6. *Lithocarpus melataiensis* S. Julia & Soepadmo, **sp. nov.** Fig.6
(Of Bukit Melatai, Sarawak)

In folii characteris Lithocarpo pusillo simillimus, petiolo longiore, cupula maiore, glande piloso differt. ***Typus****: Yii S 48455*, Borneo, Sarawak, Kapit, Batang Balleh, Bukit Melatai (*holotypus* SAR; *isotypi:* BKF, K, KEP!, KLU!, L).

Tree 12–27 m tall, 25–70 cm in diameter. Twig sparsely tomentose, smooth or fissured. Stipules linear, *c.* 10 x 1 mm. *Leaves* thin coriaceous, sparsely appressed brownish tomentose above, densely yellowish brown tomentose, sometimes with simple hairs below; blades narrowly elliptic, 9–13.5 x 2–3 cm, base sharply acute or cuneate, margin recurved, apex caudate or long acuminate, acumen 15–22 mm long; midrib slightly raised on both surfaces, glabrous above, sparsely appressed tomentose with simple hairs below; lateral veins thin, (8–)9–12 pairs, dense, flat above, raised below, faintly joining towards the margin, forming an angle of 30°–40° with the midrib; intercostal veins (sub)scalariform, lax, obscure on both surfaces or slightly prominent below; petioles 6–12 mm long. *Inflorescences* male and female. *Male inflorescences* in lateral or subterminal, lax to dense paniculate clusters on the new shoot or solitary in the axils of distal leaves, 5–11 cm long; bracts linear-triangular, 1–1.3 x 0.3 mm; bracteoles acute, 0.4–0.6 x 0.3–0.5 mm. *Male flowers* solitary along the rachis; perianth 6-lobed, coriaceous, ovate-rounded, 1–1.2 x 0.5–1 mm; stamens 12, filaments 2–2.5 mm long; pistillode globose, *c.* 1 mm in diameter. *Female inflorescences* in terminal, lax paniculate clusters on the new shoot, 9.5–12.5 cm long; bracts linear-triangular, *c.* 1.2 x 0.3–0.5 mm; bracteoles acute-rounded, 0.2–0.3 mm across. *Female flowers* solitary along the rachis; perianth 6-lobed, thick coriaceous, ovate-acute, 0.4–0.6 x 0.2–0.3 mm; staminodes 10; styles 3, conical, straight, *c.* 1 mm long. *Cupules* solitary along the rachis, sessile, deeply saucer-shaped, 0.4–0.7 x 1.2–1.7 cm, densely tomentose with stellate and simple hairs, lamellate; wall bony, thin, enclosing less than half of the acorn; lamellae distinct, minutely denticulate, set in 6–8 regular lines. *Acorn* conical, 1.7–2 x 1.1–1.5 cm, densely simple hairy, brown; scar concave, 0.7–1 cm in diameter, base flat, top sharply acute; wall bony, thin, greater parts free from the cupule.

Distribution: Endemic to Sarawak, Borneo. So far only collected from Bukit Melatai and Ulu Balleh in Kapit division.

Figure 6. ***Lithocarpus melataiensis*** S. Julia & Soepadmo, ***sp. nov.*** A, fruiting leafy twig; B, male inflorescence; C, longitudinal section of male flower: D, female inflorescence; E, longitudinal section of female flower (A, D & E from *S 48455,* B–C from *S 48454).*

Ecology: Mixed dipterocarp forests at altitude 300–880 m.

Notes: A species closely related to *Lithocarpus pusillus* in leaf characters but differs by its bigger cupule, hairy acorn and longer petiole.

Specimens Examined: BORNEO. SARAWAK: Kapit, Ulu Balleh, above Sg. Mengiong, *Othman Haron S 29203* (AA, BO, K, KLU!, L, MEL, SAN!, SAR!); Kapit, Batang Balleh, Bukit Melatai, Camp. 2, *Yii & Jegong S 48440* (BKF, K, KEP!, KLU!, L, SAR!); Kapit, Batang Balleh, Bukit Melatai, Camp. 2, *Yii S 48454* (BKF, K, KEP!, KLU!, L, SAN!, SAR!); Kapit, Batang Balleh, Sg. Melatai, Bukit Melatai, above camp 2, *Yii S 48455* (BKF, K, KEP!, KLU!, L, SAR!), *S 48463* (BKF, K, KEP!, KLU!, L, SAR!).

7. *Lithocarpus muluensis* S. Julia & Soepadmo, **sp. nov.** Fig.7
(Of Gunung Mulu, Sarawak)

Folii textura Lithocarpo rigido simillimus, folii basi late acuto ad rotundato, petiolo plerumque longiore, venis lateralibus angustioribus, glandis apice rotundato differt. ***Typus***: *Illias Paie S 15082*, Borneo, Sarawak, Gunung Mulu (holotypus SAR!).

Tree 12–24 m tall, 15–75 cm in diameter. Bark flaky. *Twig* glabrescent, fissured or sparsely lenticellate. *Leaves* thick coriaceous, rigid, glabrous above, sparsely appressed yellowish tomentose below; blades elliptic to broadly elliptic, (8–)11–17 x (4.5–)5.5–8.5(–9) cm, base broadly acute, margin strongly recurved, apex acute to acuminate, acumen (5–)13–23 mm long; midrib raised on both surfaces, stronger above, glabrescent; lateral veins thin, 9–15 pairs, dense or lax, slightly raised on both surfaces, faintly joining towards the margin, forming an angle of 40°–50° with the midrib; intercostal veins (sub)scalariform, lax, obscure on both surfaces; petioles (8–)10–13(–15) mm long. Inflorescences and flowers unknown. *Cupules* in clusters of 2 along the rachis when young, later solitary along the rachis, sessile, saucer-shaped, 1.8–2.4 x 2–2.5 cm, sparsely stellate-tomentose, scaly; wall woody, thick, enclosing less than half of the acorn; scales distinct, broad and rigid, set irregularly. *Acorn* depressed subglobose, 1.8–2.4 x 2–2.5 cm, glabrous and shiny, dark brown, base flat, top rounded; scar deeply concave, 1.5–1.7 cm in diameter; wall woody, thick, greater parts free from the cupule.

Distribution: Endemic to Sarawak, Borneo. So far only collected from Gunung Mulu in Miri division.

Ecology: In primary hill and submontane forests, 1350–1500 m.

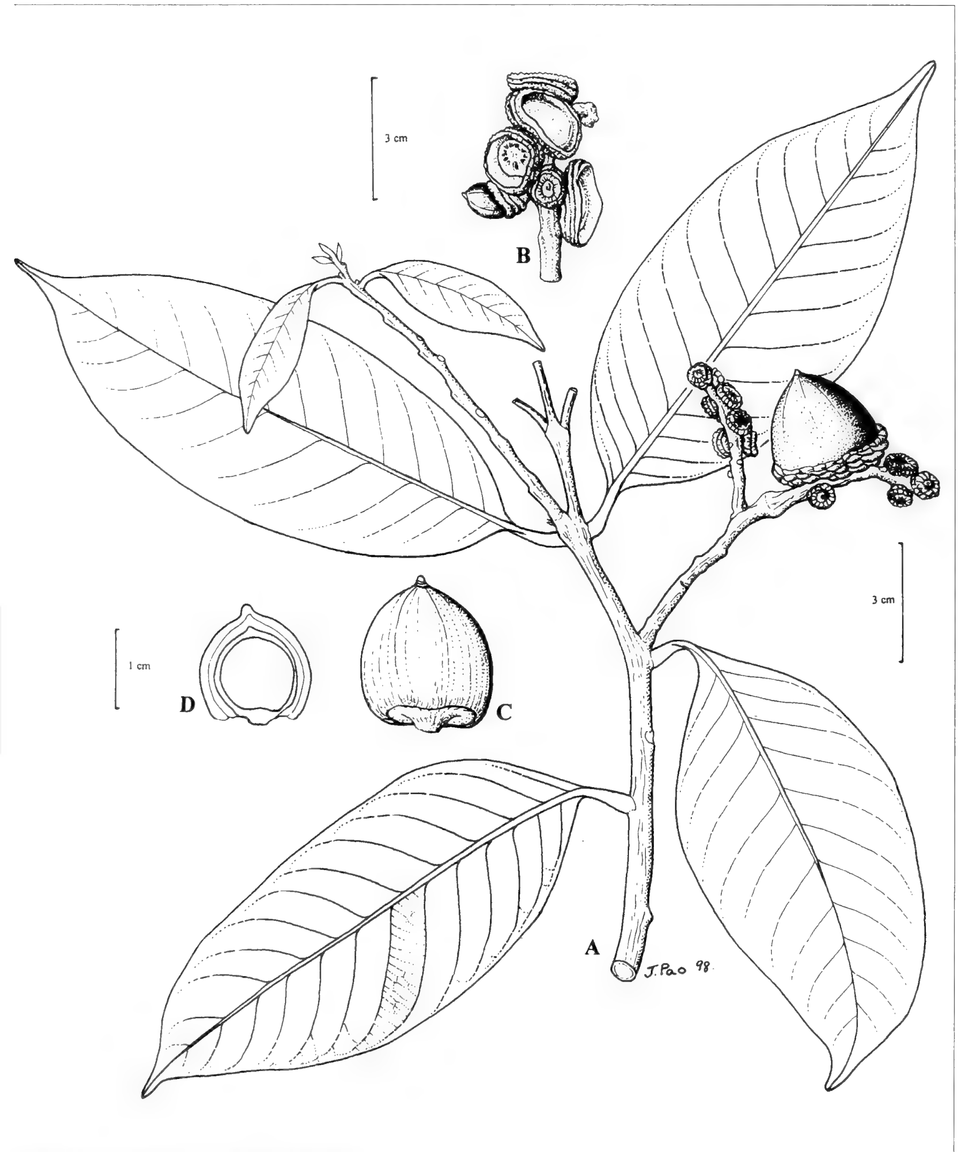

Figure 7. ***Lithocarpus muluensis*** S. Julia & Soepadmo, ***sp. nov.*** A, fruiting leafy twig; B, infructescence showing cup-shaped cupules; C, acorn; D, longitudinal section of acorn (A–B from *S 15082*, C–D from *S 15081*).

Notes: A species closely related to *Lithocarpus rigidus* in leaf texture but differs by its broadly acute or rounded leaf base, usually longer petiole, thinner lateral veins, and acorn with rounded apex.

Specimens Examined: BORNEO. SARAWAK: Gunung Mulu, path from Sg. Melinau Paku, *Anderson S 4506* (AA, K, L, SAN!, SAR!, SING), *S 4598* (AA, K, L, SAN!, SAR!, SING); Gunung Mulu, *Ilias Paie S 15077* (SAR!), S 15081 (BO, K, L, SAN!, SAR!, SING), *S 15082* (SAR!); Miri, Mulu NP, Gunung Mulu, Camp. 3, *Yii & Abu Talib S 58283* (K, KEP!, KLU!, L, SAN!, SAR!).

8. *Lithocarpus oblancifolius* S. Julia & Soepadmo, **sp. nov.** Fig.8
(Latin, *oblancifolius*=with reversed spear-shaped leaves)

In folii characteris Lithocarpo lucido simillimus, sed cupula minore tenuiore, glande conico, venarum lateralium numero minoribus, venis intercostalibus minus prominentibus differt. Cupula cupulae Lithocarpi papilliferi similis sed folia differunt. ***Typus***: *Leopold Madani SAN 133942,* Borneo, Sabah, Tawau, Tawau Hill Park (*holotypus* SAN!).

Tree up to 24 m tall, 20–45 cm in diameter. Bark lenticellate or smooth, brown or greyish; inner bark greyish to yellowish. Sapwood whitish to yellowish. *Twig* sparsely tomentose, later subglabrescent, smooth or sparsely large-lenticellate. Stipules linear, *c.* 2 x 1 mm. *Leaves* thin coriaceous, glabrous above, sparsely appressed greyish tomentose below; blades oblanceolate, (6–)8–13.5 x (2.5–)3–4.5 cm, base cuneate, margin recurved, apex rounded or shortly acute; midrib raised on both surfaces, stronger below, glabrescent; lateral veins thin, 8–13 pairs, lax, flat or impressed above, raised below, joining near the margin, forming an angle of 30°–50° with the midrib; intercostal veins reticulate or subscalariform, dense, obscure above, prominent below; petioles 3–5 x 2 mm. *Inflorescences* male, female, androgynous or mixed. *Male inflorescences* in lateral, lax to dense paniculate clusters on the new shoot, 3–11 cm long; bracts linear, *c.* 1 x 0.3 mm; bracteoles linear, *c.* 5 x 0.1 mm. *Male flowers* solitary along the rachis; perianth 6-lobed, thin coriaceous, ovate or elliptic, 0.8–1 x 0.6–0.8 mm; stamens 10–12, filaments *c.* 2 mm long; pistillode globose, 0.7–0.8 mm in diameter. *Female or androgynous inflorescences* in subterminal, lax paniculate clusters on the new shoot or solitary in the axils of distal leaves, 4–12 cm long; bracts linear-acute, 1–1.2 x 0.2–0.4 mm; bracteoles acute, *c.* 0.5 x 0.2 mm. *Female flowers* solitary along the rachis; perianth 6-lobed, coriaceous, broadly acute or rounded, 0.5–0.9 x 0.5–0.7 mm; staminodes 12; styles 3, conical, recurved, 1–1.2 mm long. *Cupules* solitary along the rachis, sessile, saucer-shaped, 1–1.2 x 1.6–2 cm, densely appressed tomentose

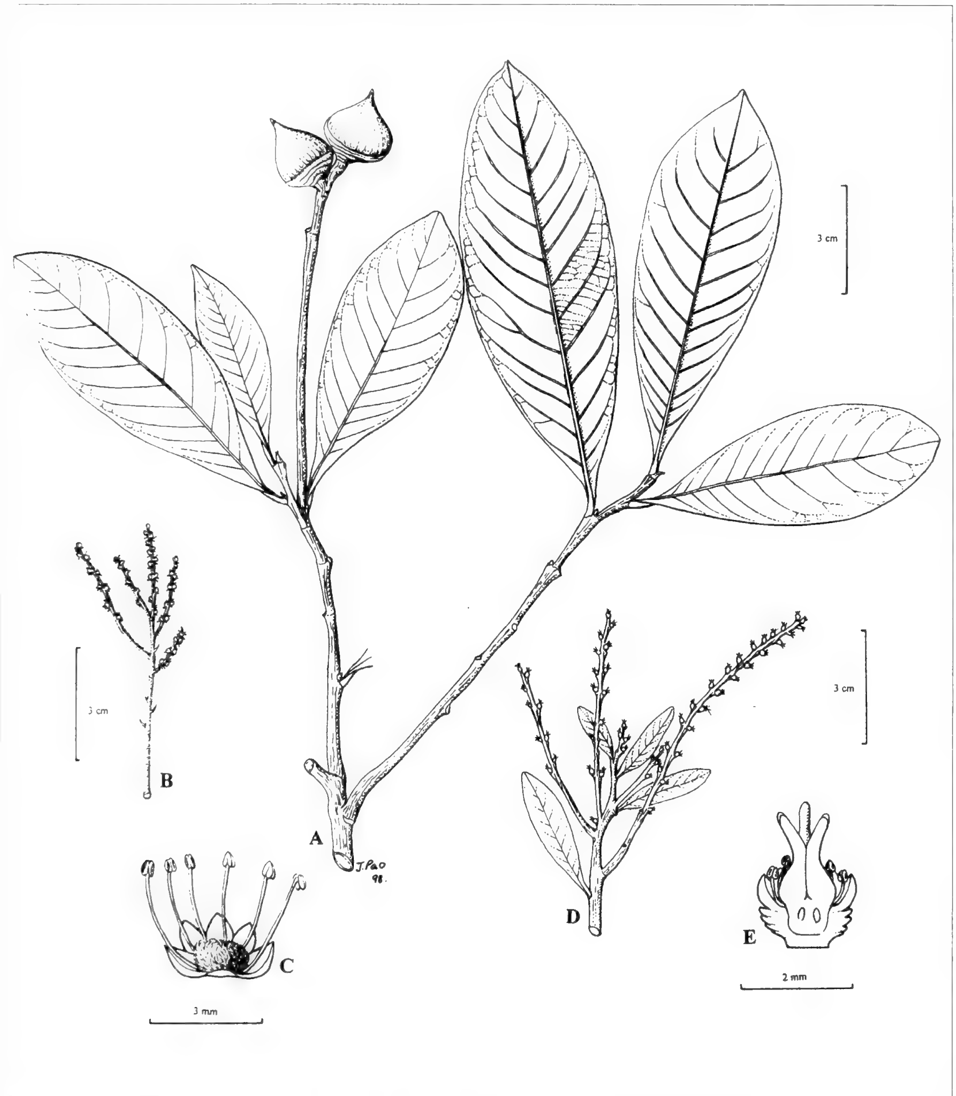

Figure 8. ***Lithocarpus oblancifolius*** S. Julia & Soepadmo, ***sp. nov.*** A, fruiting leafy twig; B, male inflorescence; C, longitudinal section of male flower; D, female inflorescence; E, longitudinal section of female flower (A from *SAN 132942,* B–C from *SAN 91636,* D–E from *SAN 111174).*

with stellate and simple hairs, lamellate; wall woody, thin, enclosing less than half of the acorn; lamellae distinct, entire, set in 6–8 regular lines. *Acorn* ovoid-conical, 1.6–1.8 x 1.6–2 cm, glabrous, brown, base flat, top acute; scar concave, *c.* 1.5 cm in diameter; wall bony, thick, greater parts free from the cupule.

Distribution: Endemic to Sabah, Borneo. Collected from Tawau Hill Park in Tawau and Sg. Piso in Labuk Sugut area.

Ecology: Near the riverbank, rather open area at altitude *c.* 90 m.

Notes: A species closely allied to *Lithocarpus lucidus* in leaf characters but differs by its smaller and thinner cupule, conical acorn, less number of lateral veins and by its less prominent intercostal veins. The cupule is similar to that of *Lithocarpus papilifer* but the leaves are different.

Specimens Examined: BORNEO. SABAH: Labuk Sugut, Sg. Piso, *Aban Gibot & Dewol SAN 91636* (K, SAN!); Tawau, Tawau Hill Park, Water Pump, *Leopold Madani & Sigin SAN 111174* (K, L, SAN!, SAR!); Tawau, Tawau Hill Park, *Leopold Madani et al. SAN 133942* (SAN!).

9. *Lithocarpus sandakanensis* S. Julia & Soepadmo, **sp. nov.** Fig.9
(Of Sandakan, Sabah)

Lithocarpo stonei simillimus, foliis tenuioribus, cupula parum minore, glande piloso distinguendus. ***Typus****: Wood SAN A 4697,* Borneo, Sabah, Sandakan, Sepilok FR, Compartment 17 (*holotypus* KEP!; *isotypi* AA, L, MEL, SING).

Tree 10–45 m tall, 15–90 cm in diameter; buttresses small. Bark smooth, greyish or brownish; inner bark yellowish. Sapwood whitish or purplish. *Twig* glabrescent, sparsely lenticellate. *Leaves* coriaceous, sparsely appressed yellowish tomentose or glabrescent above, densely appressed brownish tomentose below; blades broadly elliptic-oblong, 26–39(–46) x 7.5–11.5 cm, base acute-rounded, margin recurved, apex sharply acute to acuminate, acumen *c.* 15 mm long; midrib flat or slightly raised above, strongly raised below, glabrous on both surfaces; lateral veins thick, 11–14 pairs, dense, flat or impressed above, strongly raised below, disappearing towards the margin, forming an angle of 30°–45° with the midrib; intercostal veins subscalariform or reticulate, lax, thinly prominent on both surfaces, stronger below; petioles 8–18 x 3–6 mm. *Male inflorescences c.* 10 cm long; bracts linear-acute, 1–1.1 x 0.4 mm; bracteoles linear-acute, *c.* 0.6 x 0.2 mm. *Male flowers* solitary along the rachis; perianth 6-lobed, coriaceous, elliptic, 1.1–

Figure 9. ***Lithocarpus sandakanensis*** S. Julia & Soepadmo, ***sp. nov.*** A, leafy twig; B, part of infructescence; C, longitudinal section of cupule and acorn (All from *SAN A 4697).*

1.3 x 0.6–0.8 mm; stamens 10, filaments *c.* 2 mm long; pistillode subglobose, 0.6–1 mm in diameter. Female inflorescences and flowers unknown. *Cupules* solitary along the rachis, 0.5–0.7-cm-stalked, cup-shaped, 1.5–2 x 3–3.5 cm, densely tomentose, lamellate; wall woody, thick, enclosing up to half of the acorn; lamellae distinct, minutely denticulate or wavy, set in 7–8 regular lines. *Acorn* depressed ovoid, 3.5–4 cm across, densely tomentose with simple hairs, dark brown, base flat, top acute; scar deeply concave, *c.* 2 cm in diameter; wall woody, thick, greater parts free from the cupule.

Distribution: Endemic to Sabah, Borneo. All known specimens were collected from Sepilok FR, Sandakan.

Ecology: Primary lowland mixed dipterocarp forest, on yellow soil, up to 15 m altitude.

Notes: A species closely related to *Lithocarpus stonei* but can be distinguished by its much thinner leaves, slightly smaller cupule and by its hairy acorn.

Specimens Examined: BORNEO. SABAH: Sandakan, 15 miles W of Sandakan, Sepilok FR, Compartment 17, *Wood SAN A 4697* (AA, KEP!, L, MEL, SING); Sandakan, Sepilok FR, Jalan Batu 15, *Patrick SAN 19698* (KEP!, SAN!); Sandakan, Sepilok FR, Batu 15, *Meijer SAN 34286* (K, L, SAN!); Sandakan, Sepilok FR, Jalan Kantor Pos, *Patrick SAN 62061* (SAN!); Sandakan, Arboretum, Mile 14, *Aban Gibot, Kumin & Rakim SAN 73710* (SAN!).

10. *Lithocarpus stonei* S. Julia & Soepadmo, **sp. nov.** Fig.10
(B. C. Stone, 1933 – 1994, former Reader in Botany, Department of Botany, University of Malaya, Kuala Lumpur, Malaysia)

Species cupula magna lignosa cupuliformi, glande magno glabro apice nitido rotundato, foliis crassis rigidis notata. Cupulae Lithocarpi revoluti satis similis sed folii characteri differunt. ***Typus****: Yap & Khairuddin SAN 106051*, Borneo, Sabah, Tambunan road (*holotypus* SAN!; *isotypus* KEP!).

Tree 10–25 m tall, 60–100 cm in diameter. Bark fissured or smooth or lenticellate, dark grey; inner bark fibrous, yellowish brown or whitish. Sapwood whitish. *Twig* densely tomentose, sparsely to densely large-lenticellate. *Leaves* thick coriaceous, rigid, densely appressed yellowish tomentose above, sparsely yellowish tomentose below; blades broadly elliptic-oblong, 28–36(–40) x 9–14 cm, base rounded to broadly acute, margin recurved, apex acuminate, acumen *c.* 15 mm long; midrib strongly raised on both surfaces, stronger below, sparsely appressed tomentose on both surfaces, denser above; lateral veins thick, (9–)10–12 pairs, lax, flat or impressed above, strongly raised below, disappearing towards the margin, forming an angle of 30°–45° with the midrib; intercostal veins reticulate, lax, obscure above, prominent below; petioles 10–15 x 5–7 mm, kneed. Male inflorescences and flowers unknown. *Female inflorescences* solitary in the axils of distal leaves, much branched and sturdy, *c.* 20 cm long; bracts linear-acute, 2–2.5 x 0.2–0.5 mm; bracteoles broadly acute, *c.* 0.5 x 0.7 mm. *Female flowers* in clusters of 2–3 along the rachis; perianth 6-lobed, coriaceous, acute, *c.* 1 x 0.5 mm; staminodes 12; styles 3, conical, straight, *c.* 1.5 mm long. *Cupules* in clusters of 2–3 or rarely solitary along the rachis, sessile, deeply cup-shaped, 2–3 x 4–5 cm, densely tomentose, lamellate; wall woody, 3–5 mm thick, enclosing half or more than half of the acorn; lamellae strongly distinct, folded inward, wavy, set in 7–9 regular or irregular lines. *Acorn* depressed ovoid globose, 3–4 x 3–5 cm, glabrous and shiny, brownish, base flat, top rounded; scar deeply concave, 2–2.5 cm in diameter; wall woody, thick, greater parts free from the cupule.

Vernacular name: Sarawak: *saled urong* (Kelabit).

Distribution: Endemic to Borneo. In Sabah, collected from Crocker Range in Tenom, Gunung Alab and Tambunan road in Tambunan. In Sarawak, collected only from Sg. Marariro in Bario area.

Ecology: In lower montane forest, on recent alluvium, clay soils, at 960–1050 m.

Notes: A species characterised by its big, woody and cup-shaped cupule, big, glabrous acorn with shiny and rounded apex, and by its thick and rigid leaves. The cupule is rather similar to that of *Lithocarpus revolutus* but the leaf characters are different.

Specimens Examined: BORNEO. SABAH: Tambunan District, Crocker Range, Kota Kinabalu to Sunsuron Road, *Andrews 851* (K!); Tambunan, Crocker Range, along Tambunan-Penampang road, *Sugau et al. JBS 66* (AA, AAU, EDH, HAST, K, KEP!, L, PNH, SAN!, SAR!, SING); Kota Kinabalu, Tambunan Road, *Yap & Khairuddin SAN 106051* (KEP!, SAN!); Tambunan, Gunung Alab, km 56, Jalan Kota Kinabalu-Tambunan, *Fidilis & Sumbing SAN 121701* (K!, KEP!, L, SAN!); Tenom, Crocker Range, *Meijer SAN 136522* (CHI, KY, SAN!). SARAWAK: Bario, Ulu Baram, path to Pa'Main, near Sg. Marariro, *Anderson S 20067* (SAN!, SAR!).

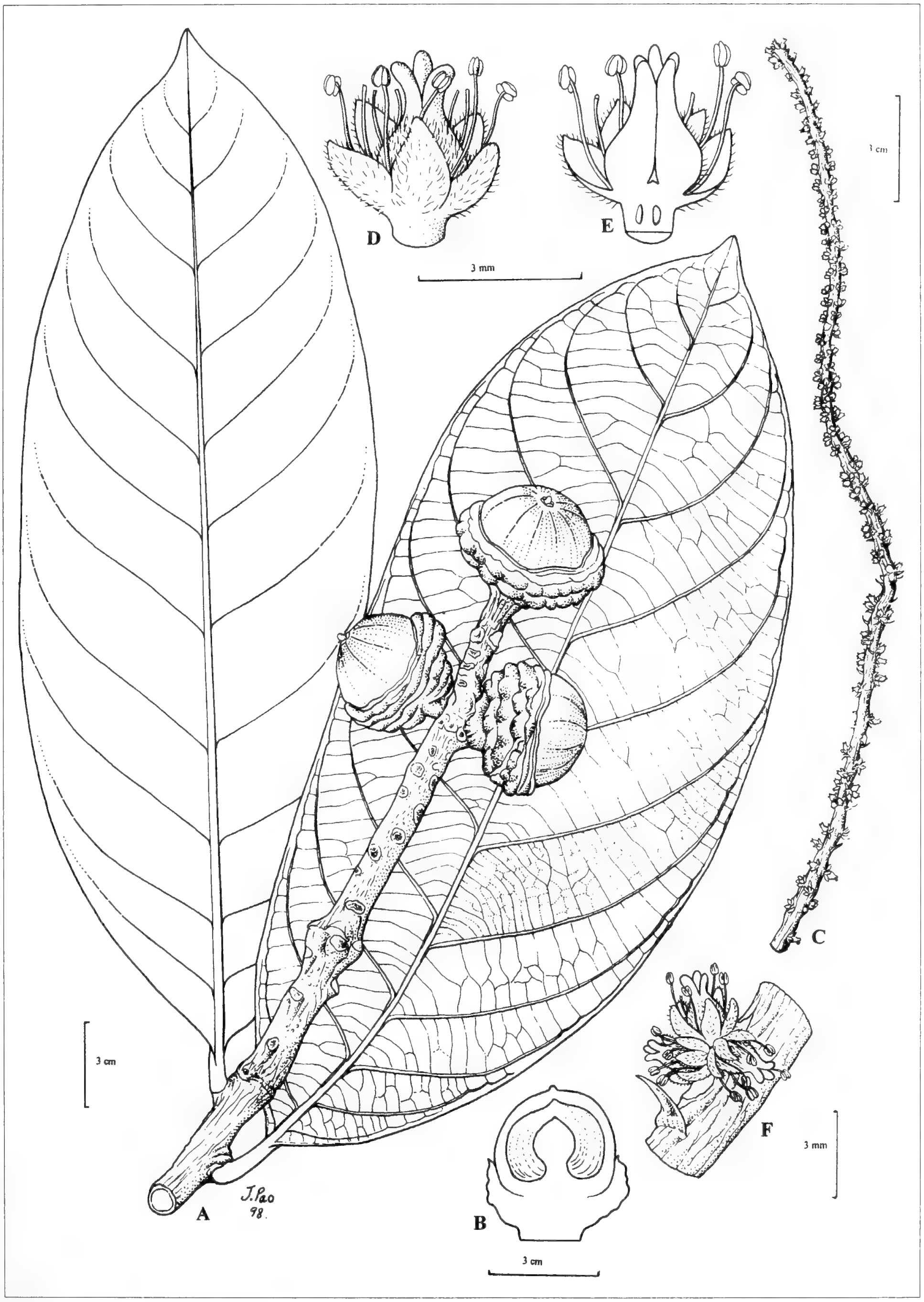

Figure 10. ***Lithocarpus stonei*** S. Julia & Soepadmo, ***sp. nov.*** A, fruiting leafy twig; B, longitudinal section of cupule; C, female inflorescence; D, female flower; E, longitudinal section of female flower; F, part of female inflorescence (A–B from *SAN 106051,* C–F from *SAN 136522).*

11. ***Lithocarpus tawaiensis*** S. Julia & Soepadmo, **sp. nov.** Fig.11
(Of Bukit Tawai, Sabah)

Ab generis speciebus omnibus foliis sessilibus crasse coriaceis rigidis, basi cordato, venis lateralibus fere invisibilis, inflorescentiis masculis validis differt. ***Typus***: *Berhaman et al. SAN 134267,* Borneo, Sabah, Bukit Tawai (*holotypus* KEP!).

Stunted treelet of about 1–1.5 m tall and *c.* 5 cm in diameter. Bark pale brown. *Twig* sparsely appressed tomentose, smooth. Stipules ovate-rounded, 10–13 x 10–18 mm. *Leaves* sessile, thick coriaceous, rigid, glabrous above, sparsely appressed yellowish tomentose or glabrescent below; blades ovate-rounded, 6.5–10.5 x 6–9 cm, base cordate, margin recurved, broadly acute; midrib raised on both surfaces, slightly stronger below; lateral veins thin, 10–12 pairs, dense, flat and almost invisible on both surfaces, faintly joining near the margin, forming an angle of 20–30° with the midrib; intercostal veins reticulate, dense, obscure above, slightly prominent below. *Male inflorescences* in lateral or terminal, lax paniculate clusters on new shoots or solitary in the axils of distal leaves, 6–15 cm long; bracts and bracteoles ovate-acute, 0.6–0.8 x 0.4–0.6 mm. *Male flowers* solitary or in clusters of 2–3 along the rachis; perianth 6-lobed, thick coriaceous, elliptic, *c.* 1.2 x 0.7 mm; stamens 12, filaments *c.* 2 mm long; pistillode globose, *c.* 0.5 mm in diameter. Female inflorescences and flowers unknown. *Young cupule* solitary along the rachis, sessile, saucer-shaped, 1–1.3 x 0.3–0.4 cm, scaly, enclosing less than half of the acorn; scales distinct, set irregularly. *Acorn* for the greater parts free from the cupule.

Distribution: Endemic to Borneo. Twice collected from Bukit Tawai, Telupid, Sabah.

Ecology: Primary hill forest on ultrabasic soil.

Notes: A species differs from any other known species of the genus by its sessile, thick coriaceous and rigid leaves with cordate base and almost invisible lateral veins, and its sturdy male inflorescences.

Specimens Examined: BORNEO. SABAH: Telupid, summit of Bukit Tawai, *Berhaman et al. SAN 134267* (KEP!); Telupid, Bukit Tawai, *Sugau et al. SAN 138832* (KEP!, SAN!).

Figure 11. ***Lithocarpus tawaiensis*** S. Julia & Soepadmo, ***sp. nov.*** A and B, flowering (male) leafy branches; C, distal twig with axillary, branched male inflorescence; D, distal part of male inflorescences with flower buds; E, cluster of 3 male flowers; F, proximal twig with young infructescence; G, cluster of 3 developing cupules and acorns; H, very young developing cupule; I, young infructescence; J, mature cupules; K, detailed venation on the leaf undersurface (A–H from *SAN 134267;* I–K from *SAN 138832).*

New record

Lithocarpus hystrix (Korth.) Rehder

The species is previously known from Sumatra, Peninsular Malaysia and Kalimantan in Borneo (Soepadmo 1972). Recent collections extend the distribution to Sarawak and Brunei.

Specimens Examined: SARAWAK: Bintulu division, Bukit Lumut, *Abg. Mohtar & Yii S 65896* (BKF, K, KEP!, L, SAN!, SAR!); 7th Division, Belaga, Dulit Range, Ulu Sg. Kayan, *Dayang Awa & Yii S 46731* (BKF, K, KEP!, KLU!, L, SAR!); Lundu, Pasir Tengah/Biawak, *Othman Ismawi et al. S 63890* (BKF, K, KEP!, KLU!, L, SAR!); 1st division, Lundu, Sampadi FR, Syarikat Woodworking Salmas, *Othman Ismawi S 37824* (K, KEP!, KLU!, L, SAR!); Kapit District, Bukit Raya, *Soepadmo & Chai S 28198* (AA, BO, K, KLU!, L, SAN!, SAR!, SING); Simanggang, Ulu Skrang, path to Bukit Sadok, *Ilias Paie, Banyeng & Manggi S 44907* (BKF, K, KLU!, L, SAR!); 4th division, Gunung Mulu NP, *Martin S 38902* (K, KEP!, KLU!, L, SAN!, SAR!); 1st and 2nd division boundary, Ulu Simunjan, Gunung Angkong, *Martin S 36953* (K, KEP!, KLU!, L, MO, SAR!); 1st division, Padawan, Bukit Woen, *Yii* S 61453 (BKF, K, KEP!, KLU!, L, SAR!). BRUNEI: Temburong River Valley, *Johns* 7325 (BRUN, KEP!).

Acknowledgements

We wish to extend our gratitude for the support and encouragement extended by the Director-General of FRIM, Kepong and to the Curators of K, L, SAN and SAR herbaria for the loan of specimens. We are also deeply indebted to Dr. J.F. Veldkamp of the Rijksherbarium, Leiden, the Netherlands for providing the Latin diagnoses of the new species, and to Ms. Rosemary Wise (OFI) and Mr. Joseph Pao (SAR) for preparing the illustrations. The research was part of the Tree Flora of Sabah and Sarawak Project, funded by the International Tropical Timber Organization (ITTO), the Malaysian Government, and the Overseas Development Administration of the United Kingdom (ODA-UK).

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Gardens' Bulletin Singapore **50** *(1998) 151–160.*

New Species of *Helicia* Lour. and *Heliciopsis* Sleumer (Proteaceae) from Borneo

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Abstract

Two new species of *Helicia* Lour. (*H. sessilifolia* and *H. symplocoides*) and two new species of *Heliciopsis* Sleumer (*H. percoriacea* and *H. litseifolia*) are described and illustrated from Borneo.

Introduction

In his accounts of Malesian Proteaceae, Sleumer (1955a, 1955b) recognised eight species of *Helicia* and two species of *Heliciopsis* from Borneo. The revision of the genera *Helicia* Lour. and *Heliciopsis* Sleumer (Proteaceae) for the Tree Flora of Sabah and Sarawak revealed, four new species. *Helicia symplocoides* and *Heliciopsis percoriacea* are endemic to Sabah and Sarawak respectively, while *Helicia sessilifolia* is known from Sabah and Sarawak only. *Heliciopsis litseifolia* is common throughout Borneo (except Brunei), Peninsular Malaysia and Sumatra. These species are described and illustrated below.

Helicia

1. *Helicia sessilifolia* R.C.K. Chung, **sp. nov.** Fig. 1
(Latin, sessilis=stalkless, folium=leaf)

Helicia sessilifolia Heliciae maxwellianae similis, sed in ramulis gracilibus, folii margine erecurvata, foliis anguste coriaceis flavido brunnescentibus in sicco, fructu stipitato ellipsoideo-apiculato castanescenti in sicco differt. Typus: Borneo, Sarawak, Limbang Division, Lawas, Ulu Trusan, Bt. Tebunan, 9 May 1986, *Bernard Lee S 52436* (*holotypus* KEP!; *isotypi* K, L, MO, SAN!, SAR!).

Treelet to small tree, up to 10 m tall. *Twigs:* youngest parts subangular, older ones terete, light brown, glabrous. *Leaves* spiral or subopposite; blades broadly oblong to elliptic, rarely obovate, (6–)9–17 x (4.5–)5–8.5 cm, thinly coriaceous, yellowish brown when dry, not shining, glabrous; base rounded to subcordate, margin entire, apex acute; midrib slightly raised above, prominent below; lateral veins 6–7 pairs, curving and joining near margin, prominent on both surfaces; intercostal veins reticulate, inconspicuous on both surfaces; petioles extremely short, up to 2 mm long, slightly swollen at base, dull brown, glabrous. *Inflorescences* racemose, axillary, solitary, *c.* 7 cm long, laxly flowered near the base; rhachis terete, *c.* 1 mm diameter, glabrous; bracts minute, less than 0.5 mm long, glabrous. *Flowers:* pedicels 5–6 mm long, in pairs, not winged, connate up to about 2–3 mm from the base, glabrous; perianth (12–)16–19 mm long, glabrous, limb ellipsoid, 0.8–1.2 mm diameter; anthers 1–1.5 mm long; ovary ovoid, glabrous; style filiform, apex clavate, glabrous; stigma punctiform, terminal, stigmatic surface glandular; disk glands almost entirely connate in a crenulate ring. *Fruits* ellipsoid, 4–4.5 x 2.4–2.7 cm, slightly oblique, glabrous, chesnut-brown when dry, apiculum 1–4 mm long, contracted into a stipe of *c.* 3 mm long; pericarp smooth, 2.5–3 mm thick; fruit stalk unknown.

Distribution: Endemic to Borneo. Rare in Sarawak and Sabah, known in Sarawak only from Bt. Tebunan, Lawas (*S 52434* and *S 52436*) and in Sabah from Tambunan (*SAN 60837* and *SAN 111305*). Not yet recorded from Brunei and Kalimantan.

Ecology: Mixed dipterocarp forest, up to 900 m.

Notes: This species is similiar to *H. maxwelliana,* from which it is distinguished by its slender twigs (stout in *H. maxwelliana*), non-recurved leaf-margin (curled inwards in *H. maxwelliana*), thinly coriaceous leaves (thickly coriaceous in *H. maxwelliana*) which turn yellowish brown when dry (olivaceous-yellowish to dark brown in *H. maxwelliana*), long-apiculate and stiped ellipsoid fruit, which turns chesnut-brown when dry (subglobose fruit, without apiculum and stipe, and black when dry in *H. maxwelliana*). The new species is apparently confined to hill mixed dipterocarp forest. In contrast, *H. maxwelliana* is restricted to submontane forest.

Specimens Examined: BORNEO. SARAWAK: Limbang Division—Lawas, Ulu Trusan, Bt. Trusan, 9 May 1986, *Bernard Lee S 52434* (K, KEP!, L, MO, SAN!, SAR!), *S 52436* (K, KEP!, L, MO, SAN!, SAR!). SABAH: Pedalaman District—Tambunan, 21 July 1984, *Amin & Suali SAN 60837* (AA, K, KEP!, L, SAN!, SAR!, SING!), Rafflesia FR, 7 Sept. 1985, *Leopold Madani & Ismail SAN 111305* (K, KEP!, SAN!).

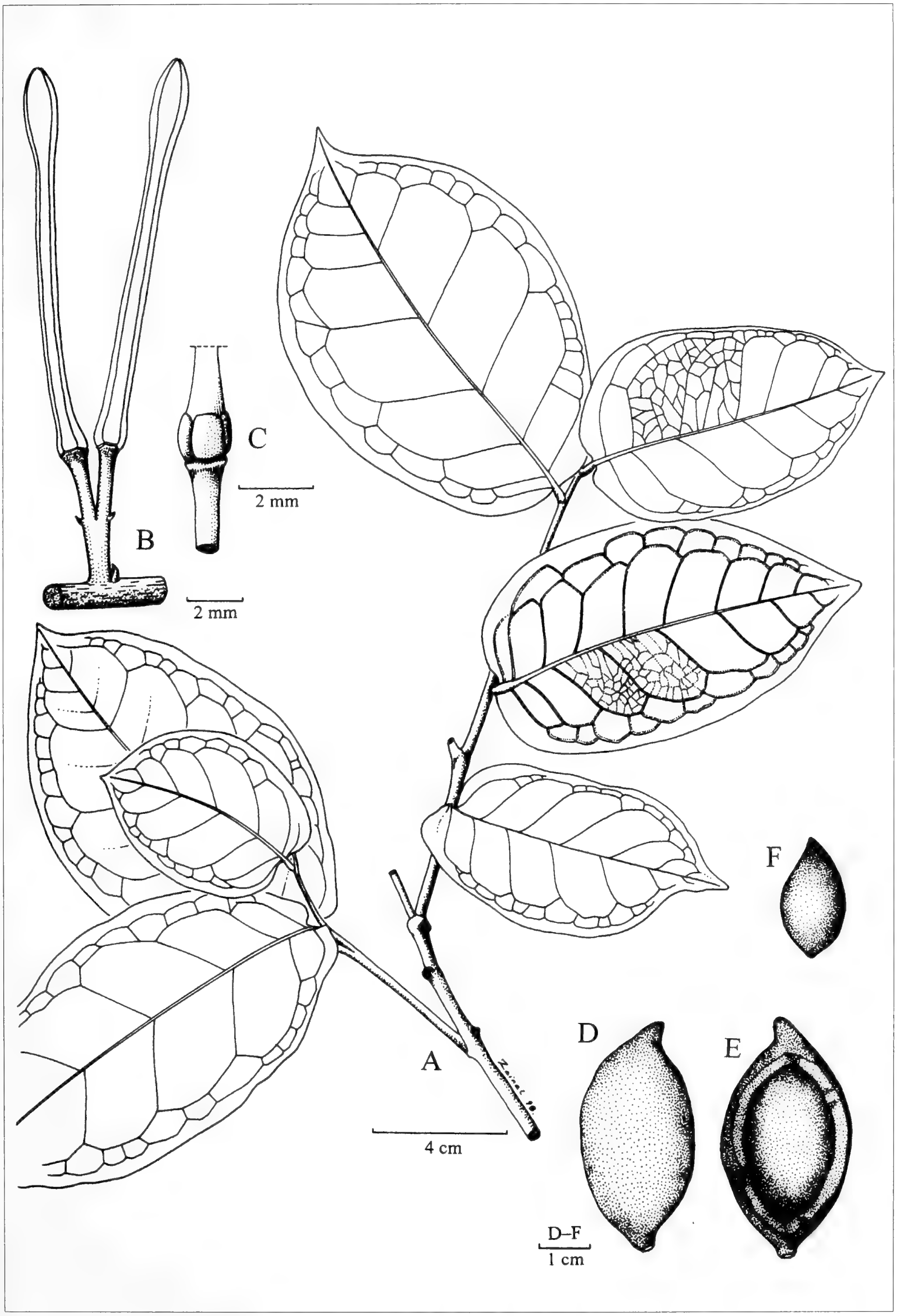

Figure 1. *Helicia sessilifolia*. A, leafy twig; B, flower buds; C, base of ovary with disk glands; D, fruit; E, fruit in longitudinal section; F, seed. (A–C from *S 52436,* D–F from *S 52434.*)

2. *Helicia symplocoides* R.C.K. Chung, **sp. nov.** Fig. 2
(Greek, -oides=resembling; with leaves resembling those of *Symplocos*)

Hac species nova a generis speciebus aliis foliis crasse coriaceis c. 10 cm longis 5 cm latis, apice emarginato vel obtuso, basi decurrenti cuneata, marginibus recurvatis, fructibus minutis ad 1.7 cm longis 1.4 cm latis differt. *Typus:* Borneo, Sabah, Pantai Barat District, Mt. Kinabalu, Mesilau Cave, 1 April 1964, *Chew & Corner RSNB 4786* (*holotypus* SAN!; *isotypi* K, L).

Tree 15 m tall, 25 cm diameter. *Twigs* terete, grey or greyish brown, glabrous with distinct leaf scars up to 3 mm diameter. *Leaves* spiral; blades obovate, 5–10 x 2.5–5 cm, thickly coriaceous, deep green above, brown below, not shining, glabrous; base cuneate, decurrent, margin entire or occasionally with 1–3 minute teeth in the upper half, recurved, apex obtuse or emarginate; midrib raised above, prominent below; lateral veins 6–8 pairs, curving near the margin and joining with next one to form looped intramarginal veins, visible below, inconspicuous above; intercostal veins inconspicuous on both surfaces; petioles 2–4 x 1.5–2 mm, swollen and wrinkled at the base, dark brown when dry, glabrous. *Flowers* not known. *Fruits* ellipsoid to broadly ellipsoid, 1.5–1.7 x 1.2–1.4 cm, oblique, glabrous, black when dry, shortly apiculate, apiculum *c.* 1 mm long, stipe *c.* 2 mm long; pericarp smooth, 0.8–1.5 mm thick; fruit stalk 5–7 x 1.5–2 mm.

Distribution: Recorded only from Sabah where it is known from a single collection, *Chew & Corner RSNB 4786*, from Mt. Kinabalu, Mesilau Cave, on ultramafic soil.

Ecology: Submontane forest at 1850 m.

Notes: The leaves of the new species resemble those of *Symplocos* Jacquin (Symplocaceae).

Specimens Examined: BORNEO. SABAH: Pantai Barat District—Mt. Kinabalu, Mesilau Cave, 1 April 1964, *Chew & Corner RSNB 4786* (K, L, SAN!).

Heliciopsis

1. *Heliciopsis litseifolia* R.C.K. Chung, **sp. nov.** Fig. 3
(With leaves resembling those of *Litsea*, Lauraceae)

Heliciopsis litseifolia Heliciopsidi montanae proxime affinis, a posteriore foliis simplicibus anguste coriaceis basi attenuata decurrenti, apice acuto vel

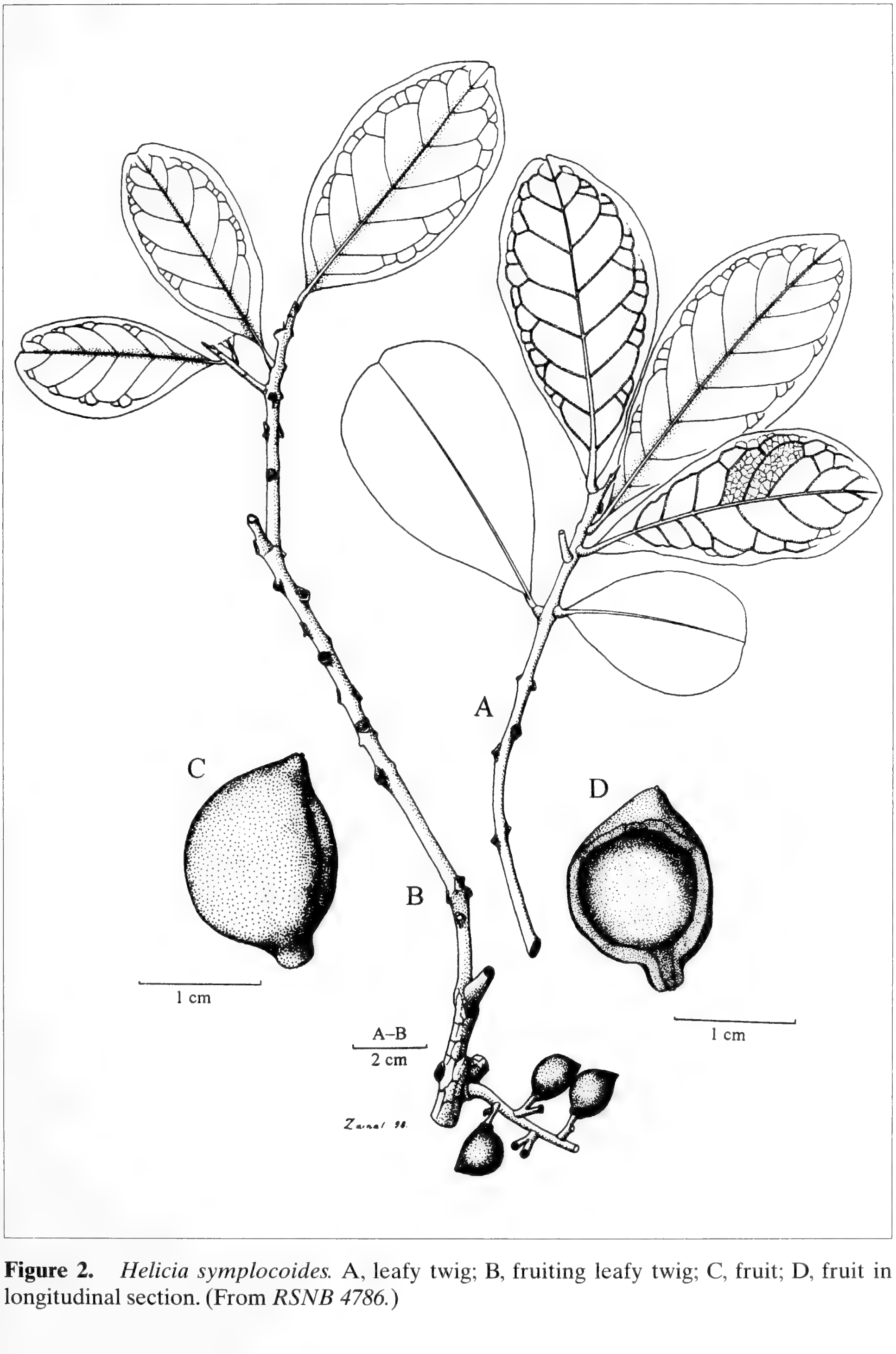

Figure 2. *Helicia symplocoides.* A, leafy twig; B, fruiting leafy twig; C, fruit; D, fruit in longitudinal section. (From *RSNB 4786.*)

acuminato, marginibus integris, petiolis brevibus ad 2 cm longis distinguendam. Typus: Borneo, Sarawak, Kapit Division, Belaga, 2 Sept. 1958, *Jacobs 5401* (*holotypus* SAR!; *isotypi* B, CANB, G, K, L, S, US).

Small to medium-sized tree, 6–25 m tall, 10–25(–50) cm diameter. *Twigs:* youngest parts angular, older ones terete, grey-brown, glabrous. *Mature leaves* elliptic to broadly elliptic, 10–25 x 4–11.5 cm, thinly coriaceous, yellowish green to olivaceous brown when dry, not shining, glabrous; base attenuate, decurrent, margin entire, apex acute or acuminate; midrib slightly raised above, prominent below; lateral veins 5–6 pairs, curved upwards and joining near the margin to form loops, prominent on both surfaces; intercostal veins reticulate, faint above, typically visible below; petiole (0.5–)1–2.5 cm long, swollen at the base, black and rarely yellowish brown when dry, glabrous. *Inflorescences* racemose, axillary or born on older, leafless branches, solitary, 12–26 cm long, laxly flowered except for about 3 cm from the base; rhachis 1–1.5(–2) mm diameter, rufous pubescent, soon glabrescent; bracts subulate, 1–2 mm long, persistent, rufous pubescent. *Flowers:* pedicels 5–8 mm long, mostly in pairs, connate up to 3–5 mm from the base, rufous pubescent; perianth 8–10 mm long, rufous pubescent to glabrescent, limb clavate, *c.* 1.5 mm diameter; anthers 1–1.5 mm long; ovary glabrous; style filiform, clavate towards the apex, glabrous; stigma discoid, lateral, stigmatic surface glandular, with distinct cleft; disk glands truncate, free, spaced. *Fruits* cylindric ellipsoid, (2.7–)3–3.5(–3.8) x (1.7–)2–2.2(–2.5) cm, smooth, shining black when dry; exocarp leathery, *c.* 1 mm thick; mesocarp built up by radial, soft brown fibres *c.* 2.5 mm long; endocarp woody, thin; fruit stalk 10–12 x 3–4 mm.

Distribution: Sumatra, Peninsular Malaysia and Borneo.

Ecology: Lowland and hill mixed dipterocarp forest, up to 900 m.

Notes: In Borneo, the leaf and petiole characters are rather variable. In *Othman Haron S 29994, Sumbing Jimpin SAN 110338,* and *Church 173,* the leaves range from 16–25 cm long and 9–11.5 cm wide, and the petioles from 2–2.5 mm in diameter. Furthermore the fruits in *de Wilde & de Wilde-Duyfjes 16611* from Sumatra, are larger (*c.* 4.5 x 3.5 cm) than those of the Bornean specimens and the endocarp is thicker (*c.* 3 mm).

Specimens Examined: SUMATRA. Atjeh, G. Leuser Nature Reserve, G. Mamas, 5 May 1975, *de Wilde & de Wilde-Duyfjes 16611* (BO, KEP!, L). PENINSULAR MALAYSIA. TERENGGANU—Ulu Setiu FR, 4 Aug. 1977, *Chan FRI 23980* (K, KEP!, L, SING!). JOHORE—Ulu Sg. Anak Endau, 3 April 1968, *Cockburn FRI 8118* (K, KEP!, SING!). BORNEO.

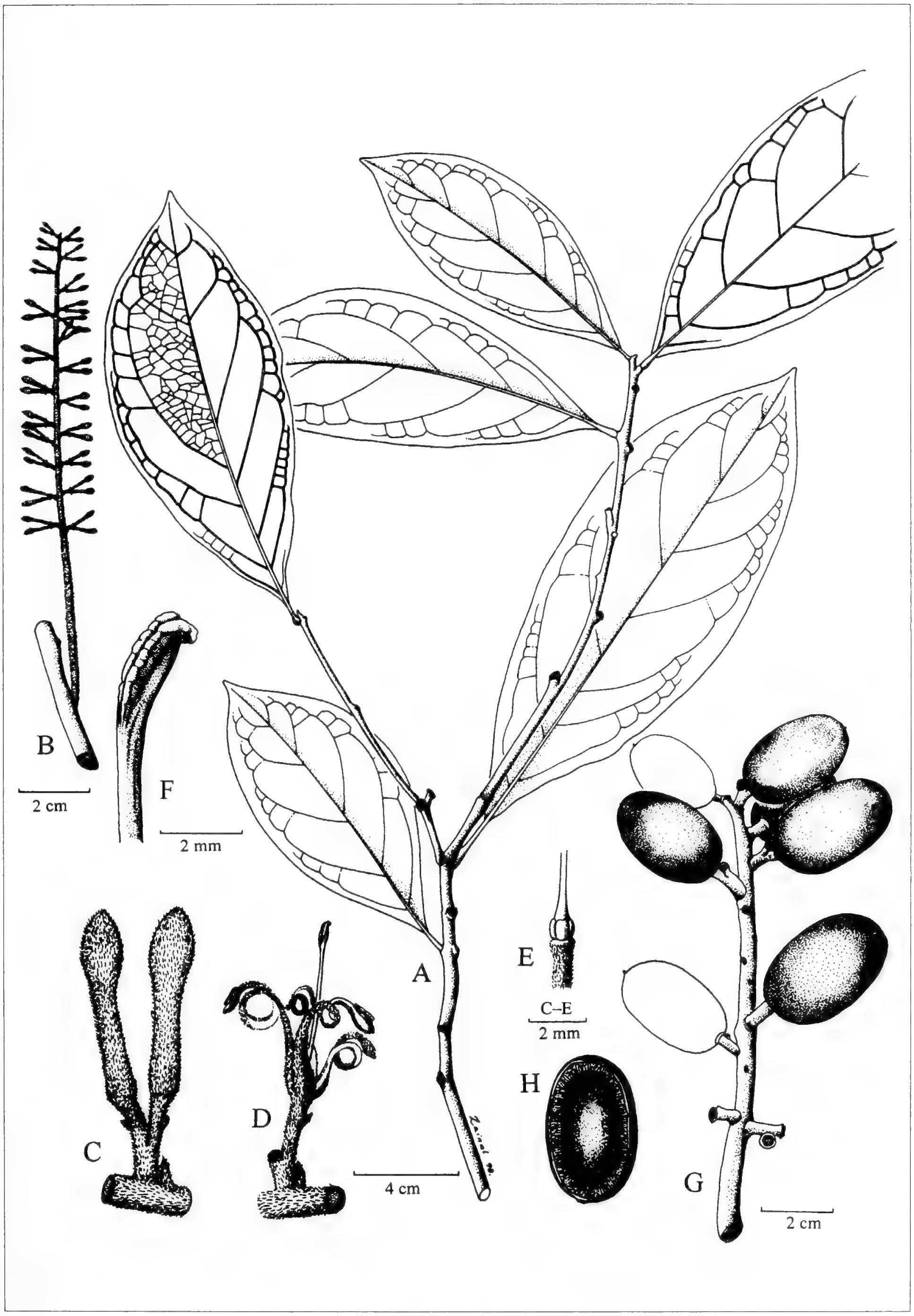

Figure 3. *Heliciopsis litseifolia.* A, leafy twig; B, male inflorescence; C, male flower buds; D, open female flower; E, base of ovary with disk glands; F, stigma; G, infructescence; H, fruit in longitudinal section. (A, G-H from *SAN 67659,* B–C from *S 34497,* D–F from *Jacobs 5401.*)

SARAWAK: Kuching Division—Sematan, G. Pueh, 23 June 1974, *James et al. S 34497* (A, K, L, MO, SAN!, SAR!). Samarahan Division—Serian, Sabal FR, 14 May 1974, *Tong S 34320* (K, KEP!, L, MO, SAN!). Sibu Division—Anap, Ulu Muput Kanan, Bt. Kemantan, 12 Oct. 1963, *Chai S 19547* (A, BO, K, L, MEL, SAN!, SAR!, SING!), Ulu Kakus, 9 March 1970, *Othman Haron S 29994* (A, K, KEP!, L). Kapit Division—Belaga, Rajang R., 2 Sept. 1958, *Jacobs 5401* (B, CANB, G, K, L, SAR!, SING!, US), Batu Laga, 4 Sept. 1984, *Abg. Mohtar S 48191* (K, KEP!, L, MO, SAN!, SAR!). SABAH: Pedalaman District—Keningau, Pensiangan FR, 16 Oct. 1985, *Sumbing Jimpin SAN 110338* (SAN!). Tawau District—Tawau, Sg. Pang Burong FR, 17 July 1969, *Leopold Madani & Saikeh SAN 67659* (K, L, SAN!, SAR!), Kinabutan Kecil, 20 May 1963, *Aban Gibot SAN 35872* (SAN!, SAR!). KALIMANTAN: Kalimanatan Barat—Sintang, Bt. Baka NP, 17 Oct. 1993, *Church 173* (A, BO, KEP!). Kalimantan Tengah—Ulu Barito, 22 June 1990, *Ridsdale PBU 595* (BO, KEP!, L).

2. *Heliciopsis percoriacea* R.C.K. Chung, **sp. nov.** Fig. 4
(Latin, per=exceedingly, coriaceus=leathery, referring to leaves)

Heliciopsidi montanae similis, foliis late ellipticis, petiolis glabrescentibus, pedicellis 8–10 mm longis, periantho 12–15 mm longo limbo c. 2.5 mm diam. distinguendam. A Heliciopside litseifolia in foliis crasse coriaceis, apice obtuso, petiolis perianthiis longioribus differt. Typus: Borneo, Sarawak, Kuching Division, Lundu, G. Pueh, 4 Oct. 1985, *Othman Ismawi et al. S 49967* (*holotypus* KEP (Sheet 1)!; *isotypi* K, KEP (Sheet 2)!, L, MO, SAN!, SAR!)

Medium-sized tree, 21 m tall, 36 cm diameter. *Twigs* terete, greyish brown, rufous tomentose when young, soon glabrous. *Mature leaves* broadly elliptic, (10–)12–18(–21) x (7–)8–11(–12.5) cm, thickly coriaceous, yellowish olivaceous or yellowish brown when dry, shining above, glabrous; base acute, margin entire, recurved, apex obtuse; midrib slightly raised above, distinctly prominent below, rufous tomentose, becoming glabrescent; lateral veins 7–8 pairs, curving and joining near the margin, slightly raised above, distinctly prominent below; intercostal veins reticulate, prominent on both surfaces; petioles 3.5–4.5 x 2.5–3 cm, rufous tomentose when young, glabrescent. *Inflorescences* racemose, solitary on older, leafless branches, 26–28 cm long, laxly flowered except for 1–2 cm from the base; rhachis terete, *c.* 2.5 mm diameter, rufous tomentose; bracts subulate, *c.* 1 mm long, persistent, rufous tomentose. *Flowers (male):* pedicels 8–10 mm long, in pairs, connate up to 4–6 mm from the base, rufous tomentose; perianth 12–15 mm long, rufous tomentose, limb ellipsoid, *c.* 2.5 mm diameter; anthers *c.* 2 mm long; disk glands ovate, free, slightly distant from each

Figure 4. *Heliciopsis percoriacea.* A, leafy twig; B, male inflorescence; C, longitudinal section of male flower. (From *S 49967* (Sheet 1).)

other. *Flowers (female)* and *fruits* not known.

Distribution: Endemic to Sarawak, it is very rare, once collected from G. Pueh. No record from Sabah, Brunei and Kalimantan.

