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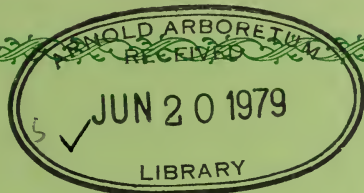
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# THE GARDENS' BULLETIN

## SINGAPORE

Vol. XXXI, Part I

14th November, 1978

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# **Bauhinia dewitii, a New Bornean Species.**

by

KAI LARSEN & SUPEE S. LARSEN

*Botanical Institute, Aarhus University, Denmark.*

## **Abstract**

A new species of *Bauhinia* from Borneo is described; De Wit was the first to draw attention to this taxon which he called: "*Phanera* spec. nov. A" on the basis of sterile material.

Flowering material is now available; we propose the name *B. dewitii* for this species belonging to the section *Bracteolanthus* (de Wit) Wunderlin.

During revisionary work on Asian *Bauhinia* species we discovered an undescribed species from Sarawak, Borneo. This plant, however, was observed already by de Wit (1956) who described it as "*Phanera* spec. nov. A" belonging to section *Bifoliola* de Wit. Only sterile material was at his disposal, Clemens 20486, collected from Kuching, Gunong Tieng — Sarawak.

In 1970 Paul Chai from the Sarawak Forest Department collected flowering branches of the same taxon which is easily recognized by its unique subbullate leaves, glistening on both surfaces as if varnished and with the nerves deeply impressed on the upper surface, sharply raised on the lower surface.

We have named this new species in honour of H.C.D. de Wit, author of the first revision of the Malaysian *Bauhinieae*.

*Bauhinia dewitii* sp. nov. sectionis *Bracteolanthi* (De Wit) Wunderlin (in sched.)  
Fig. 1.

Planta lignea scandens: rami juvenes glabri.

Folia: stipulae mox caducae (non visae); petioli glabri, 3–6 cm longi; 2 foliola libera semicordata, 8–13 x 3.5–6.5 cm magna, marginibus interioribus subrectis; apex in acumen 5–10 mm longum contractus; lamina utrinque omnino glabra, nitida, 4 nervis utrinque elevatis percursa nervulis transversis elevatis numerosis; mucro validus 3–5 mm longus inter foliola prominens.

Inflorescentia: racemus axillaris simplex vel compositus omnino glaber ad 16 cm longus; axis primarius satis tenuis; bractee triangulae, minutae. Flores pedicellis filiformibus 1.5–2 cm longis portati; bracteolae minutissimae, suboppositae, infra medium insertae. Gemma obovoides apice acuta, 8 mm longa receptaculo campanulato 2–3 mm longo incluso. Calyx inter anthesin i 5 lobos fissus. Petala alba, intra maculis perlaete roseis ornata, subaequalia, oblonga; unguis 1 mm longus; lamina 10–12 x 8–10 mm magna. 5 stamina fertilia filamentis lanuginosis, basi hirtis, 15 mm longis, antheris 1.5 mm longis; 5 stamina rudimentaria fertilibus circiter dimidio breviora, antheris parvis. Ovarium stipitatum, ad basem receptaculi insertum; stipes hirtus, inter anthesin circiter 7 mm longus; ovarium hirtum, 5 mm longum; stylus 12 mm longus; stigma capitatum.



*Bauhinia dewitii*, a. flowering twig; b. bud; c. opened receptacle, petals removed; — *Bauhinia diptera*, d. bud; e. opened bud 4 anthers removed; f. fully developed petal.

Legumen ignotum.

Holotypus die 24 Junii anni 1970 in planitie humida prope rivum ad pedes montis Doya vicinitatis oppidi Bau regionis Sarawak Forest Department 29920 insulae Borneo a Paul Chai lectus, in Herbario Kewensi (K) depositus, isotypus in SING (!)

*Bauhinia dewitii* is a very remarkable species. It does not at all belong to the *Phanera*-group, regarded by de Wit as a separate genus. It is a member of the *Bracteolanthus*-group. De Wit established *Bracteolanthus* a new, monotypic genus endemic to Borneo. He based it on *Bauhinia diptera* Blume ex Miq. We do not share de Wit's point of view in splitting up the genus *Bauhinia* in a number of smaller genera of which some, in any case, are not natural groups (See Larsen, S. S. 1975). We regard, however, *Bauhinia diptera* and *B. dewitii* as forming a distinctive group which deserve to be treated as a section. R. P. Wunderlin (written communication) has proposed the section *Bracteolanthus* (de Wit) Wunderlin (mss. in print).

The name *Bracteolanthus* was given by de Wit with reference to the large bracteoles inserted near the top of the pedicel enclosing the bud. The new species described by us makes it necessary to emend the description of the section. Furthermore de Wit describes *B. diptera* as having 6-8 antheriferous stamens. We have dissected flowers of this species and in all cases found 10 antheriferous stamens, 5 long ones belong to the outer whorl, the inner whorl being represented by 5 short. The same arrangement of the androecium is found in *B. dewitii*.

Emended description of section *Bracteolanthus*:

Giant lianas with tendrils. Leaves of the flowering shoots consist of two free leaflets. Intrastipular trichomes absent. Stipules small, early caducous. Flowers in slender racemes. Receptacle turbinate. Antheriferous stamens 10, 5 long representing the outer whorl, 5 short representing the inner whorl. Anthers opening lengthwise. Ovarial stipe free from the receptacle, insertion slightly excentric. So far the section is known from Borneo only.

KEY TO THE SPECIES

- 1. Inflorescence woolly tomentose; bracts and bracteoles persistent, subrotundate, 7-10 mm, bracteoles inserted on top of pedicel; buds floccose, petals tomentose outside ..... *B. diptera*
- 1. Inflorescence glabrous, bracts and bracteoles caducous, minute; bracteoles inserted near the middle of the pedicel; buds glabrous; petals glabrous ..... *B. dewitii*

The best distinctive characters for the section are the combination of 5 long + 5 short stamens with free ovarial stipe excentrically inserted in the turbinate receptacle and the 2 free leaflets on the flowering shoots.

LITERATURE

Larsen, S. S., 1975: Pollen morphology of Thai species of *Bauhinia* (Caesalpinia-ceae). — *Grana* 14: 114-131.

De Wit, H. C. D., 1956: A revision of Malaysian *Bauhinieae*. — *Reinwardtia* 3: 381-539.

*[The text on this page is extremely faint and illegible. It appears to be a list or a series of entries, possibly containing names and dates, but the characters are too light to transcribe accurately.]*

# Flora Malesiana Precursores: Dipterocarpaceae

by

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## Summary

Species delimitation in Dipterocarpaceae is discussed. The genus *Pentacme* DC. is reduced as a section of *Shorea* Roxb.

The following names are reduced:

*Dipterocarpus penangianus* Foxw. (to *D. caudatus* Foxw.), *D. speciosus* Brandis (*D. kunstleri* King), *D. trinervis* Bl. (*D. retusus* Bl.), *D. pseudofagineus* Foxw. (*D. fagineus* Vesque), *D. basilanicus* Foxw. (*D. eurynchus* Miq.), *D. subalpinus* Foxw. (*D. hasseltii* Bl.); *Anisoptera mindanensis* Foxw. and *A. oblonga* Dyer (*A. costata* Korth.), *A. brunnea* Foxw., *A. polyandra* Bl., and *A. kostermansiana* Dilmy (all to *A. thurifera* (Blco) Bl.), *Vatica blancoana* Foxw. (*V. umbonata* (Hook f.) Burck), *V. simalurensis* Sloot. (*V. venulosa* Bl.), *V. subcordata* Bl., *V. celebica* Bl. and *V. papuana* Dyer (all to *V. rassak* (Korth.) Bl.), *V. stipulata* Ridl. (*V. hullettii* (Ridl.) comb. nov.), *V. sumatrana* (Miq.) Burck and *V. wallichii* Dyer (*V. pauciflora* (Korth.) Bl.), *V. scaphifolia* Kosterm. (*V. javanica* Sloot.), *V. obtusifolia* Elm. (*V. mangachapoi* (Blco) Bl.), *V. songa* Sloot. (*V. perakensis* King); *Hopea argentea* Meijer (*H. cernua* T. et B.) *H. kelantanensis* Sym. and *H. garangbuaya* Ashton (*H. coriacea* Burck), *H. woodiana* Gutierrez (*H. malibato* Foxw.), *H. siamensis* Heim (*H. pedicellata* Brandis), *H. dolosa* Sloot. (*H. celebica* Brandis), *H. nabirensis* Sloot. (*H. iriana* Sloot.), *H. resinosa* Sym. (*H. pachycarpa* (Heim) Sym.), *Shorea flava* Meijer (*S. falciferoides* Dyer), *S. glaucescens* Meijer (*S. falciferoides* Foxw.), *S. ciliata* Foxw. (non King) (*S. astylosa* Foxw.), *S. rogersiana* Raizada and Smitinand (*S. laevis* Ridl.), *Pentacme mindanensis* Foxw. (*S. contorta* Vidal), *S. resinanegra* Foxw. (*S. longisperma* Roxb.), *S. kaluntii* Merr. (*S. hopeifolia* (Heim) Sym.), *S. sororia* Sloot. (*S. assamica* Dyer), *S. plagata* Foxw. and *S. agsaboensis* Stern (*S. pauciflora* King).

*Parashorea stellata* Kurz and *P. lucida* (Miq.) Kurz are reinstated as separate species.

*Balanocarpus heimii* Sym. is transferred to a new taxon *Neobalanocarpus* gen. nov.

The identity of *Parashorea warburgii* Brandis, *Hopea dasyrrhachis* Sloot., *H. gregaria* Sloot. and *H. plagata* Vidal, *S. siamensis* Miq. and *S. virescens* Parijs is discussed.

There are 3 species of *Dipterocarpus*, 5 of *Vatica*, 8 of *Hopea* and 6 of *Shorea* described for the first time; subspecies are defined in *Dipterocarpus caudatus* Foxw., *D. palembanicus* Sloot., *Anisoptera thurifera* (Blco) Bl., *Vatica venulosa* Bl., *V. granulata* Sloot., *V. javanica* Sloot., *V. mangachapoi* (Blco) Bl., *Dryobalanops oblongifolia* Dyer, *Shorea falciferoides* Foxw., *S. parvistipulata* Heim, *S. singkawang* Miq. and *S. curtisii* Dyer.

## Species delimitation

Dipterocarp taxonomy has been hampered in the past by inadequate field study: Leaf shape, tomentum density and the presence of glaucousness can change dramatically ontogenetically, while leaf and twig dimensions can vary with site conditions as well as genotypically.

Symington (Mal. For. Rec. 16, 1943) perceptively described specific and intra-specific variation in Malaya. He recognised that groups of closely allied species such as *Shorea parvifolia* Dyer, *S. leprosula* Miq., *S. lepidota* Bl., *S. dasyphylla* Foxw. and *S. macroptera* Dyer, occur commonly together in the same forest yet remain consistently distinct and easy to identify, especially at maturity, and that morphological hybrids are rare. He also recognised though that less distinct, but still nevertheless more or less discontinuous variation occurs within Malayan species as he defined them, and that this is generally allopatric in lowland species, many

(e.g. *Dipterocarpus lowii* Hook. f., *Parashorea densiflora* Sloot., *Shorea macrantha* Brandis and *S. parvifolia* Dyer) being represented by distinctly different forms, especially in Perak State in the northwest and in the eastern coastal areas. Exceptionally, two distinct forms occur sympatrically such as the two subspecies of *S. curtisii* Dyer *ex* Brandis, given formal description for the first time in the present paper. A third pattern of intra-specific variation occurs in Malaya among those species which transgress the perhumid to seasonal climatic boundary in the north-west, such as *Anisoptera costata* Korth. In them allopatric differentiation occurs but is much less clearly defined and is more or less continuous though not apparently clinal. Such variation becomes yet more continuous in the seasonal evergreen and more especially dry dipterocarp forests of Indo-Burma, where, for instance, *Shorea siamensis* Miq. *S. roxburghii* D. Don and *Dipterocarpus obtusifolius* Teysm. *ex* Miq. show great but more or less continuous variation in tomentum distribution and density which has been given taxonomic status in the past.

Less is known of the dipterocarp flora of Sumatra and Indonesian Borneo, though the pattern of variation appears to be similar to that of perhumid Malaya. The neogene basins of East Malaysia, characterised by the most diverse and least fertile soils in the region are also the present centre of dipterocarp diversity. The pattern of largely allopatric specialisation is repeated, in this case with certain rivers along the N.W. Borneo coast marking the boundaries of groups of species and geographical subspecies. Taxa appear to have rather recently fragmented into uniform segregates that constitute morphological species or subspecies; local endemism is high (for a review of this subject see Ashton Trans. II Aberdeen-Hull Symposium on Malesian ecology, 1972 pp. 35-49). Here too though some taxa appear to arise sympatrically. This is particularly evident in *Shorea* sect. *Pachycarpae* Heim: the rare *S. rotundifolia* Ashton grows together with, and completely within the geographical range of, the closely related *S. amplexicaulis* Ashton. *S. pinanga* Scheff. is polymorphic, and forms with glabrous and with pubescent leaves, and with as few as 10 or as many as 20 pairs of nerves, have been collected from nearby localities; variation in one character appears to be discontinuous, but forming a reticulum of more or less uncorrelated variation within different characters which prevents definition of intra-specific taxa. It is curious that the only apparent examples of clinal variation in Borneo occur in the riparian and valley species *Vatica umbonata* (Hook f.) Burck and *Dipterocarpus kunstleri* King. A hybrid between the former and the riparian *V. rassak* (Korth.) Bl. is also known; in Malaya *V. umbonata* varies similarly and appears to hybridise with *V. stapfiana* Ridl. The still little collected dipterocarp flora of the New Guinea lowlands appears to follow the N.W. Bornean pattern within *Hopea*, the only genus represented there by more than one species.

In the Philippines, characterised by highly fertile soils influenced by limestone and basaltic lava and ash, and by a gradually increasing seasonality towards the north-west, a different pattern of variation prevails. The dipterocarp flora is relatively poor, and local endemism low at both specific and infra-specific levels; a few species (*Dipterocarpus philippinensis* Foxw., *Shorea assamica* Dyer ssp. *philippinensis* (Foxw.) Sym., *Hopea cagayanensis* (Foxw.) Sloot.) are confined to the more strongly seasonal areas, but most are remarkably widespread in view of the range of seasonality. However, many species vary greatly and apparently continuously and clinally in the size of leaves and twigs. In *Shorea contorta* Vidal and *S. falciferoides* Dyer dimensions decline with increasing seasonality in N.W. Luzon. *Vatica mangachapoi* (Blco) Bl., *Hopea malibato* Foxw. and *Shorea polysperma* (Blco) Merr. occur throughout the Philippines on a wide range of sites but manifest great variation in relation to physiography. The leaves of *S. polysperma* and also *S. polita* Vidal are sometimes glaucous beneath, particularly in drier sites. *Shorea almon* Foxw. is considered to occur in two distinct forms in Mindanao, one

with small bullate leaves scabrid beneath, the other with larger more sparsely pubescent leaves (a pattern of variation analogous to that of *S. ovalis* (Korth.) Bl.). Field observation revealed that the two forms occur together on soft coralline limestone, and that variation appears to be continuous, though parallel ontogenetic variation necessitates a quantitative study to confirm this. It is perhaps significant that hybridisation among some Philippine dipterocarps is well known, notably between *Dipterocarpus kunstleri* King and *D. grandiflorus* (Blco) Bl. and *D. elongatus* Korth.

In the absence of experimental evidence, therefore, consistent criteria for the definition of species and subspecies are essential. I have adopted the following:

1. Size differences are not by themselves sufficient to distinguish species, neither are differences of leaf size and shape combined. Differences in fruit size are likewise unreliable and rarely correlate with other characters; collections from one tree in different years often exhibit great variation. A consistent discontinuity in leaf size, where correlated with differences in androecium or gynoecium, in qualitative (but not quantitative) characters of indumentum, with qualitative characters of the twig or stipule or with a discontinuity in the range in the number of leaf nerves does constitute an adequate criterion for separating species however.

2. Subspecies can be defined where discontinuities occur in the range of dimensions of parts, in tomentum distribution and in density. However, sometimes taxa which share an unique qualitative character, especially of fruit or flower, are recognised as subspecies even though they may differ qualitatively in vegetative parts; the subspecies of *Shorea ovalis* (Korth.) Bl. may serve as an example.

## Dipterocarpus

**Dipterocarpus obtusifolius** TEYSM. ex MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 214; DC. Prodr. 16, 2 (1868) 608; WALP. Ann. 7 (1868) 377; DYER Fl. Br. Ind. 1 (1874) 295; KURZ Fl. Burm. 1 (1877) 115; BRANDIS J. Linn. Soc. Bot. 31 (1895) 7, 27; Ind. Trees (1907) 65, 701; GUERIN in LECOMTE, Fl. Gén. I.-C. 1 (1910) 358; TARDIEU in id. Suppl. 1 (1943) 338; TROUP Silv. Ind. Trees (1921) 39; CRAIB Fl. Siam. Enum. (1925) 136; PARKER Ind. For. Rec. 16 (1931) 9; PARKINSON Burma For. Bull. 27 (1932) 23; SYM Mal. For. Rec. 16 (1943) 184. — *D. vestitus* WALL. Cat. (1828) 954; WALP. Rep. 5 (1845) 124; DC. Prodr. 16, 2 (1868) 614 *nomen nudum*; ex DYER Fl. Br. Ind. 1 (1874) 295 desc; BRANDIS J. Linn. Soc. Bot. 31 (1895) 27. — *D. punctulatus* PIERRE Fl. Coch. 3 (1892) 221; BRANDIS J. Linn. Soc. Bot. 31 (1895) 29; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1910) 357.

HOLOTYPE: Teysmann H.B. 5918, Kanburi, Thailand (U; syntypes L, BO, K).

Var. *subnudus* RYAN & KERR J. Siam. Soc. 8 (1911) 3.

LECTOTYPE: Kerr 17717, Kao Kuap, Krat, Thailand (K).

Var. *vestitus* (WALL. ex DYER) SMITINAND Thai For. Bull. 1 (1954) 51.

HOLOTYPE: Wallich 954, Martaban (K).

Var. *glabricalyx* SMITINAND Thai For. Bull. 1 (1954) 51.

ISOHOLOTYPE: R.F.D. 7739 (Dec. 462) Koke Dindaeng, Wang Sapoon, Loie, Thailand (K).

Twigs, inflorescences, flower calyx, outside of corolla, leaf buds and petioles densely pale fulvous to buff hirsute or glabrous; leaf beneath and midrib above shortly densely evenly  $\pm$  persistently buff pubescent.

A characteristic and frequently gregarious fire-resistant component of the Dry Dipterocarp (savanna) forest. Very variable, especially in the amount and density of tomentum; the more glabrous form (var. *subnudus*) prevails in the more humid areas including N.W. Malaya; var. *vestitus* is tomentose on all parts, whereas var.

*glabricalyx* differs only in the glabrous flower calyx. In view of the extreme variability of this species (*cf. S. siamensis*) I do not recognise the varieties as distinct taxonomic entities.

**Dipterocarpus caudatus** FOXW. Philip. J. Sc. 13 (1918) Bot. 177; *ibid.* 67 (1938) 256; MERR. En Philip. 3 (1923) 89; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 302, 303.

Ssp. **caudatus** Lectotype: FB 21193, Barrio Hibatac, Camarines, Luzon (K).

Leaf bud and stipule outside shortly densely pale buff pubescent, parts otherwise glabrous. Twig 1–3 mm  $\phi$  apically, slender,  $\pm$  compressed, smooth, with slightly swollen amplexicaul stipule scars. Bud 8–17 by 2–3 mm, narrow falcate or linear; apex tufted with slightly longer hairs arising from the outer surface. Stipule *c.* 3.5 by 0.5 cm., linear, obtuse. Leaves 7–11 by 3.5–5 cm, broadly elliptic, prominently plicate; base broadly cuneate; acumen to 1.2 cm long, prominent, narrow; nerves 9–12 pairs, prominent, at 35°–45°; petiole 1–1.5 cm long, slender. Raceme to 12 cm long, slightly compressed, unbranched or singly branched, the flowers secund, few; bracts unknown. Flower bud to 3 by 0.8 cm. Calyx and corolla typical, calyx puberulent. Stamens *c.* 30, shorter than the style; filament short; anthers short, linear, tapering; appendage to connective slightly shorter than anther, stout at base, tapering. Ovary conical, densely pubescent; style and stylopodium narrowly cylindrical, somewhat stouter and more densely tomentose in the basal half. Fruit calyx glabrous; tube *c.* 2 cm long and  $\phi$ , slightly obovoid, glabrous, minutely lenticellate, tapering gradually to the pedicel, *c.* 1 cm.  $\phi$  at the neck; 2 longer calyx lobes to 14 by 3 cm, oblong, 3-nerved, obtuse, rather abruptly narrowing to *c.* 5 mm broad at base; 3 shorter lobes 4–8 by 3–4 mm, variable, strongly recurved and revolute.

DISTR. Malesia: S.E. Philippines (Mindanao, Luzon).

Ssp. **penangianus** (FOXW.) *stat. nov.* — *D. penangianus* FOXW. Mal. For Rec. 10 (1932) 72; SYM. Mal. For. Rec. 16 (1943) 185; ASHTON, Man. Dipt. Brun. (1963) 43; *ibid.* Suppl. (1968) 16.

TYPE: SFN 3484 (Haniff) Mt. Olivia, Penang (SING, K).

Twig, petiole, raceme, midrib and nerves shortly sparsely fugaceous pubescent, twigs sometimes densely persistently so. Leaves narrowly elliptic, applanate, with narrowly cuneate base, hardly prominent nerves beneath and 1.5–2.5 cm long petiole.

DISTR. Malesia: Malaya (Perak, Penang, W. & E. Johor, Kelantan, Pahang), Singapore, Karimun, Mursala, Borneo (Sarawak N.E. of river Rejang; S.E. Sabah).

I do not consider that the small difference of tomentum and leaf shape are sufficient to justify maintaining these taxa as separate species, especially in view of their distinctive shared linear-falcate bud and obovoid to obturbinate fruit calyx. Malayan collections are distinguished from Bornean by their denser and more persistent indumentum on twigs, and by their prominently lenticellate fruit calyx tube. I have selected the Kew isoholotype as lectotype as the holotype is no longer in the Philippine National Herbarium and is presumed destroyed.

**Dipterocarpus hasseltii** BL. Fl. Jav. 2 (1829) 22; KORTH. Kruidk. (1841) 65; WALP Rep. 5 (1845) 123; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prodr. 16, 2 (1868) 609; BURCK Ann. Jard. Bot. Btzg 6 (1887) 196; BRANDIS J. Linn. Soc. Bot. 31 (1895) 30; K. et V. Bijdr. (1900) 109; RIDL. J. Str. Br. R. As. Soc. 33 (1900) 42; *ibid.* 34 (1900) 94; MOLL & JANSSONIUS Mikrogr. Holz. (1906) 359; KOORD. Exk. Fl. Java. 2 (1912) 620; BAKER f. J. Bot. 62 (1924) 10; CRAIB Fl. Siam. Enum. 1 (1925) 135; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1096, 1097; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 280; *ibid.* III, 16 (1940) 436; FOXW. Mal. For. Rec. 10 (1932) 67; Philip. J. Sc. 67 (1938) 251; BURK. Dict. 1 (1935) 844; SYM. Mal. For Rec. 16 (1943) 180; SMITINAND Thai For. Bull. 4 (1958) 35; BACKER & BAKH. f. Fl. Jav. 1 (1936) 329; MEIJER & WOOD Sab. For Rec. 5 (1964) 255. — *D. tampurau* KORTH. Kruidk. (1841) 63; WALP. Rep. 5 (1845)

123; BL. Mus. Bot. 2 (1852) 36; MIQ. Fl. Ind. Bat. 1, 2 (1859) 498; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prodr. 16, 2 (1868) 609; DYER J. Bot. 12 (1874) 103; BURCK Ann. Jard. Bot. Btzg 6 (1887) 198 *p.p.*; BRANDIS J. Linn. Soc. Bot. 31 (1895) 29; MERR. En. Born. (1921) 400; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 292; HEYNE Nutt Pl. ed. 1, 3 (1917) 274; *ibid.* ed. 2, 2 (1927) 1098; ASHTON Gard. Bull. Sing. 20 (1963) 234. — *D. quinquegonus* BL. Mus. Bot. 2 (1852) 36; WALP. Ann. 4 (1851) 335; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; MERR. En. Born. (1921) 400. — *D. pentagonus* DC. Prodr. 16, 2 (1868) 610; DYER J. Bot. 12 (1874) 104; BURCK Ann. Jard. Bot. Btzg 6 (1887) 199; BRANDIS J. Linn. Soc. Bot. 31 (1895) 34; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 282. — *D. lampongus* SCHEFF. Nat. Tijd. N. I. 31 (1870) 146; DYER J. Bot. 12 (1874) 102; BURCK Ann. Jard. Bot. Btzg 6 (1887) 197; BRANDIS J. Linn. Soc. Bot. (1895) 31; HEYNE Nutt Pl. 1, 3 (1917) 272; ASHTON Gard. Bull. Sing. 20 (1963) 236 in obs. sub *D. gracilis*. — *D. balsamiferus* BL. Mus. Bot. 2 (1852) 36; MIQ. Fl. Ind. Bat. 1, 2 (1859) 498; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prodr. 16, 2 (1868) 613; DYER J. Bot. 12 (1874) 108; BURCK Ann. Jard. Bot. Btzg 6 (1887) 203; BRANDIS J. Linn. Soc. Bot. 31 (1895) 40; K. et. V. Bijdr. (1900) 111; MOLL & JANSONIUS Microgr. Holz (1906) 357; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1096. — *D. trinervis* (non BL.) FOXW. Philip. J. Sc. 6 (1911) Bot. 247; *ibid.* 13 (1918) Bot. 177; MERR. En. Philip. 3 (1923) 91. — *D. subalpinus* FOXW. in ELM. Leaf. Philip. Bot. 6 (1913) 1950; Philip. J. Sc. 13 (1918) Bot. 177; *ibid.* 67 (1938) 255; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 283.

I agree with Merrill (En. Philip.) in reducing *D. subalpinus* FOXW., based on Elmer 13531, Cabadbaran, Mt. Urdaneta, Agusan here. Foxworthy (1938) claimed that *D. subalpinus* differed from *D. hasseltii* in having smaller leaves and fruit without the distinctive large suborbicular shorter calyx lobes, in this resembling *D. gracilis* BL. The problem is confounded by the frequently unusually sparsely tomentose leaves of *D. gracilis* in the Philippines, especially at higher altitudes where *D. subalpinus* appears to prevail. However, the specimens presently available convince me that Philippine material is within the range of variation of *D. hasseltii* from other parts of its range.

**Dipterocarpus retusus** BL. Cat. (1823) 77; Verh. Bat. Gen. K. W. (1823) 178; Bijdr. 5 (1825) 223; Fl. Jav. 2 (1829) 14; WALP. Rep. 5 (1845) 122; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prodr. 16, 2 (1868) 609; DYER J. Bot. 12 (1874) 102; BURCK Ann. Jard. Bot. Btzg 6 (1887) 197; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 256; BRANDIS J. Linn. Soc. Bot. 31 (1895) 30; K. & V. Bijdr. (1900) 112; KOORD. Exk. Fl. Java, 2 (1912) 21; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251; HEYNE, Nutt. Pl. ed. 2, 2 (1927) 1097; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 286; *ibid.* III, 16 (1940) 435; FOXW. Mal. For. Rec. 10 (1932) 69; SYM. Mal. For. Rec. 16 (1943) 187; BACKER & BAKH. f. Fl. Jav. 1 (1963) 329. — *Dipterocarpus trinervis* BL. Cat. (1823) 78; Verh. Bat. Gen. K. W. 9 (1823) 178; Bijdr. (1825) 223; Fl. Jav. 2 (1829) 11; KORTH. Kruidk. (1841) 61; WALP. Rep. 5 (1845) 122; LINDLEY Veg. King. (1846) 393; SCHNIZLEIN Ic. 3 (1857) t 213; MIQ. Fl. Ind. Bat. 1, 2 (1859) 496; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prodr. 16, 2 (1868) 608; SCHEFF. Nat. Tijd. N. I. 31 (1870) 346; BAILLON Hist. Pl. 4 (1873) 204; Dict. Bot. 1 (1878) 562; Tr. Bot. Med. Pharm. 2 (1884) 816; DYER J. Bot. 12 (1874) 102; BURCK Ann. Jard. Bot. Btzg 6 (1887) 195; BRANDIS & GILG in E. & P. Pfl. Fam. 1, 3, 6 (1895) 256; BRANDIS J. Linn. Soc. Bot. 31 (1895) 29; K. et V. Bijdr. (1900) 105; MOLL & JANSSONIUS Microgr. Holz (1906) 354; KOORD. Ex. Fl. Java, 2 (1912) 620; HEYNE Nutt. Pl. ed. 1, 3 (1917) 274; *ibid.* ed. 2, 2 (1927) 1098; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 284; *ibid.* III, 16 (1940) 436; BACKER & BAKH. f. Fl. Jav. 1 (1963) 329 — *D. trinervis* var. *elegans* BL., var. *canescens* BL. Fl. Jav. 2 (1829) 13; HASSK. Pl. Jav. Rar. (1848) 270; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; DC. Prodr. 16, 2 (1868) 609; DYER J. Bot. 12 (1874) 102; BURCK Ann. Jard. Bot. Btzg 6 (1887) 196. — *D. spanoghei* BL. Fl. Jav. 2 (1829) 16; WALP. Rep. 5 (1845) 122; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. (1867) 85; DC. Prodr. 16, 2 (1868) 609; BURCK Ann. Jard. Bot. Btzg 6 (1887) 198; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1097. — *D. macrocarpus* VESQUE C. R. Ac. Paris 78 (1874) 627; J. Bot. 12 (1874) 153; DYER J. Bot. 12 (1874) 4; PARKER Ind. For. Rec. (Bot.) 20, 15 (1934) 3. — *D. spanoghei* BL. var. *cordata* BURCK Ann. Jard. Bot. Btzg 6 (1887) 198. — *D. pubescens* K. & V. Bull. Inst. Bot. Btzg 2 (1899) 2; Bijdr. 5 (1900) 115; MOLL & JANSSONIUS Microgr. Holz (1906) 359; KOORD. Exk. Fl. Java 2 (1912) 621; HEYNE Nutt. Pl. ed. 1, 3 (1917) 274; *ibid.* ed. 2, 2 (1927) 1097. — *D. tonkinensis* A. CHEV. Bull. Econ. Indoch. 20 (1918) 798; TARDIEU in LECOMTE Fl. Gen. I.-C. Suppl. 1 (1943) 341.

I do not recognise Blume's two species *D. retusus* (Syntypes: Blume 1082a G. Salak (L); Van Hasselt s.n. sub. HLB 902,146–196,–197, W. Java (L)) and *D. trinervis* (Syntypes: Junghuhn s.n. sub. HLB 902 146–219,–230, *loc. incert.*, Java (L); Blume s.n. sub. HLB. 902,146–218,–234, G. Salak (L); Van Hasselt

s.n. *sub.* H.L.B. 902,146–241, G. Poelasari W. Java (L)). *D. trinervis* is said to differ in being persistently buff pubescent on twigs, panicles and often petiole. The two grow together within a single forest in Java; their similarity in other characters, and the variability of the tomentum convince me of their conspecificity. I reduce *D. macrocarpus* VESQUE (Syntypes: Griffith s.n., Kew dist. no 733, Kujoo, Lakhimpur, Assam (P, K) of Assam, north Burma and Thailand and *D. tonkinensis* CHEV. (Holotype: Chevalier 37387, Cuyen Guang, Tonkin) of Tonkin here for the first time. They both resemble *D. trinervis* but the tomentum is somewhat longer and they remain persistently pubescent on the leaf beneath; furthermore PARKER described *D. macrocarpus* var. *glaber* on Parkinson 344, Myityina which differs in no important respect from the glabrous forms *D. retusus*.

This species, as presently understood, has an interesting distribution: At the extremities of its range in mainland Asia and on Lombok and Sumbawa it occurs in a seasonal climate down almost to sea level and is relatively tomentose. In Malaya and W. Java it is confined to altitudes above 800 m. and in the former is uniformly glabrescent but for the buds and corolla.

*D. littoralis* BL. is clearly a segregate from the widespread *D. retusus*, endemic to the lowland forests of Noesa Kambangan Island, Java; I maintain it as a species. It would appear that the ecological and geographical distribution, and diversification, of the two must be explained in terms of regional Pleistocene history.

**Dipterocarpus kunstleri** KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 96; BRANDIS J. Linn. Soc. Bot. 31 (1895) 37; BRUHL & KING Ann. R. Bot. Gard. Calc. 5, 2 (1896) 148; RIDL. Fl. Mal. Pen. 1 (1922) 217; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1094, 1096; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 327; FOXW. Mal. For. Rec. 10 (1932) 83; BURK. Dict. 1 (1935) 844; SYM. Mal. For. Rec. 16 (1943) 182. — *D. speciosus* BRANDIS J. Linn. Soc. Bot. 31 (1895) 38; PERKINS Fragm. Fl. Philip. (1904) 22; FOXW. Philip. J. Sc. 6 (1911) Bot. 250; *ibid.* 13 (1918) 178; *ibid.* 67 (1938) 261; MERR. En. Philip. 3 (1923) 90; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 265; SLOOT. ex WOOD Gard. Bull. Sing. 17 (1960) 486; Reinwardtia 5 (1961) 462; ASHTON Man. Dipt. Brun. (1964) 31; *ibid.* Suppl. (1968) 14; MEIJER & WOOD Sab. For. Rec. 5 (1964) 246.

In the Philippines the species is very variable; in some collections the fruit calyx is continuously ribbed from base to apex and even winged, suggesting hybridisation with *D. grandiflorus* (BLCO) BL.; in others the twigs and petioles are densely fulvous pilose as in *D. elongatus* KORTH., which grows with it there. *D. speciosus* BRANDIS is based on Vidal 2160, in fruit (K) from Luzon, a specimen with tomentum typical of *D. kunstleri* KING and fruit similar though with narrower, more continuous ribs. I see no satisfactory solution other than to unite the two species.

In N.E. and E. Borneo the calyx tube is more or less obtusely ribbed and tuberculate distally, and the calyx lobes often (not always) short or even rudimentary. Individual trees observed in the field are rather constant in the lobe length, but geographical variation appears continuous and to some extent clinal, the lobes becoming shorter towards the S.E. limits of its range. I cannot therefore recognise distinct varieties meriting taxonomic status.

**Dipterocarpus fagineus** VESQUE C.R. Ac. Sc. Paris 78 (March 1874) 625; J. Bot. 12 (1874) 149; DYER J. Bot. 12 (1874) 152; BURCK Ann. Jard. Bot. Btzg 6 (1887) 200; KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 94; BRANDIS J. Linn. Soc. Bot. 31 (1895) 33; BURKILL J. Str. Br. R. As. Soc. 81 (1920) 51, 53; MERR. En. Born. (1921) 398; RIDL. Fl. Mal. Pen. 1 (1922) 216 *p.p.*; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 318; FOXW. Mal. For. Rec. 10 (1932) 80; SYM. Kew Bull. (1937) 318; Mal. For. Rec. 16 (1943) 177; BROWNE For. Tr. Sarawak & Brunei (1955) 108; ASHTON Man. Dipt. Brun. Suppl. (1968) 14. — *D. prismaticus* DYER J. Bot. 12 (Apr. 1874) 104; *ibid.* (May 1874) 152. — *Duvaliella problematica* HEIM Bull. Soc. Linn. Paris, 2 (1891) 1009; Rech. Dipt. (1892) 72; BRANDIS & GILG in E. & P. Pfl. Fam ed. 1, 3, 6 (1895) 263; GILG in *ibid.* 2, 21 (1925) 258. — *Dipterocarpus pseudofagineus* FOXW. Mal. For. Rec. 10 (1932) 82; SYM. Mal. For. Rec. 16 (1943) 186.

The holotype of *D. fagineus*, Beccari 3008 (P) is from Sarawak, where the species is rare in hill forests. In Malaya it also occurs in the hills of Perak and Penang island. Collections from low altitudes in coastal Pahang and Trengganu, and also Perak, previously generally described as *D. pseudofagineus* FOXW. (Holotype: Kep 25511, Keledong Saiong F.R., Perak (KEP)) have longer leaves with more nerves, generally glaucous beneath, and have fruit calyx ribs confined to the distal half. Symington, whose opinions I have learned to respect, considered these as distinct species. There is no discontinuity, among collections presently available, between these lowland and hill forms however, and they appear to occur together in the Keledang Saiong range in Perak. I therefore feel compelled to unite them.

**Dipterocarpus glabrigemmatius** *sp. nov.* — *D. sp.* ASHTON Man. Dipt. Brun. Suppl. (1968) 19.

*D. grandiflori* (BLCO) Bl. affinis, sed staminibus 15 lamina subtus sparsim pubescenti gemma glabra differt.

Midrib and nerves sparsely pubescent, other vegetative parts glabrous. Twig *c.* 3 by 2 mm  $\phi$ , somewhat compressed and ribbed, lustrous; stipule scars slender, pale, hardly raised. Leaf bud to 6 by 4 mm, acute. Stipule unknown. Leaves 6–9 by 4.5–6 cm, broadly ovate; margin sinuate distally; base obtuse; acumen to 5 mm long, short, broad; nerves 10–11 pairs, prominent beneath, at 45°–60° near the base, straight but curving near the margin; midrib applanate above, prominently terete beneath; tertiary nerves subscalariform; petiole 1.5–2.5 cm long, slender, drying rugose. Raceme to 10 cm long, to 1 mm  $\phi$  at base, axillary, unbranched, glabrous. Flower bud to 25 by 12 mm. Calyx glabrous, prominently 5-winged; corolla typical. Stamens 15, subequal; filaments compressed at base, tapering; anthers linear, 2–3 times as long as filaments; appendage to connective almost as long as anther, filiform, tapering. Ovary ovoid, small, pubescent; style *c.* 5 times length of ovary, pubescent except at apex. Fruit unknown.

HOLOTYPE: S. 23849, Bukit Raya, Kapit, Sarawak (K).

OTHER COLL: Sarawak: S. 22339, Bt. Leran, S. Miah, Rejang; Smythies s.n., S. Bena, Sut, Baleh.

*D. grandiflorus* is confined to seasonally dry habitats: in seasonal evergreen dipterocarp forests of Indo-Burma and N.W. Luzon, dry ridges in Malaya and the everwet parts of the Philippines, and dry coastal hills in N.E. Sabah. Our species, whose leaves and probably fruit (judging from the flower calyx) bear a marked resemblance to those of *D. grandiflorus*, is a rare tree on moist clay soils in everwet Central Sarawak. The 30 stamens and distinctive densely greyish puberulent bud of *D. grandiflorus* serves at once to distinguish it.

**Dipterocarpus palembanicus** SLOOT. Bull. Jard. Bot. Btjg III, 8 (1927) 336.

Ssp. **palembanicus** SYM. Mal. For. Rec. 16 (1943) 185; ASHTON Man. Dipt. Brun. Suppl. (1968) 16 *p.p.* — *D. alatus* (*non* ROXB.) FOXW. Mal. For. Rec. 10 (1932) 82.

LECTOTYPE: F.R.I.T.134 (fruit), Gunong Megang, Lematang Hilir, Palembang, Sumatra (BO).

Twig, leaf bud and stipule outside densely fulvous hirsute; petiole, midrib above and leaf beneath densely shortly puberulent; caducous on twigs and petioles, otherwise persistent. Leaves 10–14 by 5–9 cm, broadly elliptic to ovate; petiole 2–3 cm long. Fruit calyx tube to 3.5 by 1.5 cm, narrowly ellipsoid, tapering gradually to the base and the *c.* 1 cm  $\phi$  neck; broadly 5-winged, the wings thin, to 8 mm broad,  $\pm$  obtuse or subcordate at base, with the margin folded over frequently at maturity.

DISTR. Malesia: Malaya (Trengganu, C. Johore), Singapore, Sumatra (Palembang), Borneo (C. Sarawak).

Ssp. **borneensis** *ssp. nov.* — *D. palembanicus* (non SLOOT.) ASHTON Man. Dipt. Brun. (1963) 42; MEIJER & WOOD Sab. For Rec. 5 (1964) 266.

Ramuli petioli costa media costis laterales subtusque conferte breviter badio pubescentes; ramuli caduci partes aliter persistentes. Gemmae stipulae petiolique persistenti hirsuti lamina sparsim fugace pubescens. Lamina 6–11 x 3–6 cm oblonga vel ovata costis lateralibus utrinsecus 12–14; petiolo c. 15 cm longo. Tubus calycis in fructu 4.5 x 20 cm alis lateralibus 5, –15 mm latis undulatis basim et apicem versus auriculatis.

DISTR. N.E. Borneo, C. and N.E. Sarawak, E. Sabah to Nunukan. In lowland Mixed Dipterocarp forests, sometimes occurring with *ssp. palembanicus*.

HOLOTYPE: San A 1747, Beaufort, Sabah (L).

OTHER COLL.: Sarawak S. 22204, 22228, Bt. Raya, Kapit; S. 15106, Ulu Segan, Bintulu.

**Dipterocarpus fusiformis** *sp. nov.*

*D. mundi* SLOOT. affinis sed gemma persistenti alutaceo velutinata lamina subtus sparsim puberulens differt.

Large tree. Young parts densely buff velutinate, persistent on leaf buds and stipule outside, becoming sparse yet  $\pm$  persistent on twigs, petiole and leaf under-surface, elsewhere caducous. Twigs c. 2 mm  $\phi$  apically, slender, terete,  $\pm$  verrucose. Buds to 15 by 3 mm, linear, lanceolate; stipule to 30 by 6 mm, lanceolate, acute. Leaves 7–17 by 3–7 cm, elliptic or narrowly ovate, coriaceous; base cuneate or obtuse; acumen to 12 mm long, slender, prominent; nerves 13–17 pairs, slender but prominent beneath, ascending at 30°–40°; tertiary nerves densely scalariform, evident but hardly elevated beneath; petiole 2–2.6 cm long, slender. Complete inflorescences unknown; inflorescences singly branched or unbranched, axillary. Flowers unknown. Fruit pedicel c. 1 mm long, short; calyx tube to 28 by 18 mm, ellipsoid, with 5, to 6 mm broad, straight incrassate wings or narrow ridges, continuous from base to apex but generally broader in the distal half; 2 longer lobes to 10 by 2.6 cm, broadly spatulate, obtuse, c. 7 mm wide at base; 3 shorter lobes to 5 mm long, suborbicular, subrevolute.

DISTR. N.E. Borneo; rare on undulating well drained fertile soils in Mixed Dipterocarp forest.

HOLOTYPE: San 39170, Mile 81, Labuk Road, Sandakan (L).

OTHER COLL.: San 63787, S. Sipit, Semporna; San 70858, 70903, Ulu Segama, Lahad Datu; San 15279, Kalabakan, Tawau; San 17173, 16452, Balong, Tawau.

Clearly closely allied to *D. mundus* SLOOT. of the Central Bornean hills, a species which is conspicuously glabrous but for its corolla, ovary, and the inside of its stipules. The two species are therefore very different in appearance; flowers are still awaited and may provide further differences.

**Dipterocarpus eurynchus** MIQ. Sum. (1862) 485; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; D. C. Prodr. 16, 2 (1868) 613; WALP. Ann. 7 (1868) 377; BURCK Ann. Jard. Bot. Btzg 6 (1887) 203; BRANDIS J. Linn. Soc. Bot. 31 (1895) 40; SLOOT. Bull. Jard. Bot. Btzg III 8 (1927) 273, 302; ASHTON Gard. Bull. Sing 20 (1963) 238; Man. Dipt. Brun. (1964) 30; *ibid.* Suppl. (1968) 14. — *D. eurynchoides* SCHEFF. Nat. Tijds. N. I. 31 (1870) 346; BURCK Ann. Jard. Bot. Btzg 6 (1887) 203; BRANDIS J. Linn. Soc. Bot. 31 (1895) 40; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 273, 302. — *D. appendiculatus* SCHEFF. Nat. Tijds. N. I. 31 (1870) 347; *ibid.* 32 (1873) 407; DYER J. Bot. 12 (1874) 104 *p.p.*; BURCK Ann. Jard. Bot. Btzg 6 (1887) 200 *p.p.*; BRANDIS Linn. Soc. Bot. 31 (1895) 34 *p.p.*; MERR. En. Born. (1921) 397 *p.p.*; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1094; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 326; Reinwardtia 5 (1961) 458; FOXW. Mal. For. Rec. 10 (1932) 83 *in obs.*; SYM. Mal. For. Rec. 16 (1943) 167. — *D. micropterus* DYER in SLOOT. Reinwardtia 5 (1961). 458 *nomen pro syn.* — *D. basilanicus* FOXW. Philip. J. Soc 13 (1918) Bot. 179; *ibid.* 67 (1938) 259; MERR. En. Philip. 3 (1923) 88.

DISTR. Malesia: Malaya (E. coast, Trengganu to N.E. Johor), Sumatra (E. Aceh, Langsa), P. Singkep, Banka, Borneo (W. Borneo, Sarawak, Brunei), S. Philippines (rare).