Ecology: In Heath forest.

Specimens Examined: BORNEO. SARAWAK: Kuching Division—Lundu, G. Pueh, 4 Oct. 1985, *Othman Ismawi et al. S 49967* (K, KEP (2 Sheets)!, L, MO, SAN!, SAR!).

Acknowledgements

I wish to express my gratitude for the support and encouragement extended by the Director-General of FRIM, Kepong, the Directors of the Forestry Departments of Sabah and Sarawak. I am grateful to the Curators and Keepers of the BM, BO, BRUN, K, KEP, KLU, L, SAN, SAR and SING herbaria for loan of specimens and for permission to consult specimens at their institutions. I thank Dr J.F. Veldkamp of the Rijksherbarium, Leiden for providing Latin diagnoses of the new species. Dr Martin Cheek of the Royal Botanic Gardens, Kew, Mr Steve Cafferty of the Natural History Museum, London and Ms Stans Kofman of the Rijsherbarium, Leiden, for providing photographs of the type specimens. Dr L.G Saw of Forest Research Institute Malaysia, Kepong, for his assistance in searching the needed specimens during his tenure of Liaison Officer for the Tree Flora of Sabah and Sarawak Project. Grateful acknowledgement is also due to Dr E. Soepadmo and Mr K.M. Kochummen of Forest Research Institute Malaysia, Kepong, for their guidance and comments in the preparation of this paper. Mr Zainal bin Mustafa, University of Malaya, Kuala Lumpur, and Ms Rosemary Wise, Oxford Forestry Institute, U.K. kindly prepared the illustrations for this account. The present investigation is part of a revision of the Proteaceae for the Tree Flora of Sabah and Sarawak Project, funded by the U.K. Overseas Development Administration (ODA), the International Tropical Timber Organization (ITTO) and the Malaysian Government.

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Gardens' Bulletin Singapore **50** *(1998) 161–169.*

Niche Partitioning in Limestone Begonias in Sabah, Borneo, Including Two New Species

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Abstract

The begonia flora of limestone hills in Sabah is extremely biodiverse with several begonias being found at a single locality, the great majority of which have extremely local distributions. For example, on Bukit Dulong Lambu (better known as Gomantong Cave) four species co-exist. Two are new species, *Begonia gomantongensis* and *B. postarii* for which descriptions are provided. The former is endemic to Bk. Dulong Lambu, as is *B. malachosticta* Sands. The fourth species, *B. gueritziana* Gibbs is widespread on limestone, as well as on other rock types. Field observations show that niche partitioning occurs between these four species based on light conditions (that also relate to severity of water stress) and substrate. All four begonias are vulnerable to habitat changes – *B. gomantongensis* and *B. postarii* that grow in the damp and shaded conditions around the base of the hill are vulnerable to clearance or disturbance to the tree canopy, while all species are endangered by the periodic forest fires. Indeed, the summit vegetation of Bk. Dulong Lambu has still not recovered from the 1983 fires.

Introduction

The richness of the limestone flora in Peninsular Malaysia compared with the land area it occupies was highlighted by Chin (1977). Kiew (1991) ascribed this richness in part to the variety of microhabitats that limestone hills provide within a very confined area, from the damp dark conditions at the base of the hill, to the vertical walls that with increasing height become more exposed to sunlight, heat and water stress, to the variety of substrates - the friable soil at the base, the pocked boulders, crevices in rocks, peat-filled pockets and so on.

Begonias are one group of plants that are well represented on limestone. For example in Peninsular Malaysia, nine of the 55-odd begonia species grow on limestone and six of these are restricted to limestone. Most limestone hills support at least one species (the peltate *B. kingiana* Irmsch. is the most widespread) and frequently a second species occurs. For example on Batu Caves, *B. kingiana* grows on shaded vertical cliffs near the base of the hill while *B. phoeniogramma* Ridl. grows on steep earth slopes in gullies.

In Borneo, the genus *Begonia* is much more speciose and begonias are well represented on limestone. Indeed, it is common for several begonias to be found on the same hill. (There is still a great deal to be learnt about Bornean begonias as there are more species undescribed than described and field collecting continues to discover novalties).

This paper examines niche partitioning of begonias on Bukit Dulong Lambu (5° 31'30"N 118° 4'15"E), a tower karst massif 229 m high in the Gomantong Virgin Jungle Reserve. This limestone hill is famous for its caves from which birds' nests are harvested. It is better known as Gomantong Cave (Lim & Kiew, 1997). Four begonias are known from this massif, two are endemic to it (*B. malachosticta* Sands and *B. gomantongensis*, described here as a new species), one (*B. postarii*, also described here as a new species) is found in another two limestone localities on the Kinabatangan River, and *B. gueritziana* Gibbs, a widespread species, is found, not only on almost every limestone outcrop, but also on other rock types too.

Populations of these four species were observed in the field to see whether differences in their habitat characteristics could be discerned to explain how they co-exist in the same locality. At the base of the hill grow *B. gomantongensis* and *B. postarii*, both confined to damp shaded conditions below intact forest canopy. Ascending the hill, these two species are replaced by *B. malachosticta* that grows in rocky crevices in the sheer cliffs or on jagged outcrops. It is not found in deep shade but occurs at a height where the tree canopy begins to open up. Unlike any begonia species in Peninsular Malaysia, it can grow on the exposed summit fully exposed to full sunlight, heat and presumably also water stress. At one time, its population must have been quite plentiful on the summit as it is reported as eaten as a vegetable by the birdnest collectors who camp on the summit of Bk. Dulong Lambu. Leaves of some begonias are pleasantly sourish, cf. Reza and Kiew (1998). However, it is no longer found on the highly disturbed summit except for the inaccessible shoulders.

Begonia gueritziana is also not found growing in the deep shade at the base of the cliff nor is it found growing in habitats exposed to full sunlight. Unlike the other three species, it produces a compact rhizome, which grows closely appressed to its substrate. (The other three species are erect begonias, *B. malachosticta* produces woody cane-like stems, while *B. gomantongensis* and *B. postarii* have rather lax stems that tend to become decumbent). *B. gueritziana* is most frequently found in soil-filled crevices and is particularly common on lightly-shaded, humus-covered ledges.

Of the other two species, *B. postarii* is a delicate begonia with soft leaves and it is not found in conditions exposed to either hot or dry conditions. It grows most profusely in sheltered, deeply shaded habitats at the base of the hill. Substrate does not seem critical as it grows both on soil, limestone boulders and even on the base of tree trunks (semi-epiphytic).

Its distribution overlaps with that of *B. gomantongensis* and in one shaded area where the jagged limestone bedrock is exposed at soil level, both species grow together in profusion. However, *B. gomantongensis* is also found growing on vertical rock faces, but only in deep shade within 3 m of ground level where the cliff or boulder is covered by a black layer of algae. In contrast, *B. postarii* is never found on such deeply shaded vertical rock faces.

This rich biodiversity of begonias is a characteristic of the Sabah limestone flora and many other hills support at least three species, one at the base, another on the summit, as well as *B. gueritziana*. In this respect, Sabah is richer in its limestone begonia flora than Peninsular Malaysia where no begonia is found above the tree canopy, i.e no begonia is adapted to living on the exposed summit.

The niche partitioning of these four begonias illustrates the importance of protecting Bukit Dulong Lambu from habitat disturbance in order to conserve the rich biodiversity of the limestone flora. In the past, limestone hills in Sabah have been particularly vulnerable to burning in drought periods and the summit vegetation of hills such as Bk. Dulong Lambu, Gunung Madai and Batu Batangan, for example, have still not recovered from the Great Burn of 1983 and the blackened trunks of large dead trees still stand and the summit is covered by a tangle of creepers. The flora that grows at the base of the hill is particularly vulnerable to forest clearance that opens up the canopy and would expose tender species, such as *B. gomantongensis* and *B. postarii* to the drying conditions of high light and temperature. To conserve the limestone flora of these hills, it is therefore necessary to protect a broad buffer zone of primary forest around the base of the hill to prevent fire spreading from the surrounding area. In addition, Bk. Dulong Lambu and G. Madai remain particularly vulnerable to accidental fires as birdnest collectors live on or close to these hills. It is, however, in their interest to prevent fires as smoke from the burning drives away the birdnest swiftlets.

While Bk. Dulong Lambu and G. Madai are protected within virgin jungle reserves, the majority of limestone localities are not adequately protected as they are not surrounded by protected forest (Lim and Kiew, 1997). In view of the extremely rich biodiversity of the limestone flora, a strategy needs to be implemented to protect key limestone localities of which Bk. Dulong Lambu is one (Kiew, in press).

Two New Begonia Species

Both new species belong to Section Petermannia in possessing an erect, branching habit; stamens produced on an elongated column; obovate anthers, which are about the same length as the filament; female flowers with five tepals, a trilocular ovary with three bifurcating styles, the stigma forming a continuous spiral papillose band; and trilocular fruits with three equal wings, bilamellate placentas and caducous styles.

Begonia gomantongensis also possesses male flowers with two tepals, which is characteristic of Section Petermannia. However, *B. postarii* has male flowers with four tepals. Sands (1990) has already noted that a few species of this section, such as *B. malachosticta,* are anomalous in this respect.

Begonia gomantongensis Kiew **sp. nov.**
Holotype: James Awing SAN 47257 (SAN, unicate).

A Begonia pryeriana Ridley petiolis longioribus laminis latioribus et fructibus verruculosis differt.

Erect monoecious begonia up to 60 cm tall, sparsely branched.Young stem, petioles and lower surface of veins minutely bristly. *Stems* green, purplish at nodes, up to 4–5 mm thick when dry. Stipules green, narrowly lanceolate, up to 2 cm long, 5 mm at base strongly tapered towards acute apex. *Leaves* alternate, distant and held horizontally. Petiole deep purplish towards apex and base, 10–16 cm long. Lamina glossy, mid-green to dark green above, pale green beneath, unpatterned, glabrous above, obliquely subrotund, 13–16(–30) by 13.5–14(–23) cm, base cordate, not overlapping, basal lobe rounded 6–8 cm long, margin minutely serrulate, apex shortly acuminate, acumen 0.5 cm long; veins slightly impressed above, conspicuously prominent beneath, main vein and 4 lateral veins radiating from the petiole with an additional 2–4 veins supporting the basal lobes, veins bifurcating three times before reaching the margin. *Inflorescence* axillary, protogynous, with 1–2 female flowers produced from the leaf axil and many male flowers on an erect monopodial rachis up to 5 cm long with short cymose branches c. 0.5 cm long. Bracts foliaceous, broadly ovate to semi-circular, up to 25 by 17 mm, diminishing in size towards the shoot apex, margin undulate, upper bracts enveloping clusters of male flowers and overlapping with bract above. *Female flowers* with pale yellow-green pedicels c. 10–12 mm long, ovary oblong tapered into pedicel, 16 by 11 mm, outer surface verruculose, wings pale yellowish green c. 4 mm wide, 3-loculate, placentas axile, bilamellate with many ovules on both surfaces, tepals 5, white, margin entire, apex acute, outer tepals ovate 11 by 7 mm, inner narrower 7 by 4 mm, styles c. 3–4 mm long divided to base, bifurcating, stigma papillose forming a continuous twisted band. *Male flowers* with slender pedicels 3–3.5 mm long, densely bristly, tepals 2, white, rotund, 3.5–4 by 3–3.5 mm, stamens (45–)51(–53) in an obovoid cluster 1.25 by 2 mm, torus columnar c. 0.75 mm long, filament c. 0.5 mm long, anther yellow, ovoid, c. 1 by 0.5 mm, apex emarginate. *Capsule* pendant, pedicel 1.5–2.5 cm long, oblong, 17–20 by 13–15 mm, base broadly rounded, wings 3, equal, 4–5 mm wide, drying stiffly papery (not fibrous), wing tip abruptly truncate or rounded, 3-loculate with the locule reaching to the base, outer surface of locule flat and completely verruculose, dehiscing along suture between locule and wing, placentas axile, bilamellate with numerous minute seeds on both surfaces, styles caducous. *Seeds* broadly ovoid, 0.3 by 0.2 mm, base truncate, apex rounded, testa strongly reticulate.

Distribution: Endemic to Sabah, known only from Bk. Dulong Lambu, Sandakan District.

Habitat: Base of limestone hill in deep shade on boulders or cliff faces.

Specimens examined: *James Awing SAN 47257* 11 Oct 1964 (SAN), *S.P. Lim & Ubaldus LSP 785* 6 Aug 1996 (SAN, SING), *R. Kiew & S.P. Lim BDL 3* 29 Oct 1996 (SAN, SING).

Notes: In its inflorescence with 1–2 female flowers at the base and an erect rachis bearing male flowers and its oblong capsules 17–19 mm long, it resembles *B. pryeriana* Ridl., which was first described from Sandakan, Sabah. However, it would not be mistaken for this species as the leaves of *B. gomantongensis* are subrotund and 13–16 cm wide (those of *B. pryeriana* are lanceolate acuminate and about 5 cm wide) and its petioles are much longer (only 2.5 cm long in *B. pryeriana*). In addition, the outer wall of the locules of the ovary and capsule are remarkable in being verruculose, those of *B. pryeriana* are smooth.

In the field, *B. gomantongensis* is a very striking species as its large subrotund leaves are held horizontally and look like tea plates. The leaves form a perfect leaf mosaic without any overlap.

Label notes on the type specimen record flower colour as yellow. All the plants I have seen have white tepals.

Begonia postarii Kiew **sp. nov.**

Type: *R. Kiew & Lim S. P. RK 4221* Bukit Panggi, Kinabatangan (holo

SAN, iso SING)
Figure 1.

A Begonia congesta Ridley petiolis longioribus, laminis brevioribus, staminibus 23 vel 35 (non 12) et fructibus brevioribus differt.

Weak erect but rather straggling branched monoecious begonia to 50 cm tall becoming decumbent and rooting at nodes. Plant hispid with uniseriate, glandular, white (sometimes red) trichomes 1–3 mm long on the stem, stipules, petioles and lamina, bracts, inflorescence, outside of male and female tepals and the ovary, particularly dense and brownish on young stems, petioles and lower surface of veins, on upper lamina surface trichomes have raised bases. *Stem* reddish, c. 8 mm thick when dry. Stipules foliaceous, broadly elliptic with a distinct dorsal midrib, up to 2.5 by 1.5 cm, margin entire with dense fringe of hairs, apex rounded or slightly acute, persistent. *Leaves* alternate and distant. Petiole reddish, (4–)6–8 cm long. Lamina plain pale green above and beneath, soft and thin in life, drying thinly papery, obliquely ovate, (8.5–)10–11(–14) by 7–9(–12) cm, base cordate (not overlapping), basal lobe rounded, (3.5–)6–8 cm long, margin minutely dentate, apex cuspidate, acumen to 1.25–1.5 cm long, main veins 5, of almost equal length radiating from the petiole and bifurcating twice before reaching the margin, with 2 minor veins running into basal lobes, slightly impressed above and raised beneath. *Inflorescence* erect and projecting above leaves, paniculate, 13.5–18 cm long, peduncle 5.5–7 cm long, lowest 1–2 branches 1.5–3.5 cm long, each producing 2–3 female flowers, upper branches branching three times, ultimate branch 1.5–3 cm long with many male flowers. Bracts, peduncle and rachis pale green and fleshy, upper bracts tipped red and ultimate branches of rachis reddish. Lower bracts broadly oval up to 1.5 by 1 cm, margin minutely toothed; ultimate bracteoles broadly ovate, c. 3 by 4 mm with dentate margin each tooth tipped by long trichome. *Female flowers* with reddish pedicels c. 7–10 mm long, ovary broadly ovate, 8 by 9.5–10 mm, wings crimson, c. 2 mm wide, 3-loculate, placentas axile, bilamellate with many ovules on both surfaces, outer surface smooth, tepals 5, pink, margin entire, apex rounded, outer broadly ovate 8 by 4 mm, inner narrower 4.5 by 2.5 mm, slightly tapered to base, styles 3 mm long divided to base, bifurcating, stigma papillose forming a continuous twisted band. *Male flowers* with pedicels up to 8 mm long, tepals 4, outer 2 white tinged pink merging to cerise towards centre, elliptic 7–8 by 4.5–5 mm, apex rounded, conspicuously hirsute outside, inner pair glabrous, narrowly lanceolate, 7 by 1.3–2 mm, stamens 23–35 in a conical cluster c. 3 by 1.7 mm, torus columnar c. 2 mm long, filament c. 0.5 mm long, anthers yellow, 1 by 0.5 mm, apex emarginate. *Capsule* pendulous on

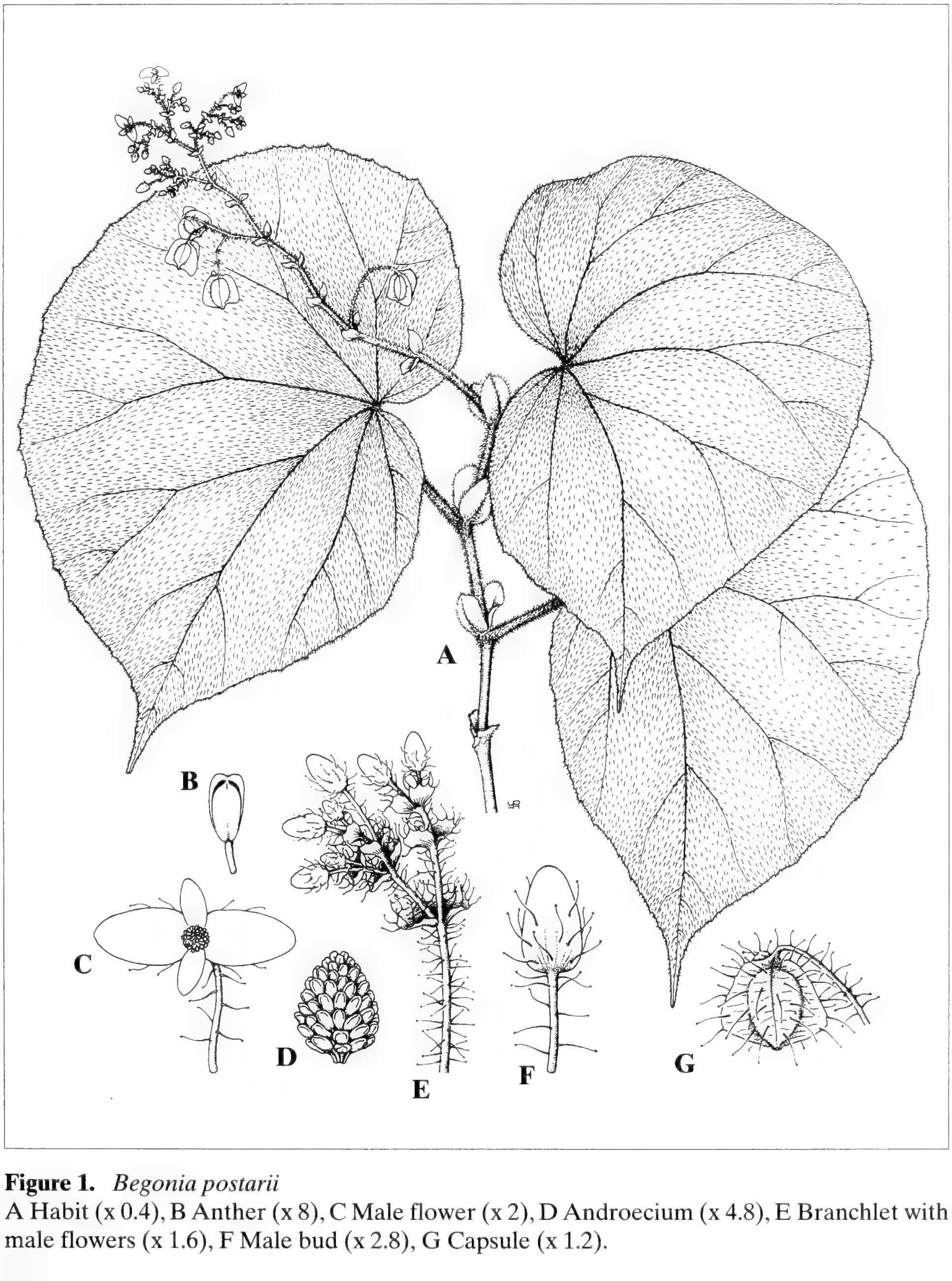

Figure 1. *Begonia postarii*
A Habit (x 0.4), B Anther (x 8), C Male flower (x 2), D Androecium (x 4.8), E Branchlet with male flowers (x 1.6), F Male bud (x 2.8), G Capsule (x 1.2).

a thin thread-like stalk c. 1.5–2 cm long, broadly ovate, (8–)10 by (9–)13 mm, hirsute outside, 3-loculate, locules bulging, wings 3 equal, narrow 3 mm wide, distinctly rounded at base, truncate distally, tip sometimes acute, drying thin and papery and dehiscing along suture between locule and wing, styles caducous leaving a scar. *Seeds* ovoid, apex and base truncate, c. 0.4 by 0.3 mm, testa strongly reticulate.

Distribution: Endemic to Sabah, known only from two limestone hills along the Kinabatangan River (Bukit Dulang Lambu and Bukit Panggi) and from a low unnamed outcrop in the Subak Estate on opposite side of the Kinabatangan River from Bukit Garam.

Habitat: At base of the limestone hill (but not on cliff faces) at about 100 m a.s.l., growing in deep shade in sheltered, damp habitats on soil, low limestone boulders or base of tree trunks.

Specimens examined: Bukit Dulong Lambu *Joseph B. et al. SAN 122763* 21 Jan 1988 (SAN), *Lim S.P. & Ubaldus LSP 802* 7 August 1996 (SAN, SING), *R. Kiew & Lim S.P. BDL4* 29 Oct 1996 (K, SAR, SAN, SING); Bk. Panggi *R. Kiew & Lim S.P. RK4221* 19 Sept 1996 (SAN, SING); Subak Estate, Lower Kinabatangan River *J. Dransfield et al. JD5770* 17 Oct 1979 (SAN).

Notes: This softly hairy begonia is quite unlike any other limestone species in Sabah. Neither are any of the Sarawak limestone begonias as hairy. *B. congesta* Ridl. from limestone in Sarawak is scantily hairy on the young shoots, leaf margins and lower vein surface but *B. postarii* is distinct from this species in leaf indumentum, shape and margin (the lamina of *B. congesta* is longer and more oblong ranging from 15–23 cm in length, is more than 1.5 times longer than wide and its margin is undulate), longer petiole c. 7.5 cm long, glabrous male flowers and fruits, and a longer oblong fruit 2.5 by 1.25 cm and, according to Ridley, only 12 stamens.

This begonia is named in honour of Postar Jaiwit, tree climber at SAN, whose sharp eyes and interest in plants led him to discover this species on Bk. Panggi.

Acknowledgements

This work forms part of the collaborative project between Universiti Putra Malaysia and Forest Research Centre, Sabah Forest Department on 'The Biodiversity and Conservation of the Limestone Flora of Sabah'. The author thanks the Ministry of Science, Technology and the Environment, Malaysia, for funding the project under IRPA Grant No. 52858; A. Berhaman and Lim S.P. for organising field excursions; herbarium staff at SAN for help in the field and in processing herbarium specimens; and Mdm Yap P. H. for the botanical drawing of *Begonia postarii*. The author particularly appreciates the constant and enthusiastic support of the project by Wong Khoon Meng and Robert C. Ong. Mark J.E. Coode is thanked for correcting the latin.

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A Survey of Termites in the Singapore Botanic Gardens Rain Forest

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Abstract

A survey on termites in the Singapore Botanic Gardens Rain Forest included termite collection and quantitative assessment of vegetation, dead trees and wood litter in 15 random sample plots, which covered 7.5% area of the forest. Termite infestation was high in the northern zone, moderate in the central and light in the southern zones. The abundance of termite-infested microhabitats shows a positive relationship with the number of big trees, dead standing trees and ground timber, and a negative relationship with the number of herbs. A total of 22 termite species were found. Three genera of gallery-forming termites identified were *Bulbitermes, Nasutitermes* and *Microcerotermes.* The major fungus-growing genera were *Macrotermes, Odontotermes* and *Microtermes.* The ground-nesting genera included *Termes, Dicuspiditermes, Hospitalitermes* and *Prohamitermes.* The other genera found were *Coptotermes*, *Schedorhinotermes*, *Subulitermes* and *Procapritermes*. Three new records for Singapore are *Bulbitermes borneensis*, *B. constrictus* and *Microcerotermes crassus. Microcerotermes* and *Nasutitermes* are involved in the self-pruning of trees. The *Bulbitermes*, *Macrotermes* and *Odontotermes* are dominant in ground timber. The different species richness and uneven distribution of termites in different parts of the forest is attributed, not only to the differences in forest structure and flora, but also the degree to which the forest floor space has been depleted for visitor and horticultural activities.

Introduction

The Singapore Botanic Gardens (SBG) includes a 6.3-ha plot of forest, which according to Corlett (1992), no longer resembles primary rain forest in structure or flora. The insect fauna is similarly depleted as exemplified by the ants (Murphy, 1973). There are few publications on the vegetation in the early years although Corner (1935) did make an interesting study of higher fungi. Turner *et al.* (1996) surveyed the vegetation and compared it with historical records of herbarium collections made since 1893 and revealed that the forest has suffered a significant loss of species. They attributed this to the rampant growth of climbers, dense undergrowth of exotic and clonal herbs and a loss of animal disposal agents, which have led to a low density of saplings and seedlings and hence no recruitment of the high forest species. *Calophyllum ferrugineum* (Guttiferae) is an exception being numerically the dominant species making up 26.2% of the trees. The death of trees, caused either by lightning strike, disease or other factors, has given rise to a great variety of fallen and standing dead timber in all stages of decay. The aim of the survey of the termite fauna in this disturbed rain forest was to record termite species diversity and their distribution and also the roles the different species play in the decomposition of the dead timber, as well as the effects the different vegetation life forms have on termite distribution.

Methods of Study

Sampling methods

A map of SBG rain forest by the Nature Conservation Branch was used for the selection of sampling points. The map has grid lines spaced 40 m apart, which give rise to 45 points evenly spaced over the entire area. Using a random table (Snedicor & Cochran, 1969), one third of these intersection points, i.e. 15, were picked as the sample points for the termite survey. These sample points, i.e. points 5, 6, 8, 15, 16, 17, 20, 24, 28, 31, 34, 40, 41, 42, 45, were located and pegged on site (Fig.1). Around each point, a sample plot of radius 10 m was cordoned off for the survey. The 15 sample plots covered a total area of 7.5% of the 6.3-ha rain forest. The sampling of termites and the quantitative assessment of the vegetation and wood litter were conducted once to three times a week from end May to end August 1998.

Termite Collection and Identification

Within each sample plot, the following microhabitats were searched: ground nests, inside of dead logs, fallen branches, leaf litter under rotten logs and galleries on logs and tree trunks up to a height of 2 m above ground level. Termites in soil, high canopy, tree stumps and fallen macro-timber equal or greater than 30 cm diameter were not surveyed. From each infested microhabitat, one series of termites comprising soldiers and workers was collected for each species found. The soldiers were identified to species level as far as possible using taxonomic keys (Thapa, 1977; Tho, 1992; Holmgren, 1913). The location of each infested microhabitat was mapped.

Quantitative assessment of vegetation and wood litter

Each sample plot was divided into quarters and a systematic count of vegetation categorised into trees, shrubs, herbs and climbers was made. To correctly categorise the plants, especially the seedlings, to their life forms, the identity of the plants was confirmed with assistance of SBG Herbarium

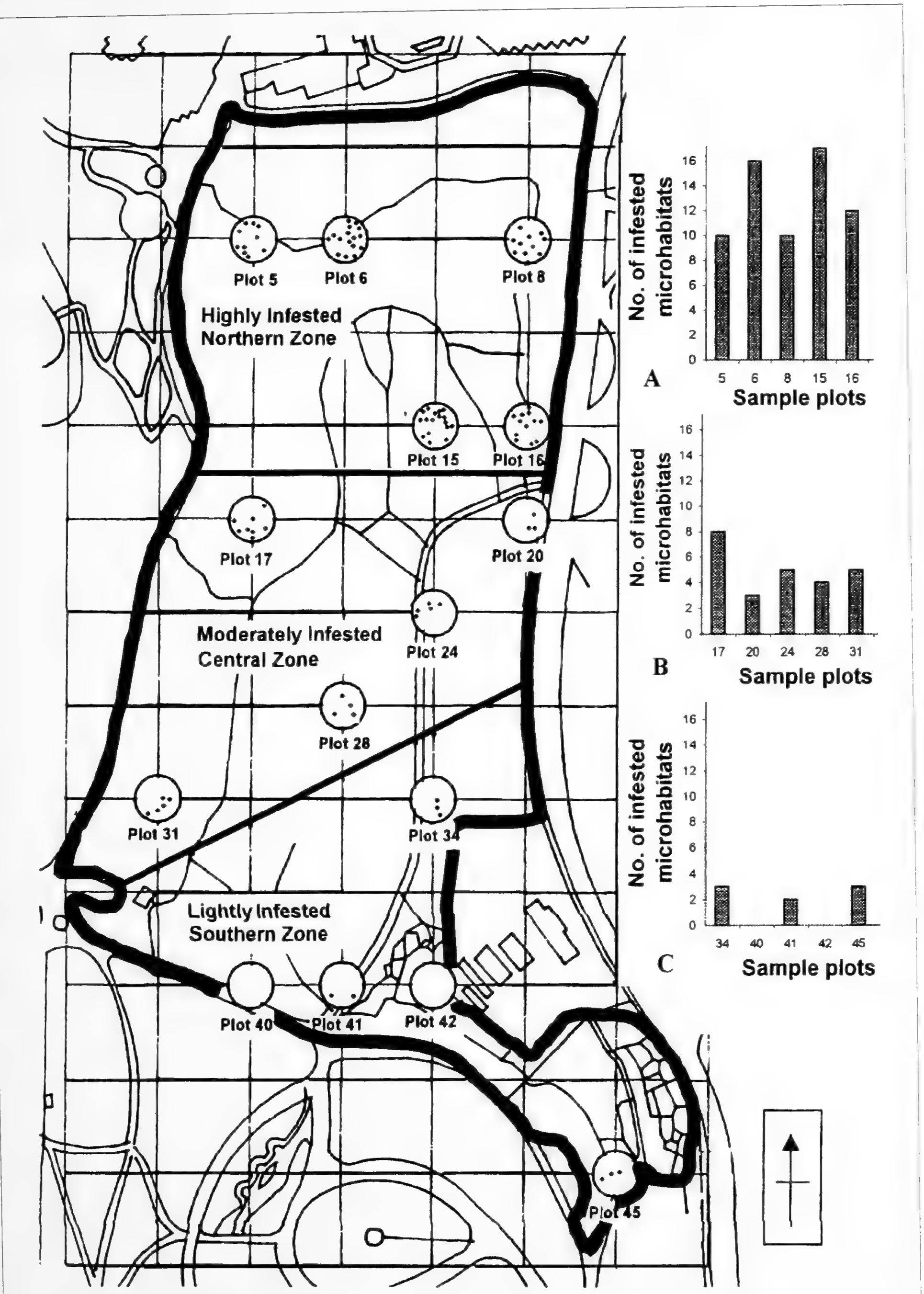

Figure 1. The three zones of SBG Rain Forest with different termite infestation levels. The locations of the termite infested microhabitats within the sample plots are marked by black dots, while their abundance is depicted by the histograms for A. northern zone, B. central zone and C. southern zone.

staff and checked to be consistent with previous studies (Turner *et al.*, 1996). The trees were further categorised into big trees (=>0.1 m dbh), the remainder into smaller trees and seedlings (below 1.5 m tall). Because the shrubs were very low in number, they were grouped into the same category as herbs during data analysis. Palm trees were assessed as a separate category as they were mostly in seedling stages and the mature ones, if present, were in very small numbers. The abundance of the wood litter on the forest floor was assessed by counting the number of logs and fallen branches above 1.5 cm in diameter.

Results

Distribution and infestation level of termites

For each sample plot, the locations of individual termite-infested microhabitats (e.g. a nest, a log or a living tree, etc.) were mapped and their abundance was depicted (Fig. 1). Termites were found in 98 microhabitats in only 13 of the 15 sample plots. Of these infested microhabitats, 65 (i.e.66.5%) were in the northern part of the rain forest, 25 (i.e.25.5%) in the central part and 8 (i.e.8.2%) in the southern part. Using F Test followed by LSD tests (Snedicor & Cochran, 1969), the number of termite infested microhabitats in the northern zone was found to be significantly higher than that in the southern zone ($P=0.01$) and in the central zone ($P=0.05$). Based on the abundance of the infested microhabitats, which reflects the infestation level of the termites, the SBG Rain Forest can therefore be divided into three zones: a) the highly infested northern zone, b) the moderately infested central zone and c) the lightly infested southern zone (Fig. 1).

The influence of vegetation and wood litter on termite infestation

The abundance of termite-infested microhabitats, the different types of vegetation and logs/branches in the sample plots are depicted in Fig. 2A-G. The abundance of termite-infested microhabitats (Fig. 2A) follows almost the same trend as the abundance of the wood litter (Fig. 2B), big trees => 0.1 m dbh (Fig. 2C) and dead standing trees (Fig. 2D), that is, high in the northern zone, moderate in the central zone, and low or absent in the south. On the other hand, a comparison of Fig. 2A and Fig. 2E shows that the abundance of termite-infested microhabitats was in contrast to the abundance of herbs and shrubs in the sample plots. Fig. 2F and 2G show that the abundance of palm trees and climbers in the sample plots do not have any influence on the abundance of the termite-infested microhabitats.

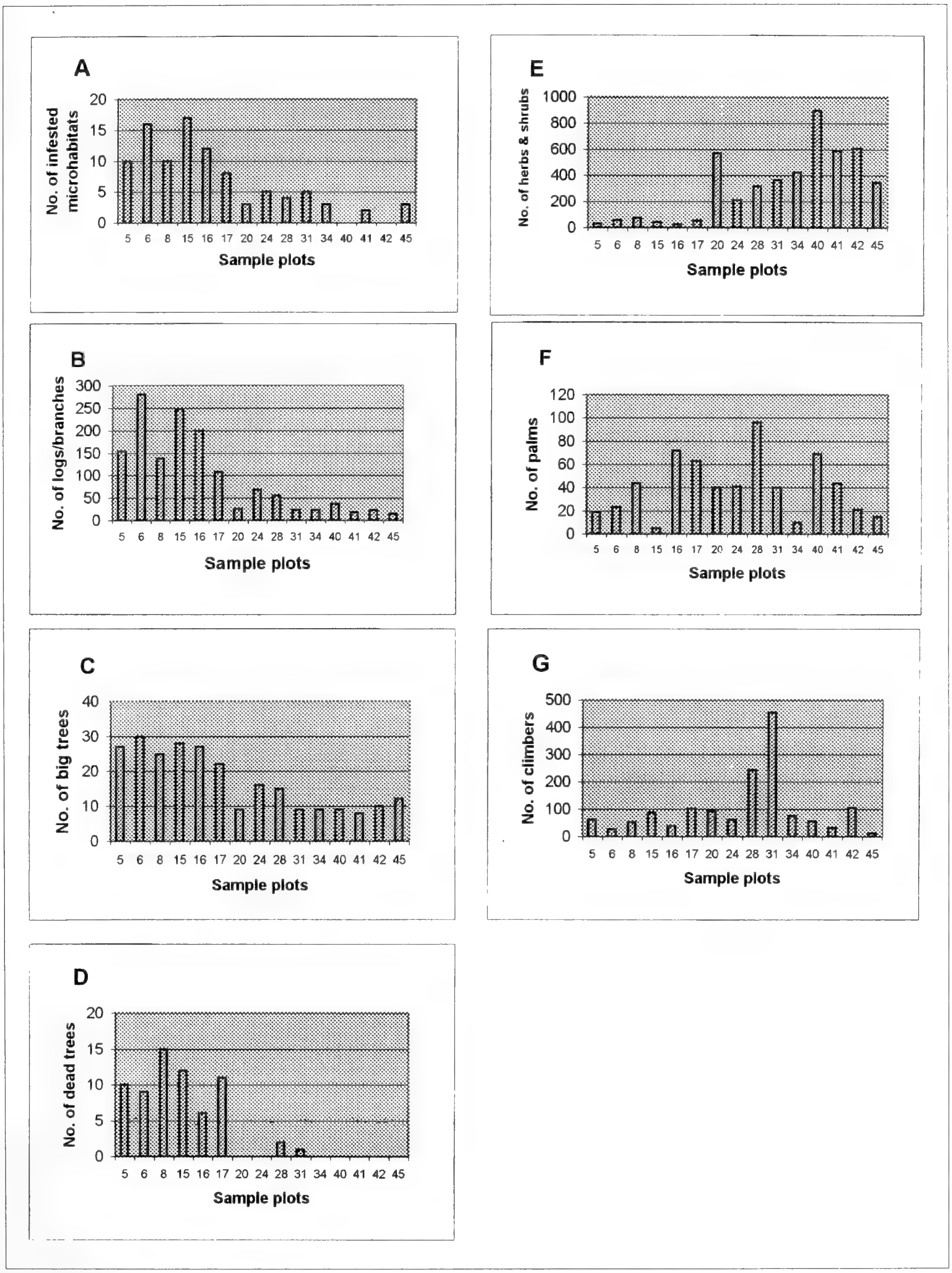

Figure 2. Characteristics of the sample plots
A. No. of infested microhabitats; B. No. of logs and fallen branches; C. No. of mature trees (=> 0.1 m dbh); D. No. of dead trees; E. No. of herbs and shrubs; F. No. of palm trees; G. No. of climbers.

The number of logs and fallen branches and the various vegetation life forms were plotted against the corresponding number of termite-infested microhabitats (Fig. 3A-F). As expected, the figures indicate that the abundance of termite-infested sites has a positive relationship with the abundance of wood litter (Fig. 3A), big trees (Fig. 3B) and dead trees (Fig. 3C), and a negative relationship with the abundance of herbs and shrubs (Fig. 3D). There is no relationship with the presence of palms and climbers (Fig. 3E and 3F).

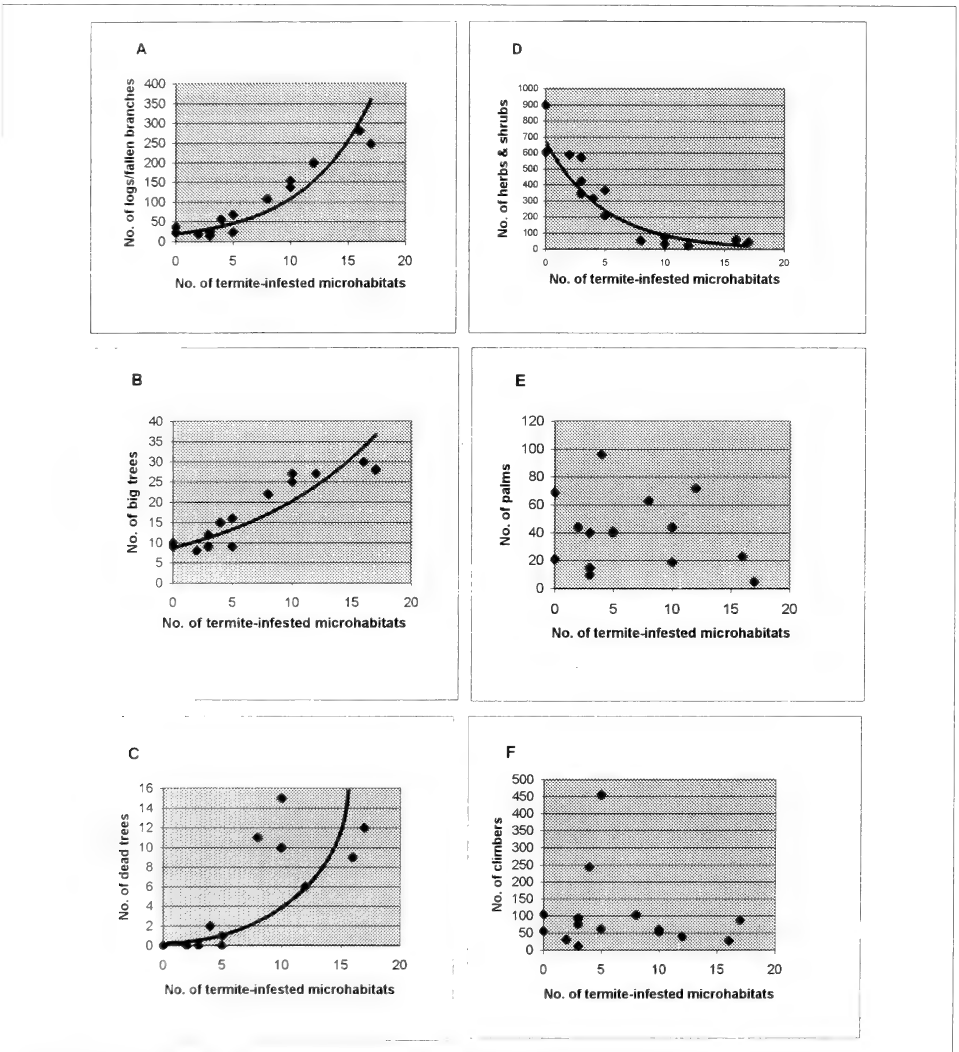

Figure 3. The relationship between the abundance of termite-infested microhabitats and the various types of vegetation and wood litter.
A. Logs and fallen branches; B. Big trees =>0.1 m dbh; C. Dead trees; D. Herbs and shrubs; E. Palms; F. Climbers.

The termite fauna

a) *Species diversity*

A total of 102 series of termites were collected from the 98 microhabitats (4 of the microhabitats had series of two co-existing termite species). These termites were identified to 22 species. The species diversity of the northern part of the forest was distinctly different from those of the other two parts. The northern zone had 20 of the 22 species, the central zone 10 species, and the southern zone only 6 species. All but 2 species in the central and southern zones were found in the northern zone.

b) *The habitats, feeding and nesting behaviour*

Table 1 indicates the occurrence of the 22 species of termites, which are described below:

i) *The wood-feeding cum gallery-forming termites*

As shown in Table 1, *Bulbitermes* was the commonest and most widespread genus, which made up 29.4% of the 102 series collected and occurred in 69.2% of the 13 infested plots. It was represented by three species: *B. borneensis*, *B. constrictus* and *B. kraepelini*. The latter was rare, being collected only once. *B. constrictus* was slightly more widespread than *B. borneensis*. The *Bulbitermes* consumed mainly the sapwood and sometimes the heartwood of dead fallen branches. They frequently formed brown, crumbly galleries on the branches and logs where they were found.

Two other genera that form galleries are the *Nasutitermes*, which are closely related to *Bulbitermes*, and *Microcerotermes*. The latter made up 15.7% and *Nasutitermes* 10.8% of the series collected. Although *Microcerotermes* was second in frequency of collection to *Bulbitermes,* it was comparatively very localized in its occurrence, as reflected by the lower percent incidence of 46.2%. Likewise, *Nasutitermes* was also very localized in its occurrence, being found in only 38.5% of the plots studied.

Of the two *Nasutitermes* species present, *N. matangensiformis* was rare being only collected once. *N. havilandi* formed galleries on both dead and live trees and was confined mainly to the northern zone. It was highly concentrated south of sample plots 5 and 6. The *Nasutitermes* fed on the dead branches of both live and dead trees. On dead fallen timber, they consumed both the sapwood and heartwood, often after these had been invaded and deserted by other species such as the *Macrotermes*. They were found mainly inside small stems or branches as small as 1.5 cm diameter.

Microcerotermes was represented by three species: *M. serrula*, *M. havilandi* and *M. crassus*. *M. serrula* was found once, in a nest at the base of a live tree. *M. havilandi* formed galleries at two plots. *M. crassus*, the most common species, was collected from many different infested microhabitats including seven around a ground nest in plot 15. It formed characteristic small and hard galleries on both live and dead trees as well as fallen branches. It attacked the sapwood of dead branches as small as 1.5 cm diameter.

Table 1. Termite species collected from the Singapore Botanic Gardens Rain Forest

Species	No. of series collected	% of series collected	No. of plots with termites	% of plots with termites	Sample plots where termites are found
Bulbitermes	30	29.4	9	69.2	
borneensis					5,6,8,15,28,31
constrictus					5,6,8,15,16,17,24,28,45
kraepelini					16
Microcerotermes	16	15.7	6	46.2	
havilandi					6,8
crassus					15,41,45
serrula					6
Nasutitermes	11	10.8	5	38.5	
havilandi					5,6,8,16,34
matangensiformis					8
Macrotermes	13	12.7	8	61.5	
gilvus					6,15,20
malaccensis					8,15,16,17,31,34
Odontotermes	12	11.8	7	53.8	
denticulates					5,15
oblongatus					5,6,15,17,20,24,28,45
Termes	8	7.8	5	38.5	
comis					6,16
rostratus					6,8,15,31
Dicuspiditermes	2	2.0	2	15.4	
nemorosus					5,28
Hospitalitermes	2	2.0	2	15.4	
umbrinus					5,41
Microtermes	2	2.0	2	15.4	
pallidus					24
Schedorhinotermes	2	2.0	2	15.4	
medio-obscurus					5,17
Coptotermes	1	1.0	1	7.7	
travians					20
Procapritermes	1	1.0	1	7.7	
augustignathus					6
Prohamitermes	1	1.0	1	7.7	
mirabilis					6
Subulitermes	1	1.0	1	7.7	
unidentified sp.					15
Total	102	100	13		

ii) *The wood-feeding cum leaf-litter feeding termites*

The two common and widespread genera found belong to *Macrotermes* and *Odontotermes* (Macrotermitinae). These are capable of growing fungi in their underground nests (Collins *et al.* 1983; Collins, 1981). Typical signs of their presence are the clayey soil refill inside the burrowed dead branches or stems. They were found inside branches or in the soil among leaf litter just beneath the branches. It was observed that both genera burrowed into the sapwood and sometimes heartwood under the bark of branches greater than 4 cm diameter.

Of the two *Macrotermes* species, *M. malaccensis* and *M. gilvus*, *M. malaccensis* was more widespread (Table 1). A nest of *M. gilvus* contained fungus gardens. Of the two *Odontotermes, O. denticulatus* was collected from only two northern plots, and *O. oblongatus* was present in eight plots all over the rain forest.

Microtermes was the other Macrotermitine found, with only two collections of *M. pallidus* from one plot.

iii) *The ground-nesting termites*

Species of *Termes* were most prevalent with eight series collected from five plots. Two series of *T. comis* were found but no nest could be located. On the other hand, *T. rostratus* was found inside two hard ground nests and in another nest freshly made with black soil refills inside a piece of rotted log. The nests were fairly easily broken into soil crumbs.

The three other species, *Dicuspiditermes nemorosus*, *Hospitalitermes umbrinus* and *Prohamitermes mirabilis,* formed prominent ground nests. Their percent incidence was comparatively low, especially for *P. mirabilis*. *Dicuspiditermes* made raised, ball-like nests. Two *Hospitalitermes* nests were found, one being free-standing while the other leaned against the base of a large tree.

iv) *Other soil and wood-feeding termites*

The other species made up only 1-2% of the series collected and included *Coptotermes travians* and *Schedorhinotermes medio-obscurus* of the Rhinotermitidae, an unidentified species of the *Subulitermes* complex and *Procapritermes augustignathus* of Termitidae.

Discussion

The distribution and infestation levels of termites in the SBG Rain Forest, as in other ecosystems, are dependent on the availability of their food sources. These include the wood and leaf litter on the forest floor, the standing dead trees and the dead branches of live trees. The northern part of the forest has a higher population of live trees than the central and southern parts and larger amounts of ground and standing dead timber as evidenced by our quantitative assessments. Having greater amounts of food for termites explains why the northern part of the rain forest is significantly more heavily infested than the central and southern parts.

In the central and southern parts, where herbaceous undergrowth thrives, there is a lower density of trees and saplings. The abundance of herbaceous plants, which are often accompanied by the presence of ants, has a negative relationship with the presence of termites. Ants have often been considered as enemies of termites (Eisner *et al.*, 1976) and strong negative associations between ants and termites had been attributed to competition between the two groups (Fowler *et al.*, 1980).

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Cluny Road, Singapore 259569

Abstract

Unique elements of the flora of the Batu Tengar Cave include *Begonia keithii* (Begoniaceae), a new species endemic to this hill, and the phytogeographic affinities of its flora, which are not only with the nearby Madai limestone hills, but also with limestone in Kalimantan (Borneo) and the Philippines. Notes on species of special interest, *Euphorbia lacei* (Euphorbiaceae), *Impatiens winkleri* (Balsaminaceae) and *Paraboea madaiensis* (Gesneriaceae) are given.

Introduction

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The earliest botanical collections from this locality (called 'Segarong' on herbarium labels) date from 1938 when Symington with Agama and then Keith collected a handful of plants. These few collections are, however, extremely interesting as they included the first collection of a balsam from limestone in Sabah, the succulent *Euphorbia lacei* (Euphorbiaceae) and a begonia with decorative leaves. In May 1997, as part of the botanical survey for 'The Biodiversity and Conservation of the Limestone Flora of Sabah Project', this hill was revisited to relocate these species and to make a general collection of fertile material (Kiew, in press).

The hill is now a 25-minute journey from Semporna by speedboat to the jetty built by the birdnest concessionaire on the Segarong River. It is then a short walk through cultivated land to the hill base that is surrounded by a narrow strip of forest. The summit of the hill (about 200 m a.s.l.) closest to the river shows signs of burning being bare of vegetation apart from dead tree trunks that are still standing (Fig. 1). However, the way to the cave on a well-beaten track is through primary forest that provides the damp shaded conditions that support lush vegetation. Once the cliff base is reached, the path ascends a narrow gully, where on the large scattered limestone boulders, *Impatiens winkleri* (Balsaminaceae) and *Epithema* *dolichopodum* Hillier & Burtt (Gesneriaceae) are encountered in abundance.

As the path ascends, it becomes steeper and the canopy is more open and here *Begonia keithii* (the new species described below) is first encountered. Higher up on the exposed shoulders of the summit it is abundant. It is an extremely decorative species with glossy cardinal red stems that look lacquered, narrowly scolloped leaves and bright red male flower buds.

The summit vegetation is remarkable being completely dominated by a cactus-like forest of *Euphorbia lacei* with a candelabrum-like crown (Fig. 2). This is unique to Batu Tengar Cave as no other limestone hill in Sabah has this type of forest on the summit. On the sheer cliffs, *Paraboea madaiensis* (Gesneriaceae) is abundant.

Phytogeographic Affinities of the Flora

Apart from the begonia, which is endemic to Batu Tengar Cave itself, two species (*Epithema dolichopodum* and *Paraboea madaiensis*) are endemic to Sabah, while *Impatiens winkleri* and *Euphorbia lacei*, while not endemic, are rare in Sabah being known from a few other localities.

Impatiens winkleri was first described from south Kalimantan and in Sabah is known from just four other limestone localities all in the south east (Fig. 3). Discounting common species that are everywhere widespread, it is the only rare species from Sabah limestone that is known to occur in both Sabah and Kalimantan.

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Three of these species are also known from Gunung Madai. *Paraboea madaiensis* is only known from Gunung Madai and Batu Tengar Cave, *Impatiens winkleri* is known also from Baturong, Batu Belas and Tempadong, while *Epithema dolichopodum* is known from six other localities, which are all located in the southeast, Batu Tengar Cave, Baturong, G. Madai and Tempadong (Fig. 3), except for one population on limestone on Pulau Balambangan and one collected by Elmer (*Elmer 20569*) from Tawau but without a specific locality.

ii) *The wood-feeding cum leaf-litter feeding termites*

The two common and widespread genera found belong to *Macrotermes* and *Odontotermes* (Macrotermitinae). These are capable of growing fungi in their underground nests (Collins *et al.* 1983; Collins, 1981). Typical signs of their presence are the clayey soil refill inside the burrowed dead branches or stems. They were found inside branches or in the soil among leaf litter just beneath the branches. It was observed that both genera burrowed into the sapwood and sometimes heartwood under the bark of branches greater than 4 cm diameter.

Of the two *Macrotermes* species, *M. malaccensis* and *M. gilvus*, *M. malaccensis* was more widespread (Table 1). A nest of *M. gilvus* contained fungus gardens. Of the two *Odontotermes, O. denticulatus* was collected from only two northern plots, and *O. oblongatus* was present in eight plots all over the rain forest.

Microtermes was the other Macrotermitine found, with only two collections of *M. pallidus* from one plot.

iii) *The ground-nesting termites*

Species of *Termes* were most prevalent with eight series collected from five plots. Two series of *T. comis* were found but no nest could be located. On the other hand, *T. rostratus* was found inside two hard ground nests and in another nest freshly made with black soil refills inside a piece of rotted log. The nests were fairly easily broken into soil crumbs.

The three other species, *Dicuspiditermes nemorosus*, *Hospitalitermes umbrinus* and *Prohamitermes mirabilis,* formed prominent ground nests. Their percent incidence was comparatively low, especially for *P. mirabilis*. *Dicuspiditermes* made raised, ball-like nests. Two *Hospitalitermes* nests were found, one being free-standing while the other leaned against the base of a large tree.

iv) *Other soil and wood-feeding termites*

The other species made up only 1-2% of the series collected and included *Coptotermes travians* and *Schedorhinotermes medio-obscurus* of the Rhinotermitidae, an unidentified species of the *Subulitermes* complex and *Procapritermes augustignathus* of Termitidae.

Discussion

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Figure 1. Batu Tengar Cave, Segarong Protected Forest Reserve. (Burnt summit visible to right)

Figure 2. *Euphorbia lacei* Craib on the summit of Batu Tengar Cave.

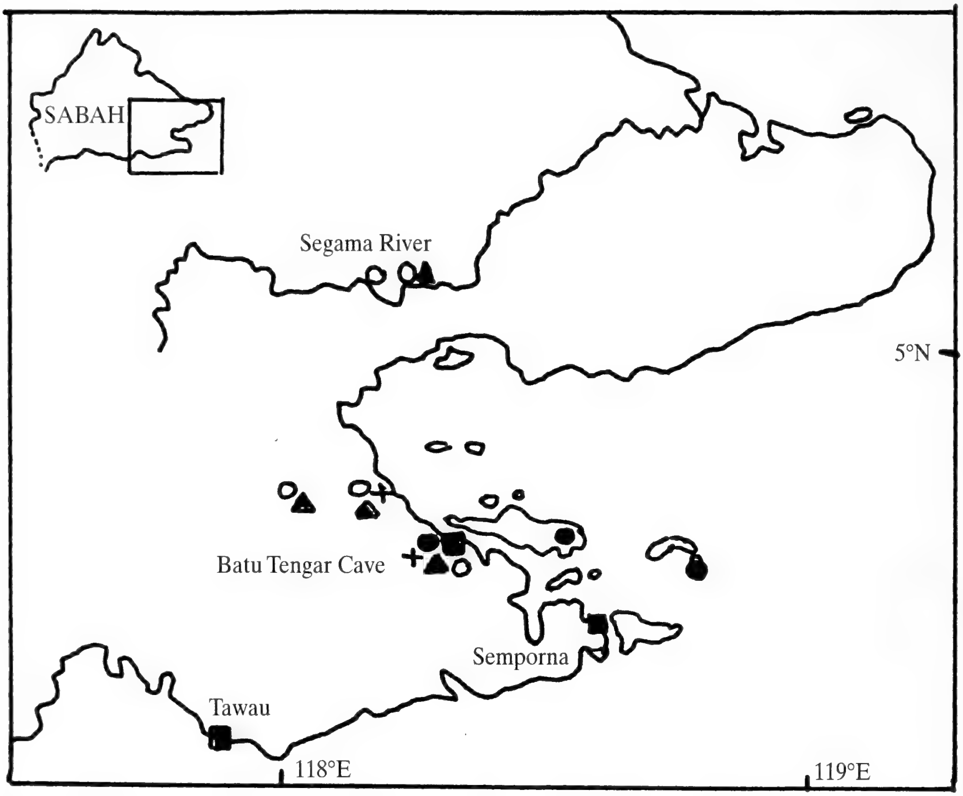

Figure 3. Distribution in Sabah of rare species from Batu Tengar Cave.
(■ localities; ● *Euphorbia lacei*; **o** *Impatiens winkleri* (also from Kalimantan limestone), **+** *Paraboea madaiensis*; ▲ *Epithema dolichopodum* (endemic to Sabah, also from Pulau Balambangan and Tawau).

Conservation Status of Batu Tengar Cave

Recently, the hill was proposed as a commercial source of limestone (Robert C. Ong, *pers. comm.*). In view of its endemic begonia species, the four rare species (Fig. 3), two of which are endemic to Sabah, and the remarkable 'cactus forest' of *Euphorbia lacei*, the like of which is not known from any other limestone hill, and the possibility of other new and endemic species becoming known as research on the collections from the hill continues (e.g. the *Cyrtandra RK4319* (Gesneriaceae) is possibly a new species), Batu Tengar Cave is one of the eight most important limestone sites (Kiew, in press) from the point of view of the conservation of plant biodiversity and it is recommended for permanent legal protection. Protection of the vegetation will also help to maintain conditions suitable for the cave swiftlets to nest which, if harvested sustainably, are a renewable economic resource for local people.

Notes on Species of Special Interest

1. *Begonia keithii* Kiew **sp. nov.** (Begoniaceae)

Typus: *R. Kiew, S. Anthony & S.P. Lim RK4327* Batu Tengar Cave, Semporna F.R., Sabah (holo SING, iso K, KEP, L, SAN, SAR).

Figure 4.

A Begonia amphioxus foliis non peltatis tepalis feminibus 5 liberi et ovari triloculari differt.

Erect bushy, cane-like, monoecious, glabrous begonia forming clumps, producing short slender branches along the length of the stem. *Stems* woody, up to 1.5 m tall and c. 1 cm thick at base, shiny, deep crimson becoming brown at base, older nodes swollen with a conspicuous leaf scar. Stipules pale green suffused red, broadly elliptic, 10–18 by 8–9 mm, margin entire, apex setose, early caducous. *Leaves* alternate. Petiole slender, crimson, 3–7(–15) mm long. Lamina mid- to dark green above, sometimes mottled silver-grey, usually green beneath but sometimes suffused crimson, margin crimson, succulent and brittle, markedly unequal sided with the narrow side scarcely developed, narrowly lanceolate, 7.5 by 2.5 cm to 10 by 1.5 cm, attenuating to acute apex, main vein of base sometimes almost in line with the midrib but frequently at a 135° angle to midrib, base very variable in shape ranging from attenuated to acute point (matching the apex) and up to 6 cm long or bluntly rounded to truncate and 1.25–2.5 cm long or base scarcely developed and 0.75 cm long, margin scolloped becoming distantly serrate towards apex and base, main vein reaching to apex with a pair running almost parallel, the other lateral veins radiating into the basal lobe. Leaves decreasing markedly in size towards the stem apex. *Female flowers* solitary from lower axils, up to 3 produced before the male inflorescences develop. Pedicel pale reddish, 10–12 mm long; bracteoles absent; ovary pale greenish with wings suffused red towards margin, 3-loculate, ovoid 9–17 mm long and 7–8 mm wide narrowing to 1.5 mm below style, wings 3, equal, placentas axile, bilamellate with many ovules on both surfaces; tepals 5, free, whitish suffused reddish; glabrous, oval, 7–8 mm long, margin entire, apex rounded, outer tepals 5–6 mm wide, inner 2.5–3.5 mm wide, style and stigma pale yellow green, styles 3, 1–2.5 mm long, branching from base, spreading and bifid with a continuous twisted papillate stigmatic band. *Male flowers* produced on erect, many-flowered, twice-branched cymose inflorescences from the upper axils, 4.25–9.5 cm long; bracts not persisting; peduncle carmen, 2–4.25 cm long, branches thread-like and slightly zigzag; bracteoles reddish, lanceolate

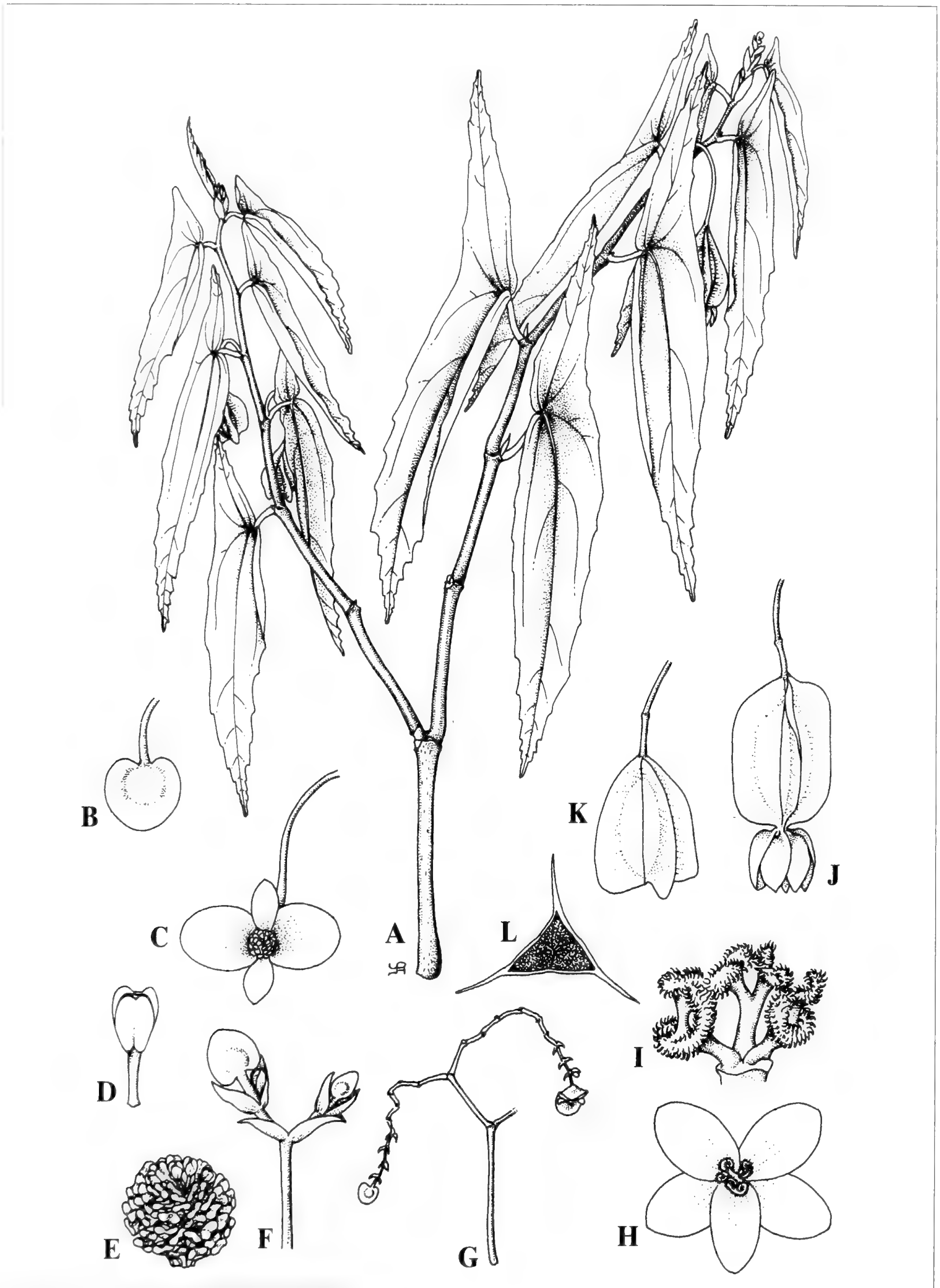

Figure 4. *Begonia keithii* Kiew.
A Habit (x 0.4), B Male flower bud (x 1.2), C Male flower (x 1.2), D. Stamen (x 8), E Androecium (x 4), F Terminal flowers of male inflorescence (x 0.8), G Male inflorescence (x 0.4), H Female flower (front view) (x 1.2), I Styles (x 4), J Female flower, side view (x 0.8), K Capsule (x 0.8), L T.S. capsule (x 1.6).