A polymorphic species, I recognise one distinctive and well collected segregate, *D. ochraceus* MEIJER, as a separate species. Others, presently ill-understood, may eventually deserve taxonomic definition: The few Malayan and Sumatran collections, for instance, have markedly larger leaves with longer petioles, and collections from Gunong Angsi, Negri Sembilan (including Kep. 23788, quoted by Symington (1943) as a possible hybrid between *D. gracilis* and *D. costatus*) come close to *D. ochraceus*. *D. basilanicus* FOXW. (Lectotype: FB 18895, Mt. Basilan, Philippines (K)), conforms more closely than these to N.E. Bornean collections and the type and must therefore be reduced. *D. eurynchus* is apparently derived from the widespread *D. costatus* GAERTN. f. of seasonal S.E. Asia as may be the closely similar *D. glandulosus* THW. of Ceylon.

**Dipterocarpus perakensis** sp. nov. — *D. alatus* (non ROXB.) FOXW. Mal. For. Rec. 10 (1932) 89 p.p.; SYM. Mal. For. Rec. 16 (1943) 166.

*D. eurynchus* MIQ., *D. ochraceus* MEIJER, *D. philippinensis* FOXW. affinis sed tubo calycis in fructu alis 5 lateralibus — 8 mm latis partibus glabris ovario excepto.

Large tree. Parts glabrous but for the cream puberulent ovary apex. Twigs c. 2 mm.  $\phi$  apically, much branched, blackish. Buds to 9 by 2 mm, lanceolate, drying blackish; stipules unknown. Leaves 4–7 by 8–13 cm, elliptic, coriaceous; base broadly cuneate to obtuse; apex shortly acuminate; nerves densely scalariform, slightly elevated beneath; petioles 1.5–3.2 cm long, slender. Flowers and inflorescence unknown. Fruit pedicel to 2 by 1 mm; calyx tube to 2.3 cm  $\phi$ , subglobose with 5 prominent continuous to 8 mm wide coriaceous wings; 2 longer lobes to 12 by 3 cm, oblong-ovate, obtuse, tapering abruptly to c. 8 mm wide at the revolute base; 3 shorter lobes to 5 by 5 mm, suborbicular, subrevolute, small.

DISTR. N. W. Malaya; Very local in lowland Mixed Dipterocarp forest on the coastal hills of Dindings, Perak and on Pangkor and Penang Islands.

HOLOTYPE: Kep 76716; South Pangkor F.R., Dindings, Perak, Malaya (KEP).

OTHER COLL.: Kep 54231, 76547, S. Pangkor F.R.; KEP. 24555 'Ipoh'; Curtis 1560, Burkill s.n. July 1918, Penang Hill.

A segregate from *D. eurynchus* MIQ. and *D. costatus* GAERTN. f., clearly distinguished by the relatively broad wings on the fruit calyx tube and conspicuous lack of tomentum.

## Anisoptera

### The problem of *A. costata* Korth. and *A. thurifera* (Blco) Bl.

The type section of *Anisoptera* KORTH. includes two distinct but obviously related vicarious species: *A. curtisii* DYER ex KING of Malaya with 25 stamens and *A. grossivenia* SLOOT, of Borneo with c. 36; also *A. megistocarpa* SLOOT. of Malaya with c. 60 stamens which shares the golden peltate leaf undersurface. The peat swamp species *A. marginata* KORTH. differs in having but 25 stamens and a small epilose few-nerved leaf, while *A. reticulata* ASHTON of the N.E. Borneo hills resembles the latter but has 35 stamens. These five are confined to the perhumid area of western Malesia, are rather constant intraspecifically and are well defined from one another.

In the seasonal extremities of the sectional range, however, more variable species occur.

**Anisoptera costata** KORTH. Kruidk. 3 (1841) 67; BL. Mus. Bot. Lugd-Bat. 2 (1852) 42; MIQ. Fl. Ind. Bat. 1, 2 (1859) 501; Ann. Mus. Bot. Lugd. Bat. 3 (1867) 85; D. C. Prodr. 16, 2 (1868) 615; PIERRE in LANESS. Pl. util. colon. Franc. (1886) 298; BURCK

Ann. Jard. Bot. Btztg 6 (1887) 220; BRANDIS J. Linn. Soc. Bot. 31 (1895) 43; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 60; Str. Br. R. As. Soc. 54 (1910) 25 *p.p.*; Fl. Mal. Pen. 1 (1922) 218 *p.p.*; MERR. En. Born. (1921) 400; SLOOT. Bull. Jard. Bot. Btztg 3, 8 (1926) 7; Reinwardtia 2 (1952) 8 *p.p.*; THORENAAR Med. Proefst. Boschw. 16 (1926) 106; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1098; FOXW. Mal. For. Rec. 3 (1927) 79; *ibid.* 10 (1932) 97; SYM. Gard. Bull. S.S. 8 (1934) 9; Mal. For. Rec. 16 (1943) 204; SLOOT. *apud* HOLTHUIS & LAM Blumea, 5 (1942) 214; WYATT-SMITH Mal. For. 18 (1955) 74; BACKER & BAKH. *f.* Fl. Jav. 1 (1963) 330; ASHTON Man. Dipt. Brun. (1964) 11; *ibid.* Suppl. (1968) 5; MEIJER & WOOD Sab. For. Rec. 5 (1964) 293.—*Anisoptera oblonga* DYER Fl. Br. Ind. 1 (1874) 301; PIERRE Fl. Coch. 3 (1892) 235, 236; BRANDIS J. Linn. Soc. Bot. 31 (1895) 42; Ind. Trees (1907) 67; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1912) 369; GAMBLE Man. Ind. Timb. (1922) 75; SYM. Gard. Bull. S. S. 8 (1934) 10; Mal. For. Rec. 16 (1943) 208; PARKINSON Ind. For. Rec. 20 (1935) 7.—*Shorea nervosa* KÜRZ Rep. Pegu App. A. (1875) XVIII, *nomen*; Fl. Burm. 1 (1877) 110.—*Anisoptera cochinchinensis* PIERRE in LANESS. Pl. Util. Colon. Franc. (1886) 268; Fl. Coch. 3 (1892) t. 235A. 253; BRANDIS J. Linn. Soc. Bot. 31 (1895) 42; HEIM Bot. Tidsskr. 25, 1 (1902) 44; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1912) 367; TARDIEU in *ibid.* Suppl. 1 (1943) 343; CRAIB Fl. Siam. Enum. 1 (1925) 139; LECOMTE Bois Indochine (1926) 115.—*Dipterocarpus parallelus*, *Dryobalanops hallii* KORTH. *ex* BURCK Ann. Jard. Bot. Btztg 6 (1887) 220, 243.—*A. robusta* PIERRE Fl. Coch. 3 (1894) t. 236; BRANDIS J. Linn. Soc. Bot. 31 (1895) 42; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1912) 368; TARDIEU in *ibid.* Suppl. 1 (1943) 343; CRAIB Fl. Siam. Enum. 1 (1925) 140; SYM. Gard. Bull. S. S. 8 (1934) 11.—*A. glabra* (*non* KÜRZ) PIERRE Fl. Coch. 3 (1892) 235B; GUERIN in LECOMTE Fl. Gén. I.-C. (1912) 368; TARDIEU *ibid.* Suppl. 1 (1943) 343.—*A. marginatoides* HEIM Bot. Tidsskr. 25 (1902) 44; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1912) 369; TARDIEU in *ibid.* Suppl. 1 (1943) 344; CRAIB Fl. Siam. Enum. 1 (1925) 139.—*A. mindanensis* FOXW. Philip. J. Sc. 13 (1918) Bot. 181; *ibid.* 67 (1938) Bot. 266; MERR. En. Philip. 3 (1923) 92.—*Anisoptera sp. A.* SYM. Mal. For. Rec. 16 (1940) 209.

Symington has already questioned the distinctness of not only *A. cochinchinensis* PIERRE of Indochina from *A. costata*, which he correct united, but also *A. oblonga* DYER of Burma. Thailand and northern Malaya (Isosyntypes: Griffith 719, 920, 939, Mergui (K) ) which he kept separate on account of its larger more sparsely pubescent leaves; according to the original description *A. cochinchinensis* has 30–35 stamens, but I have not found this to be the case. He also tentatively recognised *Anisoptera sp. A.*, with relatively small few-nerved leaves, from N.W. Malaya. I have examined the many collections under these names at Kepong, Singapore, Kew and elsewhere and am unable to find a single character to consistently distinguish them, nor can I distinguish *A. robusta* PIERRE of Laos and Vietnam (Isosyntypes PIERRE 1549-1571 (P, K) ), with densely pilose vegetative parts, or *A. mindanensis* FOXW. (known from a single flowering collection: lectotype: FB 21899, Naga Naga, Zamboanga, Mindanao (K) ) which is uniquely entirely epilose on twigs and leaves but does not otherwise differ.

As now understood, therefore, *A. costata* is distinguished by its 25 stamens and generally grey-brown pubescent leaf with generally at least 15 pairs of nerves. It occurs from Mindanao (one definite record) through Borneo, Java, Sumatra and Malaya to Chittagong, Burma, Thailand and Indochina. In Mindanao it is epilose but for petals and ovary; in Borneo it has relatively small chartaceous sparsely grey-brown pubescent leaves with 15–20 pairs of nerves; in Java, Sumatra and sometimes Malaya the leaves are similar but somewhat larger, with to 22 pairs of nerves; In Malaya the species becomes more variable however, usually being relatively large-leaved, with a rather dense, often golden tomentum; in the north-west a small golden tomentose leaved form prevails with as few as 8 pairs of nerves. In the Indochinese region the species varies much in leaf size and tomentum, and in more seasonal areas becomes shortly deciduous; no clear geographical differentiation is discernable, though variation is greatest in southern Indochina. In summary, variation appears on the whole continuous as in a panmictic population, with geographically localised forms appearing in the less seasonal areas. No forms appear distinct enough to merit taxonomic status. There is the possibility of hybridisation with *A. curtisii* in N.W. Malaya, and with *A. megistocarpa* in Johor and Singapore (large-leaved golden tomentose forms).

Van Slooten (1952) recorded *A. costata* from Celebes and the Moluccas on the basis of sterile material. It is indistinguishable from *A. thurifera* (BLCO) BL. when sterile; for phytogeographical reasons, until flowers are collected, I would prefer to tentatively associate these numbers with the latter.

**Anisoptera thurifera** (BLCO) BL. Mus. Bot. 2 (1852) 42; WALP. Ann. 4 (1857) 336; DC. Prodr. 16, 2 (1868) 615; VIDAL synopsis (1863) t. 14 E; BRANDIS J. Linn. Soc. Bot. 31 (1895) 44; BRANDIS & GILG in E. & P. Pfl. Fam. 3, 6 (1895) 258; MERR. & ROLFE Philip. J. Sc. 3 (1908) Bot. 115; MERRITT For. Bur. Bull. Philip. 8 (1908) 48; WHITFORD Philip. J. Sc. 2, 4 (1910) Bot. 703; For. Bur. Bull. Philip. 10 (1911) 78; FOX-WORTHY Philip. J. Sc. 6 (1911) Bot. 256; *ibid.* 13 (1918) Bot. 181; *ibid.* 67 (1938) Bot. 267; MERR. Sp. Blanc. (1918) 269; En. Philip. 33 (1923) 92; REYES, Philip. J. Sc. 22 (1923) 323; SLOOT. Bull. Jard. Bot. Btzig 3, 8 (1926) 4; SYM. Gard. Bull. S. S. 8 (1934) pl. 4c. — *Mocanera thurifera* BLCO Fl. Philip. ed. 1 (1937) 446. — *Dipterocarpus thurifer* BLCO Fl. Filip. ed. 2 (1845) 310; *ibid.* ed. 3, 2 (1878) 212; D. C. Prodr. 16, 2 (1858) 614.

This Philippine species, with its oblanceolate leaf, has been much collected; when sterile it is sometimes indistinguishable from the usually broader leaved *A. costata* though the acumen is generally bent downwards (or twisted over in pressed specimens). It differs markedly, however, in possessing 45–47 stamens; the tomentum is generally sparse and short, even absent, on vegetative parts. In seasonal north-eastern Luzon and as far south as Real, Quezon a form occurs, apparently mixed with the typical form, with a more or less distinctly chocolate-brown lepidote leaf undersurface and young parts. This was distinguished as *A. brunnea* FOXW. (FB 11292, Camalamugan, Cagayan Prov. (K)), but as the scale colour varies greatly and apparently continuously, from chocolate to the typical greyish colour of *A. thurifera*, I do not recognise this taxon, even at infraspecific level. *A. aurea* FOXW., a species of aseasional central east Luzon and Polillo nearby, differs not only in the distinctive golden undersurface but in having 35–38 stamens, a distinctive pale cream-brown scolloped bark with rather persistent flakes peeling away from above, and very narrow laminae in the inner bark giving it a granular appearance in transverse section. *A. thurifera*, with which it grows on ridges in Mixed Dipterocarp forest, has a distinctly different less persistently flaky grey-brown bark surface. The two species are clearly distinct.

The position is complicated, however, by the fact that no reliable distinguishing characteristics exist between *A. thurifera* and the very variable New Guinea species *A. polyandra* BL. (Type: Zippelius s.n. sub 902, 146–52, 59–64; New Guinea (L)) which must therefore be reduced to it. Though typically with an obovate leaf otherwise similar to that of *A. thurifera*, the leaves can be more or less coriaceous, glabrous and with as few as 10 pairs of nerves, as in the type of *A. forbesii* BRANDIS (Holotype: Forbes 373, Sogeri region, New Guinea (K)), already reduced to *A. polyandra* by VAN SLOOTEN (1926); they can also be relatively large and chartaceous, with as many as 17 pairs of nerves as in *A. kostermansiana* DILMY (Type: NGF 7355, Morobe dist. New Guinea (BO, K)); specimens of this kind sometimes have as many as 57 stamens. A continuous range from 37 to 57 stamens occurs among New Guinea specimens as a whole, however, and I am unable to maintain *A. kostermansiana* as a separate taxon. It should be noted also that the New Guinea range in stamen number obscures the differentiation between *A. thurifera* and *A. aurea*. I still maintain the latter separately owing to its distinctive leaf and bark, and because, though some New Guinea specimens are faintly golden lepidote, they never approach the vivid colour of *A. aurea*. It is interesting that other New Guinea collections, from West Irian, are more or less dark chocolate-brown lepidote as in the Philippines form *A. brunnea*.

*A. thurifera* is now seen to be the eastern analogue of *A. costata* with a distribution, if sterile collections from Celebes and the Moluccas are included here, from northern Luzon throughout the Philippines to Celebes, Moluccas and New Guinea. In the Philippines geographically defined variation occurs and a separate species, probably of common origin, has evolved within the aseasional parts of its

range. In New Guinea local variation is great and collections presently inadequate to define geographical forms. It is interesting that the species is known in both the Philippines and New Guinea to be the only dipterocarp which readily reinvades cultivated land.

I recognise the Philippine and New Guinea populations as geographical subspecies:

KEY TO THE SUBSPECIES.

1. Leaves oblanceolate to lanceolate, prominently acuminate, stamens 45–47 ..... Ssp. *thurifera*.
2. Leaves obovate; Stamens 37–57 ..... Ssp. *polyandra*.

Ssp. *thurifera*.—*Mocanera mayapis* BLCO Fl. Filip. ed. 1 (1837) 449. — *Dipterocarpus mayapis* BLCO Fl. Filip. ed. 2 (1845) 313; D.C. Prodr. 16, 2, (1868) 610; DYER J. Bot. 12 (1874) 108; BRANDIS J. Linn. Soc. Bot. 31 (1895) 40; MERR. Publ. Gov. Lab. Philip. 27 (1905) 21.—*Antherotriche lanceolata* TURCZ. Bull. Soc. (Imp.) Nat. Mosc. 2 (1846) 505; WALP. Ann. 1 (1848) 113.—*Anisoptera lanceolata* WALP. Ann. 1 (1848) 113; DC. Prodr. 16, 2 (1868) 616; VIDAL Phan. Cuming. (1885) 97; F.-VILL. Nov. App. (1880) 20; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 263; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 259.—*Shorea mayapis* BL. Mus. Bot. 2 (1852) 33; DC. Prodr. 16, 2 (1868) 632.—*Anisoptera oblonga* (non DYER) F.-VILL. Nov. App. (1880) 20; VIDAL Rev. Pl. Vasc. Filip. (1886) 60.—*D. turbinatus* (non GAERTN. f.) F.-VILL. Nov. App. (1880) 20.—*Anisoptera vidualiana* BRANDIS J. Linn. Soc. Bot. 31 (1895) 44; PERK. Fragm. Fl. Philip. (1904) 23; MERR. Philip. J. Sc. 1 (1906) Suppl. 97.—*Anisoptera tomentosa* BRANDIS J. Linn. Soc. Bot. 31 (1895) 45.—*Anisoptera calophylla* PERK. Fragm. Fl. Philip. (1904) 22.—*Anisoptera brunnea* FOXW. Philip. J. Sc. 6 (1911) Bot. 254; *ibid.* 13 (1918) Bot. 181; *ibid.* 67 (1938) 270; MERR. En. Philip. 3 (1923) 92.

Tall or medium sized buttressed tree. Twigs, leaf buds, stipules, petioles and leaves beneath  $\pm$  densely persistently grey-green or pale to chocolate-brown lepidote; panicles, flower calyx and ovary densely grey-brown puberulent; panicle and calyx becoming sparsely so or glabrescent in fruit. Twig *c.* 3 mm  $\phi$  apically, terete, rugulose, pale brown. Leaf bud to 4 by 2 mm, lanceolate; stipules to 8 mm long, linear. Leaves 6–15 by 2.5–6.5 cm, thinly coriaceous, elliptic to lanceolate or obovate-oblanceolate,  $\pm$  coriaceous; base broadly cuneate or obtuse; acumen to 1.3 cm long, slender, downcurved and twisting over on pressing; nerves (12–) 14–18 (–20) pairs, slender but distinctly elevated beneath, less so above (as also the reticulate tertiary nerves), arched, at 55–80°, depressed above; petiole 1.7–3.5 cm long, slender. Panicles to 20 cm long, terminal or subterminal axillary, lax, pendent; singly branched, branchlets bearing to 11 flowers. Flower buds to 9 by 3 mm, lanceolate. Sepals narrowly deltoid; 2 longer subacute, 3 shorter, prominently acuminate. Stamens 45–47, subequal; filaments short, slender, filiform; anthers narrowly oblong, somewhat tapering; appendages very slender,  $\pm$  twice length of anthers. Stylopodium narrowly ellipsoid-cylindrical, puberulent distally, with prominent trifid style. Fruit pedicel to 3 mm long, short. Calyx tube to 17 mm  $\phi$ , globose; 2 longer lobes to 15 by 1.5 cm, spatulate, narrowly obtuse, *c.* 4 mm wide at base; 3 shorter lobes to 30 by 3 mm, linear. Stylopodium short, conical.

DISTR. Malesia: Philippines, commonest in the more seasonal areas.

Ssp. *polyandra* (BL.) ASHTON *stat. nov.*—*A. polyandra* BL. Mus. Bot. 2 (1852) 42; WALP. Ann. 4 (1857) 335; MIQ. Fl. Ind. Bat. 1 (1859) 501; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 84; DC. Prodr. 16, 2 (1868) 615; SCHEFF. Ann. Jard. Bot. Btzg 1 (1876) 9; F.v. M. Descr., Not. App. 6 (1887) 97; BURCK Ann. Jard. Bot. Btzg 6 (1887) 220; BRANDIS J. Linn. Soc. Bot. 31 (1895) 45; DIELS Bot. Jahrb. 57, 4 (1922) 461; LANE-POOLE For. Res. (1925) 22, 33, 119, 167; SLOOT. Nov. Guinea 14 (1926) 222; Bull. Jard. Bot. Btzg 3, 8 (1926) 15; Reinwardtia 2 (1952) 11; WHITE & FRANCIS Proc. R. Soc. Queensl. 38 (1927) 247.—*Dipterocarpus parviflorus* ZIPP. Flora 12 (1829) 281; Alg. Konst. en. letterbode 1, 19 (1929) 296; Bijdr. Natuurk. Wetensch. 5 (1830) 178, *nomen nudum*.—*Anisoptera sp.* DYER J. Bot. 16 (1878) 99; Burck Ann. Jard. Bot. Btzg 6 (1887) 221; BRANDIS J. Linn. Soc. Bot. 31 (1895) 45; DIELS Bot. Jb. 57, 4 (1922) 461.—*A. forbesii* BRANDIS J. Linn. Soc. Bot. 31 (1895) 45; DIELS Bot. Jb. 57, 4 (1922) 491; BAKER f. J. Bot. 61 Suppl. (1923) 5.—*A. kostermansiana* DILMY Reinwardtia 3 (1956) 347; *ibid.* 5 (1960) 267,

Differing as follows: leaves 8.5–18 by 3.5–8.5 cm, elliptic to obovate, ± coriaceous; base cuneate, obtuse or cordate; apex shortly acuminate; nerves (10–) 12–14 (–17) pairs, slender but distinctly elevated on both surfaces. Stamens 37–57. Fruit pedicel to 4 x 2 mm, prominent; 2 longer calyx lobes to 9 by 1.1 cm, 2 shorter lobes to 7 by 0.6 cm.

DISTR. Malesia: New Guinea, and possibly (sterile material) Celebes, Moluccas (Morotai, Halmahera, Bacan, Obi and Aru Is.).

### Vatica

**Vatica umbonata** (HOOK. f.) BURCK Ann. Jard. Bot. Btztg 6 (1887) 232; SLOOT. Bull. Jard. Bot. Btztg 3, 9 (1927) 132, 133; ASHTON Gard. Bull. Sing. 20 (1963) 250; Man. Dipt. Brun. (1963) 78; *ibid.* Suppl. (1968) 36; MEIJER & WOOD Sab. For. Rec. 5 (1964) 320.

Ssp. **umbonata**. BRANDIS J. Linn. Soc. Bot. 31 (1895) 135; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; MERR. En. Born. (1921) 409; RIDL. Fl. Mal. Pen 1 (1922) 249 *p.p.*; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 265.—*Pachynocarpus umbonatus* HOOK. f. Trans. Linn. Soc. 23 (1860) 159; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prodr. 16, 2 (1868) 617; WALP. Ann. 7 (1868) 378.—*V. verrucosa* BURCK Ann. Jard. Bot. Btztg 6 (1887) 232; SLOOT. Bull. Jard. Bot. Btztg III, 9 (1927) 131; BROWNE For. Tr. Sarawak and Brunei (1955) 102.—*P. verrucosus* HEIM Rech. Dipt. (1892) 107; BRANDIS J. Linn. Soc. Bot. 31 (1895) 136; MERR. En. Born. (1921) 410; RIDL. Fl. Mal. Pen. 1 (1922) 249 *p.p.*—*V. blancoana* ELMER Leaf. Philip. Bot. 4 (1912) 1473; FOXW. Philip. J. Sc. 13 (1918) Bot. 196; *ibid.* 67 (1938) 326; MERR. En. Philip. 3 (1923) 102.—*V. cupularis* SLOOT. Bull. Jard. Bot. Btztg III, 9 (1927) 132; *ibid.* (1929) 20; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1129; BROWNE For. Tr. Sarawak and Brunei (1955) 100.—*V. ramiflora* (*non* HEIM) SLOOT. Bull. Jard. Bot. Btztg 3, 9 (1927) 118. *p.p. ibid.* (1929) 205 *p.p.*—*V. stapfiana* (*non* SLOOT.) BROWNE For. Tr. Sarawak and Brunei (1955) 102.

HOLOTYPE: Motley s.n., Labuan (K).

Fruit to 3 cm long and  $\phi$ , pink-brown verrucose, compressed at base; calyx united into a tube adpressed to and fused to nut, differentiated into 5, to 2.6 by 1.8 cm, oblong-elliptic, up to 5 mm, thick lobes by 5 deep longitudinal furrows; nut 3-sulcate, exposed only at apex.

DISTR. Malesia: Malaya (Pahang, Trengganu). W. and N. Borneo, Palawan.

I reduce *V. blancoana* ELMER (LECTOTYPE: Elmer 13123, Mt. Pulgar, Puerto Princesa, Palawan, K) here for the first time. Though in flower, there is no other species in the Palawan region with similar leaves.

Ssp. **acrocarpa** (SLOOT.) ASHTON *stat. nov.*—*V. acrocarpa* SLOOT. Bull. Bot. Gard. Btztg 3, 17 (1942) 241; MEIJER & WOOD Sab. For. Rec. 6 (1964) 320.

ISOHOLOTYPE: San 4298, Umas Umas, Sabah (K).

Nut ovoid, acute, the fruit sepals united to basal  $\frac{1}{2}$  only and reflexed.

DISTR. E. Borneo.

NOTE. *V. umbonata* is frequently gregarious on riverbanks and the continuous variation found in this habitat, especially in N.E. Borneo where the two subspecies occur in the same area, and in E. Malaya where the closely related *V. stapfiana* occurs in the same habitat, suggests panmixis and hybridisation.

**Vatica venulosa** BL. Mus. Bot. Lugd.-Bat. 2 (1852) 32; WALP. Ann. 4 (1857) 337; MIQ. Fl. Ind. Bat. 1, 2 (1859) 502; DC. Prodr. 16, 2 (1868) 623; BURCK Ann. Jard. Bot. Btztg 6 (1887) 232; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btztg III, 9 (1927) 78; ASHTON Gard. Bull. Sing. 20 (1963) 251; Man. Dipt. Brun. (1964) 79, *ibid.* Suppl. (1968) 36.

Ssp. **venulosa**.—*V. bancana* SCHEFF. Nat. Tijd. N. I. 31 (1870) 348; *ibid.* 32 (1873) 407; BURCK Ann. Jard. Bot. Btztg 6 (1887) 229; BRANDIS J. Linn. Soc. Bot. 31 (1895) 128; BRANDIS & GILG in E. & P. Pfl. Fam. 1, 3, 6 (1894) 269; K. & V. Bijdr. (1905) 127; MOLL & JANSSENIUS Mikrogr. Holz (1906) 360; KOORD. Exk. Fl. Java. 2 (1912) 622; KOORD.-SCHUM. Syst. Verz. (1913) Dipteroc. 4; HALLIER Med. Rijksherb.

36 (1918) 4; MERR. En. Born. (1921) 408; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 264; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1128; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 96; FOXW. Mal. For. Rec. 10 (1932) 263; SYM. Mal. For. Rec. 16 (1943) 217; BROWNE For. Tr. Sarawak and Brunei (1955) 99; BACKER & BAKH. f. Fl. Jav. 1 (1963) 332; MEIJER & WOOD Sab. For. Rec. 5 (1964) 305. — *V. schouteniana* SCHEFF. Nat. Tijd. N. I. 32 (1873) 408. — *Dryobalanops schefferi* HANCE J. Bot. 14 (1876) 307. — *Retinodendron bancanum* KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 129. — *Retinodendron kunstleri* KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 129; BRUHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 157. — *V. kunstleri* BRANDIS J. Linn. Soc. Bot. 31 (1895) 127; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; RIDL. Fl. Mal. Pen. 1 (1922) 243. — *V. schefferi* BRANDIS J. Linn. Soc. Bot. 31 (1895) 128. — *Vatica lutea* RIDL. Kew. Bull. (1926) 60.

Leaves 4–12 by 1.5–5 cm, caducously pubescent beneath; nerves 7–12 pairs; midrib persistently shortly pale pink-brown puberulent above; petiole 5–9 mm long; panicle to 3 (–6) cm long.

DISTR. Malesia: Malaya (Pahang, Perak), Sumatra (Palembang), Mentawai Is, Banka, Belitung, W. Java (Bantam), Borneo.

I reduce here *V. lutea* RIDL. based on Boden Kloss 14581 (= Iboet 275) from Pulau Siberut, Mentawai Islands (SING), which clearly represents flowering collections of this species.

Ssp. *simalurensis* (SLOOT.) *stat nov.* — *V. simalurensis* SLOOT. Bull. Bot. Btzg III, 9 (1927) 100; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1131.

Leaves 9–14 (–20) by 3.5–5.5 (–8) cm, glabrous; nerves 12–15; petiole 8–14 mm long; panicle to 7 cm long.

DISTR. Malesia: P. Simalur, W. Sumatra.

SYNTYPES: Achmad 831, 1019, 1125, Simalur (BO); Achmad 1401, 1463, Dejajan, Tapah Distr. Simalur (BO).

The collections bear a close resemblance to those of *V. venulosa* and are clearly conspecific, but the large size and absence of tomentum has persuaded me to maintain them as a distinct subspecies.

#### *Vatica chartacea* sp. nov.

*V. venulosa*, *V. havilandii* affinis sed costis lateralibus utrinsecus plus quam 16 ramulis paniculis caduce alutaceo puberulentibus petiole glabro differt.

Medium-sized tree. Young twigs, stipules and panicles caducous buff puberulent; pedicel, ovary and parts of petals exposed in bud persistently so; parts otherwise glabrous. Twig c. 2mm  $\phi$  apically, much branched, pale. Buds to 3 by 2 mm, ovoid, acute; stipule to 7 by 2 mm, lanceolate, caducous. Leaves 11–25 by 3–10 cm, oblong to obovate, thinly chartaceous and wrinkling on drying; base broadly cuneate or obtuse; acumen to 1 cm long, prominent; nerves 16–20 pairs, slender but distinctly raised beneath, with shorter secondaries; tertiary nerves sinuately subscalariform, slender and elevated on both surfaces; midrib stout, terete and prominent beneath, distinctly elevated above; petiole 10–22 mm long, slender. Panicle to 5 cm long, to 3-axillary, stout. Flower buds to 6 by 2 mm, fusiform; sepals subequal, lanceolate, subacuminate; anthers small, broadly oblong, tapering to the equally long prominent stout appendages; style columnar, somewhat longer than ovary, slightly tapering, rimmed beneath the conical stigma; flowers otherwise typical. Fruit pedicel to 6 mm long, very slender. Fruit sepals to 6 by 1.5 cm, subequal, lanceolate, subacute, cordate at base, 5–7 nerved, ascending and hiding the -13 by 11 mm ellipsoid nut.

DISTR. Malesia: W. and N.E. Borneo (Bintulu, Sarawak; Beluran and Sandakan to Tawau).

HOLOTYPES: San 46208, Sapi F. R., Beluran (K).

OTHER COLLECTIONS: San 57050, Kalumpang F. R., Mostyn; San 18397, Mile 10½, S. Limau, Kalumpang road, Lahad Datu; San 29318, Mile 14, Kalumpang, Tawau road; San 61253, A. 2959, A. 1725, S. Lagsikan, Sandakan Bay; San A. 4764, Kretam, Lahad Datu; San 17654, Lungmanis F.R., Sandakan; S. 15808, Segan, F.R. Bintulu, Sarawak; b.b. 35257, Embal, b.b. 35244, Ulu Samulang, Ulu Kapuas, West Kalimantan.

ECOL. Moist low hillsides and banks of sluggish rivers; very local.

Showing the distinctive fruit of *V. venulosa* BL. and *V. havilandii* BRANDIS, this species is characterised by its large oblong-obovate leaves, many nerves and short caducous buff tomentum.

**Vatica pauciflora** (KORTH.) BL. Mus. Bot. 2 (1852) 31; DC. Prodr. 16, 2 (1868) 618; MIQ. Sum. (1861) 191; BURCK Ann. Jard. Bot. Btzg (1887) 226; BRANDIS J. Linn. Soc. Bot. 31 (1895) 124. — *Retinodendron pauciflorum* KORTH. Kruidk. 3 (1841) 58. — *Vateria pauciflora* WALP. Rep. 5 (1845) 126; DC. Prodr. 16, 2 (1868) 626. — *V. rassak* (non BL.) WALP. Rep. 5 (1845) 126. — *Elaeogyne sumatrana* MIQ. SUM. (1861) 460, 183; MUELL.-ARG. in DC. Prodr. 15, 1 (1866) 1257; HALL. f. Med. Rijksherb. 36 (1918) 4. — *V. zollingeriana* DC. Prodr. 16, 2 (1868) 618; BURCK Ann. Jard. Bot. Btzg (1887) 227; BRANDIS J. Linn. Soc. 31 (1895) 124; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 126. — *V. wallichii* DYER J. Bot. 12 (1874) 154; BURKILL & FOXW. J. Str. Br. R. As. Soc. 86 (1922) 273; CRAIB Fl. Siam. Enum. 1 (1925) 141; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1132; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 123; FOXW. Mal. For. Rec. 10 (1932) 269; BURK. Dict. 2, 2225; SYM. Mal. For. Rec. 16 (1943) 230. — *V. lamponga* BURCK Ann. Jard. Bot. Btzg 6 (1887) 227; BRANDIS J. Linn. Soc. Bot. 31 (1895) 123; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 269; HEYNE Nutt. Pl. ed. 1, 3 (1917) 313; *ibid.* ed. 2, 2 (1927) 1131; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 264. — *V. forbesiana* BURCK Ann. Jard. Bot. Btzg 6 (1887) 228; BRANDIS J. Linn. Soc. Bot. 31 (1895) 124; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1131. — *V. ruminata* BURCK Ann. Jard. Bot. Btzg 6 (1887) 227; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1132. — *Pachynocarpus wallichii* KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 135 p.p.; BRANDIS J. Linn. Soc. Bot. 31 (1895) 136; RIDL. Fl. Mal. Pen. 1 (1922) 250 p.p.; BURK. J. Str. Br. R. As. Soc. 81 (1920) 75. — *P. ruminatus* BRANDIS J. Linn. Soc. Bot. 31 (1895) 136. — *V. ovalifolia* RIDL. J. Str. Br. R. As. Soc. 54 (1909) 26. — *V. kelsallii* RIDL. J. Str. Br. R. As. Soc. 54 (1909) 27; Fl. Mal. Pen. 1 (1922) 244. — *P. umbonatus* (non HOOK. f.) RIDL. Fl. Mal. Pen. 1 (1922) 249 p.p. — *P. ridleyanus* RIDL. Fl. Mal. Pen. 1 (1922) 250 p.p. — *V. sumatrana* SLOOT. ex HEYNE Nutt. Pl. ed. 2, 2 (1927) 1131; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 120; BACKER & BAKH. f. Fl. Jav. 1 (1963) 332.

Occupying the same habitat as *V. umbonata* and indistinguishable from it when sterile, the fruit calyx is nevertheless characteristic.

The type of *Retinodendron pauciflorum* KORTH. (Korthals s.n. sub. 902, 146-770, near Indrapura, Padang, S. Sumatra (L) ) consists of leaves and loose buds but as *V. umbonata* is unknown from Sumatra we may safely conclude that *Vatica sumatrana* (MIQ.) SLOOT., based on Teysmann 4227 and 4345 HB, Tarabangi, Lampong (L, U) in fruit is synonymous with it. The fruit characters by which VAN SLOOTEN (1927) distinguished *V. sumatrana* and *V. wallichii* DYER do not define a consistent discontinuity in variation and may in part be attributable to their degree of maturity.

#### *Vatica soepadmoi* sp. nov.

Species in sectione Vaticae fructu ovoidea verrucosa sepalis lanceolatis patentibus recurvis revolutis unguiformibus satis distinguitur.

A small tree. Twigs, leaf buds, petioles, midrib above, and panicles densely persistently pale brown scabrid puberulent, nut evenly so; nervation beneath sparsely so. Twigs c. 2 mm  $\phi$ , ribbed at first, becoming terete. Leaf buds to 8 by 4 mm, lanceolate, acute. Leaves 7.5-12 by 3-5.5 cm, elliptic, oblong to narrowly ovate, coriaceous, somewhat bullate between the nerves; margin subrevolute; base obtuse; acumen to 1.5 cm long, slender, prominent; nerves c. 11 pairs, arched, tending to branch within the margin and form a  $\pm$  indistinct looped intramarginal nerve, prominent beneath, shallowly depressed above, with short slender secondary nerves; tertiary nerves subreticulate, evident beneath,  $\pm$  obscure above; midrib stoutly

prominent beneath, evident but  $\pm$  channelled above; petiole 10–15 mm long, slender. Panicle to 6.5 cm long, axillary, hardly branched. Flowers unknown. Fruit pedicel to 6 mm long, prominent; calyx equal, to 18 by 10 mm, lanceolate, acute, recurved inwards and  $\pm$  revolute thus resembling claws; nut ovoid, not known at maturity.

HOLOTYPE: Soepadmo S. 45, Pekanbaru, Tenajan R., Upper Riau, E. Sumatra.

Known from this collection alone, in young fruit. The leaves somewhat resemble those of *V. oblongifolia* HOOK. f. ssp. *oblongifolia* but the pale brown scabrid tomentum, ovoid verrucose nut with thick pericap, and linear-lanceolate patent recurved and revolute claw-like sepals make this a rather distinctive species possibly most closely allied with *V. granulata* SLOOT. and *V. sarawakensis* HEIM.

**Vatica rassak** (KORTH.) BL. Mus. Bot. Lugd.-Bat. 2 (1852) 31; WALP. Ann. 4 (1857) 337; MIQ. Fl. Ind. Bat. 1, 2 (1859) 502; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prodr. 16, 2 (1868) 619; BURCK Ann. Jard. Bot. Btzg 6 (1887) 225; GRESH. Schets. (1900) t. 50; BRANDIS J. Linn. Soc. Bot. 31 (1895) 125; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; HEYNE Nutt. Pl. ed. 1, 2 (1917) 313; *ibid.* ed. 2, 2 (1927) 1130; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 104; *ibid.* 3, 17 (1942) 223. — *Retinodendron rassak* KORTH. Kruidk. (1841) 56. — *V. rassak* var. *subcordata* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 31; MIQ. Fl. Ind. Bat. 1, 2 (1859) 502; DC. Prodr. 16, 2 (1868) 619. — *V. papuana* DYER J. Bot. 16 (1878) 100; BURCK Ann. Jard. Bot. Btzg 6 (1887) 229; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; K. SCHUM. & HOLLR. Fl. Kais.-Wilh. Land (1889) 52; BRANDIS J. Linn. Soc. Bot. 31 (1895) 127; DIELS Bot. Jb. 57 (1922) 463; LANE-POOLE For. Res. Papua (1925) 120; SLOOT. Nova Guinea Bot. 14 (1926) 226; Bull. Jard. Bot. Btzg III, 9 (1927) 112; *ibid.* III, 17 (1942) 233; Reinwardtia 2 (1952) 63; MERR. Philip. J. Sc. 300 (1926) Bot. 411; WHITE & FRANCIS Proc. R. Soc. Queensl. 38 (1927) 247; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1129; FOXWORTHY Philip. J. Sc. 67 (1938) 328; SLOOT. *apud* HOLTHUIS & LAM Blumea, 5 (1942) 214; MEIJER & WOOD Sab. For. Rec. 5 (1964) 314; ASHTON Man. Dipt. Brun. Suppl. (1968) 35. — *Vateria papuana* DYER ex HEMSL. Bot. Chall. 1, 4 (1884-5) 123; 287, 296, *nomen nudum*; K. SCH. & HOLLR. Fl. Kais. Wilh. Land (1889) 52; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1129. — *Vatica moluccana* BURCK Ann. Jard. Bot. Btzg 6 (1887) 226; BRANDIS J. Linn. Soc. Bot. 31 (1895) 124; HEYNE Nutt. Pl. ed. 1, 3 (1917) 313; *ibid.* ed. 2, 2 (1927) 1129. — *R. moluccanum* HEIM Rech. Dipt. (1892) 104. — *V. schumanniana* GILG Bot. Jb. 18, 45 (1894) 38; BRANDIS J. Linn. Soc. Bot. 31 (1895) 127; K. SCHUM. & LAUT. Fl. Schutzgeb. (1901) 451; DIELS Bot. Jb. 57 (1922) 463; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 269. — *Vatica celebensis* BRANDIS J. Linn. Soc. Bot. 31 (1895) 126; SLOOT. Bull. Bot. Gard. Btzg III, 9 (1927) 77; *ibid.* III, 17 (1942) 254; Reinwardtia 2 (1952) 65. — *V. subcordata* HALL. f. Med. Rijksherb. 3, 6 (1918) 4; SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 228. — *V. celebica* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 237.

Twigs, petioles, buds and stipules outside (glabrous within) very shortly evenly persistently pale buff pubescent, leaf nervation beneath sparsely so. Twig c. 3 mm  $\phi$ , stout, crooked, ribbed, becoming rugose, flaky, pale grey-brown; stipule scars prominent, horizontal; internodes 1–3 cm long. Bud to 4 by 4 mm, ovoid-conical, subacute. Stipules to 14 by 4 mm, lorate, subacute, subpersistent. Leaves 13–32 by 5–11 cm, oblong to narrowly elliptic, thickly coriaceous; base broadly cuneate to subcordate; acumen to 1.5 cm long; nerves (10–) 16–20 pairs, prominent beneath, slightly elevated above, arched at 50°–60°, with short hardly elevated secondary nerves; tertiary nerves reticulate; midrib prominent beneath, applanate above; petiole 2–3.5 cm long, stout, not geniculate, drying pale buff pubescent. Panicle to 14 cm long, terminal or axillary, ribbed, at first shortly evenly buff pubescent, becoming pale brown flaky; irregularly branched, with many branches near base, appearing fascicled. Flower bud to 14 by 3 mm, fusiform; calyx densely shortly pale buff pubescent; flowers otherwise typical. Fruit glabrous. Pedicel to 3 mm long, stout. Calyx lobes to 12 by 7 mm, deltoid, acute, incrassate, reflexed, recurved. Nut to 5 by 3.5 cm, oblong to ovoid, irregularly pitted and furrowed deeply at the sutures, minutely verruculose and rugulose; pericarp thick, corky.

DISTR. Malesia: Borneo (E. of Rejang valley and Sampit, commonest on E. coast), Tawi-Tawi, Celebes, Moluccas (Sulu Isl. Mangoli, Morotai, Halmaheira, Bacan, Obi Is., Aru Is.), New Guinea, Sudest Is.

On river banks in Borneo, elsewhere also on hills to 400 m.; locally abundant.

The above description defines my interpretation of this variable species. The large oblong-elliptic coriaceous leaves with long petiole, and the large corky nut, are characteristic though the nut shape is very variable (in part owing to the degree of maturity on herbarium specimens). Its distribution into seasonal areas and its semigregarious ecology parallel that of other polymorphic species such as *A. costata* KORTH., *A. thurifera* (BLCO) BL. and *V. umbonata* (HOOK. f.) BURCK discussed elsewhere in this paper.

The most recent accounts of this species are those of Van Slooten who finally (1952) concluded that *V. rassak*, *V. papuana*, *V. celebensis* and *V. subcordata* were separate species. He distinguished *V. celebensis* (Holotype: Beccari s.n. Lepo-Lepo, Kandari, Celebes (K)) principally by its smooth obtuse symmetrical nut. The single ripe fruit collection available does suggest a distinct difference but not at the level of species as some fruiting collections from New Guinea and Borneo, named *V. rassak* by VAN SLOOTEN, have a similar nut shape, though they are more verrucose; more ripe fruit are required before the constancy of these characters can be confirmed; I fail to see any consistent difference between *V. papuana* (holotype: Beccari and D'Albertis s.n., Ramoi near Sorong, W. Irian, New Guinea (K)), and *V. rassak* (type: Korthals s.n., sub 900, 171-121, S. Borneo (L)). *V. subcordata* (type: Korthals s.n. sub. 902, 146-764, Dusun Distr., S. Borneo (L)), whose range coincides with the southern part of that of *V. rassak*, represents an extreme in the range of variation, with very long petiole and subcordate leaves and (not always) very large malformed fruit.

***Vatica granulata* SLOOT.** Bull. Jard. Bot. Btzg III, 9 (1927) 112; Bull. Bot. Gard. Btzg III, 17 (1941) 136; ASHTON Man. Dipt. Brun. (1964) 70; *ibid.* Suppl. (1968) 32.

**Ssp. granulata**

Leaf 10-20 by 2.7-7 cm; stipule to 6 by 4 mm, hastate, subacute, caducous. Fruit calyx lobes to 7 by 4 mm, chartaceous, deltoid, reflexed.

TYPE: HALLIER 3399, G. Amai Ambit, Ulu Kapuas, W. Borneo (BO, L).

DISTR. Borneo (Sarawak, Brunei, Ulu Kapuas and Barito).

Ssp. ***sabaensis* ssp. nov.** — *V. scortechinii* MEIJER (*non* KING) Sab. For. Rec. 5 (1964) 319.

Lamina 15-25 x 6-10 cm; stipulae -3 x 2 cm subsistentes oblongae vel lanceolatae acutae basim versus obtusae vel subcordatae lobis calycis in fructu — 20 x 12 mm elliptici revoluti reflexi.

DISTR. N. E. Borneo (Crocker range, S. W. Sabah to Kelabit Highlands and N.E. Sarawak).

HOLOTYPE: San 16613, N. slopes of Bt. Batanga, 5 miles south of Malaman, S.W. Sabah (K).

OTHER COLL. San 17000, Kundasan, Kota Belud; San 16708, Gunong Lamaku; S. 26312, S. Belaban, Lawas, Sarawak; Nooteboom 2233, Kelabit Highlands, Ulu Limbang, Sarawak.

Mistaken in the past for the Malayan species *V. scortechinii* KING with which it shares similar subsistent stipules. The nut of *V. scortechinii* is smooth and puberulent however.

***Vatica hullettii* (RIDL.) comb. nov.** — *Capura hullettii* RIDL. J. Str. Br. R. As. Soc. 54 (1910) 36. — *Otophora hullettii* RIDL. Fl. Mal. Pen. 1 (1922) 454; RADLK. in E. & P. Pfl. Fam. ed. 2, 98 (1932) 775. — *V. stipulata* RIDL. J. Str. Br. R. As. Soc. 82 (1907) 172; Fl. Mal. Pen. 1 (1922) 244; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 76; FOXW. Mal. For. Rec. 10 (1932) 253; SYM. Mal. For. Rec. 16 (1943) 229.

I am grateful to Dr. P. W. Leenhouts for drawing my attention to the fact that Ridley based his *Capura hullettii*, later changed by him to *Otophora hullettii*, and his *Vatica stipulata* on the same collection: Hullett 781, April 1888 from Mount Ophir, Malacca (K).

This species is now known from elsewhere in southern Malaya on hills; it differs from the closely allied Bornean species *V. albiramis* SLOOT. principally in its large elliptic subsistent stipules and puberulent petioles and panicle.

**Vatica javanica** SLOOT. Bull. Jard. Bot. Btzg III, 16 (1940) 451; BACKER & BAKH. f. Fl. Jav. 1 (1963) 332.

HOLOTYPE: b.b. Ja 6573 (BO, isoholotypes in L, K).

Ssp. **javanica**.

Leaves 13–24 by 6–10 cm, elliptic-oblong, applanate.

DISTR. Malesia: W. Java (Preanger regencies, once collected).

Ssp. **scaphifolia** (KOSTERM.) *comb. nov.* — *V. scaphifolia* KOSTERM. Reinwardtia, 4 (1955) 2.

Leaves  $\pm$  prominently boat-shaped with the lower surface concave,  $\pm$  distinctly bullate between the nerves, the nerves and sometimes tertiary nerves consequently  $\pm$  channelled above.

DISTR. Malesia: S.E. Borneo (Samarinda, Balikpapan).

HOLOTYPE: Kostermans 4085, S. Wain region, Balikpapan (BO; ISOHOLOYPES in L, K).

OTHER COLL: Kostermans 4174, b.b. 34419, S. Wain region; Kostermans 6533, Loa Djanan, W. of Samarinda.

The Bornean collections of this rare species are given a distinctive appearance by their bullate concave leaves.

**Vatica mangachapoi** BLCO Fl. Filip. ed. 1 (1837) 401; DC. Prodr. 16, 2 (1868) 623; VIDAL Sinopsis (1883) t. 15 b; Rev. Pl. Vasc. Philip. (1886) 61; BRANDIS J. Linn. Soc. Bot. 31 (1895) 134; MERR. Publ. Govt. Lab. Philip. 27 (1905) 22; Philip. J. Sc. 1 (1906) Suppl. 98; Sp. Blanc. (1918) 272; En. Philip. 3 (1923) 101; FOXW. Philip. J. Sc. 6 (1911) Bot. 282; *ibid.* 13 (1918) 196; *ibid.* 67 (1938) 321; REYES Philip. J. Sc. 11 (1923) 320; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 94; BROWNE For. Tr. Sarawak and Brunei (1955) 101; ANDERSON Gard. Bull. Sing. 20 (1963) 159. 228; ASHTON Gard. Bull. Sing. 20 (1963) 253; Man. Dipt. Brun. (1964) 71; *ibid.* Suppl. (1968) 33; MEIJER & WOOD Sab. For. Rec. 5 (1964) 310.

Ssp. **mangachapoi** — *Mocanera mangachapoi* BLCO Fl. Filip. ed. 1 (1837) 540. — *V. sinensis* (non GMEL.) BLCO Fl. Filip. ed. 1 (1837) 401; *ibid.* ed. 2 (1845) 280; *ibid.* ed. 3, 2 (1878) 156; DC. Prodr. 16, 2 (1868) 236. — *V. apterantha* BLCO Fl. Filip. ed. 2 (1845) 281; *ibid.* ed. 3, 2 (1878) 156. — *Dipterocarpus mangachapoi* BLCO Fl. Filip. ed. 2 (1845) 313; *ibid.* ed. 3 (1878) 216; DC. Prodr. 16, 2 (1868) 614. — *Shorea mangachapoi* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 34; DC. Prodr. 16, 2 (1868) 632; WALP. Ann. 4 (1857) 338; F. VILL. Nov. App. (1880) 21. — *Pteranthera sinensis* BL., *P. mangachapoi* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 30. — *Anisoptera mangachapoi* DC. Prodr. 16, 2 (1868) 616. — *V. scaphula* (non DYER) F. VILL. Nov. App. (1880) 21. — *V. bureavi* HEIM Bull. Soc. Linn. Paris, 2 (1891) 955; BRANDIS J. Linn. Soc. Bot. 31 (1895) 133; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 76. — *Synaptea bureavi* HEIM Rech. Dipt. (1892) 114. — *V. reticulata* (non DC.) KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 106; BRANDIS J. Linn. Soc. Bot. 31 (1895) 131; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 83; FOXW. Mal. For. Rec. 10 (1932) 259 *p.p.*; BURK. Dict. 2 (1935) 2224. — *Cotylelobium philippinense* HEIM ex BRANDIS J. Linn. Soc. Bot. 31 (1895) 134, *nomen pro syn.* — *Synaptea reticulata* RIDL. Fl. Mal. Pen. 1 (1922) 243. — *V. whitfordii* FOXW. Philip J. Sc. 67 (1938) 322. — *V. patula* SYM. J. Mal. Br. R. As. Soc. 19, 2 (1941) 148; Mal. For. Rec. 16 (1943) 226.

Leaf 6–11 by 2.7–5 cm, elliptic, coriaceous; base cuneate; acumen to 7 mm long; panicle to 14 cm long.

**Ssp. obtusifolia (ELMER) comb. nov.**—*Vatica obtusifolia* ELMER Leaf. Philip. Bot. 4 (1912) 1471; FOXW. Philip. J. Sc. 13 (1918) Bot. 196; *ibid.* 67 (1938) 323; MERR. En. Philip. 3 (1923) 102.

LECTOTYPE: Elmer 12963, Mt. Pulgar, Puerto Princesa, Palawan (in flower) (K).

OTHER COLL. San 25435, Bt. Mesasam, Beluran, Sabah (K).

Leaf small, thickly coriaceous, obtuse to subacuminate; panicle not exceeding 6 cm long.

DISTR. Malesia: Palawan, E. Sabah. Rocky exposed ridges and plateaux, very local.

NOTES. *V. mangachapoi* is a species with much local variation, especially in the Philippines, and I have no hesitation in reducing *V. obtusifolia* to it as a subspecies. Forms approaching both *V. odorata* ssp. *mindanensis* and *V. pachyphylla* occur, and suggest hybridisation.

**Vatica odorata (GRIFF.) SYM.** J. Mal. Br. R. As. Soc. 19 (1941) 156; ASHTON Man. Dipt. Brun. (1964) 75; Gard. Bull. Sing. 22 (1967) 263.

**Ssp. odorata.**—*V. thorelii* PIERRE Fl. Coch. 15 (1890) t. 238; *ibid.* (1891) t. 254b; GUERIN in LECOMTE. Fl. Gen. I.-C. 1 (1912) 390; TARDIEU in *ibid.* Suppl. 1 (1943) 360.

SYNTYPES: Thorel *s.n.*, 1866–68, Stung Treng (P); Thorel *s.n.*, 1885, Uban, Mekong (P); Thorel *s.n.* 1862–66 Chu Dan Moth (P), all in Cambodia.

—*Perisandra laotica* GAGNEPAIN, Bull. Soc. Bot. Fr. (1948) 27.

HOLOTYPE: Poilane 12090, Savannakhet, Laos (P).

The synonymy of this species has already been fully discussed by SYMINGTON; further additions have later been made by myself. The additional Indochina species added here, based on flowers and young fruits (*V. thorelii*) or flowering specimens alone (*P. laotica*) are in my opinion well within the range of variation of *V. odorata*. The following new subspecies, previously considered a separate species is apparently confined to quartz sand raised beaches in Vietnam, generally near the coast, and bears a relationship to ssp. *odorata* as *V. mangachapoi* Ssp. *obtusifolia* does to ssp. *mangachapoi*.

**Ssp. tonkinensis (TARDIEU) ASHTON comb. nov.**—*Vatica tonkinensis* A. CHEV. ex TARDIEU Not. Syst. 10, 3 (1942) 137; in LECOMTE, Fl. Gén. I.-C. Suppl. 1 (1943) 357.

LECTOTYPE: Poilane 7301, Tourane, route de Ba Na (P).

Young parts fulvous flocculent pubescent as in ssp. *odorata*. Leaf 4–7 by 2–3 cm, small, elliptic-lanceolate, coriaceous, cuneate at base, ± obtuse at apex; nerves 5–10 pairs. Petiole 3–6 mm long, short, not geniculate. Panicle to 8 cm long, flowers and fruit as in ssp. *odorata*.

OTHER COLL. Chevalier 37587, Quong-Yen, Yen Lap Province (P); Pételot *s.n.*, Ile de la table, Si Quang Yen Prov.; Fleury 38019, Phong Du reserve., Tonkin; Barry 75, 70, 71, 72, 73, Kuet 95, Cam Ranh peninsular.

Tardieu cites (unnumbered) collections of BONNET from Tien Yen and another, 'service forestier' from Hongay, neither of which I have seen.

Key to the subspecies of *V. odorata*.

1. Lamina typically at least 8 by 2.7 cm; nerves at least 10 pairs; petiole at least 6 mm long. ....2.
2. Petiole 6–18 mm long, not geniculate; leaf drying yellow brown ..... Ssp. *odorata*

2. Petiole 15–20 mm long,  $\pm$  geniculate; leaf drying greyish .....  
 ..... Ssp. *mindanensis*
1. Lamina to 7 by 3 cm, drying yellow-brown; nerves at most 10 pairs; petiole at most 6 mm long, not geniculate ..... Ssp. *tonkinensis*.

***Vatica brevipes* sp. nov.**

*V. micranthae* SLOOT. affinis sed lamina obovata basim versus anguste cuneata.

Small to medium sized tree. Buds, petioles and panicles densely persistently pale brown scabrid puberulent; parts of petals exposed in bud and ovary evenly so, sepals caducously evenly so; parts otherwise glabrous. Twigs c. 2 mm  $\phi$  apically, red-brown, prominently rugose and ribbed, becoming flaky. Buds to 3 by 2 mm, ellipsoid. Leaves (4–) 5–13 by (1.5–) 2.5–5.5 cm, elliptic or obovate, thinly coriaceous; base narrowly cuneate; acumen to 6 mm long, short but slender; nerves 7–10 pairs, ascending, straight at first, arching and forming a  $\pm$  incomplete intramarginal nerve, slender but prominent beneath, elevated above, with a few short secondaries; tertiary nerves distantly reticulate, clearly evident on both surfaces though more so below; petiole 5–11 mm long, short, rather stout. Panicles to 1.6 cm long, short, very slender, axillary or terminal, hardly branched; buds to 3 by 2 mm, ellipsoid; sepals narrowly deltoid, lanceolate, subacute; anthers broadly oblong, tapering distally to the deltoid appendages; style broadly columnar, slightly longer than the ovary, terminating in a prominent rim beneath the deltoid style. Fruit pedicel to 6 mm long, slender; 2 longer calyx lobes to 5 by 1.4 cm, spatulate, subacute or obtuse; 3 shorter lobes to 12 by 3 mm, lanceolate, acute; nut to 8 mm  $\phi$ , subglobose, apiculate.

DISTR. Malesia: Borneo (Sarawak: Ulu Rejang). Local, in Mixed Dipterocarp forest, to 700 m.

HOLOTYPE: S. 29633, Ulu Baleh, Kapit (K).

OTHER COLL.: S. 23943, 23991, Bt. Raya, Kapit; S. 29576, Ulu Baleh below Nanga Mengiong.

Though undoubtedly close to *V. micrantha* the obovate leaf serves at once to distinguish this species.

***Vatica perakensis* KING** J. R. As. Soc. Beng. Sc. 62, 2 (1893) 103, *p.p. emend* SYM. J. Mal. Br. R. As. Soc. Soc. 19, 2 (1941) 152; Mal. For. Rec. 16 (1943) 226; BRANDIS J. Linn. Soc. Bot. 31 (1895) 132 *p.p.*; BRUHL & KING Ann. R. Bot. Gard. Calc. 5, 2 (1896) 149 *p.p.*; SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 86 *p.p.*, FOXW. Mal. For. Rec. 10 (1932) 262 *p.p.*; BURK., Dict. 2 (1935) 2224. — *Synaptea perakensis* RIDL. Fl. Mal. Pen. 1 (1922) 242. *p.p.* — *V. songa* SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 93; HEYNE, Nutt. Pl. ed. 2, 2 (1927) 1131.

Symington (1941) has critically reviewed the taxonomy and nomenclature of this species in Malaya. I unite here *V. songa* SLOOT. (Syntypes: Theunissen 4, 4a (= b.b. 233, 234) P. Moesala, W. Sumatra (BO) ) for the first time; it bears no distinct difference and similarly occurs on coastal hills in Mixed Dipterocarp forest, in West Sumatra.

***Vatica pentandra* sp. nov.**

Vaticis alteris stamina 5 foliae minutae facile distinguitur.

Twigs, petioles and panicles persistently shortly scabrid fulvous pubescent, calyx outside  $\pm$  caducously so, parts of petals exposed in bud and ovary persistently evenly buff puberulent. Twigs c. 2 mm  $\phi$  apically, ribbed, much branched, ascending. Leaf buds minute. Leaves 18–45 by 9–20 mm, elliptic, thinly coriaceous, with subrevolute margins, obtuse to broadly cuneate base and  $\pm$  deeply retuse apex; nerves 4–5 pairs, ascending at c. 45°, slender, hardly elevated on either

surface though more so below; petiole 4–11 mm long, slender, hardly geniculate. Panicle to 4 cm long, slender, singly branched; branchlets bearing to 3 flowers. Flower buds to 9 by 3 mm; stamens 5, in a single whorl, flowers otherwise typical. Fruit unknown.

**HOLOTYPE:** Kostermans 10277, Belajan R., near Tabong, C. Kutei, E. Borneo (L).

Known from a single collection. The only *Vatica* with but 5 stamens; the leaves are among the smallest and most distinctive in the genus. Without fruit it is not yet possible to assign this species to a section though it has the general appearance of section Sunapteae.

***Vatica cauliflora* sp. nov.**

*V. sarawakensis* HEIM, *V. scortechinii* KING, *V. granulata* SLOOT. putate affinis sed costis lateralibus supra depressis acumine caudata petiolo gracili differt.

Twigs, petioles and panicles persistently scabrid fulvous pubescent; midrib beneath caducously so; calyx outside, parts of petals exposed in bud and ovary persistently evenly buff puberulent. Twigs c. 3 mm  $\phi$  apically, stout, ribbed; leaf buds minute. Leaves 7–22 by 2.5–8 cm, oblanceolate, coriaceous, with subrevolute margins, obtuse to subcordate base and  $\pm$  prominent subcaudate acumen; nerves c. 12 pairs, prominent beneath, evident but depressed above as also the many secondaries; tertiaries reticulate, barely elevated though evident on both surfaces; midrib prominent beneath, less so above; petiole 10–18 mm long, c. 2 mm  $\phi$ , relatively slender. Panicles to 6 cm long, 1-axillary, doubly branched, many flowered. Flower buds to 7 by 2 mm, lanceolate, otherwise typical. Fruit unknown.

**DISTR.** Malesia: Ulu Kapuas, W. Borneo. Locally frequent along river banks.

**HOLOTYPE:** b.b. 35234, S. Inai, Ulu Kapuas, W. Kalimantan (L).

**OTHER COLL.:** b.b. 35262, N. Lao, Ulu Kapuas; b.b. 35245, 35246, Ulu Semulang, Kapuas.

Possibly allied to *V. sarawakensis*, *V. scortechinii* and *V. granulata*; it is distinguished by the depressed nerves above, caudate acumen and slender petiole.

## Dryobalanops

***D. rappa*. BECC.**

SFN 32194, a flowering collection from swamps in S. E. Johor, Malaya, differs from *D. oblongifolius* DYER, with which it was identified, in having more coriaceous leaves and rufous flocculent pubescent innovations and inflorescence, in this resembling *D. rappa* which is otherwise unknown outside Borneo. Fruits are required to confirm this record.

**Dryobalanops oblongifolia** DYER — J. Bot. 12 (1874) 100; BURCK Ann. Jard. Bot. Btzg 6 (1887) 224; BRANDIS J. Linn. Soc. Bot. 31 (1895) 51; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 259; BECCARI For. Born. (1902) 550, 572; MERR. En. Born. (1921) 401; BURKILL J. Str. Br. R. As. Soc. 86 (1922) 291; DEN BERGER & ENDERT Med. Proefst. Boschw. 11 (1925) 104; GILG in ENGLER Pfl. Fam. ed. 2, 21 (1925) 255; THORENAAR Med. Proefst. Boschw. 16 (1926) 110; FOXW. J. Mal. Br. R. As. Soc. 5 (1927) 340; Mal. For. Rec. 1 (1921) 76; *ibid.* 3 (1927) 49; *ibid.* 8 (1930) 17; *ibid.* 10 (1932) 110; HEYNE Nutt. Pl. N. I. ed. 2, 2, (1927) 1105; SLOOT. Bull. Jard. Bot. Btzg III, 12 (1932) 22; BURK. Dict. 1 (1935) 867; CORNER Wayside Trees (1940) 212; SYM. Mal. For. Rec. 16 (1943) 196; WYATT-SMITH Mal. For. 18 (1955) 153 *p.p.*; BROWNE For Tr. Sarawak and Brunei (1955) 116; ASHTON Man. Dipt. Brun. Suppl. (1968) 23.

**HOLOTYPE:** Beccari 2533, G. Matang, Sarawak (K).

**Ssp. oblongifolia** — *Baillonodendron malayanum* HEIM Bull. Soc. Linn. Paris, 2 (1891) 867; Rech. Dip. (1892) 38. — *D. abnormis* SLOOT. Bull. Jard. Btzg III, 16 (1940) 449; ASHTON Bard. Bull. Sing. 22 (1967) 262.

Leaf 6–20 by 4.5–5 (6–6.5) cm; fruit calyx tube to 15 mm deep and  $\phi$ , massive, bordered by 5, to 5 by 7 mm, deltoid acute incrassate frequently reflexed calyx lobes; nut ellipsoid to obovoid, prominently lenticellate.

DISTR. Malesia: Borneo (Kapas hinterland, Sarawak W. of Kemana). Local on hillsides below 600 m.

**Ssp. occidentalis** ssp. nov. — *D. beccariana* RIDL. Fl. Mal. Pen. I (1922) 211. — *D. ovalifolia* BURKILL Guide Bot. Gard. Sing. (1928) 22.

Lamina 6–11  $\times$  2–4.5 cm; tubus calycis in fructu -8 mm longus campanulatus margine obscure 5-lobati; nux late ellipsoidea striata lissa haud lenticellata.

DISTR. Malesia: Malaya (E. coast, rare from Perak northwards in W.); E. Sumatra (Bengkalis, Riouw, Djambi, Palembang). By streams and in fresh water swamps, locally abundant; occasionally on hillsides.

HOLOTYPE: Kep 5452, Temerloh, Pahang (KEP).

When discussing earlier the taxonomy of *D. oblongifolia* (1967) I concluded that the Bornean, and Malayan and Sumatran, populations did not deserve separate taxonomic status; inspection of further material has convinced me otherwise.

## Parashorea

**Parashorea stellata** KURZ J. R. As. Soc. Beng. Sc. 39, 2 (1870) 66; Fl. Burm. 1 (1877) 117; PIERRE Fl. Coch. 4 (1889) 224; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 267; BRANDIS J. Linn. Soc. Bot. 31 (1895) 104; Indian Trees (1906) 70; GUERIN in LECOMTE Fl. Gen. I-C. 1 (1910) 388; TARDIEU in *ibid.* Suppl. 1 (1943) 354; RIDL. Agr. Bull. S.S. & F. M. S. 6 (1907) 170; Fl. Mal. Pen. 1 (1922) 83; BAKER f. J. Bot. 62 Suppl. (1924) 11; CRAIB Fl. Siam. Enum. 1 (1925) 144; HEYNE Nutt. Pl. ed. 1, 3 (1917) 310; *ibid.* ed. 2, 2 (1927) 1126; LECOMTE Bois de l'Indochine (1926) 113; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 373 p.p.; BURK. Dict. 1 (1935) 1664. — *Shorea stellata* DYER Fl. Br. Ind. 1 (1874) 304; KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 120.

HOLOTYPE: Brandis s.n., Martaban (BM).

— *P. lucida* (non KURZ) SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 373 p.p.; SYM. Mal. For. Rec. 16 (1943) 102. — *S. cinerea* FISCHER Kew Bull. (1926) 460.

HOLOTYPE: Parkinson 1681, Thebyu Chaung, S. Tennasserim, Burma (K).

— *P. poilanei* TARDIEU Not. Syst. 10, 3 (1942) 136; in LECOMTE Fl. Gén. I-C. Suppl. 1 (1943) 354.

HOLOTYPE: Poilane 6612, Massif de la Mère et de l'Enfant, Vietnam.

The type of *Shorea cinerea* FISCHER is a typical flowering collection of *P. stellata*; nor am I able to distinguish TARDIEU's species from the present one, the distinguishing characters enumerated by her (non-reflexed young fruit sepals, glabrous stamens, linear stipules, shortly pubescent ovary) being insufficient by themselves for specific delimitation in this genus.

Van Slooten (1927) confused this species with *P. lucida* (MIQ.) KURZ. Symington (1943) united the two under the name of *P. lucida*. I do not consider this justifiable, the two species being distinguishable as follows:

### **P. stellata**

Leaves 6–16 by 2.3–8 cm, drying as dark beneath as above (mature trees); plication obscure; nerves distinct, arched, elevated but slender and not prominent beneath; tertiary nerves dense, obscure; petiole (10–) 12–30 mm long, slender.

DISTR. Southern Burma, Thailand, Indochina and Malaya (Trengganu and Perak northwards). Frequent in lowland and hill evergreen dipterocarp forests in seasonal areas, especially in valleys, to 650 m.

**Parashorea lucida** (MIQ.) KURZ J. R. As. Soc. Beng. Sc. 39, 2 (1870) 66; BURCK Ann. Jard. Bot. Btzig 6 (1887) 221; BRANDIS J. Linn. Soc. Bot. 31 (1895) 104; HEYNE Nutt. Pl. ed. 1, 3 (1919) 310; *ibid.* ed. 2, 2 (1927) 1126; SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 373 *p.p.*; ASHTON Man. Dipt. Brun. Suppl. (1968) 38 *in nota sub P. smythiesii*. — *Shorea subpeltata* MIQ. Sum. (1862) 488; 191; DC. Prodr. 16, 2 (1868) 632; WALP. Ann. 7 (1868) 370; BURCK Ann. Jard. Bot. Btzig 6 (1887) 219; BRANDIS J. Linn. Soc. Bot. 31 (1895) 103. — *P. stellata* (*non* KURZ) SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 373 *p.p.*

Leaves 6–14 by 2.2–6.5 cm,  $\pm$  silvery lepidote beneath; plication subpersistent; nerves dense, hardly arched, prominent beneath; tertiary nerves densely scalariform, very slender but distinctly raised beneath; petiole 10–20 mm long, relatively stout.

DISTR. Malesia: Sumatra (Central E. & W. of Barisan Range), Borneo (C. Kalimantan, C. and N. E. Sarawak). Mixed Dipterocarp forest on hills, to 700 m.

Van Slooten has already discussed the synonymy of *S. peltata* MIQ.

### Neobalanocarpus nom. nov.

**Neobalanocarpus heimii** (KING) comb. nov. — *Balanocarpus heimii* KING J. R. As. Soc. Beng. 62, 2 (1893) 133; BRANDIS J. Linn. Soc. Bot. 31 (1895) 110; BURN MURDOCH Agr. Bull. S. S. & F. M. S. 7 (1908) 386; Trees and Timbers (1911) 3; BURK. J. Str. Br. R. As. Soc. 81 (1920) 3; J. Mal. Br. R. As. Soc. 1 (1923) 218; Dict. 1 (1935) 204; RIDL. Fl. Mal. Pen. 1 (1922) 247; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1128; FOXW. Mal. For. Rec. 1 (1921) 64; *ibid.* 3 (1927) 53; *ibid.* 8 (1930) 10; *ibid.* 10 (1932) 149; J. Mal. Br. R. As. Soc. 5 (1927) 399; STRUGNELL J. Mal. Br. R. As. Soc. 9 (1931) 24; SYM. Gard. Bull. S. S. 8 (1934) 27; Mal. For. Rec. 16 (1943) 147; CORNER Wayside Trees, 1 (1940) 210. — *B. wrayi* KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 134. — *B. acuminatus* (*non* BRANDIS) HEIM Ass. Franc. Adv. Sc. Besancon, 1893 (1894) 560. — *Pierrea penangiana* HELM *ex* BRANDIS J. Linn. Soc. Bot. 31 (1895) 110 *nomen in syn.*

SYNTYPES: Kunstler 3718 (K), Wray 813, Perak (K).

Large tree with tall stout buttresses. Leaves penninerved, unequal-based, with scalariform tertiary nerves. Inflorescence paniculate. Flowers medium-sized, secund; stamens 15, glabrous, with slender tapering filaments and linear-oblong anthers bearing rudimentary appendages; ovary ovoid, with long slender style. Fruit sepals short, subequal; pericarp splitting into 3 equal valves at germination; cotyledons very unequal; first 4–5 seedling leaves in a whorl.

The possession of short equal fruit sepals, in the presence of a unique androecium structure, deprives this single species from the sole character by which it could be allotted to the genera *Shorea* or *Hopea*, underlining the close affinity between these genera. The general appearance of tree and foliage and especially the inflorescence, fruit embryo and mode of germination, suggests that this unsatisfactory genus bears affinity with *Hopea*, sect. subsect *Hopeae*; the linear anthers are somewhat approached by those of *H. plagata* (BLCO) Vidal of the Philippines though there the appendage is acicular and prominent. Nevertheless the hardly contorted corolla of broad petals is distinctive and it remains too isolated to be reduced convincingly to *Hopea*. The king of the Malayan forests must therefore retain its separate status. *Balanocarpus* it certainly is not, however, that genus having already rightly been reduced to *Hopea* by Bole (Kew Bull. 1951 (1951) 146). A new generic name is therefore necessary.

## Hopea

**Hopea cernua** T. et B. — Nat. Tijd. N. I. 29 (1867) 252; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 4; BURCK Ann. Jard. Bot. Btzig 6 (1887) 241; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 244; BRANDIS J. Linn. Soc. Bot. 31 (1895) 71; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 238; MERR. En. Born. (1921) 402; ASHTON Man. Dipt. Brun. Suppl. (1968) 49. — *Hancea cernua* PIERRE Fl. Coch. 2 (1892) sub. t. 244.

SYNTYPES: Teysmann s.n. Sibolga (sterile) (K); Binnendijk s.n. flowers, Sumatra (K).

— *H. argentea* MEIJER Act. Bot. Neerl. 12 (1963) 348; MEIJER & WOOD Sab. For. Rec. 5 (1964) 207; ASHTON Man. Dipt. Brun. Suppl. (1968) 47.

HOLOTYPE: San. 16367, Ranau (K).

Meijer's type differs substantially only in the relatively broader leaf and more prominent nerves beneath. Examination of all the collections now available from Sumatra, northern and eastern Borneo indicates that genetic and ontogenetic variation is partially paralleled with regard to the prominence of the nerves; saplings from West Sarawak, where the mature tree leaf is small and nervation slender and not prominent, closely match Sabah and E. Borneo mature tree leaves; there the leaves are of the *H. argentea* type throughout life. Some collections from W. Sarawak have up to 18 stamens but this too is not constant. I understand this species therefore to be defined by its thinly coriaceous leaf, to 9 by 7 cm, frequently but not always glaucous beneath; its dryobalanoid venation with 10–12 pairs of main nerves but prominent though distinctly shorter secondaries; and its prominent midrib above, narrowly revolute margin, absence of floral stylopodium, and fruit with prominent shorter sepals which exceed the nut and enclose it.

**Hopea coriacea** BURCK Ann. Jard. Bot. Btzig 6 (1887) 237; BRANDIS J. Linn. Soc. Bot. 31 (1895) 64; MERR. En. Born. (1921) 402.

TYPE: Teysmann s.n., Borneo (K).

— *H. kelantanensis* SYM. J. Mal. Br. R. As. Soc. 19 (1941) 144; Mal. For. Rec. 16 (1943) 130.

HOLOTYPE: Kep. 50533, S. Nal, Kelantan, Malaya (KEP).

— *H. garangbuaya* ASHTON Gard. Bull. Sing. 19 (1963) 256; Man. Dipt. Brun. (1964) 101; *ibid.* Suppl. (1968) 51.

HOLOTYPE: Brun. 2006a, Ulu Senuko, Labu, Brunei (K).

Burck's species, based on a single specimen, has remained a shadowy entity. Further collection of *H. kelantanensis* from as far south as Pahang on the eastern Malayan coast, and of *H. garangbuaya* from throughout Sarawak have confirmed that these are synonymous and that both must be reduced to Burck's species. Allied to *H. cernua* T. et B., *H. coriacea* is at once distinguished by its large, 11–16 by 6–10 cm, thickly coriaceous broadly ovate leaf and large flowers and fruit. It is usually, though not always, found on sandy river banks.

**Hopea malibato** FOXW. in ELMER Leaf. Philip. Bot. 6 (1913) 1953; Philip. J. Sc. 13 (1918) Bot. 184; *ibid.* 67 (1938) 281; MERR. En. Philip. 3 (1923) 93; GUTIERREZ Act. Manil. 4, A, 2 (1968) 39.

TYPE: Elmer 13526, Mount Urdaneta, Cabadbaran, Agusan Province, Mindanao (K).

*H. pierrei* (non HANCE) FOXW. Philip. J. Sc. 6 (1911) Bot. 265 p.p.; *ibid.* 13 (1918) 184 p.p. — *H. foxworthyi* (non ELMER) FOXW. Philip. J. Sc. 67 (1938) 282 p.p. — *Hopea woodiana* GUTIERREZ Act. Manil. 4 A, 2 (1968) 42.

HOLOTYPE: PNH 97150 (Gutierrez et al.). Maluso, Canas, Basilan.

— *H. dalingdingan* GUTIERREZ Kalikasan 5 (1976) 92.

HOLOTYPE: PNH 116902, Siniloan, Laguna, Luzon (PNH).

This Philippine species, as indicated already in this paper, varies greatly in the size of its parts; leaves can vary between  $4-9 \times 1.5-4$  cm, and from lanceolate to ovate; flowers and fruit also vary in size though the former can reach 6 by 3 mm before anthesis, large for section *Dryobalanoides*.

Variation in leaf shape and size appears to be complex and both genetic and ontogenetic. The species occupies a wide range of sites from shales and limestone to basalt, and from river banks to ridges at 700 m. This variation would merit biometrical study in the field. I have been unable to see any discontinuity in variation either in the field or herbarium and consequently unite *H. woodiana* and *H. dalingdingan*, the names created by Gutierrez for small-leaved collections formerly confused with *H. pierrei* Hance and *H. foxworthyi* Elmer; these latter species conspicuously differ in their obscure depressed midribs on the leaf above as well as other characters. I define *H. malibato* therefore by its dryobalanoid unequal-based ovate-lanceolate leaf with *c.* 11 pairs of slender but elevated nerves with shorter secondaries, its evident and elevated midrib above, and by the absence of a floral stylopodium, small fruit and glabrous parts except for the petals and more or less caducous puberulent innovations. It differs therefore from *H. vesquei* HEIM in that the ripe nut does not exceed 11 mm long, from *H. dryobalanoides* MIQ. in that the fruit sepals do not exceed 4 cm long (as well as in characters of the leaf midrib and petiole) and from *H. johorensis* SYM., *H. latifolia* SYM. and *H. ferruginea* PARIJS notably in its glabrous panicle.

**Hopea pierrei** HANCE J. Bot. 14 (1876) 308; *ibid.* 16 (1877) 329; BRANDIS & GILG in E. & P. Pfl. Fam. 1, 3, 6 (1895) 263; BRANDIS J. Linn. Soc. Bot. 31 (1895) 67 *p.p.*; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1910) 372; TARDIEU in *ibid.* Suppl. 1 (1943) 344; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 238; DAKKUS Bull. Jard. Bot. Btzg 3, Suppl. 1 (1930) 162; SYM. Gard. Bull. S. S. 9 (1938) 323; Mal. For. Rec. 16 (1943) 139; SMITINAND Thai For. Bull. 1 (1954) 19.

HOLOTYPE: Pierre 1425, Phu Quoc island, Kampot, Cambodia (BM).

— *H. micrantha* (*non* HOOK. *f.*) HANCE J. Bot. 15 (1876) 242; — *Hancea pierrei* PIERRE Fl. Coch. 3 (1892) 248. — *Hopea avellanea* HEIM Bot. Tidkskr. 25 (1902) 46; SCHMIDT Bot. Tidkskr. 27 (1906) 46; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1910) 375; TARDIEU in *ibid.* Suppl. 1 (1943) 376; CRAIB Fl. Siam. Enum. 1 (1925) 147; SMITINAND, Thai For. Bull. (1954) 10; Nat. Hist. Bull. Siam. Soc. 19 (1958) 63.

HOLOTYPE: Schmidt 320, Klong Munse, Koh Chang Isl. (C).

Symington (1938) has already clarified the synonymy of this species in Malaya. I add *H. avellanea* HEIM; the distinctive depressed obscure midrib above, and hour-glass shaped stylopodium, betray the identity of the type of this name, based on insubstantial characters and inadequate material.

**Hopea inexpectata** *sp. nov.*

*H. griffithii* KURZ affinis novellis sericeis petiolo 6-7 mm longo brevi differt.

Medium sized smooth-barked tree. Young twigs, petioles and base of peduncles caducous tawny puberulent. Twigs *c.* 2 mm  $\phi$  apically, slender, much branched, somewhat ribbed, becoming blackish, smooth. Leaves 5-9 by 2.4-4.5 cm, ovate, coriaceous; margin subrevolute; base  $\pm$  equal, broadly cuneate; acumen to 15 mm long, slender; nervation dryobalanoid, main nerves 8-10 pairs, slender but distinctly elevated beneath, arched, with 1 or a few shorter less distinct secondary nerves; tertiary nerves reticulate, evident beneath; midrib sharply prominent beneath, depressed and obscure above; petiole 6-7 mm long, short, slender. Flowers unknown. Panicle to 2.5 cm long, terminal or axillary to ramiflorous, slender, singly branched; bracts unknown, caducous. Fruit pedicel to 2 mm long, slender; 2 longer calyx lobes to 7 by 1.5 cm, spatulate, subacute, tapering to 2 mm broad above the 4 by 2 mm ovate saccate thickened base; shorter lobes

to 6 by 3 mm, ovate, acuminate, shorter than nut; nut to 8 by 4 mm, ovoid-acuminate, tapering to a short apiculus bearing the vestiges of the distinct stylopodium.

DISTR. Malesia: W. New Guinea (Kebar valley). Locally frequent in lowland forest.

HOLOTYPE: BW 11331, Asiti, Kebar valley, Irian Jaya (W. New Guinea) (L).

OTHER COLL: BW 6865, Anomi, Kebar valley.

This unexpected record of the first member of section *Dryobalanoides* east of Wallace's line suggests the possibility of polyphyletic origin, presumably from section *Hopeae*, which is otherwise the only section occurring in New Guinea and already shows remarkable plasticity there as in *H. celtidifolia* (q.v.). *H. inexpectata* shows a strong superficial resemblance to *H. griffithii* KURZ, but differs in its lustrous leaf undersurface, sericeous young parts and short petiole; flowers are required for critical comparison of androecium and gynoecium.

**Hopea pedicellata** (BRANDIS) SYM. — Gard. Bull. S. S. 9 (1938) 327; Mal. For. Rec. 16 (1943) 138; SMITINAND Thai For. Bull. 1 (1954) 10, 19; ASHTON Man. Dipt. Brun. Suppl. (1968) 54.

LECTOTYPE: Curtis 167, Penang (K).

— *H. micrantha* (non HOOK. f.) KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 124 p.p.; RIDL. Fl. Mal. Pen. 1 (1922) 237 p.p. — *H. griffithii* var. *pedicellata* BRANDIS J. Linn. Soc. Bot. 31 (1895) 69 p.p. *quoad spec. Malay.*; RIDL. Fl. Mal. Pen. 1 (1922) 238, — *H. intermedia* (non KING) BRANDIS J. Linn. Soc. Bot. 31 (1895) 67 p.p.; — *H. mengerawan* (non MIQ.) BRANDIS J. Linn. Soc. Bot. 31 (1895) 70 p.p. — *H. pierrei* (non HANCE) RIDL. Fl. Mal. Pen. 1 (1922) 238 p.p.; FOXW. Mal. For. Rec. 10 (1932) 133 p.p.; BURK. Dict. 1 (1935) 1193 p.p. — *H. siamensis* HEIM Bot. Tidsskr. 25 (1902) 46; WILLIAMS Bull. Herb. Boiss. 2, 5 (1905) 147; SCHMIDT Bot. Tidsskr. 7 (1907) 46; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1910) 376; TARDIEU in *ibid* Suppl. 1 (1943) 348; CRAIB Fl. Siam. Enum. 1 (1925) 147; SMITINAND Nat. Hist. Bull. Siam Soc. 19 (1958) 63.

HOLOTYPE: Schmidt 508 c, Klong Son, Koh Chang Isl. (C).

I have inspected the type of *H. siamensis*, consisting of fruit only, and fail to see any differences between it and *H. pedicellata*.

**Hopea rudiformis** sp. nov.

*H. nervosae* KING *H. sublanceolatae* SYM. affinis sed costis lateralibus utrinsecus 11–13 lamina subtus ± glauca differt.

Medium sized tree. Twigs, leaf buds and parts of petals exposed in bud densely ± persistently pale tawny puberulent; panicles sparsely so; calyx outside and nerves and midrib beneath sparsely caducously so. Twigs c. 2 mm  $\phi$  apically, rather straight, ribbed, becoming smooth, dark brown. Bud small, ovoid, acute; stipule fugaceous, unknown. Leaves 6.5–14 by 3.5–7.5 cm, ovate to broadly lanceolate, thinly coriaceous, minutely stellate lepidote and appearing pale and dull beneath; margin subrevolute; base broadly cuneate; acumen to 1.5 cm long, broad, tapering, downcurved and twisted over on pressing; nerves 11–13 pairs, slender but prominent beneath, ± obscurely depressed above, arched, at 55°–65°; secondary nerves few, short, hardly elevated beneath; tertiary nerves densely scalariform, obscure; petiole 8–13 mm long. Panicle to 3.5 cm long, to 2-axillary; singly branched, branchlets bearing to 3 flowers; bracts unknown, fugaceous. Flower bud to 3 by 2 mm, ovoid, small. Sepals subequal, broadly ovate, subacuminate. Stamens 15, in 3 subequal verticels; filaments compressed at base, tapering medially and filiform below the shortly oblong anthers; appendages slightly longer than anthers, short, slender. Ovary ovoid, surmounted by an indistinct tapering ciliate stylopodium and short columnar style c.  $\frac{1}{2}$  length of ovary and stylopodium. Fruit pedicel to 2 mm long, short, base of ripe fruit ±

impressed. 2 longer calyx lobes to 9 by 2 cm, broadly spatulate, obtuse, c. 3 mm broad above the to 6 by 5 mm ovate deeply saccate thickened base; 3 shorter lobes to 8 by 8 mm, ovate, chartaceous at margin, subacute, reaching apex of nut and adpressed to it; nut to 8 by 8 mm, ovoid, terminating in the persistently truncate stylopodium.

DISTR. Malesia: S. E. Borneo (Sandakan to Pulau Laut); Ulu Kapuas, W. Borneo. Undulating land on deep well-drained soil in lowlands; sometimes in freshwater swamps.

VERN. Selangan jangkang, emang bahau, putang leman, damar jengkar.

HOLOTYPE: Kostermans 4394, S. Wain, North of Balikpapan (L).

OTHER COLL: Indonesian Borneo: b.b. 34778, S. Kerajan, Sengkulirang; b.b. 34314, 34250, 34295, Kostermans 4549, 4549a, S. Wain; b.b. 19460, 31175, Tanah Bumba, Seblimbingan, P. Laut; Kostermans 4109, Muan region, Balikpapan; b.b. 24655, Manggar, Balikpapan; b.b. 24939, Mentawir, Balikpapan; b.b. 25151, 25152, 25150, 25155, 25154, Loa Bakoeng, E. Koetei; b.b. 25603, Sepan; b.b. 35254, Ulu Embal, Kapuas, West Borneo; Sabah: San. 30483, 29672, Ulu Kelumpang; San. 53121, Mile 17, Kelumpang road; San 18563, Ulu Kelabakan, Tawau; Kep 35226, Segaliud, Lungmanis, Sandakan.

This species appears to be derived from the widespread *H. nervosa* KING whose geographical range includes its own. It differs in the shorter broader leaf, pale beneath and with fewer nerves; it shares however the same distinctive flowers and large fruit which associates it, with *H. nervosa* and also *H. sub lanceolata* SYM. of Malaya, in a distinct subgroup within subsection Sphaecarpae.

**Hopea bracteata** BURCK Ann. Jard. Bot. Btzg 6 (1887) 239; BRANDIS J. Linn. Soc. Bot. 31 (1895) 111; SYM. Gard. Bull. S.S. 10 (1939) 337; SLOOT. Reinwardtia 3 (1956) 317; ASHTON Man. Dipt. Brun. (1964) 97; *ibid.* Suppl. (1968) 48; MEIJER & WOOD Sab. For. Rec. 5 (1964) 229. — *B. bracteatus* MERR. En. Born. (1921) 407; FOXW. Mal. For. Rec. 10 (1932) 142; BURK. Dict. 1 (1935) 284.

HOLOTYPE: Teysmann 8265 H. B., W. Borneo (BO).

— *Balanocarpus curtisii* KING J. R. As. Soc. Beng. Sc. 62 (1893) 131; BRUHL & KING Ann. R. Bot. Gard. Calc. 5, 2 (1896) 158; BRANDIS J. Linn. Soc. Bot. 31 (1895) 111; BURKILL J. Str. Br. R. As. Soc. 81 (1920) 59; RIDL. Fl. Mal. Pen. 1 (1922) 246; SYM. Gard. Bull. S. S. 8 (1934) 27. — *H. minima* SYM. Gard. Bull. S. S. 10 (1939) 337; Mal. For. Rec. 16 (1943) 133.

TYPE: Curtis 1406, Penang (K).

DISTR. Malesia: Malaya (Penang, Perak), Borneo (Sarawak, Brunei, Sandakan, S. E. Borneo to Puruktjau).

ECOL. Locally abundant on ridges below 650 m.

Symington (1939), in critical notes on this species in Malaya, concluded that it differed sufficiently there, both in having shorter panicles and in unspecified leaf characters, to merit separate specific status from the Bornean *H. bracteata*; he also recognised significant differences between the Penang and mainland populations. The species has since been collected many more times, particularly in northern Borneo, and I am now unable to sustain the Malayan collections as a separate entity.

The rare *Hopea brachyptera* (FOXW.) SLOOT. of Zamboanga, Mindanao closely resembles *H. bracteata* though the leaf is somewhat larger. The ovary differs, according to Foxworthy (Philip. J. Sc. 13 (1918) 195; *ibid.* 67 (1938) 285) in being densely pubescent; I have seen neither flowers nor fruits, which may all have been lost when the Manila herbarium was destroyed in 1945.

***Hopea celtidifolia* sp. nov.**— *H. celtidifolia* KOSTERM. *nomen in herb.*

Hic species ab alteris propter costas laterales arcuatas conjunctas praestat.

Medium sized scaly barked buttressed tree. Young twigs, leaf buds and stipules densely  $\pm$  persistently tawny puberulent, petioles caducously so. Twig *c.* 1 mm  $\phi$  apically, much branched; internodes short. Buds small, ovoid, subacute; stipules small, fugaceous. Leaves 5–10 by 3–4.5 cm, elliptic to lanceolate, coriaceous, margin subrevolute; base obtuse to broadly cuneate; acumen to 8 mm long, slender; nerves 4–5 pairs, frequently all arising from the proximal  $\frac{1}{2}$  of the leaf, arched and coalescing midway to the margin forming an almost unlooped intramarginal nerve continuing to the acumen, the whole venation slender but prominent beneath, distinctly elevated above; intramarginal nerve with indistinct lateral branches to the margin; tertiary nerves scalariform, evident beneath, elevated above; petiole 8–10 mm long, slender. Panicle unknown; flowers unknown. Fruit pedicel *c.* 2 mm long, stout; 2 longer calyx lobes to 5 by 1 cm, spatulate, obtuse, *c.* 2 mm broad above the to 6 by 3 mm narrowly ovate saccate thickened base; 3 shorter lobes to 5 by 4 mm, obtuse to acute, similarly saccate. Nut to 15 by 6 cm, narrowly ovoid, the stylopodium showing as a prominent medially thickened apiculus.

DISTR. New Guinea; apparently local in evergreen lowland forests.

HOLOTYPE: BW 4854, R. Digoel, near Wagi, South New Guinea (L).

OTHER COLL: BW 8533, Iwoer, E. Digoel river junction, Moejoe subdiv., S. New Guinea; BW 6430, 6441, Ninati, Moejoe river; Bemeren 4, Strickland river.

Specimens of this astonishing species in the type section, distinguished from all other dipterocarps by its nervation, were annotated at Kew by Kostermans with the appropriate name *Hopea celtidifolia*.