1–3 mm long, apex acuminate, soon falling; male buds small, c. 4 mm long and carmen outside; pedicels carmen, slender, 1–5 mm long; male flowers with 4 glabrous tepals, outer two with inner surface scintillating white with carmen showing through, almost rotund, 5–7 by 4–7 mm, inner two completely white, narrowly lanceolate, 2–5 by 1–2 mm, apex rounded, margin entire; stamens c. 55–65, pale yellow green (matching exactly the colour of stigmas), forming a spherical cluster on columnar torus 1.5–1.7 mm long, filament c. 0.5 mm long, anther obovoid, 0.5–0.7 by 0.5 mm, apex deeply emarginate. *Capsule* dangling on slender thread-like stalk 2–3 cm long, ovoid and narrowed to pedicel, 18–25 by 15–25 mm; locules 3, c. 14 mm long, not reaching to pedicel or apex; wings 3, isomorphic, broader distally and 8–12 mm wide, wing tip slightly rounded or sometimes acute, becoming dry and papery and dehiscing along the junction with locule, styles caducous. *Seeds* broadly ovoid, c. 0.35 by 0.2 mm, testa strongly reticulate.

Distribution: Endemic to Batu Tengar Cave (Segarong Cave), Semporna Protected Forest Reserve, Sabah, Borneo.

Habitat: In light shade to full sun, growing in rock crevices on the tower karst limestone hill, dominating the exposed shoulders of hill where it forms thickets with its woody cane-like stems.

Specimens examined: *Symington & Agama 9315* 20 July 1938 (K, SING), *Keith* A*9416* 26 Aug 1938 (K, SING), *Kiew et al. RK4327* 9 May 1997 (K, KEP, L, SAN, SAR, SING).

Notes: A most decorative begonia, it has polished crimson stems that appear lacquered, dainty scolloped leaves with a crimson margin and the many tiny, carmen, heart-shaped buds of the male flowers set on slender sprays.

It has yet to be found on other limestone hills in Sabah or elsewhere. In possessing an erect, bushy habit, female flowers with 5 petals, 3 bifid styles and a 3-loculate fruit with 3 equal wings, it conforms to Section Petermannia, except that its male flowers have 4 tepals. (Section Petermannia is characterised by 2 tepals).

In its cane-like habit, narrow leaves with the pointed apices and serrate margin, solitary female flowers, male flower with 4 tepals, it most resembles *B. amphioxus* Sands. Sands (1990) had already noted this similarity remarking that the two species 'may be at least very closely allied'. The two species are, however, readily distinguished by the suite of characters listed in Table 1.

This begonia is named for H.G. Keith, in 1925 Assistant Conservator of Forests in the then British North Borneo, rising in 1931 to Conservator.

He survived internment during the war returning to Sandakan in 1946. It was he who in 1938 collected from Batu Tengar Cave this begonia, the first collection of a balsam from Sabah limestone and the *Euphorbia*.

Table 1. Characters that distinguish *Begonia keithii* from *B. amphioxus*.

Character	*keithii*	*amphioxus*
Max. stem length (cm)	150	75
Stem colour	glossy crimson	green
Petiole length (mm)	3–7(–15)	(10–)15–55(–60)
Petiole colour	crimson	light green
Leaf	not peltate	peltate
Leaf pattern	unpatterned or grey mottled	red spotted
Tepals female flower	5, free	3–4(–5), joined
No. styles	3	2(–3)
No. locules	3	2
Capsule shape	ovoid	columnar
Capsule size (mm)	(18–)20–25 x 15–25	(9–)10–13 x (5–)6–7
Length capsule stalk (mm)	20–30	2(–2.2)
Wings	3, equal	2(–3), third shorter
Length male inflorescence (cm)	4.25–9.5	up to 3
Colour of male buds	carmen	white

2. *Euphorbia lacei* Craib (Euphorbiaceae)

Shaw (1975) listed this *Euphorbia* as one of the seven species of Bornean Euphorbiaceae that are confined to limestone. He also expressed uncertainly as to its identity recording it as *E.* sp. cf. *lacei.* Now that more specimens are available and field observations could be made, its identity is confirmed as typical *E. lacei*, which differs from the other Malesian limestone succulent *Euphorbia, E. antiquorum* L. in its longer spines, more distant spine shields with deep sinuses between them.

Euphorbia lacei is indeed a remarkable plant, which on the summit of Batu Tengar forms a "cactus" forest, unique for limestone in Malaysia. It grows to 4–5 m tall with a stem diameter of 4.5–5 cm, the lower trunk is bare but the upper branches curve outward giving the plant a candelabrum-like appearance (Fig. 2).

However, in Sabah it is not confined to limestone. One of the localities quoted by Shaw is Mt Sidungol (correctly spelt Sirongol), which is one of the rocky peaks of Timbun Mata Island, which is of volcanic conglomerate. Staff of the Forest Department in Semporna have also collected it from the summit of Bohey Dulang Island (also of volcanic conglomerate) and are successfully growing it as a pot plant at their office.

In Borneo, *E. lacei* is presently known only from these three dry rocky summits close to the coast near Semporna (Fig. 3). Outside Malaysia it is widespread. It is recorded from Myanmar and Laos, from limestone in southern Thailand and also from the Philippines. Merrill (1923) recorded it (under the name *E. trigona* Roxb.) from Luzon, Mindoro and Palawan describing its habitat as 'in thickets and on limestone cliffs, usually along the seashore ascending to 300 m'. The local names that Merrill cites (*suda-suda* and *tuba*) are the same as Keith recorded in the Kedayan language – *tuba suduh* (*Keith 9415*). *E. antiquorum* in Peninsular Malaysia is also called *sudu-sudu* in Malay on account of its leaves that are spoon-shaped. The name *tuba* suggests that this species may be used as fish poison.

Specimens examined: Semporna District: Batu Tengar Cave *Keith A9415* 26 Aug 1938 (K), *Kiew et al. s.n.* 9 May 1997 (SING). Mount Sidungol *Keith A9337* 18 July 1938 (K, KEP).

3. *Impatiens winkleri* Hook *f.* (Balsaminaceae)

Impatiens winkleri was first collected from Sabah by Keith in 1938 from Segarong F.R. Our survey confirms that it grows on limestone on Batu Tengar Cave and also that it is more widespread growing on several limestone hills in S.E. Sabah, namely Bukit Baturong, Gunung Madai, Batu Belas and Tempadong (Fig. 3). It was originally collected from south Kalimantan by Hubert Winkler from Batu Babi but he did not record whether from limestone. More recently it was recollected from south Kalimantan from limestone on Gunung Serempaka. It therefore appears to be confined to limestone. It has not been collected from Sarawak.

Its habitat is typical of limestone balsams (Kiew, 1991) in that it grows only on limestone boulders and ledges close to the cliff base in particularly damp and deeply shaded conditions. Where conditions are suitable, e.g. in narrow gullies, it forms thickets. As forest surrounding the base of the limestone hills is cleared for agriculture, this habitat is particularly vulnerable to exposure to light and drying out, which will endanger the continued existence of this species. Already the undergrowth around the base of the hills at G. Madai and Batu Tengar Cave is disturbed by birdnest collecting activities.

Impatiens winkleri is a giant balsam up to 2 m tall. The fleshy dark green trunk ranges from 4.5 to 6 cm in diameter at the base and bifurcates or trifurcates at about 1.5 m to product a spreading crown of succulent branches. As the branches grow, they bend under their weight and many erect branches are then produced from the upper side of this horizontal branch (Rauf's tree architecture model). The thick fleshy branches are brittle and frequently break off to be replaced by many, more slender stems.

This life form is not shown on herbarium specimens as only the terminal portion of the branch with its bunch of leaves and flowers fits onto the sheet, misleadingly giving the impression it is a small herbaceous species. Indeed, Hooker (1910) described the stature as 'humilis', i.e. low growing, and the stem as at least 1 m tall and 2–3 cm thick. Shimizu (1970) identified specimens as *I. scortechinii* Hook. *f.*, a herbaceous species from Peninsular Malaysia that grows to about one meter tall.

Among all the limestone balsams in Malaysia, *I. winkleri* in its tall 'trunked' habit most resembles *I. mirabilis* Hook. *f.* from limestone in the extreme north of Peninsular Malaysia and S. Thailand. However, it differs from *I. mirabilis* as its trunk base is not swollen (*I. mirabilis* is called the 'gouty balsam' because of its swollen base). Its habit, broad leaves and white flowers make *I. winkleri* distinct from all other Bornean balsams.

Limestone balsams in Peninsular Malaysia, are very biodiverse with about ten species, of which six are endemic to Peninsular Malaysia, three are endemic to the region spanning northern Malaysia and peninsular Thailand, and one is shared with Sumatra. In Sarawak, there are at least four species (most still unnamed) collected from the Bau area and the Mulu National Park and at least three of these are endemic to Sarawak. However, in Sabah there is just *Impatiens winkleri,* which also occurs in S. Kalimantan. This mirrors a pattern seen in several other genera of herbs, e.g. *Chirita, Monophyllaea* and *Paraboea* in the Gesneriaceae, where biodiversity decreases from Peninsular Malaysia, to Sarawak, to Sabah where few or no species are found (Kiew, in press).

Specimens examined: Borneo: South Kalimantan – Batu Babi et Lumnovia *H. Winkler 2866* (type, drawing at K), G. Serempaka *J. Dransfield JD2318* (L); Sabah – Batu Tengar Cave *Keith A9329* 20 July 1938 (K), *R. Kiew et al. RK4327* (SAN, SING), Baturong *Lim S.P. et al. LSP713* 12 June 1996 (SAN, SING), R. Kiew *RK s.n.* 12 June 1996 (SING); G. Madai *Mansus et al. SAN 117117* (K, SAN), *Lim S.P. et al. LSP671* 9 June 1996 (SAN, SING), Batu Belas, Segama River *J.H. Beaman et al. 10131* 13 June 1984 (K), Tempadong, Segama River *J.H. Beaman et al. 10091* (K).

4. *Paraboea madaiensis* Xu & Burtt (Gesneriaceae)

Previously recorded only from Gunung Madai (Xu & Burtt, 1991), it is abundant on the exposed summit and cliffs of Batu Tengar Cave. Our local guides collected plants for medicine. However, since a sizeable population grows on inaccessible sheer cliffs, it is unlikely that harvesting this species for personal use will endanger the population.

Our informants (a local villager, a birdnest collector and a forest guard) used it in several remedies:

1. Used fresh, the leaves are put in hot water and the vapour is inhaled to reduce fever in adults,

The smoke from burning leaves is used to:

2. Quieten crying babies, and
3. In adults, to clear the eyes if they are cloudy.
4. The plant can be used after childbirth but our informants were unable to give precise information on how it is used.

Ackowledgements

The author is extremely grateful to the Ministry of Science, Technology and the Environment, Malaysia, for funding the collaborative project on 'The Biodiversity and Conservation of the Limestone Flora of Sabah' between Universiti Putra Malaysia and Forest Research Centre, Sabah Forest Department, under IRPA research grant 52858; to Wong Khoon Meng and Robert C. Ong for their strong support, to S. Anthonysamy, Lim S.P. and the staff at SAN for assistance in the field and herbarium, to Mdm P.H. Yap for the illustration of the begonia, to Pius Primus District Forest Officer, Semporna, who made available the speedboat and accommodation, and to the Curators of the herbaria at K, KEP, L and SAN for permission to examine specimens in their care.

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Gardens' Bulletin Singapore **50** *(1998) 197–219.*

New Species and Varieties of Moraceae from Malaysia

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Abstract

Three new species and one new variety of *Artocarpus* and fourteen new species of *Ficus* and seven new varieties are described. All the new species and varieties are from Sabah and Sarawak except *F. ngii,* which is from Peninsular Malaysia. The new species and varieties are *Artocarpus corneri, A. jarrettiae, A. primackii, A. anisophyllus* var. *sessilifolius, Ficus ashtonii, F. borneensis, F. chaii, F. chewii, F. corneri, F. dulitensis, F. gamostyla, F. ilias-paiei, F. kerangasensis, F. longistipulata, F. ngii, F. pseudotarennifolia, F. sabahana, F. soepadmoi, F. cereicarpa* var. *ashtonii, F. deltoidea* var. *recurvata,* var. *subhirsuta, F. obscura* var. *lanata, F. oleifolia* var. *calcicola,* and var. *impressicostata,* and *F. sundaica* var. *impressicostata.* Descriptions of the new taxa are provided.

Introduction

In her revision of the genus *Artocarpus* of the Malesian region, Jarrett (1959, 1960, 1975) recognised 19 species from Sabah and Sarawak. Corner (manuscript 1972) recorded 20 species. In his checklist of *Ficus* in Asia and Australasia and in additional publications, Corner (1965, 1970, 1972) recognised 128 species of *Ficus* for Sabah and Sarawak. Completion of the study of these two genera in Sabah and Sarawak has added three new species and one new variety of *Artocarpus* and thirteen new species and seven new varieties of *Ficus* making a total of 23 species of *Artocarpus* and 141 species of *Ficus* known in Sabah and Sarawak. Of the newly described species of *Artocarpus*, one is recorded only from Sarawak. Similarly of the thirteen new species of *Ficus*, four are found only in Sabah, seven only in Sarawak, and two in Sabah and Sarawak.

Description of New Taxa

1. *Artocarpus corneri* Kochummen **sp. nov.**
(E.J.H. Corner, 1906–1996, prominent Professor of Tropical Botany, University of Cambridge, UK, who undertook extensive studies of the Malesian Moraceae)

Artocarpo lanceifolio simillimus, sed in foliis in sicco badiis supra scabridis, marginibus integris, syncarpiis cylindricis differt. ***Typus*** *: Dayang Awa &*

Yii P.C. S 46878, Borneo, Sarawak, Dulit Range, Belaga (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Tree to 22 m tall, 50 cm diameter. *Twigs* 7–9 mm thick, dark brown, closely ridged, very sparsely short-hairy, with distinct ring-like stipular scars. *Stipules* lanceolate, to 3 cm long, densely covered with long hairs. *Leaves* obovate or oblong, (12–)17–28 x (5.5–)7–12 cm, base cuneate, margin faintly wavy, apex acuminate or acute; both surfaces glabrous to the naked eye but with short rough hairs on the midrib and lateral veins, drying reddish brown to chocolate brown, upper surface sandpapery to touch; midrib raised above; lateral veins 12–15 pairs, raised below, faint above; intercostal veins scalariform, faintly visible below, invisible above; petioles 3–5 cm long, with short sparse hairs. *Inflorescences* axillary, solitary. Male not seen. *Syncarp* (immature) green when fresh, cylindric, 5–7 x 3.5–4 cm; tepal densely hairy, style distinctly bifid; peduncles 5.5–8 cm long.

Vernacular name: Sarawak: *talun* (Murut).

Distribution: Endemic to Borneo, rare, known only from Sarawak.

Ecology: Submontane forest between 820–1000 m altitude.

Notes: Closely related to *A. lanceifolius* in section *Duricarpus* of subgenus *Artocarpus* but differing in the reddish brown dry leaves with scabrid upper surface, entire leaf margins and in the cylindric syncarps.

Specimens Examined: BORNEO. SARAWAK: Lawas, Maligan Range, *Ilias Paie S 32879* (BO, CGE, K, KEP!, L, SAR!); Belaga, Dulit Range, Ulu Sg. Kayan, *Dayang. Awa & Yii P.C. S 46878* (CGE, K, KEP!, L, SAN!, SAR!).

2. *Artocarpus jarrettiae* Kochummen **sp. nov.**
(J. Francis Jarrett who revised the genus *Artocarpus* for the Malesian region)

Prope Artocarpum rigidum, in syncarpio cylindrico, perianthio pilis longis glandulosis basi inflatis differt. ***Typus :*** *Amin & Francis SAN 120933*, Borneo, Sabah, Ranau (holotypus SAN; isotypi K, KEP, L).

Small tree to 15 m tall, 50 cm diameter. *Twigs* 6–7 mm thick, dark brown, closely ridged. *Stipules* lanceolate, up to 5.5 cm long, with reflexed edges, densely long hairy outside. *Leaves* elliptic or oblong, 16.5–23 x 8.5–12 cm, base cuneate, apex obtuse or acute; scabrid on both surfaces, upper sparsely and lower densely hairy; midrib raised above; lateral veins 11–13 pairs, raised below, flat or faintly sunken above; intercostal veins scalariform, visible below, faint above; petioles 3–5 cm long, covered with short hairs. *Inflorescences* axillary. Male not seen. *Syncarp* (immature) yellowish green when fresh, cylindrical, *c.* 4.5 x 3 cm; perianth covered with glandular hairs with swollen bases; style exserted, simple; peduncles 4.5–5.5 cm long, rough hairy.

Vernacular name: Sarawak: *tekalong* (Iban).

Distribution: Endemic to Borneo, very rare, only known from Sabah and Sarawak.

Ecology: Lowland forest by streams.

Notes: Near to *A. rigidus* in section *Duricarpus* of subgenus *Artocarpus* but differing in the cylindric syncarp and in the perianth with long glandular hairs with swollen bases.

Specimens Examined: BORNEO. SABAH : Ranau, Langanan, *Amin & Francis SAN 120933* (K, KEP!, L, SAN!). SARAWAK : Sarikei, km 6, *Bernard Lee S 54906* (CGE, K, KEP!, L, SAN!, SAR!).

3. *Artocarpus primackii* Kochummen **sp. nov.**
(Richard B. Primack of Boston University, U.S.A., author of *Foresters' Guide to the Moraceae of Sarawak*)

Artocarpo glauco simillimus in sectione Pseudojaca, in capitulo masculo globoso, perianthio praeter apicem lobatum connato differt. ***Typus :*** *Aban Gibot SAN 99596*, Borneo, Sabah, Kota Merudu (holotypus SAN, isotypus KEP).

Small to medium-sized tree, rarely to 33 m tall and 150 cm diameter. *Bole* with tall buttresses to 3.3 m high; bark grey brown or orange brown, smooth to cracking. *Twigs* 5–7 mm thick, covered with short rough hairs. *Stipules* ovate, *c.* 4 mm long, hairy outside. *Leaves* oblong or obovate, 12–33 x 7.5–19 cm, base cuneate or rounded, apex with 1 cm long sharp tip; upper surface glabrous except midrib, lower surface rough hairy; midrib flattened above; lateral veins 10–16 pairs, prominently raised below, finely sunken above; intercostal veins scalariform, raised below, faint above, reticulation prominently raised below; petioles 2–5.5 cm long, short-hairy, often glaucous. *Inflorescences* solitary, axillary. *Male head* globose, *c.* 1.8 cm diameter, sessile or with 5 mm long hairy peduncle; tepal 3-lobed, covered with short hairs; stamen one, exserted with stout filament; bracts numerous, with peltate heads. *Female flowers* with exserted 3–lobed styles. *Syncarp* sessile or shortly peduncled, subglobose, surface warty, *c.* 6 cm across, velvety hairy, pale yellow with pink flesh when fresh.

Vernacular names: Sabah : *beruni* ; Sarawak : *dadah* (Iban).

Distribution: Endemic to Borneo. Most collections are from Sabah with only one record from Sarawak.

Ecology: Lowland and hill forest to 600 m altitude.

Notes: Closely allied to *A. glaucus* in series *Peltatae* of section *Pseudojaca* in subgenus *Pseudogaea*, but differing by its globose male head and united perianth except for the lobed apex. It also differs from *A. tomentosulus*, (under which some of the collections mentioned below were included by Jarrett), by its rough hairy, large leaf with sunken veins, small ovate stipules, and in the sessile or shortly stalked syncarp.

Specimens Examined: BORNEO. SABAH : Keningau, Sook Road, *T. Oikawa SAN 92157* (SAN!); Kota Merudu, *Aban Gibot SAN 99596* (KEP!, SAN!); Tenom, Agriculture Station, *W. Meijer SAN 120622* (SAN!); Kinabalu National Park, *S. Kokawa et al. 5223* (SAN!); Beaufort, Lumat Estate Reserve, *Stephen Madius SAN 50064* (K, SAN!); Sandakan, Sepilok F.R., *C. Charington SAN 21181* (K, L, SING!); Lahad Datu, Silam, *Heya et al. SAN 61681* (K, KEP!, L, SAN!, SAR!, SING!); Lahad Datu, Silam F.R. Block 8, *Agam Ambullah SAN 31491* (K, L, SAN!); Tawau, *G.H.S Wood A 3684* (A, KEP!, L, SING!); Tawau, Tinagat F.R., *J. Singh et al. SAN 48990* (KEP!, K, L, SAR!, SAN!); Tawau, Mile 9 Apas Road, *F. Krispinus SAN 86649* (KEP!, SAN!, SAR!, SING!); SARAWAK : Mulu National Park, Melinau Gorge, *R.B. Primack S 43309* (A, K, KEP!, L, SAN!, SAR!).

4. *Artocarpus anisophyllus* var. ***sessilifolius*** Kochummen **var. nov.**
(Latin, *sessilis*=sessile, *folius*=leaved, i.e. the sessile leaflets)

A varietate typica in ramulis laevibus foliolisque sessilibus differt. ***Typus :*** *G.H.S. Wood SAN 16549*, Borneo, Sabah, Sepilok F.R. (holotypus SAN).

Vernacular name: Sabah : *terap ikal* (Malay).

Distribution: Widely distributed in Sabah, but known only from a single collection from Sarawak.

Notes: This new variety differs from the typical variety by the smooth twigs and sessile leaflets.

Specimens Examined: BORNEO. SABAH : Terintidon, *Aban Gibot SAN 99508* (SAN!); Kota Merudu, *Aban Gibot SAN 100079* (SAN!); Sg. Sapi, Beluran, *Ag. Ahmad & Chiba SAN 124521* (SAN!); Kinabatangan, *Austin Cuadra A 2133*; (KEP!, SAN!, SING!); Sandakan, Sepilok F.R., *G.H.S. Wood SAN 16549* (A, BO, BRI, K, KEP!, L, SAN!, SING!); Sandakan, Labuk Road, *Tamiji & Laurence SAN 47090* (SAN!). SARAWAK : Kuching, *Hewitt 177* (SAR!).

5. *Ficus ashtonii* Kochummen **sp. nov.**
(P.S. Ashton, sometime Forest Botanist in Brunei and Sarawak)

Species prope Ficum hookerianum seriei Orthoneura, subgen. Urostigma, sed bracteis basalibus non connatis cupuliformibus sunt. In foliis crassis eis Fici stupendae similis, sed costa supra impressa. ***Typus :*** *Dayang Awa & B. Lee S 47846*, Borneo, Sarawak, Limbang (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Tree up to 28 m tall, 60 cm diameter. *Twigs* yellowish brown, irregularly ridged. *Stipules* ovate–lanceolate, pointed, *c.* 2.5 cm long, caducous. *Leaves* thickly leathery, elliptic, 14.5–17.5 x 6.5–9 cm, base broadly cuneate, apex pointed; midrib sunken above; lateral veins 6–7 pairs, curving and joining near margin, trinerved, basal pair reaching to more than 1/3 of blade, raised below, faintly raised above; intercostal veins reticulate, distinct below, invisible above; petioles 2.2–3.7 cm long, wrinkled on drying. *Syconia* from leafy twigs, axillary, orange turning deep red, sessile, oblong, *c.* 2 x 1 cm, apex flat with disc-like bracts; basal bracts large, with rounded apex, persistent. *Male flowers* with long stout stalk; tepal not distinct; stamen one with short filament. *Female flowers* sessile; perianths 3, lanceolate acuminate, up to the lower half of style; ovary elliptic, brown, slightly ridged, style lateral, long, stigma clavate. *Gall flowers* similar to female flowers, but with short pedicels.

Distribution: Endemic to Borneo; known only from the Bario and Limbang districts in Sarawak.

Ecology: Submontane forest at 1020 m altitude.

Notes: A species near to *F. hookeriana* of Series *Orthoneura* in Subgen.

Urostigma but the basal bracts are not united and cup-like. The thick leaves resemble those of *F. stupenda* but the midrib is impressed above.

Specimens Examined: BORNEO. SARAWAK : Bario, Pa Ukat, 4th Division, *Peter Sie S 35394* (A, CGE, K, L, MO, SAR!); Limbang, G. Pagon Periok, *Dayang Awa & B. Lee S 47846* (CGE, K, KEP!, L, SAN!, SAR!).

6. *Ficus borneensis* Kochummen **sp. nov.**
(Of Borneo)

In subsectione Dictyoneuron prope Ficum delosyce, sed ficorum bracteis truncatis vel planis differt. ***Typus:*** *W. Meijer et al. SAN 131862*, Borneo, Sabah, Telupid, Bukit Tangkunan F.R. (holotypus KEP).

Strangling fig. *Young twigs* yellowish, grooved. *Stipules* ovate–lanceolate, *c.* 15 x 5 mm, glabrous or hairy. *Leaves* leathery, drying chocolate brown; elliptic or oblong, 6.5–10.5 x 1.5–5 cm, base broadly cuneate, apex pointed; midrib sunken above, lateral veins 4–6 pairs, trinerved, basal pair reaching 1/3 of blade, curving and joining to form a looped intramarginal vein, distinct below, invisible to faintly visible above, intercostal veins reticulate, visible below, invisible above; petioles 1–2 cm long, drying black. *Syconia* axillary, solitary or in pairs, ripening red, sessile, oblong, 10–12 x 7 mm, surface rugose and with distinct ridges, apex truncate with disc-like bracts; basal bracts triangular with acute tip, persistent. *Male flowers* stalked; tepals 3; stamen one, almost sessile. *Gall flowers* sessile; tepals 3; ovary reddish on one side, with short subterminal style. *Female flowers* shortly pedicelled; style lateral, stigma clavate; seed covered with mucilage.

Distribution: Endemic to Borneo, very rare, recorded from Sabah and Sarawak.

Ecology: Lowland to submontane forest to 1350 m altitude on ultrabasic soil.

Notes: Somewhat like *F. pellucido-punctata* but the leaves are thicker and the figs are without perforation. Within the Subsection *Dictyoneuron* of section *Conosycea* of subgenus *Urostigma* , *F. borneensis* is near to *F. delosyce* but differs by its truncate apex and flat apical bracts of the figs.

Specimens Examined: BORNEO. SABAH : Ranau, *G. Mikil SAN 38549* (SAN!, SING!); Telupid, Bukit Tangkunan F.R., *SAN 131862* (KEP!); Mount Kinabalu, *J. & M.S. Clemens 29170* (SING!), *31275* (SING!).

SARAWAK : Kapit, Ulu Balleh, *Ilias Paie S 28556* (A, CGE, E, K, L, SAR!); G. Mulu National Park, Sg. Mentawi *Paul P.K. Chai S 39749* (CGE, K, KEP!, L, SAN!, SAR!).

7. *Ficus chaii* Kochummen **sp. nov.**

(Paul P.K. Chai, sometime Forest Botanist, Forest Department, Sarawak).

Hac species prope Ficum ixoroidem sectionis Sycocarpus subgenus Ficus, sed in foliis distincte dentatis venarum lateralium paribus multis differt. ***Typus:*** *Paul P.K. Chai S 36002*, Borneo, Sarawak, Sg. Kapit (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Treelet to 1 m tall. Twigs reddish brown, angled. *Stipules* lanceolate, up to 10 mm long, caducous, finely hairy outside. *Leaves* narrowly oblong, drying to greenish yellow, 13.5–23.5 x 1.5–2.2 cm, base cuneate, apex pointed with 1–2 cm long tip, margin distantly toothed; midrib raised above; lateral veins 13–21, distinctly curving and joining near margin, trinerved, basal veins short, visible below, very faint above; intercostal veins reticulate, visible below only; petioles 1–1.5 cm long, yellowish on drying. *Syconia* from leaf axils, solitary or in pairs, pear-shaped, 5–8 x 3–4 mm, green ripening to orange; peduncles to 3 mm long; basal bracts tiny. *Gall flowers* shortly stalked; tepals 3, lanceolate, transparent; ovary globose, whitish, style short, terminal. Male flowers not seen.

Distribution: Endemic to Borneo, very rare, known from a single collection from Sarawak.

Ecology: Lowland forest by river side.

Notes: This species is near to *F. ixoroides* of Section *Sycocarpus* Subgenus *Ficus*, differing in the distinctly toothed leaves and many pairs of lateral veins.

Specimens Examined: BORNEO. SARAWAK. Kapit, Sg. Kapit, *Paul P.K. Chai S 36002* (CGE, K, KEP!, L, SAN!, SAR!).

8. *Ficus chewii* Kochummen **sp. nov.**

(W.L. Chew, formerly taxonomist, Singapore Botanic Gardens)

Species as sectionem Conosycea subgenus Urostigma pertinet Ficus sumatrana similis, sed ficis oblongis apice truncato differt. ***Typus:*** *Chew et al. RSNB 1972*, Borneo, Sabah, Mount Kinabalu (holotypus SAN; isotypus SING).

Strangling fig. *Twigs* greyish yellow, finely ridged. *Stipules* ovate–lanceolate, pointed, 15–17 mm long, hairy outside, caducous. *Leaves* thickly leathery, shiny above, elliptic or oblong, (2.7–)6–11 x 3.5–5.5(–1.5) cm, base rounded or broadly cuneate, apex acute; midrib raised above with distinct central groove; lateral veins 6–8, with short intermediate veins, trinerved, basal veins reaching to middle of blade, curving and joining near margin, faintly visible on both surfaces; intercostal veins reticulate, faint below, invisible above; petioles 7–17 mm long, drying black. *Syconia* axillary, solitary or in pairs, sessile, oblong, *c.* 10 x 6 mm, apex truncate with disc-like apical bracts, surface irregularly wrinkled; basal bracts persistent, with rounded apex. *Male flowers* with 3 spathulate tepals; stamen one, sessile. *Female flowers* sessile; tepals 3; ovary with red markings, style long, subterminal, stigma clavate.

Distribution: Endemic to Borneo; very rare, known only from Mount Kinabalu in Sabah.

Ecology: Submontane forest at 1290 m altitude.

Notes: *F. chewii* belongs to Section *Conosycea* of Subgenus *Urostigma* and is close to *F. sumatrana* but differs in the oblong figs with truncate apex.

Specimens Examined: BORNEO. SABAH : Mount Kinabalu, Ulu Liwagu and Ulu Mesilau, *W.L. Chew et al. RSNB 1972* (SAN!, SING!).

9. *Ficus corneri* Kochummen **sp. nov.**

Species ad sectionem Leucogyne subgen. Urostigma pertinet foliis sine venis intercostalibus distinctis sed venis intermediis multis brevibus venis principalibus aequiliter prominentibus, ficis globosis sessilibus bracteis basalibus minutis absconditis, ovario albido notata. A Fico ngii in staminibus sessilibus periantho rubello marginibus albis differt. ***Typus:*** *Fidilis & Asik SAN 119744*, Borneo, Sabah, Keningau (holotypus KEP; isotypus SAN).

Climber. *Twigs* yellowish brown, strongly grooved. *Leaves* yellowish green on drying, elliptic to oblong, 12–20 x 4–6.5 cm, base cuneate, apex pointed, margin curled inwards; midrib raised above with distinct central sunken groove; lateral veins 5–7 pairs, with many short veins in between each pair, trinerved, basal pair reaching almost to half the length of blade, looping and joining near margin to form a looped intramarginal vein, visible below, very faint above; petioles 2.5–4 cm long, wrinkled on drying. *Syconia* yellowish when fresh, drying to reddish brown, from leaf axils, solitary or in pairs, sessile, globose, 12–15 mm across, surface smooth, apex slightly sunken and closed by 2 bracts; basal bracts 3, small, concealed by base of syconium which is thickened and ring-like with white edge. *Male flowers* pedicelled, pedicels dark brown; tepals 4, dark brown, united; stamen one, sessile. *Gall flowers* similar to male flowers, ovary smooth, style lateral. *Female flowers* very few, sessile, with 4 narrow tepal lobes; style lateral; seeds smooth, subglobose.

Distribution: Endemic to Borneo. Recorded from Sabah and Sarawak and also from Brunei.

Ecology: Lowland and hill forests to 790 m altitude.

Notes: A species belonging to Section *Leucogyne* of Subgen. *Urostigma*, it is characterised by its leaves, which are without distinct intercostal veins but with many short intermediate veins that are as equally prominent as are the main veins, by its globose sessile figs with small concealed basal bracts and by the whitish ovary. It differs from *F. ngii* in the sessile stamen and the reddish perianth with white edges.

Specimens Examined: BORNEO. SABAH : Sipitang, *Y.F. Lee & Dewol SAN 68975* (K, KEP!, L, SAN!, SAR!); Ranau, Tempurungon, *Amin & Jarius SAN 115969* (KEP!, SAN!); Keningau, Lanas, *Fidilis & Asik SAN 119744* (KEP!, SAN!). SARAWAK : Limbang, Bukit Pagon, *Yahud Hj. Wat S 4763* (CGE, K, KEP!, L, SAN!, SAR!). BRUNEI : Temburong, Bukit Belalong, *G.T. Prance et al. 30602* (K, KEP!).

10. *Ficus dulitensis* Kochummen **sp. nov.**
(Of Mount Dulit in Sarawak)

Hac species prope Ficum binnendykii var. *coriacea sectionis Conosycea subgenus Urostigma, sed in flore masculo perianthiis 2, pedicello infundibuliformi differt.* ***Typus:*** *Dayang Awa & Yii P.C. S 46743*, Borneo, Sarawak, Belaga, Dulit Range (holotypus KEP; isotypus SAR).

Strangling fig. *Twigs* dark brown. *Stipules* oblong, pointed, *c.* 1 cm long, glabrous, caducous. *Leaves* leathery, elliptic to oblong, 4–6.5 x 2–3.5 cm, base broadly cuneate, apex acute; midrib sunken above; lateral veins 3–4 pairs, raised below, invisible above, trinerved, basal pair reaching more than half the length of blade; intercostal veins reticulate, visible below, invisible above; petioles 0.5–1 cm long. *Syconia* from leaf axils, yellowish when ripe, subglobose, *c.* 8 mm diameter, sessile, with 3 large basal bracts. *Male flowers* with obconic pedicels; tepals 2; stamen 1 with distinct filament which broadens towards the apex. *Female flowers* sessile; tepals 3, lanceolate; ovary brownish, reddish at stylar side, smooth, style long, terminal, stigma club-shaped. *Gall flowers* similar to female flowers but the style is shorter.

Distribution: Endemic to Borneo. Very rare, known only from one collection from Sarawak.

Ecology: Submontane forest at 820 m altitude.

Notes: This species is near to *F. binnendykii* var. *coriacea* of Section *Conosycea*, Subgenus *Urostigma* but differing in the male flower with 2 tepals and in the obconic pedicel.

Specimens Examined: BORNEO, SARAWAK : Belaga, Dulit Range, *Dayang Awa & Yii P.C. S 46743* (KEP!, SAR!).

11. *Ficus gamostyla* Kochummen **sp. nov.**
(Greek, *gamo*=united; with united styles of adjoining flowers)

Ad Fico disticha sectionis Rhizocladus subgenus Ficus vergens, ab hac specie in ficorum pedunculis longioribus (10–13 mm), floris foemini stylo longo apicaliter florum aliorum stylis in fici cavitate adnatis. ***Typus:*** *Amin et al. SAN 107123*, Borneo, Sabah, Tongod (holotypus SAN).

Climber. *Twigs* dark brown, hollow. *Stipules* lanceolate–acuminate, *c.* 4 mm long, caducous. *Leaves* obovate or elliptic, 7–11 x 2.5–5.5 cm, base cuneate, apex pointed, margin recurved; midrib flattened above; lateral veins 5–6 pairs, with short intermediate veins, trinerved, basal veins short, raised below, very faint above, intercostal veins fine, reticulate, distinct below, invisible above; petioles 7–10 mm long. *Syconia* arising from leafless twigs and branches, in clusters, greenish, ripening red, subglobose, *c.* 5 mm across, apex umbonate with slight depression in the centre; peduncles 10–13 mm long; basal bracts persistent. *Female flowers* pedicelled; tepals 4, dark brown, oblong; ovary oblong, pale brown with white edges, style lateral, long, joined up near the apex forming a white ring-like mesh; centre of syconium hollow. Male and gall flowers not seen.

Distribution: Endemic to Borneo, very rare, known only from one collection from Sabah.

Ecology: Lowland forest.

Notes: Near to *F. disticha* of Section *Rhizocladus* Subgenus *Ficus,* from which it differs in the longer (10–13 mm) peduncles of the syconia, and in the long style of female flower, which is united at the tip with the styles of other flowers within the fig cavity.

Specimens Examined: BORNEO. SABAH : Tongod, Ulu Sg. Pinaggah, *Amin et al. SAN 107123* (SAN!).

12. *Ficus ilias-paiei* Kochummen **sp. nov.**
(Ilias Paie, the collector of the type specimen)

Hac species ad serie Apiocarpae, sectionis Kalosyce subgenus Ficus pertinet, prope Ficum warburgii, sed in hac specie fici subglobosae pedunculis 0–4 mm longis sunt. ***Typus :*** *Ilias Paie S 42527*, Borneo, Sarawak, Path to Gunong Silantek (holotypus SAR; isotypus CGE).

Climber. *Twigs* reddish brown. *Stipules* semi-persistent. *Leaves* elliptic, 10–12 x 2.5–4 cm, base tapered, apex pointed; midrib raised above, lateral veins 5–6 pairs, very faintly visible on both surfaces with distinct areolate reticulation below, not trinerved; petioles 1.7–2 cm long. *Syconia* borne on older, leafless branches, arising on stout finger-like branches, greenish with white dots when ripe, elliptic, *c.* 7 x 2.5 cm, apex pointed, base tapered and stalk-like, about 1 cm long; peduncles 2.5–3 cm long; basal bracts tiny. *Male flowers* with pedicels; tepal united with 3 lobes; stamen one, exserted. *Gall flowers* with pedicels; tepals linear, lanceolate, brownish in the centre with white edges; ovary dark red, style lateral, stigma funnel-shaped.

Distribution: Endemic to Borneo, very rare, known only from one collection from Sarawak.

Ecology: Mixed dipterocarp forest at 200 m altitude.

Notes: This species belongs to Series *Apiocarpeae* Section *Kalosyce*, Subgenus *Ficus*, and is near to *F. warburgii* but which has subglobose figs with a 0–4 mm-long peduncle.

Specimens Examined: BORNEO. SARAWAK : Ulu Sg. Silantek, 85th Mile Simanggang Road, *Ilias Paie S 42527* (CGE, SAR!).

13. *Ficus kerangasensis* Kochummen **sp. nov.**
(Of *kerangas* forest)

Species prope Ficum tristaniifolii subgenus Urostigma, sed a hac specie in ficis oblongis, folii costa immersa differt. **Typus :** *Ilias Paie S 38595*, Borneo, Sarawak, Sabal FR, (holotypus KEP; isotypi CGE, L, SAN, SAR, SING).

Climber. *Twigs* blackish. *Stipules* lanceolate, pointed, 10–14 mm long, caducous. *Leaves* obovate, drying dark brown or blackish, 6–7.5 x 2.5–4 cm, base cuneate, apex rounded, margin curved inwards; midrib sunken above, lateral veins 6–8 pairs with short intermediate veins, curving and joining near margin, trinerved, basal pair extending up to 1/3 of blade, faintly visible below, invisible above; intercostal veins reticulate, faintly visible below, invisible above; petioles 10–15 mm long, drying black. *Syconia* axillary, in pairs, yellowish green when fresh, sessile, oblong, 8–10 x 7 mm, surface rugose, apex truncate with distinct disc; basal bracts with blunt apex, persistent. *Male flowers* pedicelled; tepals 3, brown with white edge; stamen 1. *Female flowers* sessile; tepals 3; ovary oblong, reddish brown, longitudinally ridged, style lateral, stigma broad. *Gall flowers* similar to female flowers; interfloral bracts abundant.

Distribution: Endemic to Borneo. Known only from one collection from Sarawak.

Ecology: *Kerangas* forest.

Notes: This species is near *F. tristaniifolia* of section *Conosyce* in Subgenus *Urostigma*. It differs from that species in the oblong figs and in the sunken midrib of the leaf.

Specimens Examined: BORNEO. SARAWAK : Sabal F.R., Simungan, *Ilias Paie S 38595* (CGE, KEP!, L, SAN!, SAR!, SING!).

14. *Ficus longistipulata* Kochummen **sp. nov.**
(Latin, *longistipulatus*=with long stipules)

Hac species prope Ficum globosam in sectione Conosycea subgenus Urostigma. A hac species in stipulis multo longioribus, ficis minoribus differt. ***Typus :*** *G. Argent et al. 441987*, Borneo, Sabah, Palum Tambun (holotypus SAN).

Strangling fig. *Twigs* brownish, irregularly ridged. *Stipules* lanceolate, pointed, *c.* 3.5 cm long, drying pinkish. *Leaves* elliptic to oblong, 11.5–13.5 x 5–6 cm, base rounded or broadly cuneate, apex pointed; midrib flattened above, drying to pinkish below; lateral veins 12–15 pairs with short intermediate veins, curving and joining near margin, trinerved, basal veins very short, distinct below, visible above; intercostal veins reticulate, faint below, invisible above; petioles 2–3 cm long. *Syconia* in clusters on twigs below leaves, green when fresh, subglobose, 5–7 mm across, apex swollen and prominently umbonate, basal bracts small, persistent; peduncles *c.* 1 cm long, sparsely hairy. *Male flowers* in the centre of the syconium; pedicels stout; tepal brownish, united, with 3 lobes, stamen 1, anthers oblong, sessile. *Female flowers* sessile; tepal shorter than ovary, brownish, lanceolate; ovary whitish with red brown dots, subglobose, with faint ridges, style dark brown, subterminal. *Gall flowers* similar to female flowers.

Distribution: Endemic to Borneo; very rare, known only from one collection from Sabah.

Ecology: Lowland forest at 150 m altitude.

Notes: This species is near to *F. globosa* in Section *Conosycea* Subgenus *Urostigma*. It differs from that species in the much longer lanceolate stipules and in the smaller figs.

Specimens Examined: BORNEO. SABAH : Palum Tambun, *Argent et al. 441987* (SAN!).

15. *Ficus ngii* Kochummen **sp. nov.**
(F.S.P. Ng, former Forest Botanist, Forest Research Institute Malaysia)

Prope Ficum corneri sectionis Leucogyne subgenus Urostigma, staminibus filamento valido, perianthiis albis, folii basi etrinervosa differt. ***Typus :*** *Saw L. G. FRI 44887*, Peninsular Malaysia, FRIM, Kepong (holotypus KEP).

Strangling fig when planted, becoming independent tree up to 15 m tall with multiple stems, few aerial roots, and a spreading bushy dark green crown. *Twigs c.* 3 mm thick, covered with pale white lenticels. *Stipules* lanceolate, *c.* 8 mm long, with long white hairs on the outside. *Leaves* elliptic to oblong, 10–16 x 3–5.3 cm, base cuneate, apex pointed with tip *c.* 1 cm long; midrib flattened to slightly impressed above; lateral veins 8–11 pairs, not trinerved, thin, curving and joining near margin to form looped intramarginal vein, distinct below, very faint above, with equally prominent intermediate veins and reticulations; petioles 1–2 cm long. Sapling leaves oblong, to 3 cm broad, with sharp midrib below. *Syconia* from leaf axils, solitary or in pairs, sessile, green ripening yellow to deep red, subglobose to slightly obovoid, with scattered tubercles on the surface, 8–15 mm across, apex slightly depressed, closed by 3 apical bracts; basal bracts 3, concealed by the basal part of the synconium. *Male flowers* with short pedicels; tepals 3, white; stamen one with stout filament, anthers crescent-shaped. *Gall flowers* pedicelled; tepal united at base with 3–4 lobes; ovary subglobose, slightly angled, style lateral, short. *Female flowers* with three tepals, free; ovary white, almost globose, style lateral, stigma brownish; seed smooth.

Distribution: Endemic to Peninsular Malaysia, rare, known only from two collections.

Ecology: Limestone forest.

Notes: This species belongs to Section *Leucogyne* Subgenus *Urostigma,* which until now was known from only two species: *F. amplissima*, a species of India, Sri Lanka and the Maldives, and *F. rumphii*, a species widely distributed in the Indo-Malesian region. *F. ngii* differs from these two species in leaf shape and the distinct stamen with a stout filament. *F. ngii* is near to *F. corneri* Kochummen, another newly described species of Section *Leucogyne*, but that species has red tepals with white edges and sessile stamens. In addition, *F. corneri* has leaves with a distinctly trinerved base. The type specimen was collected from a planted tree at the Forest Research Institute Malaysia, Kepong. It was grown from a cutting collected in 1982 from limestone forest near Ipoh in Perak by Dr. F. S. P. Ng. It is a very fast growing species; figs appear 2–3 times a year.

Specimens Examined: PENINSULAR MALAYSIA : Perak, Cave Temple north of Ipoh, *F.S.P. Ng FRI 27361* (KEP!); Forest Research Institute of Malaysia, Kepong, Selangor, planted tree, *Saw L.G. et al. FRI 44887* (KEP!).

16. *Ficus pseudotarennifolia* Kochummen **sp. nov.**
(Latin, *pseudo*=false, like *F. tarennifolia*)

Fico tarennifolio sectionis Sycocarpus subgenus Ficus in subserie Tuberculifasciculatae similis, floribus cecidiophoris pedicellis gracilibus, foliis multo angustioribus differt. **Typus :** *Dayang Awa S 51027*, Borneo, Sarawak, Bario, Sg. Mengalio (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Small tree to 6 m tall. *Twigs* reddish brown, angled. *Stipules* lanceolate, pointed, 15–17 mm long, caducous. *Leaves* opposite, narrowly oblanceolate, oblong or elliptic, 9.5–22.5 x 1–3.5 cm, base cuneate, apex pointed, margin recurved, faintly wavy; midrib raised above; lateral veins 8–13, often with glands in axils of veins, not trinerved, curving and joining near margin, visible below, very faint above; intercostal veins reticulate, visible below, almost invisible above; lower surface with few scattered glands, sometimes in axils of lateral veins; petioles 1–2.5 cm long. *Syconia* borne in clusters on older branches and stems, pear-shaped, *c.* 2 x 1.2 cm, apex depressed; peduncles to 1.2 cm long; basal bracts tiny, persistent. *Gall flowers* with long slender pedicels; tepal whitish, cup-shaped with irregularly shaped lobes covering 3/4 of red ovary, style short, lateral. Male flowers not seen.

Distribution: Endemic to Borneo; rare, recorded only from Sarawak.

Ecology: Lowland to submontane forests up to 950 m altitude, by streams.

Notes: Similar to *F. tarennifolia* of Section *Sycocarpus* Subgenus *Ficus* Subseries *Tuberculifasciculatae*, but differing in the gall flowers with slender pedicels and in the much narrower leaves with faintly wavy recurved margins.

Specimens Examined: BORNEO. SARAWAK : Bario, Sg. Menalio, *Dayang Awa S 51027* (CGE, K, KEP!, L, SAN!, SAR!); Kakus-Pandare primary forest, Tatau, *E.F. Brunig S 11929* (SAR!).

17. *Ficus sabahana* Kochummen **sp. nov.**
(Of Sabah, one of the states of Malaysia)

Hac species prope Ficum sagittatam sectionis Rhizocladus subgenus Ficus. A hac species in foliis glabris subcordatis infra cystolithis scabris tectis differt. ***Typus :*** *Ashik Mantor SAN 114907*, Borneo, Sabah, Pandewan, Mesopo River (holotypus SAN).

Root climber. *Twigs* flattened, greyish yellow. *Stipules* ovate lanceolate, pointed, *c.* 2 cm long, subpersistent. *Leaves* ovate-lanceolate, greyish yellow on drying, undersurface sand papery to touch, 12.5–18.5 x 7–10 cm; base cordate or subcordate, apex pointed, margin recurved; midrib flattened above; lateral veins 3–4 pairs, trinerved, basal veins reaching more than half the length of blade, prominently raised below, flattened or faintly raised above; intercostal veins scalariform-reticulate, distinct below, faint above; petioles 1–2 cm long, sparsely hairy. *Syconia* borne in clusters in the leaf axils, globose, 6–11 mm across, surface smooth on drying, apex depressed, base narrowed to a cylindrical stalk; peduncle absent; bracts densely long-hairy. *Male flowers* shortly pedicelled; tepals 3, dark red; stamens 2, filaments united, stout. *Gall flowers* shortly pedicelled; tepals 3, dark red; ovary globose with dark red spots, style short, lateral. *Female flowers* not seen.

Distribution: Endemic to Borneo. Rare, known only from Sabah.

Ecology: Lowland forest in disturbed areas.

Notes: This species is near to *F. sagittata* of Section *Rhizocladus* Subgenus *Ficus*. It differs from that species in the glabrous cordate leaves covered with rough cystoliths on the undersurface.

Specimens Examined: BORNEO. SABAH : Nabawan, Keningau, *Dewol Sundaling SAN 83817* (KEP!, SAN!, SAR!, SING!); Pandewan, Mesopo River, *Ashik Mantor SAN 114097* (SAN!).

18. *Ficus soepadmoi* Kochummen **sp. nov.**
(E. Soepadmo, Collaborator and Chief Editor of the Tree Flora of Sabah and Sarawak Project)

A subsectione Dictyoneuron sectionis Conosycea subgenus Urostigma pertinet. Ad Ficum sumatranum vergens, sed ficis carinatis et folii venatione differt. ***Typus :*** *Ilias Paie & Yeo Eng Teck S 38376*, Borneo, Sarawak, Lambir Hill National Park, Ulu Sg. Lebau (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Climber. *Twigs* dark brown, angled. *Stipules* lanceolate, *c.* 15 mm long, appressed hairy outside. *Leaves* drying greenish yellow; oblong or oblanceolate, 9–13 x 2.8–3.7 cm, base cuneate, apex pointed, margin recurved; midrib sunken above; lateral veins 5–7 pairs with a number of short intermediate veins, trinerved, curving and joining near margin to form looped intramarginal vein; intercostal veins reticulate, venation visible below, very faint to inconspicuous above; petioles 1–1.5 cm long, drying black, sparsely hairy. *Syconia* axillary, sessile, in pairs, pale green when ripe; subglobose, 6–8 mm across, apex faintly sunken and closed by 2 apical bracts; surface rugose with five prominent ridges from apex to base; basal bracts persistent, with rounded apices. *Male flowers* sessile; tepals 3, stamen 1, sessile. *Female flowers* sessile; tepals 3, oblong, reddish; ovary oblong, irregularly lobed, dark brown on one side, style lateral, long, stigma dark brown, lobed. *Gall flowers* similar to female flowers but style short; interfloral bracts abundant.

Distribution: Endemic to Borneo; very rare, known only from the type collection from Sarawak.

Ecology: Submontane forest by river side at 1400 m altitude.

Note: Belonging to Subsection *Dictyoneuron* Section *Conosycea* Subgenus *Urostigma,* it comes near to *F. sumatrana* but the ridged figs and leaf venation are different. A sterile collection from Brunei, *BRUN 5332* from S. Belalong, a juvenile stage collection, probably belongs here.

Specimens Examined: BORNEO. SARAWAK : Ulu Sg. Lebau, Lambir Hill National Park, *Ilias Paie & Yeo Eng Teck S 38376* (CGE, K, KEP!, L, SAN!, SAR!).

19. *Ficus cereicarpa* Corner var. ***ashtonii*** Kochummen **var. nov.**

A varietate typica in ramulis crassioribus, foliis maximis cordatisque, ficis longe pedunculatis differt. ***Typus :*** *P.S Ashton S 17806*, Borneo, Sarawak, Balleh, Ulu Selentang (holotypus KEP; isotypi A, BO, CGE, K, L, SAR, SING).

Small tree to 6 m tall. *Twigs* 10–18 mm thick, glabrous and prominently ridged with prominent stipular scars, young twigs covered with patent brown hairs. Stipules to 5 cm long covered with patent brown hairs. *Leaves* elliptic or oblong, 32–43 x 20-24 cm, lower surface sparsely brown hairy on the midrib and lateral veins, base distinctly cordate, apex pointed, lateral veins 16–20 pairs, palmately veined at base; petioles 9–14 cm long, covered with patent brown hairs when young, becoming glabrous. *Syconia* borne at base of bole, pear-shaped, 2.5–3 x 2.5–3 cm, surface hairy, with thick lateral bracts, peduncle 3 cm long.

Distribution: Endemic to Borneo; recorded only from Sarawak.

Ecology: Lowland forest by streams.

Notes: Differs from the typical variety in the stouter twigs, very large cordate leaves and in the long-peduncled figs.

Specimens Examined: BORNEO. SARAWAK : Balleh, Ulu Selentang, *P.S. Ashton S 17806* (A, BO, CGE, K, KEP!, L, SAR!, SING!); Lambir National Park, Sg. Riam Libau, *Rena George S 40302* (CGE, E, K, KEP!, L); Belaga, Sg. Iban, *Bernard Lee S 45512* (CGE, K, L, MO, SAN!, SAR!).

20. *Ficus deltoidea* Jack var. ***recurvata*** Kochummen **var. nov.**
(Latin, *recurvatus*=curved backwards; the leaf margin)

Ab varietatibus aliis Fici deltoideae in foliis maioribus crasse coriaceis marginibus valde recurvatis differt. ***Typus :*** *Othman, Yii et al. S 48969*, Borneo, Sarawak, Tubau (holotypus KEP; isotypi SAN, SAR).

Epiphyte. *Leaves* thickly leathery, deltoid, 7.5–12 x 4–10 cm, base tapered, apex rounded, margin curled inwards; midrib forked, sunken above on the lower half; lateral vein 1 pair, trinerved; intercostal veins reticulate, visible below, invisible above; petioles 1–3 cm long, channelled above. *Syconia* green with brown tip when fresh, becoming black on drying; subglobose, *c.* 12 mm across, apex umbonate, peduncle short. *Gall flowers* with irregularly lobed ovary and short style; tepals 3 in male and gall flowers. *Female flowers* not seen.

Distribution: Endemic to Borneo; rare, recorded from Bintulu, Semengoh, Simanggang and Tubau in Sarawak.

Ecology: Lowland swamps to submontane forest.

Notes: Differs from other varieties of *F. deltoidea* in the larger thickly leathery leaves with distinctly recurved margins.

Specimens Examined: BORNEO. SARAWAK : Simanggang, *E.W.F.O. Brunig S 4807* (SAR!); Arboretum, Semengoh F.R., *J.A.R. Anderson S 12930* (SAR!); Tubau, Dataran Tinggi Merurong, *Othman Yii et al. S 48969* (K, KEP!, L, SAN!, SAR!); Ulu Sg. Kemena, Selah, Tatau, *Rantai Jawa S 65653* (SAR!).

21. *Ficus deltoidea* var. ***subhirsuta*** Kochummen **var. nov.**
(Latin, sub=somewhat, *hirsutus*=rough hair covering; the figs)

A varietatibus aliis Fici deltoideae in ficis pubescentibus et foliis venis lateralibus in 4 vel 5 paribus differt. **Typus :** *Yii P. C. S 48452*, Borneo, Sarawak, Batang Balleh, Bukit Melatai (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Epiphyte. *Twigs* dark brown, scaly. *Leaves* in life yellowish on the under surface; obovate, 2.2–3.5 x 1.7–2 cm, base tapered, *apex rounded; midrib forked near the apex;* lateral veins 4–5 pairs, curving and joining near margin, distinct below, faint above; petioles 3–6 mm long. *Syconia* axillary, red when ripe, solitary, elliptic, *c.* 3 x 2 mm, *surface rough hairy*; peduncles *c.* 2 mm long; basal bracts persistent, hairy.

Distribution: Endemic to Borneo, very rare, known only from Sarawak.

Ecology: Hill forest at 870 m altitude.

Note: Differs from other varieties of *F. deltoidea* in having hairy figs and leaves with 4–5 pairs of lateral veins.

Specimens Examined: BORNEO. SARAWAK : Batang Balleh, Bukit Melatai, *Yii P. C. S 48452* (CGE, K, KEP!, L, SAN!, SAR!).

22. *Ficus obscura* Blume var. ***lanata*** Kochummen **var. nov.**
(Latin, *lanatus*=woolly)

A varietate typica in pilis lanuginosis in ramulis foliis ficisque differt. ***Typus:*** *Henry T. Sinanggul SAN 57361*, Borneo, Sabah, Semporna, Kuala Kalumpang (holotypus KEP; isotypus SAN).

Twigs with woolly reddish brown hairs. *Leaves:* petioles and undersurface of leaves woolly hairy, uppersurface rough to touch. *Syconia* from leaf axils and on twigs below leaves, in pairs or in clusters, sessile or with peduncles, covered with woolly hairs, subglobose, 8–10 mm broad.

Distribution: Endemic to Borneo, frequent in Sabah, very rare in Sarawak.

Ecology: Lowland and hill forest, often by streams, at Serian on limestone.

Note: Differs from the typical variety in having woolly hairs on the twigs, leaves and figs.

Specimens Examined: BORNEO. SABAH : Lahad Datu, Kennedy Bay Timber Co. Road, *G.H.S. Wood SAN 16080* (A, BO, BRI, K, KEP!, L, SAN!, SING!); Semporna, Kuala Kalumpang, *Henry T. Sinanggul SAN 57361* (KEP!, SAN!); Ranau, Kampung Takutan, *G. Shea & Aban SAN 77208* (A, K, KEP!, L, SAN!, SAR!, SING!); Kalabakan, Hap Song logged area, *Fedilis & Sumbing SAN 91428* (BO, K, KEP!, L, SAN!, SAR!, SING!); Kalabakan, *Fedilis Krispinus SAN 94809* (KEP!, SAN!, SAR!), *SAN 95899* (KEP!, SAN!); Ranau, Poring, *Amin et al. SAN 121496* (KEP!, SAN!). SARAWAK : Serian, *S 28102* (SAR!).

23. *Ficus oleifolia* King var. ***calcicola*** Kochummen **var. nov.**
(Referring to the limestone habitat)

A varietatibus aliis Fici oleifoliae in venatione indistincta et habitione calcarea differt. ***Typus : Bernard Lee S 38626***, Borneo, Sarawak, Gunung Doya (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Small tree to 4.5 m tall. *Twigs* grey brown. *Stipules* linear, *c.* 4 mm long.

Leaves elliptic, drying to greenish yellow; base cuneate, apex pointed, margin recurved; midrib raised above, lateral veins and intercostal veins very faint to inconspicuous; petioles 7–10 mm long. *Syconia* ellipsoid to subovoid, *c.* 3 mm diameter, apex umbonate; peduncles 3–4 mm long.

Distribution: Endemic to Borneo; recorded only from the 1st Division in Sarawak, locally frequent.

Ecology: Limestone forest.

Note: Differing from other varieties of *F. oleifolia* in the indistinct venation and its limestone habitat.

Specimens Examined: BORNEO. SARAWAK : Bau, G. Jebong, *Banyeng Ludong S 38535* (CGE, K, KEP!, L, SAN!, SAR!); G. Doya, *Bernard Lee S 38626* (CGE, K, KEP!, L, SAN!, SAR!); G. Jambuan, *Bernard Lee S 38604* (CGE, K, KEP!, L, SAN!, SAR!); G. Majar, Tebekang, *Yii & Othman S 46283* (CGE, K, KEP!, L, SAN!, SAR!); Bukit Jambusam, Bau, *Yii et al. S 50349* (CGE, K, KEP!, L, SAN!, SAR!).

24. *Ficus oleifolia* King var. ***impressicostata*** Kochummen **var. nov.**
(Latin, *impressus*=sunken, *costa*=midrib; midrib impressed above)

Prope Ficum oleaefoliam var. memecylifoliam, sed in foliis costà immersa differt. ***Typus :*** *Ilias Paie S 40961,* Borneo, Sarawak, Kapit, Melinau (holotypus KEP; isotypi CGE, K, L, SAN, SAR).

Epiphyte. *Leaves* elliptic, base cuneate, apex pointed; midrib sunken above, lateral veins and intercostal veins very faint to invisible; petioles short, 2–3 mm long. *Syconia* oblong to subglobose, 3–4 mm wide, on 5–8 mm long slender peduncles.

Distribution: Endemic to Borneo; reported only from Sarawak, rare.

Ecology: Hill and submontane forest between 700–1300 m altitude.

Notes: Very close to var. *memecylifolia* but differing in the leaves with the midrib sunken.

Specimens Examined: BORNEO. SARAWAK : Ulu Melinau, Hose Mountains, *Paul Chai et al. S 37304* (CGE, K, KEP!, L, MO, SAN!, SAR!); Anap, Bukit Mersing, *Sibat ak Luang S 21943* (A, BO, K, KEP!, L, MEL, P, SAN!, SAR!, SING!); Kapit, Melinau, *Ilias Paie S 40961* (CGE, K, KEP!, L, SAN!, SAR!).

25. *Ficus sundaica* Blume var. ***impressicostata*** Kochummen **var. nov.**

A varietatibus aliis Fici sundaicae a folii pagina superiore costa immersa distinguendam. ***Typus :*** *Talip Bidin SAN 80664*, Borneo, Sabah, Papar, Mandahan (holotypus KEP; isotypi K, L, SAN, SAR, SING).

Twigs grey brown, ridged. *Stipules* glabrous, ovate–lanceolate, 1–1.5 cm long. *Leaves* elliptic to narrowly obovate, 6.5–11 x 2.8–5.5 cm; drying chocolate brown; base broadly cuneate, apex cuspidate with short tip, margin wavy, recurved; midrib sunken above; lateral veins 5–6 pairs with 3–4 intermediate veins between each pair, looping and joining near margin to form an intramarginal vein, trinerved, basal pair reaching more than half the length of blade, very faint on both surfaces; intercostal veins reticulate, very faint below, almost invisible above; petioles 1.5–2 cm long, distinctly channelled above. *Syconia* axillary, sessile, oblong, 15–22 x 12–20 mm, yellowish when fresh, irregularly wrinkled on drying, apex almost flattened; basal bracts large, ovate, *c.* 10 x 8 mm, persistent.

Distribution: Endemic to Borneo. Common and widely distributed in Sabah and Sarawak.

Ecology: Lowland forest on sandy soils, in *kerangas* and peat swamp forests.

Notes: It is distinguished from the other varieties of *F. sundaica* by the midrib, which is impressed on the upper surface.

Specimens Examined: BORNEO. BRUNEI : Bukit Pasir Puteh, *Ladi anak Bikar BRUN 5116* (BRUN, KEP!); Seria, *B.E. Smythies et al. S 5864* (BRUN, KEP!, SAR!); Temburong, *S. Atkins et al. 498* (BRUN, K, KEP!); Belait, Badas, *M.J.E. Coode et al. 6470* (BRUN, K, KEP!), *D. Kirkup et al. 387* (BRUN, K, KEP!); Tutong, Pasir Puteh, *M.J.E. Coode et al. 6850* (BRUN, K, KEP!); Tutong, Tanjong Maya, *D.A. Simpson et al. 2188* (BRUN, K, KEP!); Tutong, Bukit Pasir, *K.M. Wong* 161 (BRUN, K, KEP!). SABAH : Papar, Kimanis F.R., *Aban Gibot SAN 49382* (SAN!); Papar, Bongawan F.R., *Dewol & Talip Bidin SAN 80345* (A, KEP!, OX, SAN!, SAR!, SING!); Papar, Mandahan, *Talip Bidin SAN 80664* (K, KEP!, L, SAN!, SAR!, SING!); Beaufort, Hindian F.R., *Talip Bidin SAN 84555* (KEP!, SAN!, SAR!); Sipitang, Malalia F.R., *R.A. Marsal & Heya SAN 86202* (KEP!, SAN!); Sipitang, Maritinetaman Forest Area, *Ag. Amin & Heya SAN 86485* (KEP!, SAN!, SAR!, SING!); Membakut, Sg. Damit, *Ag. Amin SAN 103271* (K, KEP!, L, SAN!, SAR!); Weston, Sianggu F.R., *Ag. Amin SAN 105981* (KEP!, SAN!); Sipitang, Mengalong F.R., *L. Madani SAN 111407* (KEP!, SAN!); Sipitang, Melakis F.R., *Ag. Amin SAN 114863*

(KEP!, SAN!). SARAWAK : Miri, Lambir Hills, *Joseph Au S 17259* (A, BO, CGE, K, L, MO, SAN!, SAR!); Balingian, Begruh, Bawan, *Paul Chai S 19474* (A, BO, CGE, K, L, SAN!, SAR!, SING!); Baram, Mt Dulit, *Sylvester Tong S 34898* (CGE, K, KEP!, L, MO, SAR!); Ulu Simunjan, G. Buri, *Bernard & Ilias S 36850* (CGE, K, KEP!, L, MO, SAR!); 99th mile Sri Aman, Kampung Gum, *Ilias Paie S 42734* (CGE, K, KEP!, L, SAN!, SAR!); 99th mile Sri Aman, *Ilias Paie S 42739* (CGE, K, KEP!, L, MO, SAN!, SAR!); Batang Balleh, Bukit Melatai, *Yii P. C. S 48453* (CGE, K, KEP!, L, SAN!, SAR!).

Acknowledgements

I wish to extend my gratitude for the support and encouragement of the Director-General of FRIM, Kepong and to the Curators of K, L, SAN, SAR and SING herbaria for the loan of specimens. I am also deeply indebted to Dr. J.F. Veldkamp of the Rijksherbarium, Leiden, the Netherlands, for providing the Latin diagnoses of the new taxa. The research was part of the Tree Flora of Sabah and Sarawak Project, funded by the International Tropical Timber Organization (ITTO), the Malaysian Government, and the Overseas Development Administration of the United Kingdom (ODA-UK).

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The Genus *Alocasia* (Araceae-Colocasieae) in West Malesia and Sulawesi

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Abstract

Alocasia (Schott) G. Don is revised for West Malesia and Sulawesi. Thirty one species are recognised, including one extremely variable species, *A. longiloba* Miq. *s. l.*, in which seven incompletely delineable informal entities are further recognised. Ten species are new to science. The history, geography, ecology and morphology of the genus and conservation status of its species are discussed and foci for further study are briefly delineated. A key to species is provided. Approximately 25% of names are epi- or neotypified owing to lack of adequate original material - a situation deriving mainly from the horticultural history of the genus. New synonyms include *A. margaritae* L. Linden & Rodigas, *A. ovalifolia* Ridl., *?A. crassinervia* Engl. = *A. puber* (Hassk.) Schott; *A. imperialis* L. Linden, *A. guttata* N.E. Br., *A. villeneuvei* L. Linden = *A. scabriuscula* N.E. Brown; *A. porphyroneura* Hallier f. = *A. princeps* W. Bull; *A. grandis* N.E. Br. = *A. macrorrhizos* (L.) G. Don; *A. nobilis* Hallier f, = *A. inornata* Hallier f.; *A. bantamensis* Koord., *A. crassifolia* Engl. = *A. alba* Schott; *A. lowii* Hook., *A. korthalsii* Schott, *A. denudata* Engl., *A. putseyzii* N.E. Br., *A. eminens* N.E. Br., *A. watsoniana* Mast., *A. curtisii* N.E. Br., *A. cuspidata* Engl. = *A. longiloba* Miq. *s. l.*. *Alocasia perakensis* Hemsl. is reinstated. Indian *Alocasia montana* (Roxb.) Schott is considered a synonym of *A. macrorrhizos*.

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Aims, Scope and Limitations

The present review is, as with previous papers on this genus covering other parts of Malesia (Hay & Wise, 1991; Hay, in press), limited to an 'alpha-taxomonic' review of the species as a precursor to a treatment for Flora Malesiana (see Hay, 1994b) and aims to bring understanding of the genus to a basis point for more intensive phylogenetic, molecular, biogeographic and ecological analyses. *Alocasia* species are widely cultivated as ornamental plants and often abundant in the herb layer and gap phase of forests, and there is an urgent need for the means of identification of species. Defining species through standard herbarium-based methods is difficult, as the plants are generally unpleasant to collect and unsuited to herbarium preservation, often having enormous leaves and rhizomes, soft parts, often complex and bulky synflorescences, ephemeral inflorescences and irritant sap, and they are phenotypically variable. Moreover, they are highly attractive to herbarium beetles and the percentage of specimens with well preserved floral parts is minute.

Field work and the assembling of a living collection, in which sterile field-collected plants can be brought to flower, has been an essential prerequisite to this revision. While this has enabled many species to be described from fresh material, there still remain a number known only from herbarium specimens, and a number in which variability has to be interpreted almost solely from the inadequate resource of dried material. Many cultivated accessions have been cited, from which further preserved material will be distributed to relevant herbaria in due course. The convention I have used in citing these is to give the RBG Sydney Accession Number as well as the original collection number. Wild-collected vouchers bear only the original collection number, while preserved specimens made from the cultivated plants bear both numbers.

Infrageneric species groups have been recognised informally, as it is beyond the scope of the present work to engage in the rigorous analysis of species relationships that would justify formal infrageneric nomenclature. Comment on the coherence or otherwise of the informal groups may be found under each in the body of this paper. The division of the genus into two formal sections based on stigma shape, as proposed by Engler &

Krause (1920) is plainly unsatisfactory. It splits the Longiloba Group, for example, presumably on misobservation, and aligns, in Sect. Ensolenanthe, *A. zebrina* Schott ex van Houtte (Philippines) with *A. cuprea* and members of the *A. longiloba* complex - a very probably heterogeneous assemblage.

History

The first Malesian *Alocasia* species were attributed, as were many monoecious aroids before the advent of Schott, to the genus *Arum*. In the pre-Linnean period, Rumphius (1747) illustrated two 'species' (within which he recognised further 'species' in his discussion), *Arum indicum sativum* and *Arum sylvestre*. The former was the widespread *Alocasia macrorrhizos* (L.) G. Don, for which, as the genus becomes better understood in the wild state, there is a growing body of evidence that it is a cultigen associated almost entirely with human habitation and agriculture as an inferior starch crop. *Arum indicum sativum* was taken up by Loureiro (1790) as *Arum indicum* Lour., the basionym of *Alocasia indica* (Lour.) Spach, now recognised as a synonym of *A. macrorrhizos*. *Arum sylvestre* has remained of obscure identity, though Hasskarl (1844) considered it perhaps identical with West Malesian *Colocasia pubera* Hassk. (= *Alocasia puber* (Hassk.) Schott). That interpretation seems incorrect, however, and it seems more plausible that *Arum sylvestre* is *A. aequiloba* N.E. Br., an East Malesian species.

The generic name *Alocasia* was first attributed to Necker by Rafinesque (1837: 64) for some aroid species now in *Arisaema*. The name was earlier used by Schott (1832), the first significant specialist in the taxonomy of Araceae, as a section in *Colocasia*. That concept of *Alocasia* was raised to generic rank by Don in Sweet (1839), with the Indochinese *A. cucullata* (Lour.) G. Don as the type. The name has been used in Schott's and Don's sense ever since, with Nicolson (1963) proposing it be conserved over *Alocasia* Rafinesque. Early species now in the genus were described or combined in *Colocasia* for some time after Don with Kunth (1841) transferring *Arum indicum* Lour. into *Colocasia* and Hasskarl (1842) misapplying *Colocasia odora* Roxb. to (probably) *Alocasia macrorrhizos* and *Colocasia montana* (Roxb.) Kunth to *Alocasia flemingiana* (a species newly described here). In 1844 he called one of the earliest described (post-Linnean) Malesian endemic *Alocasia* species *Colocasia pubera* Hassk. Hasskarl further recognised several forms of *Alocasia macrorrhizos* (now best regarded as cultivars) in *Colocasia*. However, from Miquel (1855) onward, *Alocasia* has been consistently treated by botanists of Malesian aroids, including Hallier, Ridley, Hemsley, Koorders, and more recently Backer & Bakhuizen and Hotta as a genus distinct from *Colocasia*, though confusion persisted among those describing species in the horticultural arena. Curiously, van Alderwerelt van Rosenburg, who wrote a series of papers on Malesian Araceae (Alderwerelt 1920, 1922), did not deal with *Alocasia* at all.

Much earlier, the great botanist of the Malesian flora Blume took a particular interest in Araceae (1837) but did not deal with any *Alocasia* species either, though in his Catalogus (1823: 102) he listed *Arum maximum* (presumably *Alocasia macrorrhizos*). He also determined certain of his herbarium collections as *Caladium pubigerum* (= *Alocasia puber*), though the name was apparently never published. *Caladium* had been erected by Ventenat (1801) for the ornamental, peltate-leaved neotropical *C. bicolor*. The genus is superficially similar to *Alocasia* (though on molecular evidence no longer considered very closely allied - French *et al.*, 1995; Mayo, Bogner & Boyce, 1997), and the earliest post-Linnean Malesian *Alocasia* - Philippine *A. heterophylla* (Presl) Merr. first apeared in it (*Caladium heterophyllum* Presl, 1835). By the mid-19th Century, in spite of the development of Schott's generic concepts (1853–1860), some ornamental peltate-leaved *Alocasia* species, coming to be known in the stream of exotic plants being brought into cultivation in Britain and Europe, were still first described in *Caladium*, including *Alocasia cuprea* (C. Koch & Bouche) C. Koch) and *Alocasia veitchii* (= *A. longiloba* Miq.).

Included in the history of *Alocasia* is the recognition of four segregate genera: *Ensolenanthe* Schott (1861), proposed without any binomials and later used by Engler & K. Krause at infrageneric rank; *Schizocasia* Engl. for a group of species with deeply divided leaf blades, now understood to be heterogeneous (Bunting, 1962; Nicolson 1968); *Xenophya* Schott, now regognised as an East Malesian species group within *Alocasia* (Hay & Wise, 1991); and monotypic *Panzhuyia* Z.Y. Zhu (1985), conspecific with the type of *Alocasia*, *A. cucullata*.

The role of British and Continental nurserymen in the discovery of Malesian (particularly Bornean and Philippine) *Alocasia* species in the latter part of the 19th century has been considerable, notably the firms of Veitch, Sander, Bull and the Compagnie Continentale d'Horticulture Gand. Some spectacularly beautiful plants were introduced and named, principally by Lucien Linden, Masters and N.E. Brown, through the horticultural route. However, a legacy has been left of species named in the absence of any understanding of variation in the wild - since evidently only the most striking forms were introduced on the basis of their commercial potential, of protologues consisting of short entries in retail catalogues or rhapsodic accounts of horticultural qualities neglecting botanical detail, fragmentary or non-existent type specimens or second-rate and barely interpretable illustrations, and provenances inaccurate, vague and sometimes quite probably deliberately misleading to commercial competitors.

This has resulted both in a high level of new synonymy, and, together with the WWII destruction of the herbaria at Vienna and Berlin, where the two great figures in Araceae taxonomy, Schott and Engler, worked, a particularly large number of cases of difficulty in interpreting the application of names in this genus, requiring the neotypification or epitypification of no less than a quarter of them.

The genus was last revised *in toto* by Engler & Krause (1920). Nicolson (1987) revised the Sri Lankan species, Hay & Wise (1991) revised the East Malesian and Australian species, Noltie (1994) revised Himalayan species and Hay (in press) has revised the Philippine species.

Ecology

Alocasia species are predominantly lowland tropical plants of 'ever-wet' areas. A few species, such as *A. perakensis* and *A. kerinciensis* are montane elements, though few occur above about 1200 m alt. and none above about 2000 m alt. in the region under study here. Some species, such as *A. princeps*, have wide altitudinal ranges. Several species, such as *A. sarawakensis*, *A. minuscula* and *A. puber* show a preference for or restriction to swampy habitats, while others, such as *A. princeps* and *A. beccarii*, are restricted to well-drained sites. Several are facultative or obligate lithophytes, including *A. longiloba* 'watsoniana', *A. longiloba* 'lowii', *A. principiculus*, *A. puteri*, *A. pangeran, A. ridleyi*, *A. venusta* and *A. reversa.*

Detailed information is often lacking, but some species are associated with or confined to particular substrates. *Alocasia melo* is confined to ultramafic areas. *A. reversa*, *A. venusta*, *A. ridleyi*, *A. puteri*, *A. pangeran*, *A. principiculus* are confined to limestone areas. *A. minuscula* is known only from peat swamp forest. Several species do not appear to be much influenced by substrate - for example, *A. cuprea* is found on sandstone, limestone and in ultramafic areas, and *A. princeps* occurs on a wide variety of substrates, limestone, sandstone, shale and so on.

The genus can be broadly divided into gigantic species, which are associated with open sites - gap phase of forests, landslips, river banks, open swamps, road-sides and plantations - such as *Alocasia robusta, A. sarawakensis*, *A. alba*, *A. puber*, and smaller elements that are generally found within forest. *Alocasia scabriuscula* and *A. inornata*, and to a lesser extent, some elements of the *A. longiloba* complex can be found both within forest and in open conditions.

Geography and Endemism

Few Malesian *Alocasia* species are widespread, other than those distributed directly by human activity, such as *A. macrorrhizos*. Borneo is the main node of diversity, endemism and richness in *Alocasia*, with a second node in New Guinea/Australia which, though slightly less speciose than the Philippines, is taxonomically distinct (Hay & Wise, 1991; Hay, 1994a). The ratios of endemic species to total species (calculated excluding *A. macrorrhizos* and including entities of the *A. longiloba* complex) for the main land masses in Malesia are as follows: Malay Peninsula - 1:8; Sumatera - 3:8; Java: 2:4; Borneo - 20:23; Philippines - 14:14; Sulawesi - 3:4; Papuasia - 12:12; [Australia - 1:1].

Of the informal infrageneric groups recognised here, the Puber Group group has four species, two Bornean endemics, one Philippine endemic and one species from Java and the Malay Peninsula, possibly also represented in Sumatera. This group appears to be closely allied to the Scabriuscula Group, which is endemic to, richly represented and abundantly common in Borneo, including two highly variable complex entities - *Alocasia scabriuscula* and *A. princeps* - each with several narrowly defined localised segregates. The Longiloba Group is predominantly West and Central Malesian, extending from the central highlands of Vietnam to the Philippines and Sulawesi. With the exception of Philippine and Sulawesi segregates, it is treated here as one species including localised, sometimes sympatric 'topospecific' entities that merge globally into a single presently intractable complex. It is most diverse in Borneo and Sumatera. The Cuprea Group is mainly Bornean, with a single endemic representative in each of Sumatera and the Malay Peninsula. Remaining species have been very provisionally placed in an alliance with *A. macrorrhizos* as the Macrorrhizos Group, which occurs from mainland Asia and thoughout the Malesian range of the genus except Borneo. However, this grouping may prove heterogeneous on further study.

Conservation Status

One outcome of a taxonomic study is to highlight species that are known from very few collections or that are known from only a few localitites and which may therefore be rare and in need of protection. However, before listing those species, it should be emphasised that conservation status of course requires verification on the ground, preferably by local botanists. Nevertheless, existing herbarium records are a start in evaluating how abundant or localised the species may be.

The following species are known from very few collections and/or localities: Sumatera - *Alocasia kerinciensis*, Borneo - *A. melo*, *A. minuscula*, *A. pangeran*, *A. principiculus*, *A. puteri*, *A. reginae*, *A. reginula*, *A. venusta* and Sulawesi - *A. suhirmaniana* and *A. celebica,* the latter known only from its type, collected over a century ago in Sulawesi.

The following wide-ranging species are known from few collections in certain main subdivisions of the Malesian Archipelago while being more frequent elsewhere: *Alocasia puber* in the Malay Peninsula and Sumatera, and *A. longiloba* 'watsoniana' in the Malay Peninsula and Borneo.

Many of these, especially *Alocasia melo*, *A. principiculus*, *A. reginae*, *A. reginula, A. suhirmaniana*, *A. venusta* and A. *longiloba* 'watsoniana' are highly ornamental (as indeed are less rare species such as *A. reversa*, *A. cuprea* and certain forms of *A. inornata*, *A. longiloba*, *A. perakensis*, *A. princeps* and *A. scabriuscula*). On the one hand they are potentially threatened by unsustainable unscrupulous collecting from the wild, and on the other they are open to *ex situ* conservation (in a broad sense) through the medium of ornamental horticulture sustained by tissue culture. Indeed, a number of species have been successfully micropropagated, especially in the U. S. A., and are available for sale over the internet. With increasing ease of developing and implementing tissue culture protocols for micropropagation, there is great potential for commercially developing these plants within their countries of origin at the same time as relieving collecting pressure on limited wild plant populations. A horticultural account describing a large number of cultivars in some detail was given by Burnett (1984), though there is a pressing need to stabilise the nomenclature of the cultivars and to align it, where appropriate, with the botanical nomenclature.

Structure and Terminology

The stem, typically of most Araceae, is a physiognomically unbranched sympodium. The number of foliage leaves per module is variable between and within species and individuals, but during flowering episodes in some species it may be reduced to one. In some species, e.g. *A. kerinciensis*, foliage leaves alternate with cataphylls within a module. In such instances the cataphyll performs the role of protecting the subsequent emerging leaf. That role in other species is performed by the sheath of the next oldest foliage leaf. Those species with regularly interspersed cataphylls typically have very short leaf sheaths, while those without interspersed cataphylls have longer sheaths. A prophyll and usually at least one cataphyll is always associated with the initiation of a new vegetative module.

The vascular system of the petiole divides, as it runs into the blade, into three principal veins - the anterior costa (midrib) and two posterior costae which support the anterior and posterior lobes of the blade respectively. The shape of the posterior lobes of the leaf is sometimes of diagnostic importance. Terms used here to describe them are for the most part self-explanatory, such as 'acute', 'obtuse', etc. The posterior lobes are assymetric, the outer sides being united with the anterior lobe, while the inner sides (i.e. those that face each other across the sinus) are free (unless the leaf is peltate). In some instances, such as the Scabriuscula Group, the shape of the piece of lamina on the 'inside' of each posterior lobe may need to be used for identification purposes. For these parts I have used terms such as 'lanceolate', 'ovate', etc. even though the posterior lobe is not symmetrical about the posterior costa. Thus, 'inner side of posterior lobe lanceolate' means that the inside piece of lamina is shaped like a longitudinally bisected lanceolate leaf (Fig. 1).

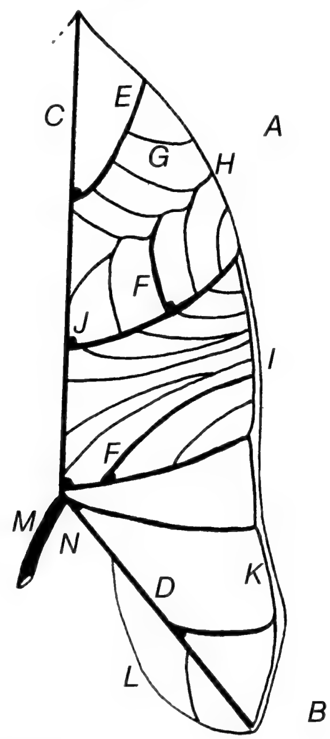

Figure 1. Diagram of *Alocasia* leaf blade
A. anterior lobe; B. posterior lobe; C. anterior costa; D. posterior costa; E. primary lateral vein; F. subsidiary vein (with axillary gland); G. secondary vein; H. sector with interprimary collective vein formed by meeting of secondary veins; I. sector with interprimary collective vein not formed; J. axillary gland; K. intramarginal vein; L. inner side of posterior lobe; M. petiole; N. sinus.

Primary veins run pinnately off both sides of the anterior costa and pedately off the outer (anterior) side of each posterior costa. Glands, of unknown function, are found in the axils of the primary veins on the abaxial surface of the leaf, and may also occur scattered over the surface of the petiole. Secondary venation arises direct from the costae and from the primary lateral veins and is typically colocasioid: secondary veins arising from the primary lateral veins typically run initially at a wide angle from the primary venation and are then deflected towards the margin of the blade. In some species the secondary veins unite between the primary veins into more or less sinuous interprimary collective veins. These may be very well developed and distinct, and while they are a useful feature for distinguishing some species, the state intergrades with a complete absence of interprimary veins and some species evince a variety of intermediate states. In some species (e.g. *Alocasia suhirmaniana*), some secondary veins are intermediate in thickness between the normal secondary venation and the primary veins, and they may even bear glands in their axils like the primary venation. These are termed subsidiary veins. The primary and secondary veins run into a marginal vein, or in some species a distinct intramarginal vein (e.g. *A. peltata*). The primary and secondary venation patterns in those species with interprimary collective veins is highly suggestive of derivation by connation of leaflets or segments of a pinnate or pinnatifid leaf. Indeed, more or less deeply pinnatifid leaves occur sporadically in the genus in different species groups, e.g. Philippine *A. sanderiana* W. Bull (Longiloba Group), Papuasian *A. brancifolia* (Schott) A. Hay (Xenophya Group) and Philippine *A. portei* Schott (Macrorrhizos Group), and (radiately) divided leaves are found in the allied relict Seychelles endemic genus *Protarum* Engl. (Hay & Mabberley, 1991).

Seedling leaves, where known, are peltate with partially to completely connate posterior lobes, a condition which may or may not persist into various stages of subadulthood and which may be retained altogether in the Cuprea Group. *Alocasia reversa* is variable in this respect and may have all peltate leaves, no peltate leaves or mixed states as adult plants.

In most, if not all species, the rhizome produces at or below soil level a number of short slender branched or unbranched stolons terminating in more or less globose cormels. These remain dormant for protracted periods, often until the stolons that bear them have decayed. Conditions that stimulate either their production or their release from dormancy are unclear, and while cormels are often produced in large quantities, the plants are typically solitary, though very dense, apparently clonal, populations may occur.

Except in the most diminutive species where the inflorescence is solitary (e.g. *Alocasia minuscula*), the vegetative module is terminated by a synflorescence composed of pairs of inflorescences forming bimodular synflorescence subunits (Fig. 2). Each consists of a cataphyll subtending a terminating inflorescence (i.e. peduncle with spathe and spadix) and a second inflorescence arising in the axil of the cataphyll and itself subtended by a bicarinate prophyll. A relay axis develops from the axil of the leaf (or leaf homologue) immediately below the first cataphyll of the bimodular subunit. It bears first a bicarinate prophyll and then, depending on whether or not the relay module is initially vegetative, a foliage leaf (which may or

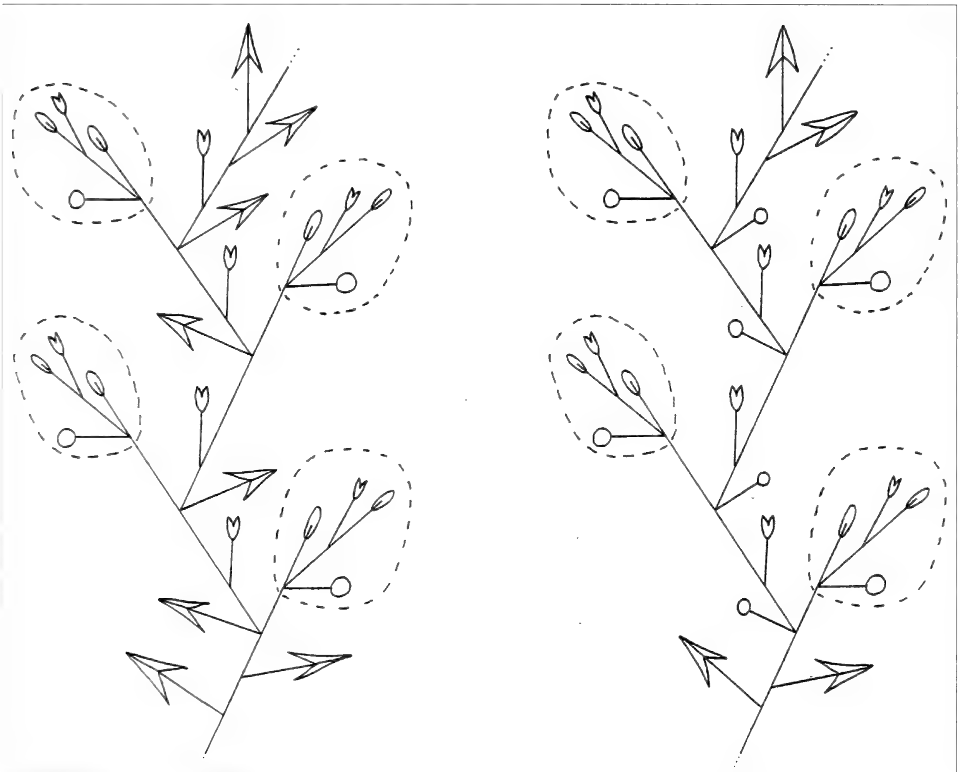

Figure 2. Schematic representation of synflorescence construction in *Alocasia*
Left: synflorescence subunits of cataphyll, inflorescence, prophyll and inflorescence (contained in dotted outlines), interspersed with foliage leaves. Right: synflorescence subunits repeated with the foliage leaves substituted by cataphylls - making a compound synflorescence, followed by resumption of vegetative growth. = foliage leaf; = cataphyll; = inflorescence; = prophyll. Note that in the two-dimensional diagrams, some prophylls are followed by leaves or cataphylls that appear superposed and all other organs appear distichous. This is not the case in life, where all organs are produced in three-dimensional phyllotactic spirals. Organ numbers within the dotted lines appear constant throughout the genus (except in species with solitary inflorescences); with respect to outside the dotted lines, a prophyll is a constant feature at the beginning of modules, but additional cataphylls may be present in either case between the prophyll and the first cataphyll of the synflorescence subunit.

may not be preceded by one or more vegetative cataphylls) or another bimodular synflorescence subunit. If a foliage leaf has been produced, the module may continue to produce foliage leaves and the flowering episode has consisted simply of two inflorescences - the usual case, for example, in *A. reversa.* Alternatively, the foliage leaf may be followed immediately by another pair of inflorescences and another relay axis with a single foliage leaf and so on, so that the flowering episode consists of a compressed sympodium of bimodular flowering units displaced into physiognomically lateral positions and interspersed with foliage leaves, as in *A. macrorrhizos.* If, however, the first relay axis is not initially vegetative, a second pair of inflorescences follows upon the first, and a third and fourth and so on, each arising from the axil of the cataphyll subtending the previous subunit. Eventually the flowering episode ceases and the last relay axis bears a foliage leaf, which emerges from the centre of a larger or smaller sympodial cluster of inflorescence pairs - up to about 20 in robust species such as *A. sarawakensis.* After rapid resumption of vegetative growth, the stem may bear a ring of physiognomically lateral infructescences below the leaf crown of the new vegetative module, e.g. in *A. robusta.*

The spathe is divided into a convolute thicker lower portion - the 'lower spathe' - housing the female zone of the spadix and persisting into fruiting, and a thinner, ephemeral open limb (this part is also convolute and persistent in some East Malesian species of the Xenophya Group). The two portions of the spathe are differentiated by a constriction so that the lower part is globose to ovoid. The spadix, as is the general case in Araceae, is protogynous and at the time of stigma receptivity the spathe constriction loosens, providing pollinators access to the pistils; simultaneously the inflorescence may emit a detectable scent - highly fragrant to an odour of decay - which appears to be produced from the inside of the lower spathe and not from the floral organs themselves (e.g. *A. alba*, *A. robusta*) or from the appendix (e.g. East Asian *A. odora* (Lodd.) Spach). At this time the spathe limb is generally erect. At the end of female anthesis, the spathe constriction closes and grips the spadix and scent production ceases. There is a sterile zone between the male and female zones of the spadix and typically the spathe constriction is level with this so that after female anthesis the female zone is isolated from the male zone. Male anthesis then occurs. The pollen is mealy and drops to collect between the lip of the limb and the spadix or in a trough-like annular fold that has developed at the base of the limb.

Pollination has not been observed in detail (but see van der Pijl (1933) who described pollinator attraction by deceit in *A. puber*), though one might speculate that in order to leave the lower spathe chamber, insects must force their way between the spadix and the spathe constriction and pick up pollen as they leave. However, while many species have the sterile zone of the spadix and the spathe constriction aligned, this is not universal. The Scabriuscula Group, for example, usually has part or even all of the male zone contained within the lower spathe chamber. What the implications of this are for pollination mechanisms and breeding systems is unknown.

The female zone of the spadix consists of naked pistils. The sterile zone, or interstice, is partly or entirely covered with truncate neuter organs (synandrodia), which often but not always appear to be of two types. The lower whorl(s) (with respect to the spadix) may be composed of smaller, often more prominent structures than the upper ones and they commonly react differently (remaining white) in alcohol to the wider upper ones which closely resemble the male flowers except for the absence of pollen thecae (Plate 1). This differentiation of the neuter organs is much clearer

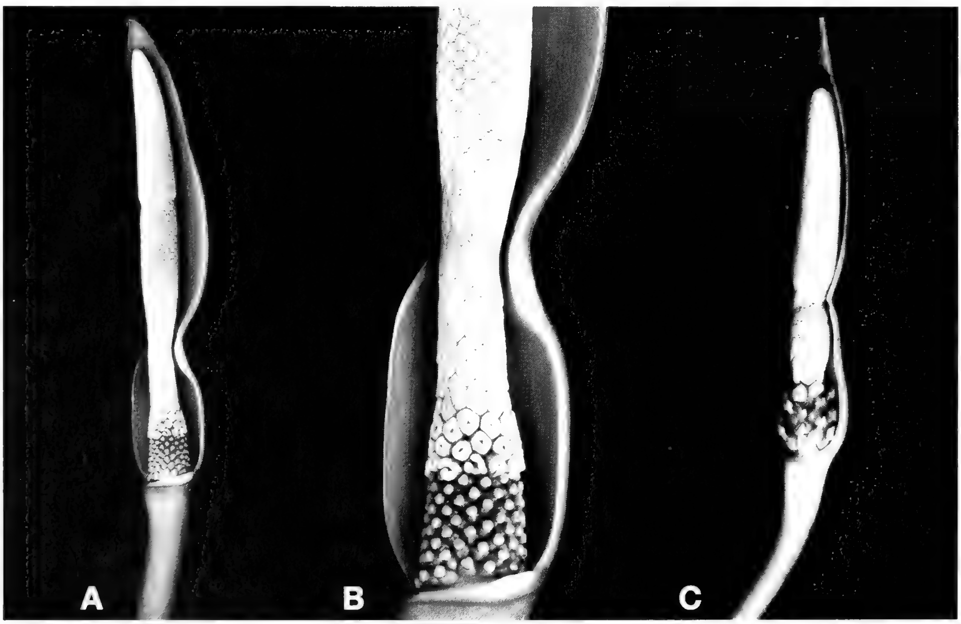

Plate 1. Inflorescence structure in *Alocasia*
A. Whole spadix of (extra-Malesian) *Alocasia odora* (Lodd.) Spach [RBG Sydney Acc. No. 940137, voucher NSW], ca. 25 cm long, showing, from the base, female zone, large sterile interstice, male zone of regularly hexagonal synandria and terminal appendix; lower spathe containing female zone and most of sterile interstice, constriction corresponding with upper part of interstice and limb subtending the male zone and appendix. B. Detail of lower part of same spadix showing interstice with basal free staminodial neuter organs, then connate staminodial organs and upper synandrodial neuter organs. C. Spadix of *A. principiculus* [*Hay et al. 12162*], ca. 5 cm long, with reduced sterile interstice of a few lax lower staminodial neuter organs and above, whorls of sterile synandria; remaining fertile synandria with pollen thecae visible as dark dots; both fertile zones contained within the lower spathe chamber. Pollen thecae not visible in *A. odora* as they are overtopped by the synconnective.

in *Alocasia odora*, and sometimes in *A. alba*, where the lowermost neuter organs are not in connate groups, but instead partially encircle the uppermost pistils clearly in the positions of staminodes. The next whorl (with respect to the spadix) of neuter organs consists of united 'staminodes' with a central hole, seemingly where the pistil would be. There is then one or more similar whorls followed by an abrupt transition to structures resembling sterile synandria. This situation closely resembles that in the relict *Protarum*, which differs in having all the pistils regularly subtended by staminodes. Comparison with *Protarum* suggests that the organs of the sterile interstice in *Alocasia* are differently derived in the lower and upper parts of that zone - in the lower part by connation of staminodes, in the upper by sterilisation of synandria. The rhombohexagonal synandria - fertile male flowers - are generally 4–6-merous and consist of connate truncate stamens. The body of the male flower is here termed the synconnective and the vertical pollen thecae are attached throughout their length to its flanks. Typically the thecae reach the top of the synandrium and open through apical pores. However, in some species the synconnective is expanded over the top of the thecae which release pollen from apical slits into the spaces between the synandria.

The upper part of the spadix forms a well-developed sterile appendix, which is at least sometimes thermogenic (as may be the male zone). The appendix surface is occasionally smooth, but is more usually sinuously, longitudinally and finely channelled - apparently formed of irregular elongate compressed synandrodia.

After anthesis, only the female part of the spadix and the lower spathe remain, the rest rotting and falling away. As the fruits develop and expand, the peduncle generally elongates and the lower spathe enlarges, sometimes becoming conspicuously coloured (e.g. *A. balgooyi* A. Hay). When the fruits ripen, the fruiting spathe dehisces to reveal them, analogous to arillate seeds in a capsule. The fruits are orange to red, odourless as far as is known, fleshy and contain one to several seeds a few millimetres in diameter.

Distinguishing *Alocasia* from *Colocasia*

Traditionally, these two genera, which are undoubtedly closely allied and frequently confused with one another, have been separated on the basis of ovule number and placentation - many ovules on parietal placentas in *Colocasia*, few on basal placentas in *Alocasia* (e.g. Mayo, Bogner & Boyce, 1997: 90). These rather academic states are not really of practical use in field identification. However, they translate in the fruiting plants into markedly different dispersal syndromes apparently (though not observed in West Malesia) involving birds in *Alocasia,* in marked contrast to the mammal dispersal syndrome of *Colocasia* where the fruits are smelly and inconspicuously coloured with many tiny seeds in slimy mucilage (see Hay, 1996).

In respect of synflorescence architecture, *Alocasia* may be readily distinguished from *Colocasia* by its bimodular synflorescence subunits. Inflorescence multiplication in *Colocasia* is achieved in such a way that the whole synflorescence is equivalent to one bimodular unit in *Alocasia*. Where the inflorescence terminating the vegetative module has only one further inflorescence in the axil of its subtending cataphyll in *Alocasia* (with the synflorescence being built up by relay axes), in *Colocasia* the second inflorescence has a third in the axil of its prophyll and so on up to ca. 8 in *Colocasia gigantea*. The relay axis in *Colocasia* is vegetative and thus the whole synflorescence is displaced to a quasi-lateral position on one side of the shoot.

Foci for Further Study

The iterative taxonomic process in the genus as a whole needs additional data - from further collections throughout the range but especially from Kalimantan, Aceh (Sumatera) and Sulawesi, and from additional data sources, such as macromolecular analysis. Three areas stand out as potentially fruitful subjects for intensive analysis - the problem of circumscribing two species groups and of developing biological species concepts in the genus.

First, the *Alocasia longiloba* complex: this is treated here as an ochlospecies - a taxon where locally discrete entities coexist but globally merge. Such taxa are being recognised under whatever label with increasing frequency in the Malesian flora. Whether this example is ontologically 'real' or whether the term is a smoke screen for the taxonomic 'too hard basket' (cf. Gentry, 1990), the *A. longiloba* complex is extremely interesting not only because of the enormous amplitude of its apparent continuum of variation, but also because of the large and fragmented land area, which the threads of the continuum pervade. On present understanding, forms may discreetly coexist in Sabah, for example, but merge in Sarawak, or discretely coexist in both Borneo and the Malay Peninsula, but merge in Sumatera. The precise nature and history of these patterns, uncovered at geological, ecological, morphological and molecular levels would doubtless provide valuable insights to speciation processes.

Second, the Scabriuscula Group: confined to Borneo, this group appears to be in active and recent speciation. There are two wide-ranging highly variable species, *A. scabriuscula* and *A. princeps*, rather narrowly differentiated from one another, each with a small set of diminutive, geographically confined and sometimes edaphically specialised segregates. Again, how the elements are related and what processes and historical events may be driving speciation and maintaining their differentiation are intriguing questions relating to the evolution of diversity in Borneo.

Third, the development of biological species concepts in the genus: *Alocasia* inflorescences are structurally and behaviourally complex and next to nothing is known in detail about how they work, beyond observations of spathe behaviour during the phases of anthesis (see above under 'Structure'). Mechanisms for biological species differentiation may reside in some or all of the following parameters (or indeed others) and their impact on pollinators and breeding systems:

- differing flowering times
- differing synflorescence architecture
- differing colours
- differing odours
- differing patterns of odour production during anthesis
- differing sources of odour in the inflorescence
- differing patterns of thermogenesis during anthesis (at least partly independent of odour production)
- differing sites of thermogenesis
- corresponding differing patterns of infra-red radiation and, perhaps, visibility
- differing proportions of staminodial and synandrodial neuter organs in the insterstice
- differing proportions of the fertile male zone within the lower spathe chamber.

Now that a preliminary taxonomic framework exists, the way is open for those resident in the region to be making comparative systematic studies of reproductive biology in the genus.

A Note on Types

Several types designated in this paper consist of specimens occupying more than one herbarium sheet or of paintings executed on more than one sheet. The ICBN clearly defines types as specimens (or images) and not sheets, bottles or any other incidental object whose status as an entity is defined merely by mechanics of curation and not by the biological nature of the specimens concerned. Many specimens of Araceae, and, of course, many other taxa, such as palms, are each preserved in numerous sheets, bags, bottles or combinations of those. This is a necessity arising from the size of the parts of many of the species, which are quite incompatible with standard herbarium methods of preservation based in the neatness of temperate twigs and wildflowers. While there may be some good reason for preferring that types be single objects, it would plainly be ludicrous in plants where only a fragment of a whole leaf can be mounted on a single herbarium sheet or where leaf and inflorescence require separate accommodation, to elevate one fragment of the same specimen to higher status than another or to altogether disqualify a complete and maximally informative specimen from serving as a type. It is beneficial to indicate the number of sheets, so that it is clear how many sheets should be examined.

ALOCASIA

Alocasia (Schott) G. Don in Sweet, Hort. Brit. Ed. 3 (1839) 631; Schott, Oesterr. Bot. Wochenbl. 2 (1852) 59; Miq., Fl. Ind. Bat. 3 (1855) 205; Schott, Syn. Aroid. (1856) 44; Schott, Prodr. Syst. Aroid. (1860) 144; Engl. in A. & C. DC., Monogr. Phan. 2 (1879) 497; Hook. f., Fl. Brit. Ind. 6 (1894) 524; Engl. in Koord., Meded. Lands Plantentuin 19 (1898) 299; Ridl., Mat. Fl. Mal. Pen. 3 (1907) 16; Koord., Exkurs.-Fl. Java 1 (1911) 261-261; K. Krause in Engl., Pflanzenr. 71 (IV.23E) (1920) 71; Merr., J. Straits Br. Roy. Asiat. Soc. special number (1921) 104; Koord., Fl. Tjibodas 6 (1922) 36; Ridl., Fl. Mal. Pen. 5 (1925) 97; Henderson, Mal. Wildfl. Monoc. (1954) 224; Backer & Bakh.f., Fl. Java 3 (1968) 118; A. Hay & Wise, Blumea 35 (1991) 503; nom. cons., non *Alocasia* Necker (1790), see Nicolson (1963) - *Colocasia* Schott sect. *Alocasia* Schott, in Schott & Endl., Melet.Bot. (1823) 18. - Type: *Alocasia cucullata* (Lour.) G. Don. (*Arum cucullatum* Lour.).

[*Ensolenanthe* Schott, Bonplandia 9 (1861) 368 - no binomials were proposed].

Xenophya Schott, Ann. Mus. Lugd.-Bat. 1 (1863) 124; Nicolson, Blumea 16 (1968) 116. Type: *Xenophya brancifolia* Schott ('*brancaefolia*') [= *Alocasia brancifolia* (Schott) A. Hay].

Schizocasia Schott ex Engl., Bot. Jahrb. Syst. 1 (1880) 186; K. Krause in Engl., Pflanzenr. 71 (IV.23E) (1920) 115; Bunting, Baileya 10 (1962) 112. Type: *Schizocasia acuta* Engl. [= *Alocasia brancifolia*].

Panzhuyuia Z.Y. Zhu, J. Sichuan Chinese Med. School 4 (5) (1985) 49 -

Type: *Panzhuyuia omeiensis* Z.Y. Zhu [= *Alocasia cucullata* (Lour.) G. Don].

Massive, sometimes arborescent, to small erect, decumbent or creeping terrestrial or lithophytic herbs with irritant juice; *stems* sympodial, sometimes bearing multiple cataphylls; *leaves* glabrous to scabrid or pubescent, solitary to multiple; *petiolar sheath* persistent to deliquescent; *leaf blade* simple, deeply pinnatifid to entire, sagittate to hastate to rarely almost lanceolate and then basally auriculate, peltate or not, sometimes strikingly coloured and/or bullate, membranous to strongly coriaceous or subsucculent; primary lateral veins pinnate, usually with conspicuous glands in their axils on the lower leaf surface; secondary venation reticulate, arising along the primary veins and costae, often uniting between the primary veins to form interprimary collective veins, or these ill-defined or absent; *inflorescences* sweet- to foul-smelling, rarely solitary, usually in pairs orientated parallel to the circumference of the stem, the pairs sometimes in series interspersed with leaves (with inflorescences appearing lateral) or interspersed with cataphylls (with inflorescences appearing as a terminal cluster); peduncles usually short or hidden within subtending leaf sheath or cataphyll, occasionally subequalling the petioles; *spathe* constricted; the limb persistent to deciduous, variably coloured purple to green, yellow or white, sometimes spotted or streaked; *spadix* stipitate or not, shorter than to subequalling the spathe; *female zone* free or sometimes partly adnate to the spathe; pistils naked; ovaries unilocular to (usually incompletely) plurilocular; stigma button-like to stellate, sessile or not; male and female zones separated by a *sterile interstice* of at least one (very rarely incomplete) whorl of sterile male flowers (synandrodia), more usually of several whorls, the lower morphologically and ?physiologically differentiated from the upper, the interstice usually but not always attenuate and corresponding to spathe constriction; *male zone* of mostly 4–6-sided male flowers composed of united stamens (synandria); *appendix* well developed, pointed to blunt, smooth to somewhat rugose; *fruits* mostly red to orange berries, contained within the persistent spathe base; fruiting spathe dehiscing at maturity; seeds ca. 3–5 mm diam., albuminous.

Distribution: Indomalesia, ca. 65 species with *A. macrorrhizos* (L) G. Don now naturalized pantropically; in Malesia 57 indigenous species and one widely cultivated (*A. cucullata*); 31 species in West Malesia and Sulawesi.

Habitat: Primary and secondary forests, early regrowth and open swamps, sometimes lithophytic, rarely rheophytic; primarily in everwet conditions, but some species tolerant of quite strong seasonality; predominantly in the lowlands, extending from sea level to lower and mid-montane zones.

Key to Species and Species Complexes

1a. Leaf blades not peltate 2
1b. Leaf blades distinctly (shallowly to completely) peltate in adult plants 22

2a. Secondary venation distinctly prominent abaxially *and* forming well-defined interprimary collective veins 3
2b. Secondary venation not prominent abaxially, or, if prominent, then *not* forming well-defined interprimary collective vein 5

3a. Petiole and abaxial leaf blade pubescent (Java, ?Sumatera, Malay Peninsula) .... **1. A. puber**
3b. Petiole and abaxial leaf blade glabrous in adult plants (beware juvenile *A. sarawakensis*) 4

4a. Lower spathe green; spathe constriction level with sterile interstice (Java) .... **18. A. alba**
4b. Lower spathe ivory, marked red-purple; spathe constriction within male zone (Borneo) .... **2. A. sarawakensis**

5a. Leaf blade membranous, often immense, abaxially waxy-glaucous (Borneo, Natuna Islands)... **3. A. robusta**
5b. Leaf blade of various sizes and textures, not waxy-glaucous (though sometimes abaxially grey-green) 6

6a. Leaf blade thickly coriaceous; posterior costae not naked in the sinus; all secondary venation obscure in the dry state; petiole finely pubescent (Sulawesi) .... **23. A. celebica**
6b. Not this combination 7

7a. Male zone of spadix completely exserted from lower spathe chamber (not Borneo except *A. macrorrhizos*) 8
7b. Male zone of spadix partly or wholly within lower spathe chamber (Borneo) 13

8a. Thecae of synandria not overtopped by synconnective (pores visible on surface of male zone); stigma stellate (with pointed lobes) (S. Malay Peninsula, E. Sumatera) .... **22. A. longiloba 'denudata'**
8b. Thecae of synandria overtopped by synconnective; stigma not lobed or lobes rounded 9

9a. Posterior costae (usually) with lamina to the sinus; spathe limb coriaceous; synandria very numerous and small (ca. 1 mm diam., dry); fruiting spathe (usually) red (Sulawesi) .... **19. A. balgooyi**
9b. Posterior costae naked in the sinus; spathe limb more or less membranous; synandria ca. 2 mm diam. or more (dry); fruiting spathe green 10

10a. Inflorescence pairs in a central cluster; leaves distinctly leathery coriaceous, either (rarely) purple throughout or with the petiole apically purple (Malay Peninsula, Sumatera) .... **17. A. inornata**
10b. Inflorescence pairs interspersed with foliage leaves; leaves more or less membranous and not thus coloured 11

11a. Secondary venation very fine but distinctly darker than abaxial ground colour, forming interprimary collective veins (Sumatera) .... **21. A. arifolia**
11b. Secondary venation not forming interprimary collective veins 12

12a. Massive plants with leaf blades ca. 80 cm long (or more); primary venation not gathered into a distinct intramarginal vein (widespread in association with people) .... **16. A. macrorrhizos**
12b. Smaller plants with leaf blades ca. 35 cm long; primary venation running into a distinct intramarginal vein (Java) .... **20. A. flemingiana**

13a. Leaf blade narrowly to broadly ovato-sagittate, nearly always stiffly leathery to subsucculent 14
13b. Leaf blade hastato-sagittate, triangular in outline, mostly rather thinly leathery 18

14a. Adaxially leaf blade grey-green and distinctly dark green about main veins 15
14b. Adaxially leaf blade of various colours but not variegated 16

15a. Abaxially leaf blade purple; anterior costa with ca. 6 primary lateral veins on each side, with conspicuous subsidiary veins (Sarawak, Semengoh) .... **31. Alocasia sp. A**
15b. Abaxially leaf blade not purple; anterior costa with 2–3 primary lateral veins on each side; subsidiary veins absent (S. Sarawak) .... **14. A. reversa**

16a. Inflorescence pairs solitary *and* secondary venation adaxially impressed (scattered in Borneo) .... **5. A. reginae**

16b. Inflorescence pairs clustered or if solitary then secondary venation not impressed 17

17a. Posterior lobes ca. half or more the length of the anterior; blade stiffly leathery (S. Sarawak - lithophytic on or terrestrial in close association with limestone) .... **8. A. ridleyi**

17b. Posterior lobes less than to ca. half the length of the anterior; blade thickly coriaceous to subsucculent; (widespread in Borneo - terrestrial and not especially associated with limestone) .... **4. A. scabriuscula**

18a. Terrestrial 19

18b. Lithophytic on limestone 20

19a. Petiole mottled with wavy oblique zones of dense brown lines, occasionally scabrid; spathe dusky brownish mauve, the limb darker; lower spathe narrowly ovoid; limb mostly narrowly lanceolate (Sabah) .... **10. A. wongii**

19b. Petiole variously and more or less haphazardly marked with lines and/or dots, smooth or occasionally faintly bumpy (glands), but not scabrid; spathe mostly ivory to yellowish ivory, variously marked or not with pink to purple, and/or purple-margined; lower spathe broadly ovoid; limb more or less oblong (widespread in Borneo) ...... **9. A. princeps**

20a. Male zone of spadix completely within lower spathe chamber; leaf blades distinctly grey-green adaxially (Sabah, E. Kalimantan) .... **13. A. principiculus**

20b. Male zone of spadix partly exserted from lower spathe chamber; leaf blades dark to bright green adaxially (Sabah) 21

21a. Leaf blade bright green adaxially; inner side of posterior lobe ovate; male zone more or less adjunct to female zone or interstice short, not attenuate, formed of 1–2 whorls of synandrodia resembling synandria .... **12. A. puteri**

21b. Leaf blade dark green adaxially; inner side of posterior lobe elliptic to narrowly ovate; interstice elongate, partly naked, with neuter organs resembling staminodes below and resembling synandria above .... **11. A. pangeran**

22a. Leaf blades more or less membranous and pendent, often solitary or only 2–3 together, often adaxially dark green with whitish major veins (sometimes adaxially concolorous), often purple-backed, shallowly to deeply peltate; stigma stellate with pointed lobes; insterstice corresponding with spathe constriction and male zone completely exserted 23

22b. Leaf blades variously coriaceous, pendent or not, few to several together, mostly not variegated, deeply to almost completely peltate; stigma not lobed or lobes rounded; interstice and part or all of male zone within lower spathe chamber (except *A. kerinciensis*) 24

23a. Petiole glabrous; spathe limb greenish white (widespread) .... **22. A. longiloba complex**

23b. Petiole minutely and densely pubescent; spathe limb purple-black (Sulawesi) .... **24. A. suhirmaniana**

24a. Leaf blades metallic greenish brown adaxially, bullate between primary veins; lower primary veins diverging at first at more than 90° (Sabah) .... **30. A. cuprea**

24b. Not this combination 25

25a. Adaxial leaf surface rugose with the tertiary venation raised (Sabah) .... **7. A. melo**

25b. Adaxial leaf surface smooth or with secondary venation impressed 26

26a. Adaxial leaf blade dark green with whitish impressed primary and secondary venation; spadix with appendix reduced (origin unknown) .... **6. A. reginula**

26b. Leaf blade not variegated, or if variegated then main veins and neighbouring blade darker than the rest; appendix well developed 27

27a. Leaf blade with conspicuous intramarginal and marginal vein 28

27b. Leaf blade with more or less conspicuous marginal vein only 29

28a. Blade broadly ovate to ovate, with the base rounded; male zone exserted from lower spathe (S.W. Sumatera) .... **29. A. kerinciensis**

28b. Blade broadly to narrowly elliptic, with the base cuneate; male zone within the lower spathe Borneo) .... **28. A. peltata**

29a. Primary lateral veins numerous, 8–10 on each side of midrib; secondary venation striate; (Sarawak - in peat swamp forest) .... **27. A. minuscula**

29b. Primary lateral veins much fewer; secondary venation clearly colocasioid, but not forming interprimary collective veins 30

30a. Leaf blade (ovate to) narrowly ovate to oblanceolate; connate posterior lobes attenuate; male zone of spadix within lower spathe chamber 31
30b. Leaf blade oblong-elliptic; connate posterior lobes cuneate; male zone only partly included within the lower spathe chamber (Sarawak - on limestone) 32

31a. Leaf blade (coriaceous to) thickly coriaceous to subsucculent, 14 x 6 to 34 x 12 cm; spathe ca. 6 cm long. (Malay Peninsula, usually above 1000 m) .... **25. A. perakensis**
31b. Leaf blade coriaceous, 9 x 2.2 – 18 x 6 cm; spathe ca. 4 cm long; (N.W. Borneo, usually below 1000 m) .... **26. A. beccarii**

32a. Leaf blade dark green throughout and somewhat darker around mid-veins; inflorescences to ca. 6 together; stigma mostly tri-lobed (Niah, Sarawak) .... **15. A. venusta**
32b. Leaf blade grey-green and dark blue-green around veins; inflorescences solitary to paired; stigma mostly bi-lobed (S. Sarawak) ... **14. A. reversa**

Puber Group

Species 1—3

Massive arborescent or decumbent plants; *leaves* several together, often hairy; *inflorescences* numerous in succession not interspersed with foliage leaves, usually with horizontal elliptic often dark red glands on the lower spathe; *male zone* of spadix held partly within lower spathe chamber.
Note: The group includes the three west Malesian species described below and Philippine *A. maquilingensis* Merr. The species are elements of gap phase, secondary forests and open swamps.

1. Alocasia puber (Hassk.) Schott

Alocasia puber (saepe '*pubera*') (Hassk.) Schott, Syn. Aroid. (1856) 47; Miq., Fl. Ind. Bat. 3 (1856) 209; Schott, Prodr. Syst. Aroid. (1860) 146; Engl. in A. & C. DC., Monogr. Phan. 2 (1879) 500; Koord., Exkurs.-Fl. Java 1 (1911) 261; K. Krause & Engl., Pflanzenreich 71 (IV.23E) (1920) 79; Koord., Exkurs.-Fl. Java 4 (1923) 197, fig. 398; Ridl., Fl. Mal. Pen. 5 (1925) 99; Backer & Bakh. *f.*, Fl. Java 3 (1966) 119. - *Colocasia pubera* Hassk., Cat. Bog. (1844) 302. - Neotype: Indonesia, Java, Djampangs, Cicurug, 1914, *Backer 17192* (BO, designated here).

Alocasia margaritae L. Linden & Rodigas, Ill. Hort. 33 (1886) 155; Anon., Kew Bull. (1888) 92; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 92. - Type: L. Linden & Rodigas, Ill. Hort. 33 (1886) t. 611. Epitype: Java, Desa Ciomas, Kampung Pabuaran, Serang, West Java, 12 Dec 1997, *Yuzammi 297017* (BO, NSW, designated here - see below).

Alocasia ovalifolia Ridl., J. Straits Br. Roy. Asiat. Soc. 41 (1904) 47; Ridl. Materials Fl. Mal. Pen. 3 (1907) 18; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 109; Ridl., Fl. Mal. Pen. 5 (1925) 99. - Type: Malaysia, Perak, Sungei Larut, July 1888, *L. Wray Jr. 2457* (SING, lecto, selected here; K, isolecto; see discussion below).

?*Alocasia crassinervia* Engl., Pflanzenr. 71 (IV.23E) (1920) 82. - Type: Indonesia, cult. Hort. Bogor, Jan/Feb 1906, *A. Engler 4101* (B!, holo) - see note under *A. sarawakensis.*

[*Caladium pubigerum* Bl., mss]

Robust to massive herb; *stem* erect to decumbent, to ca. 10 cm diam.; *leaves* several together; *petiole* to ca. 1.1–1.5 m long, sheathing in the lower ca. 1/3, green to dark red, sparsely glandular, it and abaxial lamina venation sparsely to densely hairy; hairs straight, short, ca. 0.5 mm long, colourless fresh, becoming yellowish brown when dry; *blade* usually sagittate, occasionally broadly ovato-sagittate, to ca. 80 cm x 70 cm; *anterior lobe* ca. 60 cm long, widest at about the base; anterior costa with ca. 10 primary lateral veins on each side, diverging at ca. 50°, with rather conspicuous glands in their axils; primary veins distally often bearing subsidiary veins (with glands in their axils) running the same course as the secondary venation; secondary veins rather prominent abaxially, numerous and close-spaced, running into well defined interprimary collective veins; posterior costae diverging mostly at ca. 90°, naked in the sinus for up to 4 cm; *posterior lobes* ca. 30 cm long, more or less triangular, rarely rounded; *inflorescences* appearing as clusters in the centre of the leaf crown, up to ca. 14 together not interspersed with foliage leaves; peduncle hardly exserted from subtending bracts; *spathe* ivory white, suffused purple, especially near the base of the limb margins, with scattered purple horizontal elliptic glands especially near the junction of spathe and peduncle, 9–18 cm long; lower spathe narrowly ovoid, somewhat angular in cross section, differentiated from the limb by an initially rather weak constriction about 1/3 of the way from the base of the spathe and corresponding to about midway along the length of the male zone of the spadix; limb more or less cucullate at first, leathery-membranous, broadly lanceolate with the tip obtuse, sometimes conspicuously apiculate, initially sharply reflexed at the base, forming an annular trough, the rest erect, then entirely reflexed; *spadix* slightly shorter than the spathe, ca. 6–15 cm long, very shortly stipitate; *female zone* 1–2 cm long, subcylindric; ovaries very pale green, subglobose, close-packed, ca. 1.2 mm diam., style short, slender, ca. 1 mm long; stigma ivory, cap-like, weakly 3–4-lobed; *sterile interstice* hardly more slender than the fertile zones, ca. 2 whorls of flat white synandrodia ca. 2 mm diam.; *male zone* yellowish ivory, half within and half exserted from the lower spathe chamber, ca. twice as long as female zone; synandria mostly rhombohexagonal and ca. 2 mm diam., sometimes united into irregular horizontal bands; synconnective impressed, not overtopping the thecae; *appendix* pale apricot, about half the length of the spadix, about as thick as the male zone, slightly narrowed at its base and distally tapering to a pointed tip; *fruiting spathe* ca. 4 cm long.

Habitat: In open swampy areas, and wet places in open forests, sea level to ca. 1000 m alt.

Distribution: West to central Java, ?southern Sumatera, Peninsular Malaysia.

Notes: 1. No Hasskarl material has been located that might be the type of *A. puber*. In the protologue, Hasskarl cited *Arum sylvestre* Rumph. (Herb. Amb. 5: 310, t. 107) as a synonym, but with doubt indicated by 'an'. Rumphius' concept of *Arum sylvestre* included more than one 'species', though only one was illustrated. The plate, which does not appear to be of a Javan plant at all, bears insufficient resemblance to *A. puber* in the sense of Schott and subsequent authors, to warrant using it as the type. It gives no indication of the characteristic features of pubescence on the leaves and horizontal red markings on the lower spathe that Hasskarl mentions for *C. puber* and, which indicate that Hasskarl's and Schott's concepts are almost certainly of the same species. Moreover, it shows a configuration of inflorescences paired amongs the leaves, which is also not characteristic of this species. It is probable that Rumphius' plate is of the east Malesian *Alocasia aequiloba* N.E. Br. Hence there is no alternative but to designate a neotype. There are very few fertile Javan collections to select from, *Backer 17192* being the most complete.