***Hopea dasyrrachis* SLOOT., *Hopea plagata* VIDAL and *H. gregaria* SLOOT.**

I draw attention to the fact that the following specimen from the N. E. Sarawak limestone has been tentatively identified as *H. dasyrrachis* owing to the suborbicular longer fruit sepals: S. 24037, Melinau Gorge, G. Api, Ulu Tutoh. Nevertheless, the leaves differ from *H. dasyrrachis* from Indonesian Borneo in being narrow, glabrous, usually lacking domatia and with shorter, 5–10 mm long petioles, in all these characters resembling the Philippine species *H. plagata*. *H. plagata* fruit are occasionally (but not always) nearly suborbicular too; *H. dasyrrachis* has 10 stamens and a sericeous ovary, *H. plagata* *c.* 35 and a glabrous ovary though one collection (Loher 12914, Luzon) possesses only 15 stamens and has a puberulent ovary as already pointed out by Gutierrez (Act. Manil. 4, A, 2 (1968) 55). It would appear that the two species are closely related.

*H. gregaria* SLOOT. of Celebes, which also has 15 stamens and shares suborbicular fruit sepals, but which has a glabrous gynoeceum bearing a long slender stylopodium unlike the short stylopodium of the other two species, would appear related also. More flowering collections from *H. plagata* and from *H. dasyrrachis* in N. E. Borneo are urgently required to clarify these inter-relationships.

***Hopea aptera* sp. nov.**

*H. ultima* sp. nov., *H. novoguineensis* SLOOT., *H. scabra* sp. nov., *H. papuana* DIELS similis lobis calycis brevibus subaequalibus differt.

Small, smooth-barked, stilt-rooted tree. Twigs, petioles and panicles  $\pm$  persistently greyish sericeous, outside of calyx and leaf nervation beneath caducously so, parts of petals exposed in bud densely pubescent. Twig *c.* 2 mm  $\phi$  apically, becoming terete,  $\pm$  rugulose. Buds minute, ovoid; stipules fugaceous,

not seen. Leaves 10.5–25 by 4–8 cm, oblong-lanceolate, coriaceous; margin sub-revolute; base obtuse or shallowly cordate; acumen to 3 cm long, prominent, slender; nerves 15–21 pairs, slender but prominent beneath,  $\pm$  obscurely depressed above, arched towards the margin, at 55°–70°, without secondaries; tertiary nerves scalariform, very slender but elevated beneath; midrib prominent beneath, elevated above; petioles 8–12 mm long. Panicle to 7 cm long, 1-axillary to ramiflorous, lax, slender; singly branched, branchlets to 1.5 cm long, bearing to 3 secund flowers. Flower buds to 5 by 3 mm, ellipsoid, rather long. Sepals subequal, suborbicular, pubescent, fimbriate, patent. Stamens 15, in 3 unequal verticels; filaments compressed and broad at base, tapering and filiform in the distal  $\frac{1}{2}$ ; anthers small, subglobose; appendage *c.* 3 $\frac{1}{2}$  times length of anthers, very long and slender. Ovary and stylopodium narrowly hour-glass shaped, with short but distinct columnar style. Fruit pedicel very short. Calyx lobes to 8 by 6 mm, subequal, ovate, acute, saccate,  $\pm$  thinly incrassate. Nut to 10 by 6 mm, ovoid, crowned by a prominent medially swollen stylopodium.

DISTR. N. W. New Guinea (Vogelkop peninsula). Locally common, primary and secondary forest below 300 m., clay soil including limestone.

HOLOTYPE: BW 7409, Aitinjoe, Vogelkop, West New Guinea (L).

OTHER COLL.: BW 7414, 7415, loc. cit.

One of the several species in New Guinea which apparently belong to sect. and subsect. *Hopeae* yet which share with subsect. *Pierreae* a large oblong leaf with more or less unequal base and narrow tapering, though not spindle-shaped, stylopodium; *H. aptera* is distinguished by its short subequal fruit sepals.

***Hopea ultima* sp. nov.**

*H. scabra* sp. nov., *H. papuana* DIELS affinis aed lamina basim versus subequali subcordata tomento conferto persistenti brevi ravo differt.

Medium sized unbuttressed tree with flaky bark. Twigs, petioles, panicles and calyx densely pale tawny puberulent, midrib beneath sparsely so; parts of petals exposed in bud densely pubescent. Twigs *c.* 2 mm  $\phi$  apically, terete,  $\pm$  rugose, pale brown, becoming smooth. Leaves 6–17 by 3–6 cm, oblong, subsericeous; base subcordate,  $\pm$  equal, margin narrowly revolute; acumen to 5 mm long, stout; nerves 16–18 pairs, slender but prominent beneath, at 50°–65°; tertiary nerves slender, hardly elevated, scalariform; midrib slender but prominent beneath, elevated above; petiole 9–14 cm long. Panicles to 5 (-8) cm long, -3 axillary to ramiflorous or sometimes terminal, short, slender; 1–2 branched, the branchlets bearing to 6 secund flowers. Flower buds to 5 by 2 mm, ellipsoid. Sepals unequal, the outer 2 lanceolate, inner 3 ovate, erose. Stamens 15; filaments dilated at base, tapering medially; anthers subglobose; appendage 2 $\frac{1}{2}$ –3 times length of anthers, aristate. Ovary and stylopodium narrowly fusiform, tapering into a shorter style. Fruit unknown.

DISTR. E. New Guinea (Milne Bay area, Normanby Is.).

HOLOTYPE: Brass 25419, Waikaiuna, Normanby Island (K).

OTHER COLL.: NGF 1342, Milne Bay area, S. E. New Guinea.

Though superficially similar to *H. scabra* and *H. papuana* the less unequal subcordate leaf base and short even tawny puberulent indumentum distinguish it.

***Hopea scabra* sp. nov.**

*H. novoguineensis* DIELS affinis sed fructus -8  $\times$  6 mm minori costis tertiaris subtus glabrescentibus differt.

Medium sized buttressed tree. Twigs, petioles, leaf buds and stipules  $\pm$  persistently pale rufous scabrid pubescent, leaf nervation beneath and midrib above sparsely but distinctly so; calyx fugaceous puberulent outside. Twigs *c.*

2 mm  $\phi$  apically, much branched, becoming terete, smooth, pale brown. Leaf buds minute, ovoid; stipules to 7 by 3 mm, lanceolate, caducous. Leaves 6.5–17 by 2.3–6.5 cm, oblong to lanceolate-falcate, coriaceous; margin subrevolute; base unequal, cordate; acumen to 1.5 cm long  $\pm$  caudate, slender; nerves 15–24 pairs, slender but prominent beneath, obscurely  $\pm$  shallowly depressed above, arched, at 70°–80°, with many short but distinct secondary nerves; tertiary nerves scalariform, distinctly elevated beneath; midrib slender but prominent beneath, elevated above; petiole 4–6 mm long. Panicle to 4.5 cm long, short, slender, 1-axillary; singly branched, branchlets to 13 mm long, bearing to 4 flowers; bracts to 1 mm long, deltoid, acute. Flowers buds at anthesis unknown. Very young fruit with 2 narrowly deltoid-acuminate outer sepals, 3 suborbicular fimbriate obtuse inner sepals, and ovoid ovary surmounted by a slightly narrower, equally long, prominent stylopodium and short but distinct style. Fruit pedicel short; 2 longer calyx lobes to 8 by 1.8 cm, spatulate, obtuse, 2 mm wide above the to 5 by 4 mm ovate deeply saccate thickened base; 3 shorter lobes to 8 by 6 mm, ovate, acuminate, similarly saccate. Nut to 8 by 6 mm, ovoid; stylopodium prominent, tapering.

DISTR. W. New Guinea (Hollandia Div., Madang). Clay soils on undulating land, locally frequent.

HOLOTYPE: BW 2376, Sidoarsi mountains, 200 km. west of Jayapura (Hollandia), W. New Guinea (L).

OTHER COLL.: BW 7988, Sidoarsi mountains, BW 4826; Noordwijk, Hollandia; BW 5887, 8087, Bodem R., 600 km. S. E. of Saruni, Hollandia division; BW 15, Cyclops mountain, Hollandia Division; BW 2705, 2715, Tami, Merading, Hollandia; b.b. 25089, Kostermans and Soengeng 76, 154, 125, Jayapura (Hollandia); Hoogland 4966, Kokun R. near Jaal village, Gogol R. country, Madang distr., E. New Guinea.

The smaller nut and sparser, less scabrid tomentum distinguishes this species from *H. papuana* DIELS. Sterile collections of *H. scabra* have sparsely scabrous tertiary nerves beneath whereas in the latter they are glabrous.

### *Hopea ovoidea* sp. nov.

*H. semicuneata* SYM. similis sed ovario ovoidea conferte pubescenti aristis antherorum brevioribus differt.

Large buttressed flaky barked tree. Leaf bud, panicle, parts of perianth exposed in bud and ovary densely persistently pale buff pubescent, parts otherwise glabrescent. Twigs c. 1 mm  $\phi$  apically, slender, becoming terete, smooth or rugulose. Buds minute; stipule unknown, fugaceous. Leaves 9–13 by 3–6.5 cm, elliptic to narrowly ovate, chartaceous and undulate on drying; base equal, cuneate,  $\pm$  shortly decurrent; acumen to 2 cm long, slender, tapering; nerves 7–8 (to 10 in young trees) pairs, slender but distinctly elevated beneath, arched, ascending at 65°–55°, without or with a few porous canaliculate domatia; tertiary nerves scalariform,  $\pm$  distinctly elevated beneath; petiole 10–15 mm long, slender. Panicle to 13 mm long, erect, slender, to 2-axillary or terminal, singly branched; branchlets to 3.5 cm long, bearing to 7 second flowers; bracteoles fugaceous. Flower buds to 3 by 2 mm, ovoid; 2 outer sepals narrowly deltoid, subacute; 3 inner sepals broadly ovate, acute; stamens 15, in 3 subequal verticels; filaments compressed at base, tapering to the narrowly elliptic subacute anthers; appendages 1½–2 times length of anther, acicular, relatively stout; ovary and stylopodium ovoid, surmounted by a short glabrous columnar style c. ½ their length. Fruit unknown.

DISTR. N. E. Borneo (Sandakan to Tawau). Low hills near coast; rare.

HOLOTYPE: E'mer 21428, Elphinstone province, Tawau (K).

OTHER COLL.: San 21690, Segama road, Lahad Datu; San A 4829, Kretam; San A 2489, Matrid, Lahad Datu.

Closely resembling *H. semicuneata* SYM. when sterile, it can nevertheless be distinguished by its brown, rather than grey-brown, drying leaves and small canaliculate rather than pustular domatia which are at times absent; the pubescent ovoid ovary and rather stout short connectival appendages (slender and thrice as long as the anthers in *H. semicuneata*) define this species.

**Hopea celebica** BURCK Ann. Jard. Bot. Btzg 6 (1887) 237; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1110; SLOOT. Reinwardtia 2 (1952) 15; BACKER & BAKH. f. Fl. Jav. 1 (1963) 331.

TYPE: Teysmann 12779 H. B., Maros, S. W. Celebes (L, BO).

— *Hopea dolosa* SLOOT. Reinwardtia, 2 (1952) 18.

TYPE: Kjellberg 2065, Lampen, Malili, S. E. Celebes (BO).

The only consistent difference between Burck's and Van Slooten's species that I can confirm is the persistence of the tomentum in the former, especially on the panicle. This does appear to distinguish specimens of the S. E. from S.W. peninsulars of Celebes but, on the meagre material presently available, would hardly appear enough to merit taxonomic recognition even at infraspecific level.

**Hopea iriana** SLOOT. Reinwardtia 2 (1952) 28; van ROYEN Man. Forest Trees Papua New Guinea 8 (1965) 35.

TYPE: b.b. 25644, Hollandia (BO, L).

— *Hopea nabirensis* SLOOT. Reinwardtia 2 (1952) 27; van ROYEN Man. Forest Trees Papua New Guinea 8 (1965) 38.

HOLOTYPE: Kanehira and Hatusima 12544, Sennen Nabire, Geelvink Bay, W. New Guinea (BO).

The type of *H. nabirensis*, in fruit, in my opinion represents a specimen of *H. iriana* with unusually short leaves and prominent domatia, but comes within the range of variation of that species.

**Hopea pachycarpa** (HEIM) SYM. Gard. Bull. S. S. 8 (1934) 30; BROWNE For. Tr. Sarawak and Brunei (1955) 125; ASHTON Man. Dipt. Brun. (1964) 105; Gard. Bull. Sing. 22 (1967) 271; Man Dipt. Brun. Suppl. (1968) 54. — *Pierrea pachycarpa* HEIM Bull. Soc. Linn. Paris 2 (1891) 598; Rech. Dipt. (1892) 78; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 268; BRANDIS J. Linn. Soc. Bot. 31 (1895) 113; MERR. En. Born. (1921) 408; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 263.

TYPE: Beccari 3314, Sarawak (P, K).

— *Balanocarpus pubescens* RIDL. Fl. Mal. Pen. 1 (1922) 247; FOXW. Mal. For. Rec. 10 (1932) 147; SYM. Gard. Bull. S. S. 8 (1934) 28, 32; BURK. Dict. 1 (1935) 288. — *Pierreocarpus pachycarpa* RIDL. ex SYM. Gard. Bull. S. S. 8 (1934) 30 *nomen in syn.* — *H. laxa* SYM. Gard. Bull. S. S. 8 (1934) 33; BROWNE For. Tr. Sarawak and Brunei (1955) 125; ASHTON Man. Dipt. Brun. Suppl. (1967) 54.

— *H. resinosa* SYM. Gard. Bull. S. S. 8 (1935) 278; Mal. For. Rec. 16 (1943) 141.

HOLOTYPE: Kep 3602, Kuantan, Pahang, Malaya (KEP).

I have earlier (1967) discussed the synonyms of this species in Borneo. I now reduce here also the Malayan *H. resinosa*. Though this typically has somewhat smaller, fewer nerved leaves which are less glaucous beneath several Bornean collection from mature trees, especially from West Sarawak, fall well within its range of variation and I am unable on present evidence to define even geographical subspecies.

**Hopea bilitonensis** *sp. nov.*

Species in sect. *Hopeae* subsect. *Pierreae* costis lateralibus utrinsecus 6–8 remotis costis tertiariis remote subreticulatis paniculis l-axillaribus facile distinguitur.

Small smooth barked tree with stilt roots. Leaf buds and parts of petals exposed in bud densely tawny pubescent, young twigs and panicles fugaceously so, otherwise glabrous. Twigs *c.* 1 mm  $\phi$  apically, slender, much branched, red-brown, terete, smooth. Leaf buds *c.* 1 by 1 mm, ovoid, acute; stipules unknown, fugaceous. Leaves 7.5–16 by 3.5–6 cm, ovate-lanceolate,  $\pm$  chartaceous, lustrous; base obtuse to subcordate, subequal; acumen to 2 cm long, attenuate; nerves 6–8 pairs, prominent beneath, applanate above, arched at 50°–60°; tertiary nerves distantly subreticulate, slender but distinctly elevated beneath; petiole 6–8 mm long, short. Panicle to 18 cm long, slender, axillary, solitary, lax, pendent; twice branched, branchlets to 4 cm long, bearing to 6 flowers; bracts and bracteoles minute, deltoid, caducous. Flower bud to 3 by 2 mm, lanceolate. Sepals fimbriate; 2 outer deltoid, subacute; 3 inner ovate, subacute. Stamens 15, in 3 unequal verticels, shorter than style at anthesis; filaments somewhat slender, compressed at base, tapering distally and filiform beneath the small subglobose anthers; appendages *c.* 3½ times as long as anthers, very long and slender,  $\pm$  crisped. Ovary small, ovoid, with somewhat longer oblanceolate stylopodium and short terminal style. Fruit pedicel to 2 mm long, stout. 2 longer calyx lobes to 5 by 1.2 cm, broadly spatulate, obtuse, *c.* 7 mm broad above the to 7 by 4 mm subauriculate centrally thickened base; 3 shorter lobes to 9 by 6 mm, ovate, acuminate, shorter than nut. Nut to 10 by 6 mm, ovoid, prominently slender apiculate.

DISTR. Malesia: Belitung, N. W. Malaya. Locally common in lowland forest, once recorded from limestone in Perak, N.W. Malaya.

HOLOTYPE: b.b. 23087, Air Malih, Billiton (Belitung) (L).

OTHER COLL.: b.b. 20335, Air Malih; b.b. 23085, Kepayang; Teysmann 11070, Tg. Pandan; Teysmann 11068, Mangar; Van Rossum 3, 8, b.b. 20112, Herb Billiton 4, Belitung; Kep 110201, G. Gajah, Kampar, Perak, Malaya.

An interesting species, locally common on the relatively seasonal islands of Banka and Belitung and now recorded from limestone in relatively seasonal N. W. Malaya — a distribution that has apparently become disjunct since the Pleistocene. Though an isolated species on account of its leaves, solitary axillary inflorescences and small fruit the leaves nonetheless recall those of the anomalous *H. polyalthioides* SYM. of East Johor, still unknown in flower or fruit, though they differ in size and shape.

## Shorea

***Shorea falcifera*** DYER *ex* BRANDIS J. Linn. Soc. Bot. 31 (1895) 86; BECC. For. Born. (1902) 571; MERR. En. Born. (1921) 571.

HOLOTYPE: Beccari 3046 (K).

— *Hopea linggensis* BOERL. Cat. Hort. Bog. (1901) 103.

HOLOTYPES Tree VII. C. 2, in hort. Bog. (BO).

— *S. glauca* (*non* KING) BROWNE For. Tr. Sarawak and Brunei (1955) 168 *p.p.* — *S. flava* MEIJER Act. Bot. Neerl. 12 (1963) 325; ASHTON Man. Dipt. Brun. Suppl. (1968) 69.

HOLOTYPE: S. 9480, Santubong, Sarawak (K).

There is no doubt that Meijer's and Brandis' types represent the same species, distinguished by its relatively small glaucous falcate leaf with *c.* 10 pairs of nerves.

***Shorea falciferoides*** FOXW. Philip. — J. Sc. 13 (1918) Bot. 189; *ibid.* 67 (1938) 296.

SSP. ***falciferoides***.

LECTOTYPE: F. B. 25664, Masinloc, Zambales Province, Luzon (K).

— *S. Balangeran* (non BURCK) VIDAL Phan. Cuming. (1885) 97; Rev. Pl. Vasc. Filip. (1886) 61; BRANDIS J. Linn. Soc. Bot. 31 (1885) 86; FOXW. Philip. J. Sc. 4 (1909) Bot. 508; *ibid.* 6 (1911) Bot. 269; *ibid.* 13 (1916) Bot. 187; WHITFORD Bull. For. Bur. Philip. 10 (1911) 73; MERR. En. Philip. 3 (1923) 96; REYES Philip J. Sc. 22 (1923) 336; SYM. Gard. Bull. S.S. (1935) 273.

— *S. gisok* FOXW. Philip. J. Sc. 67 (1938) 294.

LECTOTYPE: F. B. 25657, Tayabas (now Quezon) Province, Luzon (K).

Large tree, Young twig, panicle, petiole, leaf bud and stipule shortly densely evenly cream pubescent. Twig *c.* 2–3.5 mm  $\phi$  apically, terete or  $\pm$  compressed and ribbed, stout, smooth; stipule scars *c.* 1.5 mm long, pale, cuneate, horizontal. Bud to 5 by 3.5 mm, globose to ovoid, subacute, slightly compressed. Stipules *c.* 10 by 4 mm, obtuse, fugaceous. Leaves 10–18 by 4.5–8 cm, ovate-lanceolate, thinly coriaceous, pale cream-brown lepidote beneath; base obtuse to cuneate, equal; acumen *c.* 8 mm long; nerves 9–14 pairs, slender, hardly elevated beneath, at *c.* 40°–50°; tertiary nerves slender, densely scalariform, at *c.* 90° to the nerves; petiole 1.5–2 cm long, bearing to 6 close second flowers; bracteoles to 3 mm long, elliptic, shortly pubescent, fugaceous. Flower bud to 5 by 2.5 mm, small, lanceolate. Calyx densely pubescent outside, glabrous within; lobes suborbicular, obtuse, subequal. Petals cream, narrowly elliptic, acute, shortly pubescent on both surfaces. Stamens 33–45; filaments glabrous, applanate at base, tapering and filiform distantly, somewhat gibbous; anthers subglobose, the two outer cells slightly larger; appendage to connective very short on inner anthers,  $\pm \frac{1}{4}$  length of anthers on outer anthers, sparsely shortly setose but for a single long apical bristle. Ovary and stylopodium ovoid, densely pubescent, tapering into the short glabrous style. Fruit calyx sparsely puberulent, more densely so at the base; 3 longer lobes to 9.5 by 2.2 cm, broadly spatulate, obtuse, with *c.* 8 by 8 mm thickened saccate base closely adpressed to the base of the nut; 2 shorter lobes to 7 by 1 cm, subequal, broad, tapering to 5 mm broad above the saccate base. Nut *c.* 15 by 15 mm, broadly ovoid, shortly densely cream-buff tomentose; style remnant *c.* 4 mm long, tapering.

DISTR. Throughout the Philippines to Zambales and Bulacan in the moderately seasonal north-west; in Mixed Dipterocarp forest to 1000 m., more or less confined to ridge tops in the everwet areas.

Specimens in the seasonal part of Luzon, represented by F. B. 25664, usually have somewhat smaller leaves but do not otherwise differ from those of the everwet area represented by the type of *S. gisok*. This is a common pattern of variation in Philippine dipterocarps, already discussed, and here as in other species appears to be continuous.

**Ssp. glaucescens** (MEIJER) *stat. nov.*

— *Shorea glaucescens* MEIJER Act. Bot. Neerl. 12 (1963) 327; MEIJER & WOOD Sab. For. Rec. 5 (1964) 170; ASHTON Man. Dipt. Brun. (1964) 134; *ibid.* Suppl. (1968) 71.

HOLOTYPE: San. 15484, Sepilok F. R., Sandakan (K).

Leaves broadly ovate-falcate, chartaceous, base subequal; nerves 8–12 pairs, well spaced, raised but not prominent beneath; petiole rather stout.

DISTR. Borneo (except the west and south-west); clay rich soils in Mixed Dipterocarp forest to 600 m.

The flowers of the two subspecies, with 33–45 stamens, appear identical and the leaf differences, though rather constant, in my opinion do not constitute adequate grounds for maintaining them separately.

***Shorea astylosa*** FOXW. — Philip. J. Sc. 13 (1918) Bot. 188; *ibid.* 67 (1938) 297; MERR. En. Philip. 3 (1923) 96. — *S. ciliata* (non KING) FOXW. Philip. J. Sc. 13 (1918) Bot. 188; *ibid.* 67 (1938) 300.

Foxworthy maintained that B. S. 18575, Biliran island and FB. 22788, Quezon Province represented a different taxon from FB. 13271 (Foxworthy and Demesa) Dumaguilis R., Zamboanga (in flower), type of *S. astylosa*. He compared them with *S. ciliata* KING of Malaya but Merrill was in disagreement. I concur with Merrill that they belong to *S. astylosa*.

This species differs from the Bornean *S. domatiosa* ASHTON, with which it is vicarious, principally in having a prominent stylopodium and *c.* 32, in comparison with 25–30, stamens.

**Shorea laevis** RIDL. Fl. Mal. Pen. 1 (1922) 232; HEYNE Nutt. Pl. ed. 1, 2 (1927) 1121; FOXW. Mal. For. Rec. 10 (1932) 179; SYM. Mal. For. Rec. 16 (1943) 18; BROWNE For. Tr. Sarawak and Brunei (1955) 169; ASHTON Gard. Bull. Sing. 20 (1963) 273; Man. Dipt. Brun. (1964) 139; *ibid.* Suppl. (1968) 73; MEIJER & WOOD, Sab. For. Rec. 5 (1964) 178. — *S. ciliata* (non KING) RIDL. Agr. Bull. Str. & F. M. S. 4 (1905) 63; FOXW. Mal. For. Rec. 1 (1921) 69; *ibid.* 3 (1927) 66; *ibid.* 8 (1930) 19; EDWARDS Mal. For. Rec. 9 (1931) 142. — *H. laevifolia* PARIJS in Fedde, Rep. 33 (1933) 244. — *S. laevifolia* ENDERT Tectona 28 (1935) 292; BROWNE For. Tr. Sarawak and Brunei (1955) 171. — *S. rogersiana* RAIZADA & SMITINAND Thai For. Bull. Bot. 1 (1954) 7.

I have already (1963) discussed the synonyms of this species. I further reduce here *S. rogersiana*, based on Rogers 350 T, Sin Yat hill, Tavoy (Dehra Dun); the principal difference indicated by the authors is in the size and ovoid shape of the buds, which would strictly place *S. rogersiana* in the type subsection rather than in subsection Barbatae with *S. laevis*. The other floral characters, however, are typical of subsection Barbatae and it is clear that the buds are of this shape because they are approaching anthesis. *S. laevis* is now known to occur therefore in peninsular Burma and Thailand.

**Shorea micans** *sp. nov.*

*S. asahi* ASHTON proxime affinis lobis inaequalibus 3 aliformibus differt.

Medium sized tree. Panicles and nut densely greyish puberulent, fruit calyx sparsely so, other known parts glabrous. Twigs *c.* 1 mm  $\phi$  apically, slender, much branched, smooth, terete. Buds minute; stipules not seen. Leaves 5–10 by 1.8–4.7 cm, ovate-lanceolate, thinly coriaceous, lustrous on both surfaces; margin narrowly subrevolute; base broadly cuneate,  $\pm$  unequal; apex to 1.3 cm caudate; nerves 7–8 pairs, very slender, slightly elevated beneath,  $\pm$  appanate above, at 50°–55°; tertiary nerves obscure, scalariform; midrib slender, evident and slightly elevated on both surfaces; petiole 7–12 mm long, rather short, very slender. Panicle to 7 cm long, terminal or subterminal axillary, slender, shortly branched. Flowers unknown. Fruit pedicel *c.* 1 mm long, slender; 3 longer calyx lobes to 5 by 1.5 cm, spatulate, obtuse, *c.* 4 mm broad above the to 8 by 7 mm elliptic saccate thickened base; 2 shorter lobes to 25 by 4 mm, narrowly spatulate, acute, similar at base; nut to 19 by 7 mm including the prominent slender apiculus, ovoid.

DISTR. Malesia: N. E. Borneo (Twice collected, north of Sandakan), on ultrabasic rock in lowlands.

HOLOTYPE: San 39312, Bukit Meliau, Karamuak, N. E. Sabah.

OTHER COLL.: San 24279, Telupid road, Beluran, Sabah.

Differing (in the absence of flowering collections) from *S. asahi* only in the fruit sepals.

**Shorea** Section **Pentacmes** (DC.) *stat. nov.*

— *Gen. Pentacme* DC. Prodr. 16, 2 (1868) 626; KING Ann. R. Bot. Gard. Calc. 5, 2 (1896) 151; BRANDIS J. Linn. Soc. Bot. 31 (1895) 72; FOXW. Mal. For. Rec. 10 (1932) 154; SYM. Mal. For. Rec. 16 (1943) 104.

TYPE SPECIES: *S. siamensis* MIQ.

Flowers large, cream, ovoid, on lax spreading racemes; petals broadly elliptic, ovate, hardly contorted, falling separately; stamens 15, in 3 verticils; filaments short, applanate, tapering; anthers linear, glabrous, with 4 pollen sacs each prolonged and tapering apically into a prominent awn at least as long as the stoutly acicular  $\pm$  recurved appendage; ovary ovoid, style filiform. Stipules and bracts fugaceous, small. Leaf with scalariform tertiary nerves; midrib raised, evident, above. Bark surface flaky. Wood anatomy and properties widely divergent between S. E. Asia and Philippine species.

DISTR. 1 species in seasonal South-East Asia, 1 in the Philippines.

I have elsewhere (Gard. Bull. Sing. 20 (1963) 254–259, 261–271) elaborated Symington's (1943 and elsewhere) conclusion that fruit provide the principal characters for generic definition among Brandis' tribe Shoreae (which includes *Parashorea*, *Hopea*, *Shorea* and, formerly, *Balanocarpus* and *Pentacme*), while the characters of the flower and in particular androecium provide definitive characters for the sections of *Hopea* and *Shorea*. De Candolle raised *S. siamensis* MIQ. to generic status on account of its flowers. Its 3-winged fruit possesses no unique characters not found in *Shorea* and it is clear that two courses alone would be consistent: to reduce *Pentacme* once again to *Shorea* as a separate section or to raise the sections of *Shorea* (and presumably *Hopea* too) to generic level. I choose the former for both theoretical and utilitarian reasons; this decision has been anticipated by my earlier (Blumea 20, 2 (1972) 361) reduction of *Doona* THW. of Sri Lanka (Ceylon) to sectional status within *Shorea*.

Though the floral morphology of the two species is unique in the genus and closely similar, the bark and wood anatomy differs widely between them. The bark of *S. siamensis* is cracked and flaky, that of *S. contorta* densely V-section fissured. This is exceptional among Dipterocarpaceae and suggests that the section is polyphyletic in origin. The appearance of the two trees — crooked and deciduous in *S. siamensis*, tall straight and evergreen in *S. contorta*, reinforces this view. A detailed comparison of bark and wood anatomy would be very worthwhile.

***Shorea siamensis* MIQ.** Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 214; DC. Prodr. 16, 2 (1968) 631; WALP. Ann. 7 (1868) 379; DYER Fl. Br. Ind. 1 (1874) 304; RYAN & KERR J. Siam. Soc. 8 (1911) 7, 15, 35. — *Hopea siamensis* WALL. Cat. (1828) n. 959 *nomen nudum*. — *Pentacme siamensis* KURZ J. R. As. Soc. Beng. Sc. 39, 1 (1870) 66; Fl. Burm. 1 (1877) 119; PIERRE Fl. Coch. 3 (1892) 225–227; HEIM Rech. Dipt. (1892) 56; Bot. Tidsskr. 25 (1902) 46; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3 6 (1895) 263; GUERIN in LECOMTE Fl. Gén. I.-C. 1 (1910) 385; TARDIEU in *ibid.* Suppl. 1 (1943) 352; CRAIB Fl. Siam. Enum. 1 (1925) 145; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 238; FOXW. Mal. For. Rec. 8 (1930) 15, 35; *ibid.* 10 (1932) 155; BURK. Dict. 2 (1935) 1960; SYM. Mal. For. Rec. 16 (1943) 105. — *Vateria siamensis* BURCK Ann. Jard. Bot. Btzg (1887) 184.

HOLOTYPE: Teysmann s.n. near Kanburi, Thailand (U).

— *Hopea suave* WALL. Cat. (1828) n. 959 *nomen nudum*; ex DC. Prodr. 16, 2 (1868) 635. — *Pentacme suave* DC. Prodr. 16, 2 (1868) 626; BRANDIS J. Linn. Soc. Bot. 31 (1895) 72; Indian Trees (1911) 68; GAMBLE Man. Ind. Timb. (1922) 77; TROUP Silv. Ind. Trees 1 (1925) 145; CRAIB Fl. Siam. Enum. 1 (1925) 145; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 259; SMITINAND Thai For. Bull. 1 (1954) 9, 10, 24. — *Shorea suave* PIERRE ex LANESSAN Pl. Util. Colon Franc. (1886) 301.

HOLOTYPE: Wallich 959, Martaban (K).

— *S. bracteata* PIERRE ex LANESSAN Pl. Util. Colon Franc. (1886) 301. — *S. mekongensis* PIERRE ex LANESSAN Pl. Util. Colon Franc. (1886) 301. — *S. tomentosa* (non MIQ) PIERRE Fl. Coch. 3 (1892) *sub. t.* 225 *in syn.* — *Pentacme tomentosa* CRAIB Kew. Bull. (1915) 423; Fl. Siam. Enum. 1 (1925) 145.

HOLOTYPE: Kerr 3184, Me Maw, Thailand (K).

— *Pentacme malayana* KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 107; BRUHL & KING Ann. R. Bot. Gard. Calc. 5, 2 (1896) 151; RIDL. Agr. Bull. Str. & F. M. S. 1 (1901) 62; Fl. Mal. Pen. 1 (1922) 220; CRAIB Fl. Siam. Enum. 1 (1925) 145.

ISOHOLOTYPE: Curtis 2095, Langkawi (K).

Small gnarled  $\pm$  deciduous tree. Leaves glabrous or one or both surfaces  $\pm$  persistently pubescent; young calyx, twigs and panicle  $\pm$  caducous puberulent, otherwise glabrous. Twigs 3–5 mm  $\phi$  apically, terete, smooth; stipule scars short, pale. Bud small, ovoid, acute; stipule to 18 by 7 mm, ovate-falcate, fugaceous. Leaves 9–12 by 6–13 cm (smaller if subtending panicles), broadly ovate-oblong, chartaceous; base deeply cordate to cuneate (if subtending panicles); acumen to 1 cm long, short, broad; nerves 13–16 pairs, slender but prominent beneath, barely elevated above as also the midrib, arched, the basal pair with prominent lateral branchlets; tertiary nerves remotely scalariform, sinuate but typically prominently elevated beneath; petiole 3–5 mm long, c. 2 mm  $\phi$ , straight. Panicle to 14 mm long, terminal or axillary, lax, peduncle stout at base; irregularly branched, branchlets to 7 cm long, bearing a few  $\pm$  secund flowers. Anthesis directly following leaf fall; bud to 15 by 6 mm, large, ellipsoid; sepals narrowly ovate, prominently slender, acuminate, subequal; petals broadly elliptic, glabrous or pubescent; stamens 15, subequal; filaments lorate, slightly tapering; anther cells linear, extended apically beyond the connective into prominent tapering horns c.  $\frac{1}{2}$  their length; appendages acicular, glabrous, c.  $\frac{1}{2}$  length of anthers; ovary narrowly ovoid, tapering into a stoutly columnar style c. twice its length and exceeding the stamens at anthesis. Fruit pedicel to 5 by 3 mm, broadening into the receptacle; 3 longer calyx lobes to 12 by 1.3 cm, narrowly spatulate, narrowly obtuse, c. 4 mm broad above the to 8 by 7 mm elliptic saccate thickened base; 2 shorter lobes to 7 by 0.5 cm, lorate, subacute, similar at base. Nut to 20 by 12 mm, ovoid, tapering into an up to 8 mm long prominent acicular style remnant.

Varying greatly in the distribution and density of the tomentum, reduction of which is roughly correlated with increasing humidity of climate or soil; The species *P. malayana* (leaf glabrescent) and *P. tomentosa* (both surfaces of leaf tomentose) were distinguished from *P. siamensis* (= *suavis*) with tomentose leaf undersurface, but the continuous variation which exists in nature suggests merely ecotypic differentiation in panmictic populations.

**Shorea contorta** VIDAL Sinopsis (1883) 15; Rev. Pl. Vasc. Filip. (1886) 61; BRANDIS J. Linn. Soc. Bot. 31 (1895) 88; MERR. Philip. J. Sc. 1 (1906) Suppl. 98. — *Pentacme contorta* MERR & ROLFE Philip. J. Sc. 3 (1908) Bot. 115; MERRITT Bull. Bur. For. Philip. J. Sc. 8 (1908) 48; WHITFORD Philip. J. Sc. 4 (1910) Bot. 703; Bull. Bur. For. Philip. 10 (1911) 61; FOXW. Philip. J. Sc. 4 (1910) Bot. 511, 516; *ibid.* 6 (1911) Bot. 266; *ibid.* 13 (1918) Bot. 186; *ibid.* 67 (1938) 287; MERR. En. Philip. 3 (1923) 95; REYES Philip. J. Sc. 22 (1923) 332.

SYNTYPES: Vidal 987, Rizal Prov. Luzon (K); Vidal 2159, Tayabas (Quezon) Province, Luzon (K).

— *Pentacme paucinervis* BRANDIS J. Linn. Soc. Bot. 31 (1895) 73.

SYNTYPES: Vidal 79, 1166, 2167, Luzon (K).

— *Pentacme mindanensis* FOXW. Philip. J. Sc. 13 (1918) Bot. 185; *ibid.* 67 (1938) 289; MERR. En. Philip. 3 (1923) 95; REYES Philip. J. Sc. 22 (1923) Bot. 332.

LECTOTYPE: F. B. 21893 (Villamil) Zamboanga Prov. Mindanao (K).

Medium sized, sometimes large evergreen tree. Panicle, parts of petals exposed in bud, ovary and leaf buds densely persistently pale brown puberulent, twigs, petioles and calyx outside caducously so. Twig c. 2–3 mm  $\phi$  apically, terete or  $\pm$  ribbed; stipule scars short, descending. Leaf buds to 6 by 3 mm, lanceolate; stipules fugaceous. Leaves 9–29 by 5.5–11 cm, ovate to oblong-lanceolate, thinly coriaceous; base subequal, obtuse or rarely cordate (subpeltate in young trees); apex broadly to 1 cm long acuminate; nerves 5–9 pairs, slender but prominent beneath, distant, arched,  $\pm$  applanate above as also the midrib, set at c. 45°–70°; tertiary nerves densely scalariform, slender, hardly elevated on either surface; petioles 20–33 mm long, slender. Panicles to 22 cm long (if terminal), to 14 cm long (if axillary), singly or doubly branched; branchlets to 4 cm long. Flower

buds to 7 by 4 mm, ovoid, lanceolate; sepals ovate, obtuse, the outer 3 somewhat the larger; petals broadly oblong-elliptic, acute; stamens 15, subequal; filaments short, broad, appanate; anther cells linear and as long as the stout appendage; style columnar, *c.* thrice length of ovary. Fruit shortly pedicellate; 3 longer calyx lobes to 12 by 3 cm, spatulate, obtuse, tapering to *c.* 8 mm wide at the incrassate saccate base; 2 shorter lobes to 9 by 1.5 cm, otherwise similar. Nut to 35 by 15 mm, narrowly ovoid, apiculate.

The species is widespread in the Philippines. BRANDIS' name is based on small leaved collections from the seasonal area of N. W. Luzon, Foxworthy's represents the large-leaved form which is found scattered, mainly in the west, of Mindanao. Foxworthy himself recognized the synonymy of Brandis' species yet created a further one for large leaved collections. In discussions with foresters in the Philippines I have been informed that *P. mindanensis* has larger fruit than *P. contorta*, and that it has smaller fruit; a specimen tree of *P. mindanensis* at Los Baños, Laguna, yielded specimens with large fruit one year (Barban 11982, 11983), small in another (Barban 588). It is sometimes also said that the base of the leaf is obtuse rather than acute. There seems no doubt to me that *S. contorta* is yet another widespread Philippine species whose leaf size varies greatly, increasing from seasonal to everwet habitats. It is commonest in seasonal areas, becoming scattered, even rare in the everwet forest of the east (cf. *Anisoptera thurifera*).

**Shorea henryana** PIERRE in LANESSAN Pl. Util. Colon. France. (1886) 302; Fl. Coch. 15 (1890) t. 229; *ibid.* 16 (1891) t. 351b; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 89; GUERIN in LECOMTE, Fl. Gén. I.-C. 1 (1910) 382; TARDIEU in *ibid.* Suppl. 1 (1943) 350.

HOLOTYPE: Pierre 1593, Xuyen Kot, Baria, Dinh Province, Vietnam (P; Syntype in K).

— *S. sericeiflora* FISCHER & HUTCH. Kew Bull. 1926, 433; PARKINSON, Ind. For. Rec. (Bot) 1 (1937) 43; SYMINGTON J. Mal. Br. R. As Soc. 19, 2 (1941) 160; Mal. For. Rec. 16 (1943) 41.

HOLOTYPE: Conservator of Forests 1954, Pegu, Burma (K).

— *S. longistipulata* TARDIEU Not. Syst. 103 (1942) 132; in LECOMTE, Fl. Gén. I.-C. Suppl. 1 (1943) 349.

HOLOTYPE: Fleury, Herb. Chev. 29.994, Gia Ray forest reserve, Cochinchina (P).

Pierre's species is based on a collection with flowers, fruit and leaves apparently from an immature tree; the velutinate parts, absence of pale lepidote leaf undersurface and prominent narrow stipules give a very different appearance from the type of *S. sericeiflora*, collected from a mature tree, but are nevertheless unmistakably of this species as is the type of *S. longistipulata* in which the foliage is in a yet more immature stage.

**Shorea kuantanensis** *sp. nov.*

*S. faquetianae* HEIM affinis lobis calycis in fructu quam fructus brevioribus lamina nervis lateralibus utrinsecus 8-9 differt.

Medium sized tree. Twig apices and leaf buds sparsely buff puberulent, ovary densely so. Twig *c.* 2 mm  $\phi$  apically, terete, striated. Leaves 7.5-12 by 2.7-5 cm, lanceolate, thinly coriaceous; base cuneate, subequal; acumen to 1 cm long, slender, margin subrevolute; nerves 8-9 pairs, slender but elevated beneath, obscurely depressed above; tertiary nerves reticulate; midrib prominent beneath, hardly elevated above; petiole 15-18 mm long, slender. Panicles and flowers unknown. Fruit pedicel to 4 mm long, expanding into the fruit base; calyx lobes to 22 by 4 mm, subequal, linear except at the expanded incrassate saccate base; nut to 25 by 11 mm, narrowly ellipsoid, acute, exceeding fruit sepals.

HOLOTYPE: Kep 31771, Bukit Goh F. R., Kuantan, E. Malaya. (KEP).

OTHER COLL.: Kep, 31806, Bt. Goh F. R.

This curious little tree will probably never be collected in flower; the fertile basalt soils of Bt. Goh forest reserve, east Pahang, on which it grew now support a cover of *Elaeis guineensis* JACQ.

***Shorea chaiana* sp. nov.**

*S. longispermae* ROXB. *S. obovoideae* SLOOT. affinis lobis calycis in fructu brevibus subequalibus lamina basim versus inaequali costa media supra manifesta differt.

Large buttressed tree. Petiole, panicles, perianth outside and ovary persistently  $\pm$  densely cream-buff puberulent; sepals, twig and leaf nervation below sparsely  $\pm$  caducously so; other parts glabrous. Twigs c. 1 mm  $\phi$  apically, much branched, terete, becoming smooth, dark brown. Buds minute. Leaves 6–11 by 2–4 cm, elliptic-lanceolate,  $\pm$  distinctly falcate, subcoriaceous; margin subrevolute; base cuneate or obtuse, subequal; acumen to 15 mm long, slender, caudate; nerves 8–11 pairs, slender but prominent beneath, evident above, arched; tertiary nerves reticulate, distinctly elevated beneath; midrib prominent and terete beneath, evident but appanate to shallowly depressed above; petiole 5–8 mm long, short, slender. Panicle to 6.5 cm long, terminal or axillary, slender, singly branched; branchlets to 2 cm long. Flower buds to 5 by 2 mm, lanceolate. Sepals broadly ovate, subacuminate, subequal. Stamens 15; filaments expanded and gibbous in the basal  $\frac{1}{2}$ , filiform distally; appendages acicular, c.  $2\frac{1}{2}$  times as long as the narrowly ellipsoid 2-locular anthers. Ovary ovoid-conical, surmounted by an equally tall columnar puberulent stylopodium and shorter glabrous style. Mature fruit unknown; sepals ovate, subequal; ovary ovoid.

DISTR. Malesia: Northern Borneo (C. and N. E. Sarawak). Local, in Mixed Dipterocarp forest below 1000 m.

HOLOTYPE: S. 29722 (Suib) S. Spanggil, Kapit, Sarawak (K).

OTHER COLL.: Sarawak: S. 29517, Ulu S. Sekentut, Kapit; S. 29632, Ulu Balleh, Kapit; S. 29626, S. Mengiong, Balleh.

The leaves somewhat resemble those of *S. longisperma* ROXB. though the tomentum beneath is more sparse, the base unequal and besides, the fruit calyx lobes are short and unequal. The leaf base and tomentum also differentiates it from *S. obovoidea* SLOOT.

***Shorea tenuiramulosa* sp. nov.**

*S. angustifoliae* ASHTON *S. maximae* (KING) SYM. affinis paniculis – 18 cm longis gracilibus petiolis – 20 mm longis gracilibus epilosis differt.

Small to medium sized tree. Panicles caducous greyish puberulent; bracts persistently so, parts of petals exposed in bud and ovary persistently densely so. Twigs 1–2 m  $\phi$  apically, terete, pale greyish brown, rugulose. Buds and stipules not seen. Leaves 9–24 by 4–11 cm, elliptic to lanceolate, thinly coriaceous, drying pale greyish brown; margin undulate, somewhat revolute; base broadly cuneate to obtuse; apex shortly broadly acuminate; nerves 8–9 (-11) pairs, arched, at  $55^{\circ}$ – $66^{\circ}$ , very slender but distinctly elevated beneath, slightly so above as also the laxly reticulate tertiary nerves; midrib prominent on both surfaces; petioles 11–20 mm long, drying cream-brown at the ends, otherwise blackish. Panicles to 18 cm long, terminal or to 3-axillary or ramiflorous, slender, many flowered; doubly branched, branchlets to 2 cm long; bracts to 2 mm long, elliptic, fugaceous. Flower buds to 5 by 2 mm. Sepals ovate-deltoid, incrassate, subacute, glabrous, subequal. Stamens 15, in 3 unequal verticils; filaments dilated at base, tapering and filiform distally; appendages slender, villous distally, c.  $1\frac{1}{2}$  times as long as the

narrowly ellipsoid anthers. Ovary ovoid, tapering into the somewhat shorter stout columnar style; style villous in the basal  $\frac{1}{2}$ . Fruit pedicel to 2 by 2 mm; sepals to 6 by 5 mm, equal, ovate, subacuminate, thickened; nut to 25 by 8 mm, fusiform-lanceolate.

DISTR. Malesia: N. E. Borneo (E. Sabah, Sakar Island). Local on dry rocky ultrabasic ridges near the coast.

HOLOTYPE: San 39306, Bukit Meliau, Karamuak, E. Sabah (K).

OTHER COLL.: San 54801, 21621, 21626, 36031, Look Megulang, Pulau Sakar, San 21475, Mt. Silam, Lahad Datu.