2. *Alocasia margaritae* L. Linden & Rodigas was described from Javan material cultivated in Europe. No herbarium material has been located. The illustration in the protologue is of a sterile, immature plant, but the description includes reference to the puberulent petioles typical of *A. puber* and the depicted leaf shape is not incompatible with that species. *A. margaritae* appears to be no more than a particularly strongly red-brown

coloured variant of *A. puber* and it is epitypified accordingly to remove all doubt.

3. The identity Ridley (1904) intended for *Alocasia ovalifolia* is obscured by various muddles. The description in the protologue is scant and sloppy. The leaf is said to have 20 pairs of 'nerves', which I understand to be primary lateral veins. I know of no species of *Alocasia*, with the exception of the gargantuan Bornean *Alocasia robusta* that has this many. The spathe is said to be up to six inches long, while the dimensions given for its components, the lower part and the limb, add up to four and a half inches. On top of these incongruities, the description records no distinctive features by means of which it could be matched with known Malay Peninsula species. Four syntypes were cited thus: 'Johore, base of Gunong Panti; Selangor, Tras Route at the 15th mile Pahang Track (*Ridley 8487*), Ginting Peras, Bukit Kutu; Perak, Sungei Larut (*Wray 2457*), Larut Hills; Penang, Moniots Road (*Curtis*).' All of these are missing from or perhaps misplaced in the Singapore herbarium and are not duplicated elsewhere, with the exception of *Wray 2457*. That specimen is of *Alocasia puber*, but it is not annotated by Ridley with any name and by no-one as *A. ovalifolia*. I suspect therefore that it was cited in error; indeed it was later cited as *A. puber* in Ridley's Flora, while other previously cited material remained under *A. ovalifolia* (Ridley 1925: 99). Other specimens, not syntypes but which might guide interpretation of *A. ovalifolia*, are equivocal. There are two collections made by Ridley and annotated by him with this name. One is *Ridley s.n.* (SING) with the locality 'Thaiping Hills'; this is *Colocasia esculenta*. The other is *Ridley 13392* (SING), collected at Batu Caves in 1908 (but not cited in the Flora). This latter is of a common Malay Peninsula species (see *A. inornata* Hallier *f.*) which seems very unlikely to have been overlooked by Ridley as a species distinct from other *Alocasia* in the Malay Peninsula. It seems probable to me, in spite of his bad description, his citation of *Wray 2457* and his misdetermination of a plant in another genus as *A. ovalifolia*, that the plant in *Ridley 13392* is what Ridley intended *A. ovalifolia* to be. Nevertheless, the ICBN demands lectotypification from among the syntypes (Art. 9.9). An alternative is not to lectotypify, and simply leave the issue open in the hope that the remaining syntypes turn up one day. However, since the name *Alocasia ovalifolia* has never been taken up by subsequent authors [Henderson and Furtado, for example, both misapplied other names to this species (i.e. *A. inornata*) on herbarium sheets, which suggests they had never seen the other syntypes either] and cannot be said to be in current use, there seems to be no pressing need to do other than simply dispose of the name on the basis of the identity of the one syntype that is available. *Alocasia ovalifolia* is therefore reduced to the synonymy of *A. puber*.

4. Backer & Bakh. *f.* (1968: 119) pointed out that the epithet '*pubera*' is grammatically incorrect, and amended it to *puber* without elaboration. It is evident that Hasskarl intended the epithet to refer directly to the hairiness of the leaves and peduncles, for in the description he used the adjectival '*puberis*' (in the ablative plural) referring specifically to those parts of the plant that are hairy. It would appear that he used the word as though it were a 'group A' adjective such as *glaber*, which it is not. *Puber* (or *pubes*) is used in mediaeval and classical latin as a noun referring to adolescence, and *puber* was used in classical latin specifically of plants as an adjective referring to juiciness (which Hasskarl also described in the protologue of this plant, but without using this word). In botanical latin *puber* (or preferably *pubes*) could be used as a substantive epithet for hairiness, and *puberula* as an adjectival epithet for hairy [see Oxf. Lat. Dict., ed. P.G.W. Clare, 1982]. Since Bakh. *f.* has already chosen one of these alternative corrected forms, I follow him.

5. *Alocasia puber* is apparently very rare in the Malay Peninsula, having been collected there only four times, and only once at all recently (*Chua FRI 26675*). Although Javan representatives have been collected more frequently, there is very little fertile material from which to judge intraspecific variability, but the Malay Peninsula element seems to have a rather smaller inflorescence. The collections made by Corner also show rather widely rounded posterior lobes to the leaf blade in contrast to the more typical triangular shape in Java, and it may be that the Malay Peninsula element could be recognised as a segregate subspecies once it is better known. However, it evidently has the same habitat preference as *A. puber* in Java.

6. A single collection from Sumatera (*Praetorius s.n.)* determined by Schott as *A. macrorrhizos*, is apparently of this or a closely allied species, being quite densely hairy on the leaf underside, with rather prominent secondary venation forming well defined interprimary collective veins. The specimen, from Palembang, is sterile

Other specimens seen: PENINSULAR MALAYSIA: Terengganu, Besut, Sg. Kemia, foothills of G. Lawit, *Chua FRI 26675* (KEP); Terengganu, Kemaman, Ulu Kajang, *Corner 30138* (SING); Johore, Mawai Rd., *Corner s.n.* (SING); Johore, Jason Bay, Mile 4, Block 1, *Sinclair 10869* (E, SING); Perak, Sg. Larut, *Wray 2457* (K, SING). SUMATERA: Palembang, *Praetorius s.n.* (L). JAVA: Tjidadapi Tjibeber, Preanger, Cadas Kabang, *Bakhuizen 2484* (BO); *Blume s.n.* (L) & *792* (L); Bidara Tjina, *Edeling s.n.* (BO); Tjiloewar, nr Bogor, *Hallier s.n.* (BO); Danau Situgunung, *Hay & Yuzammi 14001* (NSW); Djapara Ngarongan, *Koorders 34996b* (BO, L); Bantam, Lebakkidoel, G. Kantjana, *Koorders 41042b* (BO); *Kuhl & van Hasselt s.n.* (L); Djasinga, 45 km W of Bogor, *Nicolson 938* (BO); Tjitjadas, Batavia, *van Steenis 5364* (BO); Cult. Bogor, *Wigman s.n.* (BO); Blok Cimanuk, Rawa

Danau Natural Reserve, Serang, West Java, *Yuzammi 297013* (BO, NSW), *Yuzammi 297016* (BO, NSW); Desa Ciomas, Kampung Pabuaran, Serang, West Java, *Yuzammi 297007* (BO, NSW), *Yuzammi 297017* (BO, NSW); *Zollinger 472* (K).

2. Alocasia sarawakensis M. Hotta

Alocasia sarawakensis M. Hotta, Acta Phytotax. Geobot. 22 (1967) 159, fig. 6, G-L. - Type: Malaysia, Sarawak, Mardi, along Sungei Melinau, 14 Mar 1964, *M. Hotta 1439* (KYO, holo; n.v.)

[?*Alocasia crassinervia* Engl., Pflanzenr. 71 (IV.23E) (1920) 82. - Type: Indonesia, cult. Hort. Bogor, Jan/Feb 1906, *A. Engler 4101* (B, holo) - see note below.]

[*Alocasia puber* (*'pubera'*) sensu auct. non (Hassk.) Schott: Hotta, Acta Phytotax. Geobot. 22 (1967) 158.]

Massive arborescent herb; *stem* more or less erect, to ca. 15 cm diam., to 70 cm tall; *leaves* several together with the blades erect to oblique; *petiole* to 130 cm long, sheathing in the lower 1/3–2/5, pale dull green, very slightly rough, with numerous glands mainly in the sheathing portion, these ellipsoid, ca. 4 mm long, aligned along the axis of the petiole, red at first, later turning yellow, in juveniles often ringed with blackish purple; *blades* somewhat glossy mid-green above, paler below, glabrous in adult plants, abaxially hairy in juveniles, cordato-sagittate, ca. 90 cm x 80 cm; *anterior lobe* ca. 60 cm long, with the margins slightly undulate; *posterior lobes* ca. 35 cm long, rounded, held somewhat above the plane of the anterior lobe; posterior costae diverging at ca. 80–90°, naked in the sinus for ca. 2 cm; primary lateral veins 10–12 on each side of the anterior costa diverging at ca. 45°, their distal portions often emitting subsidiary veins, especially on side facing posterior lobes; secondary veins forming very well-defined interprimary collective veins; costae and primary veins whitish abaxially, green adaxially; primary and secondary venation very prominent abaxially, more or less flush adaxially; glands conspicuous in axils of primary veins and very large at junction of petiole with costae, yellowish green; *inflorescences* very numerous, to ca. 40 crowded in the centre of the leaf crown from within which the relay axis eventually appears, paired and subtended by somewhat persistent (thence marcescent-deliquescent) ca. 30 cm long lanceolate cataphylls bearing glands; peduncles ca. 30–40 cm long, mostly hidden within the cataphylls, with a few scattered glands, pale dull green, ca. 2 cm diam.; *spathe* ca. 19 cm long; lower spathe 7 cm x 2.5 cm and somewhat flattened, white with a basal ring of confluent glands, these at first shiny white, becoming purple, the remainder of the lower spathe with scattered ellipsoid glands aligned transverse to the long axis of the spathe and somewhat clustered at about 2/3 of the way up the lower spathe; spathe limb white, to 12 cm long, erect at female anthesis, then sharply reflexed and rolled back at male anthesis, broadly lanceolate, to 5 cm wide, horizontally wrinkled abaxially; *spadix* to ca. 16 cm long, stipitate for ca. 5 mm, stipe white; *female zone* 2.5 cm long ca. 1.5 cm wide at base, distally somewhat tapering; ovaries whitish ivory, sub-globose, ca. 1.5 mm diam; style very slender, ca. 1 mm long; stigma abruptly wider than style, ± rounded and inconspicuously 2–3-lobed, like the style, ivory; *sterile interstice* ca. 1 x 1 cm, hardly attenuate; synandrodia flat-topped, ivory, rhomboid, ca. 3 mm long; *male zone* 3 cm x 1 cm, partly within the lower spathe chamber; synandria ± hexagonal, opening by apical pores not overtopped by synconnective, 6–8-merous, ivory; *appendix* apricot coloured, 9 cm long, 1.5 cm diam., tapering to a point, the surface covered with horizontally elongate, sinuous staminodes; *fruiting spathe* white, dehiscing longitudinally; fruits red.

Distribution: Endemic to Borneo; in Sabah and Sarawak, with one doubtful record from Kalimantan.

Habitat: Common in open swampy places; often seen in roadside ditches; encountered in swampy places in forest as a hairy juvenile; from sea level to ca. 1200 m altitude.

Notes: 1. This species is easily distinguished from *A. robusta* and *A. macrorrhizos*, which sometimes all occur together and resemble each other in the very large broad leaves and preference for open habitats, by the very prominent venation on the abaxial side of the leaf blade, forming well defined interprimary collective veins. It can be distinguished further from *A. robusta* by having the posterior costae naked in the sinus and the abaxial side of the lamina not glaucous. However, occasional specimens are intermediate (e.g. *Agama & Valera 9887*): they suggest that some hybridization may take place where the two species occur together.

2. *Alocasia sarawakensis* is far more common that the meagre number of herbarium collections would suggest, perhaps because it (and *A. robusta*) is mistaken for *A. macrorrhizos* and threrefore not considered worth collecting. Aside from the leaf venation characteristics, it is amply distinguished from *A. macrorrhizos* by the basically white spathe with red markings, and by the arrangement of the inflorescences in a large central cluster, where the spathe of *A. macrorrhizos* is green and yellow, and the inflorescence pairs are interspersed with foliage leaves. Moreover, while

A. sarawakensis (and *A. robusta*) are found widely in disturbed places, *A. macrorrhizos* is hardly ever encountered more than a short distance from human habitation, suggesting that it is not a native Bornean plant at all, while *A. sarawakensis* and *A. robusta* are Bornean endemics (the latter also in the Natuna Islands).

3. *Alocasia crassinervia* Engl. was described from a seedling cultivated at Bogor, said to have been from Borneo. The type consists of a single early juvenile pubescent leaf, which could be from *A. sarawakensis*. However, it could equally be a juvenile of *A. puber*, which grows in the vicinity of Bogor. In the event that it could be demonstrated clearly that the type of *A. crassinervia* is of the Bornean species, I would recommend conserving the name *Alocasia sarawakensis*.

4. I have not seen the Bornean specimens determined by Hotta (loc. cit.) as *A. puber* (*Hotta 14175* and *14231*), but it seems highly probable that these hairy sterile plants are juveniles of *A. sarawakensis*. The only collection of this species from Kalimantan *(Burley et al. 596)* is identified with some doubt, as the usually characteristic persistent horizontal glands on the lower spathe appear to be lacking. The specimen is in fruit. The leaf matches this species more than any other known Bornean element.

Other specimens seen: SABAH: Semporna, Timbun Mata F.R., *Agama & Valera 9887* (K, SING); Kinabatangan Besar, Kori Timber Camp, *Cuadra A2144* (all seedlings: BO, KEP mixed - see also *A. robusta*, K, L, SING); Sepilok, Forest Research Centre grounds, *Hay 10010* (SAN, spirit only); Lahad Datu Rd, ca. 10 mi ex jnct Sandakan-Kota Kinabalu Rd, *Hay 10013* (SAN); Cult. RBG Sydney Acc. No. 950366 ex Ulu Dusun, *Hay 10029* (NSW); Cult. RBG Sydney Acc. No. 950374, Madai Falls, *Hay 10037* (NSW); Cult. RBG Sydney Acc. No. 960547 ex Tibau Forest Station, Kinabatangan, *Hay 12138* (NSW); Cult. RBG Sydney Acc. No. 960577 ex 2.5 km above Maliau Falls, G. Rara F.R., *Hay 12056* (NSW); Cult. RBG Sydney Acc. No. 960597 ex Kinabatangan, Kalabakan Virgin Jungle Reserve, *Hay 12017* (NSW); Semporna, Timpun Mata F.R., Mapat R., *Keith BNB 7419* (A, KEP, K, L). KALIMANTAN: Headwaters of Sg. Kahayan, 5km N.E. of Haruwu Vill., *Burley et al. 596* (KEP, K, SING).

3. Alocasia robusta M. Hotta

Alocasia robusta M. Hotta, Acta Phytotax. Geobot. 22 (1967) 159, fig. 6, A-F; A. Hay in Plant Talk 5 (1996) 25, un-numbered photo. - Type: Malaysia, Sarawak, Bintulu, at the foot of Bukit Kana, 22 Nov 1963, *M. Hotta 15502* (KYO, holo - n.v., L, iso).

Colocasia gigantea sensu auct. non (Bl.) Hook.*f*.: Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 178 & Merr., Enum. Bornean Pl. (1921) 107.

Gigantic arborescent herb to palmiform tree to 6 m tall with clear sap that almost instantly turns orange on contact with air; *stem* erect to decumbent, 15–30 cm diam. (the base swelling to ca. 40 cm), smooth; *leaves* several together; *petiole* smooth, somewhat glaucous, pale green to pinkish brown, ca. 1.5–3.5 m long, sheathing in the lower 1/3, with scattered flat ± circular glands; *blade* ovato-sagittate, ca. 1.5–4 m long, ca. 80 cm to 2.5 m wide, slightly glossy mid-green adaxially, abaxially waxy glaucous, the margin entire to slightly sinuate; *anterior lobe* up to ca. 3.2 m long, widest at the base; anterior costa with 10–18 primary lateral veins diverging at ca. 70–80°; secondary venation not prominent, not forming interprimary collective veins; *posterior lobes* to ca. 90 cm long, rounded; posterior costae diverging at ca. right angles, bearing lamina right into the sinus (in juveniles peltate until leaf blades are ca. 30 cm long); *inflorescences* ca. (10–)30–40 crowded together in the centre of the leafy crown, subtended by robust broadly lanceolate deliquescent to marcescent cataphylls; peduncles stout, hardly exserted from the cataphylls, ca. 15–20 cm long; spathe to ca. 20 cm long, constricted at ca. 4–5 cm from the base; lower spathe pale greenish ivory with few to numerous shiny colourless to (?or becoming) dark red horizontal glandular markings, ovoid, ca. 2.5 cm diam.; limb cowl-like, by male anthesis the base sharply reflexed then the rest erect, forming a pollen-filled trough at the bottom, deep purplish pink to greyish ivory faintly suffused pink, ca. 15 cm long x 6 cm wide; *spadix* somewhat shorter than the spathe, ca. 15–19 cm long, sessile to very shortly stipitate; *female zone* subpyramidal, trigonous, 2–3 cm long, ca. 2 cm diam at base, tapering to ca. 1.5 cm diam. distally; pistils ivory; ovary subglobose, faintly longitudinally ridged, ca. 1.5 mm diam.; style slender, ca. 0.5 mm long or absent; stigma button-like to faintly 3–4-lobed; *sterile interstice* slightly wider than female zone, reduced to 1–2 whorls of small yellow synandrodia with the staminodes incompletely fused; *male zone* ca. 4 cm long, much expanded (ca. 2 cm diam.) in the part distal to the spathe constriction, below the spathe constriction ca. 1.2 cm diam; synandria rhombohexagonal, 1.5–2 mm diam., ivory, with the thecae overtopped by the synconnective; *appendix* dirty pale yellow to ivory, slightly constricted at base, narrower than distal part of male zone, tapering gradually to a fine point; *fruiting spathe* whitish, sometimes borne quasi-laterally in a ring on the trunk below the leaf crown and then pendulous, the spathe dehiscing longitudinally; fruits reddish orange, rather small, ca. 4 mm diam., mostly single-seeded.

Distribution: Widespread in Borneo, though mainly in the northwest, and with one record from the Natuna Islands.

Habitat: Wet but well-drained open disturbed places, road sides, plantations, river banks, land slides, canopy gaps in lowland to lower montane forest.

Notes: 1. A magnificent arborescent herb with, in the biggest examples, certainly the largest undivided leaf of any herbaceous plant (not counting the habitually tattering leaves of the biggest Musaceae) and challenging the few palms with large undivided leaves. It is strikingly glaucous on the underside. It is common and widespread in northern Borneo at low elevations, and it is remarkable that it was not described until 1967. From a distance it resembles, but is much larger than, *A. macrorrhizos*, with a rather similar subtriangular ovato-sagittate leaf outline, which may account for it having been overlooked. Vegetatively it may be distinguished by the posterior costae with lamina to the sinus and the glaucous abaxial side to the lamina. The seedlings, even when quite large, have peltate leaves with the undersides glaucous and the whole glabrous (cf. *A. sarawakensis*). The inflorescences are very different from those of *A. macrorrhizos*, both in their clustered arrangement, and the thick marcescent/deliquescent cataphylls (bits of which often adhere to the open spathe), the ivory horizontally red-marked lower spathe and the thick greyish to purplish limb.

2. Though they are morphologically almost identical, plants I have observed in the living state in Sarawak and Sabah differ in the spathe limb colour and inflorescence odour. In the former, the spathe limb is purple and the inflorescence smells of decomposing beef extract; in the latter, the spathe limb is sometimes greyish, slightly suffused with purple, and sweetly fragrant. This may suggest that they are biologically differentiated by having differing pollinators, and warrants further investigation. In plants at Sepilok, I observed that the odour is produced from the inside of the lower spathe, not the spadix.

3. The sap turns orange on exposure - a feature not common in *Alocasia*, but known in allied *Colocasia gigantea.*

4. Possible hybridity with *A. sarawakensis* was noted under that species. *Hay 10039* (cult. RBG Sydney Acc. No. 950376) appears in the vegetative state to be intermediate between *A. robusta* and *A. wongii*. At the Madai Falls, Sabah, the two putative parents grow together.

5. Ridley's Bornean record of *Colocasia gigantea* (reiterated by Merrill, loc. cit.), was based on a sighting at 'Byte Estate' near Sandakan, with no

specimen preserved. *Colocasia gigantea* is unknown in Borneo, but bears some resemblance to *Alocasia robusta* - particularly in the large size and glaucousness of the leaf blade. It seems probable that Ridley, who was interested in Araceae, would have encountered *Alocasia robusta*, which is a common plant in northern Borneo, and I can only assume that this record is his misidentification of it.

Other specimens seen: NATUNA ISLANDS: Pulau Bunguran, E of G. Ranai, *van Steenis 1117* (BO); SARAWAK: Cult. RBG Sydney Acc. No. 940569 from Kubah National Park, Matang, *Hay et al. 9416* (NSW). BRUNEI: Temburong Prov., Batu Apoi F.R., *Poulsen et al. 43* (E, K). SABAH: Mt Kinabalu, E shoulder, *Chew et al. 574* (K); Lahad Datu Rd, ca. 10 mi from jnct Sandakan-Kota Kinabalu Rd, *Hay 10012* (SAN); Cult. RBG Sydney Acc. No. 950378 ex Madai Falls, *Hay 10041* (NSW); Elopura, Leila Rd., Sandakan, *Kadir A2698* (KEP, SING). KALIMANTAN: Central East Borneo, W. Koetai, No 45 Kombeng, *Endert 5234* (BO, K, L).

Scabriuscula Group
Species 4—7

Small to very robust lithophytic to terrestrial herbs; *leaves* coriaceous, leathery to subsucculent; petioles glabrous to scabrid, occasionally pubescent, often ornamented with purple lines, dots and circles; secondary venation generally flush with the lamina abaxially and adaxially, sometimes impressed adaxially, sometimes prominent abaxially; *inflorescences* (2–)several to many together not interspersed with foliage leaves; *spathes* typically with the ground colour white to ivory or yellowish, occasionaly brownish pink throughout, with purple dots and/or margins, sometimes the limb wholly suffused purple to brown, usually constricted at a level well above the sterile interstice of the spadix, sometimes level with the interface of the male zone and the appendix; *spadix* typically ivory throughout - including the ovaries; stigmas typically with two drop-shaped lobes suberect; *fruiting spathe* generally white.

Notes: 1. This group is endemic to Borneo and appears closely allied to the more widespread but less speciose Puber group, sharing the multiple inflorescences, white, often purple-marked spathes constricted in the male zone. The Puber group is relatively different ecologically, however, evidently associated with open sites, disturbed places and the gap phase of forest, while this group generally is associated with more shaded situations (though *A. scabriuscula* itself is sometimes found in open sites).

2. The Scabriuscula Group is taxonomically difficult, with, as currently understood, two widespread highly variable species, *Alocasia scabriuscula*

and *A. princeps,* and a number of local segregates, which may be difficult to differentiate morphologically at the extremes of their variation. Interpreting herbarium material is exceptionally difficult in this group. There is a strong need for more field-based data on their ecology, phenology and pollination biology. Only *Alocasia melo, A. principicula* and *A. reginula* are very clearly defined morphospecies, the latter known only from cultivated plants.

3. A curious feature of the Scabriuscula Group, noted already for the Puber Group, is the common positioning of the spathe constriction above the base of the male zone of the spadix such that all or part of the male zone is held within the lower spathe chamber. More usually in this genus, the spathe constriction corresponds in position with the sterile interstice and tightening of the constriction between female and male anthesis appears to be a mechanism that precludes self-fertilisation, preventing pollen from falling into the lower spathe chamber. It might seem that the arrangement of (some of) both fertile zones within the lower spathe chamber could allow self-fertilisation, which might in turn promote the formation of local entities through inbreeding. However, self fertilisation does not appear to take place in this group, as cultivated plants do not set seed spontaneously (though in the field there does seem to be an extremely high level of fruit production). Moreover, the *A. longiloba* complex (q.v.), which also has highly complex variation patterns, has the more usual relationship between the sterile interstice and the spathe constriction. Whatever the explanation, both these groups appear to be undergoing active evolution.

4. Alocasia scabriuscula N.E. Br.

Alocasia scabriuscula N.E. Br., Gard. Chron. 12 (2) (1879) 296; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 179; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 79. - Type: Cult. RBG Kew ex N.W. Borneo, Aug 19 1879, *N.E. Brown s.n.* (K, holo, 3 sheets).

Alocasia imperialis L. Linden ex N.E. Br., Gard. Chron. n.s. 21 (May 1884) 711 - *Alocasia guttata* var. *imperialis* (L. Linden ex N.E. Brown) N.E. Br., Ill. Hort. 31 (Dec 1884) 185, t. 541. - Type: Cult. Comp. Cont. d'Hort., Gand, 10 Sep 1884, *Anon. s.n.* (K, holo).

Alocasia guttata N.E. Br., Ill. Hort. 31 (Dec 1884) 185, syn. nov. - Type: Cult. Hort. Veitch ex Lawas R., N.W. Borneo, Jan 1879, *N.E. Brown s.n.* (K, holo, 2 sheets).

Alocasia villeneuvei L. Linden & Rodigas, Ill. Hort. 34 (1887) 59; Anon., Kew Bull. (1888) 92 ('*villaneuvii*'); Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 179; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 86; Merr., Enum. Bornean Pl. (1921) 106 ('*villanuevei*'). - Type: Ill. Hort. 34 (1887) t. 21. Epitype: Brunei Darussalam, Temburong, Gunong Retak, 13 Mar 1991, *R.J. Johns 6721* (K, designated here).

[*Alocasia porphyroneura* auct. non Hallier *f.*: Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 100, p.p. quoad specim cit. *Hallier 328*]

[?*Alocasia reginae* sensu auct. non Linden ex N.E. Br.: M. Hotta, Acta Phytotax. Geobot. 22 (1967) 156 ('*regia*')]

Robust herb ca. 0.5–1.2 m tall; *rhizome* ca. 5–10 cm thick; *leaves* several together; *petioles* typically spreading and proportionately rather short - about equalling the length of the blade, ca. 40–100 cm long, smooth to scabrid or sparsely to densely minutely pubescent, rarely plain pale grey-green, usually ornamented with irregular sparse to dense purple-brown dots, circles and longitudinally aligned broken fine lines, sheathing in the lower ca. 1/3; *blade* ovato-sagittate to broadly ovato-sagittate, ca. 40–85 cm long, adaxially dark to light grey-green and sometimes conspicuously darker along the main venation, abaxially pale grey-green to rich purple, occasionally flushed purple on both surfaces, very thickly leathery to almost succulent; *anterior lobe* widest at ca. 1/4 of the way distal to the petiole insertion, the apex acute to obtuse; anterior costa with (4–)5–8 primary lateral veins on each side diverging at 45–60° and with conspicuous green, purple or purple-ringed axillary glands, these sometimes also present in the axils of the larger secondary veins; secondary venation ± flush with the lamina to somewhat impressed on both surfaces (depending on thickness of blade), often abaxially obscure or conversely sometimes conspicuous through pigmentation of the bordering lamina, forming more or less well-defined interprimary collective veins; *posterior lobes* ca. 1/3–1/2 the length of the anterior, usually acute, sometimes rounded, the inner sides usually narrowly to very narrowly oblanceolate, sometimes wider becoming ovate; posterior costae diverging at 60–120°, naked in the sinus for ca. 2–4 cm, rarely with lamina to the sinus, but never peltate as adult plants; *inflorescences* several together in a tight low cluster; peduncle hardly or not exserted from the subtending cataphylls and leaf sheaths; cataphylls ovate, rather fleshy, often marked like the petiole; *spathe* greenish to yellowish white to ivory, often speckled purple, sometimes suffused purple throughout or the limb purple, (7–)9–10 cm long, constricted (2–)2.5–3(–5) cm from the base; lower spathe thick, narrowly to broadly ovoid; limb oblong to ovate, 2–3 cm wide, eventually completely reflexed, the tip apiculate to acuminate for 1.5 cm; *spadix* very shortly stipitate for ca. 1.5 mm, (5.5–)6–7 cm long; *female zone* (1–)ca. 1.5 cm long, subcylindric to slightly conic, squat, (0.8–)1.2–1.5 cm wide at base; ovary pale green to cream, ovoid, 1–2 mm long; style slender, 0.5–1 mm, facing diagonally out- and up-wards; stigma cream (turning yellow in spirit) mostly 2-lobed; *sterile interstice* (4–)7–8 mm long, somewhat narrower than female zone at base and ca. 3–4 mm diam., narrowly obconic, basally ca. 2 whorls of somewhat lax white subcylindric synandrodia ca. 1.5 mm diam., distally composed of ca. 3 whorls of synandrodia ca. 2–3 mm diam., closely resembling synandria; *male zone* ivory, ca. 1.5–2 cm long, 5–7 mm diam., often somewhat constricted level wth spathe constriction, (1/4–)1/3–1/2 (–2/3) within the lower spathe chamber; synandria 2–3 mm diam., rhombohexagonal to somewhat irregular; thecae not overtopped by synconnective; *appendix* ivory, (2–)2.5–3 cm long, tapering to slightly spindle shaped, 5–7 mm diam. at base, the tip usually slightly obtuse; *fruiting spathe* ca. 4.5 cm long broadly ovoid, white, usually speckled purple.

Distribution: Endemic to Borneo, widespread.

Habitat: Lowland forest to hill forest to ca. 1200 alt., often in disturbed areas, in swampy to well-drained sites, river banks, occasional on roadsides and in plantations.

Notes: 1. As conceived here, this is a highly variable species. Typical forms have ovatsagittate and thick, dark to mid grey-green leaves with the inner sides of the posterior costae very narrowly oblanceolate. These forms conform with the type of *A. guttata* N.E. Br. Rather less common are large forms with well developed, broad posterior lobes, which conform with the type of *A. scabriuscula.* There are intermediates. There is also very considerable variation in the thickness of the leaf blade, from distinctly though rather thinly leathery, to blades almost 5 mm thick and virtually succulent. The petiole varies considerable in texture from finely pubescent to scabrid to smooth.

2. *Alocasia scabriuscula* s. l. is only narrowly distinguished morphologically from *A. ridleyi* (q.v.), which has relatively longer posterior lobes, longer peduncles, a more slender inflorescence and is a limestone element confined to SW Sarawak.

3. Of the specimens cited below, *Beaman et al. 7451* is tentatively ascribed to this species. It differs in the rather long posterior lobes, long peduncles

and paired infructescences. *Hay 9381* has unusually thinly textured leaves and atypically small inflorescences, with the spathe only ca. 7 cm long, but conforms in other respects. *Poulsen 235* is evidently taken from an exceptionally robust plant, as the lower spathe is ca. 5 cm long.

4. There are a number of colour variations, including specimens with red-purple leaf undersides or the leaves entirely suffused with purple (e.g. *Afriastini 406*).

5. No original material has been found that could serve as a type of *Alocasia villeneuvei*. The protologue, though singing the praises of this plant in horticulture, contains almost no botanical information. However, it is attributed to Borneo. Dimensions are not given, but the plant is clearly robust. The description does mention brown spotting on the petioles, which is clearly apparent in the illustration. This feature is found in some forms of the *A. princeps* complex, and to varying intensity in *A. sarawakensis*, *A. reginae* and *A. scabriuscula*. The illustration is not of high quality, but *A. sarawkensis* can be eliminated as there is no sign at all in the plate of that species' conspicuous interprimary collective veins. Moreover, it is hardly ornamental. The leaves are too broad and the petioles relatively too short for any larger forms of the *A. princeps*. *Alocasia reginae* is small and characteristicaly has the inner side of the posterior costae narrowly lanceolate, while the plant depicted has broadly developed lamina there, which matches the type of *A. scabriuscula*. Furthermore, the upper side of older leaves is depicted dark dull grey-green which is also typical of this species. *Alocasia villeneuvei* is therefore epitypified accordingly. The epitype, *Johns 6721*, has broad posterior lobes, matching well those apparent in the original illustration of *A. villeneuvei.*

6. *Alocasia imperialis* and *A. reginae* may have been first described by Linden, just prior to N.E. Brown, in an 1883 or 1884 catalogue of the Compagnie Continentale d'Horticulture Gand. However, I have not been able to locate the relevant issues. The plants were exhibited by the Compagnie in May 1884 at the International Exhibition of the Imperial Society of Horticulture at St Petersburg, on which Brown reported in the Gardener's Chronicle in the same year, describing (validly but unintentionally) *Alocasia imperialis*. There he also mentioned and briefly described *A. reginae*, but said it was the same species as *A. imperialis*, thus invalidating it.

Other specimens seen: SARAWAK: Santubong, *Carrick & Enoch JC/191* (SING); Cult. RBG Sydney Acc. No. 940505 ex Niah Caves area along track from Niah town, *Hay et al.*

9354 (NSW); Cult. RBG Sydney Acc. No. 940471 ex 2.5 km past Kemena R. bridge on Bintulu-Sibu Rd., *Hay et al. 9317* (NSW); Cult. RBG Sydney Acc. No. 940531 ex Kg Sentah, nr Kuching, *Hay et al. 9381* (NSW); Kuching, *Hewitt 6* (SING); Semunsan Wildlife Sanctuary, *Kiew RK885* (KEP); Anap, Ulu Muput Kanan, path to Bukit Kemantan, *Paie S19507* (US); Matang, *Ridley s.n.* (SING); Santubong, *Ridley s.n.* (SING). BRUNEI: Temburong Distr., Bukit Biang, *Forman 897* (K) & *931* (K); Temburong, Batu Apoi F.R., Sg Baki, *Poulsen 108* (K); Temburong, Batu Apoi F.R., Sg Temburong, *Poulsen 235* (K) SABAH: Ranau Distr., Pinosuk Plateau, W Mesilau R. at waterworks dam, *Beaman et al. 7451* (K, US); Cult. RBG Sydney Acc. No. 960516 ex 2.5 km above main Maliau Falls, G. Rara F.R., *Hay et al. 12045* (NSW); Cult. RBG Sydney Acc. No. 960520 ex Kinabatangan, Kalabakan VJR, *Hay et al. 12006* (NSW). KALIMANTAN: Central Kalimantan, sei Sampit, Kualakuayan, *Afriastini 406* (BO); Pulau Lemoehoetan, *Hallier 328* (L).

5. Alocasia reginae L. Linden ex N.E. Br.

Alocasia reginae L. Linden ex N.E. Br., [Gard. Chron n.s. 21 (1884) 711 ('*regina*'; invalidly published - not accepted by author)]; Ill. Hort. 32 (1885) 11, t. 544; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 82 ('*regina*'). - Type: Cult. RBG Kew ex Hort. Compagnie Continentale d'Horticulture Gand, Nov 1883, *N.E. Brown s.n.* (K, holo).

Small herb 20–30 cm tall; *rhizome* ca. 1.5 cm diam.; *leaves* 2–4 together; petiole 10–25 cm long, sheathing in the lower 1/4–1/3, sparsely to densely minutely pubescent, green to densely spotted purple; blade broadly ovato-sagittate to ovato-sagittate, 13–25 cm long, thickly leathery, dark green, paler abaxially or flushed purple throughout; margin entire to slightly and irregularly sinuate; *anterior lobe* widest ca. 1/3 of the way from the base, the apex acute to obtuse and then apiculate; anterior costa with 3–4 abaxially pubescent primary lateral veins on each side diverging at 60° (proximal)–45° (distal) and with small axillary glands; secondary venation adaxially impressed, abaxially flush with the lamina to somewhat impressed (dry), conspicuous and apparently broad (ca. 1 mm) owing to pigment in the bordering lamina, forming mor-or-less well-defined interprimary collective veins at least in the outer part of the blade; *posterior lobes* 1/3–2/5 the length of the anterior, the inner sides very narrowly oblanceolate; posterior costae naked in the sinus for 4 mm to 1 cm, basally diverging at ca. 90–100° then somewhat to abruptly back-turned; *inflorescence* pairs solitary; peduncles ca. 1/3 the length of the petiole at anthesis (not or hardly elongating in fruit), subtended almost throughout their length by very narrowly lanceolate cataphylls; *spathe* ca. 5–7 cm long, constricted ca. 1.5–2 cm from the base; lower spathe ovoid, white, sometimes spotted purple; limb narrowly ovate, white and spotted to suffused purple; *spadix* distinctly shorter than to subequalling the spathe, sessile, ca. 5 cm long; *female zone* 1 cm long; pistils flask-shaped; style short, ca. 0.5 mm; stigma 2–3-lobed; *interstice* 3–5 mm long, partly naked to covered with synandrodia;

male zone subcylindric, 9–15 mm long ca. 1/4–3/4 held within the lower spathe chamber; synandria rhombohexagonal, ca. 1.5 mm diam.; thecae not overtopped by synconnective; *appendix* 1–2 cm long tapering to somewhat obtuse, ca. 3 mm diam (dry); *fruiting spathe* ovoid, ca. 2.5 cm long.

Distribution: Endemic to Borneo, known from only three–localities in Sarawak and Central Kalimantan.

Habitat: On the floor of primary lowland rain forest: *Jermy 13579* on alluvial soil with residual limestone karst; ca. 40–270 m altitude.

Notes: 1. This species is evidently closely allied to the variable *Alocasia scabriuscula*, differing in the smaller size overall, inflorescences in single pairs, relatively much longer peduncle and the long, narrow inflorescence cataphylls.

2. The description is pieced together from four incomplete collections. The type differs from the only other flowering specimen, *Jermy 13579*, in having a larger proportion of the male zone exserted from the lower spathe and in having the interstice covered with synandrodia.

3. Hotta (1967: 156) cited several specimens from Brunei and Sarawak as this species. I have not seen any of the collections concerned, but it would appear from his notes (loc. cit.), in which he gives significantly larger dimensions, that these specimens are probably of *A. scabriuscula.*

4. *Alocasia reginae* has been in cultivation in the U.S.A. for some years, under the name *Alocasia* Elaine. An image may be found at http://www.skg.com/alocasia4.html, and the cultivar is also illustrated in Burnett (1984: 77, fig. 4).

Other specimens seen: SARAWAK: Limbang Distr., Sg. Terikan, *Chew 1183* (GH, K, L, SING); G. Mulu National Park, around Sg. Berar Camp, *Jermy 13579* (K). KALIMANTAN: Headwaters of Sg. Kahayan, 5 km NE of Haruwu Village, *Burley et al. 527* (GH).

6. Alocasia reginula A. Hay, *sp. nov.*

Ab *Alocasia melo* folii lamina atrovirida haud rugosa, nervis albidis impressis, spathae lamina et appendice valde brevioribus differt. - TYPUS: Cult. U.S.A., Florida, Jul 1998, *D. Fisk s.n.* (NSW, holo).

Small herb to ca. 25 cm tall; *leaves* several together; *petioles* ca. 18 cm long, sheathing in the lower ca. 1/3; *blade* elliptic to ovate, ca. 15 cm long, 8–11 cm wide, thickly coriaceous, almost completely peltate save for a shallow retuse notch between the tips of the connate posterior lobes, apically acute to obtuse and mucronate for ca. 1 cm, adaxially very dark matt green, abaxially paler and flushed purple; anterior costa with 2–3 primary lateral veins on each side, diverging at ca. 90° (proximal ones) to 45° (distal ones); primary veins adaxially whitish, somewhat impressed, abaxially with inconspicuous axillary glands; secondary venation somewhat impressed adaxially, more or less flush with the lamina abaxially (the larger ones somewhat prominent abaxially in the dry state and adaxially whitish), forming interprimary collective veins towards the margin only; *posterior lobes* about 2/5 the length of the anterior, with the posterior costae diverging at ca. 30°; *inflorescences* paired, subtended by short, broad cataphylls; peduncle very short, hidden within cataphyll; *spathe* ca. 5* cm long, white with scattered purple flecks on the lower part; lower spathe ca. 2.5 cm long, ovoid to subcylindric, separated from limb by a rather weak constriction; limb much reduced, erect even after anthesis, broadly lanceolate, ca. 2 cm long; *spadix* sessile, somewhat shorter than spathe, ca. 4.5* cm long; *female zone* about 1/4 of the length of the spadix; *sterile interstice* a single whorl of close-packed synandrodia, not attenuated; *male zone* cylindric, about half the length of the spadix, about 2/5 as wide as long, ivory; synandria with the thecae not overtopped by synconnective; *appendix* about 1/4 of the length of the spadix, much reduced, narrowly conic; *infructescence* unknown.

Distribution: ?Borneo (see notes).

Habitat: Unknown.

Notes: 1. This plant is known only in cultivation, but it is clearly quite distinct from any known species. It exhibits few if any characteristics which might suggest that it is of hybrid origin, and is therefore described here as a new species. The description is based on dried leaves sent to me by Mr Dewey Fisk (Florida) and on images posted on the internet (http://u1.netgate.net/~kk/Araceae/Alocasia/Black_Velvet.html and http://www.skg.com/alocasia2.html). Since there is no scale on the images, the dimensions above indicated '*' are estimates. *Alocasia reginula* is well-established in cultivation under the U.S.A. trade-mark cultivar name Black Velvet, and has been successfully micropropagated (see http://www.agristarts.com/tech.htm).

2. The origin of *Alocasia reginula* is unclear. Scott Hyndman (*pers. comm.*),

who named the cultivar, obtained material from Lyon Arboretum in Hawaii purportedly having been in turn obtained from a Japanese collector in Borneo. In aspect it appears to belong in the Bornean *A. scabriuscula* group.

3. The specific epithet means 'little queen', following the several regal epithets that have been used in this group.

7. Alocasia melo A. Hay, P.C. Boyce & K.M. Wong

Alocasia melo A. Hay, P.C. Boyce & K.M. Wong, Curtis's Bot. Mag. 14 (1997) 82, pl. 315. - Type: Cult. RBG Kew from material collected in Sabah, Malaysia by Mrs S. Collenette s.n., Accession No. 1960 - 443 (holotype K, isotype K spirit coll. no. 22427!).

Small herb ca. 25–35 cm tall; *stem* to ca. 3 cm diam., erect, short; *leaves* to ca. 4 together, their bases overlapping; *petiole* ca. 14–19 cm long, pale green, glabrous, smooth, sheathing and sparingly purple-spotted in the lower 1/5; wings of sheath rather broadly triangular; leaf *blade* very broadly ovate to sub-orbicular, 18–25 cm x 15 cm, rugose and bullate and deep somewhat bluish green adaxially, smooth and pale greenish white abaxially, coriaceous, almost completely peltate; *anterior lobe* ca. 12.5–16 cm long, the tip broadly acute to obtuse and then shortly acuminate for ca. 1 cm and/or apiculate; *posterior lobes* to 8.5 cm long, united for 75–90% of their length; posterior costae diverging from one another at ca. 20–30°, poorly developed and not or hardly differentiated in size from the primary venation arising from the anterior costa; primary lateral veins 3–4 on each side of anterior costa, diverging at 90° (most proximal) to 45° (most distal), adaxially deeply impressed, abaxially more or less flush with lamina and dark green, irregularly bearing veins intermediate in thickness between primary and secondary venation, running the same course as the latter; secondary venation deeply impressed adaxially, abaxially somewhat raised and concolorous with abaxial lamina, arising at a wide angle (c. 80°) from the primary venation and running to form quite well-defined interprimary collective veins; tertiary venation strongly raised adaxially into an irregular honeycomb pattern, abaxially imperceptible; *inflorescences* paired, subtended by conspicuous broadly lanceolate persistent cataphylls ca. 8–10 cm long; peduncle ca. 5 cm long; *spathe* ivory-white, 9–16 cm long, constricted slightly less than half way from the base; lower spathe purple-spotted, especially towards the insertion of the peduncle, ovoid, ca. 1.5 cm wide; spathe limb broadly lanceolate, strongly reflexed by male anthesis, the tip acuminate for ca. 1 cm, margins translucent, the entire limb swiftly withering and marcescent (in cultivation; probably deciduous or deliquescent in nature); *spadix* shortly stipitate, much shorter than spathe, ca. 5 cm long, with the male and female zones enclosed within the lower spathe; *female zone* 1.2 cm long, 1.3 cm wide at base, tapering distally; ovaries pale green, ca. 1.5–2.2 mm diam., ovoid; style virtually none, stigma 2–3-lobed, orange-brown; *sterile interstice* much narrower than female zone, ca. 5 mm long, 1.2 mm thick, bearing a few somewhat distant white synandrodia; *male zone* cylindric, pale ivory-white, 1.3 cm long, 4–6 mm thick; synandria rhombohexagonal, 1–2 mm across; thecae not overtopped by synconnective, opening by apical pores; *appendix* ivory-white to pinkish, cylindric-subclavate, 1.7 cm long, 4 mm thick; *fruiting peduncle* ca. 12 cm long; fruiting spathe ovoid, ca. 4 cm long; ripe fruit unknown.

Distribution: Endemic to Sabah, Borneo.

Habitat: Rain forest on ultramafic rock: in rock crevices and on thin soil along steep banks of fast-flowing streams, 120–400 m.

Notes: 1. This species is the only one so far known to be confined to ultramafic substrate, though Sulawesi *Alocasia balgooyi* (qv) shows a rather strong association with it.

2. The peculiar finely and strongly rugose adaxial leaf surface appears to be unique in the genus, and *A. melo* would appear to have potential for horticultural exploitation.

Other specimens seen: SABAH: Labuk, Sg. Porog, *Collenette 502* (K); Cult. Royal Botanic Gardens Sydney, Acc. No. 960489 ex Tongod, G. Tingkar, *Hay & Wong 12001*, (NSW); Beluran, Porog, W side of Bidi Bidu nr Kubar Labuk, *Meijer 41241* (K, L, SAN); cult. Royal Botanic Gardens Sydney, Acc. No. 950381 ex Tongod, G. Tingkar, *Radin s.n.* (NSW, sterile).

Alocasia princeps Complex

Species 8—15

Very robust to small terrestrial or lithophytic herbs; *petioles* smooth to asperous, sheathing in the lower 1/9–1/3, concolorous and bright mid-green to purple-brown or variously marked with oblique zones of close-spaced longitudinal brownish lines or with scattered longitudinal thin or thick purple-black lines and dots; *blades* triangular to narrowly triangular in outline, hastato-sagittate to sagittate, rarely ovato-sagittate, mostly rather thinly leathery to strongly coriaceous, but not subsucculent, usually very dark green adaxially, occasionally grey-green; secondary veins mostly flush with the lamina adaxially and abaxially, occasionally abaxially somewhat prominent and adaxially slightly impressed, not forming interprimary collective veins, or these poorly formed and then only towards the blade margin; posterior lobes about 1/3 to subequalling the length of the anterior, acute, the inner side ovate to very narrowly lanceolate (lamina rarely almost entirely lacking on inner side of poserior costa); posterior costae naked in the sinus; *inflorescences* (2–)several– ca. 10 together, not interspersed with foliage leaves; *spathe* usually white to ivory to pale yellow throughout, marked with purple dots on the lower spathe, the limb often with a thin purple margin, or spathe dirty pinkish brown and then sometimes sparsely mottled darker and with the limb darker in colour throughout, or spathe greenish; *spadix* sessile, somewhat shorter than the spathe, pistils usually somewhat acroscopic, ovoid, close-packed to barely touching one another, mostly ivory to pale yellow-green throughout (including stigma); style slender; stigma 2(–3)-lobed, the lobes drop-shaped and suberect to spreading; *interstice* sometimes partly naked or with the synandrodia loosely packed, or densely covered with synandrodia; *male zone* subcylindric, often partly to wholly within the lower spathe chamber, ivory; synandria with the thecae not overtopped by synconnective and opening by apical pores; *appendix* ivory to very pale violet; *fruiting spathe* (ovoid to) globose, more or less the same colour as the flowering lower spathe, 2–5 cm diam., dehiscing longitudinally from the top.

Distribution: Endemic to Borneo; there widespread, but with a concentration of variation in northwest Borneo. *Alocasia princeps* itself is widespread (though it is interpreted here rather broadly, particularly with respect to material from Kalimantan), while *A. ridleyi*, *A. wongii*, *A. pricipiculus, A. puteri* and *A. pangeran* are localised segregates.

Notes: 1. This complex consists of a number of very similar, closely related elements and presents the greatest difficulties for interpretation of species limits in the genus. Members of the complex cohere in their relatively long, erect petioles, narrowly triangular leaf blades, which are thinly leathery to leathery but not subsucculent (cf. *A. scabriuscula*), relatively elongate inflorescences with tapering appendices (cf. *A. scabriuscula*). In other respects, the group is very similar to *A. scabriuscula*, and *Alocasia ridleyi* is intermediate, approaching it in its stiffly leathery leaves and relatively short, squat inflorescences. Nevertheless in aspect that species is fairly clearly nearer to *A. princeps* than to *A. scabriuscula*. Within the limitations imposed by the material that there is to work with and the timetable for this Flora Malesiana precursor, the treatment of this group, more than any other, should be regarded as no more than a basis for further studies, not only in the way of further collecting and field observation, particularly in Kalimantan, but also studies both at the lower, molecular level, and at the higher, ecological level of population and pollination biology. It is not unreasonable to speculate that this group is in active speciation.

2. Where I have been able to study the plants in the field and in cultivation, it has been possible to recognise species segregated from *A. princeps s.l.* Given the difficulties of interpreting herbarium material in this group, I suspect that study of living plants in or from other parts of the range would enable the recognition of further segregates - particularly in Kalimantan Selatan, and further refinement of the concept of *A. princeps*.

3. Members of the *Alocasia princeps* complex have been frequently misidentified as *Alocasia denudata* (see *A. longiloba* 'denudata'), which is restricted to southern Malay Peninsula and Sumatera, and which is not closely related to *A. princeps*. They can be quickly differentiated on the basis of the spathe, which in *A. longiloba* 'denudata' is green in the lower part and yellowish in the limb, while in this group the spathe is generally ivory coloured with various patterns of purple, and by the stigmas, which are stellate and 3–4-lobed in the *A. longiloba* group and generally bi-lobed with drop-shaped lobes in the *A. princeps* complex. *A. longiloba* has distinctly membranous cataphylls, becoming papery and fibrous on drying, whereas those of this group are comparatively leathery in the fresh state.

8. Alocasia ridleyi A. Hay, *sp. nov.*

Ab *Alocasia scabriuscula* in habitu calcicola, folii lamina plus producta, minus crassa, superne atro-viridi, spatha valde albida vel rosea differt. - TYPUS: Cult. RBG Sydney Acc. No. 940541 ex Malaysia, Sarawak, Bau, *Hay et al. 9388* (NSW, holo; iso, K, KEP, L, SAR, SING (to be distributed)).

[?*Alocasia denudata* auct. non Engl.: Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 178.]

Small to robust herb ca. 45–ca. 1 m tall; *rhizome* 3–6 cm thick; *leaves* several together; *petioles* 35–50(–85) cm long, smooth or rarely scabrid, suberect to somewhat spreading, pale green and unmarked or with few to dense purple-brown dots and lines to flushed purple-brown throughout, sometimes with scattered small circular glands, sheathing in the lower ca. 1/5; *blade* narrowly ovato-sagittate to ovato-sagittate, ca. 15–30(–50) cm long; stiffly leathery, dark green adaxially and shining when young, becoming dull, paler abaxially; *anterior lobe* widest ca. 2–6 cm distal to petiole insertion; anterior costa with 3–4(–6) primary lateral veins, diverging

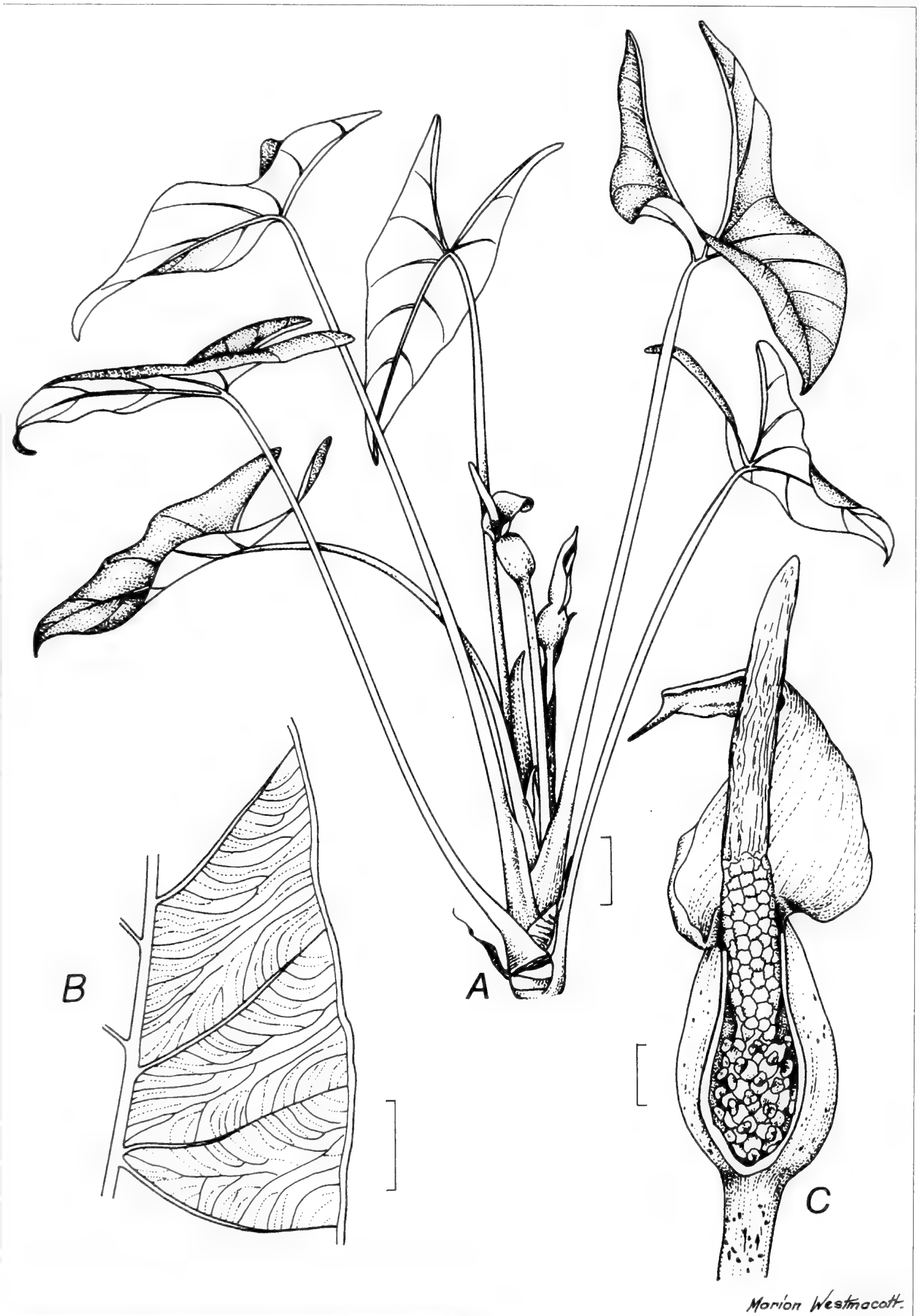

Figure 3. ***Alocasia ridleyi* A. Hay**
RBG Sydney Acc. No. 940541 - A. habit; B. venation; C. inflorescence with part of spathe removed. - Scale: A, bar = 4 cm; B, bar = 2 cm; C, bar = 8 mm.

at ca. 70° (proximal ones) to 50° (distal ones); axillary glands conspicuous (when petiole heavily pigmented) or not (when petiole not so); secondary venation flush on both surfaces, or very slightly prominent abaxially, not or hardly forming interprimary collective veins (these sometimes present in robust specimens); *posterior lobes* more than 1/2 to subequalling the length of the anterior, the inner sides narrowly to very narrowly (ob)lanceolate; posterior costae diverging at 60–90°; *inflorescences* several together; peduncle ca. 8–15 cm long, somewhat exserted from the cataphylls; *spathe* white to pink, sometimes with purple spots, 7–10(–13) cm long; lower spathe ovoid to pyriform, 2–4 cm long; limb oblong-lanceolate, erect then completely reflexed; *spadix* somewhat shorter than the spathe, very shortly stipitate for 1.5 mm, 6–9 cm long; *female zone* 1.5–2 cm; ovaries subglobose, close-packed, ca. 2 mm diam.; style very short, 0.25–0.5 mm long; stigma 2–3-lobed, turning yellowish in spirit; *interstice* 0.5–1 cm long, slightly attenuate, 4–5 mm diam., composed of 2–3 whorls of more or less close-packed rhombo-hexagonal synandrodia ca. 1.5–2 mm diam.; *male zone* 1.5–2 cm long, 1/4–1/2 within the lower spathe chamber, usually slightly constricted level with the spathe constriction; synandria ivory, rhombo-hexagonal, ca. 2 mm diam.; *appendix* tapering, 2–3 cm long, slightly narrower than male zone, 5–6 mm diam. at base; *fruiting peduncle* elongating, to ca. 13 cm long; fruiting spathe broadly ovoid, white, sometimes with red spots; longitudinally dehiscent; fruits orange-red.

Distribution: Restricted to S.W. Sarawak.

Habitat: In forest on limestone at low elevation.

Notes: 1. *Alocasia ridleyi* is named for H.N. Ridley, who took a special interest in Aroids of Borneo (Ridley, 1905), and who was the first to collect this species.

2. *Alocasia ridleyi* is evidently very closely allied to *A. scabriuscula*, which also has ovato-sagittate leathery leaf blades and narrowly lanceolate posterior lobes. It differs in the very dark green adaxial leaf surface, relatively longer petioles, relatively narrower leaf blades and somewhat more elongate posterior lobes. The leaves are stiffly coriaceous, but are not subsucculent as those of *A. scabriuscula* often are. The spathe is recorded as white to pink, whereas that of *A. scabriuscula* is generally greenish white to yellowish, speckled with purple (though the latter feature is sometimes present in *A. ridleyi*, as indeed it is in several species in this group). In all these respects, this species is somewhat intermediate between A. *scabriuscula* and *A. princeps*. These differences seem quite trivial, but

they are correlated with a restricted geographic distribution and association with limestone substrate. Even within its restricted distribution, *A. ridleyi* exhibits a high level of variability; *Nicolson 1285* is exceptionally robust.

Other specimens seen: SARAWAK: Seburan, Bau, *Anon. 14596* (K); Ist Division, Bukit Rawan, Tebakang area, *Awa & Paie S45245* (K); nr Bau, *Bogner 1433* (US); Bau, *Brooke 9895* (L), *10797* (BM, L); Bidi Cave, *Clemens & Clemens 21920* (BO, K); Cult. RBG Sydney Acc. No. 940545 ex G. Gading, Lundu, *Hay et al. 9392* (NSW); Bukit Krian [?= G. Kerian], *Madison 7344* (K); Bau limestone hills, G. Setiak (SE of G. Doya), *Martin S38666* (K); vicinity of Bau, *Nicolson 1285* (L, US); Bau, *Purseglove P4467* (GH, K, L, SING); Bau, *Ridley 11715* (K, SING); Cult. RBG Sydney Acc. No. 942741 ex Bau, *Vogel s.n.* (NSW).

9. Alocasia princeps W. Bull

Alocasia princeps W. Bull, Retail List (1888) 7; ?N.E. Brown, Kew Bull. (1889) 76. - Neotype: Malaysia, Sabah, Mt Kinabalu, Dallas, 27 Aug 1931 *Clemens & Clemens 26213* (BM, neo; K, SING, isoneo; designated here - see below).

Alocasia porphyroneura [Engl. ex Hallier *f.*, Bot. Jahrb. Syst. 25 (1898) 25, nom. nud. & Notizbl. Koenigl. Bot. Gart. Berl. 2 (1898) 185, nom. nud.] Hallier *f.*, Bull. Herb. Boiss. ser. 2, 1 (7) (June 1901) 671, nom. illeg. (incl. *A. princeps* W. Bull); Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 100; M. Hotta, Acta Phytotax. Geobot. 22 (1967) 156.

Robust to very robust herb ca. 0.8–1.8 m tall; *rhizome* ca. 5–10 cm diam.; *leaves* ca. 4 together; *petioles* suberect, to ca. 1.6 m long, sheathing in the lower 1/4–1/3, smooth to slightly rough but not scabrid, dark brownish green, very faintly mottled with an oblique wavy pattern, paler distally, varying to thickly and densely, haphazardly marked with longitudinally aligned purple-brown lines and dots, occasionally with few scattered slightly raised circular glands ca. 2 mm diam.; *blade* to ca. 55 cm long, leathery but not subsucculent, dark green and shining at least when young, paler and sometimes more or less faintly flushed purple beneath, hastato-sagittate, triangular to narrowly triangular in outline, the margin entire to slightly sinuate and undulate; *anterior lobe* widest at base; anterior costa with 3(–5) primary lateral veins on each side diverging at ca. 60°, often purple-tinged, with conspicuous axillary glands; secondary venation flush on both surfaces, fine and usually purple-tinged, not or hardly forming interprimary collective veins; *posterior lobes* subequalling the anterior, narrowly lanceolate to ovate; posterior costae diverging at ca. 90°; *inflorescences* several (ca. 6) to numerous together, subtended by somewhat leathery marcescent green to pinkish or chocolate brown cataphylls marked similarly to the petioles; *spathe* white

Figure 4. ***Alocasia princeps* W. Bull**
RBG Sydney Acc. No. 950357 - A. habit; B. venation; C. petiole ornamentation; D. inflorescence with part of spathe removed. - Scale: A, bar = 5 cm; B, bar = 2 cm; C, bar = 4 mm; D, bar = 8 mm.

to yellowish ivory, ca. 11 cm long, constricted at ca. 3 cm; lower spathe ovoid, somewhat to densely spotted purple; limb oblong lanceolate, usually with purple margins, occasionally pink-tinged to bright purple throughout, reflexed and rolled back, the tip acuminate for 1–2 cm; *spadix* ivory throughout or the female zone very pale green, distal parts sometimes suffused rose, very shortly stipitate for ca. 2 mm, ca. 8 cm long; *female zone* ca. 1.5 cm long, subcylindric, ca. 1 cm diam.; ovaries subglobose, ca. 1.5 mm diam.; style ca. 0.5 mm, slender; stigma mostly bi-lobed, yellowing in spirit; *interstice* ca. 5 mm long, slightly attenuate, ca. 4 mm diam.; synandrodia lax and ca. 1 mm diam. in the lower 2 mm, the remainder 2–3 dense whorls of more or less rhombohexagonal synandrodia; *male zone* ca. 2 cm long, 1/2 within the lower spathe chamber, subcylindric, somewhat constricted level with the spathe constriction, ca. 5 mm diam.; synandria rhombohexagonal, ca. 1–2 mm diam. (larger in the lower part of the zone), ivory; *appendix* 3.5–4 cm long, slightly narrower than the male zone, 4–5 mm diam., tapering gradually to a point, ivory to flushed pink; *fruiting peduncle* to ca. 20 cm long; fruiting spathe broadly ovoid, ca. 3–4 cm diam, white, sometimes spotted purple.