Clearly allied to *S. angustifolia*; the rather broad chartaceous leaf, curling over irregularly at the margin and with matte undersurface, and the long and slender epilose petiole cream coloured only at the distal end, serve to distinguish it.

**Shorea longisperma** ROXB. Hort. Beng. (1814) 93 *nomen nudum*; Fl. Ind. Careys ed. 2 (1832) 618; DC. Prodr. 16, 2 (1868) 632; BRANDIS J. Linn. Soc. Bot. 31 (1895) 103; RIDL. Fl. Mal. Pen. 1 (1922) 143. — *Parashorea longisperma* KURZ J. R. As. Soc. Beng. Sc. 39, 2 (1870) 66; DYER Fl. Br. Ind. 1 (1874) 441; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 571; FOXW. Mal. For. Rec. 10 (1932) 226.

HOLOTYPE: Roxburgh s.n., Prince of Wales Island (BR).

— *Shorea resinanegra* FOXW. Mal. For. Rec. 10 (1932) 205; BURK. Dict. 2 (1935) 204; SYM. Mal. For. Rec. 16 (1943) 56; ASHTON Man. Dipt. Brun. Suppl. (1968) 89.

HOLOTYPE: Kep. 24205, S. Lalang F. R., Ulu Langat (KEP).

The type of *S. longisperma* has for long remained lost and a mystery; Symington surmised that it might represent *S. curtisii* DYER ex KING. Thanks to a tip-off from Professor Van Steenis I have rediscovered it hidden in the Brussels herbarium among the Roxburgh collections. It proves to consist of fruits only, but unmistakably those of *S. resinanegra* FOXW.

**Shorea hopeifolia** (HEIM) SYM. Gard. Bull. S. S. 8 (1933) 150; *ibid.* 8 (1934) 36; Mal. For. Rec. 16 (1943) 52; BROWNE For. Tr. Sarawak and Brunei (1955) 163; MEIJER & WOOD Sab. For. Rec. 5 (1964) 73; ASHTON Man. Dipt. Suppl. (1968) 84. — *Cotylelobium? hopeifolium* HEIM Bull. Soc. Linn. Paris 1 (1891) 971; BRUHL & KING Ann. R. Bot. Gard. Calc. 5, 2 (1896) 153; BRANDIS J. Linn. Soc. Bot. 31 (1895) 95. — *S. ridleyana* KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 115 *p.p.*; SLOOT. ex MERR. Pl. Elm. Born. (1929) 204; RIDL. Fl. Mal. Pen. 1 (1922) 226 *p.p.*; FOXW. Mal. For. Rec. 3 (1927) 353; *ibid.* 10 (1932) 209 *p.p.* — *Hopea heimiana* BRANDIS J. Linn. Soc. Bot. 31 (1895) 63; MERR. En. Born. (1921) 402. — *H. albescens* RIDL. J. Str. Br. R. As. Soc. 73 (1916) 142; Fl. Mal. Pen. 1 (1922) 236. — *S. kalunti* MERR. Philip J. Sc. 26 (1925) 475; DESCH Mal. For. Rec. 12 (1936) 35, 39; FOXW. Philip J. Sc. 67 (1938) 307. — *H. hopeifolia* SLOOT. Bull. Jard. Bot. Btzg III, 10 (1929) 396.

Symington has already discussed the synonymy of this species. I add *S. kalunti* MERR., based on F.B. 27701 (Angeles and Hilario) Banauan, Davao Prov., Mindanao in fruit (isoholotype in K). It shares the somewhat larger leaf, lacking domatia and with more remote tertiary nerves, that also prevails in N. W. Sabah, but the densely cream flocculent pubescent inflorescences, flowers and fruits are characteristic of *S. hopeifolia*; this species therefore occurs in Malaya, Sumatra, Borneo and in Mindanao.

Symington considered the pair of porous domatia on either side of the base of the midrib as a diagnostic character in Malaya; it is usually absent in Borneo however, as in Mindanao.

**Shorea assamica** DYER Fl. Br. Ind. 1 (1874) 307; BRANDIS J. Linn. Soc. Bot. 31 (1895) 85; Ind. Trees (1911) 70; FOXW. Philip. J. Sc. Bot. 4 (1909) 516; TROUP Ind. Woods and Uses (1909) 241; Silv. Ind. Trees (1921) 133; GAMBLE Man. Ind. Timb. (1922) 83; PEARSON & BROWN Commer. Timb. Ind. 1 (1932) 119; KANJILAL & DAS Fl. Assam (1934) 136; PARKINSON Ind. For. Rec. (Bot.) 1 (1937) 40; SYM. Gard. Bull. S. S. 9 (1938) 331.

Ssp. **globulifera** (RIDL.) SYM. Gard. Bull. S. S. 9 (1938) 331; Mal. For. Rec. 16 (1943) 31. — *S. globifera* RIDL. Fl. Mal. Pen. 1 (1922) 232; FOXW. Mal. For. Rec. 3 (1927) 35; *ibid* 10 (-932) 191; BURK. Dict. 2 (1935) 2010; SYM. *ex* DESCH, Mal. For. Rec. 12 (1936) 27. — *Shorea sororia* SLOOT. Bull. Bot. Gard. Btzg III, 18 (1949) 247.

I follow Symington's interpretation (1938) of this species except that Ssp. *koordersii* is now recorded from Luzon (Rojo 100, BBLC1, Bislig, Surigau del Sur, Mindanao). Van Slooten (Reinwardtia 2 (1952) 42) could not bring himself to accept such a wide concept of this species. He recognized that *S. globifera* RIDL. occurs in Sumatra yet described *S. sororia* based on b.b. 31387, Perhutan Lajan, Tapanuli, W. Sumatra (BO), from there also without defining the differences between the two species; indeed, he did not even comment on their similarity. I am unable to separate *S. sororia* SLOOT. from *S. assamica* DYER ssp. *globifera* (RIDL.) SYM. on any character.

**Shorea virescens** PARIJS in Fedde, Rep. 33 (1933) 244; Kennis Oost-Ind. Damarhars (1933) 120; SLOOT. Bull. Bot. Gard. Btzg III, 18 (1949) 240; ROJO Kalikasan 5 (1976) 99.

HOLOTYPE: b.b. 13898, Sanggau, West Borneo (L).

— *S. lamellata* (non FOXW.) ASHTON Man. Dipt. Brun. (1964) 164 p.p.; *ibid*. Suppl. (1968) 94 p.p.

Twig, panicle, bud, stipule, petiole, midrib (both surfaces) and nervation beneath shortly densely persistently grey-buff tomentose. Twig 2.5–4 by 1.5–3 mm, compressed, becoming finely cracked; stipule scars *c.* 2.5 mm long, glabrous, horizontal. Bud 2–3 by 4 mm, globose to stoutly ovoid, obtuse. Stipule to 25 by 3–4 mm, linear, acute. Leaves alternate, 8–15 by 4–8 cm, obovate; base subcordate; acumens to 7.5 mm long; nerves 20–26 pairs, at 90° at base, *c.* 40°–55° along the midrib; tertiary nerves very slender, scalariform, dense, at 90° to the nerves; petiole 1.5–2 cm long. Panicle to 10 cm long, terminal or axillary, ± compressed, slender, straight; unbranched or singly branched; bracteoles to 8 mm long, narrowly lanceolate, densely pubescent outside, puberulent within, caducous. Flower buds to 6 by 3 mm, ellipsoid, obtuse. Calyx densely puberulent outside, glabrescent within; 3 outer lobes ovate, subacute; 2 inner lobes shorter, smaller, thinner, ovate-acuminate. Petals narrowly lanceolate, densely pubescent on parts exposed in bud. Stamens 15, of 2 lengths; filaments broad at base, tapering and filiform distally; anthers narrowly oblong; appendage to connective about twice length of anther, exceeding style apex. Ovary ovoid, minutely puberulent; style filiform, as long as ovary, distinctly trifid. Fruit calyx shortly puberulent or glabrous when mature; 3 longer lobes to 8 by 1.3 cm, spatulate, ± obtuse, to 6 mm broad above the to 8 by 7 mm elliptic somewhat thickened saccate base; 2 shorter lobes to 5.5 by 0.5 cm, linear, similar at base. Nut to 1.3 by 1 cm, glabrescent; style remnant to 3 mm long, tapering.

DISTR. Malesia: Borneo, Philippines (Mindanao, Samar).

I had earlier confused this species with the next, now given formal description for the first time. *S. virescens* differs in its compressed persistently grey-buff pubescent twigs and obovate leaves with at least 20 pairs of nerves. Mr. J. ROJO has provided the first records of this species from the Philippines, and the following collections now exist: Mindanao: Rojo CLP 102; PICOP concession, Nyhalu fall, Surigau del Sur; Rojo CLP 190, DASTECO concession, Davao city; Rojo CLP 88 (young fruit), 76, ADECOR concession, Asuncion, Davao del Norte; Rojo CLP 1553, Sang, Asuncion, Davao del Norte; Lomibao Bel. 176, Monkayo, Davao. S. E. Samar: Medulid 1500, Guinmaayohan forest.

**Shorea confusa** sp. nov.

— *S. virescens* (non PARIJS) ASHTON Man. Dipt. Brun. (1963) 167; *ibid* Suppl. (1968) 95; MEIJER & WOOD, Sab. For. Rec. 5 (1964) 60.

*S. virescenti* PARIJS affinis ramulis glabrescentibus teretis lamina elliptica costis lateralibus utrinsecus minus quam 18 differt.

Large tree. Leaf bud, panicle, stipule outside, petiole, and very young twig caducous pubescent. Twig 2–3.5 mm  $\phi$  apically, frequently rugulose; stipule scar short, obscure. Bud 3–4 by 2 mm, conical, acute. Stipule c. 8 by 3 mm, linear to deltoid, subacute. Leaves 6–12 by 3.5–8 cm, elliptic to slightly obovate; base obtuse; acumen broad, 0.5–1.0 cm long; nerves (10-) 13–18 pairs, curved, at 90° to nerves; petiole 1–1.5 cm long, c. 1 mm  $\phi$ , rather slender. Panicle to 22 cm long, terminal or axillary, terete, lax; singly or doubly branched, branchlets to 10 cm long, bearing to 6 flowers; bracts and bracteoles unknown. Flower bud to 9 by 5 mm, narrowly ovoid, obtuse. Calyx puberulent outside, glabrous within; lobes equal, narrowly deltoid, obtuse. Petals large, narrowly ovate, acute, puberulent on parts exposed in bud. Stamens 15, in 3 subequal verticels; filaments c.  $1\frac{1}{2}$  length of anther, slender, tapering gradually; anthers oblong, tapering; appendage to connective c.  $3 \times$  length of anther, reaching  $\frac{2}{3}$  length of style. Ovary small, ovoid, puberulent; style stoutly filiform, c.  $3 \times$  length of ovary, glabrous in the apical  $\frac{1}{3}$ , otherwise puberulent, shallowly trifurcate. Fruit pedicel stout. Calyx glabrous; 3 longer lobes to 12 by 1.5 cm, narrowly spatulate, obtuse, hardly tapering, slightly broadening at the thickened saccate base; 2 shorter lobes to 6 by 0.5 cm, unequal, linear, similar at base; base of calyx obconical, tapering into the pedicel. Nut to 2 cm long, ovoid, glabrescent; style remnant c. 6 mm long, slender.

DISTR. Malesia: N. E. Borneo (N. E. Sarawak, Sabah S. E. to Sangkulirang). Scattered, undulating land and hills below 650 m. on leached clay soils in Mixed Dipterocarp forest.

HOLOTYPE: San 19395, Mile 24 Cocoa Estate, Tawau (K).

OTHER COLL.: Sabah: San 9276, Pababag Isles F.R.; San 40334, Mt. Templer P.F., Kota Belud, San A 3522, 16349, 16180, S. 2976, A 2664, 15485, Wyatt-Smith *s.n.* 12.8.54, *s.n.* 25.5.54, Kep. 35607, 55175, 55340, 48863, Kabili-Sepi'ok F.R.; San A 3691, A 3663, A 4148, Kalabakan, Tawau; San 16592, Ulu Moyah, Sipitang; San 16108, Sabahan R., Lahad Datu; San 15027, Masuli-Koyah F.R., Lahad Datu; San A 4233, Bt. Garam, Kinabatangan; San 4948, Kep. 41085, Supu, Sandakan; Wyatt-Smith *s.n.* 16.8.54, Dalas; *s.n.* 16.8.54, Tamparuli; Kep. 38816, Mile 15, Sandakan; Kep 38690, Sekong valley, Sandakan; Kep. 28768, Bettotan, Sandakan; Kep. 80479, South of Talibong, Kota Belud. Sarawak: Kep 79343, Lambir hills; S. 1533, Lawas; S. 23023, Bt. Mentagai, Bok-Tisam F.R.; S. 23307, G. Dulit at Long Atun. Brunei: Kep 30535, Ulu Batu Apoi; Brun 5281, Ulu Belalong at K. Ropan; S. 5641, Peradayan F.R.; Brun 895, Rh. Sigat, Ulu Tutong; Brun 2004, Bangar; S. 1690 S. Belaban, Tutong.

For differences from *S. agami* WOOD *ex* ASHTON, see ASHTON (1963).

**Shorea dispar** *sp. nov.*

*S. negrosensis* FOXW. affinis lamina 4–7  $\times$  2–3.5 cm minori staminibus c. 25 aristis antherorum longioribus differt.

Large buttressed tree. Twigs, petioles, bud, panicles, perianth outside and ovary densely  $\pm$  persistently pale tawny pubescent, leaf nervation beneath sparsely so. Twigs c. 2 mm  $\phi$  apically, much branched, terete, at first rugulose and  $\pm$  ribbed, becoming smooth, dark brown dappled; stipule scars short, dark, horizontal. Buds to 3 by 2 mm, ellipsoid, obtuse. Stipules unknown. Leaves 4–7 by 2–3.5 cm, elliptic, coriaceous,  $\pm$  distinctly but sparsely cream lepidote beneath; margin subrevolute; base cuneate; acumen short, broad; nerves 9–11 pairs, ascending, prominent beneath, obscure and narrowly depressed above as also the midrib; petiole 12–16 mm long. Panicle to 8 cm long, terminal or axillary, rigid, ascending; singly or doubly branched, branchlets to 3 cm long. Flower buds

to 6 by 4 mm, ovoid. Sepals broadly ovate, subequal, shortly subacuminate. Stamens *c.* 25; filaments long, lorate, somewhat tapering to the oblong anthers; appendages *c.*  $\frac{3}{4}$  length of anthers; ovary small, ovoid, glabrous, surmounted by a slender filiform style *c.* twice its height. Fruit unknown.

DISTR. Malesia: Borneo (C. Sarawak; once collected). Mixed Dipterocarp forest on inland hills.

HOLOTYPE: S. 29208, Ulu Baleh above Nanga Mengiong, Kapit.

Superficially resembling *S. parvifolia* DYER ssp. *velutinata* ASHTON, the flowers betray the close relationship of this rare tree with red lauan (*S. negrosensis* FOXW.), the celebrated timber tree of the Philippines, and assign both to section *Rubellae* ASHTON.

**Shorea parvistipulata** HEIM Bull. Soc. Linn. Paris, 2 (1891) 974 *Ssp. parvistipulata*. BRANDIS J. Linn. Soc. Bot. 31 (1895) 95; MERR. En. Born. (1921) 406 (*Sphalm. parvistipula*); ASHTON Man. Dipt. Brun. Suppl. (1968) 114; MEIJER & WOOD Sab. For. Rec. 5 (1964) 132.

TYPE: BECCARI 2547, Sarawak (K, P).

— *S. squamata* (non BENTH. & HOOK *f.*) BRANDIS J. Linn. Soc. Bot. 31 (1895) 92; MERR. En. Born. (1921) 407 p.p. *quoad sp. Born.* — *S. dyeri* (non THW. *ex* TRIM.) HEIM Bull. Soc. Linn. Paris, 2 (1891) 957. — *S. cristata* BRANDIS J. Linn. Soc. Bot. 31 (1895) 97; MERR. En. Born. (1921) 404; ASHTON Man. Dipt. Brun. (1964) 106; *ibid.* Suppl. (1968) 106; MEIJER & WOOD Sab. For. Rec. 5 (1964) 102.

HOLOTYPE: Beccari 2115, Sarawak (K).

Leaves 6–20 by 3–9 cm, not lepidote beneath; nerves 13–21 pairs; longer fruit calyx lobes to 20 cm long.

DISTR. Borneo (excepting S.W.). Widespread on clay rich soils on alluvium and especially hillsides and low ridges to 1300 m.

I no longer consider that *S. cristata* can be maintained as a separate species. *S. palosapis* (BLCO) MERR. is undoubtedly closely allied but differs in its amplexicaul stipule scars, large deltoid subpersistent stipules, and its oblong irregular crown, branching from low on the bole.

**Ssp. nebulosa** (MEIJER) *stat. nov.*

— *S. nebulosa* MEIJER Act. Bot. Neerl. 12 (1963) 337; MEIJER & WOOD Sab. For. Rec. 5 (1964) 123.

Partes ut in ssp. *parvistipulata* sed lamina  $-13 \times 6$  cm costis lateralibus utrinsecus minus quam 15; lobis celycis in fructu  $-9 \times 18$  cm differt.

DISTR. N. E. Borneo; Crocker range and Mt. Kinabalu region. Hill forests between 800–1300 m.

HOLOTYPE: San 16355, Paring, Ranau (L).

OTHER COLL.: San. 16273, Ulu Moyah, Sipitang; San A 4378, Keningau; San 17010, 17025, Tambunan; San 16357, Paring, Ranau.

**Ssp. albifolia** ssp. nov.

Partes ut in ssp. *parvistipulata* sed lamina subtus roseoargentea lepidota differt.

DISTR. Borneo: N. E. Sarawak (Niah), Brunei; S. E. Sabah southwards to Balikpapan. Fertile soils on undulating land and periodically inundated alluvium.

HOLOTYPE: S. 29276, Ulu Sekaloh, Niah, Sarawak (L).

OTHER COLL.: Brunei: S. 1689, S. Belaban, Tutong; S. 1692, S. Kiaput, Ulu Tutong; Brun 5630, Ulu Pelangaoung, Belait. Indonesian Borneo: b.b. 34918, Sambodja, Balikpapan, S. E. Borneo.

**Shorea pauciflora** KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 116; BRANDIS J. Linn. Soc. Bot. 31 (1895) 98; BURKILL J. Str. Br. R. As. Soc. 81 (1920) 51, 69; RIDL. Fl. Mal. Pen. 1 (1922) 228; FOXW. Mal. For. Rec. 3 (1927) 51 *p.p.*; *ibid.* 10 (1932) 218; SLOOT. in MERR. Pl. Elm. Born. (1929) 203; BURK. Dict. 2 (1935) 2020; SYM. Mal. For. Rec. 16 (1943) 78; BROWNE For. Tr. Sarawak and Brunei (1955) 149; ASHTON Man. Dipt. Brun. (1963) 207; *ibid.* Suppl. (1968) 114; MEIJER & WOOD Sab. For. Rec. 5 (1964) 133.

ISOHOLOTYPE: Curtis 1537, Penang Hill (K).

— *S. plagata* FOXW. Philip. J. Sc. 13 (1918) Bot. 192; *ibid.* 67 (1938) 308.

ISOHOLOTYPE: F.B. 13758 (Foxworthy, Demesa and Villamil) Fort Banga, Zamboanga Province, Mindanao (K).

— *S. agsaboensis* W. L. STERN Brittonia 17 (1965) 36; ZAMUCO et al. Forestry leaves, Philippines, 15, 3 (1965) 75.

ISOHOLOTYPE: Stern 2102 Tungao, Agsabo R., Agusan, Mindanao (K, LBC).

The type of *S. plagata* differs from *S. pauciflora* substantially only in the unusually small leaf size and the usual but not universal presence of small axillary domatia up the midrib. Foxworthy described the timber as being a heavy red lauan as is *S. pauciflora* and I have little doubt that they are conspecific, though flowers of *S. plagata* are still unknown and would provide useful confirmatory evidence.

Under *S. polysperma* (BLCO) MERR. Foxworthy (*ibid.* (1938) 309) commented on the presence of a hill form in Laguna and Tayabas (now Quezon) provinces, Luzon, known as Tiaong, with significantly lighter softer wood. I have seen this tree in the field, and am convinced that it represents nothing more than the small-leaved extreme in a continuous range of variation in *S. polysperma*, leaf size increasing down the hillside into the valleys sheltered from the typhoons; larger leaved forms prevail in the everwet forests of southern Luzon to Mindanao. However, the name has also been applied by foresters (from Luzon) to a small-leaved tree in timber concessions in northwest Mindanao which undoubtedly represents *S. plagata* though the leaves are generally somewhat larger than the type and more closely match those of *S. pauciflora* KING. There it also has the reputation of being light-timbered and liable to 'trashy heart', which is not in character with *S. pauciflora*; Zamuco et al. found the wood to be anatomically similar to *S. negrosensis* and *S. polysperma* though paler than the former; they did not compare density. Stern, who also regarded the Luzon 'tiaong' to be either *S. polysperma* or *S. negrosensis* described a fresh species on the basis of Surigao del Norte specimens, under the name *S. agsaboensis*.

This form of *S. pauciflora* is now known from throughout Mindanao including Zamboanga, Lanao, Surigao del Norte, Agusan and Bukidnon (according to Foxworthy, specimens destroyed). Flowers are urgently required to establish its exact status, which may be as a distinct subspecies of *S. pauciflora*.

OTHER COLL.: from Mindanao: Stern and Rojo 2102A, Esmade and Tamesis s.n., 30.8.1963, Lomibao 1436, Tungao, Agusan; Tamesis and others CLP N-69, PNH 40893, Mamato plateau, Misamis Oriental; Rojo CLP 1583, Rojo 1570, NALCO, Agusan Norte (all at LBC).

**Shorea singkawang** MIQ. Ann. Mus. Bot. Lugd. -Bat. 3 (1865) 87.

Ssp. **singkawang**. BURCK Ann. Jard. Bot. Btzg 6 (1887) 219; BRANDIS J. Linn. Soc. Bot. 31 (1895) 87; HEYNE Nutt. Pl. ed. 1, 3 (1917) 307; *ibid.* ed. 2, 2 (1927) 1125; FOXW. Mal. For. Rec. 10 (1932) 164; BURK. Dict. 2 (1935) 2022; SYM. Mal. For. Rec. 16 (1943) 92. — *Hopea singkawang* MIQ. Sum. 1 (1860) 489, 191; DC. Prodr. 16, 2 (1968) 635; WALP., Ann. 7 (1868) 379; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1125.

HOLOTYPE: Teysmann s.n., Sidjungjung, Sumatra (U).

— *S. thiseltoni* KING J. R. As. Soc. Beng. Sc. 62, 2 (1893) 122; BRANDIS J. Linn. Soc. Bot. 31 (1895) 265; BRUHL & KING Ann. Bot. Gard. Calc. 5, 2 (1896) 155; BURKILL J. Str. Br. R. As. Soc. 86 (1922) 285; HEYNE Nutt. Pl. ed. 2, 2 (1927) 1125. — *S. forbesii*

KING *ex* BRANDIS J. Linn. Soc. Bot. 31 (1895) 77, *nomen in syn.* — *Pachychlamys thiseltoni* RIDL. Fl. Mal. Pen. 1 (1922) 233; Fl. Mal. Pen. 3 (1927) 38. — *P. beccarianus* (*non* DYER *ex* BRANDIS) RIDL. Fl. Mal. Pen. 1 (1922) 233.

Young twigs, petioles, midrib and fruit calyx caducous ochrous-buff puberulent; panicles, parts of perianth exposed in bud and nut persistently so. Leaves (8-) 12-24 by (2.3-) 5.5-9 cm, oblong-lanceolate, coriaceous; base  $\pm$  broadly cuneate; acumen to 1.5 cm long, tapering; nerves 7-12 pairs.

DISTR. Malesia: Malaya, Lingga, E. Sumatra (Indragiri, Palembang, Lampong).

Ssp. *scabrosa* ssp. nov.

— *Shorea* sp. C. SYMINGTON Mal. For. Rec. 16 (1943) 95.

Ramuli gemmae stipulae petioli costa media costae laterales subtus paniculi calyx externusque primo conferte scabrido fulvo pubescentes costae subtus dein sparsim calyx caduce alteris persistente pubescentes. Lamina coriacissima basim versus obtusa vel cordata acumine brevi vel obtusa costis lateralibus utrinsecus 12-17.

DISTR. Malesia: E. Malaya (coastal Pahang, Trengganu, and N. E. Johor).

HOLOTYPE: Kep. 66959, Bukit Bauk Forest Reserve, Dunguan, Pahang (KEP).

OTHER COLL.: Kep. 26729, 26708, 26734, 26740, 26904, 26755, S. Paka, Trengganu; Kep. 44139, Bt. Lonchong, Ulu Paka; Kep. 94931, 93845, 94934, 94943, 94963, Kerteh, Ulu Chukai reserve, Kemaman, Trengganu; Kep 43058, Dungun; Kep. 31681, 31680, S. Taroh, Lesong F. R., Pahang; SFN 29331, S. Kayu Ara, Mawai-Jemaluang road, Johor.

*Shorea curtisii* DYER *ex* KING J. R. As. Soc. Beng. Sc. 2 (1893) 111; BRUHL & KING, Ann. R. Bot. Gard. Calc. 52, 2 (1896) 152. — ssp. *curtisii*. BRANDIS J. Linn. Soc. Bot. 31 (1895) 101; RIDL. Agr. Bull. S. S. & F. M. S. 1 (1901) 58; Fl. Mal. Pen. 1 (1922) 223; HEYNE Nutt. Pl. ed. 1, 3 (1917) 299; *ibid.* ed. 2, 2 (1927) 1116; BURK, J. Str. Br. R. As. Soc. 81 (1920) 71; FOXW. Mal. For. Rec. 1 (1921) 78; *ibid.* 3 (1927) 39; *ibid.* 10 (1932) 226; BURK. Dict. 2 (1935) 2009; CORNER, Wayside Trees 1 (1940) 213; SYM. Mal. For. Rec. 16 (1943) 67; BROWNE For. Tr. Sarawak and Brunei (1955) 147; ASHTON Man. Dipt. Brun. (1964) 185; *ibid.* Suppl. (1968) 106; MEIJER & WOOD, Sab. For. Rec. 5 (1964) 103.

SYNTYPES: Curtis 427, 1394, 1395, Penang Hill; Kunstler 8143, Larut, Perak, Malaysia (K).

Twig *c.* 1.5 mm  $\phi$  apically. Leaves 6-9 by 2.5-3.5 cm, ovate-lanceolate; nerves 9-11 pairs; petiole 10-13 mm long.

DISTR. Peninsular Thailand (Pattani) and in Malesia: Malaya, Singkep, Lingga, Borneo (Rejang valley to S. W. Sabah).

Ssp. *grandis* ssp. nov.

— *Shorea* sp. B. SYMINGTON Mal. For. Rec. 16 (1943) 95.

Ramuli apices versus *c.* 4  $\times$  2 mm  $\phi$ . Lamina 11-17  $\times$  5-8 cm elliptica costis lateralibus utrinsecus 10-13 petiolo 20-25 mm longo.

DISTR. Malaya: Perak.

HOLOTYPE: Kep 16276, Ulu Chemor, Kinta hills Forest Reserve, Perak (KEP).

OTHER COLL.: Kep 85601, Kinta Hills F.R., Kep 25412, 15440, Upper Chemur valley, Perak; Kep 32165, 33701, 28981, 25642, 40610, Keledong Saiong F. R. Perak.

This distinct form grows in mixture with the type subspecies in the Perak hills.

## A New Variety of *Cnesmone javanica* Bl. from South Andaman Island, India.

by

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### Summary

A new variety *Cnesmone javanica* Bl. var. *glabriuscula* Balakr. & N. G. Nair (EUPHORBIACEAE) is described with illustrations, from South Andaman Island of Bay of Bengal in India.

***Cnesmone javanica* Bl. var. *glabriuscula* Balakr. & N. G. Nair var. nov. Fig. 1.**

Differt a var. *javanica* planta subglabra, gracili; internodiis stipulis et petiolis longioribus; foliis regulatum et minute dentatis; dentibus positibus distantibus; bracteis femineis longioribus; calycibus femineis glabris vel minute disperse puberulis.

Differs from var. *javanica* in being subglabrous slender plant; internodes, stipules and petioles longer; leaves regularly and minutely dentate; teeth distantly placed; female bracts longer; female calyx lobes glabrous or with very minute scattered hairs.

Twining herbs; internodes 15-30 cm long,  $\pm$  4 mm thick, puberulous. *Leaves* oblong-ovate, 6-15 cm long, 4-12 cm broad, cordate at base, acuminate at apex, minutely toothed at margins, with scattered stiff hairs on nerves above, glabrous and light green below; petioles 8-12 cm long,  $\pm$  2 mm thick, puberulous; stipules ovate-elliptic, 12-15 mm long, 4-6 mm broad, cordate at base, acuminate at apex. *Flowers* in leaf-opposed androgynous racemes, apetalous; male flowers superior in the raceme, female flowers inferior; lowest bracts ovate-lanceolate, 12-13 mm long, 8-9 mm wide; upper bracts successively narrower, linear-lanceolate, 2-4 mm long, 1-3 mm broad. *Male-flowers*:—pedicels 3-4 mm long, puberulous; calyx 3-partite, ovate-deltoid,  $\pm$  5 mm long,  $\pm$  8 mm wide; stamens 3,  $\pm$  2 mm long, connective with long aristate and arcuate appendage at apex; anthers oblong, truncate, yellow, longitudinally dehiscent. *Female flowers*:—Calyx 3, imbricate, ovate, acute at apex, cuneate to subobtusate at base,  $\pm$  12 mm long,  $\pm$  8 mm broad, enlarging in fruits; ovary 3-celled,  $\pm$  3 mm diam., covered densely with long stiff white hairs; styles 3, united at base, oblong-ovoid, fleshy,  $\pm$  6 mm long,  $\pm$  3 mm thick; stigmatic surface many-papillose, greenish or rarely pinkish, fleshy; fruiting calyx 12-15 mm long, 8-10 mm broad; fruiting pedicels 3-5 mm long; fruits sparsely white hairy, 3-lobed,  $\pm$  2 cm across,  $\pm$  1 cm high; seeds globose, 6-8 mm in diam., white, smooth.

SOUTH ANDAMAN ISLAND: Guptapara, 23 Nov. 1973, *Balakrishnan* 641 A (HOLOTYPE in CAL); *ibid.* 641 B-E (ISOTYPI in PBL\*); *ibid.* 641 F (ISOTYPI in K); Guptapara, 22 Oct. 1975, *Balakrishnan & Nair* 2287 (PARATYPE in PBL, CAL, K, L, SING).

### Acknowledgments

The authors express their grateful thanks to Mr. H. K. Airy Shaw, Kew for kindly going through the manuscript and giving his expert opinion.

\* Andaman-Nicobar Herbarium, Botanical Survey of India, Port Blair.

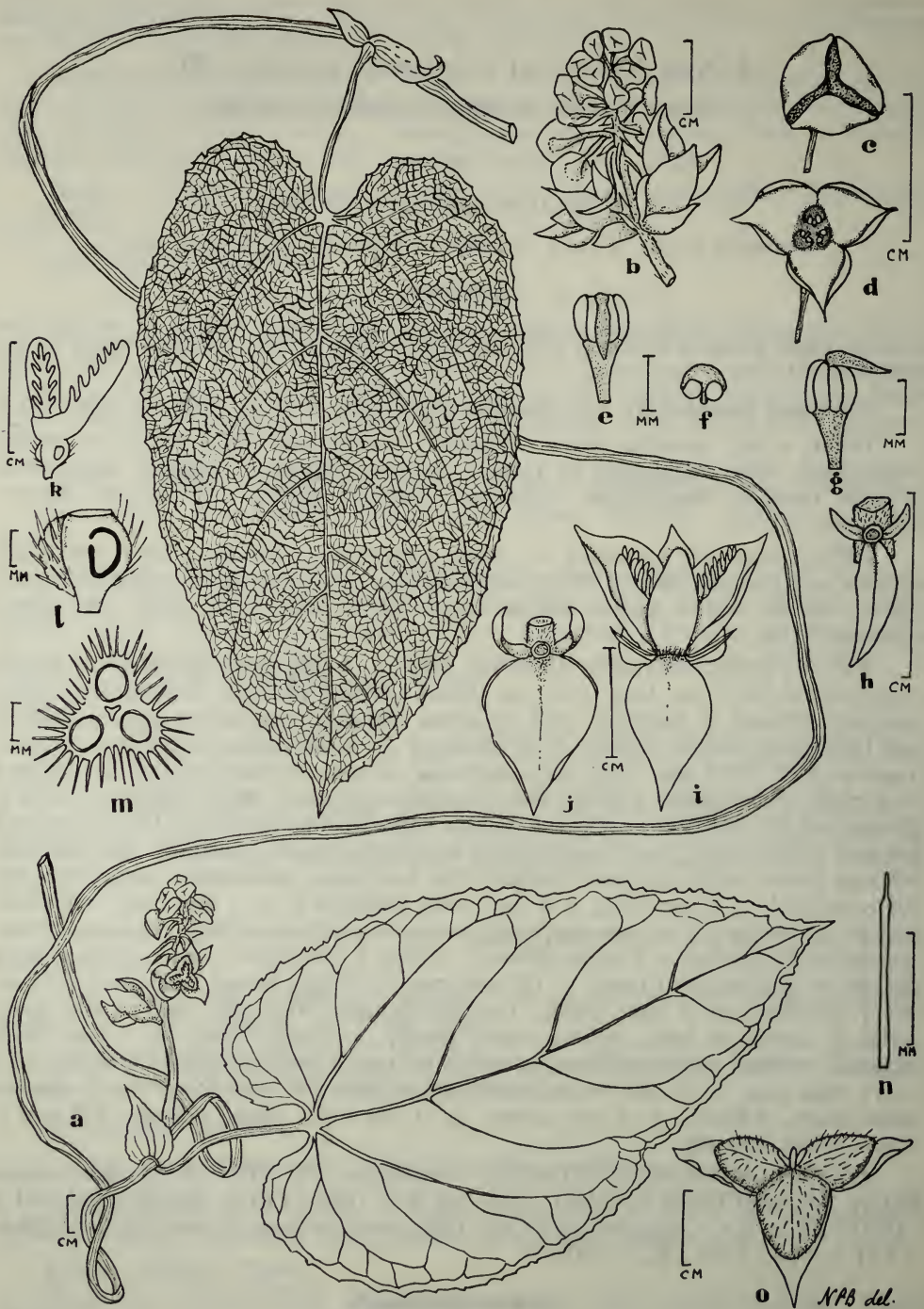


Fig. 1. *Cnesmone javanica* Bl. var. *glabriuscula* Balakr. & N. G. Nair. a. branch; b. inflorescence; c. male flower with closed tepals; d. male flower with open tepals; e. stamens with appendage in normal position; f. anther, top view; g. stamen with appendage lifted up; h. bracts of male flower; i. female flower; j. bracts of female flower; k. ovary, showing stigmatic lobes; l. l.s. of ovary; m. t.s. of ovary; n. hair of ovary; o. fruit with persistent tepals.

## Studies in *Macaranga* VII\*

### The genus in 'Greater India'

by

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#### Summary

Only 12 *Macaranga* are known from 'Greater India', these are keyed out and annotated. Several remain very inadequately collected. *M. gmelinifolia* is reduced to *M. pustulata* and confusion between *M. indica* and *M. peltata* is resolved.

#### Introduction

The term 'Greater India' is used in this paper with no political connotations as a convenient designation for the Indian subcontinent north to the Tibetan frontier, plus Ceylon, the Andaman & Nicobar Islands and Burma. Airy Shaw (*Kew Bull.* 26 (1971) 191–363) has enumerated *Macaranga* for Thailand and the present author for Malaya (*Tree Flora of Malaya* 2 (1973) 106–13). The present contribution extends these studies westwards to the Asian limit of the genus.

In Greater India *Macaranga* is far less rich and diverse than further south and east. The fragmentary ecological notes on collecting labels suggest most species (perhaps all) are gregarious pioneer trees of secondary forest. There are a few slim indications that they are restricted to rain forest and monsoon forest. Further, they extend to elevations which suggest occurrence in lower montane as well as lowland rain forest.

The account is based on the collections at K and BM. There is little material from later than the second decade of this century. In fact, of the thirteen recorded species, only *M. denticulata*, *M. indica*, *M. peltata* and *M. pustulata* are well represented. *M. conifera* is included on the word of Kurz. A second collection is recorded of *M. gamblei*, previously known only from the type.

The recent discovery in the Nicobar and Andaman Islands of *M. nicobarica*, a new species related to *M. gigantea* of West Malesia, suggests that there may be more species awaiting discovery or ranges awaiting extension, and that, just as in Malaya, an observant forest botanist could gather a rich harvest in this genus of conspicuous, gregarious, wayside trees.

#### Abbreviations

The principal publications are abbreviated in the enumeration as follows:

1. Airy Shaw — in *Kew Bull.* 26 (1971) — i.e. Euphorbiaceae of Siam.
2. Brandis, D. — *Indian Trees* (1906).
3. Cowan, A. M. & Cowan, J. M. — *The Trees of Northern Bengal*. Revised by J. S. Gamble (1929).

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\* continued from *Kew Bull.* 29(1974) 445-50.

4. Gamble, J. S. — Flora of the Presidency of Madras 2 (7) (1925).
5. Haines, H. H. The Botany of Bihar & Orissa (1925).
6. Hook, f. — in Hook. f., Fl. Brit. Ind. 5 (1887).
7. Kurz, S. — Forest Flora of British Burma 2 (1877).
8. Muell. Arg. — in DC., Prodr. 15 (2) (1866).
9. Pax & Hoffh. — in Engl., Pflanzenr. IV. 147 (1914).
10. Trimen, H. — A Handbook to the Flora of Ceylon. 4 (1898).
11. Whitmore, T. C. 1973 — Tree Flora of Malaya 2 (1973).
12. Whitmore, T. C. 1975 — *Macaranga*: in The Euphorbiaceae of Borneo. Kew Bull. Addit. Ser. 4.

*Key to Macaranga species in Greater India*

1. Leaves peltate at base ..... 2  
    Leaves not peltate at base ..... 6
2. Stipules persistent ..... 3  
    Stipules immediately or soon caducous ..... 4
3. Leaves below with reddish granular gland dots, sparsely pilose. Bracteoles entire (male) or shallowly irregularly dentate (female). Fruits smooth ..... **M. nicobarica**  
    Leaves below not granular glandular, finely velvety. Bracteoles densely toothed. Fruits spiny ..... **M. tanarius**
4. Leaves with broadly truncate base; basal pair of secondary nerves rather straight; tertiary nerves scalariform, raised, pale, conspicuous on lower surface. Fruits 2-shouldered with short persistent stigmas. Twigs coarsely striate, ochre-fawn tomentose at first ..... **M. denticulata**  
    Leaves with rounded base; basal pair of secondary nerves markedly curved; tertiary nerves not regularly scalariform, not strongly conspicuous, Fruits usually globose, style eccentric. Twigs not coarsely striate, often slightly glaucous ..... 5
5. Leaves usually with 2 large glands near petiole insertion. Bracteoles linear, with a conspicuous apical gland. Fruits *c.* 2 mm diam., pedicel 10 mm, borne on secondary branches; infructescences pyramidal, forming a tangled mass ..... **M. indica**  
    Leaves never with such glands. Bracteoles ovate, dentate. Fruits *c.* 4 mm diam, pedicel 20 mm, borne on primary branches; infructescences oblong, more or less discrete ..... **M. peltata**
6. Some or all leaves with 3–5 lobes ..... 7  
    Leaves not lobed ..... 8
7. Most leaves with 5 lobes, drying beetroot-red beneath. Fruits horned ..... **M. quadricornis**  
    Leaves with 3 lobes. Fruits softly spiny, enclosed in leafy bracts ..... **M. kurzii**
8. Leaves palmately nerved ..... 9  
    Leaves pinnately nerved ..... 10
9. Leaves with 2 glands at petiole insertion; truncate to subcordate. Fruits shouldered. Tree ..... **M. pustulata**  
    Leaves without such glands; truncate. Fruits spiny. Sarmentose shrub ..... **M. trichocarpa**

10. Petioles 10 mm ..... 11  
 Petioles 20 mm or more ..... 12
11. Inflorescences simple, lateral; male thread-like; female capitate, with persistent leafy bracts ..... **M. andamanica**  
 Male inflorescences compound, terminal (female unknown) ..... **M. gamblei**
12. Leaves cuspidate ..... **M. digyna**  
 Leaves acuminate ..... **M. conifera**

**Macaranga andamanica** Kurz: 389 (1877); Pax & Hoffm. vii: 365 (1914); Parkinson, For. Fl. Andaman Is.: 238 (1923); Airy Shaw in Kew Bull. 19: 318 (1965) & 26: 287 (1971); Whitmore in Malayan Nature Journ. 20: 95 (1967), Biol. Journ. Linn. Soc. 1: 225 (1969) & in Tree Flora Malaya 2: 112 (1973).

*M. brandisii* King ex Hook. f.: 453 (1887); Brandis: 592 (1906); Pax & Hoffm. loc. cit. (1914).

*M. bracteata* Merr. in Lingnan Sci. Journ. 6: 281 (1928).

? *M. rosuliflora* Croiz. in Journ. Arn. Arb. 23: 51 (1942).

Lower Burma, Andaman Isl., S. China (Yunnan, Hainan), Indochina (Tonkin), Thailand, Malaya.

A typical species of Sect. *Pseudo-Rottlera*.

**Macaranga conifera** (Zoll.) Muell. Arg.: 1005 (1866). Pax & Hoffm. vii: 392 (1914). Whitmore: 112 (1973) &: 157 (1975).

*Mappa conifera* Zoll. in Linnaea 29: 466 (1857).

*Pachystemon populifolius* Miq., Fl. Ind. Bat. Suppl.: 462 (1861).

*M. populifolia* (Miq.) Muell. Arg.: 1006 (1866); Kurz: 381 (1877); Hook. f.: 450 (1887); Pax & Hoffm. vii: 322 (1914).

Andamans (fide Kurz), Malaya, Sumatra, Borneo.

The only record is that of Kurz, which is entirely plausible both to location and identity.

**Macaranga denticulata** (Bl.) Muell. Arg.: 1000 (1866); Kurz: 387 (1877); Hook. f.: 446 (1887); Brandis: 591 (1906); Pax & Hoffm. vii: 334 (1914); Haines: 108 (1925); Cowan & Cowan: 120 (1929). Whitmore in Malayan Nature Journ. 20: 94, 96 (1967) and in Tree Flora Malaya 2: 111 (1973); Airy Shaw: 288 (1971).

? *Trewia hernandiifolia* Roth, Nov. Pl. Sp.: 374 (1821).

*Mappa denticulata* Bl., Bijdr.: 625 (1825).

*Rottlera glauca* Hassk. in Flora 25. ii Beibl. 2: 41 (1842).

*Mappa gummiiflua* Miq., Fl. Ind. Bat. Suppl.: 430 (1858).

*M. wallichii* Baill., Ét. Gén. Euphorb.: 430 (1858).

*M. truncata* Muell. Arg. in Linnaea 34: 198 (1865).

*Macaranga gummiiflua* (Miq.) Muell. Arg.: 1000 (1866).

*M. perakensis* Hook. f.: 447 (1887).

*M. henricorum* Hemsl. in Journ. Linn. Soc. London 26: 442 (1894).

Common, widely distributed Nepal eastwards in the southern Himalaya, to Burma, Andaman Isl., Thailand, S. China, Malaya, Sumatra and Java.

Distinguished from *M. indica* and *M. peltata* by the broadly truncate base, basal secondaries rather straight and tertiaries straight and parallel (ie. scalariform) and pale and clearly visible on the lower leaf surface. Furthermore, the twigs are usually coarsely striate with an ochre-fawn (but caducous) tomentum, the fruits are two-shouldered with very short reflexed stigmas. Rarely the leaf has several big glands on the main basal nerves near the petiole insertion, but they are smaller than similar glands in *M. indica*, which are always 2 in number.

Roth's description of a peltate-leaved plant with entire bracteoles most closely fits here rather than with *M. indica* where J. D. Hooker thought it might belong. If a specimen can ever be traced the epithet is four years earlier.

**Macaranga digyna** (Wight) Muell. Arg.: 1007 (1866); Hook. f.: 453 (1887); Trimen: 70 (1898); Pax & Hoffm. vii: 323 (1914); Airy Shaw in Kew Bull. 19: 327 (1965).

*Claoxylum digynum* Wight, Ic. Pl. Ind. Or. 5: 23, t. 1884 (1852).

*Rottlera digyna* (Wight) Thwaites, Enum. Pl. Zeylan.: 273 (1864).

*Mappa digyna* (Wight) Muell. Arg. in Linnaea 34: 198 (1865).

Ceylon.

A typical species of section *Pseudo-Rottlera*.

**Macaranga gamblei** Hook. f.: 445 (1837); Brandis: 592 (1906); Pax & Hoffm.: 364 (1914); Cowan & Cowan: 120 (1929). Airy Shaw in Kew Bull. 19: 327 (1965) passim.

*Tanarius gamblei* (Hook. f.) O. Kuntze, Rev. Gen. Pl.: 620 (1891).

Sikkim at Dalkajhar (type, K!) and Darjeeling (Hans 77, BM!)