Distribution: Widespread and common in Borneo.

Habitat: In rain forest generally on well-drained slopes and ridgetops, on a variety of substrates including basalt and limestone, from more-or-less sea level to ca. 1200 m altitude.

Notes: 1. *Alocasia princeps* was described from a sterile plant from 'the Malay Archipelago' in an 1888 retail horticultural catalogue produced by the British nurseryman William Bull. The description is by no means exhaustive but nevertheless is quite detailed about leaf texture, shape and colour, and it does not seem to fit anything other than the species defined here. The following year the description appeared in Kew Bulletin, very slightly re-worded, in an anonymously compiled list of the previous year's new plants. Since N.E. Brown was the aroid authority at Kew at the time, it seems quite probable that he contributed at least those plants to that list, if not compiled the list entirely himself. Hallier (loc. cit.) had seen *A. princeps* growing at Kew (though not until 1897) and considered it the same as his *A. porphyroneura*. Hallier evidently did not think *A. princeps* had been properly published, but since it had been, and since he placed it, albeit attributed to Brown and not Bull, in the synonymy of *A. porphyroneura*, I conclude that the latter is superfluous.

Although Brown usually preserved material of new aroids in cultivation at Kew, no identifiably original material nor illustration exists, which fixes the application of *A. princeps* or can directly assist in its interpretion. The leaf is described as having 'deeply sinuate' margins, which is extreme for this species, in which the leaf margin is usually more or less entire, sometimes somewhat undulate and occasionally shallowly sinuate (Hallier described the leaf margin of *A. porphyroneura* as repand-sinuate and strongly undulate, which fits better the states I have observed). However, 'deeply sinuate' is perhaps open to a variety of interpretations, and the state may even have been somewhat exaggerated by Bull for marketing purposes. Although, as has been said, there is no original material bearing this name at K, a sterile specimen nevertheless exists there obtained from Bull, allegedly originating from the Philippines, dated Aug 11 1887 and with Bull's number 4454/5. It is simply annoted '*Alocasia*' in Brown's hand. It matches Bull's catalogue description of *A. princeps* closely (except that the leaf margin is shallowly sinuate), and is clearly not Philippine, conforming exactly to *Alocasia princeps* in the sense here. It seems likely that this specimen is from the original plant Bull introduced and perhaps only subsequently called *Alocasia princeps*.

Since Hallier had seen what is presumed to be the original plant and considered it the same as *A. porphyroneura*, which he had described in considerable detail and of which he had preserved material, I consider that *A. princeps* should be neotypified accordingly. This interpretation is to some extent further supported by the only preserved material I have come across originally annotated with this name: a plant cultivated at the Peradeniya Gardens, Ceylon, collected by Alston in 1926 (*Alston 794*, K!) and which clearly falls within the present concept of *A. princeps*. The designated neotype collection is one of few that is fertile, of known wild provenance and that exists in duplicate.

Other specimens seen: SARAWAK: Betong, Saribas F.R., *Anderson 8507* (L); Hose Mts, Mujong, Ulu Temalad, *Ashton S17639* (L); Simpang Tiga, Ulu Mayeng, Kabu, *Chai S19219* (US); Baram Distr., G. Api foothills, *Chew 1099* (GH, K, SING); Lingga, *Hullett s.n.* (SING); 4th Div., Garden of Eden, Mulu National Park, *Primack S42403* (K). BRUNEI: Temburong Distr., Sg. Temburong at Kuala Belalong, *Boyce et al. 384A* (K); Temburong, headwaters of Sg. Temburong to NE Guning Retak, *Johns 6733* (K); Temburong Prov., Batu Apoi F.R., Sg. Belalong, *Poulsen 18* (K); Temburong Prov., Batu Apoi F.R., Sg. Enkiang, *Poulsen 264* (K). SABAH: Kudat Distr., Pulau Balembangan, NE inner side of Telok Lung, *BCS-EFA-LM et al.* (sic) *SAN 86716* (L); Mt Kinabalu, Ulu Liwagu and Ulu Mesilau, *Chew et al. 1954* (K, SING); Mt Kinabalu, Dallas, *Clemens & Clemens 26134* (BO) & *26268* (BM, SING); Penibukan, *Clemens & Clemens 30519* (BM, SING) & *31161* (BM, K, SING) & *32095* (BM, BO, GH, L, SING); Mabul Isl., *Creagh s.n.* (K); Moyog, along rd Kota Kinabalu-Tambunan, 24 mi SE of Kota Kinabalu, *Croat 53102* (MO); Kinabatangan Besar, Kori Timber Camp, *Cuadra A2153* (BO, K, KEP, L, SING); Nungkok Mt, *Darnton 443* (BM); Kinabalu, Tenompok, *Clemens & Clemens 29148* (BM, BO, GH, K, L) & *29149* (BM, SING) & 29150 (SING)); Cult. RBG Kew EN 441-63 ex Sapong estate, nr Tenom, *Giles & Woolliams s.n.* (K); Cult. RBG Sydney Acc. No.950357 ex Kinabatangan, Gua Batu Puteh, *Hay et al. 10015* (NSW; fertile voucher SAN); Cult. RBG Sydney Acc. No. 960560 ex 2.5 km above main Maliau Falls, G. Rara F.R., *Hay et al. 12039* (NSW). Cult.

RBG Sydney Acc. No. 960467 ex Tibau Forest Station, Kinabatangan, *Hay et al. 12140* (NSW); Lahad Datu, Selangan Island F.R., Semporna, *Keith A1519* (K, KEP, L) & *7658* (SING) & *9281* (KEP, SING) & *9286* (KEP); Bajau, Mt Sidungol, *Keith 9295* (K, KEP, SING) Keringau Distr., Camp C area Tiulan, *Maikin Lantoh 102054* (K); Ranau, ca. 3 mi NW of Kg Pinawanti, *SAN 76856* (K). KALIMANTAN: Sungei Utung, *Amdjah 356* (BO); East Kalimantan, Balikpapan, PT. ITCI area, *Darnaedi 431* (BO); Kalimantan Selatan, G. Halauhalau (G. Besar), Pegunungan Meratus, Barabai, *Dransfield 2870* (BO); Kalimantan Selatan, Djaro Dam, Muara Uja, *Dransfield & Saerudin 2210* (BO) & *2217* (BO); Kalimantan Selatan, 2km S of Djaro Dam, Muara Uja, *Dransfield & Saerudin 2296* (BO); Central East Borneo, W. Koetai, *Endert 2702* (BO, L); Cult. Hort. Bogor, *Hallier s.n.* (BO); Lombok Utan, *Hallier 358* (BO, L); Amai Ambit, *Hallier 3455* (BO); East Kalimantan, Loa Haur, W of Samarinda, *Kostermans 6810* (BO, K); East Kalimantan, Nanukan Island, *Kostermans 8784* (BO); Kutei, G. Beratus, piek van Balikpapan, *Meijer 653* (BO); East Kalimantan, Nunukan, N of Tarakau, *Meijer 2033* (BO) & *2168* (BO) & *2300* (BO)

10. Alocasia wongii A. Hay, *sp. nov.*

Ab *Alocasia princeps* inflorescentia tenuiore, spatha brunneo-rosacea, spathae lamina fusca, inflorescentia mascula minus exserta, petiolo *Alocasia longiloba* 'denudata' simulans sed tenuiore saepe aspero differt. TYPUS: Cult. RBG Sydney Acc. No. 960457 ex Madai Caves, *Hay et al. 12180* (NSW, holo: iso, K, KEP, L, SAN – to be distributed).

Terrestrial herb ca. 60(–90) cm tall; *rhizome* ca. 2.5–4 cm diam.; *petioles* smooth or asperous, slender, erect, grey-green, tinged pinkish at the base, densely mottled in an oblique pattern of crowded longitudinally aligned fine dark brown lines, sheathing in the lower 1/5–1/8; *blade* ca. 3/4 the length of the petiole, hastato-sagittate, narrowly triangular, dark (grey-)green above, paler below; *anterior lobe* widest at the base, the margin sometimes slightly undulate; anterior costa with 2–3 primary lateral veins on each side diverging at ca. 45–80(–90)°; axillary glands inconspicuous, sometimes conspicuous at the junctions of costae and petiole; secondary venation flush with the lamina to somewhat prominent abaxially and sometimes markedly divaricating, forming ill-defined interprimary collective veins towards the margin or these absent; *posterior lobes* rather slender, subequalling the anterior, the inner sides lanceolate to ovate; posterior costae diverging at ca. 100°, naked in the sinus for 2–4 cm; *inflorescences* to ca. 6 together; cataphylls membranous, mottled pinkish brown and green, marcescent; peduncle ca. 10 cm long, pale dirty pinkish; *spathe* ca. 7–8 cm long; lower spathe pear-shaped to ellipsoid, ca. 3 cm long, pale brownish pink, the mottling often forming vertical streaks; constriction usually oblique; limb narrowly (to broadly) lanceolate, distally tapering, brownish pink, distinctly darker than the lower spathe; *spadix* 5–7 cm long, very shortly stipitate for ca. 1 mm; female zone pale green; pistils somewhat distant - barely touching; ovaries subglobose; style slender, ca. 0.5 mm

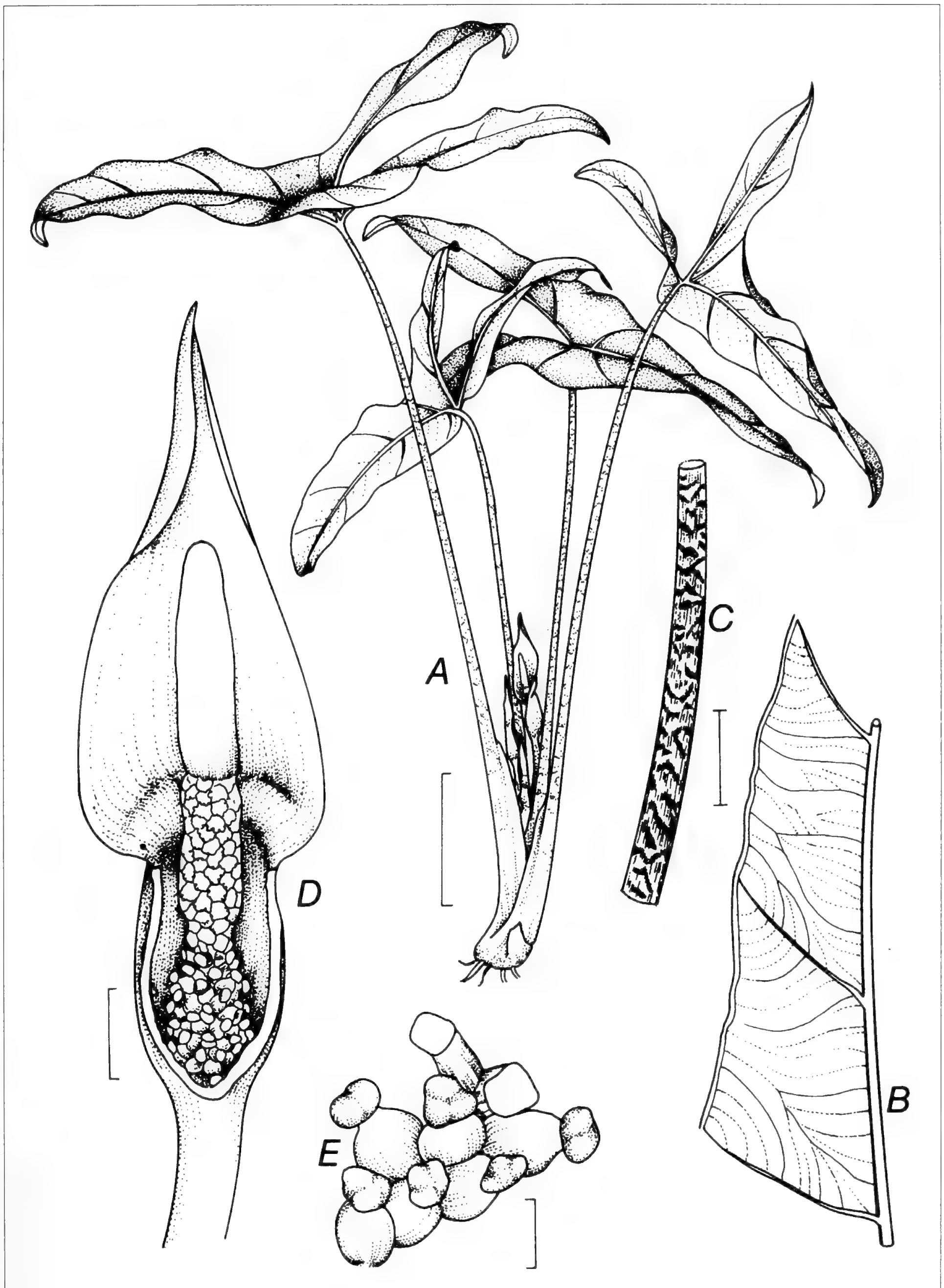

Figure 5. ***Alocasia wongii* A. Hay**
RBG Sydney Acc. No. 960478 - A. habit; B. venation; C. petiole ornamenation; D. inflorescence with part of spathe removed; E. pistils and two staminodes. - Scale: A, bar = 8 cm; B, C, bar = 2 cm; D, bar = 8 mm; E, bar = 1 mm.

long, abruptly differentiated from the ovary; stigma 2-lobed; *interstice* ca. 5 mm, partly naked, slightly attenuate, 3–5 whorls of synandrodia, the lower ones lax; *male zone* ca. 1.2–1.5 cm long, ca. 4 mm diam., cylindric, somewhat constricted at level of spathe constriction, 3/4 to almost entirely within lower spathe chamber; synandria rhombo-hexagonal, ca. 2 mm diam., not overtopped by synconnective; *appendix* ca. 3 cm long, somewhat constricted at base, ca. 4 mm diam. near base, tapering to a blunt tip; *fruiting spathe* ovoid, to 4.5 cm long, off white to dusky pink with vertical darker streaks.

Distribution: Northeastern Sabah.

Habitat: Terrestrial in lowland mixed dipterocarp forest on well-drained and occasionally inundated sites at low elevation.

Note: A fairly well-defined and geographically coherent element distinguished from *Alocasia princeps* s.s. by the generally more slender stature, the petiole with markings distinctive in the complex but almost identical to those typically found in *Alocasia longiloba* 'denudata'. The spathes are suffused a rather dirty purple-brown or violet-brown, with the limb somewhat darker than the lower spathe. The lower spathe in flower and the fruiting spathes are less rotund, and the limb shorter and more slender than in *Alocasia princeps*. The spadix is more slender with the pistils and synandrodia rather loosely arranged and the male zone is less exserted.

Populations in the vicinity of Sandakan have distinctively asperous petioles and the secondary venation is somewhat prominent abaxially and, towards the leaf margin, forms rather widely and loosely divaricating interprimary collective veins. Elsewhere in the range, e.g. at Madai, the petioles are smooth, the secondary venation is flush with the lamina and only faintly forms interprimary collective veins if at all.

Alocasia wongii is named in honour of Dr Wong Khoon Meng, who has contributed much to knowledge of the botany of Sabah.

Other specimens seen: SABAH: Tongod, Ulu Sg. Pinangah, *Amin & Ismail SAN 107302* (K); Bettotan, nr Sandakan, *Boden Kloss 19095* (SING); Tongod, ridge of Bukit Mengalas-Kalas, *Dewol Sundaling SAN 93149* (GH, K); Cult. RBG Sydney Acc. No. 950375 ex Madai Falls, *Hay et al. 10038* (NSW; fertile voucher SAN); Cult. RBG Sydney Acc. No. 950358 ex Ulu Dusun, *Hay et al. 10021* (NSW); Cult. RBG Sydney Acc. No. 960478 ex 2.5 km above main Maliau Falls, G. Rara F.R., *Hay et al. 12068* (NSW); Kabili, Sandakan, *Keith 4969* (K, SING) & *9951* (K); Sepilok F.R., *Kiew RK 757* (KEP); Tawau Dist., Gemok Hill F.R., *Madani & Sigin SAN 111570* (KEP); Sandakan, *Ramos 1580* (K, US).

11. Alocasia pangeran A. Hay, *sp. nov.*

Ab *Alocasia principicula* folio fusco-viridi, inflorescentia majore, interstitio valde attenuato partim nuda, inflorescentia mascula dimidium exserta differt. - TYPUS: Cult. RBG Sydney Acc. No. 960509 ex Malaysia, Sabah, Lahad Datu, Madai Caves, *Hay et al. 12175* (NSW, holo; iso, K, KEP, L, SAN, SING - to be distributed).

Lithophytic herb to ca. 60 cm tall; *leaves* ca. 4 together; *petioles* to ca. 60 cm long, often somewhat spreading, smooth, dark green, sheathing in the lower ca. 1/7; leaf *blade* variable, sagittate to hastate, triangular in outline, dark green adaxially, paler abaxially, ca. 20–35 cm long; *anterior lobe* widest at the base, the tip acute and slightly acuminate; anterior costa with 3 primary lateral veins on each side, diverging at 45–60°; axillary glands inconspicuous; secondary venation flush with the lamina on both surfaces, not forming interprimary collective veins, or these sporadic, ill-defined and only in the outer part of the blade; *posterior lobes* more than 1/2 to subequalling the anterior, widely spreading or not, acute to narrowly rounded, the inner sides elliptic to narrowly obovate; posterior costae diverging at ca. 120°, straight (when leaf hastate) or somewhat back-curved (when leaf sagittate); *inflorescences* to 6 together; peduncle ca. 15 cm long, subtended by lanceolate cataphylls 8–14 cm long; *spathe* ca. 11 cm long, constricted ca. 2.5 cm from the base; lower spathe ovoid, greenish ivory; limb ca. 8.5 cm long, lanceolate, acuminate for ca. 2 cm, ivory; *spadix* subsessile, stipitate for 1.5 mm, 8 cm long; *female zone* 1 cm long; pistils facing diagonally upward, ovaries subglobose, ca. 2 mm diam.; stigma more or less sessile, bilobed; *interstice* 8 mm long, naked and attenuate in the lower 5 mm with scattered small synandrodia, in the upper part with 1–2 whorls of close-packed synandrodia; *male zone* ivory, 1.5 cm long, 6 mm diam., 1/2 exserted from the lower spathe chamber and constricted level with the spathe constriction; synandria ca. 2 mm diam., rhombo-hexagonal; thecae not overtopped by synconnective; *appendix* subcylindric, isodiametric with male zone, distally tapering; *fruiting peduncle* about half the length of the petiole; fruiting spathe broadly ovoid, white.

Distibution: Endemic to Sabah, known only from Madai Caves, where it is abundant.

Habitat: In soil and humus pockets on limestone outcrops and boulders in mixed lowland dipterocarp forest at ca. 400 m alt.

Note: This species is distinguished from *Alocasia princeps* by its calcicolous lithophytic habit, smaller stature, more slender inflorescence, relatively

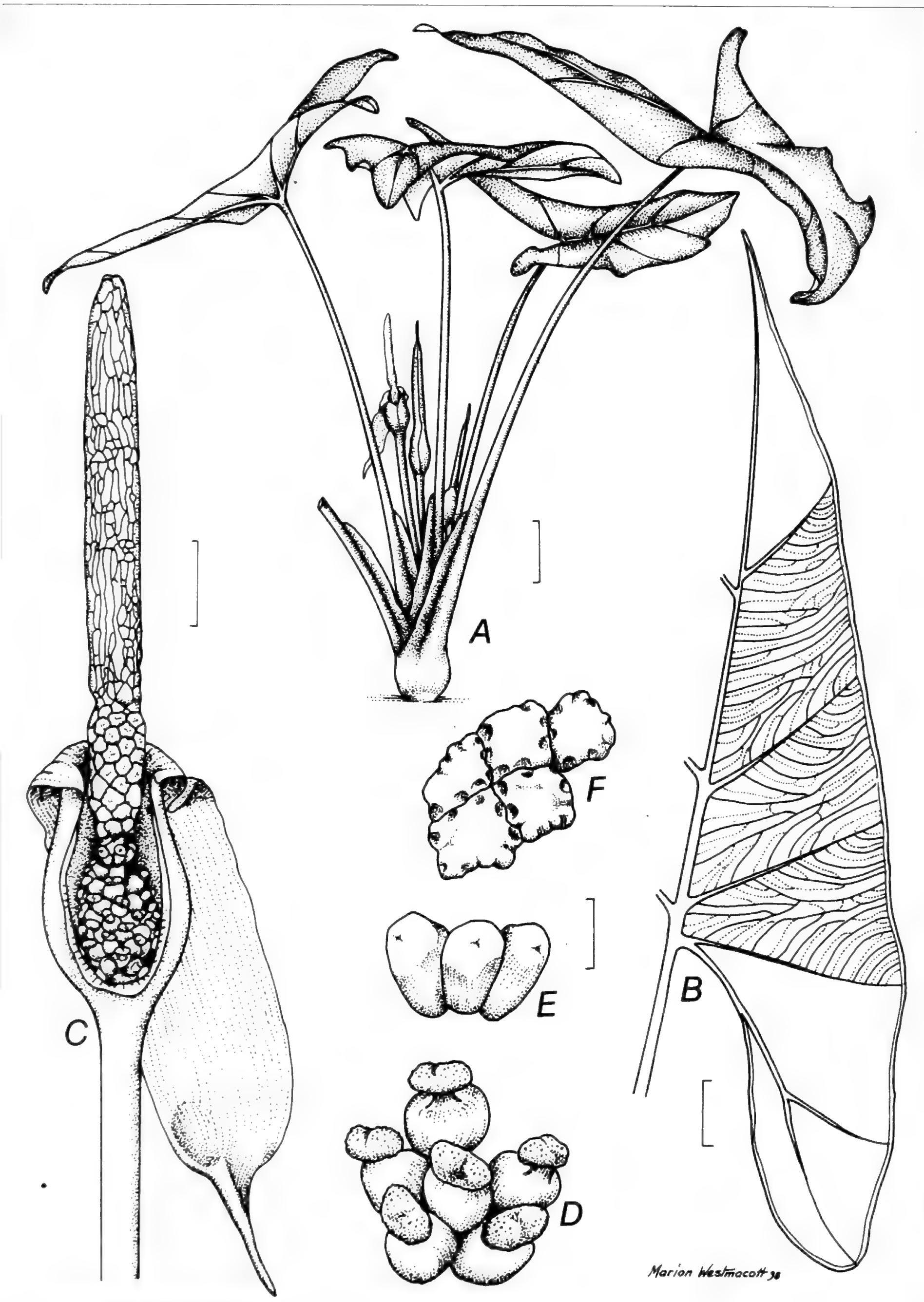

Figure 6. ***Alocasia pangeran*** **A. Hay**
RBG Sydney Acc. No. 960509 - A. habit; B. venation; C. inflorescence with part of spathe removed; D. pistils; E. lower neuter organs; F. synandria. - Scale: A, bar = 4 cm; B, bar = 2 cm; C, bar = 1 cm; D, E, F, bar = 2 mm.

longer lower spathe and lax interstice. It coexists with the terrestrial *A. wongii* and the lithophytic *A. puteri* (q.v.).

The specific epithet is a princely title in Malay, alluding to the relationship of this species to *Alocasia princeps*. For further discussion see under *Alocasia puteri*.

12. Alocasia puteri A. Hay, *sp. nov.*

Ab *Alocasia pangeran* A. Hay lamina folii claro-viride, lobis posticis intus ovatis, inflorescentia breviori, interstitio neutro brevissimo crasso vel nullo, inflorescentia mascula minus exserta, stigmate trilobato differt. - TYPUS: Cult. RBG Sydney Acc. No. 960603 ex Malaysia, Sabah, Lahad Datu, Madai Caves, *Hay et al. 12178* (NSW, holo; iso, K, KEP, L, SAN, SING - to be distributed).

Lithophytic herb to ca. 60 cm tall; *rhizome* ca. 3 cm diam.; *leaves* ca. 3 together; *petioles* more or less erect, to ca. 50 cm long, bright green, very faintly mottled slightly darker green, sheathing in the lower $^{1}/_{6}$; *blades* hastato-sagittate to slightly ovato-sagittate, ca. 30 cm long, bright green adaxially, somewhat paler abaxially, thinly leathery; *anterior lobe* widest at or slightly above the base, the apex acute to obtuse and apiculate for ca. 1 cm; anterior costa with 2–3 primary lateral veins on each side diverging at 45–70°; axillary glands very inconspicuous; secondary venation flush with the lamina on both surfaces, faint, forming poorly defined interprimary collective veins in the outer part of the blade; *posterior lobes* acute, more or less equalling the anterior, the inner sides ovate, peltate even in subadult plants but eventually free; posterior costae naked in the sinus for ca. 2 cm, diverging at ca. 60°; *inflorescences* ca. 4 together; cataphylls lanceolate, to ca. 7 cm long; peduncles exserted, to 15 cm long; *spathe* ca. 8 cm long, constricted 2 cm from the base; lower spathe ovoid, greenish ivory; limb lanceolate, green; *spadix* subequalling the spathe, minutely stipitate; *female zone* ca. 6 mm long; pistils subglobose, ca. 2 mm diam., pale greenish ivory, more or less outward-facing; style short, ca. 0.5 mm, sharply differentiated from the ovary and stigma; stigma (2–)3-lobed; *sterile interstice* more or less lacking, the male zone adjunct to the female with some of the lowermost synandria incompletely fertile, or one to two whorls of close-packed synandrodia resembling the synandria, not or hardly attenuated; *male zone* ivory, cylindric, ca. 1.8 cm long ca. 4 mm diam., $^{2}/_{3}$ within the lower spathe chamber, somewhat constricted level with the spathe constriction; synandria rhombo-hexagonal, ca. 2 mm diam., the thecae not overtopped by synconnective; *appendix* ivory, basally isodiametric with male zone, tapering; *infructescence* unknown.

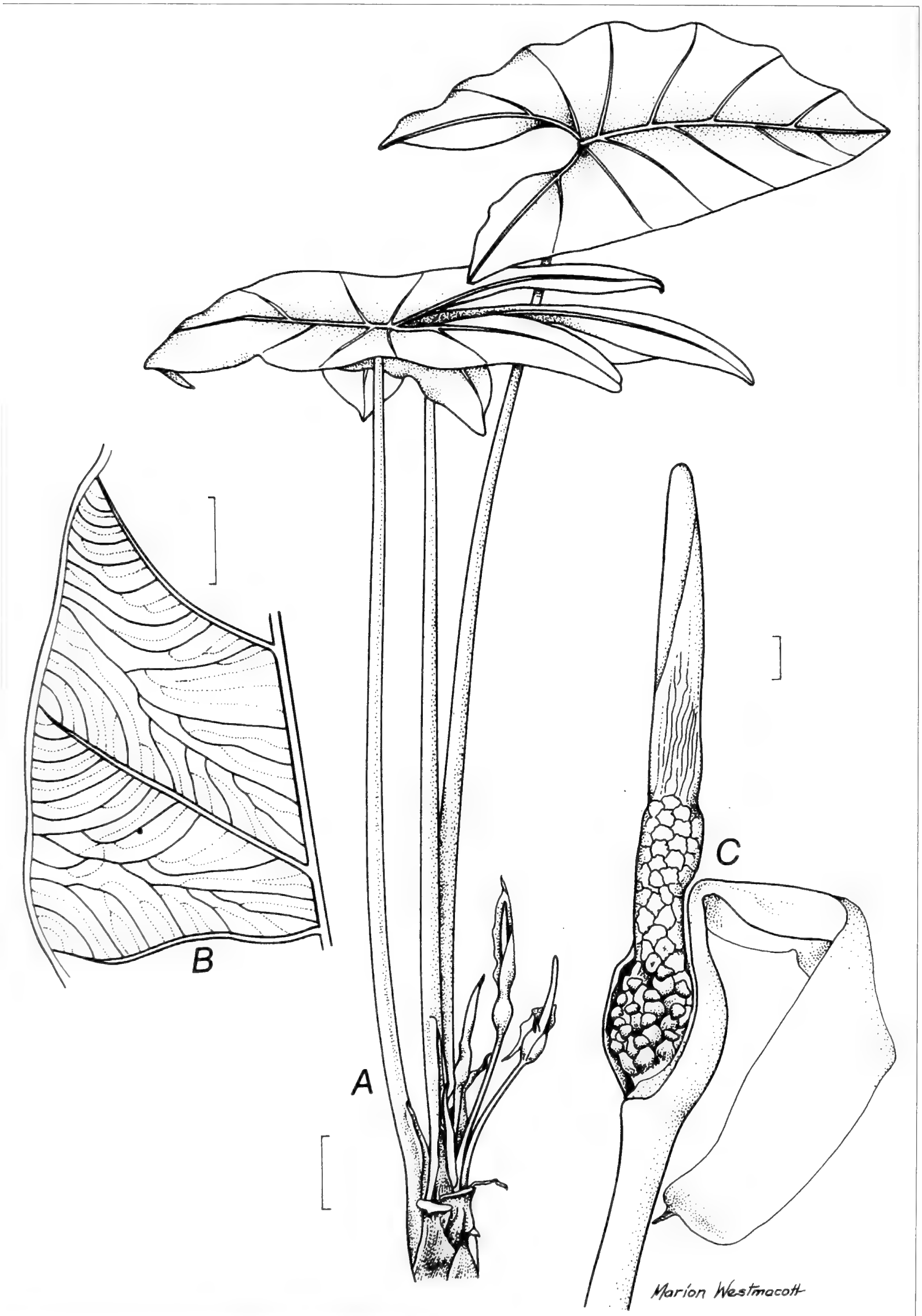

Figure 7. ***Alocasia puteri*** **A. Hay**
RBG Sydney Acc. No. 960603 - A. habit; B. venation; C. inflorescence with part of spathe removed. - Scale: A, bar = 4 cm; B, bar = 2 cm; C, bar = 4 mm.

Distribution: Endemic to Sabah, known only from Madai Caves where it is uncommon.

Habitat: In soil pockets on limestone outcrops and boulders in mixed lowland dipterocarp forest, at ca. 400 m altitude.

Notes: 1. The specific epithet, Malay for 'princess', alludes to the relationship with *Alocasia princeps* and to this species' coexistence with *A. pangeran*.

2. *Alocasia puteri* occurs together with and in the same habitat as *A. pangeran*. They can be differentiated by the former's bright green leaf colour (unusual for this entire species group) vs darker green, the broader posterior lobes, more upright petiole, tendency for the leaves to be peltate in sub-adult plants, virtually lacking sterile interstice of the apendix vs a long partially naked interstice of lax synandrodia, and the stigma being usually 3-lobed vs generally 2-lobed. Moreover, at the time of original collecting both of these species at Madai Caves, plants of *A. pangeran* were extensively in fruit, while no plants of *A. puteri* were in either flower or fruit, suggesting they may be isolated by flowering time.

13. Alocasia principiculus A. Hay, *sp. nov.*

Ab *Alocasia princeps* W. Bull stature valde minore, habitu calcicola lithophytica, pedunculo longo, inflorescentia mascula haud exserta differt. - TYPUS: Cult. Royal Botanic Gardens Sydney Acc. No. 960576 ex Malaysia, Sabah, Kinabatangan Distr., Gomantong Caves, originally collected 24 Apr 1996, *Hay et al. 12162* (NSW, holo; iso, K, L, KEP, SAN, SING – to be distributed).

Small more or less lithophytic herb; *rhizome* ca. 1.5–2 cm diam.; *leaves* several together; *petioles* ca. 20–30 cm long, sheathing in the lower $1/7$–$1/6$, grey-green to dark purple-brown, becoming paler distally, somewhat spreading, smooth; *blade* ca. 20(–25) cm long, hastato-sagittate, narrowly triangular in outline, occasionally somewhat ovato-sagittate, sometimes some subadult leaves peltate, dull to slightly glossy, distinctly grey-green above, paler below, very thinly leathery; *anterior lobe* ca. 9–14 cm long, widest at base; anterior costa with 2(–3) primary lateral veins on each side, diverging at ca. 45–60°; secondary venation flush with the lamina, forming poorly defined interprimary collective veins towards the margin; axillary glands inconspicuous; *posterior lobes* ca. $2/3$ the length or subequalling the anterior, the inner sides lanceolate; posterior costae diverging at ca. 60–90°; *inflorescences* mostly 2 together (1–4); peduncles much extended

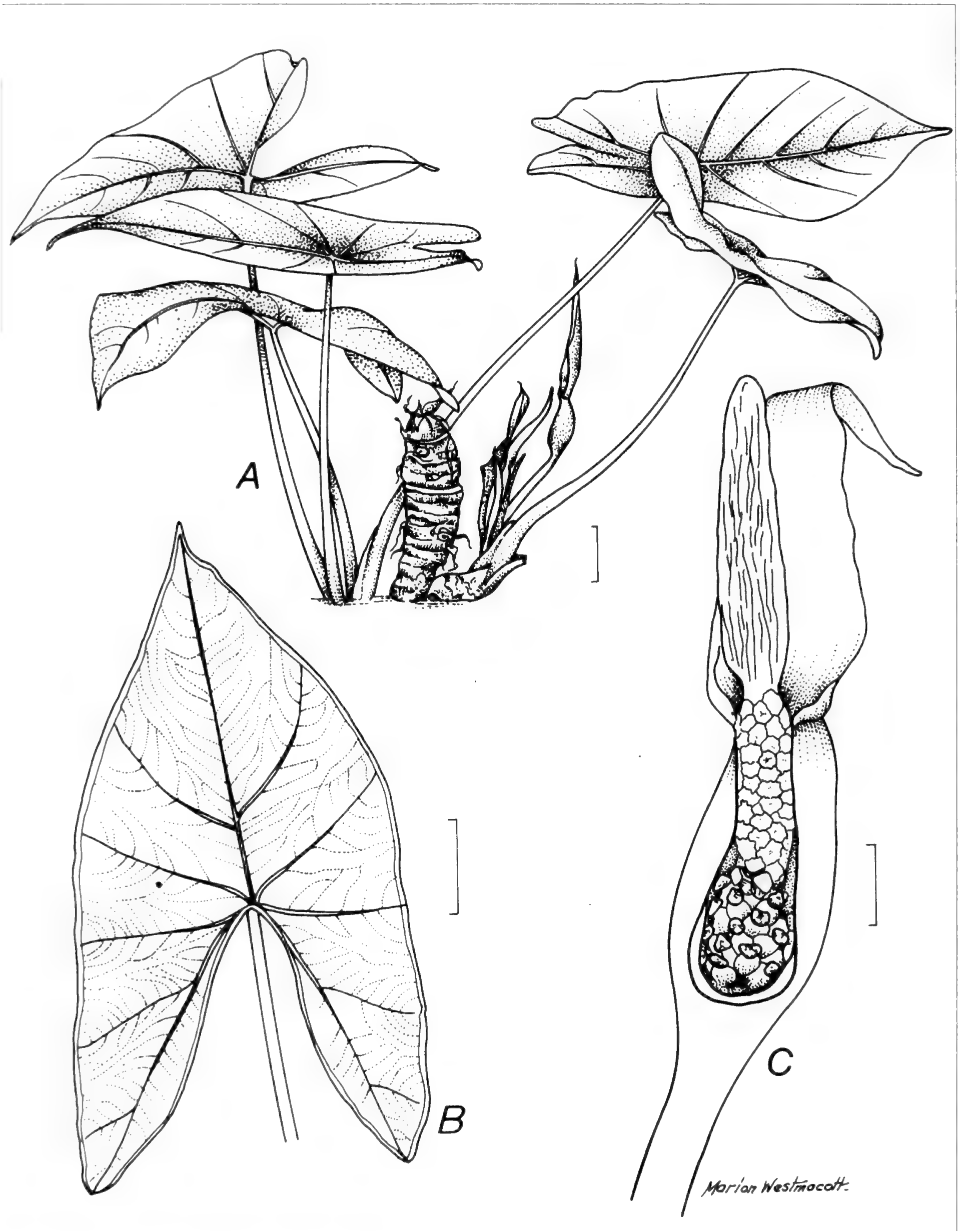

Figure 8. ***Alocasia principiculus*** **A. Hay**
RBG Sydney Acc. No. 960576 - A. habit; B. venation; C. inflorescence with part of spathe removed. - Scale: A, B, bar = 2 cm; C, bar = 8 mm.

from the cataphylls, ca. 1/3–2/3 the length of the petioles; cataphylls lanceolate, ca. 7 cm long; *spathe* ca. 6–7 cm long; lower spathe ovoid, ivory to yellowish ivory, ca. 2 cm long; limb lanceolate, pale green faintly suffused brown; *spadix* ca. 5 cm long; *female zone* ca. 1 cm long; pistils not or hardly touching one another, pale green; ovaries ovoid, ca. 1.5 mm diam., facing diagonally up, pale greenish yellow; style short, ca. 1 mm; stigma white, bilobed; *interstice* ca. 4 mm long, attenuate, 2–3 whorls of loosely arranged synandrodia (sometimes partly naked); *male zone* ca. 8 mm to 1 cm long, pale ivory, completely within the lower spathe chamber; *appendix* ivory, ca. 2.5–3.5 cm long, 4 mm diam., slightly constricted at junction with male zone corresponding to spathe constriction; *fruiting peduncle* subequalling petioles.

Distribution: Endemic to Borneo: Sabah and East Kalimantan.

Habitat: Lowland rain forest, on and among limestone boulders; sea level to 600 m altitude.

Notes: 1. The substantive epithet, meaning ‘little prince’, is the diminutive of *princeps*, alluding to the small stature and relationship of this species.

2. *Alocasia principiculus* differs from other members of the *A. princeps* complex in its small overall size, grey-green, thinly leathery leaves, relatively long peduncles and in the male zone being held entirely within the lower spathe chamber.

Other specimens seen: SABAH: Sandakan Forest District, Elopura, Gomantong, *Cuadra A1489* (BO, BRI, K, KEP, L, SING); 20 mi S of Sandakan, Gomantong Caves Hill, *Wood A4602a* (L). KALIMANTAN: East Kalimantan, Berouw, Mt Bungaan, *Kostermans 13781* (L).

14. Alocasia reversa N.E. Br.

Alocasia reversa N.E. Brown, Gard. Chron. 8 (2) (1890) 38; Hook.f. in Curtis’s Bot. Mag. Ser. 3, 52 (1896) t. 7498; Usteri, Beitr. Kenntn. Philipp. (1905) 130; K. Krause & Engl., Pflanzenr. 71 (IV.23E) (1920) 95; Merr. Enum. Philipp. Fl. Pl. 1 (1922) 185. - Type: Cult. RBG Kew ex Hort. Sander, Apr 1890, *N.E. Brown s.n.* (K, holo).

Small herb to ca. 35 cm tall (often less); *rhizome* short, condensed, erect to decumbent, ca. 3 cm diam.; *leaves* several together, irregularly interspersed with marcescent brown lanceolate cataphylls to ca. 7 cm long; *petioles* ca. 10–20(–30) cm long, sheathing in the lower ca. 10–15%; *blades* thinly leathery, in adult plants all peltate or (usually) mixed peltate and non-peltate, occasionally none peltate, ovate to rather narrowly ovato-sagittate, 14 x 6 cm to 22 x 10 cm, widest at or slightly distal to junction of petiole, glossy dark green about the midrib and primary veins adaxially, the rest grey-green; *anterior lobe* acute, with the tip abruptly acuminate for ca. 1 cm; anterior costa with 3–4(–5) primary lateral veins on each side, diverging at ca. 90° proximally, the distal ones at ca. 60°, running almost straight to the margin and joining a submarginal vein; axillary glands not conspicuous; secondary venation fine, not forming interprimary collective veins, or these very poorly defined, flush with the lamina; *posterior lobes* about 1/2–2/5 the length of the anterior, united for 50–90% of their length or free, when maximally united the base of the lamina rounded except for an acute notch; posterior costae diverging at ca 15° when blade peltate, or at ca. 90° when not peltate but then soon curved back (so posterior lobes not widely divergent) and naked in the sinus for ca. 1 cm; *inflorescences* 1–2 together, subtended by lanceolate marcescent brown cataphylls; peduncle ca. 10 cm long at anthesis, often exceeding the petioles at fruiting; *spathe* ca. 6 cm long; lower spathe ca. 2 cm long, ovoid, pale green; limb paler green to ivory edged purple with the colour extending into the constriction ventrally, at first erect, then sharply deflected, oblong lanceolate, mucronate for ca. 6 mm; *spadix* somewhat shorter than the spathe, white except for bright green ovaries, stipitate for ca. 3 mm; *female zone* 1 cm long; pistils somewhat loosely packed, flask-shaped, ca. 1.5 mm diam., facing obliquely upwards; style slender, ca. 0.5 mm long; stigma 2-lobed; *sterile interstice* ca. 4 mm long, not much attenuated and situated within the chamber of the lower spathe, lower synandrodia irregular in shape, ca. 2 mm diam., upper ones rhombo-hexagonal; *male zone* ca. 1 cm long, 4 mm diam., subcylindric, slightly constricted ca 2/3 from the base corresponding to spathe constriction; synandria rhombo-hexagonal ca. 2 mm diam., 4–6-merous, the thecae opening by apical pores, synconnective not expanded; *appendix* about isodiametric with male zone, ca. 2 cm long, gradually tapering to a blunt point, faintly longitudinally channelled; *fruiting spathe* broadly ovoid, ca. 2 cm long, eventually reflexed, pinkish to orange; berries bright orange to red.

Distribution: Borneo, endemic to Sarawak

Habitat: In forest over limestone, often on boulders, to 300 m altitude.

Notes: 1. This species, first described from cultivation in Britain following introduction by Sander & Sons, was originally attributed to the Philippines and consequently cited by some later authors as a Philippine plant. No authentically Philippine material of this species has been found however, and it must be assumed that Sander's attribution was a mistake, or deliberately misleading - a practice, according to Burnett (1984), of competing nurserymen of the time.

2. This and the following species appear in their inflorescence structure to belong in the Scabriuscula Group. They differ in their (usually) peltate leaves and the frequent (but ?irregular) cataphylls among the foliage leaves, which suggests relationship with the Cuprea Group.

3. A clone of *Alocasia reversa* is traded in Singapore under the cultivar name *Alocasia* 'Hana'. An image may be found at http://www.springleaf.com.sg/hana.html.

Other specimens seen: SARAWAK: Kuching Distr., Tiang Bekap, Padawan Rd, *Anderson 10095* (K, L, SING); Cult. RBG Edinburgh Acc. no. 67.1612 ex Bukit Serapat, ca. 13 mi from Kuching on Semenggang Rd, *Burtt & Martin 4745* (E); Kuching Distr., Tiang Bekap, Mt Mentawa, *Chew 670* (GH, K, L, SING), *1292* (GH, K, SING); Along Kuching-Padawan Rd, 10 mi SW of main Kuching-Serian Highway, *Croat 53183* (MO); Bukit Manok, Padawan, 38 mi from Kuching, *Erwin & Paul S.27408* (K, US); Zuab (CHECK), *Hewitt s.n.* (K); Bidi, *Hewitt 4* (SING); Bukit Mentawa off 32nd Mile Padawan Rd, Kuching, 1st Div., *Mamit S.32673* (K, L, SING, US); Gat, *'Native Collector' D106* (E); Cult. RBG Sydney Acc. no. 942723 ex cult. Hort. Leiden Acc. no. 933071 ex N of Padawan, *Vogel s.n.* (NSW); Bukit Payang, 10 km Tebakang-Tebedo Rd, Ist Div., *Yii & Othman S.46241* (K, KEP).

15. Alocasia venusta A. Hay, *sp. nov.*

Ab *Alocasia reversa* planta robustiore, folio tenuiter oblongo-ovato atro-viride, inflorescentibus 4–6 in synflorescentia confertis, pedunculo breviore, inflorescentia majore, stigmate trilobato differt. - TYPUS: Cult. RBG Sydney Acc. No. 940504 ex Niah National Park, path between Niah town and Niah caves, *Hay et al. 9346* (NSW, holo).

Lithophytic herb to 45 cm tall; *rhizome* condensed, to 3 cm thick; *leaves* to 6 together, interspersed with marcescent cataphylls ca. 5 cm long; *petiole* to ca. 40 cm long, sheathing in the lower 1/9; *blade* ca. 27–35 cm long, completely peltate, stiffly leathery, shiny very dark bluish green adaxially and somewhat darker about the main veins, somewhat paler abaxially, oblong-ovate, ca. 9–12 cm wide; *anterior lobe* widest at the base, the apex acute, acuminate for 1.5 cm; anterior costa with 3 primary lateral veins on each side, diverging at ca. 60–80°, drying flush with the lamina, with very inconspicuous axillary glands; secondary venation fine, not forming interprimary collective veins, almost striate; combined *posterior lobes* cuneate, somewhat elevated, ca. 8 cm long, ultimately with a shallow retuse notch between the posterior costae; posterior costae diverging at ca. 15°;

inflorescences 4–6 together not interspersed with foliage leaves, subtended and equalled to exceeded in length by lanceolate cataphylls to 10 cm long; peduncle ca. 6 cm long at anthesis; *spathe* ivory, suffused and spotted purple, ca. 9 cm long, constricted at ca. 3 cm from the base; lower spathe ovoid; *spadix* ca. 7 cm long, stipitate for 1–4 mm with the stipe obliquely inserted; *female zone* 1–1.5 cm long, subcylindric, slightly conic; ovaries ovoid, ca. 1.5 mm diam; style ca. 1 mm long; stigmas mostly 3-lobed with drop-shaped diagonally upward-facing lobes; *sterile interstice* 3–4 mm long, partly naked, with 1–2 whorls of synandrodia; *male zone* 1.5 cm long, narrowly conic, ca. 4 mm diam. at base, 3/4 held within lower spathe chamber; synandria ivory, rhombo-hexagonal, ca. 2 mm diam.; thecae not overtopped by synconnective; *appendix* subcylindric, slightly narrowed at the base, then more or less isodiametric with top of male zone, tapering, ca. 4 cm long; *infructescence* unknown.

Distribution: Endemic to Borneo, known only from the Niah Caves area, northern Sarawak.

Habitat: Lithophytic on limestone in swamp-forest at ca. 200 m altitude.

Notes: 1. This species is evidently closely allied to *Alocasia reversa*. It differs in the more robust habit, the more complex synflorescence (inflorescences solitary to paired in *A. reversa*), shorter peduncles, more densely arranged pistils and trifid stigmas. The leaves are all completely peltate and narrowly oblong-ovate, whereas they are often mixed peltate and non-peltate in *A. reversa*, especially in more robust forms approaching *A. venusta* in size. The leaf blades of *A. reversa* are conspicuously variegated. *Alocasia venusta* is geographically disjunct from *A. reversa*, which is known only from SW Sarawak.

2. The specific epithet alludes to the plant's highly ornamental qualities. It does not appear yet to have entered commercial horticulture, in which it has potential.

Macrorrhizos Group

Species 16—21

Moderately to very robust herbs; inflorescence pairs mostly interspersed with foliage leaves, occasionally clustered; spathe constriction corresponding with sterile interstice of the spadix; thecae of synandria overtopped by synconnective.

The species in this group are of somewhat doubtful affinity, but the group extends throughout Malesia except Borneo (other than *A. macrorrhizos* itself).

16. Alocasia macrorrhizos (L.) G. Don

Alocasia macrorrhizos (saepissime '*-rrhiza*') (L.) G. Don in Sweet, Hort. Brit. ed. 3 (1839) 631 ('*-rrhizon*'); Schott in Oesterr. Bot. Wochenbl. 4 (1854) 409; Engl. in A. & C. DC., Monogr. Phan. 2 (1879) 502; Engl. in Koord., Meded. Lands Plantentuin. 19 (1898) 300; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 178; Koord., Exkurs.-Fl. Java 1 (1911) 261; Merr., Interpr. Herb. Amboin. (1917) 130; K. Krause & Engl., Pflanzenr. 71 (IV.23E) (1920) 84, fig. 15; Furtado in Gard. Bull. Straits Settlem. 11 (1941) 244–257- *Arum macrorrhizon* L., Sp. Pl. (1753) 965; - *Colocasia macrorrhiza* (L.) Schott in Schott & Endl., Melet. Bot. (1832) 18. - Type: *Arum maximum macrorrhizon zeylanicum* Herm., Parad. Bat. (1698) t. 73 (lecto; selected by Furtado, 1941).

Arum indicum Lour., Fl. Cochinch. (1790) 536; ed. Willd. (1793) 655; Roxb., Fl. Ind. ed. 2, 3 (1832) 498. - *Colocasia indica* (Lour.) Kunth, Enum. Pl. 3 (1841) 39. - *Alocasia indica* (Lour.) Spach, Hist. Nat. Veg. Phan. 12 (1846) 47; Schott, Oesterr. Bot. Wochenbl. 4 (1854) 410; Engl. in A. DC, Monogr. Phan. 2 (1879) 501 & Bot. Jahrb. Syst. 25 (1898) 23; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 178; Koòrd., Exkurs.-Fl. Java 1 (1911) 262; K. Krause & Engl., Pflanzenr. 71 (IV.23E) (1920) 87; Backer & Bakh.f., Fl. Java 3 (1968) 119. - *Caladium indicum* C. Koch, Berl. Allg. Gartenz. (1857) 136. - Type: *Arum indicum sativum* Rumph., Herb. Amboin. 5 (1747) t. 106 (lecto; selected by Nicolson, 1979).

Colocasia indica var. *atroviridis* Hassk., Flora 25(2), Beibl. 1 (1842) 8 = *Alocasia macrorrhizos* (L.) G. Don. - Type: None designated; based on Rumphius' very brief description of a second 'species' of *Arum indicum sativum* Rumph., Herb. Amb. 5 (1747) 308.

[*Colocasia odora* ('*odorata*') sensu auct. non (Roxb.) Brongn.: Hassk., Flora 25 (2), Beibl. 1 (1842) 9; see Hay (1996)]

Arum montanum Roxb., Fl. Ind. 3 (1832) 497. - *Colocasia montana* (Roxb.) Kunth, Enum. Pl. 3 (1841) 40. - *Alocasia montana* (Roxb.) Schott, Oesterr. Bot. Wochenbl. 4 (1854) 410. - Type: India, Orissa, Circars, *Roxburgh drawing No. 248* (CAL, K). **Plate 2.**

Plate 2. Type of *Arum montanum* Roxb.
Icones Roxburghianae 248 (K, copyright R.B.G., Kew).

[*Alocasia grandis* N.E. Brown, Gard. Chron. n.s. 25 (2) (1886) 390, nom. illeg., non *Alocasia grandis* Clemenc., Rev. Hort. 40 (1868) 380 (see below)].

Massive pachycaul with the *stem* decumbent or erect, to 4 m tall; *petioles* to 1.3 m long, sheathing in lower 1/3–1/2; *blades* ovato-sagittate, bluntly triangular in general outline, held more or less erect, with the margin entire to very slightly; *anterior lobe* ca. 70 cm to over 1 m long, ca. 60–90 cm wide at base, with ca. 9 rather distant primary lateral veins on each side of the anterior costa diverging at ca. 60°; glands in axils of primary veins on abaxial side distinct; secondary venation flush with the lamina or but slightly raised abaxially, not forming interprimary collective veins or these poorly defined; *posterior lobes* ca. 1.3–1/2 the length of the anterior, somewhat rotund, often overlapping; *inflorescences* paired among the leaf bases, subtended by membranous cataphylls; peduncles barely exceeding the cataphylls at anthesis; *spathe* rather variable in length, ca. 13–35 cm long, constricted about 1/6th of the way from the base; lower part green, ovoid; limb broadly oblong-lanceolate, cowl-like at anthesis, later reflexed, then deliquescent, membranous, pale yellow; *spadix* slightly shorter than the spathe, shortly stipitate; *female zone* 1–2 cm long, ca. 1.5 cm diam.; ovaries pale green, ca. 3 mm diam.; stigma sessile, 3–5-lobed, the lobes conic, yellow; *sterile interstice* slightly shorter than to equalling the female zone, whitish, very slightly narrowed corresponding to the spathe constriction, composed of rhombo-hexagonal synandrodia ca. 2.5 mm diam., the lower ones paler, incompletely connate or with a central hole, the upper ones resembling synandria; *male zone* cylindric, ca. 3–7 cm long, ca. 2 cm diam., whitish; synandria rhombo-hexagonal, convex-topped due to cap-forming synconnective, ca. 2 mm diam; *appendix* yellowish, slightly thicker than the male zone at the base, thence tapering, equalling to considerably exceeding half the length of the spadix, staminodial; *fruiting spathe* ca. 8 cm long, longitudinally dehiscent, green; berries scarlet.

Distribution: IndoMalesia to Oceania. It is not clear where, if anywhere, this species occurs wild. It has evidently been distributed widely in tropical Asia in prehistoric times as a subsistence crop and is now pantropical by introduction as an ornamental.

Habitat: Road sides, waste places, gardens, mostly in wet sites at low to medium elevation.

Notes: 1. A number of ornamental varieties have been recognised, which were discussed by Furtado (1941). As cultivated plants they should be named as cultivars within the domain of the International Code of Nomenclature for Cultivated Plants. One element, *Alocasia macrorrhizos* var. *rubra* (Hassk.) Furtado, was discussed further by Bunting & Nicolson (1963), who considered it sufficiently distinct from other varieties as to be recognised as a distinct species - *Alocasia plumbea* van Houtte (Fl. des Serres 21 (1875) t. 2206). While differing somewhat from other forms of *Alocasia macrorrhizos* in dimensions and leaf shape, it is not known except in cultivation, and I doubt that it is more than a sport of *A. macrorrhizos*. *Alocasia grandis* N.E. Br., introduced to cultivation in Britain from 'the East Indian Islands' appears to be the same element.

2. This species does not appear to be a wild plant at all in Malesia, though the situation in the Philippines, where there is indirect evidence for natural hybridisation with *A. portei* Schott, is unclear. No collections exist that are from places unequivocally away from human habitation, and I have never encountered it in the field except closely associated with human settlement. Arguably *Alocasia macrorrhizos* is a cultigen.

3. *Alocasia grandis* N.E. Brown, based on a specimen Brown took from a plant cultivated at Kew ex Hort. Bull, 10 Sep 1886 (K!), is evidently the same or very similar to *Alocasia macrorrhizos* var. *rubra*. It is, however, illegitimate due to the pre-existence of *Alocasia grandis* Clemenc. The identity of the latter is not clear.

4. Discussion of the identity of *Alocasia montana* (Roxb.) Schott can be found under *Alocasia flemingiana*. The type is reproduced in Pl. 2.

Other specimens: PENINSULAR MALAYSIA: Negeri Sembilan, Kuala Pilah Rd., *Burkill 1648* (SING); Kelantan, Khota Baru, *Gimlette s.n.* (SING); Selangor, Genting Simpah F.R., *Nicolson 1145* (US), Telok Gading, *Md Nur 3002* (SING). SINGAPORE: Botanic Gardens, *Sinclair 8340* (K, US). SABAH: Sandakan, *Kadir A2698* (K, L); Kelawat, Kota Belud, *Keith 6787* (SING); Kuala Napagun, *Keith 9345* (SING); JAVA: Buitenzorg cult., *Bakhuizen 8169* (L); Java, Buitenzorg, *Hallier 1893* (L); Java, *Horsfield s.n.* (K); Java, Batavia, *Junghuhn s.n.* (L); Java, *Kuhl & van Hasselt s.n.* (L); Java, *Zollinger 472* (L).

17. Alocasia inornata Hallier *f.*

Alocasia inornata Hallier f., Meded. Herb. Leiden 26 (1915) 7; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 86. - Neotype: Indonesia, Sumatera, Riau Province, Tigapulu Mts., 5 km W of Talanglakat on Rengat-Jambi Road, Bukit Karampal area, 13 Nov 1988, *J.S. Burley, Tukirin et al. 1444* (K, neo; KEP, SING, US, isoneo; designated here).

Alocasia nobilis Hallier f., Meded. Herb. Leiden 26 (1915) 6. - Type: Indonesia, Java, Cult. Hort. Bogor ex Deli, Sumatera, 14 Jan 1896, *H. Hallier s.n.* (L, holo)

Robust herb to 1.3 m tall; *stem* erect to decumbent, to ca. 8 cm diam; *leaves* several together, glabrous to minutely pubescent on the petiole and abaxial lamina; *petiole* ca. 50 cm – 1 m long, sheathing in the lower 1/3–1/2, pale green to pale chocolate brown with the apical 1–6 cm deep purple, or the whole purple throughout, otherwise more or less unmarked; *blade* sagittate to broadly ovato-sagittae, distinctly but not very thickly leathery, to ca. 50 (–80) cm long and up to 40 (–50) cm wide, slightly olive mid-green to suffused brownish chocolate to deep purple throughout and slightly shining adaxially, paler and dull abaxially; *anterior lobe* widest at or slightly above the base, the tip mostly obtuse and apiculate for ca. 1 cm; anterior costa with 4–7 primarly lateral veins on each side diverging at ca. 65–45°, with prominent glands in their axils abaxially; secondary venation flush with the lamina abaxially and adaxially, forming not very well-defined slightly sinuous to almost straight interprimary collective veins; *posterior lobes* ca. 1/2 the length of the anterior, rounded to acute, the inner side lanceolate to narrowly ovate to subrhomboid; posterior costae naked in the sinus for ca. 1.5 cm; *inflorescences* rather slender, (2–)several together, forming a cluster in the centre of the crown and not interspersed with foliage leaves; peduncle mostly hidden within leaf sheaths and cataphylls, pubescent if the leaves are; cataphylls semi-persistent; *spathe* ca. 12 cm long; lower spathe rather narrowly ovoid, green, ca. 2 cm long, separated from the limb by a rather weak constriction level with the basalmost part of the male zone of the spadix or with the sterile interstice; limb to ca. 4 cm wide, as first erect and cucullate with the basalmost part reflexed, then wholly reflexed, pale greenish yellow to white, deciduous after anthesis; *spadix* subequalling the spathe, stipitate for ca. 3 mm; *female zone* ca. 1 cm long, ca. 7 mm diam.; ovaries flattened subglobose, somewhat lobed, green, ca. 1.5–2 mm diam.; stigma sessile, about 1.2 mm wide, of 3–5 rounded lobes, white; *sterile interstice* basally as broad or broader than female zone, distally attenuate, ca. 7 mm long, composed of numerous white to pale apricot synandrodia, the lowermost sometimes with the staminodes incompletely united, the rest closely resembling the synandria; *male zone* cylindric, ca. 1.5–2 cm long, ca. 7 mm diam., white; synandria hexagonal, 1.5 mm diam., slightly convex-topped; thecae overtopped by synconnective and opening by short apical slits; *appendix* to 7.5 cm long, slender, basally isodiametric with male zone, tapering very gradually to a point, pale orange-yellow to yellowish ivory; *fruiting spathe* green, to ca. 6 cm long, ovoid.

Distribution: Southern parts of Peninsular Malaysia (not recorded from Singapore) and Sumatera.

Habitat: This species has wide ecological amplitude and is found in disturbed places in forest, scrub, swampy areas, river banks, sometimes on limestone, from sea level to ca. 1200 m altitude.

Notes: 1. *Alocasia inornata* was described from a sterile plant cultivated at Bogor, originally collected by Jaheri from Deli, Sumatera. Preserved material neither of the cultivated plant nor of the original field collection has been located. However, Hallier's description includes reference to the leaves being pubescent and the petiole being purple at the apex, and there can be little doubt that this name is applicable to the species defined here. The neotype here designated is weakly pubescent, reference is made in the notes to the petiole being purple at the top (this feature becomes obscured on drying) and the specimen includes a well-preserved inflorescence. While the colour of the petiole apex may seem trivial, purple pigmentation is present at that point in all living plants I have seen of this species, both in Sumatera and in Peninsular Malaysia, and appears to be a diagnostic feature.

The exception is cases where the entire leaf is suffused with purple - the condition of the type of *A. nobilis*. Pubescence on the other hand is not a constant feature of Sumateran specimens and apparently is absent from Peninsular Malaysian ones.

2. *Alocasia nobilis* was also described from cultivation at Bogor and the cultivated plant also originated from a collection by Jaheri from Deli. The description includes reference to the inflorescence, though this does not appear to have been preserved. The leaf, besides being suffused purple throughout, is at the extreme of narrowness overall and reduction of the posterior lobes for this species, but it connects with rather than falls outside the rest of the morphological range, *Lörzing 5061* being an intermediate example. As might be expected if the leaf is suffused purple, the spathe is described as being so too, where typically in *A. inornata* it is green in the lower part and pale greenish yellow to white in the limb.

3. It was possible that the name *Alocasia ovalifolia* Ridl. had priority, if syntype material of that species could have been located that is conspecific with *A. inornata*. The issues around this uncertainty are discussed under *A. puber* (q.v.) in the synonymy of which *A. ovalifolia* has been placed on the basis of the identity of the only syntype so far located and on which *A. ovalifolia* has been lectotypified in order to dispose of the name.

4. The distinguishing combination of features of this species includes, in addition to the purple-topped petiole, the slender spadix, the spathe constriction corresponding with the basalmost part of the male zone or the interstice, the narrowly tapering appendix, the large, sessile, rounded 3–5-lobed stigma and syandria with the thecae overtopped by synconnective.