Pax & Hoffmann place this species in Sect. *Pseudo-Rottlera*. As Hooker remarked it is highly distinctive. Unfortunately it is still only known from the original gathering (Gamble 503C, 503D, ! at K) now a century old (4 [18] 76) and one more recent gathering (1963). Both are male. The Gestalt is of Sect. *Pseudo-Rottlera* but, as Airy Shaw pointed out, the branched, compound, terminal male inflorescence is very different from anything else in the section. More material is needed.

**Macaranga indica** Wight, Ic. Pl. Ind. Or. 5:23, t. 1883 (1852) and 6:5 t. 1949, ii (1853); Muell. Arg.: 1009 (1866); Kurz: 397 (1877); Hook. f.: 446 (1887); Trimen: 70 (1898); Brandis: 592 (1906); Pax and Hoffm. vii: 349 (1914); Haines: 108 (1925); Gamble: 1326 (1925); Cowan & Cowan: 121 (1929); Hurusawa and Tanaka in Hara, Fl. E. Himalaya: 179 (1966); Airy Shaw in Kew Bull. 23: 93 (1969), 26: 290 (1971); Whitmore & Airy Shaw in Kew Bull. 25: 241 (1971); Whitmore: 107 (1973).

W. Peninsular India, Ceylon, E. Himalaya, SW. China, Assam, Andaman Isl., Thailand, Malaya.

Very easily confused with *M. peltata*, and sterile specimens cannot be certainly named. *M. indica* usually has 2 large glands on the leaf near the petiole insertion, but not always; such glands are never present in *M. peltata*. Both species have almost terete twigs which may be glaucous to a variable degree, distinctions from *M. denticulata*. The broad papery stipules are soon to very soon caducous. The leaves in both species are deeply peltate with rounded base, and velvety to almost glabrous below. The bracteoles of *M. indica* are essentially spoon-like, linear, with a large apical gland. Those of *M. peltata* are ovate, dentate, rusty tomentose and very conspicuous. In both species the bracteoles are caducous, especially in the female. The male panicles of *M. indica* have slender zig-zag branches, and those

of the female are slightly zig-zag. *M. peltata* has stouter straightish branches. Both species have the style long and eccentric. The fruits of *M. indica* mature at c. 2 mm diam. rarely it is bilobed (but nearly always in the sparse Malayan material at K); the pedicel is 10 mm long; fruits are borne on secondary branches and the panicles are pyramidal and form dense, tangled clusters. In *M. peltata* the mature fruit is c. 4 mm diam. and the pedicel is 20 mm long; fruits are borne on the primary branches, the infructescences are smaller, racemose and roughly oblong, they do not form dense tangles. *M. flexuosa* has the bracteoles of *M. peltata*; it is clearly conspecific with that, not *M. indica* where it has long been placed.

**Macaranga kurzii** (O. Kuntze) Pax & Hoffm. vii: 360 (1914); Airy Shaw: 290 (1971).

*M. membranacea* Kurz in Journ. As. Soc. Bengal 42: 246 (1873) & For. Fl. Brit. Burma 2: 389 (1877); Hook. f.: 454 (1887); non Muell. Arg. (1866).

*Tanarius kurzii* Kuntze, Rev. Gen. Pl.: 619 (1891).

Lower Burma (apparently rare), Thailand, S.W. China, Indochina.

**Macaranga nicobarica** Balakrishnan and Chakraborty in Gdns' Bull. Sing. 31: 57-60.

Great Nicobar Isl., Katchal Isl., Andamans and possibly Burma at Amherst.

The description suggests that this recently discovered species is related to *M. gigantea* but differs in the entire leaves, the bracteoles entire (♂) or only shallowly irregularly dentate (♀) not deeply dentate, and the leaves below only sparsely pilose and with minutely red — lepidote. Maung Tha Myaing 159 (commun. Lace) at K (!) is very similar but the leaves have two short lateral lobes.

**Macaranga peltata** (Roxb.) Muell. Arg.: 1010 (1866); Pax & Hoffm. vii: 347 (1914); Gamble: 1326 (1925); Cowan & Cowan: 121 (1929).

*M. roxburghii* Wight Ic. Pl. Ind. Or. 5: 23 (1852) & 6: t 1949 iv (1853); Hook. f.: 448 (1887); Brandis: 592 (1906); Haines: 108 (1925).

*M. tomentosa* Wight, Ic. Pl. Ind. Or. 5: 23 (1852) & 6: 1949, i (1853). Muell. Arg.: 1010 (1866); Trimen: 70 (1898).

*M. flexuosa* Wight, Ic. Ind. Or. 5: 23 (1852) & 6: t. 1949, iii (1853); Gamble: 1326 (1925) **Syn. nov.**

*M. wightiana* Baill., Ét. Gén. Euphorb.: 432 (1858).

*Mappa peltata* (Roxb.) Wight, Ic. Pl. Ind. Or. 3: t. 817 (1844).

*Osyris* ? *peltata* Roxb., Fl. Ind. ed. 2, 3: 755 (1832).

India from Sikkim southwards, Ceylon, Andaman Isl., Tenasserim.

Extremely easily confused with *M. indica*, q.v. for a full discussion.

**Macaranga pustulata** King ex Hook. f.: 445 (1887); Pax & Hoffm. vii: 338 (1914); Brandis: 592 (1906); Cowan & Cowan: 120 (1929); Hurusawa & Tanaka in Hara, Fl. E. Himalaya: 179 (1966).

*Tanarius pustulatus* (King ex Hook. f.) O. Kuntze, Rev. Gen. Pl.: 619 (1891).

*M. gmelinifolia* King ex Hook. f.: 445 (1887); Brandis: 592 (1906); Cowan & Cowan: 120 (1929). **Syn. nov.**

Himalaya from Kumaon eastwards, 3-6000 ft., chiefly on old clearings, often gregarious.

**Macaranga quadricornis** Ridley in Bull. Misc. Inf. Kew 1923: 367 (1923) & Fl. Mal. Penins. 3: 300 (1924); Whitmore in Biol. Journ. Linn. Soc. 1: 227-230 (1969) & Tree Flora Malaya 2: 107 (1973) &: 149 (1975); Airy Shaw: 291 (1971) '*M. ? tenuifolia*' sec. Corner: 269 (1940), *an* Muell Arg.?

*M. triloba* sec. Airy Shaw: 292 (1971) in annot. 'Lower Burma' *an* (Bl.) Muell. Arg.

Lower Burma, Thailand, Malaya, Borneo.

**Macaranga tanarius** (L.) Muell. Arg.: 997 (1866); Kurz; 388 (1877); Hook, f.: 447 (1887); Brandis: 592 (1906); Pax and Hoffm. vii: 352 (1914) (excl. synonym. *M. clavata* Warb.); Whitmore in Malayan Nature Journ. 20: 94, 99 (1967), 111 (1973) and: 158 (1975); Airy Shaw in Kew Bull. 23: 999 (1969), in clavi & 26: 291 (1971).

*Ricinus tanarius* L. in Stickm. Herb. Amboin.: 14 (1754) and in Amoen, Acad. 4: 125 (1759).

*Mappa tanarius* (L.) Bl., Bijdr.: 624 (1825).

*M. tomentosa* Bl., Bijdr.: 624 (1825).

*Macaranga molliuscula* Kurz in Journ. As. Soc. Bengal 42: 245 (1873).

Lower Burma, Andaman Isl., Nicobar Isl., S. E. and Lower Thailand, Cochinchina, S. China, Taiwan, Ryu Kyu Isl., throughout Malesia to N. Australia and Melanesia.

**Macaranga trichocarpa** (Reichb. f. & Zoll.) Muell. Arg.: 1003 (1866); Hook. f.: 450 (1887); Pax & Hoffm. vii: 358 (1914); Whitmore in Malayan Nature Journ. 20: 95, 99 (1967), Tree Flora Malaya 2: 112 (1973) &: 158 (1975); Airy Shaw in Kew Bull. 23: 97 (1969), 26 *q.v* for full synonymy, 26: 292 (1971).

*Mappa trichocarpa* Reichb. f. & Zoll. ex Zoll. in Verhand. Natuurk. Vereen. Ned. Ind. 1: 8 (1856), & in Linnaea 28: 307 (1856).

*Macaranga minutiflora* Muell. Arg. in Flora 47: 466 (1864) & in DC.: 1012 (1866); Pax & Hoffm. vii: 358 (1914); Pax apud Schmidt in Bot. Tidsskr. 32: 390 (1916). Brandis: 592 (1906). Kurz: 388 (1877).

*M. helferi* Muell. Arg.: 1004 (1866).

Lower Burma, ? Andaman Isl. (Helfer 4750, K !), Thailand, Indochina, Malaya, Sumatra, Borneo.

### *Doubtful and excluded species*

**Macaranga depressa** (Muell. Arg.) Muell. Arg.: 989 (1866); Hook. f.: 454 (1887); Trimen: 71 (1893); Whitmore: 146 (1975).

This is recorded for Ceylon by Muell. Arg. on the basis of specimen of Thunberg's in Herb. Upsala. The species is a Bornean endemic and I agree with Trimen that there must be an error of labelling.

**Macaranga involucrata** (Roxb.) Baillon, Ét. Gén. Euphorb.: 432 (1858). Muell. Arg.: 1011 ex parte Pax & Hoffm.; Hook. f.: 454 (1887); Pax & Hoffm. vii: 374 (1914).

*Urtica involucrata* Roxb., Hort. Beng.: 67 (1814).

Moluccas. Cult. in Calcutta Botanic Garden (Wallich 4621).

**Macaranga sp.** Hook. f.: 454 (1887) 'Chittagong, (Hook. f. & C. T. Clarke)'. This collection is not represented at BM or K.

## A New Species of *Macaranga* from Nicobar Islands

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### Summary

A new species *Macaranga nicobarica* (Euphorbiaceae) is described with illustrations from Nicobar group of islands in the Bay of Bengal.

During a survey of the flora of Katchal Island in Nicobar group of islands situated in the Bay of Bengal in August 1974, the junior author collected a very large-leaved *Macaranga* from dense evergreen hill forests near a place called Mildera at an altitude of about 100 m above M.S.L. The solitary tree noticed was in flower and three specimens were collected and flowers were preserved in liquid. On study of the materials it is found that they do not fit into any of the described species of *Macaranga*. Again in October 1975 a large population of the same species was noticed near a place called Kapanga on the same island in dense hill forests. They were in fruiting condition. Further studies showed that this can be described as a new species close to *M. gigantea* Reichb. f. & Zoll. but differs in being a smaller tree with larger entire leaves, larger floral bracts completely concealing flowers, entire male bracts, much reduced cupular female perianth and globose seeds. The figures of fruits and seed were drawn from *P. Chakraborty 2584* and the rest from *P. Chakraborty 2041*.

***Macaranga nicobarica* Balakr. & Chakrab. sp. nov. (Fig. 1)**

*M. giganteae* affinis a qua imprimis differt arboribus brevioribus; foliis majoribus integris; bracteis majoribus omnino tegentibus flores; bracteis integris; perianthio reductissimo cupulato, subtruncato, adherenti ovarii basim; seminibus globosis, non compressis.

*Arbor* parva, ramosa, monoecia, 4–10 m alta; caulis principalis 15–25 cm crassus, molliter lignosus, medulla magna; nodi incrassati, hirsuti; rami parce pubescentes; ramuli dense pubescentes; stipulae erectae, lanceolatae peranguste acuminatae ad apices, affixae ad dimidas ambitua caules basibus latis, 4–8 cm longae, 2.5–5.0 cm latae, internodia aequantia vel eis longiora, extra dense villosae hirsutae, intra glabrosae. *Folia* ovata, integra, basi rotundata, apice abrupte breviter tenuiter caudata, 50–70 cm longa, 40–60 cm lata, alte (12–17 cm) peltata, subcoriacea, juniora dense rufo-tomentella, matura supra subglabra subtus parce stellato-pilosa, minute rubro-lepidota; nervi subtus tereti porcati prominentes, stellato pilosi et rubro-lepidoti; nervi primarii 10–12, palmati radiatim ex petiolis apicibus; nervi primarii ascendentes 5; nervi descendentes 5–7, graciliores; nervi laterali ex costis 10–12 jugi; nervi tertiari numerosi, paralleli regulariter scalariformes; nervi minores scalariformes, reticulati, subprominentes; petioli teres, 30–75 cm longi, 1.0–1.3 cm crassi, incrassati ad bases, puberuli ad bases et apices, parce

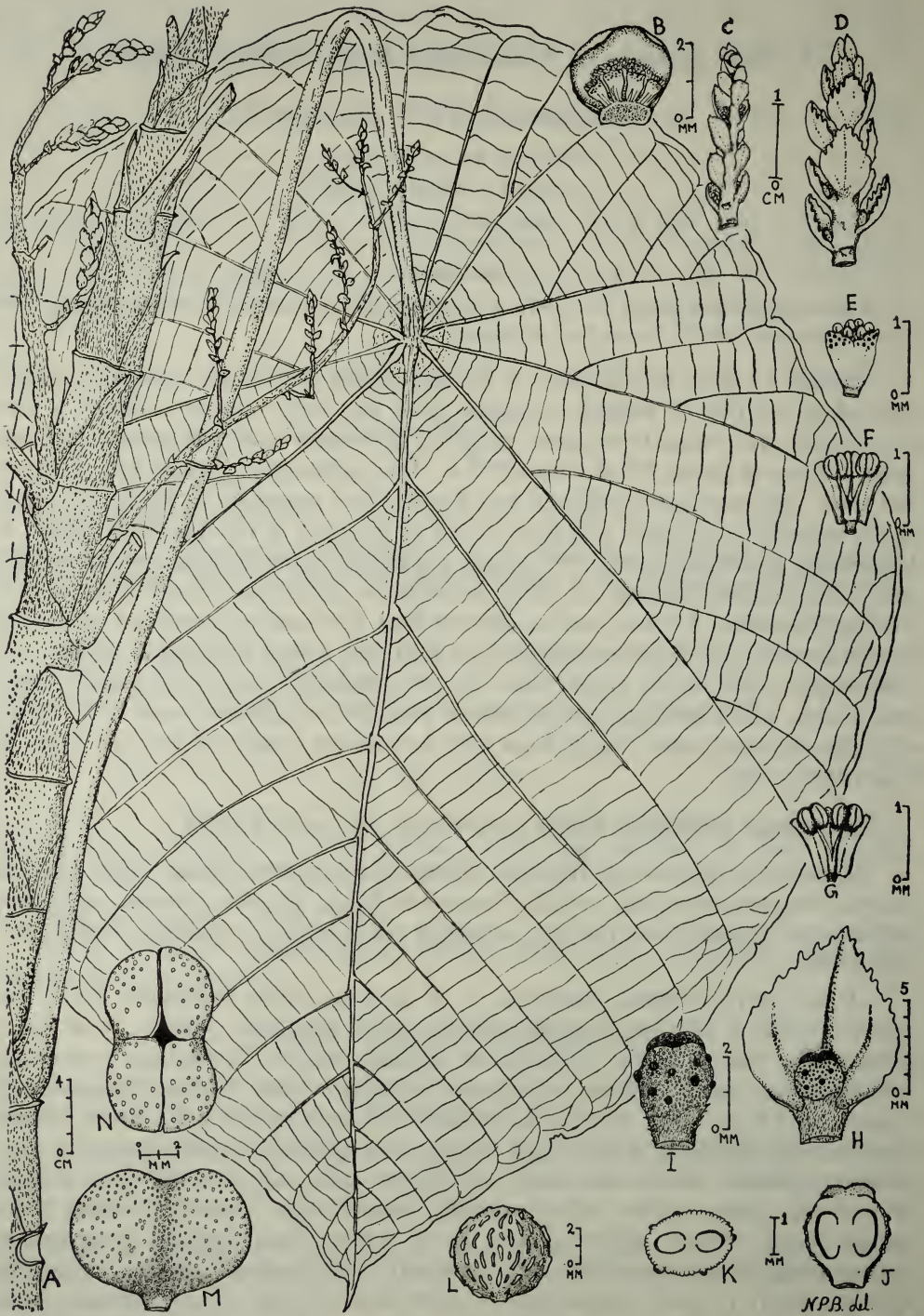


Fig. 1. *Macaranga nicobarica* Balakr. & Chakrab. A. twig; B. male bract with flowers; C. male spike; D. female spike; E. male flower; F. 3-stamened male flower, opened out; G. 2-stamened male flower, opened out; H. female bract with flower; I. female flower; J. ovary, ls.; K. ovary, t.s.; L. seed; M. fruit, side view; N. fruit, top view showing dehiscence.

N.P.B. del.

minute rubro-lepidoti. *Inflorescentia* ♂ laxe paniculata racemosa, gracilis, 20–30 cm longa, dense puberula, ramulis 6–8 cm longis, bracteis ramealibus ovatis 3–5 mm longis persistentibus, bracteis floralibus numerosis laxe spiratim dispositi sessilibus suborbicularibus integris  $\pm$  2.5 cm diametro pubescentibus lepido-glanduliferis. *Flos* ♂ numerosus in axilla bractee omnis, sessilis, fasciculatus; perianthium campanulatum, 3-lobatum,  $\pm$  0.8 mm longum; lobi subacuti, puberuli paucis luteis lepido-glanduliferis ad apices; stamina 2 vel 3,  $\pm$  0.7 mm longa; filamenta connata ad bases; antherae 3–4-locellatae, oblongae, subglobosae longitudinales dehiscentes. *Inflorescentia* ♀ leviter dense paniculatim racemosa, brevior et crassior, 10–15 cm longa, dense puberula; ramulis 5–6 cm longis; racemi strobiliformis; bractee ramis ovatae, sessiles, pubescentes, 3–5 mm longae; bractee florum foliaceae spiratim dense dispositae, erectae, ovatae, subacutae, brevipetiolatae, brevi dentatae pectinatae ad margines, 8–10 mm longae, 6–8 mm latae, intra pubescentes, extra puberulae, luteae lepido-glanduliferes, 3–5-nervatae; nervi supra sulcatae; infra elevatae. *Flos* ♀ solitariis in axillae bractee subsessilis,  $\pm$  3 mm longus; perianthium reductissimum, cupulatum, subtruncatum, adherens versus ovarii basim,  $\pm$  0.8 mm longum, dense pubescens; ovarium biloculare, ovoideum, oblongum, dorsoventraliter compressum, sparsim tuberculatis obtusis atrobrunneis et dense luteo-lepidotis; stigma bilobatim, sessilis, adherens ad ovarii apicem, dense papillosum, atrobrunneum; ovulum solitarium in omni cellula, in placenta axialibus. *Capsula* bicellularis, reniformis, transverse oblonga,  $\pm$  1 cm lata,  $\pm$  6 mm alta,  $\pm$  5 mm crassa, dense rubro-lepidota; semina solitaria in omni cellula, globosa,  $\pm$  4 mm crassa; testa atrobrunnea, crustacea, plurimis fractis porcatis.

NICOBARS. *Katchal Island*: Milder, 11 Aug. 1974, *Chakraborty 2041 A* (HOLOTYPUS in CAL); *ibid.* 2041 B-C (ISOTYPI in PBL\*); *Kapanga*, 19 Oct. 1975, *Chakraborty 2584 A-B* (PARATYPI in PBL); *ibid.* 2584 C-D (PARATYPI in CAL). *Great Nicobar Island*: 33 KM on East-West Road, 22 July 1976, *Balakrishnan 3950* (PBL); *Campbell Bay*, 28 July 1976, *Balakrishnan 4053* (PBL).

Small branched monoecious tree, 4–10 m high; main stem 15–25 cm thick, soft woody with large pith; nodes thickened, hirsute; branches sparsely pubescent; branchlets densely pubescent; stipules erect, lanceolate, narrowly acuminate at apex, attached to half the circumference of stem by broad base, 4–8 cm long, 2.5–5.0 cm wide, equal to internode or longer, densely villous hirsute outside, glabrous inside. *Leaves* ovate, entire, rounded at base, abruptly short slender acuminate at apex, 50–70 cm long, 40–60 cm wide, high (12–17 cm) peltate, subcoriaceous, young ones densely rufous tomentose, mature ones subglabrous above, sparsely stellate-pilose and minutely red lepidote beneath; nerves prominently terete ridged, stellate pilose and red-lepidote; primary nerves 5–7, slender; lateral nerves from midrib 10–12 pairs; tertiary nerves parallel, regularly scalariform; nervules scalariform-reticulate, subprominent; petiole terete, 30–75 cm long, 1.0–1.3 cm thick, thickened at base, puberulous at base and apex, sparsely minutely red-lepidote. *Inflorescence* ♂ lax panicle of racemes, slender, 20–30 cm long, densely puberulous; branches 6–8 cm long; bracts of branches ovate, 3–5 mm long, persistent; floral bracts numerous laxly spirally arranged, sessile, suborbicular, entire,  $\pm$  2.5 mm diam. pubescent, lepidote-glandular. *Flower* ♂ many in axil of each bract, sessile, fasciculate; perianth campanulate, 3-lobed,  $\pm$  0.8 mm long; lobes subacute, puberulous, with some yellow lepidote glands at apex; stamens 2 or 3,  $\pm$  0.7 mm long; filaments

\*Andaman–Nicobar Herbarium, Botanical Survey of India, Port Blair.

connate at base; anthers 3-4-celled, oblong subglobose, longitudinally dehiscent. *Inflorescence* ♀ somewhat densely racemose paniculate, shorter and thicker, 10-15 cm long, densely puberulous; branches 5-6 cm long; racemes strobiliform; bracts of branches ovate, sessile, pubescent, 3-5 cm long; floral bracts foliaceous, dense, spirally arranged, erect, ovate, subacute, shortly petiolate, shortly dentate pectinate at margins, 8-10 mm long, 6-8 mm wide, pubescent inside, puberulous and yellow lepidote glandular outside, 3-5-nerved; nerves sulcate grooved above, raised beneath. *Flower* ♀ solitary in axil of each bract, subsessile,  $\pm$  3 mm long; perianth much reduced, cup-shaped, subtruncate, adherent to base of ovary,  $\pm$  0.8 mm long, densely pubescent; ovary 2-celled, ovoid-oblong, dorsoventrally compressed, sparsely obtuse dark brown tuberculate and densely yellow lepidote; stigma bilobed, sessile, adherent to top of ovary, densely papillose, black brown; ovule solitary in each cell, on axile placenta. *Capsule* 2-celled, reniform, transversely oblong,  $\pm$  1 cm wide,  $\pm$  6 mm high,  $\pm$  5 mm thick, densely red-lepidote; seed solitary in each cell, globose,  $\pm$  4 mm thick; testa dark brown, crustaceous, with many broken ridges.

#### Acknowledgement

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# Plantlets from Paulownia Tissue Culture

by

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## Summary

Plantlets were produced from white and firm callus tissue of *Paulownia taiwaniana* Hu & Chang initiated on a modified Murashige and Skoog medium. Illuminated by 400 ft.-c of light for 16 hrs/day at 25°C., leafy shoots were initiated followed by roots at a later stage. Whole plantlets were then isolated from callus. Plantlets after transplanting into the soil survived.

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## Introduction

There have been many successful cases in the induction of complete plants from tissue and cell culture of herbaceous angiosperms and monocots (Murashige, 1974) (1). However, plantlets from woody tree tissue culture have been reported only in very limited cases. According to Winton (1974) (2) plantlets have been produced successfully by tissue culture method in the following few trees; *Eucalyptus citriodora* (3), *Ephedra foliata* (4), *Zamia floridana* (5), *Pinus palustris*, *Pinus elliottii*, *Pinus rigida* (6), *Populus tremuloides* (triploid, tetraploid and diploid plants), *Populus alba* (7, 8, 9), *Ulmus glabra* (10), *Ilex aquifolium* (12), *Eucalyptus obliqua*, *Eucalyptus viminalis* (12), *Broussonetia kaziniokii* (13), *Populus deltoides*, *Populus nigra* (14, 15), *Citrus sinensis* (16, 17, 18, 19), *Citrus aurantiifolia* (20), *Citrus maxima* (21), *Populus euramericana* cv. *robusta*, *Manihot esculenta* (22).

This paper reports \* the success of organ initiation from *Paulownia taiwaniana* stem callus into complete plantlets and the transplanting of these plantlets in open air.

The genus *Paulownia* is a native of East Asia and has been introduced to Europe and North America for commercial purposes. It is a kind of lumber tree renowned for its light weight combined with strength. It has been used extensively in industries for making chest, guitar and other types of musical instruments. It is also useful for building small boats and as military aircraft plywood.

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\* A preliminary note under the same title has been published in Chinese in the Taiwan Forestry Research Institute Bulletin No. 286 in December 1976.

### Materials and Methods

The physiological conditions required for callus production and organ initiation into plantlets varied somewhat with the age of the explants employed. Generally, the younger the explants, the easier the organ initiation. Two types of *Paulownia taiwaniana* (23) stems, one from seedlings and the other from saplings of approximately one year old were used to initiate callus culture.

1. Seedling stem callus cultures: *Paulownia* seeds were sterilized in 10% w/v calcium hypochloride and sown aseptically on agar medium containing only inorganic salts of Murashige and Skoog medium 1964 (24). Toole and his associates in 1958 (25) found *Paulownia* seeds required more light energy for germination than seeds like lettuce. Thus, for the germination of *Paulownia* seeds, the cultures were exposed to 400 ft-c of light for 16 hours each day. Four to six weeks were required to initiate germination and likewise for the seedling stem to grow to a length of 2 cm with a diameter of 0.05 cm. The seedling stem was very slender and it was very difficult to separate the nodes from the internodes. Subsequently two-thirds of the length from the apex of these slender stems were cut off to induce straighter and stronger new shoots to grow out from the seedling stumps. It took only two to three weeks for a new shoot to grow to a stem of 8 to 10 cm in length and 0.2 cm in diameter. Nodes and internodes of the stem could be clearly distinguished. The seedling stem was excised into nodal and internodal segments of 0.2 to 0.3 cm in length. Nodal and internodal segments were planted separately on 5 different media (Table I). All cultures were grown at 25°C in darkness. Temperature has been found to be an important factor. If the temperature was higher than 28°C degree, the callus culture turned brown.

Table I. Nutrient Medium Composition for Formation of Callus from *Paulownia* (all values expressed as milligrammes per liter).

Constituent	A	B	C	D	E
NH <sub>4</sub> NO <sub>3</sub>	1650	1650	1650	1650	825
KNO <sub>3</sub>	1900	1900	1900	1900	950
MgSO <sub>4</sub> 7H <sub>2</sub> O	370	370	370	370	185
CaCl <sub>2</sub> 2H <sub>2</sub> O	440	440	440	440	220
KH <sub>2</sub> PO <sub>4</sub>	170	170	170	170	85
FeSO <sub>4</sub> 7H <sub>2</sub> O	27.84	27.84	27.84	27.84	13.92
Na <sub>2</sub> EDTA	37.24	37.24	37.24	37.24	18.62
MnSO <sub>4</sub> ·H <sub>2</sub> O	16.9	16.9	16.9	16.9	8.45
ZnSO <sub>4</sub> ·7H <sub>2</sub> O	8.6	8.6	8.6	8.6	4.3
H <sub>3</sub> BO <sub>3</sub>	6.2	6.2	6.2	6.2	3.1
KI	0.83	0.83	0.83	0.83	0.415
CoCl 6H <sub>2</sub> O	0.025	0.025	0.025	0.025	0.0125
CuSO <sub>4</sub> ·5H <sub>2</sub> O	0.025	0.025	0.025	0.025	0.0125
Na <sub>2</sub> MoO <sub>4</sub> ·2H <sub>2</sub> O	0.25	0.25	0.25	0.25	0.125
Thiamine, HCl	0.4	0.4	0.4	0.4	0.4
myo-Inositol	100	100	100	100	100
Indole-3-acetic acid	—	—	—	—	5
2,4-D	3.0	0.3	3.0	0.3	—
Kinetin	0.03	0.1	0.03	0.1	2.5
Casein hydrolysate	—	—	3000	3000	—
Coconut Milk	—	—	—	—	15%
Sucrose	3000	3000	3000	3000	3000

2. Sapling stem cultures: Five one year old *Paulownia* saplings of height two-feet tall were grown in pots in the open. Stem segments of 0.3 to 0.5 cm in length and 0.5 to 0.8 in diameter were excised from both green hairy young shoots and old brown lignified stem and planted on 5 different media (Table I). The cultures were incubated in darkness until callus was produced. The callus was then cut into four to six pieces and transferred to 11 different media E, F, G, H, I, F', G', H', I', J, K (Table II) for organ initiation. Medium E, found to produce white and firm callus was chosen as the medium for producing stock callus for organogenesis studies. Thus some of the callus was subcultured in medium E and incubated in darkness for stock callus. All callus tissues for organogenesis studies were incubated under 400 ft-c light for 16 hours per day at 25°C in various media. Eleven media, E, F, G, H, I, F', G', H', I', J, and K were used in organ initiation studies (Table II). All the callus used in these studies were from brown lignified internodal stem. Media E, F, G, H, I are Murashige and Skoog medium with varying concentrations of kinetin and Auxin. Media F', G', H' and I' are the same as F, G, H, I respectively except that there is a higher concentration of ammonium nitrate (2000 mg/l instead of 1650 mg/l). Media J and K are Winton's (26). *Aspen* medium with zero and 0.15 mg/l 6-amino-benzyladenine respectively. The callus tissues planted in various media were all kept under 400 ft-c light for 16 hours/day at 25°C.

Table II. Nutrient Medium Composition for Formation of Plantlets from *Paulownia* Callus (all values expressed as milligrammes per liter)

Constituents	F	G	H	I	F'	G'	H'	I'	J	K
Inorganic salts	MS	MS	MS	MS	MS <sup>1</sup>	MS <sup>1</sup>	MS <sup>1</sup>	MS <sup>1</sup>	W <sup>2</sup>	W <sup>2</sup>
Organic constituents										
Thiamine, HCl	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.1	0.1
myo-Inositol	100	100	100	100	100	100	100	100	100	100
Nicotinic acid	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Glycine	2	2	2	2	2	2	2	2	—	—
Pyridoxine, HCl	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.1	0.1
Adenine sulfate (dihydrate)	40	80	40	40	40	40	40	40	—	—
Kinetin	1	0.6	2	6	1	0.6	2	6	1	0
6-Benzyladenine	—	—	—	—	—	—	—	—	—	0.15
Indole-3-acetic acid	0.1	0.2	2	2	0.1	0.2	2	2	—	—
Sucrose	3000	3000	3000	3000	3000	3000	3000	3000	2000	2000
Coconut Milk	15%	15%	15%	15%	15%	15%	15%	15%	—	—
2, 4-D	—	—	—	—	—	—	—	—	0.04	—

1  $\text{NH}_4\text{NO}_3$  2000 mg per liter, the rest of the composition as Murashige & Skoog Medium (1962)

2 Same as Winton Medium (1970)

## Results

Stem segments excised from green hairy young shoots of *Paulownia* harboured all kinds of contaminants in the hairs and were very sensitive to surface sterilization with calcium hypochloride. They had no chance to form callus for they were killed by either contamination or sterilization procedures. On the other hand the brown lignified stem can resist sterilization procedures. The outside layers were easily peeled off before segmenting into lengths of 0.3 to 0.5 mm and planting on the media. Thus more than 90% stem segments in culture formed callus after four to six weeks' growth in darkness.

Fine media (Table I) were used to produce *Paulownia* stem callus. On medium A, callus was produced in the first week but appeared to be a very loose soft structure of brown color. Media B and C produced firm callus of mixed white and brown color. Medium D failed to produce callus. Medium E produced white and firm callus. Thus callus from medium E was chosen for organogenesis studies. The time required to form callus from different stem sections of *Paulownia* on Medium E is as shown in Table III.

Table III. Callus Formation from Stem Segments

	% formed callus	Time required to form callus
Seedling internode	100%	2-3 weeks
Seedling node	100%	2-3 weeks
lignified brown stem node	100%	4-6 weeks

It has been found that in brown lignified stem sections, culture callus grew from the cambium and phloem regions, and thus looked like a doughnut in shape. When the callus was cut into four to six pieces and subcultured on medium E under the same conditions each piece grew into a new lumpy callus of 2 cm diameter in three weeks (Fig. 1).

After two to three weeks, the callus planted in media F, G, H and I enlarged quickly and turned bright green in colour. Though the callus appeared as if it would sprout any time yet it turned brown and withered after a couple of months with no formation of shoots at all. The callus in media F', G', H' and I' showed a pale green colour and no shoots came out after two months. The callus in media J and K grew slowly, turned into a brown colour and finally died. Surprisingly, the callus in medium E showed green spots and started to sprout (Fig. 2) after several weeks exposure to 400 ft-c light for 16 hours per day at 25°C. The time required for shoots to sprout from callus tissue from various stem sections is shown in Table IV.

Table IV — Shoot Formation from Callus

	% Sprouting	Time required to sprout
Seedling internode	50-60 %	3- 5 weeks
Seedling node	95-100%	2- 3 weeks
Callus from brown lignified stem-internode and subcultured several times	20-30 %	6-10 weeks

Two or three weeks after the sprouting, roots started to grow out and whole plantlets were isolated (Fig. 3). The plantlets after transplanting into the soil survived (Fig. 4).

Callus from seedling node has almost 100% chance to sprout shoot compared to callus from stem internode section. Possibly because node have pre-existing axillary buds (meristem). Cells from meristem tissue usually are more active than cells from other tissues and are always more easy to form adventitious bud. Callus from the lignified internode stem showed a lower percentage of sprouting than callus from seedling internode. There are three possible reasons to explain this. Firstly, all the callus from lignified stem segments for organ initiation studies have been subcultured several times. The same phenomenon has been reported in carrot tissue (27). Secondly, the more subculturing done, the lesser the origin cambium tissue left. Cambium is a kind of meristem tissue and may form adventitious bud. Thirdly, the brown lignified tissue is older than tissues of the seedling stem. The younger the tissue, the easier it is to form adventitious bud.

Results of organ initiation in the 10 media indicate that tests on *Paulownia* requires a higher concentration of auxin than kinetin. Adverse results were shown in the media F, G, H, I, F', G', H' and I' where there was less kinetin than auxin. The callus turned green but no shoots were formed whereas in medium E with the concentration of auxin doubled that of kinetin the callus sprouted. Yet, medium E had only half the strength of inorganic salts of the other eight media. Whether half strength instead of full strength of Murashige and Skoog inorganic salts is of critical importance for organogenesis or not requires further research.

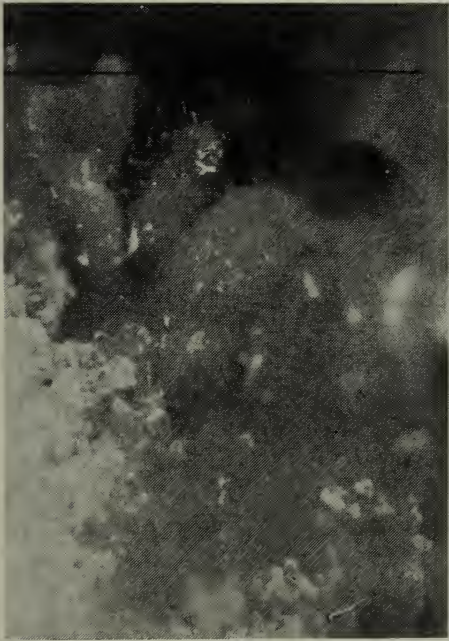
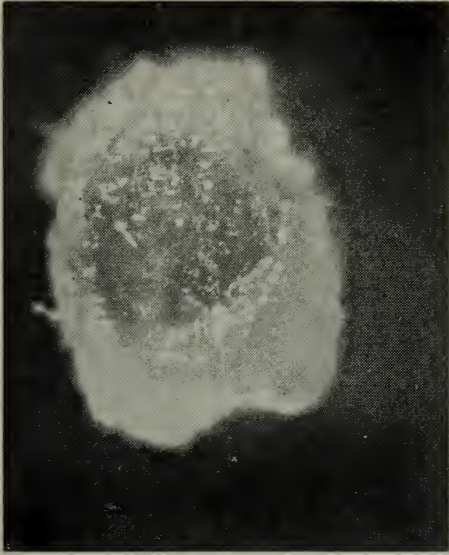
It is observed that the seedling with the top cut off produced new shoots which grew faster and straighter. This is also true for *Paulownia* sapling in the forest. There must be some hormone stimulation for adventitious shoot formation following the removal of the stem apex. However, some plantlets isolated from callus grew even faster than adventitious shoots from the seedling stumps in flask culture. This may be due to the effects of auxin and kinetin which were present in the media used for organ initiation. It is also possible that quick growing plantlets isolated from callus are polyploids (28). Further research on the chromosomes of the plantlets can reveal whether the faster rate of growth of the plantlets isolated from callus is due to polyploidy or not. Plantlets from tissue culture method of some other woody plant has been reported to be difficult to survive in the open on soil because of the defective root system. They dehydrated and died after transplanting in the soil. However, plantlets of *Paulownia* produced in this experiment after transplanting into the soil survived (Fig. 4).

It has been found that medium E is very good for callus formation. Medium E has induced the formation of white and firm callus from:— rice anther in anther culture, chrysanthemum stem, rose stem, dahlia underground stem and some other plants. In the case of *Begonia*, new plantlets have been found on segments of flower stalks in medium E under direct light.

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left

Fig. 1. Subcultured callus from brown lignified stem segment of *Paulownia taiwaniana*. (x 0.5)

Fig. 2. Young shoot sprouting from callus of brown lignified stem. (x 50)

right

Fig. 3. *Paulownia* plant produced from tissue culture, (x 1)

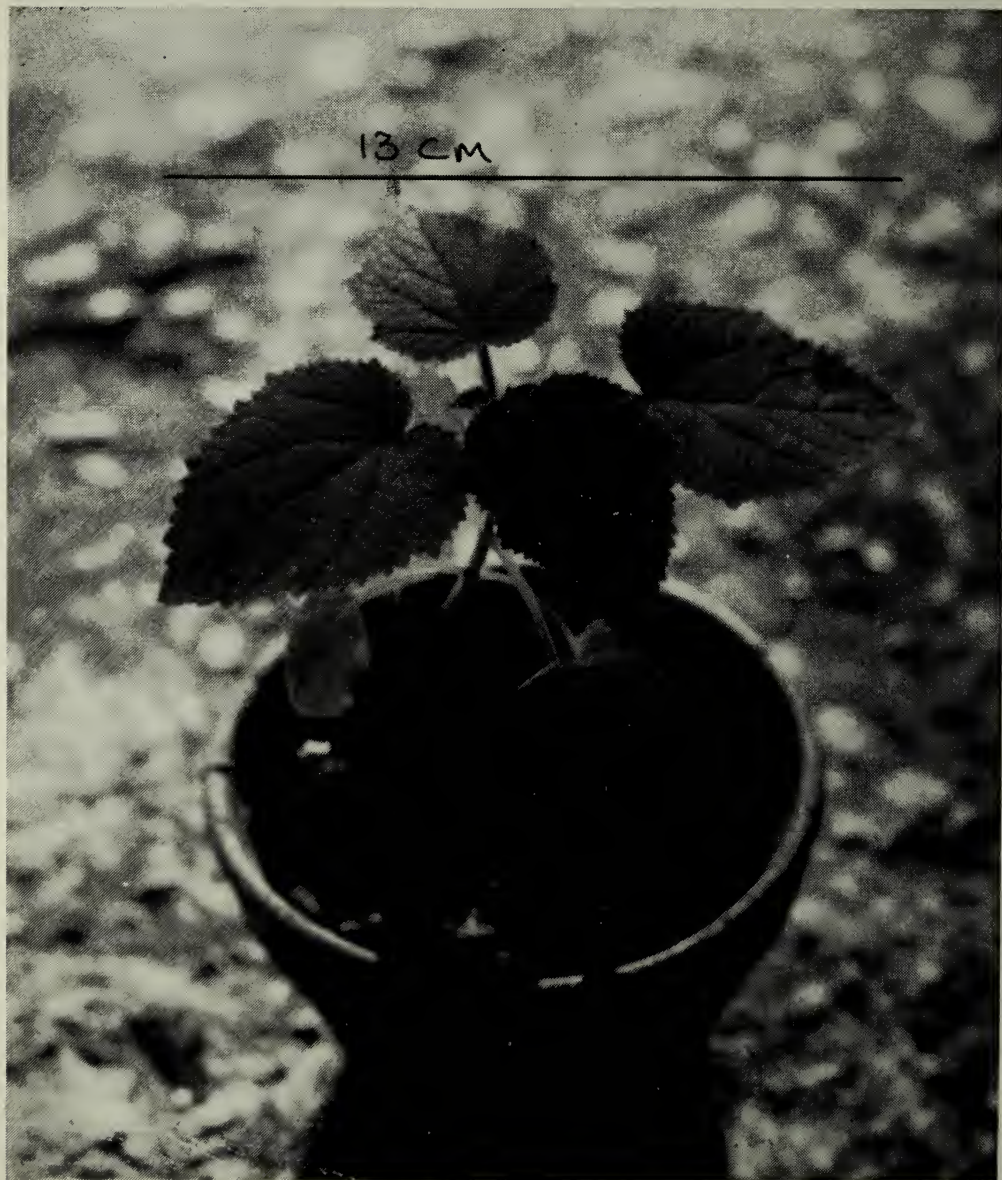


Fig. 4. *Paulownia taiwaniana* planted in soil.

## SAURAUIAE GERONTOGEAE

### II. Notes on some species of Java

by

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#### Abstract

Nomenclatural notes are given for 4 species from Java: *Saurauia bracteosa* DC., *S. javanica* (Nees) Hoogl. (*Reinwardtia javanica* Nees; syn.: *S. reinwardtiana* Bl.), *S. lanceolata* DC. (syn.: *S. micrantha* Bl.), and *S. microphylla* Vriese (syn.: *S. blumiana* Benn. non *S. blumeana* Spreng.). *S. bogoriensis* Hoogl. is described as a new species from Java.

#### Introduction

In the course of the preparation of a new account of the species of *Saurauia* of Java, it was found that some nomenclatural adjustments are required. As further fieldwork in Java is envisaged before the full account is presented, these are published here in advance.

During visits to the Ciapus gorge on the slopes of the Salak near Bogor in 1973 and 1975, specimens were collected of an apparently undescribed species. For assistance in this and other fieldwork in West Java the author is indebted to the Director of Herbarium Bogoriense, Dr. Mien A. Rifai, and his staff, in particular Gregory Hambali without whose assistance it would have been impossible to obtain the material on which the description of this new species is based.

Herbarium specimens were studied in and from the same herbaria as listed in the first paper of this series, and their cooperation is gratefully acknowledged. For the opportunity to study the Noronha manuscript, containing the plates and descriptions on which *Saurauia gigantea* DC. and *S. cauliflora* DC. are based, the author is indebted to the librarian of the Central Library of the Muséum National d'Histoire Naturelle, Paris.

The illustrations of *S. bogoriensis* were prepared by Mrs. Cathy Porter.

#### I. NOMENCLATORIAL NOTES ON SOME SPECIES

1. *Saurauia bracteosa* DC. in Mém. Soc. Phys. Hist. Nat. Genève 1 (1822) 423, t. vi A. — LECTOTYPE: "ex India tulit Lahaye" in P-JU (11,955).

*Synonyms*: *Saurauia bracteosa* var. *punctata* DC. l.c. (1822) 423, t. vi B. — HOLOTYPE: "Java — De La Haye. Hb. DELESSERT" in G.

*Saurauia gigantea* DC. l.c. (1822) 424; Bl., Bijdr. Fl. Ned. Ind. (3) (1825) 129. — TYPE: "Scapha gigantea. Noronha ic. ined. in bibl. Juss.", now in the Bibliothèque Centrale du Muséum National d'Histoire Naturelle (manuscripts 42 and 43, plate 59).

*Saurauia blumeana* Spreng., Linn. Syst. Veg. (ed. 16) 4 (2) (1827) 210. — TYPE: "Java (*S. gigantea* Blum.)."



Fig. 1. *Saurauia bogoriensis* Hoogl. Flowering branch,  $\times \frac{2}{5}$ . After Hoogland 12628.

The protologue for *S. bracteosa* is inconclusive as to whether the typification "*Hab. In Java. La Haye* (v.s.sp. in herb. Deless.)" applies to the species or to its variety *punctata*. In the Prodrômus [1 (1824) 526] De Candolle typified the species "in Javâ (v.s. in h. Juss.)", but the variety, though mentioned, is not typified. The only specimen in the Delessert herbarium in Geneva annotated by De Candolle clearly forms the basis for his var. *punctata*, and is accepted as HOLOTYPE for the variety. In the absence of clear typification of the species in the original publication and on the basis of the reference in the Prodrômus I accept the specimen in the Herbarium A.L. de Jussieu the LECTOTYPE for the species. There are in the main herbarium in Paris two further sheets of specimens collected by De Lahaie (no. 2118) which may represent isotypes. The differences for var. *punctata* are so slight that this specimen may even have been collected from the same tree.

*S. gigantea* was described by Blume without any reference to the earlier publication by De Candolle, though he gave the same Sundanese name: "Kileho mundin(g)". Blume appears to have had access to the De Candolle publication as he compared his new species *S. reinwardtiana* [l.c. (1825) 128] with *S. bracteosa*. It is reasonable to assume that Blume used De Candolle's name, supplying his own description. To me there is no doubt that the same species was involved, and consequently that there was no taxonomic justification in Sprengel supplying a new name for Blume's taxon. I refrain from typifying his *S. blumeana*; Sprengel's description could have been based merely on Blume's, or he may have had an actual specimen which should be considered the type. I have seen no such specimen.

## 2. *Saurauia javanica* (Nees) Hoogl., *comb. nov.*

*Basionym*: *Reinwardtia javanica* Bl. ex Nees in Syll. Pl. Nov. Ratisb. 1 (1822) 98 = *Blumia javanica* (Nees) Spreng., Linn. Syst. Veg. (ed. 16) 3 (1826) 126 = *Saurauia blumia* Steud., Nomencl. Bot. (ed. 2) 1 (1840) 212 et 2 (1841) 440, 516, *nom. illeg.* — TYPE: Blume, "Habitat ad *Salak Javae insulae*", lost; NEOTYPE: Blume s.n., "Sallak", in L (908.251-1101).

*Synonym*: *Saurauia reinwardtiana* Bl., Bijdr. Fl. Ned. Ind. (3) (1825) 128. — TYPE: "in montosis *Javae insulae*"; LECTOTYPE: Blume s.n., "Sallak", in L (908.251-1101).

The detailed generic and specific descriptions of *Reinwardtia javanica* Nees are in all aspects in full agreement with the genus *Saurauia* and the species currently known as *S. reinwardtiana* Bl. Koorders and Valetton [in Bijdr. 3 Booms. Java (1896) 250] do not wish to include Nees's taxon in *Saurauia* but they have apparently not seen the original description, only Sprengel's excerpt. Their objection against the yellow colour of the flowers as given by Sprengel, is not valid as Sprengel misinterpreted Nees's description "*Floris aperti interiora lutea*" which is perfectly acceptable in *Saurauia* as indicating the colour of the anthers.

I am using the same specimen to typify *Reinwardtia javanica* Nees and *Saurauia reinwardtiana* Bl. which I hope will eliminate any confusion which might otherwise arise in the future. *S. javanica* is one of a number of closely similar taxa found in Java, Sumatra, and Borneo, and including i.a. *S. hirsuta* Bl., *S. dasyantha* Vriese, and *S. trichocalyx* Kds & Val.

## 3. *Saurauia lanceolata* DC. Mém. Soc. Phys. Hist. Nat. Genève 1 (1822) 421, non t. iv. — TYPE: "Hab. in Java ubi dicitur *Popko*. Lechenault. (v. s. sp. in h. Mus. Par.)"; HOLOTYPE in P.

*Synonym*: *Saurauia micrantha* Bl., Bijdr. Fl. Ned. Ind. (3) (1825) 127. — TYPE: "ad margines catarrhactarum fervidarum montis Gede."; LECTOTYPE: Blume s.n., Java, in L (910.95-454).



Fig. 2. *Saurauia bogoriensis* Hoogl. a. Individual inflorescence from cluster on main trunk,  $\times \frac{1}{2}$ ; b. open flower,  $\times 2\frac{1}{2}$ ; c. longitudinal section of flower,  $\times 2\frac{1}{2}$ ; d. stamens,  $\times 2\frac{1}{2}$ ; e. flower section without corolla and stamens,  $\times 2\frac{1}{2}$ ; f. immature fruit,  $\times 2\frac{1}{2}$ . All after Hoogland 12628.

The confusion which arose from the discrepancy between the original description of *Saurauia lanceolata* and the plate associated with it has prevented this name from having been accepted for a Javanese species. As already indicated by Choisy [in Mém. Soc. Phys. Hist. Nat. Genève 14 (1855) 116] and more recently again by Merrill [in J. Arn. Arb. 35 (1954) 144, t. i], plate iv of De Candolle's, though given the name *Saurauia lanceolata* and referred to in the text under that name bears no relationship to the species described on the basis of the Lechenault specimen in the Paris herbarium, a photograph of which was reproduced in Merrill's paper. Choisy suggested that De Candolle's remark on the similarity of this species and *Apatelia lanceolata* was due to him not realising that his illustrator had twice sent him a drawing of the one species. Similarly the introduction of his [var.] *β. glabrata* can only be understood as having been made in the final stage of the manuscript without reference to actual specimens; only the single collection by Lechenault appears to be involved.

The plate is referable to *Apatelia lanceolata* (Ruiz & Pavon) DC., a South American species described and illustrated in the same publication [DC. l.c. (1822) 427, t. viii] which is now considered synonymous with *Saurauia biserrata* (Ruiz & Pavon) Spreng.

*Saurauia lanceolata* is endemic to West Java.

4. *Saurauia microphylla* Vriese, Pl. Ind. Bat. Or. (1856) 49. — TYPE: "In insulae Javae monte Dieng ibique in sylvis vidit cel. Junghuhn"; LECTOTYPE: Junghuhn 62 in L (910.95-619), ISOTYPES in G, L.

*Synonym: Saurauia blumiana* Benn., Pl. Jav. Rar. (1840) 174, t. 37, *nom. illeg.*, non *S. blumeana* Spreng. 1827. — TYPE: Horsfield, Java; HOLOTYPE: Horsfield 1 : 105 in BM.

Because of the earlier homonym the name for this well known species, so excellently illustrated by Bennett, unfortunately has to be changed. Under Article 73 of the Seattle Code *blumeana* and *blumiana* are to be considered orthographic variants which invalidates the later name. The variant *blumeana*, preferable in accordance with Recommendation 73C of the Code as the name honours C.L. Blume, has been used for the species under consideration by several later authors, e.g. Choisy & Zollinger, De Vriese, Miquel, Koorders, Koorders-Schumacher, Koorders & Valetton, and Gilg & Werdermann.

The type collection of *S. microphylla* has, as suggested by the epithet, particularly small leaves. These specimens were gathered from a 30 m tall tree whereas all other collections seen, as far as adequately annotated in this respect, represent shrubs or small trees up to ca 6 m only. It is not unusual in tropical trees for leaf size to decrease with tree height. The height indicated for this particular collection greatly exceeds that recorded for any of the other species known from Java though tall trees are well known to occur amongst species of *Saurauia* elsewhere, e.g. in New Guinea.

*Saurauia microphylla* is endemic to Java, most frequent in Central and East Java and absent in the Western half of West Java.

## II. A NEW SPECIES FROM WEST JAVA

5. *Saurauia bogoriensis* Hoogl. *sp. nov.* (fig. 1, 2)

Arbor parva usque 10 m alta, 20 cm diametro. Folia ovato-oblonga vel oblonga, plerumque 17-27 cm longa, 8-11 cm lata, 12-18-nervata, apice obtusa subacuminata, basi obtusa ad rotundata, petiolo 4-6 cm longo. Inflorescentiae solitariae, usque 5 cm longae in axillis foliorum, solitariae vel 2-4 fasciculatae, usque 8 cm longae in axillis cicatricium foliorum in ramulis minoribus, usque 10 vel plures fasciculatae, usque 25 cm longae in ramulis crassioribus et in trunco;

cyosae, identidem ramosae, pauciflorae vel usque 100-florae. Pedunculus brevis, usque 2 cm longus, subcrassus (2 mm diametro). Pedicelli usque 2 cm longi, 1 mm diametro, bracteis bracteolisque ovato-oblongis usque 5 mm longis, 2 mm latis. Sepala 2 exteriora late triangulari-ovata, 7.5-9 mm longa, 9.5-11.5 mm lata; 2 interiora transverse elliptica, 7.5-9 mm longa, 8.5-11 mm lata. Corolla late campanulata, ca 10 mm longa, 35 mm diametro; tubus 3.5-4.5 mm longus, 11-12.5 mm diametro; lobi 11-14 mm longi, 10-14 mm lati, apice bilobulati. Stamina plerumque 25-35, filamentis subaequalibus 3.5-5.5 mm longis, antheris versatilibus dorsifixis 2.5-3.5 mm longis. Ovarium conicum, apice rotundatum, 2.5-3 mm longum, 4.5-5 mm diametro, dimidio inferiori glabrum, dimidio apicali pilosum, (3-) 4-5 (-6)-loculare; styli 7-8 mm longi, basi 2-2.5 mm connati.

Squamae tenuiter subulatae, in ramulis usque 8 mm longae, in costa usque 5 mm longae, secus nervos et in intervenio usque 3 mm longae; costa et nervi facie inferiori foliorum dense squamosi, facie superiori sparsim squamosi; intervenium facie inferiori foliorum satis dense squamulosum et, inter squamas, dense villosum, facie superiori glabrum.

TYPE: *Hoogland 12628*, Ciapus Gorge SW of Bogor, W. Java, 6 June 1975, in dense fairly low forest on steep slope at ca 650 m altitude. HOLOTYPE in CANB, ISOTYPES being distributed to A, BO, G, K, L, US, SING.

Further collections examined: *Hoogland 12384* (collected from the same tree as the type; B, BO, CANB, KEP, MEL, P, SING, US), *12631* (BO, CANB, L), *Van Steenis 5649* (BO, L).

When I first collected it, I had confused this species with *S. cauliflora* DC. on account of the similarity in leaf shape and nature (including colour) of the tomentum. On subsequent analysis of the flowers there appeared to be clear distinguishing features between the two species: while in *S. cauliflora* the outer sepals are glabrous, or have at most only a few scales on the outside, they have a dense cover of scales and floccose tomentum similar to the lower side of the leaves in *S. bogoriensis*. The number of stamens in the flowers of *S. cauliflora* generally ranges between about 16 and 20, in those of *S. bogoriensis* between 25 and 35. The number of ovules per carpel is of the order of 150-160 in *S. cauliflora*, of 400-550 in *S. bogoriensis*. The number of carpels per flower varies from 2-4 (mostly 3) in *S. cauliflora*, from 3-6 (3 and 6 only rare) in *S. bogoriensis*. The ovary of *S. bogoriensis* has a tomentum of fairly stiff, generally straight hairs in the upper part, that of *S. cauliflora* is glabrous or has a loose thin-floccose tomentum in the upper part. The inflorescence of *S. bogoriensis* is much more clearly and divergently branched than that of *S. cauliflora*, particularly in the cauline clusters. *Saurauia cauliflora* rarely, if ever, exceeds 5 m in height and 10 cm in diameter, whereas both trees of *S. bogoriensis* collected by me were about 10 m tall and 20 cm in diameter.

The epithet of the new species, apart from its geographical connotation, honours the National Biological Institute at Bogor.

# SAURAUIAE GERONTOGAEAE

## III. Two new species from Flores

by

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### Abstract

Two new species of *Saurauia* are described from the island of Flores in the Lesser Sunda Islands: *S. schmutzii* Hoogl. and *S. verheijenii* Hoogl.

### Introduction

From a study of herbarium specimens it has become apparent that the genus *Saurauia* is represented in the Lesser Sunda Islands by some species extending their range eastward from Java, as well as by some other, endemic ones represented on one or more islands of the chain. During a short visit to Flores in June 1975 the author was able to collect two of the endemic species which are here formally described.

Fieldwork from Ruteng was greatly facilitated by Fathers Jilis A. J. Verheijen and Erwin Schmutz of the Catholic Mission at Ruteng, and by Father M. Malar, the Rector of the Mission. The assistance of the Bupati, Mr. Salesius Lega, is also gratefully acknowledged.

The illustration of *S. schmutzii* was prepared by Mrs. Cathy Porter, that of *S. verheijenii* by Miss Jill Ruse.

#### 1. *Saurauia schmutzii* Hoogl., *sp. nov.* (fig. 1)

Arbor parva usque 7 m alta, 10 cm diametro. Folia oblonga, plerumque 12-32 cm longa, 5-14 cm lata, 18-25-nervata, apice obtusa usque acuta, basi retusa vel subcordata, petiole 4-6 cm longo. Inflorescentiae solitariae vel 2-6 fasciculatae in axillis foliorum vel cicatricium foliorum, nonnullae in ramulis brevibus in axillis foliorum parviorum (usque 8 × 4 cm); dichasiales, 1-12-florae, usque 7 cm longae. Pedunculus 2-3 cm longus. Pedicellus 5-15 mm longus. Sepala ovalia vel suborbicularia, 2 exteriora 4.5-6 mm longa, 5-6 mm lata, 2 interiora 7-7.5 mm longa, 6-7 mm lata. Corolla anguste campanulata, 11-12 mm longa, 12-15 mm diametro; tubus 1.5-2 mm longus, 7-8 mm diametro; lobi 10-12.5 mm longi, 8.5-11.5 mm lati, apice bilobulati. Stamina plerumque 20-26, filamentis 2-3 mm longis, antheris versatilibus dorsifixis 1.5-2.5 mm longis. Ovarium depresso globosum, ca 2.2 mm altum, 3.7 mm diametro, parte basali glabrum, parte apicali sparsim villosum, (4- vel) 5-loculare; styli 4.5-5 mm longi, basi 0.5-1 mm connati.

Squamae suborbiculares usque acuminatae, glabrae; inter squamas tomentum villosum. Squamae ramorum usque 4 mm longae, 1 mm latae (plerumque minores), foliorum usque 2 mm longae, pedunculorum et pedicellorum usque 1 mm longae. Tomentum plerumque densum, sed facie superiori foliorum apertum.

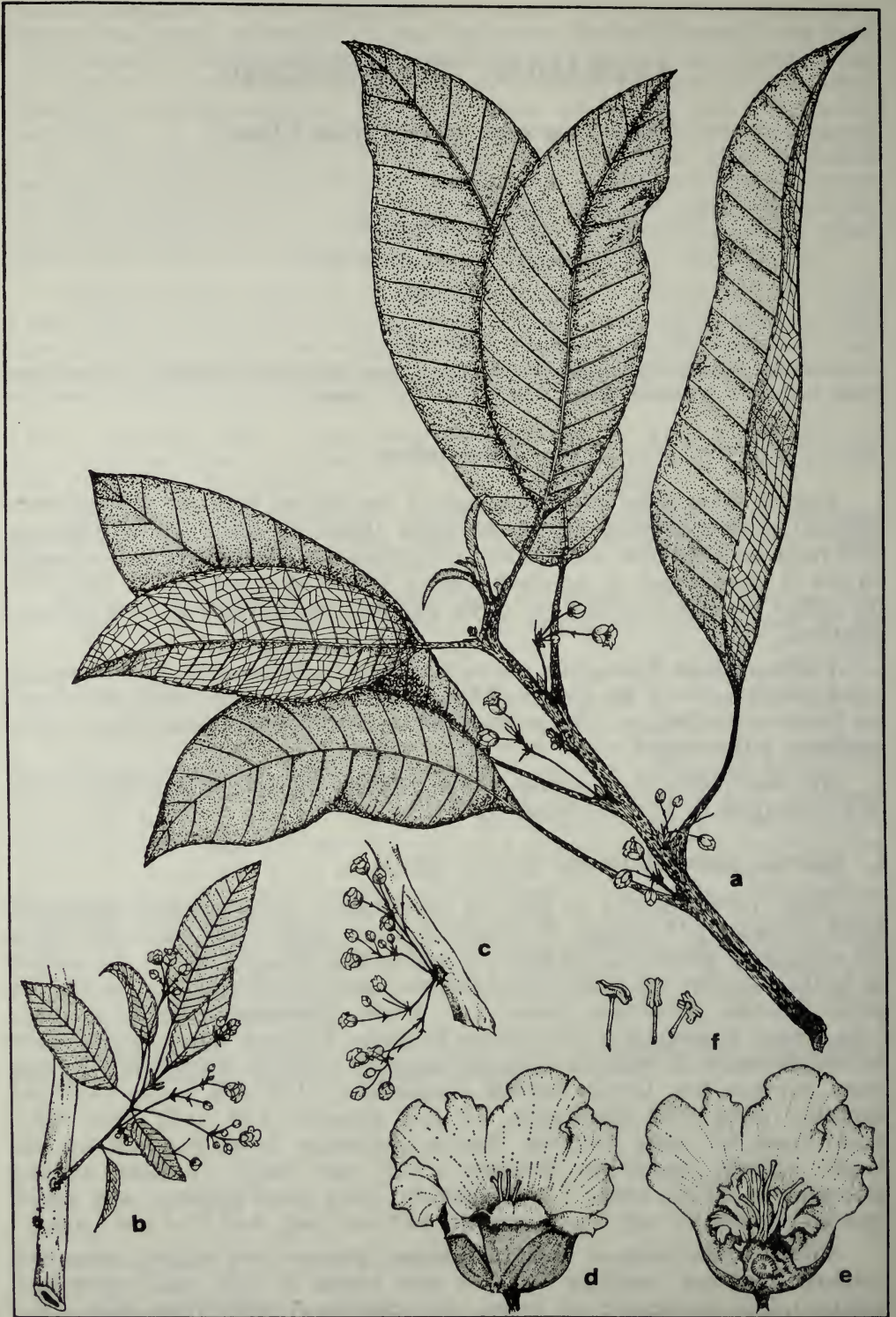


Fig. 1. *Saurauia schmutzii* Hoogl. a. flowering branch,  $\times \frac{1}{3}$ ; b. small-leaved lateral flowering branch,  $\times \frac{1}{3}$ ; c. clustered inflorescences on leafless branch,  $\times \frac{1}{3}$ ; d. open flower,  $\times 2$ ; e. longitudinal section of flower,  $\times 2$ ; f. stamens,  $\times 2$ . All after Hoogland 12652.

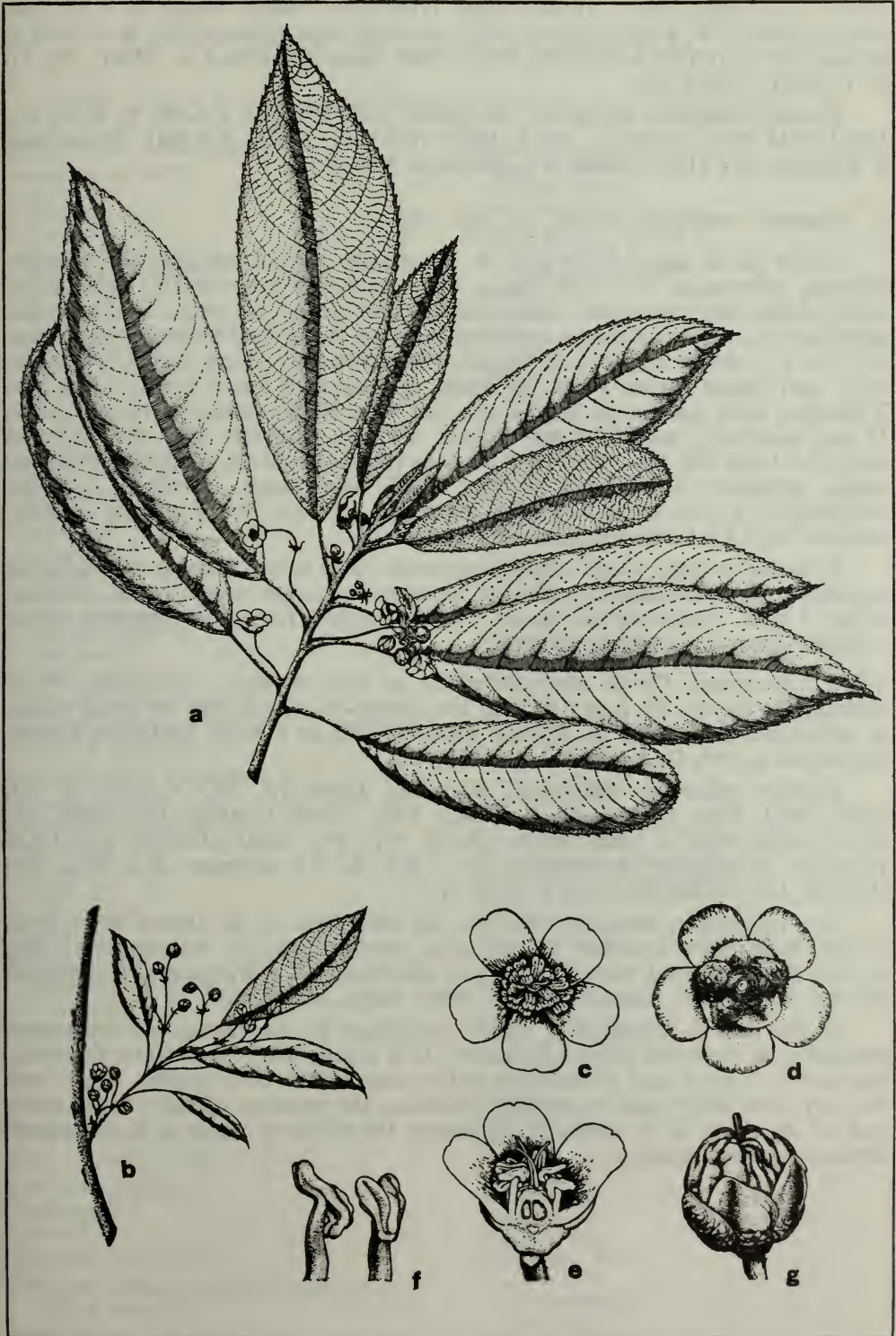


Fig. 2. *Saurauia verheijonii* Hoogl. a. flowering branch,  $\times \frac{1}{4}$ ; b. small-leaved lateral flowering branch,  $\times \frac{1}{4}$ ; c. open flower, upper view,  $\times 1\frac{1}{2}$ ; d. open flower, lower view,  $\times 1\frac{1}{2}$ ; e. longitudinal section of flower,  $\times 2$ ; f. stamens,  $\times 4$ ; g. immature fruit,  $\times 2$ . All after Hoogland 12648.

TYPE: *Hoogland 12652*, Tsuntsarompe creek near Nderu village ca 2 km due west of Ruteng, W. Flores, 28 June 1975, on steep slope of deep gully at ca 1200 m altitude. HOLOTYPE in CANB, ISOTYPES being distributed to BISH, BO, G, K, L, MEL, SING, US.

Further collections examined: *Hoogland 12650* (A, BO, CANB, E, KEP, L), *12651* (BM, BO, CANB, L, NY), *12657* (CANB), *12658* (CANB), *Kostermans & Wirawan 883* (BO, CANB, L), *Verheijen 784* (L).

## 2. *Saurauia verheijenii* Hoogl., *sp. nov.* (fig. 2)

Arbor parva usque 12 m alta, 30 cm diametro. Folia oblonga vel obovato-oblonga, plerumque 11-25 cm longa, 4-10 cm lata, 13-16-nervata, apice acuta usque obtusa, basi late acuta usque rotundata, petiolo 3-5 cm longo. Inflorescentiae solitariae vel 2-4 fasciculatae in axillis foliorum vel cicatricium foliorum, racemosae, (1-) 3-5 (-7)-florae, usque 7 cm longae. Pedunculus 0.5-3.5 cm longus. Pedicellus 20-25 mm longus. Sepala ovata vel ovalia, 2 exteriora 8.5 mm longa, 7 mm lata, 2 interiora 9-9.5 mm longa, 6.5-7.5 mm lata. Corolla campanulata, 12 mm longa, 15 mm diametro; tubus 1-2 mm longus, 5.5 mm diametro; lobi 12.5-13.5 mm longi, 7.5-9 mm lati, apici bilobulati. Stamina plerumque 21-26, filamentis 3-4.5 mm longis, antheris versatilibus dorsifixis 3-3.5 mm longis. Ovarium conicum, rotundatum, 3 mm altum, 4.2 mm diametro, glabrum, verrucosulum, 3-4(-5)-loculare; styli 4.5-5 mm longi, basi 2.5 mm connati.

Squamae anguste acutae usque acuminatae, basi villosa excepto glabrae; inter squamas tomentum stellatum villosum. Squamae ramorum usque 3 mm, foliorum usque 2 mm, pedunculorum usque 1 mm longae. Tomentum apertum, faciei superiori foliorum interdum nullum.

TYPE: *Hoogland 12648*, near Golorukal at foot of Poco Taduwalog, W of Ruteng, W. Flores, 26 June 1975, in low forest on alluvial fan on lower slopes of mountain, at ca 1500 m altitude. HOLOTYPE in CANB, ISOTYPES being distributed to BO, G, K, L, MEL, SING, US.

Further collections examined: *Hoogland 12644* (A, BO, CANB, K, L), *12645* (BO, BRI, CANB, E, L, SING, US), *12647* (CANB, L), *12649* (A, BM, CANB, NSW), *12653* (BO, CANB, NY, P), *12655* (CANB, L), *12656* (CANB), *Kostermans & Wirawan 579* (BO, K, L), *Schmutz 272* (L), *3846* (CANB, L), *Verheijen 333* (L), *2076* (L).

The two species here described are the only ones so far known to occur in Flores. Both were collected in the close surroundings of Ruteng, with only *S. verheijenii* collected elsewhere as well (*Schmutz 272*: Wangkung, probably at 800-900 m altitude: *Schmutz* in litt.; *3846*: Naga, at 900 m).

In the field *S. schmutzii* is readily recognised by the ferruginous tomentum, especially on the lower side of the leaves. It is usually more abundantly flowering, but there is a great deal of variation in this character in both species. Apart from the very clear differences in external tomentum, the presence of hairs in the upper part of the ovary in *S. schmutzii*, as against the glabrous ovary of *S. verheijenii*, separates the two species.

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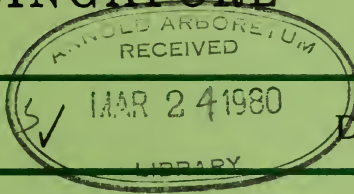
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## Notes on the Systematy of Malayan Phanerogams

### XXV AQUIFOLIACEAE \*

by

R. KIEW

*Agricultural University of Malaysia, Serdang, Selangor, Malaysia.*

#### ABSTRACT

*Ilex tahanensis* Kiew nom. nov. replaces *I. rupicola* Ridley — a nomen nudum; *I. polyphylla* Ridley and *I. triflora* var *longifolia* Ridley are reduced to *I. triflora*; and *I. venulosa* var *nervulosa* Loes. is *I. macrophylla* Hook. f.

#### ILEX

##### ***Ilex tahanensis* Kiew nom. nov.**

*I. rupicola* nomen nudum Ridley J. Fed. Mal. St. Mus. 6:142, 1915; Fl. Mal. Pen. 1:439, 1922.

**non:** *Ilex rupicola* Humboldt, Bonpland & Kunth, Nov. Gen. Sp. 7:55, 1824; Loesener Nov. Acta Acad. Caes. Leop-Carol. Nat. Cur. 78:170-1, 1901.

*Ilex tahanensis* most resembles in its habit and foliage *I. epiphytica* King, a widespread montane holly, and *I. praetermissa* Kiew, which is only known from Klang Gates Ridge, Selangor. It is distinguished from these two species by its inflorescence, a simple cyme with a long peduncle about 1 cm long: *I. epiphytica* has umbels and *I. praetermissa* has solitary fruits. Ridley (1915) had originally described his species as having terminal panicles but corrected this in his flora. Most species of *Ilex* bear their flowers on young shoots, the flowers develop before the leaves so that the whole shoot has the appearance of a terminal inflorescence.

I have called this species *tahanensis* because it was originally described in Ridley's paper (1915) entitled "The Botany of G. Tahan, Pahang". It is a rare montane shrub known only from G. Tahan (Pahang) and G. Rabong (Kelantan).

Specimens: Pahang, G. Tahan. Ridley 16040 (Type) K!, Ridley 16173 K!, Haniff & Nor 7993 SING!; Kelantan, G. Rabong, Soepadmo & Mahmud 1072 KLU!

***Ilex triflora*** Bl. Bijdr. 1150, 1826, Loesener loc. cit. 344-347, Ridley Fl. Mal. Pen. 1:438, 1922, Hu J. Arnold Arb. 30:328-333, 1949.

**Syn. nov.** *Ilex polyphylla* Ridley J. Fed. Mal. St. Mus. 4:45, 1915, Fl. Mal. Pen. 1:438-9, 1922. *Ilex triflora* var *longifolia* Ridley Fl. Mal. Pen. 1:438, 1922.

*Ilex triflora* is the most common Malayan holly and is found on almost every mountain. It is also the Malayan holly with the widest geographical range, extending from China through Indo-China and Assam to Malaya and south to Borneo, Sumatra and Java (Kiew & Stone, in press). It is extremely variable in such characters as the indumentum, shape and size of the leaf and the length of

\* continued from Gdns' Bull. Sing. 28:231-234 1976.

the fruit pedicel. This variation led Loesener to describe seven varieties, two of which were present in Malaya viz. var. *lobbiana* (Rolfe) Loes. and var. *kurziana* Loes. Hu considered that there was no key character to separate the material collected from the various geographical areas and concluded that *I. triflora* was a variable species. She reduced Loesener's seven varieties as there were no constant differences in floral and fruit characters to support them.

Within Malaya the variation in leaf shape and size is marked (Corner, 1940, Text-fig. 116 and Kiew, in press). This variation does not correlate with any floral or fruit characters or with geographical range. Thus *Ilex polyphylla* from G. Kerbau, Perak, was characterised by small, thick leaves with a shiny upper surface (Ridley, 1915); similar plants have been collected from the Cameron Highlands, Pahang and G. Ulu Kali, Selangor. Specimens of *I. triflora* collected from the Cameron Highlands, where several peaks are readily accessible, show a complete range of leaf shape and size. Ridley's var. *longifolia*, with larger and thinner leaves, does not represent a lowland form as his original collections are from the montane vegetation of Taiping Hills (1000m), Perak, where typical specimens are also present. Odd plants with equally large and thin leaves have been collected from several other localities, such as Cameron Highlands, where the typical form predominates. Neither *I. polyphylla* nor *I. triflora* var. *longifolia* can be justified as distinct taxa and are here reduced to synonymy with *I. triflora*.

***Ilex macrophylla*** Hooker f. Fl. Brit. Ind. 1:704-5, 1872. King J. As. Soc. Bengal ii 64:136, 1895. Loesener loc. cit. 84. Ridley Fl. Mal. Pen. 1:442, 1922, Corner Wayside Trees 329 & fig 115, 1940.

**Synonym:** *Ilex venulosa* var. *nervulosa* Loesener loc. cit. 90. Ridley loc. cit. 442.

Specimen: Singapore, Beccari s.n. FI sheet no. 2935, 2935A & 2935B FI!

*Ilex venulosa* is a Burmese species and has not been recorded from Malaya. Loesener's variety is known from a single unnumbered collection made by Beccari in Singapore. Examination of photographs of this collection show that Loesener's variety is *Ilex macrophylla* in young bud with leaves more coriaceous than the average specimen. Both *I. macrophylla* and *I. venulosa* have large entire, membranous or subcoriaceous leaves and cymose inflorescences with many tiny fruits. *I. venulosa* can readily be distinguished from *I. macrophylla* by its long acumen (up to 5 cm long) and the inflorescence which is a trichotomously branched cyme with extremely short secondary branches giving the inflorescence the appearance of a stalked umbel: in contrast, *I. macrophylla* has an acumen up to 1½ cm long and the inflorescence is an open lax cyme with secondary branches about ½-1 cm long. Loesener's description of var. *nervulosa* differed from that of the Burmese variety in its shorter acumen, 1-1½ cm long, and its lax inflorescence, thus conforming to the description of *I. macrophylla*.

Loesener records his variety from Malacca but this is probably an error as he cites Beccari's single specimen from Singapore. Ridley had not seen this specimen but took Loesener's description for his flora. Singapore has been intensively collected and several collections of *I. macrophylla* exist from Bukit Timah and it is from these trees that Corner (1940) based his observations on the flowering, fruiting and leaf fall of this species.

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# ANNOTATED LIST OF SEED PLANTS OF SINGAPORE (V)\*

by

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\* Continued from Gdns' Bull. Sing. 28: 237-258, 1976.

## II. ANGIOSPERMAE-DICOTYLEDONS (Continued)

## 57. PROTEACEAE

*Helicia excelsa* (Roxb.) Bl.

Tree; racemes erect; densely covered with dark red soft hairs; in forests; Chua Chu Kang, Kranji, Mandai Road (*Sinclair 40049*).

*Hel. petiolaris* Benn.

Tree, glabrous; racemes thick, angled; Bukit Mandai, Changi (No specimens available).

*Hel. robusta* R. Br. ex Wall.

Tree, glabrous; racemes stout, lax; Bukit Timah, Gardens' Jungle (No specimens available).

## 58. PIPERACEAE

Key to the genera

- A. Low herbs, erect; leaves without stipules ..... *Peperomia*  
 A. Mostly woody plants, climbing or erect; stipules present, joined to the leaf-stalk ..... *Piper*

*Peperomia pellucida* HBK.

Tiny herb; stem and leaves succulent and translucent; flowers very small and simple, in long spikes. A common garden weed, native of S. America.

*Pep. sandersii* DC. var. *argyreia* Bailey

Herb; leaves ovate, with 9 broad white bands between the veins. This and a few other species are sometimes cultivated as pot plants.

*Piper betle* L.

The leaves of this plant (known as betel pepper) together with betel nut (*Areca catechu* L.), are used for chewing. Native of E. and C. Malesia.  
 Vern. *Sireh*, 玳 蓚

*Pip. caninum* Bl.

Slender climber or small trees; leaves variable in shape and size; common in woods; Seletar, Gardens' Jungle (*Chew 1467*), Kranji, Siglap, Pulau Tekong.  
 Vern. *Sireh utan*.

## Piper chaba Hunter

Climbing, glabrous; leaves oblong or ovate; near and almost identical with *Pip. betle* from the Malay Islands. Vern. *Bakek*.

## Pip. flavimarginatum C. DC.

Woody climbers or trees; leaves ovate; Chua Chu Kang, Bukit Timah (*Corner 34996*).

## Pip. lanatum Roxb.

Slender climber; Ponggol (*Ridley, s.n.* in 1905). Prob. not specifically distinct from *Pip. caninum*.

## Pip. maingayi Hook. f.

Climber; leaves elliptic-lanceolate; rarely flowering; common; Bukit Timah, Gardens' Jungle, Chua Chu Kang.

## Pip. minatum Bl.

Climber; fruit spikes red; in woods; Bukit Mandai, Tuas, Chua Chu Kang, Reservoir Areas. Vern. *Sireh Ayer*.

## Pip. muricatum Bl.

Erect herb or shrubby; stem and leaves hairy; in woods, not common; Bukit Timah, Chua Chu Kang, Jurong.

*Pip. nigrum* L.

A climbing shrub of the Malabar Coast of India. Pepper of commerce is the dried and ground fruits of this plant; black pepper is the whole dried fruit, and white pepper is the fruit which has been retted in water and the mesocarp removed. Vern. *Lada hitan* 胡椒

## Pip. pachyphyllum Hook. f.

Glabrous climber; leaves broadly ovate; in forests; Bukit Timah, Gardens' Jungle.

## Pip. pedicellosum Wall.

Woody climber; leaves elliptic ovate; in woods; Chua Chu Kang.

## Pip. porphyrophyllum N. E. Br.

Slender; leaves ovate-cordate, deep green spotted silver and pink; rarely fruiting; in woods; Bukit Timah, Seletar, Gardens' Jungle (*Hullett 397*).

## Pip. protractum C. DC.

Erect shrubby; leaves oblong; in woods; Jurong, Chua Chu Kang.

## Pip. ribesioides Wall.

A climber; leaves ovate-oblong; not common; in Reservoir Woods (*Sinclair 40227*).

*Piper sarmentosum* Roxb.

Erect herb, with long runners; common in villages and shady places as a weed. Vern. *Chabei, Kadok*.

## 59. CHLORANTHACEAE

*Chloranthus elatior* R. Br. ex Link

Shrublet, with slender spikes of white flowers and translucent white berries; in damp ravine in jungles, formerly locally abundant; Bukit Timah (*Holtum 19791*), Bukit Mandai, Kranji, Jurong. Called *Chl. officinalis* Bl. in Ridley's Flora.

*Chl. spicatus* (Thunb.) Makino

A pot plant growing for its pale yellow, fragrant flowers 金粟蘭; never set fruit under local conditions; propagate vegetatively by division. Also called *Chl. inconspicuus* Swartz.

## 60. CASUARINACEAE

*Casuarina equisetifolia* J. R. & G. Forst.

Tall tree with green needle-like branchlets; leaves reduced to whorled tiny scales; often planted but possibly wild, originally between Tanjong Rhu and Changi (*Hullett 501*). Vern. Ru, 木麻黃 (available).

*Cas. nobile* T. C. Whitmore

A beautiful tree with a cone-shaped crown, superficially like a conifer, native of Borneo. Several other species are occasionally planted, these including *Cas. glauca* Sieb. from Australia, *Cas. nodiflora* Thunb. (= *Cas. rumphiana* Miq.) from New Caledonia and *Cas. sumatrana* Jungh. & DeVriese. from W. Malesia. The last two species together with *Cas. nobile* are sometimes classified under a separate genus *Gymnostoma*.

## 61. SALICACEAE

*Salix babylonica* L.

A small tree with slender drooping, light-green twigs. Native of China; all the trees planted were probably originated from the cuttings of a male tree; occasionally producing male catkins. 垂柳

*Salix tetrasperma* Roxb.

Less common than the above; twigs and leaf-stalks reddish on the upperside; native of S. India.

## 62. FAGACEAE

## Key to the genera

1. Fruit triangular or irregularly ovoid, completely enclosed in a spiny cupule which splits open to expose 1–3 nuts ..... *Castanopsis*
1. Fruit ovoid, conical or cylindrical, cupule rarely completely enclosing the fruit, not splitting, containing a single fruit (acorn).
  2. Leaf-stalks thickened throughout their length; midrib always raised above; margin rarely toothed; stigma tiny ..... *Lithocarpus*
  2. Leaf-stalks usually thickened at base; midrib often sunken above; margin often toothed; stigma a big head ..... *Quercus*

*Castanopsis inermis* (Lindl. ex Wall.) Benth. & Hook. f.

Big tree; cupule 4-angled with lines of short blunt warts in rings around each angle; cooked fruit edible.

*Cast. lucida* (Nees) Soepadmo

Big tree; cupule splitting into 4 valves, the valves deeply ridged; Gardens' Jungle, Bukit Timah, Sembawang, Bukit Mandai. Called *C. hulletti* King in Ridley's Flora.

*Cast. malaccensis* Gamble

Cupule covered with long sharp branched spines; Tuas.

*Cast. nephelioides* King ex Hook. f.

Cupule flattened, covered with short ridges and warts; rare: Bukit Timah, Pulau Damar.

*Cast. megacarpa* Gamble

Big tree; cupule large, round to ellipsoid, covered with long branching spines; Bukit Timah, Gardens' Jungle. Vern. *Berangan Gajah*.

*Cast. shefferiana* Hance

Tree; cupule densely covered with short stout spines, splitting by 4 valves; Gardens' Jungle, Changi. Called *C. andersonii* Gamble in Ridley's Flora.

*Cast. wallichii* King ex Hook. f.

Tree; cupule round, covered with triangular, sharp-tipped spines; common in woods; Gardens' Jungle, Bukit Timah, Chua Chu Kang, Changi.

*Lithocarpus bennettii* (Miq.) Rehd.

Cupule thin flat, with short stout base; fruit conic-ovoid; in woods; Seletar, Holland Road (*Ridley, s.n.* in 1899). All the *Lithocarpus* species were classified under *Pasania* in Ridley's Flora and under *Quercus* in Corner's Wayside Trees.

*Lith. cantleyanus* (King ex. Hook. f.) Rehd.

Cupule thin saucer-shaped with ring-like flanges; fruit flattened; Changi, Gardens' Jungle, Bukit Timah, Kranji (*Ridley s.n.* in 1893).

*Lith. conocarpus* (Oudem) Rehd.

Cupule shallow saucer-shaped, thin; fruit conical, pointed; Gardens' Jungle, Changi, Seletar.

*Lith. cyclophorus* (Endl.) A. Camus

Cupule saucer-shaped, enclose  $\frac{1}{3}$  of fruit; fruit flattened, very large, Gardens' Jungle, Seletar.

*Lith. elegans* (Bl.) Hortus ex Soepadmo

Cupule cup- to saucer-shaped, with tiny, pointed scales  $\pm$  in rings; fruit ovoid, flattened; Bukit Timah.

*Lith. enclisacarpus* (Korth.) A. Camus

Cupule thin, completely enclosing the fruit; Gardens' Jungle, Seletar, Changi.

*Lith. ewyckii* (Korth.) Rehd.

Cupule saucer-shaped; fruit ovoid, conic; Bukit Timah, Gardens' Jungle, Seletar. Including *Lith. lamponga* Rehd.

*Lith. hystrix* (Korth.) Rehd.

Cupule saucer-shaped; fruit depressed, ovoid; Gardens' Jungle, Tuas.

*Lith. lucidus* (Roxb.) Rehd.

Cupule woody, saucer-shaped, very thick, with a broadly ringed rim protruding at the fruit base; fruit hemispheric; Seletar, Tampines, Bukit Timah.

*Lith. wallichiana* (Lindl. ex. Hance) Rehd.

Cupule cup- or saucer-shaped, rim thin, sessile; fruit round; Seletar, Jurong, Pulau Ubin.

*Quercus argentata* Korth.

Big tree; cupule with 6-9 prominent, slightly toothed flanges; fruit ovoid with a short tip; Gardens' Jungle, Bukit Timah (*Ngadiman 36398*).

## 63. MYRICACEAE

*Myrica esculenta* Buch.-Ham.

Small tree; leaves dark green, the margin serrate or entire, but coarsely toothed in seedling and sappling leaves; fruit a small red, then black drupe; common on the seashores and also in secondary forests; Tuas (*Goodenough 3955*), Changi, Jurong. Called *Myr. farquhariana* Wall. in Malayan literature. Vern. *Geliche*.

## 64. JUGLANDACEAE

*Engelhardia serrata* Bl.

Medium-sized tree; leaves even-pinnate, with 3-5 pairs of leaflets; fruits crowded in catkins, each is a small nut, but attached to the base of a large, 3-lobed wing; rare; Kranji (*Goodenough 2833*), Gardens' Jungle. Vern. *Sepoh Petri*, *Kedi*.

## 65. ULMACEAE

## Key to the genera

1. Leaves entire, leathery, with 1 main vein; fruit flattened, each with 2 long and conspicuous styles ..... *Gironniera*
2. Leaves toothed, thin, 3-nerved from the base; fruit rounded, each with 2 short styles ..... *Trema*

*Gironniera nervosa* Planch.

Small or big tree; branches and leaves densely covered with short brown hairs; fruit a small or large drupe; common in woods; Tanglin, Chua Chu Kang, Water Catchment Area (*Chew 28*), Changi. Vern. *Kasap*.

*Gir. parvifolia* Planch.

Leaves glabrous, thin-leathery; in dense jungle, rare; Bukit Timah (*Ngadiman 34908*), Kranji.

*Gir. subaequalis* Planch.

Leaves glabrous, thick-leathery; less common; Tanglin, Chua Chu Kang.

*Trema angustifolia* (Planch.) Bl.

Shrub or small tree; leaves narrow, brownish hairy beneath; Changi, Chua Chu Kang, Tanglin.

*Trema cannabina* Lour,

Leaves glabrous beneath; berry yellow to orange; Tanglin, Chua Chu Kang (*Cantley's collector, s.n.*). Called *Tre. virgata* Bl. in Ridley's Flora.

*Tre. tomentosa* (Roxb.) Hara

Leaves ovate, acuminate, densely hairy beneath; berry green then blue-black; in waste ground; Tanglin, Changi (*Cantley's collector, s.n.*). Called *Tre. amboinensis* Bl. or *Tre. orientalis* Bl. in Malayan literature. 山黄麻

## 66. URTICACEAE

### Key to the genera

1. Herbs,
  2. Herbs often with sting hairs; leaves alternate ..... *Laportea*
  2. Herbs without sting hairs,
    3. Leaves opposite; flowers cymose ..... *Pilea*
    3. Leaves alternate,
      4. Flowers cymose ..... *Elatostemma*
      4. Flowers in axillary heads ..... *Pouzolzia*
1. Shrubs, erect or climbing,
  5. Erect; flower heads distinct on spikes; fruiting perianth dry ... *Boehmeria*
  5. Scrambling or climbing; fruiting perianth fleshy,
    6. Flowers yellow, in spikes or paniced clusters ..... *Pipturus*
    6. Flowers whitish, in axillary cymose heads ..... *Poikilospermum*

*Boehmeria nivea* (L.) Gaud.

Shrubby, 1-2 m high; leaves broadly ovate, alternate. Ramie is a well-known fibre-yielding plant, native of E. and S.E. Asia. 苧麻

*Laportea interrupta* (L.) Chew

A weed, sometimes stinging; Tanglin, Serangoon (*Ridley s.n.* in 1897); formerly called *Fleurya interrupta* Gaud.

*Elastostema repens* Hall. f.

Small creeping plant; leaves alternate, very unequal at the base; native of S.E. Asia. Also called *Pellionia duvauana* N.E. Br.

*Pilea microphylla* (L.) Liebm.

Tiny herb, with many branches; leaves very small, arranged in two rows. A weed of American origin, common in waste spots in gardens.

*Pipturus mollissimus* Wedd.

Shrub, climbing; leaves elliptic-ovate, 3-nerved; flowers yellow; fruit white; rare; Tuas (No specimens available).

*Poikilospermum suaveolens* (Bl.) Merr.

Large scrambling and epiphytic shrub; leaves large; flowers whitish, in compound heads; in woods; Bukit Timah, Bukit Mandai, Nee Soon (Chew 32), Pulau Ubin. Vern. *Akar Murah*, *Ara Jankang*. Called *Conocephalus suaveolens* Bl. and *Con. amoenus* HK. f. in Ridley's Flora.

*Pouzolzia indica* Linn.

A low weed, not common, sometimes used as a vegetable; Bukit Timah, Chua Chu Kang (*Cantley s.n.*). Vern. *Ubai Ubai*.

## 67. MORACEAE

## Key to the genera

1. Flowers and fruits borne inside a round, hollow receptacle ..... *Ficus*
1. Flowers and fruits borne on a axis, usually forming a spike or head,
  2. Fruit a multiple one (*sorosis*),
    3. Fruit often very large (3–35 cm long) ..... *Artocarpus*, *Parartocarpus*
    3. Fruit rather small (to 1.5 cm long) ..... *Morus*
  2. Fruit not multiple,
    4. Leaves narrowed to the base; fruit berry-like wrapped round in the persistent sepals, white or yellow ..... *Streblus*
    4. Leaves round or heart-shaped at the base; fruit pulpy, red to black ..... *Antiaris*

*Antiaris toxicaria* Lesch.