Other specimens seen: PENINSULAR MALAYSIA: Pahang, Pulau Tioman, *Burkill s.n.* (SING), Cult. RBG Sydney, Acc. No. 893742 *Goodwin 16* (NSW), *Md Nur 18890* (BO, SING); Selangor, Forest Research Institute, Kepong. *Croat 53294* (K); Cult. RBG Kew Acc. No. 472-82.05004 ex Selangor, Ulu Gombak, *Hay s.n.* (K); Cult RBG Sydney, Acc. No. 940101 ex Selangor, Batu Caves, *Hay 9057* (NSW); Cult. RBG Sydney, Acc. No. 940338 ex Pahang, Semangoh Pass, *Hay 9271* (NSW); Pahang, Fraser's Hill, *Henderson 11389* (BO); Perak, Gua Badak, Lenggong, *Henderson 23836* (BO, SING); Selangor, Batu Caves, *Ridley 8168* (K, SING), 13392 (SING); Selangor, Anak Takun, Templer Park, *Sang JS33* (KEP). SUMATERA: Atjeh, NE of Kroengloeas, E of Troemon, *Asdat 74* (L); G. Koerintji, *Bünnenmeijer 9222* (BO) & *10354* (BO, L); NE Sebessi Island, Docters van Leeuwen-*Reijnvaan 5139* (BO); East Coast, Karo Highlands, E of Berastagi, *Hamel & Rahmat si Toroes 631* (L); Cult. RBG Sydney Acc. No. 970531 ex Lembah Anai Nature Researve, *Hay & Yuzammi 13105* (NSW); Sibolangit, *Lörzing 5061* (BO); Karohoogvlakte bij Lingga, *Lörzing 6274* (BO); South Sumatera, Enggano, *Lütjeharms 3856* (BO, GH, K, L) & *4745* (BO, K, L); W. Sumatera, Pesisir selatan Kerintji, Mt Kerintji, nr Pondok Patjet, *Meijer 6219* (L); Batoe Island, *Raap 8* (BO).

18. Alocasia alba Schott

Alocasia alba Schott, Oesterr. Bot. Wochenbl. 2 (1852) 59; Miq., Fl. Ned. Ind. (1855) 210; Schott, Syn. Aroid. (1856) 48; Schott, Prodr. Syst. Aroid. (1860) 149; Engl., in A. & C. DC., Monogr. Phan. 2 (1879) 500; Hook. *f.*, Fl. Brit. India. 6 (1894) 528; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 84. – NEOTYPE: *Alocasia alba* Schott, Icones no. 86-88 (W, lecto; designated here) [fiche 68: d6-d8 in the microfiche edition].

Alocasia bantamensis Koord., Bull. Jard. Bot. Buitenzorg III, 1 (1918) 162, figs 11–13; K. Krause & Engl., Pflanzenr. 71 (IV.23E) (1920) 84; Koord., Exkurs.-Fl. Java 4 (1923) 195-196, fig. 395-396; Backer & Bakh.f., Fl. Java 3 (1968) 119. - TYPE: Indonesia, Java, Bantam, Danoe-moeras, 26 May 1912, *Koorders 41445*b (L, lecto; selected here).

Alocasia crassifolia Engl., Pflanzenr. 71 (IV.23E) (1920) 82; Koord., Fl. Tjibodas 6 (1922) 36; Burnett, Aroideana 7 (1984) 134, fig. 101. - TYPE: Indonesia, Java, cult. Hort. Bogor, Jan-Feb 1906, *Engler 4101* (B, holo).

[*Alocasia macrorrhizos* ('*-rrhiza*') sensu auct. non (L.) G.Don: Backer & Bakh.f., Fl. Java 3 (1968) 119].

Massive pachycaul, stout, up to 2 m tall; *leaves* several together, held erect; *petiole* greenish, whitish at the sinus, with scattered yellowish glands, up to 170 cm long, sheathing for about 1/3 its length, wings of sheath persistent, straight to recurved; *blade* thick, tough, usually slightly bullate, green above, light yellowish-green below, broadly ovato-sagittate to cordato-sagittate, margin entire; *anterior lobe* ca. 80 cm long, ca. 75 cm wide at base, the tip shortly acuminate; anterior costa with up to 11 primary veins diverging at an angle of about 40°–60°, prominent on both surfaces, with conspicuous small flat glands in the axils on the abaxial side; secondary veins sunken adaxially, prominent abaxially, interprimary collective vein well-defined; submarginal vein 1–2 mm from margin; *posterior lobes* obtuse, ca. 45 cm long from the sinus; *inflorescences* in groups of up to ca. 10 at a centre of leaf crown, not interspersed with foliage leaves (but occasionally pairs produced singly); peduncle up to 38 cm long, like the petiole with scattered small broadly elliptic glands; *spathe* to ca. 17 cm long, constricted at level of sterile zone of spadix, lower spathe broadly ovoid-cylindric, ca. 5 cm from the base, green, the limb reflexed between male zone and sterile zone, thinly leathery, greenish yellow to greenish white; *spadix* cylindrical, ca. 15 cm long, sessile to very shortly stipitate; *female zone* ca. 1.7–2.2 cm long, 1–1.4 cm wide, with ca. 60–100 close-packed pistils; ovary green, ovoid to subglobose, 2–3 mm in diam.; style abruptly-differentiated from ovary and c.. 1 mm long, to lacking; stigma white, 2–3-lobed, the lobes rounded; *sterile interstice* ca. 1–1.6 cm long, with ca. 5–6 whorls of rhombo-hexagonal synandrodia, the lowermost whorls isodiametric with female zone and resembling connate staminodes, the upper portion attenuate and resembling sterile synandria; *male zone* white, ca. 2.5–3.5 cm long, ca. 1–1.5 cm wide; synandria white, swollen-topped, rhombo-hexagonal, 2 mm diam., thecae overtopped by synconnective, opening through apical slits; *appendix* ivory, ca. 5.5–8 cm long, tapering, smooth to faintly rugose and composed of irregular sinuous staminodes, basally isodiametric to or slightly narrower than the male zone; *fruiting peduncle* to ca. 25 cm long; fruiting spathe broadly ovoid, to 6 cm long: fruit ellipsoid, orange, 5 mm.

Distribution: Java, widespread at low to medium elevation. Plants sighted by me in 1996 near Telukbetung along the Palembang road in SE Sumatera may also be of this species. Circumstances prevented my collecting specimens.

Habitat: In open spots in forest and beside roads and fields, mainly in swampy sites, but also on well drained soils.

Notes: 1. Schott evidently described this species from cultivated material known in horticultural circles of the time as *Colocasia alba* and *Homalomena alba* (the former apparently never validly published, the latter not in the sense of *H. alba* Hassk.). Schott did not know the origin of the plant, though he indicated it was probably Malesian (*'verosimiliter in insulis Archipelagi Indiae orientalis'*). No collector or collection was cited in the protologue, but illustrations were prepared which are here designated as the neotype. They show the distinctive venation of this species, and give the clear impression of its characteristically coriaceous and slightly bullate leaves. That the plant illustrated was very probably the same one as that described in the protologue is suggested by the illustration of the ovaries (in Ic. 87) which appear abortive and which were described by Schott in the protologue as *'ovariis (in spadicibus omnibus speciminis nostri) rudimentariis'*. This appears to be a teratum: the pistils of other specimens of this species are normal.

2. Engler (1879: 500) attributed *Alocasia alba* to Sri Lanka, on the basis of a Burmann specimen at G. Although I have not seen this specimen, the attribution of *A. alba* to Sri Lanka appears to be erroneous, an opinion shared implicitly or explicitly by Brown (1884: 870), Hooker (1894: 528) and Trimen (1898: 360), who attributed it to Java. Moreover, Nicolson (1987: 55) did not include *Alocasia alba* in his treatment for Sri Lanka,

where the only species approaching it is the amply distinct *A. macrorrhizos*.

3. Backer & Bakhuizen (1968: 119) misapplied the name *Alocasia macrorrhizos* to what, from their description, specimen annotations and synonymy, is clearly this species. For the species correctly named *A. macrorrhizos*, they used its synonym *A. indica* (Lour.) Spach. What lead them to make the misapplication is not apparent.

4. The function of the distinctive glands on the petiole and peduncle, which resemble those in the axils of the primary veins, is not clear. At female anthesis the inflorescence is sweetly fragrant with the scent produced from the inside of the lower spathe.

Other specimens seen: JAVA: Buitenzorg, *Boerlage s.n.* (L); W. Java, Batavia, Solear, Tjisoka, *Eyma s.n.* (L); Cult. RBG Sydney Acc. No. 892944 ex Bogor, *Hay 4087* (NSW); W. Java, Curug Sawer, *Hay & Yuzammi 14002* (NSW); Bawean, G. Tunggangan, *Karta 30* (BO, L); Djapara, Ngarengan, *Koorders 34996* (L); Hort. Bogor, *Koorders 42804* (L); Preanger, Tasikmalaya, Pendjaloe, *Koorders 44346* (L); *Kuhl & van Hasselt s.n.* (L); *Mousset 589* (BO); Bantam, Danoe Moeras, *van Steenis 10513* (L); Hort. Bogor, Teijsmann s.n. (L); Kediri, Pandan, Djeroek, *Thorenaar 290* (BO).

19. Alocasia balgooyi A. Hay, *sp. nov.*

Ab *Alocasia macrorrhizos* (L.) G. Don costis posticis haud vel vix nudis, spathae lamina coriacea breviore, inflorescentia femina et interstitio neutro longioribus tenuioribus, synandriis minoribus, spatha fructifera rubra differt. - TYPUS: Indonesia, South Sulawesi, Soroako, Malili Road, 29 Jun 1979, *M. van Balgooy 3812* (BO, holo; GH, K, L, iso).

Robust to massive herb 1–3 m tall; *rhizome* stout (?diam.), clothed in fibrous leaf base remains; *leaves* several together; petiole ca. 70–100 cm (?or more) long, glabrous, sheathing in the lower 1/3–1/2; *blade* broadly ovato-sagittate to cordato-sagittate, ca. 50–100 cm long, membranous; *anterior lobe* widest slightly above the base, the apex obtuse and apiculate; anterior costa with 5 (?or more) primary lateral veins on each side diverging at 45–70°; axillary glands inconspicuous; secondary venation not or hardly raised abaxially, not or hardly forming interprimary collective veins; *posterior lobes* 1/2–3/4 the length of the anterior, obtuse, the inner sides ovate to more or less rhomboid; *inflorescences* in pairs ?interspersed with foliage leaves; peduncle ca. 30 cm long; *spathe* ca. 17–20 cm long, constricted 3–4 cm from the base with the constriction corresponding with the sterile interstice of the spadix; lower spathe narrowly ovoid to ovoid, thick; limb oblong-lanceolate, coriaceous, erect and later reflexed and somewhat persistent, thence deciduous, greenish cream; *spadix* somewhat shorter than to subequalling the spathe, ca. 14 cm long, stipitate for ca. 4 mm and the stipe inserted obliquely; *female zone* 2 cm long, ca. 5 mm wide; pistils close-packed, globose-cuboid, ca. 2 mm diam.; stigma sessile, bluntly 3-lobed, ca. 1 mm diam.; *sterile interstice* 1–1.5 cm long, distinctly attenuate, ca. 3 mm thick, composed of numerous small synandrodia resembling the synandria; *male zone* 3–4 cm long , cylindric, 5–6 mm diam., cylindric; synandria very numerous, small, ca. 1 mm diam.; thecae overtopped by synconnective; *appendix* 4–5.5 cm long , slightly narrower than the male zone, deeply longitudinally channelled, tapering to a point; *fruiting peduncle* to ca. 50 cm long; fruiting spathe broadly ovoid to spindle-shaped, 6–12 cm long, creamish green, becoming bright red.

Distribution: Endemic to Sulawesi.

Habitat: Low to mid-elevation forests, sometimes in swamp forest *(Kjellberg 2396),* or on slopes, often in disturbed places and on ultrabasic soils; sea level to 1200 m altitude.

Notes: 1. The description is pieced together from fragmentary dry specimens. This species appears at least superficially similar to *A. macrorrhizos*, though clearly differing in the leaves with the posterior costae usually not naked in the sinus, the thick and relatively short spathe limb, longer peduncle, the relatively longer and narrower female and sterile zones of the spadix, the smaller and more numerous synandrodia and synandria, and the red fruiting spathe.

2. *Alocasia balgooyi* is named for Dr Max van Balgooy, who first drew attention to this new species.

Other specimens seen: SULAWESI: Menado, Poso, above baroega S. Malei, *Eyma 1670 (BO, L);* nr Malino, *Eyma 3460* (BO, L); Malili, *Kjellberg 2396* (BO) & *2116* (BO); Matamo Lake nr Soroako, NE of Malili, *Meijer 11120* (BO); Larona, W of Towuti lake, E of Malili, *Meijer 11298* (BO); N Sulawesi, Dumoga Bone National Park, Gorontalo Distr., Sg. Olama below G. Gambuta, *Millikin 976* (K); Tangguma, Poli-polia, Kolaka, *Prawiroatmodjo & Maskuri 1530* (BO); N shore of Lake Matano, E of Nuha, *de Vogel 5840* (K).

20. Alocasia flemingiana Yuzammi & A. Hay, *sp. nov.*

Ab aliis speciebus javanicis statura minore, folii lamina adulta haud peltata nervo intramarginale praedita, interstitio neutro et spathae constrictio congruentibus, stigmate lobato sessili, synconnectivo expanso differt æ TYPUS: Indonesia, West Java, Ciseeng, 25 km NNW of Bogor, 28 Jan 1961, *Nicolson 848* (L, holo; BO, US, iso).

[*Colocasia montana* auct. non (Roxb.) Kunth: Hassk., Pl. Jav. Rar. (1848) 148.]

[*Alocasia montana* auct. non (Roxb.) Schott: Miq., Fl. Ned. Ind. 3 (1855) 209, p.p., quoad loc. 'Java'; Engl., in A. & C. DC., Monogr. Phan. 2 (1879) 499, p.p., quoad loc. 'Java'; Hook.*f.*, Fl. Brit. India 6 (1894) 525, p.p., quoad loc. 'Java'; Koord., Exkurs.-Fl. Java 1 (1911) 261; K.Krause & Engl., Pflanzenr. 71 (IV.23E) (1920) 77, p.p., quoad loc. 'Java'; Koord., Exkurs.-Fl. Java 4 (1923) 194, fig. 393, non fig. 394 - i.e. *Alocasia montana* s.s. (= *Alocasia macrorrhizos*)]

[*Alocasia heterophylla* sensu auct. non (Presl) Merrill: Backer & Bakh.*f.*, Fl. Java 3 (1968) 120.]

Small herb, ca. 50 cm tall; *rhizome* to ca. 3.5 cm diam.; *leaves* several together; *petiole* green, sometimes mottled reddish purple, sometimes purple-streaked, 25–55 cm long, sheathing in the lower about 1/4–1/3 of its length; *blade* mid-green adaxialy, green-yellowish abaxially, sagittate to broadly ovato-sagittate, thin, membranous, glabrous on both surfaces; *anterior lobe* ca. 25 cm long, ca. 19 cm wide, the tip acuminate, ca. 1 cm long, anterior costa with 3 or 4 primary veins on each side, diverging at ca. 40°–60°, prominent abaxially; primary veins often bearing small flat glands in the axils abaxially, running to a distinct submarginal vein ca. 1–3 mm from margin; secondary veins flush to lamina, interprimary collective veins absent or poorly differentiated; *posterior lobes* acute, up to ca. 16 cm long, inner sides elliptic to obovate; posterior costae diverging at ca. 90–110°, naked in the sinus for 0–1 cm; *inflorescences* in pairs interspersed with foliage leaves; peduncle, ca. 2/3 the length of the petiole at anthesis, elongating in fruit, up to ca. 31 cm long; *spathe* white to greenish white, ca. 10–15 cm long, lower spathe ovoid, ca. 2–4 cm long, constricted level with top of sterile zone of spadix (to half way along male zone); limb narrowly-oblong and falling after anthesis; *spadix* somewhat shorter than to subequalling the spathe, ca. 8–11 cm long, slender, stipitate for ca. 0.5 cm; *female zone* to 1 cm long, with ca. 40 pistils; ovary globose, ca. 2 mm diam.; stigma sessile, ca. 1 mm diam., 2–3 lobed, the lobes bluntly pointed; *sterile interstice* hardly to somewhat attenuate, ca. 5 mm long, ca. 3 whorls of rounded to rhombo-hexagonal synandrodia; *male zone* 1.5 cm long, 5 mm wide; synandria rhombo-hexagonal to rhomboid, 1 mm diam., thecae somewhat displaced to overtopped by synconnective, opening through apical slits; *appendix* 6.5 cm long, tapering, cream; *fruiting spathe* becoming white.

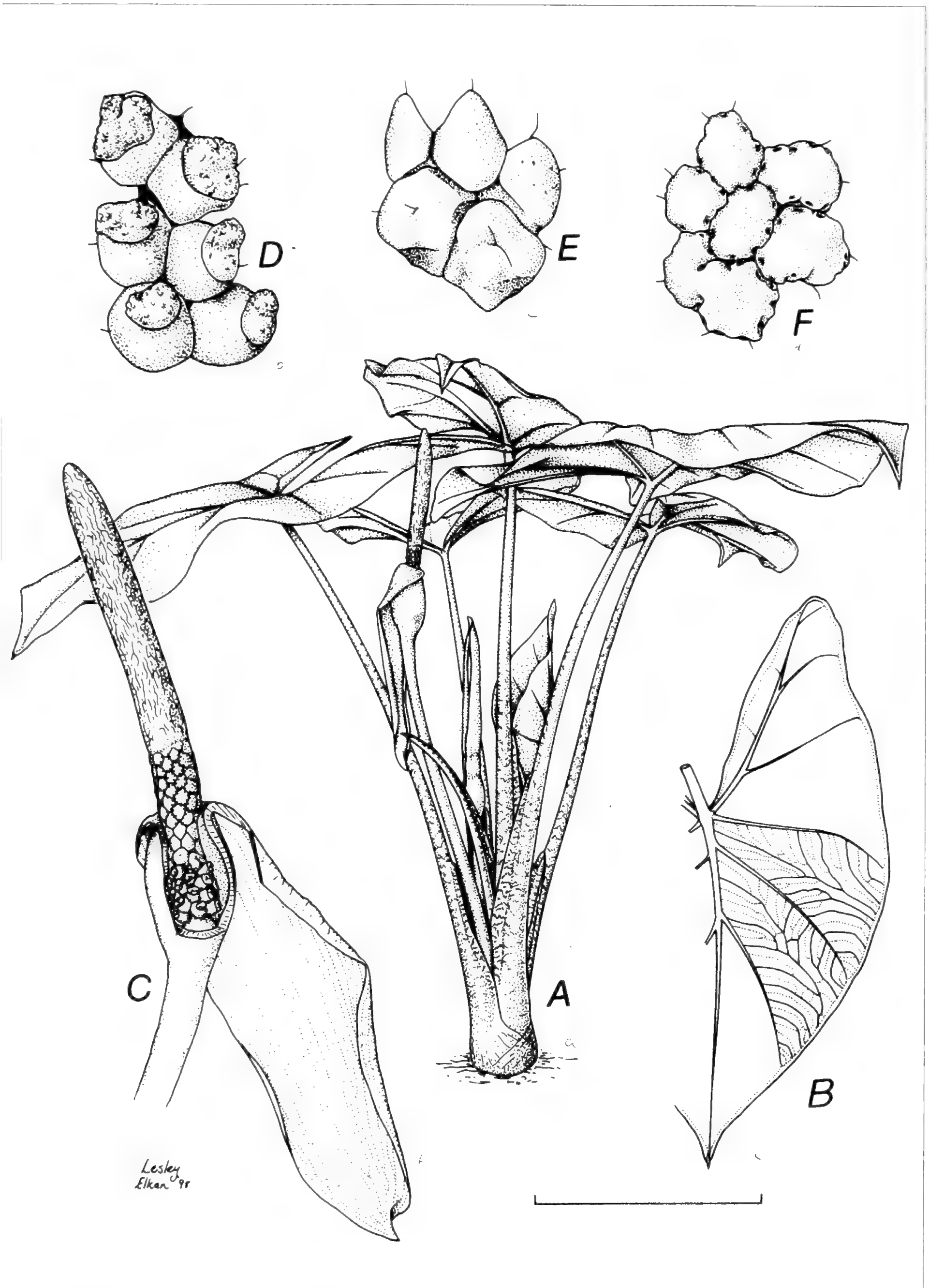

Figure 9. ***Alocasia flemingiana*** **Yuzammi & A. Hay**
RBG Sydney Acc. No. 980045. A. habit; B. venation; C. inflorescence with part of spathe removed; D. pistils; E. neuter organs; F. synandria. - Scale: bar to A, B = 8 cm, to C = 32 mm, to D, E, F = 6 mm.

Distribution: Endemic to Java; widespread in West Java and sporadic in Central Java.

Habitat: Found in teak-forest, swamp-forest, disturbed forest, on volcanic soils, sometimes over limestone, from sea level to ca. 1000 m altitude. *Murata et al J-2042* (BO) recorded that this species was found on 'rocky sea coast'. This seems an unlikely habitat for *Alocasia*, and possibly there has been an error in labelling of this specimen.

Notes: 1. The rationale behind the application of *Colocasia montana* or *Alocasia montana*, both based on *Arum montanum* - which Roxburgh had coined for a plant from the Northern Circars in the Indian state of Orissa - to Javan material remains obscure, doubly so since the identity of *Arum montanum* is itself unclear. The earliest misapplication appears to have been that of Hasskarl (loc. cit.) who made the connection on the basis that his Javan plant and *Arum montanum* were both 'stemless', followed by Miquel and, much later, Koorders. Hooker (1894) also noted in his Flora of British India that *A. montana* extended to Java. That opinion was not followed by Backer & Bakh. *f.* (1968) - though they in turn misapplied *Alocasia heterophylla* (Presl) Merr. to this species.

Arum montanum Roxb. first appeared in Hortus Bengalensis (1814: 65) as a nomen nudum, and the first valid publication was in Roxburgh's Flora Indica 3 (1832: 497). There, he wrote:

'I long considered this to be A. [Arum] *macrorrhizon, but changed my opinion on observing that Forster, who must have seen and examined that species in its recent state, says, the flowers are hermaphrodite; there being six sessile, twin anthers surrounding each germ, and that the stigma is orbicular. There are no traces of stamina, anthers or glands round the germs of my* [Roxburgh's] *plant; and the stigma is regularly three or four-lobed. In short, a very perfect Arum, or Caladium according to Ventenat'.*

Roxburgh did not record from where he took Forster's observation, but it was probably his dissertation on esculent plants (Forster, 1786), where he said of *Arum macrorrhizon* [I am indebted to Dan Nicolson for this]:

'Fructificatio a charactere generico aliquanto recedit, floculis in spadice omnibus et singulis hermaphoditis...COR. nulla./ STAM. Filamenta nulla. Antherae sex, spadice adnatae, didymae, singulo stylos cingunt./ PIST. Germen subrotundum. Stylus solitarius, brevis, crassiusculus, apice depressus. Stigma maculata orbiculata in apice styli....'

Arum macrorrhizon L. is the basionym of *Alocasia macrorrhizos* (L.) G. Don, and there is little doubt that either Forster's observation, or the way Roxburgh interpreted it, or the identification of the plant Forster observed, was incorrect. That being so, the probability is raised that *A. montana* is identical with *A. macrorrhizos*, as Roxburgh had originally thought. Neither Kunth, Schott, nor Engler and Krause, nor authors of floristic accounts of *Alocasia* in India have cited any additional specimens when treating *Alocasia montana*, simply reiterating descriptions obviously based on Roxburgh's protologue and the incomplete and rather naive illustration which, unless pertinent preserved material comes to light (Forman's (1997) account of Roxburghian species does not include *A. montanum*), will form the type. In the absence of evidence to the contrary, it would seem reasonable to treat *Alocasia montana* (Roxb.) Schott as an Indian synonym *of A. macrorrhizos* (q.v.), at least provisionally; however, epitypification of *Arum montanum* will be dealt with elsewhere. Suffice to say that, even without unequivocally disposing of the name *Alocasia montana* (Roxb.) Schott, there appears no tangible basis for applying the name of a 'species' known from a bare description and a poor painting of a plant from Orissa and resembling *Alocasia macrorrhizos*, to plants of a species apparently endemic to Java and bearing little resemblance to *A. macrorrhizos*, on the sole basis of 'stemless' habit - a characteristic of juveniles of most if not all species of *Alocasia*.

2. *Alocasia flemingiana* was incorrectly identified as *Alocasia heterophylla* (Presl) Merrill by Backer & Bakh. *f.* (1968). However, these species are readily distinguished by the following features: *A. flemingiana* has the lamina ovato-sagittate, with the margin entire, the leaf is only peltate in juvenile plants, and the sterile zone has relatively small synandrodia; *Alocasia heterophylla* has the lamina narrowly (hasto-) sagittate, sometimes deeply peltate in adult plants, with the margin sometimes undulate and the sterile zone with large synandrodia filling the upper part of the lower spathe chamber.

3. The specific epithet acknowledges Conrad D. Fleming's generous sponsorship of field work on Malesian Araceae, including Yuzammi's field work in Java during December 1997.

Other specimens seen: JAVA: Hort. Bogor, *Adelbert 400* (L); Banjumas, Tjilatjap, *Backer 21009* (BO); Java, Batavia, *Backer 34987* (BO); Java, Preanger, Tjadas Malang, *Bakhuizen. 1379* (BO); Preanger, Tjadas Malang, Tjidadap, Tjibeber, *Bakhuizen 1930* (BO); Madjalengka, Cirebon, *Beumée 1753* (BO); Pekalongan, Margasari, *Beumée 1767* (BO); Banjumas, *Beumée 4845* (BO); Batavia, Krawang, *Beumée 5397* (BO); Bidara Tjina, *Edeling s.n.* (BO); Tjiampea bij Buitenzorg, *Koorders 30810*b (BO); Pelabuhan Ratu, *Koorders*

*34459*b (BO), *Koorders 34463*b (BO), *Nicolson 935* (BO, US), *Nicolson 957* (BO); Cultuur Sepakaeng, Oengaran, Telomojo, Ambarawa, Semarang, *Koorders 35968*b (BO); Depok, Buitenzorg, *Koorders 42817*b (BO, L); Kranhau, West of Pelabuhan Ratu, W. Java, *Murata, Kato, Mogea J-2042* (BO); Depok, W. Java, *van Ooststroom 12609* (L); Tjilatjap, *Rivière s.n.* (L). Java, Preanger, Tjibodas, *Sapiin 85* (BO); Tjirebon, Telaga Erang, *Vermeulen 6* (BO); Miramere, Pamempek, West Java, *Yuzammi 297042* (NSW); Miramere, Pamempek, West Java, *Yuzammi 297043* (NSW).

21. Alocasia arifolia Hallier *f.*

Alocasia arifolia Hallier f., Bull. Herb. Boiss. Sér 2, 1 (1901) 670, fig. 11; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 79. - Type: Cult. Hort. Bogor ex Sumatera, Deli, Permandian, 1 Apr. 1896, *H. Hallier 105d,* (BO, holo; Herbarium Bogoriense sheets 100563 and 100564).

Herb to 70 cm tall; *stem* erect to decumbent, to ca. 30 cm long, 2–4 cm diam.; *leaves* several together; *petiole* ca. 20–50 cm long, finely but densely puberulent to finely scabrid to glabrous, sheathing in the lower ca. 1/4–1/3, mid-green to purplish brown; *blade* sagittate to hasto-sagittate, somewhat glossy mid/dark green adaxially, paler below, membranous to thinly coriaceous, to ca. 30 cm long; *anterior lobe* to ca. 22 cm long, widest at base, to 16 cm wide; anterior costa with 3–5(–6) primary lateral veins on each side, diverging at ca. 45–60°, with inconspicuous axillary glands, sometimes abaxially puberulent; secondary venation flush with lamina when fresh, somewhat prominent abaxially when dry, fine but abaxially conspicuous, forming undulating to zig-zag interprimary collective veins and running to a rather conspicuous submarginal vein ca. 1.5–2 mm from the margin; *posterior lobes* acute, to ca. 15 cm long; posterior costae diverging at obtuse to very obtuse angles, naked in the sinus for up to 3 cm; *inflorescences* paired, the pairs interspersed with foliage leaves; peduncle to ca. 6 cm; *spathe* 5.5–9 cm long; lower spathe 1–1.5 cm long, separated from the limb by an abrupt constriction, ovoid; limb oblong to oblong lanceolate, apiculate for up to 1 cm, greenish white, sometimes suffused purple-brown, erect, then reflexed; *spadix* subequalling the spathe, 4.5–8 cm long, shortly stipitate; stipe white, ca. 3 mm long; *female zone* ca. 8 mm long; ovaries subglobose, green, ca. 1.5 mm diam.; style very short, ca. 0.5 mm long; stigma white, 3–4-lobed, the lobes rounded; *sterile interstice* ivory, hour-glass shaped, corresponding with spathe constriction, ca. 7 mm long, ca. 3 whorls of rhombo-hexagonal synandrodia; *male zone* short, about equalling female zone, ca. 6 mm diam.; synandria ivory, rhombo-hexagonal, 2–3 mm diam.; thecae opening by apical pores overtopped by synconnective; *appendix* somewhat constricted at base, the rest slightly narrower than male zone, finally tapering to a point, pale apricot; *fruiting peduncle* to ca. 20 cm long; fruiting spathe ovoid, ca. 2.5 cm long.

Distribution: Endemic to Sumatera, recorded from few, scattered localities.

Habitat: Low montane forest 400–1300m alt., often near streams, but not rheophytic.

Notes: 1. The two sheets that comprise the type, as interpreted here, consist of a leaf and an inflorescence respectively. However, it is not entirely clear that they represent the same collection (the second is undated and has no collection number), though they are both collected from the Bogor Botanic Garden. I am in no doubt that they are of the same species and they are both determined as *A. arifolia* by Hallier *f.* It would be desirable to designate an unambiguous epitype, but, as yet, complete, authentically provenanced material is not available.

2. Relationships of *Alocasia arifolia* are not readily apparent, but the arrangement of inflorescences and the synandria with the synconnective overtopping the thecae suggest alliance to Javan *A. flemingiana*.

Other specimens seen: SUMATERA: Cult. RBG Sydney Acc. No. 942737 ex cult. Hort. Leiden Acc. No. 940819 ex Sumatera, *Vogel s.n.* (NSW); Cult. RBG Sydney Acc. No. 970498 ex West Sumatera, G. Gadut, *Hay et al. 13069* (NSW); Mentawi Islands, Siberut Island, *Iboet 26* (BO); Lampung Prov., Mt Tanggamus, *Jacobs 8265* (L); Aceh, Gajolanden, Bivak Aer Poetih waterfall, nr Pendeng, *van Steenis 9283* (BO);

Longiloba Group

Species 22—24

Growth pattern strongly rhythmic, with a pronounced delay between flowering and resumption of leaf-production; cataphylls thinly membranous, degrading into rather sparse fibres; *leaves* solitary or few together, the *blades* mostly peltate and pendulous, often purple-backed and/or with white major venation; interprimary collective veins absent to very pronounced and zig-zagged; *spathe* limb opening wide and deciduous; *spadix* stipitate; stipe white; ovaries green with white to yellowish stellate stigmas; *sterile interstice* attenuate and corresponding with spathe constriction; *male zone* ivory; thecae not overtopped by synconnective; *appendix* pale orange-pink to yellow, occasionally ivory.

Distribution: About four species from Indochina to West Malesia, the Philippines and Sulawezi.

Note: This group coheres on the basis of its highly uniform inflorescence morphology, strongly rhythmic growth and membranous, fibrous cataphylls, and leaves with usually peltate, often dark green, purple-backed and white veined blades. There is nevertheless a great deal of variation in leaf blade shape, colour and venation. It is represented by three morpho-geographically circumscribable species - Philippine *A. sanderiana* W. Bull and *A. boyceana* A. Hay ined. and Sulawesi *A. suhirmaniana* Yuzammi & A. Hay. The fourth 'species' is a taxonomically intractable complex centred on West Malesia, extending into mainland Asia to the north and Sulawesi to the east, here treated as the *Alocasia longiloba* complex. Seventeen names have been proposed for Malesian elements within this complex.

22. Alocasia longiloba Miq.

Alocasia longiloba Miq., Bot. Zeit. 14 (1856) 561 & Fl. Ind. Bat. 3 (1856) 207; Schott, Prodr. Syst. Aroid. (1860) 153; Engl. in A. & C. DC., Monogr. Phan. 2 (1879) 506; Hook.*f.*, Fl. Brit. India 6 (1894) 527; Hallier f., Bull. Herb. Boiss. 7 (1898) 607; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 179; K. Krause & Engl., Pflanzenr. 71 (IV.23E) (1920) 103; Backer & Bakh.*f.*, Fl. Java 3 (1968) 118); M. Hotta, Acta Phytotax. Geobot. 22 (1967) 156. Type: Indonesia, Java, Tjikoja, 15 Aug 1856, *Zollinger 601* (L, holo; B, BM, K, P iso).

Caladium veitchii Lindley, Gard. Chron. (1859) 740. - *Alocasia veitchii* (Lindley) Schott ('*veitchi*'), Ann. Mus. Lugd.-Bat. 1 (1863) 125; Koord., Exkurs.-Fl. Java 1 (1911) 261. - *Alocasia lowii* var. *veitchii* (Lindley) Engl. in A. DC., Monogr. Phan. 2 (1879) 508; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 107. Neotype: Java, without date, L sheet nos. 898. 87 115 & 898. 87 116, *Kuhl & van Hasselt 12* (L, designated here).

Caladium? lowii Lem., Ill. Hort. 10 (Jan 1863) descr. ad t. 360. Type: Ill. Hort. 10 (1863) t. 360.

Alocasia lowii Hook., Curtis's Bot. Mag. (May 1863) descr. ad t. 5376; Engl. in A. & C. DC., Monogr. Phan. 2 (1879) 508; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 178 ('*lawii*'); Ridl., Mat. Fl. Mal. Pen. 3 (1907) 18; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 106; Ridl., Fl. Mal. Pen. 5 (1925) 98; M. Hotta, Acta Phytotax. Geobot. 22 (1967) 156. - Type: Cult. RBG Kew ex Hort. Low, *Anon. s.n.* (K!, holo). [Not based on *Caladium lowii*; see Hay in Hay *et al.*, Blumea Suppl. 8 (1995) 16].

Alocasia korthalsii Schott in Miq., Ann. Mus. Bot. Lugd.-Bat. 1 (Nov 1863) 124; Engl. in A. & C. DC., Mongr. Phan. 2 (1879) 509 & Bot. Jahrb. Syst.

25 (1898) 25; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 179; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 108, fig. 25; M. Hotta, Acta Phytotax. Geobot. 22 (1967) 156. - Type: Indonesia, Kalimantan, G. Sakumbang, *Korthals s.n.* (L, holo).

Alocasia singaporensis Linden, Gartenfl. 14 (1865) 252. - Neotype: Cult. R.B.G. Kew, 12 Feb 1879, *N.E. Brown s.n.* (K; designated here - see below).

Alocasia lowii var. *picta* Hook.*f.*, Curtis's Bot. Mag. (1865) descr. ad t. 5497. - Type: Bot. Mag. (1865) t. 5497.

Alocasia thibautiana Mast., Gard. Chron. 9 (1878) 527; N.E. Br., Ill. Hort. 28 (1881) 72, t. 439; N. E. Br., Gard. Chron. ser. 3, 17 (1895) 485, fig. 68. Neotype: Cult. RBG Kew ex Hort. Veitch, 25 Jan 1879, *N.E. Brown s.n.* (K, designated here).

Alocasia amabilis W. Bull, Retail List 143 (1878) 9. - Neotype: Cult. RBG Kew ex Hort. Bull, 20 Sep 1878, *N.E. Brown s.n.* (K, designated here).

Alocasia denudata Engl. in A. & C. DC., Monogr. Phan. 2 (1879) 507; Hook.f., Fl. Brit. Ind. 6 (1893) 525; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 178; Ridl., Mat. Fl. Mal. Pen 3 (1907) 17; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 100; Ridl., Fl. Mal. Pen. 5 (1925) 97; Corner, Gard. Bull. Sing. Suppl. 1 (1978) 73, 100. Type: Singapore, *Gaudichaud 106* (G, holo, n.v.; P iso).

Alocasia putzeysii ('*putzeysi*') N.E. Br., Ill. Hort. 29 (1882) 11; N.E. Br., Gard. Chron. ser. 2, 19 (1883) 501, fig. 75; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 108. - Type: Cult. RBG Kew ex Hort. Linden, Dec 1881, *N.E. Brown s.n.* (K, holo).

Alocasia eminens N.E. Br., Gard. Chron. ser. 3, 1 (1887) 105; anon., Kew Bull. (1888) 91. - Type: Cult. RBG Kew ex Hort. W. Bull (no. 3954), 10 Nov 1886, *N.E. Brown s.n.* (K, holo).

Alocasia watsoniana Mast., Gard. Chron. ser. 3, 13 (1893) 442; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 109; Burnett, Aroideana 7 (1984) 128, figs. 93-94. - Type; Gard. Chron. ser. 3, 13 (1893) 569, fig. 83. Epitype: Cult. RBG Kew ex Hort. Sander, April 1893, *N.E. Brown s.n.* (2 sheets) (K, designated here).

Alocasia curtisii N.E. Br., Kew Bull. (1894) 347; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 106. - Type: Cult. RBG Kew ex Malaysia, Penang, 16 July 1894, *N.E. Brown s.n.* (K, holo).

Alocasia cuspidata Engl., Bot. Jahrb. Syst. 25 (1898) 25; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 102. - Type: Indonesia, Kalimantan, Dusson Timor, Telang, *Grabowski s.n.* (B, holo).

Alocasia denudata var. *elongata* Engl., Pflanzenr. 71 (IV.23E) (1920) 100, fig. 21, A-E. - Type: Singapore Botanic Garden, December 1905, *Engler 3803* (B, holo; presumed destroyed). Neotype: Singapore, Seletar forest behind Rifle Range, 29 Aug 1948, *J. Sinclair 5020* (E, designated here - see below).

Small to robust herbs ca. 40–150 cm tall; terrestrial to lithophytic; *rhizome* generally elongate, erect to decumbent, often completely exposed, sometimes swollen and sub-cormous, ca. 8–60 cm long, 2–8cm diam., usually bearing remains of old leaf bases and cataphylls; growth markedly rhythmic with renewal growth delayed after flowering; vegetative modules often unifoliar (to 3-leaved), subtended by conspicuous lanceolate papery-membranous often purplish-tessellate cataphylls degrading to papery fibres; *petioles* glabrous, purple-brown to pink to green, often strikingly obliquely mottled chocolate brown, ca. 30–120 cm long, sheathing in the lower ca. 1/4 or less; *blades* often pendent, shape and venation extremely variable, peltate (except 'denudata'), plain mid-green throughout to adaxially dark green and abaxially rich purple, often adaxially with the major venation white to pale grey-green and sometimes with the lamina bordering the main veins grey-green, hasto-sagittate and triangular in outline to ovato-sagittate and shield-shaped, 27–65(–85) cm long x 14–ca. 40 cm wide, with the widest point anterior to the petiole insertion to near the tips of the posterior lobes; anterior costa with 4–8 primary lateral veins on each side, the proximal ones diverging at ca. 60–100°, the angle decreasing in distal veins and the course more or less straight to the margin to markedly acropetally deflected; axillary glands conspicuous abaxially at the junctions of the main veins and costae; secondary venation obscure to conspicuous abaxially, mostly arising from the primary veins at a wide angle then sooner or later deflected towards the margin, forming variously well-defined interprimary collective veins or these absent, concolorous with the abaxial lamina or sometimes markedly paler; interprimary collective veins when present weakly undulating to strongly zig-zagging at broadly acute angles; *posterior lobes* ca. 3/4 to 1/2 the length of the anterior lobe, when peltate united for (5–)10–66% of their length; posterior costae straight to pedately incurved; *inflorescences* (solitary to) paired, with up to 4 pairs in succession

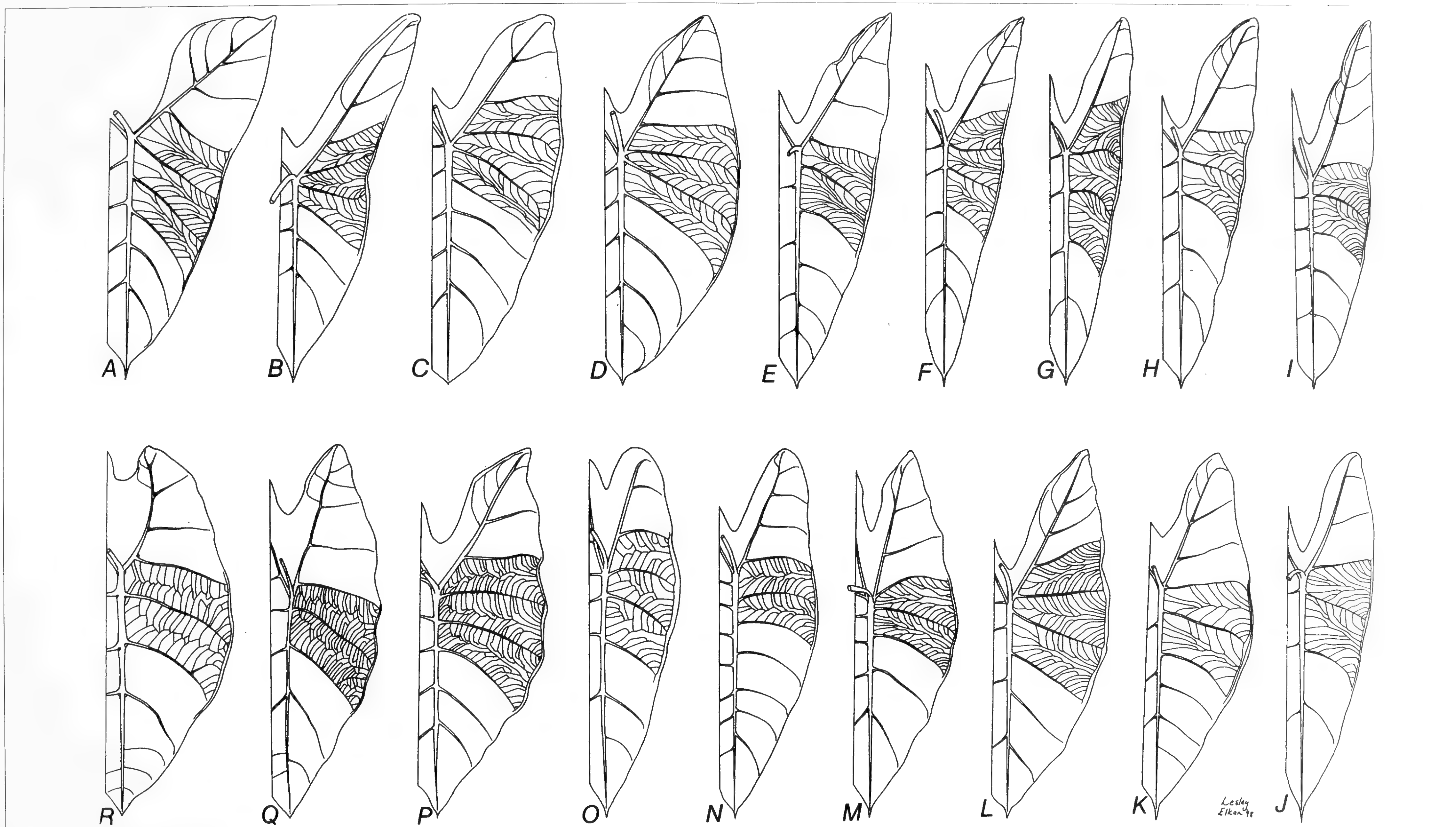

Figure. 10. ***Alocasia longiloba*** **Miq. s. l.**
Leaf blades showing a continuum of variation, some exemplifying entities recognised in the text. - A. 'denudata'; D. 'thibautiana'; F, 'longiloba'; K, 'lowii'; M, 'korthalsii'; O, 'putseyzii'; R, 'watsoniana'. - Scale: 1/5 approx. (not all drawn to exactly the same scale). A. 901379 - *Hay s.n.*, Singapore; B. 940485 - *Hay 9332*, Bintulu, Sarawak, C. 940102 - *Hay 9058*, Batu Caves, Selangor; D. 821121 - cult. unknown origin; E. 940355 - *Hay 9288*, Fraser's Hill, Pahang; F. 942735 - *Vogel s.n.,* Sarawak; G. 950372 - *Hay 10035*, Kebun Cina, Sabah; H. 940138 - *Hay 9142*, Bukit Tanka, Negeri Sembilan; I. 904647 - *Boyce 384*, Temburong, Brunei; J. 940165 - *Hay 9069*, Bukit Larut, Perak; K. 940064 - *Hay 9019*, Kaki Bukit, Perlis; L. 940047 - *Hay 9001*, Kangar, Perlis; M. 940462 - *Hay 9308*, Bintulu, Sarawak; N. 970528 - *Hay 13002*, Lembah Anai, West Sumatera; O. 942718 - *Vogel s.n.*, Bau, Sarawak; P. 970474 - *Hay 13036*, Kerinci Seblat NP, Jambi; Q. *Lörzing 4804*, Sibolangit, Sumatera; R. 920745 - *Dearden s.n.,* Long Jowe, Sarawak. Six-figure numbers are all Royal Botanic Gardens Sydney Accession numbers with vouchers at NSW.

without interspersed foliage leaves; peduncles ca. 8–18 cm long, usually resembling the petioles in colour and markings, erect at first, then often declinate, elongating and then erect in advanced fruit, subtended by a series of progressively larger cataphylls resembling those of the vegetative phase; *spathe* ca. 7–17 cm long, abruptly constricted ca. 1.5–3.5 cm from the base; lower spathe green, ovoid to subcylindric; limb pale green, membranous, lanceolate, canoe-shaped and longitudinally in-curved, eventually reflexing after male anthesis; *spadix* somewhat shorter than to subequalling the spathe, ca. 6–13 cm long, stipitate, with the stipe conic, whitish, to 5 mm long; *female zone* 1–1.5 cm long; ovaries subglobose, ca. 1.5–2 mm diam., green; stigma subsessile or on a slender style to ca. 0.5 mm long, white, acutely and conspicuously 3–4-lobed, the lobes pointed, more or less spreading; *sterile interstice* 7–10 mm long, narrower than the fertile zones, corresponding with the spathe constriction; lower synandrodia often with incompletely connate staminodes, the rest elongate rhombo-hexagonal, flat-topped; *male zone* subcylindric, somewhat tapered at the base, 1.2–2.5 cm long, 4.5–8 mm thick, ivory; synandria more or less hexagonal, ca. 2 mm diam., 4–6-merous; thecae opening by apical pores not overtopped by synconnective; *appendix* 3.5–9 cm long, about the same thickness as the male zone and demarcated from it by a faint constriction, subcylindric, distally gradually tapering to a point, faintly rugose to rugose in the lower part, very pale orange to bright yellow; *fruiting peduncle* to 25 cm long; fruiting spathe ovoid, ca. 4–7 cm long; fruits orange-red.

Distribution: Indochina to West and Central Malesia excluding the Philippines.

Habitat: In rainforest and swamp-forest floor, regrowth, on boulders in forest and on exposed cliffs and ravines at low to medium elevation.

Notes: 1. In developing a classification that reflects what is at present known of this complex, I have avoided reducing its elements blithely to a single species without a clear qualification that it is not equivalent to a 'simple' species of low variation content. However, the complex cannot have forced onto it overstated and simplistic hierarchical discontinuities that would be implied in recognising separate species and/or infraspecific taxa within it on the basis of currently available evidence (cf. Gentry, 1990).

Like many *Alocasia* species, the elements of this complex freely hybridise in cultivation, but within this group hybrid series involving three or four 'species' are recorded (see Burnett, 1984), confirming their close relationship. Many of the formally named parent forms are highly ornamental and striking, and the horticultural community may be irritated by their disappearing as named species. However, there is no reason why these names cannot be transposed into the nomenclature for cultivated plants as cultivars or cultivar groups. The background to the description of 'species' within this complex has been largely horticultural, through the introduction of the finest and most striking forms to European stove culture in the 19th Century. These forms represent what I have called the 'peak variants' in the complex, and I have used their types and associated nomenclature as a framework for the informal infraspecific classification proposed here. The entities proposed cannot at present be regarded as more than peaks in an overall continuum of variation and so not all specimens encountered can be categorically accomodated in this classification. Nevertheless, there are perceptible but incompletely resolved geographical patterns to the variation, and some ecological variation, which is somewhat but incompletely correlated with morphological variation and geographic pattern, discussed under the relevant 'peak variants'. The key provided to these variants must be regarded as a guide only to 'typical' forms, and no pretence is made that by using it all specimens encountered can be unequivocally identified.

2. This complex can be considered an ochlospecies since, while there is a continuum of variation globally, at particular localities sharply differing forms may coexist and evidently behave locally as discrete sympatric 'topospecies'. A rigorous analysis of variance might reveal statistically significant narrow discontinuities, which could form the basis for species distinctions at the global level. However, at present, carrying out such an anlysis is impeded by the inadequate and very uneven sampling over the range, exacerbated by the incompatibility of this genus with standard herbarium preservation methods. As a consequence of this incompatibility, collections consist of conveniently sized leaves or fragments which cannot be deemed comparable between individuals when the plants are known to show considerable plasticity of form depending on age and environmental factors.

The local coexistence of distinct forms presupposes the existence of local reproductive isolating mechanisms regardless of whether or not these might translate into the defintion of species within the complex globally. The percentage of specimens preserved directly from the wild that bear inflorescences is extremely low and inadequate to form a basis for detecting isolation mechanisms based on flowering time. Moreover, there is an almost total dearth of ecophysiological data on finer aspects of phenology, which are known to be complex in this genus involving intricate patterns of flux in thermogenesis (Leick, 1915 - n.v., cited in Grayum, 1990) possibly associated with scent production and the differentiation of pollinator preferences.

3. Lindley described *Caladium? veitchii* from a cultivated plant obtained from Borneo. No original material has been located, and Lindley did not illustrate it. When Schott (1863) made the combination in *Alocasia*, he cited a collection by Kuhl and van Hasselt, from Java, in addition to noting the original provenance Borneo. Since Schott was the world authority on aroids at the time and had established an enormous collection of living plants, it is highly probable that he knew *Caladium veitchii* first hand. I therefore consider it enough to be guided by Schott's interpretation and designate the *Kuhl & Hasselt* specimen as the neotype.

4. The above-cited illustration of *A. watsoniana* is of a sterile plant, though it shows the distinctive bullate blade and in-curved posterior costae. It does not actually accompany the protologue, having appeared in an issue of Gardeners' Chronicle one month later. However, the caption includes direct reference to the protologue. Whether or not direct connection may be inferred between the illustration and the protologue, application of the name requires to be established more firmly. The above-selected epitype is preserved from a flowering cultivated plant of, evidently, the same clone introduced by Sander & Co, which Masters described.

5. No material was preserved of *Alocasia thibautiana* when it was first described, nor was it illustrated. The designated neotype consists of two sheets annotated by N.E. Brown 'from the type plant'. Both consist of leaf only. A third sheet, dated 12 November 1881 consists of a dried inflorescence.

6. Linden's description of *Alocasia singaporensis* is extremely scant, reading, from the German, 'From Singapore. The large leaf is arrow-shaped, with large spreading basal lobes and of dark green colour'. Assuming the provenance Singapore alludes to origin from the wild, this description can only match *Alocasia longiloba* 'denudata'. Material preserved by Brown at Kew under the name *A. singaporensis* is indeed of that entity.

7. *Alocasia denudata* var. *elongata* Engl. was differentiated from the typical variety by the narrower lobes of the leaf blade. The designated neotype well exemplifies this state. The illustration that accompanied the protologue is not good enough to serve as the type in the absence of the material it was apparently based on. There are no details of leaf venation and the lower part of the spadix is stylised.

8. *Alocasia amabilis* W. Bull was validly published in the above-cited retail list, and is neotypified with material preserved by Brown at Kew from a plant obtained from Bull under that name.

KEY TO THE PEAK VARIANTS

1a. Leaf blade of adult plant not distinctly pendent, not peltate (S. Malay Peninsula, E Sumatera) .... **'denudata'**
1b. Leaf blade of adult plant pendent, peltate 2

2a. Leaf blade narrowly triangular in general outline (ca. 3 times as long as broad) or sometimes slightly hastate (throughout range of species) .... **'longiloba'**
2b. Leaf blade broadly triangular to broadly oval in general outline (ca. 2 times as long as broad), not hastate 3

3a. Posterior lobes of leaf united for at least half their length 4
3b. Posterior lobes of leaf united for less than half their length 5

4a. Interprimary collective veins zigzagging at acute angles (Peninsular Malaysia, Sumatera, Borneo) .... **'watsoniana'**
4b. Interprimary collective veins more or less undulate (Borneo) .... **'korthalsii'**

5a. Interprimary collective veins zigzagging at ca. right angles; secondary venation paler than blade ground colour (Sumatera) .... **'putzeysii'**
5b. Interprimary collective veins weakly formed to indiscernible; secondary venation concolorous with leaf blade 6

6a. Blade broadly triangular (Peninsular Malaysia, NW Borneo) .... **'lowii'**
6b. Blade broadly ovato-sagittate (northern Peninsular Malaysia, ?NW Borneo) .... **'thibautiana'**

a. 'denudata'

- *Alocasia singaporensis* Linden - *Alocasia denudata* Engl. - *Alocasia denudata* var. *elongata* Engl.

Terrestrial herb to ca. 1m tall; *leaves* 1–3 together; *petiole* to 80 cm (often less), mostly rather densely obliquely mottled chocolate, the ground colour occasionally bright pink; *blade* green, sagittate, usually not pendent, with the primary venation not or barely of a different colour from that of the lamina; *posterior lobes* subequalling the anterior; posterior costae naked in the sinus for up to 7 cm; interprimary collective veins absent to weakly formed and then only slightly undulating.

Distribution: Southern Malay Peninsula and E . Sumatera.

Habitat: In rain forest and regrowth understorey at low elevation.

Note: This entity is qualitatively distinct from others on the basis of its non-peltate leaves, which are not as makedly pendulous as they are in the rest of the complex. However, even quite advanced sub-adult plants have peltate leaves, which are identical to *A. longiloba* 'lowii'. It is geographically fairly coherent, but intergrades in Sumatera, through very shallowly peltate forms, with 'longiloba' (e.g. *Docters van Leeuwen-Reijnvaan 11790* (BO)) and 'putzeysii' (e.g. *Meijer 6859* (L)) variants.

Were this entity to be recognised as a separate species, *A. singaporensis* would have priority over *A. denudata*. However, *A. denudata* ha been a name in wide use, while *A. singaporensis* has never been taken up to any significant extent, and I would recommend that *A. denudata* be proposed for conservation.

Selected other specimens seen: PENINSULAR MALAYSIA: Malacca, Pulau Nangka, *Burkill 2641* (K); Selangor, Kuala Langat, nr Klang, *Burkill 4102* (SING); Johore, Jason Bay, *Corner s.n.* (SING); cult. RBG Sydney Acc. no. 940260 ex Johor, G. Panti via Kg Lukit, *Hay et al. 9192* (NSW); Johore, Kluang F.R., *Holttum 9235* (K, SING); Johore, 20th Milestone, Kota-Tinggi - Jemalung Rd, *Nicolson 1229* (US); Sembilan Islands, Pulau Rembia, *Sinclair 76443* (KEP); Dindings, Lumut, *Ridley s.n.* (SING). SINGAPORE: Jurong Rd, *Burkill 255* (SING); Mandai Rd., *Burkill 11432* (SING); Singapore Botanic Garden, *Croat 53241* (B, K); Cult. RBG Sydney Acc. no. 901379 ex Singapore Botanic Garden Rain Forest, *Hay s.n.* (NSW); Singapore Botanic Garden Jungle, *Nicolson 1007, 1120, 1121* (all US); Bukit Timah, Upper Fern Valley Ravine, *Nicolson 1106* (US); 'Woodlands', *Ridley s.n.* (SING); Chan Chu Kang, *Ridley s.n.* (SING), Changi, *Ridley s.n.* (SING); Tuas, *Ridley s.n.* (SING); Bukit Timah, *Ridley s.n.* (K, SING), Kranji, *Ridley s.n.* (SING); Kg. Pulau Damar Darat, *Sinclair 6874* (E, US). SUMATERA: Siberut Island, *Boden-Kloss 11438* (SING); Banka, P. Pinang, G. Mangkol, *Bünnenmeijer 2124* (BO); Riau Archipelago, Belobang, *Bünnenmeijer 7696* (BO, L); Cult. RBG Sydney Acc. no. 970448 ex Jambi Prov., 100km along rd Jambi-Palembang, *Hay et al. 13007* (NSW); Mentawi Islands, Siberut Island, *Iboet 26* (BO, L, SING); SE Bangka, Lobok Besar, *Kostermans 266* (BO); Malacca Straits, Pulau Bukala, *Sinclair 76419* (KEP).

b. 'longiloba'

- *Alocasia longiloba* Miq. s. str. - *Alocasia cuspidata* Engl. - ?*Caladium veitchii* Lindl. - *Alocasia veitchii* (Lindl.) Schott - *Alocasia lowii* var. *veitchii* (Lindl.) Engl. - *Alocasia amabilis* W. Bull.

Generally terrestrial (occasionaly lithophytic) sometimes robust herb, to ca. 1m (1.5m) tall (usually ca. 60 cm); *leaves* solitary to 3 together; petiole to 80 cm tall (usually ca. 40 cm), mottled dark green to chocolate; *blade* hasto-sagittate, rather narrowly triangular, dark to very dark green, usually with the major venation grey-green adaxially, *posterior lobes* 1/2–2/3(–3/4) the length of the anterior, peltate for (5–)10–30% of their length, acute; secondary venation initially widespeading, then sooner or later deflected towards the margin; interprimary collective veins absent to weakly formed and zig-zag at widely obtuse angles.

Distribution: Central Vietnam and Thailand to Peninsular Malaysia, Sumatera, Borneo, Java and Sulawesi.

Habitat: In rain forest and regrowth understorey, in swampy areas and well drained slopes, occasionaly on rocks, at low to medium elevation; in Sulawesi from sea level to ca. 2000 m altitude.

Note: This form is very widespread. In Borneo and Peninsular Malaysia it intergrades with *A. longiloba* 'lowii', which typically has broader leaf blades and is generally lithophytic. In Sumatera it intergrades with *A. longiloba* 'putzeysii' (e.g. Hay *et al.* 13080). All the collections from Sulawesi are sterile. Those plants have extremely shallowly peltate leaves.

Selected other specimens seen: PENINSULAR MALAYSIA: Perak, Taiping Waterfall, *Furtado s.n.* (SING); Cult. RBG Sydney Acc. no. 940165 ex Perak, Thaiping, Bk Larut, *Hay et al. 9069* (NSW); Selangor, Ulu Langat, *Millard 1866* (SING). SUMATERA: Asahan, Silo Maradja, *Bartlett 6441* (US); Aceh, G. Leuser Nature Resrve, Upper Mamas R., ca. 15 km W of Kutacane, *de Wilde & de Wilde-Duyfjes 19001* (L); Cult. RBG Sydney Acc. no. 970459 ex Jambi Prov., 120 km along rd Sungei Penuh - Bangko, *Hay et al. 13018* (NSW); Cult. RBG Sydney Acc. no. 970509 ex West Sumatera, Padang, Gunung Gadut, *Hay et al. 13080* (NSW). JAVA: West Java, Bogor, *Boerlage s.n.* (L); Bantam, Lebak Kidoel, G. Kancana, *Koorders 40970b* (L); Preanger, Tasik Malaja, Pendjalu, *Koorders 44348b*, (L); West Java, W of Djasinga, Djankapa forest reserve, *Meijer 2947* (BO); Batavia, Wanajasa, *Wisse 1237* (L). KALIMANTAN: Pulau Lampei, *Korthals s.n.* (L); East Borneo, Berau distr., *Kostermans 21838* (L); West Kalimantan, Pontianak, S. Raja, *Mondi 15* (L). SARAWAK: Matang F.R., 10 mi W of Kuching, *Nicolson 1271* (US); Bako National Park, 20 mi NE of Kuching, *Nicolson 1307* (US); Kuching, *Ridley 12250* (SING); Binatang, Pulau Bruit, *Sanusi bib Tahir 9219* (L). BRUNEI: Temburong Distr., Sg. Temburing at Kuala Belalong, *Boyce 359, 384* (both K); Belait Distr., Sg. Liang Arboretum, *Foreman & Blewett 1082* (K); Bangarmassing, *Motley 1131* (L); Belait District, Rasau, *van Niel 4247* (L). SABAH: Cult. RBG Sydney Acc. no. 950372 ex Sandakan, Kebun Cina, *Hay et al. 10035* (NSW); cult. RBG Sydney Acc. no. 960481 ex Sepilok F.R., *Hay et al. 12152* (NSW); Cult. RBG Sydney Acc. no. 960512 ex G. Rara F.R., ca. 2.5 km above main Maliau Falls, *Hay et al. 12050* (NSW). SULAWESI: Masamba, Takala-Teboro, *Eyma 1460* (BO); E Central Sulawesi, Morowali Prov., *Grimes 1906* (K); Central Celebes, Mt Nokilalaki, *Meijer 9859* (L); Makassar, Malinoboren, *Rant 440* (BO); Enrakang Distr., Latmojong Mts, Bunteh Tjejeng, *Sands 193* (K);

c. 'putzeysii'

- *Alocasia putzeysii* N.E. Br.

Terrestrial (?always) herb to ca. 90 cm tall; *leaves* 1–3 together; petiole to ca. 80 cm, brown-mottled or more or less concolorous brownish purple; *blade* narrowly ovato-sagittate, rather shallowly peltate (to ca 20% of the depth of the posterior lobes), nearly always purple-backed; secondary venation conspicuous, forming weakly zig-zag interprimary collective veins.

Distribution: Sumatera.

Habitat: On rainforest floor, usually on slopes at low to medium elevation.

Note: This element is distinguished from 'watsoniana' by the straight posterior costae diverging at a wider angle, the more triangular leaf outline and the less deeply peltate posterior lobes. The interprimary collective vein is mostly less markedly zig-zag in course, though *Hay et al. 13102* comes from a population in which some individuals have the venation pattern typical of 'watsoniana', though the leaf shape is of 'putzeysii'. The secondary venation is typically paler in colour than the ground colour of the lamina on either the adaxial side or both sides. This element links 'watsoniana' with 'longiloba'. *Meijer 6859* resembles 'denudata' in its long posterior lobes distinctly elliptic on the inner sides, but matches 'putzeysii' in other respects.

The type of *Alocasia putzeysii* is of a leaf only, but it is quite distinctive. The shape is narrowly ovato-sagittate with the posterior lobes 2/3 the length of the anterior and peltate for ca. 20% of their length. The interprimary collective veins form a weakly zig-zag pattern and the secondary venation is paler than the ground colour. In the protologue, *A. putzeysii* was attributed to Java, however, this form matches Sumateran material, not Javan. That the attribution to Java was in error appears to be confirmed by N.E. Brown's notes on the type specimen, where he states the provenance as Sumatera, 'Atchin' (?= Aceh) Province.

Specimens seen: SUMATERA: Cult. RBG Sydney Acc. No. 970528 ex W. Sumatera, Lembah Anai, *Hay et al. 13102* (NSW); W. Sumatera, Taram, E of Pajakumbuh, *Meijer 6859* (L); 'West Coast', *Micholitz s.n.* (K);

d. 'watsoniana'

- *Alocasia watsoniana* Mast

Mainly lithophytic but also terrestrial moderately robust herb to ca. 1.25 m tall; *leaf* usually solitary (–3 together); *petiole* purplish, not or faintly mottled; *blade* ovato-sagittate, shield-shaped, to ca. 60 (–85) cm long, adaxially dark green with strikingly whitish major venation, abaxially purple, sometimes shallowly undulate on the margin, often bullate with long narrow wrinkles running between and more or less perpendicular to the primary veins and arranged more or less concentrically around the insertion of the petiole; proximal primary venation diverging at a very wide angle (to over 90º), distal primary veins diverging at ca. 45º; secondary venation rather dense, arising at a very wide angle and uniting into an interprimary collective veins very strongly zig zagging at acute angles; *posterior lobes* rounded acute, united for over half their length; posterior costae diverging at ca. 45–90º then somewhat incurved in the manner of the posterior rhachises of a pedate leaf.

Distribution: Peninsular Malaysia, Sumatera, Borneo.

Habitat: Terrestrial and on cliffs and on boulders in forest, sometimes on limestone, from sea level to ca. 700m.

Notes: In Sumatera this element closely approaches, in its blade shape and secondary venation pattern, and occasionally intergrades with, 'putzeysii', but that typically has less deeply peltate leaves, straight posterior costae and blades that are not bullate. The two evidently differ to some extent ecologically, *A. longiloba* 'putzeysii' found usually on forest floor, while *A. longiloba* 'watsoniana' appears generally lithophytic, at least in Borneo and Peninsular Malaysia. Unfortunately in those Sumateran specimens most closely conforming to 'watsoniana', habitat details are not clear, though *Hay et al. 13036* is terrestrial. Within the Bornean and Peninsular Malaysian part of the range, it appears sharply distinct morphologically from other elements of the *A. longiloba* complex. If ecological differentiation between the Sumateran and these other repesentatives of 'watsoniana' could be demonstrated more clearly, the Bornean and Peninsular Malaysian element should perhaps be regarded as a distinct (and in that case, new) species, and Sumateran 'putzeysii' and 'watsoniana' might be more usefully recognised as a single, though still fuzzily circumscribed, local variant of the *A. longiloba* complex.

Selected other specimens seen: PENINSULAR MALAYSIA: Perak, Kuala Dipang, *Curtis s.n.* (SING); Perak, Kampar, G. Tempurong, *Ng FRI 5834* (FRIM, L). SUMATERA: Cult. RBG Sydney, Acc. No. 970474 ex Jambi, Kerinci Seblat National Park, above Lempur Vill., *Hay et al. 13036* (NSW); Sibolangit, *Lörzing 4804* (BO). KALIMANTAN: [without locailty] *Amdjah 165* (BO); Kalimantan Timur, foot of G. Batukenye, along Sg. Belayan, NW of Tabang, *Murata et al. 1519* (BO); Bidang Menabei, *Winkler 1064* (E, L). SARAWAK: Cult. RBG Sydney, Acc. No. 920745 ex Long Jowe, *Dearden s.n.* (NSW); SABAH: Cult. RBG Sydney, Acc. No. 960609 ex Kinabatangan, Kalabakan Virgin Jungle Reserve, *Hay et al. 12012* (NSW).

e. 'korthalsii'

- *Alocasia korthalsii Schott*

Moderately robust terrestrial herbs, *rhizome* rather slender, to ca. 2.5 cm diam; *leaf* usually solitary (–4 together); *blade* ovatosagittate, shield-shaped, to ca. 40 cm long x 17 cm wide, widest ca. 3 cm anterior to the petiole insertion, plain mid-green on both sides to deep purple abaxially and then deep green adaxially, not usually with contrastingly pale major venation; anterior costa with 3–4 primary lateral veins, the proximal ones diverging at ca. 85°, the distal at ca. 45°; secondary venation arising at a wide angle, thence deflected towards the margin and forming rather weakly undulating interprimary collective veins; posterior costae diverging at ca. 45° or less; *posterior lobes* peltate for ca. 60% of their length, the free part rounded to rounded-acute; *inflorescences* mostly at the smaller end of the size range for this complex, with the spathe limb rather markedly cucullate; appendix ivory to yellow.

Distribution: Borneo.

Habitat: Terrestrial on rainforest floor mainly at low elevation (*Purseglove & Shah P4749* at ca. 1200 m).

Notes: This form is distinguishable from the other shield-shaped leaved member of this complex, 'watsoniana', by the smaller rhizome and inflorescence, more cucullate spathe limb, undulating interprimary collective veins and (in Borneo) terestrial habit. *A. longiloba* 'korthalsii' intergrades with *A. longiloba* 'lowii' in Sarawak. In Sabah it is found, e.g. at Sepilok, mixed and not intergrading with *A. longiloba* 'longiloba'. The population I have seen near Bintulu, Sarawak, is mostly of unifoliar individuals with dark green, purple-backed leaves, while the above-mentioned population at Sepilok is of multifoliar individuals with plain green leaves.

Other specimens seen: KALIMANTAN: Kalimantan Timur, 10-20 km N of Sebulu, *Murata et al. 703* (BO). SARAWAK: Cult. RBG Sydney Acc. no. 940462 ex 2.3 km from Kemena R. bridge towards Sibu, *Hay et al. 9308* (NSW); G. Pueh, *Purseglove & Shah P4749* (SING); Tambusan, *Ridley s.n.* (SING). SABAH: Cult. RBG Sydney Acc. no. 960519 ex Sepilok F.R., *Hay et al. 12153* (NSW); Danum, *Lambert TB6* (E).

f. 'thibautiana'

- *Alocasia thibautiana* Mast. - *Alocasia curtisii* N.E. Br.

Robust, often lithophytic, herb usually with the rhizome somewhat swollen, subcormescent; *leaves* 1–several together; *blades* broadly ovato-sagittate, to ca. 50 cm long, peltate for ca. 25% of the length of the posterior lobes, plain mid green throughout to dark green, red-backed and with whitish primary adaxial venation; secondary venation not or hardly forming interprimary collective veins.

Distribution: Peninsular Malaysia, ?Sarawak.

Habitat: Terrestrial or on limestone rocks at low elevation.

Note: Intergrades with 'lowii'. Leaves of juveniles of this form strongly resemble 'korthalsii'. I recognise this entity around its extreme form, which has not only rather shallowly peltate, ovato-sagittate leaves with no or weak interprimary collective veins, but also a distinctive swollen and abbreviated corm-like stem. The type of *A. thibautiana* is alleged to be from Borneo. Some wild-collected specimens from Borneo are intermediate between this entity and 'lowii', though I have seen no authentically Bornean material, which corresponds directly with 'thibautiana'.

Other specimens seen: PENINSULAR MALAYSIA: Penang, Waterfall, *Curtis s.n.* (SING); Cult. RBG Sydney Acc. no. 940064 ex Perlis, Kaki Bukit, Gua Kelam, *Hay et al. 9019* (NSW); Pahang, Pulau Tioman, Pulau Tulai, *Henderson 18506* (SING);

g. 'lowii'

- *Alocasia lowii* Hook. f. - *Alocasia lowii* var. *picta* Hook.f. - *Alocasia eminens* N.E. Br.

Robust, often lithophytic, herb ca. 70cm –1.5 m tall; *leaves* (1–)2–4 together; *petiole* usually obliquely mottled dark green or chocolate, sometimes unmottled; *blade* sagittate, rather broadly triangular in outline, usually dark green with contrastingly paler major venation adaxially, sometimes purple-backed, sometimes concolorous green throughout; *anterior lobe* sometimes slightly ovate, ca. 30–70 (–90) cm long, generally widest about level with or slightly distal to the insertion of the petiole (occasionally widest almost at the tips of the posterior lobes); anterior costa with ca. 4 primary lateral veins on each side, the proximal ones diverging at ca. (100–)80°, the distal ones at ca. 45°; secondary venation arising from the primary at a wide angle then soon deflected towards the margin and forming ill-defined interprimary collective veins or these absent; posterior costae straight, diverging at ca. 45–90°; *posterior lobes* shallowly peltate - for 10–15% of their length, acute.

Distribution: Peninsular Malaysia, NW Borneo.

Habitat: In forest, often on rocks including limestone at low to medium elevation, extending into quite markedly seasonal areas.

Notes: 1. This element represents little more than a robust aspect of *A. longiloba* 'longiloba', with which it intergrades, indeed ascription of a considerable number of collections to one or other of these is somewhat arbitrary. The anterior lobe is typicaly relatively wider and the posterior lobes relatively longer than in typical 'longiloba', and in this respect it approaches 'denudata'. *Alocasia veitchii* (Lindley) Schott, whose basionym is earlier than *A. lowii*, falls in between. If it was classed in the same group as specimens conforming to 'lowii', it would of course formally have priority, however, it seems to me marginally closer to 'longiloba' and since the nomenclatural framework used here is anyway informal, rules of priority need not apply in the event that another worker interpreted *A. veitchii* as falling within the 'lowii' variant. The epithet 'lowii' is more widely used by both botanical and horticultural collectors. In Borneo *A. longiloba* 'lowii' also intergrades with 'korthalsii' in a few instances, for example *Chew 709* and *Jacobs 5476* (see below).

Selected other specimens seen: PENINSULAR MALAYSIA: Kedah, Langkawi Is, P. Bumbon Besar, *van Balgooy 2293* (L); Perak, Kuala Kangsar, logging road up G. Bubu from Manong, *Boyce 706* (KEP); Malacca, Pulau Nangka, *Burkill 2641* (SING); Kelantan, Kota Bahru, *Gimlette 5962* (SING); Cult. RBG Kew ex Negeri Sembilan, Pasoh F.R., *Hay 2005* (K); Cult. RBG Kew ex Kedah, Langkawi Is., Pulau Dayang Bunting, *Hay 2032* (K); Cult. RBG Sydney, Acc. no. 940047 ex Perlis, Kangar, Bukit Lagi, *Hay et al. 9001* (NSW); Cult. RBG Sydney Acc. no. 940102 ex Selangor, Batu Caves, *Hay et al. 9058* (NSW); Cult. RBG Sydney Acc. no. 940138 ex Negeri Sembilan, Bukit Tangga, nr Jelabu, *Hay et al. 9142* (NSW); Cult. RBG Sydney Acc. no. 940355 ex Pahang, Bukit Fraser, *Hay et al. 9288* (NSW); Selangor, Sg. Tinggi, *Md Nur 34111* (A); Pahang, Ulu S. Krau, NE G. Benom, *Whitmore FRI 3135* (K). BRUNEI: Belait Melilas, Kuala Ingei, Melilas side of Belait R., *Thomas 216* (K); Temburong Distr., Bukit Belalong, *Wong 1417* (K). SARAWAK: Kuching district, Tiang Bakap, Mt Maja, *Chew 709* (L); Ist division, 30 km SW of Kuching, Sebuaran Bau, *Jacobs 5476* (L).

23. Alocasia celebica Engl.

Alocasia celebica Engl. in Koord., Meded. s'Lands Plantentuin 19 (1898) 299; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 106. - Type: Indonesia, Sulawesi, Minahassa Prov., Ratatotok, 25 Mar 1895, *S. H. Koorders 16162β* (B, holo).

Herb ca. ?1.5 m tall; *rhizome* ca. 4 cm diam., clothed in old cataphyll bases; *leaves* two together subtended by papery fibrous marcescent cataphylls; *petiole* ca 35 cm long, sheathing in the lower 1/4, densely and minutely pubescent, mottled with an oblique zig-zag pattern; *blade* somewhat ovato-sagittate, 36 cm long, rather thickly coriaceous; *anterior lobe* widest ca. 3 cm above the petiole insertion, the apex acute; anterior costa with 6 primary lateral veins on each side, diverging at 80–60° and running almost straight to the margin; axillary glands inconspicuous; secondary venation obscure; *posterior lobes* about half the length of the anterior, acute, distally slightly out-turned, the inner sides oblanceolate; posterior costae diverging at ca. 60°, not naked in the sinus (leaf blade very slightly peltate? - sinus obscured on holotype); *inflorescence* unknown.

Distribution: Endemic to Sulawesi, known only from the type collection.

Habitat: Unknown; the type was collected at 200 m altitude.

Notes: 1. The affinities of this species are not clear from the type, which is sterile. However, the papery-fibrous cataphylls, mottled petioles and (almost) peltate leaf suggest the Longiloba Group. The obscurity of the secondary venation is due to the thickness of the leaf blade, which is not a feature of any other member of this group. Koorders and Engler & Krause overlooked the pubescence on the petiole, which also occurs, among Sulawesi species, in *A. suhirmaniana* (q.v.), from which *A. celebica* is amply distinct.

2. The holotype has three Koorders numbers on it: the field number *2587* attached to the specimen; the Herb. Koordersianum number *16162ß* on a label dated 25 Mar 1895 giving the provenance Ratatotok (as in the protologue), and a Museum Botanicum Berolinense label dated 3 Jul 1895 with the number *Koorders 19750* and the provenance Ratahan.

24. Alocasia suhirmaniana Yuzammi & A. Hay

Alocasia suhirmaniana Yuzammi & A. Hay, Telopea 7 (1998) 303, fig. 1. - Type: Cult. Kebun Raya Bogor ex SE Sulawesi, Kabupaten Kolaka, 23 Jun 1997, *Yuzammi s.n.* (BO, holo; NSW, photo).

Terrestrial herb to ca. 65 cm tall; *rhizome* 13–15 cm long, ca. 3 cm diam.; *leaves* 1–3 together; *petiole* to ca. 60 cm long, sheathing in the lower 1/5–1/4, yellowish green, densely longitudinally and obliquely mottled purple-brown, minutely and densely puberulous, subtended by papery-membranous cataphylls; *blade* broadly ovato-sagittate, to ca. 55 cm long, peltate, pendent, thinly leathery, with the margin somewhat undulate, glossy dark green adaxially with the major venation pale grey-green, dark purple abaxially; anterior lobe widest about 1/4 of the way from the base, the tip broadly acute to obtuse, shortly apiculate; anterior costa with up to 8 primary lateral veins on each side, diverging at 80–45°, with conspicuous purple glands in their axils abaxially; subsidiary veins frequent in the outer part of the blade; secondary venation otherwise inconspicuous, forming undulating interprimary collective veins; *posterior lobes* acute, about 1/2–2/3 the length of the anterior, united for 1/2–2/3 of their length; posterior costae more or less straight, diverging at ca. 35–45°; *inflorescence* pairs solitary (?always), subtended by papery membranous cataphylls to ca. 11 cm long; peduncle to 24 cm long, minutely puberulent in the upper part, purple-brown; *spathe* ca. 12 cm long, deep purple, slender, glabrous, abruptly constricted at ca. 2 cm from the base; lower spathe subcylindric; limb narrowly lanceolate; *spadix* somewhat shorter than the spathe, ca. 10 cm long, slender, very shortly stipitate for 4 mm, stipe ivory; *female zone* ca. 1.2 cm long; ovaries greenish yellow; stigma bluntly 2–4-lobed, subsessile, yellow; *sterile interstice* ca. 0.5 cm long, attenuate, level with spathe constriction; lowermost synandrodia strongly lobed, the rest rhombo-hexagonal, ca. 1.5 mm diam.; *male zone* ca. 2 cm long, 1 cm diam., cylindric; synandria rhombo-hexagonal, the tops impressed, ca. 2 mm diam., yellowish ivory; thecae opening by apical pores somewhat laterally displaced by overgrowth of the synconnective; *appendix* ca. 6 cm long, 8 mm diam. at base, slightly constricted at junction with male zone, the rest cylindric, then tapering in the upper 1/3, yellowish, somewhat rugose in the lower half; *infructescence* unknown.

Distribution: Endemic to SE Sulawesi.

Habitat: In damp shady spots in lowland rain forest on slopes, sometimes over limestone.

Note: This species is distinguished from other members of the Longiloba Group by its puberulent petioles, blackish-purple spathe and somewhat marginally expanded synconnectives.

Other specimen seen: SULAWESI: SE Sulawesi, Tolala, *Kjellberg 2428* (BO).

Cuprea Group

Species 25—30

Leaves more or less completely peltate, interspersed with cataphylls; spadix generally distinctly shorter than the spathe; male zone often mostly or completely within the lower spathe.
Note: This group includes six species, four Bornean, one from each of the Malay Peninsula and Sumatera. The vegetative characteristics that define it do not seem to be matched by distinctive reproductive features and it is not clear that this group is natural. It may be linked to the Scabriuscula group via *A. reversa* and the *A. princeps* complex.

25. Alocasia perakensis Hemsl.

Alocasia perakensis Hemsl., J. Bot. 25 (1887) 205. - Type: Malaysia, Perak, Birch's Hill, *Wray 29* (K, holo; iso K, SING).

[*Alocasia beccarii* sensu auct. non Engl.: Hook.*f*., Fl. Brit. Ind. 6 (1893) 527; Ridl., Mat. Fl. Mal. Pen. 3 (1907) 17; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 95, pro parte quoad *A. perakensis* in synon. et specim. cit. Mal. Pen.; Ridl., Mat. Fl. Mal. Pen. 3 (1907) 16 & Ridl., Fl. Mal. Pen. 5 (1925) 97 pro parte quoad specim cit.; Henderson, Mal. Wildfl. Monoc. (1954) 225, excl. fig 134 (i.e. *A. beccarii s.s.*)].

Herb to ca. 75 cm tall (often smaller); *stem* creeping to decumbent, somewhat elongate - the internodes as long as or longer than wide, ca. 2.5 cm diam.; *leaves* several along the stem, (?)irregularly interspersed with lanceolate cataphylls to 8 cm long and drying red-brown; *petiole* to ca. 40 cm long, sheathing in the lower 1/4, grey-green to purple-brown; *blades* dark green to grey-green, ovate to elliptic, peltate, coriaceous to thickly coriaceous and subsucculent, 14 x 6 – 34 x 13 cm; *anterior lobe* widest ca. 2–4 cm distal to insertion of petiole, the tip broadly acute, acuminate for ca. 1.5 cm, the margin mostly entire, occasionally somewhat sinuous in the lower part; anterior costa with 2–3(–4) primary lateral veins on each side, diverging at ca. 45–60°, running to a submarginal vein ca. 1 mm from the margin; secondary venation not forming interprimary collective veins, mostly inconspicuous, but, like primary venation, adaxially impressed in dry state in thickly coriaceous leaves; *posterior lobes* completely united except for a shallow retuse notch, rarely with an acute notch to ca. 1 cm deep, together cuneate to slightly attenuate, 1/3–1/2 the length of the anterior lobe; posterior costae subparallel; *inflorescence* solitary to paired; peduncle about half to subequalling the length of the petioles; *spathe* greenish yellow to white, ca. 6 cm long; lower spathe ovoid, ca. 3 cm long; limb narrowly ovate, at first erect, then reflexed; *spadix* shorter than spathe, ca. 5 cm long, stipitate for 4 mm; *female zone* ca. 7 mm long; pistils few - ca. 15, rather large - ca. 4 mm long; ovary globose, 2.5 mm diam.; style 1.5 mm long; stigma prominently 2–3-lobed; *sterile interstice* ca. 2.5 mm long, a single whorl of synandrodia; *male zone* 1.5 cm long, entirely within and filling the upper half of the lower spathe chamber, conic - ca. 8 mm diam. at base narrowing to 5 mm at apex corresponding with spathe constriction; synandria relatively large - 4 mm diam., more or less hexagonal, 3–5-merous; thecae opening by apical pores not overtopped by synconnective; *appendix* narrowly cylindric, ca. 2.5 cm long, 4 mm diam., deeply grooved, white to yellowish; *fruiting peduncle* subequalling the petioles; fruiting spathe ovoid, ca. 4 cm long, the spathe dehiscing longitudinally; berries bright red.

Distribution: Endemic to Peninsular Malaysia.

Habitat: In montane forests, in leaf litter and on rocks, mostly at 1100–1525 m altitude. Ridley (ll. cc.) noted it as low as 650 m (2000 feet), probably based on his collection from Kuala Teku.

Notes: Although *Alocasia perakensis* has not been accepted as an entity distinct from *A. beccarii* by any author since its first description, they are readily distinguishable, though evidently closely related, allopatric species. *Alocasia perakensis* is on the whole much more robust, the leaves are generally more leathery - sometimes almost succulent, and the connate posterior lobes are cuneate rather than attenuate, the stem is more elongate, the bracts between the leaves are less frequent, the inflorescence, though structurally very similar to that of *A. beccarii*, is about twice the size, and the spathe is greenish yellow to whitish. With the exception of two high altitude collections from Mt Kinabalu (Sabah), doubtfully attributed here to *A. beccarii* (q.v.), it has a higher altitudinal range than that species. Although quite a number of collections have been made, this species is poorly known in flower and the description of the inflorescence is prepared from a single spirit collection (*Hay et al. 9280*).

Other specimens seen: PENINSULAR MALAYSIA: Pahang, Cameron Highlands, *Batten Pool s.n.* (SING); Perak, Larut, trail from Bk. Larut to G. Hijau, *Boyce 681* (K, KEP); Perak, G. Hijau, *Burkill & Haniff 12769* (SING); Negeri Sembilan, Ladang Gadis, *Carrick 692* (SING); Selangor, along old abandoned rd to Genting Highlands, *Croat 53321* (K); Perak, Genting Highlands, *Croat 53338* (K); Perak, G. Hijau, *Mohd. Haniff & Mohd. Nur 2350* (K, SING); Cult. RBG Sydney Acc. No. 940347 ex Pahang, Bukit Fraser, *Hay et al. 9280* (NSW); Pahang, No. 5 Camp, Cameron Highlands, *Henderson FMSM 11666* (BO); Perak, Larut Hill, Thaiping, *Long 6* (K); Selangor, top of Fraser's Hill, along path from

Red Cross to Wray's Cottage, *Nicolson 1175* (US), *1178* (US); Pahang, Cameron Highlands, along S path to G. Beremban, *Nicolson 1194, 1201* (both SING, US); Pahang, Fraser's Hill, *Mohd. Nur 10548* (SING); Pahang, Boh Plantation, Cameron Highlands, *Mohd. Nur s.n.* (SING); Pahang, Fraser's Hill, below Methodist Mission, *Purseglove P.4283* (GH, K, L, SING); Pahang, Kuala Teku, *Ridley s.n.* (K); Perak, *Scortechini s.n.* (K, SING); Perak, Maxwell's Hill, path to G. Hijau, *Mohd. Shah & Sidek 1071* (K, SING); Kelantan, G. Stong, *Symington 37727* (KEP).

26. Alocasia beccarii Engl.

Alocasia beccarii Engl., Bull. Soc. Tosc. di Ort. 4 (1879) 300 & in Becc, Malesia 1 (1882) 293, t. 16, figs 1–4; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 179, pro parte excl. specim. cit. Ridley, Matang (i.e. *Alocasia peltata* M. Hotta); Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 95, fig. 19, A–D, pro parte excl. *A. perakensis* in synon. et. specim. cit. Ridley, Matang); Mayo, Bogner & Boyce, Genera of Araceae (1997) pl. 104(i), M (non pl. 104(ii), i.e. *Alocasia kerinciensis* A. Hay). - Type: Borneo, Sarawak, Matang, *O. Beccari PB 1674* (FI, holo).

Small herb 12–28 cm tall; *stem* slender, 5–10 mm diam., condensed with the internodes usually somewhat wider than long; *leaves* several together, irregularly but frequently interspersed with lanceolate cataphylls to 5 cm long and drying red-brown; *petioles* green, sometimes flecked pale mauve, 6–16 cm long, sheathing in the lower 1/7 or less; *blades* narrowly elliptic to ovate to narrowly obovate, mid-green above, paler below, coriaceous, 9 x 2.7–18 x 6 cm; *anterior lobe* widest usually ca. 1/4 of the way distal to petiole insertion, occasionally level with petiole insertion, occasionally 1/2 way distal to petiole insertion; margin occasionally somewhat sinuate; anterior costa with 2–3 primary lateral veins on each side, diverging at ca. 45–60° and running to a submarginal vein 0.5–1 mm from the margin; axillary glands inconspicuous; secondary venation not forming interprimary collective veins; *posterior lobes* almost completely connate save for a shallow retuse notch, (1/4)1/3–2/5 the length of the anterior lobe, together attenuate; posterior costae subparallel; *inflorescence* solitary to paired; peduncle subequalling the petioles; *spathe* whitish, ca. 4 cm long, constricted ca. 1.5–2 cm from the base; lower spathe narrowly ovoid, distally somewhat curved adaxially; limb narrowly oblong-lanceolate; *spadix* shorter than the spathe, very shortly stipitate; *female zone* 4 mm long, a few loosely packed large pistils, or reduced to a single whorl; pistils ca. 3 mm long; ovary globose-ovoid, 2.5 mm diam.; style ca. 0.5–1 mm long, slender; stigma prominently ?2-lobed; *sterile interstice* a single whorl of synandrodia ca. 1.5 mm diam., or reduced to a single synandrode and the rest naked; *male zone* conic, 5–8 mm long, entirely within and filling the upper spathe chamber; synandria large, ca. 3 mm diam., 3–4-merous, thecae not overtopped by synconnective; *appendix* pale apricot, narrowly cylindric, 1.3–2 cm long, ca. 3 mm diam.; *fruiting peduncle* hardly longer than flowering peduncle; fruiting spathe ovoid, ca. 2 cm long; ripe fruit orange to orange-red.

Distribution: Endemic to N.W. Borneo.

Habitat: In forest on slopes at low elevation - to ca. 850 m, possibly to 1500 m on G. Kinabalu (but see note below), often among or on boulders, often over sandstone.

Notes: 1. This name has been used, in the literature and/or on herbarium sheets, for five West Malesian species of rather small plants sharing various manifestations of a distinctive more or less elliptic entirely peltate leaf blade - *A. beccarii s.s., A. kerinciensis*, *A. minuscula*, *A. peltata* and *A. perakensis*. Of these, *A. peltata* and *A. kerinciensis* have very conspicuous intramarginal veins and are montane species, *A. minuscula* has distinctive striate venation, very large synandrodia and is restricted to lowland peat swamp-forest, and *A. perakensis* is much more robust than *A. beccarii* and is a montane element restricted to Peninsular Malaysia. *A. beccarii* itself is distinguished by the combination of absence of intramarginal leaf vein, more or less condensed stem, secondary venation arising from the costae and primary veins, small size compared to *A. perakensis* and occurrence at low elevation in non-swampy sites. Further discussion of its distinction from *A. perakensis* can be found under that species.

2. The two collections from G. Kinabalu cited below differ from *A. beccarii* in the strict sense in having relatively broader posterior lobes with the tips less markedly acute, less completely joined and slightly out-turned at the tips. The leaf texture appears to be more membranous. The venation is nevertheless typical for *A. beccarii*. The altitude from which they were collected (4000–5000 ft) is significantly higher than collections of *A. beccarii s.s.*, and it is possible that they represent another species in this group. Neither collection is in flower.

Brooke 8680, from Keranji, Sarawak, is anomalous in having oblanceolate leaves, with very reduced posterior lobes.

Other specimens seen: SARAWAK: Kuching, *Brooke 8318* (L); Keranji, *Brooke 8680* (L). BRUNEI: N. Temburong, Bukit Biang, *Ashton A172* (K); Belait Distr., Ulu Ingei, Bukit Batu Patam, *Boyce et al. 274* (K); Temburong Distr., Bangar, Bukit Patoi, *Boyce et al. 350* (K); Temburong, Batu Apoi, Bukit Gelagas, *Simpson & Marsh 2271* (K). SABAH: Kinabalu, Penibukan, *Clemens & Clemens 31548 & 50499* (both SING); Sipitang Distr., W slope of G. Lumaku, *Wood 798* (K).

27. Alocasia minuscula A. Hay, sp. nov.

Ab *A. beccarii* lamina folii tenuiora, venis striatis, venis primariis duplo numerosis, sylvam palustrem incolenti differt. TYPUS: Borneo, Sarawak, Betong Distr., Saribas Forest Reserve, 14 Aug 1957, *J.A.R. Anderson 8364* (L, holo; BO, K, iso);

Diminutive herb 10–20 cm tall; *stem* suberect, ca. 1 cm diam, condensed, rooting along its length and clothed in old leaf bases and marcescent cataphylls; *leaves* several to 9 together, interspersed with papery-membranous cataphylls to ca. 5.5 cm long (these occasionally bearing reduced petiole and blade); *petiole* 5–10 cm long, sheathing in the lower ca. 1/7; *blade* narrowly ovate to oblanceolate, 8 x 2–13 x 3 cm, peltate, coriaceous, pale abaxially; *anterior lobe* 7–10.5 cm long, the tip acuminate for ca. 1 cm; anterior costa with 8–10 primary lateral veins on each side, diverging at 60–45° then somewhat up-curved and joining a marginal vein; primary lateral veins much darker than blade abaxially in dry specimens and the majority not visibly reaching the midrib; secondary venation obscure on both sides of the blade, striate, arising from the midrib; *posterior lobes* almost completely united save for a ca. 2 mm incision at the extreme base of the leaf; combined posterior lobes attenuate, 1–2 cm long; *inflorescence* solitary; peduncle about the same length as the petioles at anthesis, later extending somewhat; *spathe* 3.5–4 cm long; lower spathe narrowly ovoid, 1.5–2 cm long, separated from limb by a weak constriction; limb ca. 2 cm long, lanceolate, colours unknown; *spadix* shorter than the spathe, ca. 2 cm long, stipitate for ca. 3 mm, the fertile zones entirely within the lower spathe; *female zone* 3 mm long; pistils few, ca. 10, bottle-shaped, more or less acroscopic, 1.5 mm long, style ca. 0.5 mm long; stigma small, weakly ?3-lobed; *sterile interstice* ca. 2 mm long, the thickest part of the spadix, ca. 2.5 mm diam.; synandrodia inflated, more or less rhomboid, ca. 2 mm diam.; *male zone* 5 mm long, subcylindric, 2.2 mm diam.; synandria few, ca. 12, irregular, ca. 1.5 mm diam., more or less 4-merous, mainly composed of loosely adherent thecae, the synconnective not well developed; *appendix* ca. 6 mm long, 1 mm diam., cylindric; *fruiting spathe* ca. 1.5 cm diam.; berries red-orange.

Distribution: Endemic to Sarawak.

Habitat: In lowland peat swamp forest.

Notes: The specific epithet derives from the fact that this is the smallest presently known species in the genus. *Alocasia minuscula* can be readily distinguished from *A. beccarii* and *A. peltata*, which it closely resembles, in its narrow peltate leaf shape and reduced posterior lobes, and in its diminutive stature, by the distinctive pattern of leaf venation. The primary veins are much more numerous, and characteristically some appear, in the dried state, not to reach the midrib. The secondary venation is obscure on both sides of the blade, but it appears on the abaxial side that the secondary venation arises hardly or not at all from the primary veins, nearly all the secondary veins running directly into the midrib - a condition more usually associated with striate-veined genera such as *Schismatoglottis*. Moreover, *Alocasia minuscula* appears restricted to swamp forest, while *A. beccarii* and *A. peltata* are hill and montane forest species. The description is based entirely on dried material.

Other specimens seen: SARAWAK: Tuso Peninsula, *Anderson 2129* (SING); Sibu, Naman F.R., *Anderson 9299* (K, L); Simanggang, *Brooke 10764* (L).

28. Alocasia peltata M. Hotta

Alocasia peltata M. Hotta, Acta Phytotax. Geobot. 22 (1967) 156, fig. 5, A-E. - Type: Borneo, Sarawak, Bintulu, eastern ridge of Bukit Kana, 20 Nov 1963, *M. Hirano & M. Hotta 1464* (KYO, holo, n.v.)

Alocasia peltata var. *muluensis* M. Hotta, op. cit.: 158, fig. 5, F. - Type: Borneo, Sarawak, Mardi, Gunung Mulu, 16 Mar 1964, *M. Hotta 14513* (KYO, holo, n.v.).

[*Alocasia beccarii* sensu auct. non Engl.: Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 179 & 49 (1907) 48; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 95, pro parte quoad specim. cit. *Ridley s.n.*, Sarawak, Matang.]

Small herb to ca. 30 cm tall; *stem* more or less elongate, slender, sprawling, with internodes to 2 cm long; *leaves* several along the stem, regularly alternating with papery membranous lanceolate cataphylls to 4 cm long; *petiole* to 16 cm long, sheathing in the lower 1/10; *blade* narrowly elliptic to oblong ovate, 12 x 3 – 28 x 10 cm, peltate, somewhat to thickly leathery, glossy green or suffused purple adaxially, paler abaxially, drying with the venation somewhat to markedly impressed adaxially; *anterior lobe* 9–12 cm long, widest more or less level with petiole insertion, the tip acuminate for 1.5 cm; anterior costa with two primary lateral veins on each side (subopposite) diverging at ca. 60° and running straight or somewhat upcurved into a conspicuous intramarginal vein (2–)3–6 mm from the margin; secondary venation not forming interprimary collective veins, inconspicuous to invisible in thickly leathery forms; *posterior lobes* completely united or with a slight retuse notch, 3–6 cm long, together cuneate, ultimately truncate; *inflorescence* solitary; peduncle about half as long as to equalling the petiole; spathe ca. 5 cm long, green; lower spathe narrowly ovoid, ca. 2 cm long; limb lanceolate, ca. 3 cm long, separated from the lower spathe by a weak constriction; *spadix* somewhat shorter than the spathe, to 3 cm long, stipitate for 2 mm; *female zone* 4 mm long; pistils few - ca. 12, 2 mm long, flask-shaped, more or less acroscopic; style distinct, almost 1 mm long; stigma weakly 2–3-lobed; *sterile interstice* a single inconspicuous whorl of synandrodia, not attenuate; *male zone* fully within the lower spathe, ca. 9 mm long, ca. 3 mm diam. at base, tapering to ca. 1 mm diam. at junction with appendix and corresponding with spathe constriction; synandria 3-merous, with anthers only dorsally, not laterally connate; thecae opening by apical pores not concealed by synconnective; *appendix* white, 1.5 cm long (much reduced in *Burtt & Woods 2121*), narrowly spindle-shaped, ca. 2 mm wide at widest; *fruiting spathe* obovoid, with the peduncle elongating; fruits red-orange.

Distribution: Borneo, scattered localities in Sarawak, Brunei and central Kalimantan.

Habitat: In mossy forest floor on ridges at ca. 1200 m altitude.

Notes: 1. This species rather closely resembles Sumateran *A. kerinciensis* (q.v.), sharing the pronounced intramarginal vein and regularly alternating foliage leaves and cataphylls, and the (usually) elongate stem with internodes longer than wide. It differs in the more slender leaves and spathe, the more elongate appendix, the male zone entirely within the lower spathe, the less robust synandria and longer pistils.

2. Hotta (loc. cit.) distinguished the variety *muluensis* on the basis of slightly smaller leaf size and longer peduncle. The material he described was in various stages post anthesis, and it appears that the peduncle continues to elongate as the fruits ripen. I am doubtful that the lower and upper leaf length extremes of 21 cm and 19 cm that he cites respectively for the typical and segregate varieties can be viewed as sufficiently significant to warrant their recognition.

Other specimens seen: SARAWAK: Bakelalan, *Brooke 10559* (US); 4th Div., G. Mulu, *Burtt & Woods 2121* (E); Matang, *Ridley s.n.* (SING). BRUNEI: Temburong, valley N of Pagon Ridge, *Wong & Weber Booth 1903* (K). KALIMANTAN: Central Kalimantan, Bukit Raya, SE side, ca. 10 km NNW of Tumbang Tosah, *Mogea 3856* (BO, K, KEP).

29. Alocasia kerinciensis A. Hay, *sp. nov.*

Ab *A. perakensis* Hemsl. caudice producto tenuiore, foliis et cataphyllis alternantibus, lamina minus incrassata, venis intramarginalibus valde conspicuis, inflorescentia parviore, inflorescentia mascula exserta differt. TYPUS: Indonesia, Sumatera, Gunung Kerinci, 16 Apr 1920, *Bünnenmeijer 9511* (L, holo; BO iso).

[*Alocasia beccarii* sensu auct. non Engl.: Mayo, Bogner & Boyce, Genera of Araceae (1997) fig. 104(ii).]

Small terrestrial herb; *rhizome* elongate, slender, stiff, decumbent-creeping, epigeal, ca. 1 cm diam., to ca. 40 cm long, with internodes to 5 cm long; *leaves* several, alternating with cataphylls, with leaf-cataphyll internodes subequalling cataphyll-leaf internodes; cataphylls membranous, narrowly oblong-lanceolate, to 8 cm long, drying red-brown; *petiole* to ca. 25 cm long, sheathing in the lower $^{1}/_{5}$th or less, wing of sheath basally broad, membranous, like the cataphylls in colour and texture; *blades* stiffly membranous, dull mid-green, broadly to narrowly ovate, peltate with the posterior lobes almost completely joined, ca. 13 x 6 –16 x 9 cm, widest ca. 1 cm distal to petiole insertion, the tip broadly acute to obtuse and shortly acuminate, base rounded with a retuse notch; anterior costa with 2–3 primary lateral veins on each side diverging at up to 100° (proximal) to 45° (distal) and running into a conspicuous intramarginal vein ca. 3–5 mm from the margin; secondary venation forming ill-defined interprimary collective veins; venation more or less flush with the lamina abaxially and adaxially; *inflorescence* solitary, rarely paired; peduncle subequalling the petioles; *spathe* 5–6.5 cm long; lower spathe ovoid, ca. 1.5 cm long, separated from limb by a pronounced constriction; limb broadly lanceolate; *spadix* shorter than the spathe, 3–4.5 cm long, shortly stipitate; *female zone* ca. 7 mm long; ovaries globose, ca. 1 mm diam., expanding to ca. 3 mm diam while inflorescence still fully intact; style very short apically expanded into a 3-lobed stigma; *sterile interstice* ca. 7 mm long, narrowed above corresponding to spathe constriction; synandrodia more or less rhomboid, 1.2–3 mm long; *male zone* ca. 1 cm long, subcylindric, ca. 4 mm diam.; synandria 4–5-merous, rhombo-hexagonal; synconnective somewhat inflated; thecae opening by apical pores; *appendix* about isodiametric with male zone at base, subcylindric, tapering in upper third, ca. 1.2–2 cm long, white; *fruiting spathe* ovoid, ca. 2 cm long; berries globose, ca. 4 mm diam.

Distribution: Sumatera, known only from an area between G. Kerinci to Lake Kerinci straddling the border of West Sumatera and Jambi Provinces.

Habitat: On montane forest floor at 1500-2000 m altitude.

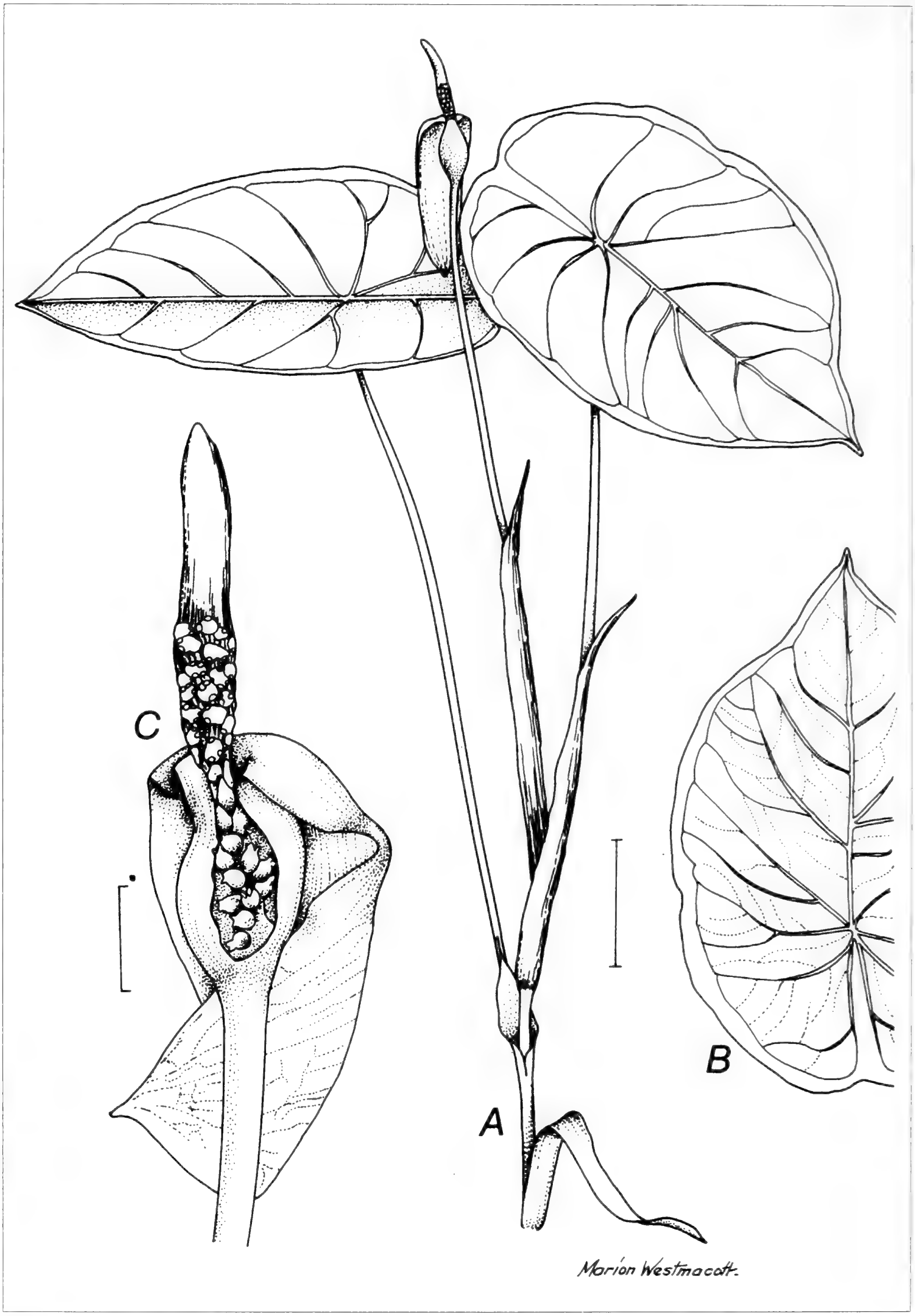

Figure 11. ***Alocasia kerinciensis* A. Hay**
Bünnenmeijer 9511 - A. habit; B. venation; C. inflorescence with part of spathe removed. - Scale: A, B, bar = 2 cm; C, bar = 4 mm.

Other specimens seen: SUMATERA: W. Sumatera, G. Kerinci, *Bunnenmeijer 9106, 9308, 9416, 10128* (all BO); *9195, 10321* (both BO, L); Cult. RBG Sydney Acc. no. 970481 ex Jambi Prov., Kerinci Seblat National Park, above Lempur Village, *Hay et al. 13046* (†, no voucher);

30. Alocasia cuprea (C. Koch & Bouché) C. Koch

Alocasia cuprea (C. Koch & Bouché) C. Koch, Wochenschr. Vereines Befoerd. Gartenbanes Koenigl. Preuss. Staaten 4 (1861) 141; Engl. in A. & C. DC., Monogr. Phan. 2 (1879) 509; Ridl., J. Straits Br. Roy. Asiat. Soc. 44 (1905) 179; Engl. & K. Krause, Pflanzenr. 71 (IV.23E) (1920) 110; Merr., Bibliogr. Enum. Bornean Pl. (1921) 104; Merr., Pl. Elmer. Born. (1929) 26; Burnett, Aroideana 7 (1984) 76, figs 2 & 3. - *Caladium cupreum* C. Koch & Bouché, Ind. Sem. Hort. Berol., Appendix (1854) 6. Type: Not located, presumed destroyed at B. Neotype: Cult. RBG Kew ex Borneo, *N.E. Brown s.n.*, May 11th 1876 (K; designated here).

[*Gonatanthus cupreus* C. Koch, Wochenschr. Vereines Befoerd. Gartenbanes Koenigl. Preuss. Staaten 4 (1861) 141 - nom. in synon.]

[? *Caladium metallicum* Ed. Otto, Hamburger Garten- Blumenzeitung (1853) 517, nom. subnud.; Koch, Berlinen. Allg. Gartenzeitung. 1 (1857) 135].

[*Colocasia cuprea* Engl., Araceae Exsiccatae et Illustratae No. 253 [date not ascertained, see Hay *et al.* (1995:174)]. - ?sphalm. pro *Alocasia cuprea*].

[*Alocasia metallica* Schott, Oesterr. Bot. Wochenbl. 4 (1854) 410, nom. nud.; Schott, Syn. Aroid. (1856) 46 (nom. superfl. pro *Caladium cupreum*); Hook., Bot. Mag. 86 (1860) t. 5190; Lemaire, Ill. Hort. 8 (1861) pl. 283; van Houtte, Fl. des Serres & Jardins 21 (1875) t. 2208-9].

Herb to ca. 80 cm tall; *rhizome* decumbent, to ca. 6 cm diam.; *leaves* several together, each (?always) subtended by two marcescent reddish brown cataphylls, the first ca. 1/4 and the second ca. 1/2 the length of the petiole; *petiole* to ca. 70 cm long, green, faintly mottled brown or greenish brown throughout, sheathing in the lower 1/5th; *blades* coriaceous, hanging, ovate, bullate between the main veins, to ca. 60 cm long x 40 cm wide, adaxially glossy bronze-green, darker near the primary veins, abaxially deep purple, with a hyaline colourless margin ca. 1.5 mm wide; *anterior lobe* with the tip obtuse and abruptly and shortly acuminate; anterior costa with 8–11 primary lateral veins on each side, proximal ones diverging at ca. 100° then arching forward and outward to join a submarginal vein - more distal primary veins diverging at ca 60°; all primary veins with very conspicuous axillary glands abaxially; secondary veins forming well-defined undulating interprimary collective veins; *posterior lobes* completely united except for a shallow retuse notch, rounded; posterior costae diverging at ca. 20°; *inflorescences* paired, not forming multiple series, subtended by cataphylls similar to those subtending the leaves; peduncle similar to the petiole, to ca. 22 cm long; *spathe* green to greenish purple, ca. 10 cm long; lower spathe oblong ovoid, ca. 4.5 cm long ca. 2 cm diam; limb about equalling the lower spathe, at first erect and cucullate, then sharply deflexed, separated from the lower spathe by an abrupt constriction; *spadix* considerably shorter than the spathe - ca. 6 cm long, very shortly stipitate, cylindric except appendix; *female zone* narrowly cylindric, ca. 2 cm long x 8 mm wide; ovaries subglobose, longitudinally 3–4-ribbed; stigma raised on a very short slender style, conspicuously 2–4-lobed; *sterile interstice* not attenuate, isodiametric with male and female zones, ca. 2 whorls of rhomboid synandrodia; *male zone* cylindric, 2/3rds or all within the lower spathe, 2 cm long; synandria rhomboid, 4–6-merous, with the synconnective raised above but not overcapping the thecae; thecae opening by apical pores; *appendix* white, spindle-shaped, blunt, faintly irregularly channelled, ca. 2 cm long, constricted at union with male zone; *fruit* unknown.

Distribution: Borneo, endemic to Sabah.

Habitat: On slopes in rain forest, over a wide variety of substrates including ultramafics, sandstone and limestone, ca. 1000–1500 m altitude.

Notes: 1. Confusion around the use of the epithet '*metallica*' was discussed by Bunting and Nicolson (1963). Because of historical confusion over the identity of *Caladium cupreum*, the epithet *metallica* has been applied botanically both to what is here called *A. cuprea* (e.g. Hooker, loc. cit.) and to a form of *Alocasia macrorrhizos* [*A. indica* var. *metallica* Schott = *A. macrorrhizos* var. *rubra* (Hassk.) Furtado (which in turn, if to be regarded as a species separate from *A. macrorrhizos*, should be called *Alocasia plumbea* van Houtte)].

Assuming they are synonymous, the priority of *Caladium cupreum* is based on the paucity of the description in Otto (loc. cit) such that the earlier *Caladium metallicum* Otto is to be regarded as invalid. When Schott (loc. cit.) first published *Alocasia metallica*, he included *Caladium cupreum* as a synonym, thus rendering *A. metallica* superfluous.

It can be clearly inferred that Schott intended *A. metallica* to be applied to, and interpreted *Caladium cupreum* as applicable to, a species different from what is currently called *Alocasia cuprea*. This is evident from Schott's later work, when *A. metallica* was reduced to varietal status under *Alocasia indica* (= *A. macrorrhizos)* (Schott, 1860: 145). *Caladium cupreum* was still a synonym in Schott's view.

It appears that Koch considered his *A. cuprea* and Schott's *A. metallica* different species, though as the type of *Caladium cupreum* has not been found, it is not possible to prove the correct application of this name. Confounding matters, there is at K an outline, drawn by N.E. Brown, of a specimen from Koch's herbarium, allegedly the type of *Caladium cupreum*, but resembling *Alocasia macrorrhizos* - hence implying that *Alocasia metallica* Schott and *Caladium cupreum* may be conspecific, as Schott had indicated. However, material of *A. cuprea* in the sense here, preserved at K, has the annotation by N.E. Brown - 'A specimen of this was sent by me to Carl Koch, for comparison with his type of *A. cuprea*, & in reply he stated that it was certainly his *A. cuprea* & not *A. metallica* Schott'. This, together with the fact that Engler, who would almost certainly have seen the type at Berlin, applied the name *Alocasia cuprea* to this species, leads me to conclude that this application is correct. Moreover, *Alocasia cuprea* has been and currently is widely used, both botanically and horticulturally, in the sense used here. The accordingly designated neotype is the sheet annotated by N.E. Brown as above.

2. *Alocasia cuprea* has long been recognised as one of the most spectacular and bizarre foliage plants in the genus and is a parent of several interspecific horticultural hybrids (see Engler & Krause, 1920: 112; Burnett, 1984: 142). Its occurrence in the wild is sporadic, but it sometimes occurs in very densely abundant local populations (K.M. Wong, *pers. comm.*).

Other specimens seen: SABAH: Kinabalu, N of Mesilau Camp, *Allen AK 66-38* (SING); Cult. RBG Sydney Acc. no. 912634 ex cult. RBG Edinburgh Acc. no. 19852175 ex Kinabalu, Marai Parai, *Argent s.n.* (NSW); Kinabalu, Penibukan, nr Dahobang R., *Clemens & Clemens 40588* (SING); Elphinstone Prov., Tawao, *Elmer 20471* (BO, GH, K, L, SING); Cult. RBG Sydney Acc. no. 960584 ex Maliau Basin, G. Rara F.R., 2.5 km above main Maliau Falls, *Hay et al. 12092* (NSW, voucher SAN); Kinabalu, S. Dahobang, *Holttum s.n.* (SING); Cult. RBG Sydney Acc. no. 841539 ex Tenom, Kallang Falls, *Wallace 84/206* (no voucher);

Inadequately Known Species

31. Alocasia sp. A.

Herb to ca. 40 cm tall; *leaves* several together, glabrous; *petiole* ca. 30 cm long, sheathing in the lower ca. 1/3, green, spotted purple; *blade* ovato-sagittate, to ca. 30 cm long, coriaceous, somewhat bullate, adaxially grey-green, dark green about the main veins, abaxially purple; *anterior lobe* widest somewhat above the base, the tip acute to obtuse and apiculate;

anterior costa with 5–6 primary lateral veins on each side, diverging at 80–50°, with conspicuous axillary glands abaxially; secondary venation forming abaxially and adaxially conspicuous subsidiary veins themselves forming interprimary collective veins in the outer part of the leaf blade, the remaining secondary venation obscure abaxially, faint adaxially; *posterior lobes* acute, about 1/2 the length of the anterior, the inner sides very narrowly lanceolate; posterior costae diverging at ca. 90°, naked in the sinus for ca 1 cm; *inflorescence* unknown.

Distribution: Sarawak.

Habitat: Reported from forest floor among limestone rocks.

Notes: 1. Plants of this species are cultivated in the Semenggoh botanic garden, near Kuching, and are said to have been collected from the wild locally (P. Boyce, *pers. comm.*).

2. This highly ornamental plant is traded in the U.S.A. under the name *Alocasia guttata* var. *imperialis* or *Alocasia guttata* Imperialis. An image may be found at http://www.skg.com/alocasia3.html. This species is evidently allied to *A. scabriuscula* (which includes *A. guttata*) and *A. reginae*, differing from both in the variegated leaf blade, and from the former in its smaller stature and bullate blade, and from the latter in being glabrous and more robust with a larger number of primary lateral veins. I would suggest to the horticultural community that either an altogether new cultivar name is formally proposed or that the plant be called *Alocasia* Imperialis and that a standard be designated and preserved to fix the application of the cultivar name Imperialis to this particular clone, so that there is no longer any ambiguity about whether or not the plant is the same as *A. guttata* var. *imperialis*.

Doubtful Species and Records

Alocasia pallida C. Koch & Bouché, Ind. Sem. Hort. Berol., App. (1854) 5.

If a type ever existed of this, it was presumably destroyed in the bombing of Berlin. Koch & Bouché described it from sterile material without provenance, compared it with *Alocasia montana*, which itself appears to be a synonym of *A. macrorrhizos*, and distinguished it (trivially) on the basis of the 'stemless' habit of *A. montana*. They further compared it with *A. alba* Schott, noting that the latter differed in its slightly peltate leaves (which it does have as a juvenile, like most species in the genus). Engler (1879) and Engler & Krause (1920) placed *A. pallida* in the synonymy of *A. alba*. However, since Engler's interpretation of *A. alba* appears to have been associated with material only from Sri Lanka (where that species in the strict sense does not naturally occur), there is some doubt about their determination. It seems likely that this is a synonym and variant of *A. macrorrhizos*.

Alocasia warburgii Engl., Bot. Jahrb. Syst. 25 (1898) 25 (= *Alocasia heterophylla* (Presl) Merr.).

Engler cited *Warburg 15723* from Sulwesi in the protologue; the specimen (and a Philippine syntype) is presumed destroyed at B. Engler later concluded that *A. warburgii* was conspecific with *A. heterophylla*, a distinctive Philippine species of which no other Sulawesi material has been found (Hay, in press).

Alocasia wavriniana Mast., Gard. Chron. 21 (1898) 241, fig. 98 (= *Alocasia lauterbachiana* (Engl.) A. Hay).

This was originally attributed to Sulawesi, but no material with this provenance authenticated has been found. *Alocasia lauterbachiana* is from New Guinea and the Bismarck Archipelago (Hay & Wise, 1991).

Acknowledgements

I am greatly indebted to Conrad D. Fleming for his generious financial support of field work in Peninsular Malaysia, Borneo, Java and Sumatera over the last four years. For invaluable assistance in the field I am very grateful to: Prof. Ruth Kiew, Mr Anthonysamy and Roy Banka (Universiti Pertanian Malaysia) in 1994, Yahud bin Hj. Wat, Saupel B. Atot and Chang Ban Sem (Sarawak Forestry Department) in 1994, Dr Wong Khoon Meng, Mr A. Berhaman, Ubaldus, Postar and Ahmat (Forest Research Centre, Sepilok) in 1995 and 1996, and Dr Ir. Suhirman, Dra Yuzammi and Pak Tahrodin (Kebun Raya Bogor) in 1996 and 1997. The Directors or Curators of the following herbaria made their material available: B, BM, BO, BRI, E, GH, K, KEP, L, MO, SAN, SAR, SING, UPM, US. I thank Prof. David Mabberley for his invaluable advice on matters of typification and nomenclature, and Peter Boyce and Ken Hill - the latter during his tenure as Australian Botanical Liaison Officer at K - for generous assistance with library matters. I am grateful to Sylvia Fitzgerald, Chief

Librarian at K for permission to reproduce the type of *Arum montanum*. I also thank Dewey Fisk for providing very informative material of *Alocasia* in his cultivated collection. I would also like to thank Ian McLellan, Randy Sing and nursery staff of the RBG Sydney for cultivating the living plants cited here, Lesley Elkan and Marion Westmacott for the botanical drawings, Suzanne Bullock for the photographs in Plate 1, and Clare Herscovitch for stoic technical assistance and curation of the living Aroid collection at Sydney. Peter Boyce, Ruth Kiew and Dr Dan Nicolson (US) provided constructive criticism of the manuscript.

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FLORA MALESIANA SERIES II - FERNS AND FERN ALLIES, VOLUME 3 (Polypodiaceae, Davalliaceae, Azollaceae, Cheiropleuriaceae, Equisetaceae, Matoniaceae, Plagiogyriaceae), edited by C. Kalkman and H. P. Nooteboom, vi + 1–334 pp. (1998). Rijksherbarium, P. O. Box 9514, 2300 RA Leiden, The Netherlands.

This new volume of series II of Flora Malesiana on Ferns and Fern Allies contains revised treatments of seven families of Malesian pteridophytes by various authors. The families revised are as follows: Polypodiaceae by P. H. Hovenkamp *et al.*, pp. 1–234; Davalliaceae by H. P. Nooteboom, pp. 235–276; Azollaceae by R. M. K. Saunders, pp. 277–284; Cheiropleuriaceae and Equisetaceae by J. E. Leferrière, pp. 285–286 & 287–288; Matoniaceae by M. Kato, pp. 289–294; and Plagiogyriaceae by X.-C. Zhang and H. P. Nooteboom, pp. 295–316.

A two-page abstract precedes the volume and an index to the scientific plant names concludes it. The format of the new pteridophyte volume is similar to that of the new volumes of seed plants in series I. Compared to the old format, the layout of paragraphs in the new volume runs across the entire page width, instead of forming two columns. The font size of the print is also bigger, which makes the reading of the text easier.

For each family, one sees a general description, followed by a concise discussion of the distribution, morphology, habitat and ecology, chromosomes and taxonomy, and at times, economic importance. The same categories of information are repeated for the genera and species. Well-constructed, dichotomous keys to genera and species within the family, extensive synonymy, taxonomic bibliography and accurate illustrations are also provided. For speciose and difficult genera, such as *Microsorium* and *Selliguea*, separate keys to the species known from a large island and country, or from an island group, are provided.

Because of the number of included taxa, the family Polypodiaceae, with 18 genera and 183 species, easily becomes the main feature of this large volume, to be followed by Davalliaceae (3 genera and 31 species) and Plagiogyriaceae (one genus and 7 species), in terms of family size. The rest of the families treated are either monotypic or oligotypic. Important taxonomic ideas put forth in the new volume include the generic fusion between *Humata* and *Davallia*, *Pyrrosia* and *Drymoglossum*, *Crypsinus* and *Selliguea*, and also, *Phymatosorus* and *Microsorum*. The supportive arguments justifying a broad concept for these genera have been published previously by the authors and are not repeated in volume 3. On the other hand, several traditionally accepted small genera, such as *Photinopteris* (=*Aglaomorpha*), *Thayeria* (=*Aglaomorpha*), *Merinthosorus* (=*Aglaomorpha*), *Schellolepis* (=*Goniophlebium*) and *Araiostegia*

(=*Davallia*) are not recognized by the authors of this volume. No taxonomic novelty is described in the new volume. *Aglaomorpha acuminata* (Willd.) Hovenkamp is published as a nomenclatural novelty.

The present volume, with its updated revision, is truly a handy source of taxonomic information for the seven families of Malesian ferns treated. Being an occasional student of Malesian fern taxonomy, I find the discussion on the family morphology and relationship, as well as the many taxonomic comments scattered through the pages, very educational and enlightening.

However, I miss the selected distribution maps of plant taxa so elegantly reproduced in early volumes of this series. To me, these range maps provide an effective visual aid to our understanding of the dispersal and evolution of the Malesia flora. Future volumes of series II should perhaps consider the inclusion of distribution maps of selected pteridophytes to illustrate the biogeographical highlights of Malesian fern flora.

Undoubtedly, the usefulness of a flora revision lies in its inclusiveness of the taxa found locally and its workability with the specimens collected from the area. Judging by the text presentation, especially the wording of the dichotomous keys and the illustrations, the new volume appears to be another excellent and useful guidebook to the correct identification of Malesian ferns. Both the authors and the editors of this new volume are to be congratulated for a difficult job well done.

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