A large evergreen tree, formerly found at Bukit Timah, now probably extinct. The fresh latex of this famous upas tree is extremely poisonous, and at one period was in use by the aboriginal tribes of the Malay Peninsula to tip their arrows. Vern. *Ipoh*.

*Artocarpus altilis* (Park.) Fosberg

The bread-fruit tree, a native of Polynesia, is variously called *Art. communis* J. R. and G. Forst. and *Art. incisus* Linn. f. in literature. Leaves pinnately lobed or incised; fruiting heads globose or ellipsoid, 20–30 cm across, smooth and green; cultivated locally as an ornamental, rather than a fruit tree. 麵包樹

*Artocarpus anisophyllus* Miq.

Large tree with huge pinnate leaves (over 60 cm long); fruiting head globose, with linear-oblong spines; in forest, Gardens' Jungle (*Ridley 4113*), Water Catchment Areas. Also called *Art. superbus* Becc.

*Art. dadah* Miq.

Bushy tree; fruiting head green or orange-red; in open woods; Bukit Timah (*Ngadiman 34682*), Chua Chu Kang, Tanglin, Changi, Water Catchment Areas. Called *Art. lakoocha* Roxb. in Ridley's Flora. Vern. *Tampang Ambong*.

*Art. elasticus* Reinw. ex. Bl.

Large tree; leaves dimorphic, those in young trees deeply lobed, in adult trees ovate-oblong, entire; fruiting head dark yellow, oblong, to 16 cm long; common all over Singapore (*Sinclair 10683*). Called *Art. kunstleri* Hook. f. in Ridley's Flora. Vern. *Getah Terap*.

*Art. gomezianus* Wall. ex Tréc

Medium-sized tree; leaves oval-oblong; fruiting head smooth, round or ovoid, yellow and shining outside, inside rose pink, edible but sour; Bukit Timah; Bukit Mandai; Gardens' Jungle.

*Art. heterophyllus* Lamk.

The jack fruit is a native of S. India; leaves glabrous, entire; fruiting head of very large size, ellipsoid and yellow (30-90 x 25-50 cm). Called *Art. integrifolia* L. in literatures. Vern. *Nangka*, 波羅蜜

*Art. integer* (Thunb.) Merr.

Hairy small tree; leaves oblong, entire, but in young trees often 3-lobed; fruiting head ellipsoid (20-35 x 10-15 cm), golden yellow, strongly foetid; cultivated as a fruit tree, wild in Malaya. Vern. *Champedah*.

*Art. lanceifolius* Roxb.

Large tree, timber highly valuable; fruiting head oblong (15 cm long), brown, pubescent; Tanglin, Changi Gardens' Jungle, Bukit Timah (*Sinclair SFN 40249*). Vern. *Keledang*.

*Art. maingayi* King

Small tree; fruiting head oblong, 2-3 cm long, pubescent; rare; Tuas, Bukit Timah, Gardens' Jungle.

*Art. rotundus* (Houtt.) Panzer

The Monkey Jack is a large tree; fruiting head globose, yellow (7-11 cm across), covered with short spines and enclosing numerous seeds embedded in an orange coloured, sweep pulp, edible; Tanglin, Changi (*Ridley 3357*), Chua Chu Kang, Gardens' Jungle. Called *Art. rigidus* Bl. in Ridley's Flora. Vern. *Tampuneh*.

*Artocarpus scortechinii* King

Tall tree; fruiting head oblong, to 8 cm or more long; Tanglin, Kranji (*Ridley 11366*).

*Ficus annulata* Bl.

Climber or tree; fig large, orange in colour; rare; Bukit Timah (*Ridley 3783*). The genus *Ficus* with nearly 40 species occurs in Singapore. They are either shrubs, or trees, or climbers. Their fruits are sought for by birds and fruit-bats which frequent the trees during the fruiting season. Most of the trees are of rapid growth with soft and valueless timber and with white or rarely yellow sap. The common fig (*Ficus carica* Linn. 無花菓) selling in supermarkets is native to the Mediterranean Region. Attempt to grow it in Singapore, according to Burkill, was not successful. Figs of one introduced species *F. roxburghii* Wall. are edible.

*Fic. apiocarpa* Miq.

Large climber; figs pear-shaped, large, orange-red; Tanglin, Kranji, Tuas, Gardens' Jungle (*Corner 32787*).

*Fic. aurantiacea* Griff.

Called *Fic. callicarpa* Miq. in Ridley's Flora. Large climber; stem flattened; figs large (5–6 cm long), pear-shaped, orange-red with white spots; Bukit Timah, Chua Chu Kang, Keppel Harbour (*Corner s.n.*).

*Fic. bengalensis* Linn.

Big tree with many aerial roots, some of them developing into massive pillar-roots, thus forming a "forest" of its own. Known as Indian Banyan, sometimes planted. Native of India.

*Fic. benjamina* Linn.

Small to large tree; commonly planted, wild in Malaya. Vern. *Waringin*.

*Fic. binnendijkii* Miq.

Tree, formerly found at Chua Chu Kang, Mandai (*Kiah 36543*) and Bukit Timah.

*Fic. botryocarpa* Miq.

Called *Fic. miquelii* King in Ridley's Flora. Large tree, figs green with white spots, on simple or branched racemes; in woods; Bukit Timah (*Ridley 5632*).

*Fic. bracteata* Wall. ex Miq.

Medium-sized tree; leaves rusty beneath; figs orange; in swamp forest, sometimes near the sea; Changi, Chua Chu Kang, Seletar (*Sinclair 24797*).

*Fic. caulocarpa* Miq.

Called *Fic. infectoria* Roxb. in Ridley's Flora. Deciduous tree; figs small, round, whitish with red or orange dots; Bukit Timah, Alexandra Road (*Corner s.n.*).

*Ficus chartacea* Wall. ex King

Slender shrub; figs small, yellow; in thick woods; Gardens' Jungle, Changi (*Ridley 3407*), Bukit Timah, Bukit Mandai; the bark is used for string.

*Ficus consociata* Bl. var. *murtoni* King

Large shrub or tree; figs orange; more common near the coast; Changi, Ponggol, Seletar, Bukit Timah (*Burkill 4896*).

*Ficus deltoidea* Jack

Called *Fic. diversifolia* Bl. in Ridley's Flora. Small shrub, sometimes an epiphyte; leaves extremely variable (narrowly obovate to broadly obovate, and bilobed); in sandy places or mangrove swamps; Sungei Morai (*Sinclair 40178*), Changi, Kranji, Seletar.

*Ficus dubia* Wall. ex King

Tree; like *Fic. benjamina* but with larger leaves and figs; Bukit Timah, Tengah (*Goodenough 5636*).

*Ficus elastica* Roxb. ex Hornem.

The Indian rubber tree is sometimes planted; the young plant is often grown in pots for its thick glossy, evergreen leaves.

*Ficus excavata* King

Epiphytic small-leaved creeper; in swamp forest; Jurong (*Corner s.n.* in 1934), Seletar.

*Ficus fistulosa* Reinw. ex Bl.

Small bushy tree; figs green, in pairs on pedicels or in fascicles on stem tubercles; Bukit Timah (*Chew 12*), Changi, Chua Chu Kang.

*Ficus fulva* Reinw. ex Bl.

Called *Fic. chrysocarpa* Reinw. ex Bl. in Ridley's Flora. Small shrub, leaves hairy; figs golden hairy; common in open country; Nee Soon (*Chew and Whitmore s.n.*).

*Ficus glandulifera* (Wall. ex Miq.) King

Small tree with spreading crown; figs yellow; Bukit Timah (*Corner 34922*); Gardens' Jungle, Changi.

*Ficus globosa* Bl.

Bushy tree; figs dark green; in thickets; Bukit Timah; Bukit Mandai, Changi (*Ridley s.n.* in 1893), Tuas.

*Ficus grossularioides* Burm. f.

Called *Fic. alba* Reinw. ex Bl. in Ridley's Flora. Shrub; leaves large and lobed when young, smaller and entire in older trees, white beneath; figs yellow, becoming reddish; very common in open country; Mandai (*Hullett 193*).

*Ficus heteropleura* Bl.

Called *Fic. urophylla* Wall. ex Miq. in Ridley's Flora. A shrub, often epiphytic on other trees; figs small, orange; common; Tanglin, Bukit Timah (Ridley 5630), Chua Chu Kang. Vern. *Ara Supudeh*.

*Fic. laevis* Bl.

Epiphyte or small tree; rare; Bukit Timah, Chua Chu Kang (Ridley 8034), Pulau Ubin.

*Fic. microsyce* Ridl.

Shrub or epiphyte; fig globose; sessile, in pairs; Gardens' Jungle, Jurong, Sungei Hantu (Sinclair 39528).

*Fic. obscura* Bl.

Small tree; figs white; common; Bukit Timah, Bukit Mandai, Chua Chu Kang, Pulau Ubin (Ridley 5625). Also called *Fic. pisifera* Wall. ex Miq.

*Fic. pellucido-punctata* Griff.

Called *Fic. indica* Linn. in Ridley's Flora. One of the commonest wild species of strangling fig; Seletar, Pulau Ubin, Mandai (Corner 37127).

*Fic. pisocarpa* Bl.

Called *Fic. microstoma* Wall. ex King in Ridley's Flora. Tree: figs globose, in axillary pairs, green with a conspicuous yellow umbo; Geylang, Bukit Timah, Pasir Panjang.

*Fic. pumila* Linn. var. *awkeotsang* (Makino) Corner

Epiphyte from Taiwan, adherent to walls or tree trunks by aerial roots; remaining vegetative in lowland.

*Fic. recurva* Bl.

Epiphytic and rock-climber; Bukit Timah, Chua Chu Kang, Cluny Road (Ridley 6919).

*Fic. religiosa* Linn.

The Bodh-tree is commonly planted as roadside tree, but really also a strangling plant; native of India, sacred to both Hindus and Buddhists;  
菩提樹

*Fic. retusa* Lin.

Tree; leaves often asymmetric with a blunt tip; figs pink to purple black; Geylang (Ridley 5680), Changi, Bukit Timah, Bajau. 榕樹

*Fic. roxburghii* Wall.

Small tree with very large leaves; native to E. India and Burma; producing large figs at base of the trunk which are edible and can be made into jam. The cultivated form is probably parthenocarpic, as it only bears female flowers within the fig.

*Ficus sagittata* Vahl

Called *Fic. ramentacea* Roxb. in Ridley's Flora. Climber, with yellow and bitter sap; figs nearly sessile, solitary or in pairs, globose, red, narrowed at base to a stalk; Bukit Timah, Chua Chu Kang (*Ridley 6731*), Tanglin.

*Fic. sinnata* Thunb.

Called *Fic. rostrata* Lamk. in Ridley's Flora. Epiphytic on trees, glabrous leaves often long-cuspidate; figs globose, orange coloured; Gardens' Jungle.

*Fic. subgelderi* Corner

Called *Fic. rigida* Miq. in Ridley's Flora. Epiphyte, glabrous; figs oblong, 1.5 cm across sessile on branch ends, in pairs, orange with white spots; Bukit Timah (*Ridley 5621*).

*Fic. subsecta* Corner

Called *Fic. procera* Reinw. ex Bl. in Ridley's Flora. Big tree; figs in pairs, globose, 1.5 cm long, sessile; Fort Canning (*Ridley 3396*), Changi.

*Fic. variegata* Bl.

Called *Fic. polysyce* Ridl. in Ridley's Flora. Large, deciduous tree, with conspicuous buttresses; figs pear-shaped, 2-4 cm across, long stalked, in dense clusters on the trunk and main branches; in secondary growth and forests; Gardens' Jungle, Chua Chu Kang (*Ridley s.n.*).

*Fic. vasculosa* Wall. ex Miq.

Small tree; leaves often cuspidate; figs pear-shaped, 1.5-2 cm long, light yellow then deep rose-red, stalked, on leafy twigs; often in gardens and hedges; Seletar (*Ridley 3403*); Changi, Bukit Timah.

*Fic. virens* Ait var. *glabella* (Bl.) Corner

Called *Fic. glabella* Bl. in Ridley's Flora. Big tree; figs small, white, with pinkish spots; Bedok, Bukit Timah, Chan Chu Kang (*Ridley 1602*).

*Fic. villosa* Bl.

Climber; figs clustered on axillary tubercles, yellow or red, hairy; common; Gardens' Jungle, Bukit Mandai, Changi, Chua Chu Kang (*Ridley 6202*).

*Fic. xylophylla* Wall. ex Miq.

Big epiphyte or small tree, strangling; figs 5-6 cm long, orange with dark spots; Geylang, Bukit Timah, Changi, Seletar, Mandai Road (*Corner 37136*).

*Morus australis* Poit.

The mulberry tree is native of China; the local strain (which appears to have female flowers only) produce fruits parthenocarpically. The trees are frequently visited by birds because of the edible fruits. 小葉桑

*Parartocarpus venebisus* (Zoll. & Mor.) Becc. ssp. *forbesii* (King) Jarrett

Tree; young twigs appressed with hairs, soon glabrescent; fruiting head with spines; Jurong (*Corner 21845*).

*Streblus elongatus* (Miq.) Corner

Big tree; heart wood dark brown, very durable; "The plant flowers readily even in seedling...; the fruit is soft white drupe enclosed in the four

thickened white sepals; these are sweet and edible and any pressure on them ejects the fruits to some distance so that if a bird attempts to eat them, the fruit is thrown out" (Ridley). Common in dry woods, Tanglin, Chua Chu Kang, Changi, Bukit Timah (CWL 14). Called *Sloetia elongata* Miq. in literature. Vern. *Tempinis*.

## 68. RHIZOPHORACEAE

### Key to the genera

- A. Trees and shrubs of mangrove\* forest; leaves opposite with interpetiolar stipules
  - B. Calyx 5–16 lobed; seedlings usually much less than 25 cm long before fallings,
    - C. Calyx 8–16 lobed; stem with knee roots ..... *Bruguiera*
    - C. Calyx 5–6 lobed; stem with appressed stilt roots ..... *Ceriops*
  - B. Calyx 4 lobed; stem supported by branched stilt roots; seedlings often over 30 cm long before falling ..... *Rhizophora*
- A. Trees and shrubs of inland (usually secondary) forest,
  - D. Leaves alternate, without stipules; style 4 ..... *Anisophyllea*
  - D. Leaves opposite, with interpetiolar stipules; style 1,
    - E. Calyx divides to the base, glabrous inside; stipules imbricate and overlapping.
      - F. Young branches solid ..... *Carallia*
      - F. Young branches hollow ..... *Gynotroches*
    - E. Calyx tubular, divides only at the tip, the tube hairy inside below; stipules flat, not imbricate ..... *Pellacalyx*

#### *Anisophyllea disticha* Baill.

Shrub; branches spreading, pendulous; leaves of two kinds in 4 rows (with 2 large and 2 small, but almost in one plane); flowers yellowish white, tiny; fruit ellipsoid, red, 2–2.5 cm long. Common in woods, Tanglin, Changi (Ridley in 1892), Seletar and Bukit Timah.

#### *Anis. griffithii* Oliv.

Tree; leaves of one kind, lanceolate to elliptic, 5–10 cm long; fruit broadly ellipsoid, 4–5 cm long. Chua Chu Kang, Water Catchment Area (Corner s.n. in 1937).

\* The mangroves are characteristic of coastal swampy regions in tropics, and sometimes also in subtropics. The seeds of some of the dominant trees, such as *Bruguiera*, *Ceriops*, *Kandelia*, *Rhizophora* (belonging to the Rhizophoraceae), and some other genera have the peculiar habit of germinating within the fruit wall ("vivipary") and hanging on the branches, then the fully developed seedlings fall downwards into the mud. The wood is hard, but difficult to season, often used as fuel. Tannin extracts can be obtained from the thick bark of many of the mangrove trees.

*Bruguiera cylindrica* (L.) Bl.

Formerly called *B. caryophylloides* Bl. Small to large tree; stem base buttressed, also with many knee roots; flowers greenish, calyx 8-lobed, petals with 2-3 bristles at the apex; seedlings 8-15 cm long before falling. A very common mangrove tree, formerly even occurred in River Valley Road, Serangoon, Seletar (*vide* Ridley), now still found in Changi, Tuas, Jurong, Kranjii and in many off-shore islands (Pulau Ubin, *Ridley 366*). Vern. name: *Pakau putih*.

*Brug. gymnorhiza* Lamk.

Calyx pinkish red, usually 12-14 lobed. Common, Jurong, Changi, Tuas (*Ridley 4669*).

*Brug. parviflora* W. & A. ex Griff.

Calyx green, 8-lobed. Jurong, Ulu Pandan (*Sinclair 39660*). Vern. name: *Lenggadi*.

*Brug. sexangula* (Lour.) Poir.

Formerly called *B. eriopetala* W. & A. Calyx usually 10-12 lobed. Bakau, Kranji, Jurong, Tanjong Pasir Laba (*Sinclair 40175*).

*Carallia brachiata* (Lour.) Merr.

Formerly called *C. lucida* Roxb. and *C. scortechinii* King. In forest, Bukit Timah, Nee Soon (*Kiah 36546*).

*Ceriops tagal* C. B. Robins.

Formerly called *C. candolleana* Arn. Tree; stem with appressed stilt roots up to 1 m tall; calyx deeply 5-6 lobed; seedlings 15-25 cm long before falling, sharply angular. In mangrove, Jurong, Changi (*Md. Shah 868*). Vern. name: *Tengah*.

*Gynotroches axillaris* Bl.

Tree; young branches hollow; leaves opposite, with numerous tiny green flowers in axils; fruits very small, red to black. In woods (Bukit Timah, *Ngadiman 36119*) and secondary jungles, common in water catchment area.

*Pellacalyx axillaris* Korth.

Tree, young branches hollow; leaves rusty pubescent beneath; flowers in axillary clusters, calyx tubular, 5-lobed. Bukit Timah, Tanglin, Nee Soon, Bukit Mandai (*Ridley 3883*).

*Pell. saccardianus* Scott.

Leaves glabrous beneath; calyx 4-lobed. In forest. Bukit Timah (*Holtum 19785*), Nee Soon.

*Rhizophora apiculata* Bl.

Formerly called *R. conjugata* L. in Malayan literature. Small or large tree; stem supported by stilt roots; flowers in pairs; seedlings up to 38 cm long

before falling. Common in mangrove swamps, Changi, Jurong (*Ridley 3795*), Seletar, Bajau.

*Rhizophora mucronata* Lamk.

Like the above species, but flowers 2–12, in 2–3 forked cymes, and seedlings 40–65 cm long before falling. In all mangrove swamps, Jurong,, Bajau, Changi, Kranji, Pulau Brani (*Ridley in 1890*). Vern. name: *Belukup*.

## 69. COMBRETACEAE

### Key to the genera

- A. Large trees; flowers small, without petals; drupe compressed, often winged ..... *Terminalia*
- A. Small trees or shrubs, erect or climbing; flowers usually showy; petals present,
  - B. Erect small trees or shrubs; calyx-tube short; fruit cylindrical, not winged ..... *Lumnitzera*
  - B. Climbers; fruit winged
    - C. Calyx-tube slender, produced beyond ovary ..... *Quisqualis*
    - C. Calyx-tube short ..... *Combretum*

*Combretum sundaicum* Miq.

Climber or scandent shrub; leaves opposite; flowers green, in terminal dense compound racemes; fruit with 4-wings. In open bush and edges of forest, Bukit Timah (*Ridley 10918*), Changi, Jurong, Bedok.

*Lumnitzera littorea* (Jack) Voigt

Formerly called *Lum. coccinea* W. & A. Small tree or shrub, with scarlet flowers in dense racemes. In mangrove near the sea, Bajau, Serangoon, Jurong, Kranji (*Ridley 334*).

*Lum. racemosa* Willd.

As above species, but flowers white in elongate, racemes. In mangrove swamps. Jurong, Ulu Pandan (*Corner 38160*).

*Quisqualis indica* L.

Climber; flowers in terminal spikes, white then turning dark red. Native of the Old tropics, a garden escape in Singapore. Vern. *Akar Suloh*, 使君子

*Terminalia catappa* L.

A large tree; leaves deciduous, often turning red before they fall; flowers small, green, in spikes; fruit flattened ovoid, keeled all round, pinkish green; seeds edible (hence called 'Sea almond'). Common along the coast (*Hullett 311*), and planted as a roadside tree. Vern. *Ketapang*, 欖仁樹

*Terminalia phellocarpa* King

Large tree; fruit ellipsoid, mango-like, corky. In damp spots in woods, Mandai (*Corner 36987*), Bukit Panjang, Chua Chu Kang. Vern, *Mampelam babi*.

*Term. subspathulata* King

Large tree; fruit broadly 2-winged. Gardens' Jungle, Bukit Timah (*Ridley 10817*).

## 70. MYRTACEAE

## Key to the genera

- A. Leaves opposite.
  - B. Leaves with a main midrib.
    - C. Twigs and leaves glabrous; fruit usually a large berry ..... *Eugenia*
    - C. Twigs and leaves hairy.
      - D. Leaves large (10–15 cm long), conspicuously veined; fruit large ..... *Psidium*
      - D. Leaves smaller (less than 10 cm long), faintly veined; fruit small (less than 1 cm across) ..... *Decaspermum*
  - B. Leaves 3-nerved,
    - E. Tree with small (around 5 mm across) white flowers; leaves silvery beneath ..... *Rhodamnia*
    - E. Shrub with showy (4–5 cm across) pink flowers; leaves woolly white beneath ..... *Rhodomyrtus*
- A. Leaves alternate, spirally arranged; fruit capsular.
  - F. Leaves with 5–7 transverse veins ..... *Melaleuca*
  - F. Leaves with a midrib,
    - G. Flowers in panicles, terminal ..... *Tristania*
    - G. Flowers in dense spikes near the end of branches ..... *Callistemon*

*Callistemon citrinus* Skeels

Also called *Cal. lanceolatus* Sweet. Shrub with linear leaves; flowers in dense spikes near the ends of young branches; stamens many in a flower, crimson red, the whole inflorescences with spreading stamens resembling a bottle brush (hence the common name). Native of Australia, sometimes planted as ornamental.

*Decaspermum fruticosum* J. R. & G. Forst.

Shrub or small tree; leaves small, narrowly elliptic; flowers white; berry rounded, flattened, purple. In secondary forest, Mandai, Jurong, Chua Chu Kang, Bukit Timah, Seletar (Md. Shah & Ahmad Shukor 2364).

*Eugenia aquea* Burn.

Small tree; flowers white, fruit transparent, rose or white, edible. Cultivated, probably a native of southern India. Vern. name: *Jambu Ayer*. This species, together with most of the following ones, has been segregated by some taxonomists from *Eugenia* (a genus thus defined as restricted to the New World tropics) into a separate genus, *Syzygium*. The alternative name for this species for example, is *Syzygium aqueum* (Burm.) Alston. Species of *Eugenia* (or *Syzygium*), in general, possess opposite, glandular punctate leaves with conspicuous submarginal veins. Those with larger (and edible) fruits are known as *jambu* or *jambo* by the Malays, and those with smaller fruits as *kelat*.

*Eug. attenuata* Koord. & Valet (= *E. penangiana* Duthie)

Tree; flowers white; fruit oblong (0.7 × 0.5 cm) pinkish. Kranji (*Corner 29056*), Bukit Timah.

*Eug. avenis* (Miq.) Henders. (= *E. scoparia* Duthie)

Tree; fruit globose (0.4 cm across). Only represented by an earlier collection (*Wallich 3594*).

*Eug. caryophyllus* Bull. & Harris (= *E. aromatica* Baill.)

The clove tree is a native of Moluccas, grown in Singapore in large scale in early 19th century but failed. The cloves of commerce are the dried unopened flower-buds.

*Eug. cerina* Henders. (= *E. punctulata* King)

Tree; flowers small; fruit oblong ovoid (1.4 × 0.8 cm), greenish.

*Eug. claviflora* Roxb.

Tree; flowers creamy white; fruit oblong-globose (2 cm long), crimson then black. Labrador, Pasir Panjang (*Corner s.n.*).

*Eug. conglomerata* Duthie

Tall tree; flowers white; fruit depressed globose (1.2 cm across), dark purplish. Botanic Gardens (*Ridley 5073*).

*Eug. cumingiana* Vidal (= *E. acuminatissima* Kurz) (= *Acmena acuminatissima* Merr. & Perry)

Tree; flowers small, white.

*Eug. cumini* Druce (= *E. jambolana* Lamk.)

Tree; flowers white to rosy pink; fruit oblong (2 × 1.7 cm), black. Vern. *Jambolan*.

*Eugenia densiflora* Miq.

Small tree; flowers pink; fruit globose (2.5 cm across), pinkish. Changi, Siglap, Bukit Timah. Vern. Name: *Kelat Jambu*.

*Eug. duthieana* King

Tree; flowers white; fruit globose or slightly pear-shaped (2 cm long).

*Eug. filiformis* Duthie

Small tree; flowers white with long slender pedicles; fruit globose (1.5 cm across) greenish white. Gardens' Jungle, Changi, Seletar.

*Eug. glauca* King

Tree; flowers sessile; fruit globose (2.5 cm across) green, faintly ridged. Bukit Timah (Henderson 34780).

*Eug. grandis* Wight

A big tree; flowers white; fruit globose (1.2–1.5 cm across) green, leathery. Common on sandy and rocky shores, and widely planted along the roads. Vern. name: *Jambu Ayer Laut*.

*Eug. griffithii* Duthie (= *E. subrufo* King)

Tree; flowers white; fruit globose (2 cm across); in woods, Changi, Seletar, Bukit Timah.

*Eug. jambos* L.

Small tree; flowers large, white; fruit dull yellow, tinged pink, depressed globose (–5 cm across). Long cultivated of doubtful origin. Vern. names: *Jambu Mawar*, *rose apple*,

*Eug. javanica* Lamk.

Small tree; flowers white; fruit pear-shaped (–6 cm long and broad), waxy white. Native of Java, Nicobars and Burma, sometimes cultivated.

*Eug. longiflora* F. – Vill. (= *E. lineata* Bl.)

Tree; flowers white or pale green; fruit oblong (1.3 × 1 cm), opaque white. Very common in secondary jungles.

*Eug. linocieroides* King

Small tree; flowers white; fruit oblong 1 cm long). Resembles *E. longiflora* but differs from it in the more angled calyx tube.

*Eug. malaccensis* L.

Tree; flowers brilliant pink; fruit large, pear-shaped (5–7.5 cm long), white or pink. Cultivated for the edible fruit. Vern. name: *Jambu bol*.

*Eug. michelii* Lam. (= *E. uniflora* L.).

A bush from Brazil, occasionally planted.

*Eugenia microcalyx* Duthie

Tree; flowers creamy white; fruit small (0.4–0.5 cm across), white tinged red. Bukit Timah, Bukit Mandai (*Ridley 10410*).

*Eug. muelleri* Miq. (= *E. venulosa* Duthie)

Tree; flowers white; fruit globose (1.3 cm across), green. Tampines, Bukit Mandai.

*Eug. ngadimaniana* Henders.

Small tree; fruit ovoid (2 cm long) dark green, flushed dull purplish red at apex. Bukit Timah (*Ngadiman 36129*).

*Eug. nigricans* King

Tall tree; flowers white. Bukit Timah (*Corner 34988*).

*Eug. oblongifolia* Duthie

Small tree; flowers creamy white; fruit globose (1.7 cm across), pale green. Gardens' Jungle, Chua Chu Kang.

*Eug. oleina* Wight (= *E. acuminatissima* Kurz, = *E. myrtifolia* Roxb.)

Small tree, flowers white; fruit obovoid, small (0.5 × 0.7 cm), dark red. In river banks and near the sea. Seletar, Jurong (*Ridley 4985*).

*Eug. pachyphylla* Kurz

Small tree; flowers white, fruit obovoid (2.5 × 2 cm).

*Eug. palembanica* Merr. (= *E. lepidocarpa* Kurz)

Small tree; flowers white; fruit urn-shaped (2 cm across), ribbed. Common on the sea coast and inland. Tanglin, Kranji, Changi.

*Eug. papillosa* Duthie

Tall tree; flowers white; fruit globose (2.5 cm across) green; in fresh water swamp forest.

*Eug. polyantha* Wight

Slender tree; flowers white; fruit globose (1.2 cm across), pink to purple. In inland forest.

*Eug. pseudocrenulata* Henders. (= *E. crenulata* Duthie. non Willd.)

Small tree; fruit depressed globose (1 × 1.5 cm). Seletar (*Ridley 6232*), Mandai.

*Eug. pseudiformosa* King

Small tree; flowers pink; fruit oblong-globose (2 cm across).

*Eug. pseudosubtilis* King

Tree; flowers yellow; fruit depressed globose (1.5 cm across), pink to black. In fresh water swamp forest.

*Eugenia pustulata* Duthie

Small tree; flowers greenish yellow; fruit oblong globose (1.4 × 0.6 cm).

*Eug. ridleyi* King

Tree; flowers pale green; fruit globose (to 2 cm across), dull green.

*Eug. rugosa* Merr.

Tree; flowers white; fruit broadly obconic (1 × 0.75 cm). Bukit Timah (Corner 34605), Jurong.

*Eug. spicata* Lamk. (= *E. zeylanica* Wight)

Small tree; flowers white; fruit oblong (0.6 cm long), white. In sandy spots near the sea; Tanglin, Changi, Kranji, Tuas.

*Eug. subdecussata* Duthie

Tall tree; flowers greenish yellow; fruit globose (2 cm across), green, flushed dull pink. Gardens' Jungle, Changi, Tuas.

*Eug. syzygioides* Henders. (= *Eug. cymosa* Wight)

Small tree; flowers white, fruit small, round (1 cm across), cherry red. In secondary growth, Changi, Pulau Tekong.

*Eug. tumida* Duthie (= *E. pyrifolia* Wall.)

Like *E. longiflora*, but fruit round, larger (1.5–2 cm across), leathery, green. Cluny Road, Changi.

*Melaleuca cazuputi* Powell (= *M. leucadendra* L.)

Tree, with twisted trunk; bark whitish, papery flaky; leaves with 5–7 longitudinal veins; flowers white, in spikes. Seletar (Sinclair 40633). Indigenous, but sometimes planted. A medicinal oil, known as Cajeput oil, is distilled from the leaves. Ridley observed that "Kampong Gelam may perhaps take its name from trees formerly growing here". Vern. name: *Gelam*, 白千層

*Psidium guajava* L.

Small tree; branches drooping; fruit fleshy, with numerous seeds inside, edible. Native of tropical America, often planted in gardens. Vern. names: *Guava*, *Jambu batu*, 番石榴

*Rhodamnia cinerea* Jack (= *R. trinervia* Bl.)

Small to medium-sized tree; leaves with 3 main nerves, the lower surface shining silvery if growing in open country (hence the name "silver back tree"); flowers small, white; berry red to black. Very common in secondary forests (Changi, Hullett 315).

*Rhodomyrtus tomentosa* (Ait) Hassk.

Bushy shrub; leaves 3-nerved, whitish woolly; flowers prominent, pink; berry purplish, edible. Common in sandy spots. Vern. *Kemunting*, 桃金娘

*Tristania merguensis* Griff.

Tree; leaves spirally arranged; flowers small, yellow, in axillary clusters; capsules small, compressed globose, 1–1.2 cm across, half immersed in the calyx cup. Bukit Timah (*Corner s.n.*).

*Tristania sumatrana* Miq.

Small tree. Once collected from Pulau Ubin (*Ridley 4970*).

## 71. LECYTHIDACEAE

## Key to the genera

- A. Leaves very large (over 30 cm long), in 2 rows; flowers yellow ... *Bertholletia*
- A. Leaves relatively small, spirally arranged; flowers white, pink or red,
  - B. Inflorescences arising from persistent, much branched, woody inflorescence-stalks on trunk ..... *Couroupita*
  - B. Inflorescences usually arising from young or old branches,
    - C. Fruit one-seeded ..... *Barringtonia*
    - C. Fruit many-seeded ..... *Planchonia*

*Barringtonia asiatica* (L.) Kurz

Large coastal tree; leaves, flowers and fruits all very large; flowers white, in pendulous spikes; fruit with a broad square base, tapering to the 2 persistent sepals. Changi, Kranji (*Ridley 14453*), Pulau Tekong. Vern. *Putat Laut*, 棋盤腳樹

*Barr. conoidea* Griff.

Large shrub, in tidal rivers; fruit conical with 8 strong flanges round the base. Seletar, Chua Chu Kang (*Ridley 2057*).

*Barr. macrostachya* (Jack) Kurz

Small tree; fruit ovoid or ellipsoid, smooth. In dry woods, Bajau (*Ridley s.n.* in 1894). Vern. *Putat hutan*.

*Barr. racemosa* (L.) Spreng.

Small tree; fruit egg-shaped, green, in damp places near tidal rivers or the sea. Tanglin, Kranji, Geylang (*Ridley 8051*), Sentosa. Vern. *Putat Kampong*.

*Barr. reticulata* (Bl.) Miq.

Large shrub; fruit oblong, 4-angled, narrow to the base. In sandy woods near the sea, Tuas, Jurong, Macpherson Road (*Ridley 8419*).

*Bertholletia excelsa* HBK.

Large tree, native of the Amazon region, rarely planted. The large seeds (called 'Brazil nuts'), rich in oil and very nutritious, are imported..

*Couroupita guianensis* Aubl.

Native of S. America, planted for the showy flowers on trunk. Cannon-ball-like (thus 'Cannon Ball Tree') fruits are occasionally formed.

*Planchonia grandis* Ridl.

Big tree; buttressed; flowers green, in terminal spikes, fruit globose. Gardens' Jungle (Ridley 6423, type), once collected.

## 72. MELASTOMATACEAE\*

## Key to the genera

- A. Herbs, sometimes semi-woody below,
  - B. Small herbs, erect or creeping; flower parts in 3s; fruits capsular ..... *Sonerila*
  - B. Tall herbs, sometimes soft woody below; stems erect, hairy; flower parts in 4s; fruit a black berry ..... *Clidemia*
- A. Shrubs or trees,
  - C. Shrubs,
    - D. Twining or climbing, stems slender
      - E. Inflorescence short, few-flowered, on leaf axils ..... *Macrolenes*
      - E. Inflorescence paniced, terminal ..... *Dissochaeta* & *Diplectria* (*Anplectrum*)
    - D. Erect shrubs,
      - F. Mostly epiphytic; stems more or less fleshy ..... *Medinilla*, *Pogonanthera*, *Pachycentria* & *Plethiandra*
      - F. Usually terrestrial; stems not fleshy,
        - G. Stems covered with chaffy scales; leaves entire; flowers large (5-6 cm across), 3-5 together ..... *Melastoma*
        - G. Stems glabrous; leaves with finely toothed margins; flowers small, 5-15 in bundles ..... *Ochthocharis*
  - C. Trees,
    - H. Leaves with a single midrib; berry usually 2-seeded ..... *Medinilla*
    - H. Leaves 3-nerved; berry many-seeded ..... *Pternandra*

*Clidemia hirta* Don

Hairy herb, sometimes soft woody below; flowers white, in axillary clusters; fruit a round berry, black. A common weed on roadside or in forest edge, native of South America, naturalized.

\* Thanks to Mr J.F. Maxwell for going through most of the plants listed under this family.

*Diplectria glauca* (Jack) Veldk.

Slender climber; flowers white or purple, in panicles. Also called *Anplectrum glaucus* Triana or *Backeria glauca* Bakh. f. In woods, Gardens' Jungle, Bukit Timah, Water Catchment Area.

*Diplectria viminalis* (Jack) O.K.

Formerly called *Anplectrum pallens* Bl. Slender climber; flowers white. Seletar (Ridley in 1889), Pulau Ubin.

*Dissochaeta annulata* Hook. f. ex Triana

Climber; flowers rose pink, in large panicles (to 15 cm long). In edge of forests, or on tall trees, Bukit Timah (Goodenough in 1889).

*Dis. celebica* Bl.

Lower leaf-surface rusty; flowers pale pink. Common; Bukit Timah (Ridley 2025), Water Catchment Area.

*Dis. gracilis* Bl.

Slender climber; flowers white. Bukit Timah (Burkill 3123), Bukit Mandai.

*Dis. intermedia* Bl.

Bukit Mandai, Chua Chu Kang (Ridley 6056).

*Dis. pallida* Bl.

Water Catchment Areas, Bukit Mandai, Bukit Timah (Ridley 176).

*Dis. punctulata* Hook. f. ex Triana

Bukit Timah (Goodenough 341), Bukit Mandai, Seletar, Ponggol.

*Macrolenes nemorosa* (Jack) Bakh. f.

Formerly called *Marrumia nemorosa* (Jack) Bl. A climber, thickly covered with rusty hair; flowers with 4 pink petals and 8 (4 longer and 4 shorter) stamens. On borders of forests.

*Macro. echinata* Nand.

Ang Mo Kio (Ridley 258).

*Medinilla radicans* (Bl.) Bl.

Small bushy or scrambling shrub, epiphytic on trees or rocks; stems not tubercled; flowers white; fruit deep red or purple. In mangroves or damp forests, Bukit Mandai (Goodenough 1637), Kranji, Bajau.

*Melastoma malabathricum* L.

A very common shrub all over the island, in open places; flowers light to dark pink, showy. Misleadingly called the "Singapore Rhododendron". Vern. Sendudok, 野牡丹

*Memecylon amplexicaule* Roxb.

Small tree. Bukit Timah (*Ngadiman 37009*). *Memecylon* species, in general, is rather similar to *Eugenia* spp. (Myrtaceae), but can be distinguished by its small blue flowers with 8 short stamens. In *Eugenia*, the flowers are green, white, yellow or red, and the stamens are long and numerous.

*Memecy. caeruleum* Jack

Shrub. In sandy open spots. Singapore (*Furtado 34854*).

*Memecy. cantleyi* Ridl.

Shrub. In woods, Gardens' Jungle (*Ridley 13012*, type).

*Memecy. edule* Roxb.

Shrub or small tree; leaves elliptic or ovate. In dry spots near the sea (*Henderson 35783*). Vern. *Dalek ayer*.

*Memecy. edule* Roxb. var. *ovatum* Clarke

A variety with round ovate leaves (*Ridley 9565*).

*Memecy. fruticosum* King.

Epiphytic shrub. Singapore (*Ridley 5753*).

*Memecy. garcinioides* Bl.

Small tree. In lowland forests; Seletar, Bukit Timah (*Ngadiman 34975*).

*Memecy. oleaefolium* Bl.

Slender tree. In woods; Gardens' Jungle (*Ridley 6414*).

*Ochthocharis borneensis* Bl.

Small shrub; flowers small, white, with 4 white or pale pinkish petals, about 10-15 in a cluster. In tidal rivers; Seletar (*Ridley 6221*).

*Ochth. javanica* Bl.

Small shrub. In tidal mud; Changi, Kranji (*Goodenough 2008*).

*Ochth. paniculata* Korth.

Low shrub. *Wallich 4083* said to be collected from Singapore.

*Pachycentria constricta* (Bl.) Bl.

Glabrous epiphytic shrub; roots tuberous, woody; flowers pale pinkish, in panicles. Sungei Morai, Seletar (*Ridley in 1890*). Formerly called *Pachy. tuberculata* Korth.

*Pachy. maingayi* (Clarke) Maxw.

Small bushy epiphyte; flowers and fruit both pink. Sungei Buloh, Chua Chu Kang (*Ridley in 1894*), Bukit Timah. Formerly called *Medinilla maingayi* Clarke.

*Plethiandra sessiliflora* (Cogn.) Burk.

Epiphytic spreading shrub; flowers waxy pink, solitary or in axillary fascicles. In mangrove swamps; Tuas, Seletar, Kranji (*Ridley in 1892*), Sungei Buloh.

*Pogonanthera pulverulenta* Bl.

Epiphytic spreading shrub, scaly; flowers small, white. Pulau Ubin, Kranji (*Ridley 276*), Bukit Timah.

*Pternandra coerulescens* Jack

Small tree; flowers in axillary cymes or rarely in terminal panicles; petals light blue; fruiting calyx marked with square or oblong depressions. Tanglin, Changi (*Ridley in 1894*), Chua Chu Kang.

*Ptern. echinata* Jack

Bushy tree; flowers white, often deeply tinted with light blue or lilac; fruit echinate. In woods, common; Changi, Bukit Timah (*Goodenough 352a*). Vern. *Serai manau*.

*Ptern. tuberculata* (Korth.) Maxw.

Tree. MacRitchie (fide Maxwell).

*Sonerila begoniifolia* Bl.

Small herb, densely hairy to 15 cm tall; flowers white or pink, in clusters. In damp woods; Chua Chu Kang, Bukit Mandai (*Ridley 2005a*).

*Soner. heterostemon* Naud.

A glabrous herb. In forests; Bukit Timah (*Hullett 449*), Chua Chu Kang.

## 73. LYTHRACEAE

## Key to the genera

- A. Trees and shrubs, near or in the sea,
  - B. Shrubs; fruit a capsule, 1-chambered ..... *Pemphis*
  - B. Trees; fruit berry-like, 10–15-chambered ..... *Sonneratia*
- A. Inland trees and shrubs,
  - C. Flowers small, unisexual, apetalous, in terminal panicles ... *Crypteronia*
  - C. Flowers medium to large, bisexual,
    - D. Calyx-tube swollen on one-side, slightly curved ..... *Cuphea*
    - D. Calyx-tube straight,
      - E. Shrubs, flowers relatively smaller, sepals and petals 4 ..... *Lawsonia*

- E. Trees, flowers large and showy, sepals and petals usually 6 ..... *Lagerstroemia*

*Cuphea ignea* DC.

Small bush, much branched; calyx orange red; petals absent. Native of Mexico, sometimes cultivated.

*Crypteronia cumingii* (Planch.) Endl. var. *griffithii* (Clarke) Osinga

Tall tree; branches with swollen nodes; flowers very small, in large terminal panicles. In Water Catchment Areas, Bukit Timah (*Ngadiman 36472*). Vern. *Talinga badak*.

*Lagerstroemia speciosa* (L.) Pers.

Also called *Lag. flos-reginae* Retz. Tree, with spreading branches; flowers pale to deep pink. Native of S.E. Asia, widely planted in gardens and along the roads, easily propagated by cuttings or marcoting. Vern. Bungor, 大花紫薇

*Lag. indica* L.

Shrub or small tree; leaves smaller than the above species; flowers white, rose or pink. Native of the Orient, sometimes cultivated. Vern. *Crepe myrtle*, 紫薇花

*Lawsonia inermis* L.

Shrub or small tree. Native of W. Asia, sometimes cultivated as a hedge plant. The leaves are the source of a red dye. Vern. Henna. 指甲花

*Pemphis acidula* J.R. & G. Frost.

A coastal shrub, often partly submerged in sea-water during high tide; leaves fleshy, thick; flowers white, with short or long styles. Changi (*Md. Shah 864*), St. John's Island.

*Sonneratia alba* J. Smith

Tree, near or in the sea, with upright conical breathing roots around the trunk; leaves broadly elliptic; flowers large with 6 white petals; stamens white. Tuas, Changi, Jurong, Pulau Brani (Ridley in 1907). Vern. *Bedada*.

*Sonn. caseolaris* (L.) Engl.

Formerly called *Sonn. acida* Linn. Tree; leaves narrowly elliptic; stamens pinkish red. In tidal river, Balestier plain, Changi (*Sinclair 40023*).

## 74. PUNICACEAE

*Punica granatum* L.

The pomegranate tree is a native of West Asia. A dwarf form is commonly planted in pots or on the ground for its bright scarlet (rarely yellow) flowers and handsome, edible fruits. Vern. *Dalima*, 石榴, 安石榴

## 75. ONAGRACEAE

*Ludwigia adscendens* (L.) Hara

Formerly called *Jussiaea repens* L. Herb, prostrate or ascending, often floating in streams with swollen pithy floats; petals creamy white. Tanglin (Ridley 16697).

*Ludwigia erecta* (L.) Hara

Erect herb, nearly glabrous; petals pale yellow. Tanglin, Tanjong Katong (Cantley 2871).

*Lud. octovalis* (Jacq.) Raven spp. *sessiliflora* (Mich.) Raven

Formerly called *Jussiaea suffruticosa* L. Robust herb, shrubby, densely covered with spreading hairs; petals yellow. Serangoon, Kallang.

*Lud. peruviana* (L.) Hara

Formerly called *Jussiaea speciosa* Ridl. Shrub, to 3 m tall; petals bright yellow. Ditches and swamps, Serangoon, Balestier.

*Lud. prostrata* Roxb.

Small annual herb, subglabrous; petals yellow, narrowly spoon-shaped. In wet spots, Tanglin.

## 76. HALORAGACEAE

*Haloragis chinensis* Merr.

Small herb, leaves opposite; flowers yellow, very small. Known only from a small spot near the sea, Lim Chu Kang (Sinclair 40276).

## 77. TRAPACEAE

*Trapa bicornis* Osb. var. *cochinchinensis* Gluck ex Steenis

Floating herb, occasionally growing in ponds; fruit (also called "water chestnut" not to be confused with the corm of *Eleocharis dulcis* Trin. of the Cyperaceae, both are imported from China) with two conspicuous horns, edible. 菱, 菱角

## 78. THYMELAEACEAE

## Key to the genera

- A. Fruit capsular; petaloid appendages usually distinct and always pubescent ..... *Aquilaria*
- A. Fruit drupaceous; petaloid appendages if present, always glabrous,
  - B. Woody climbers; inflorescence usually provided with 2 leafy bracts on each branch; ovary densely pubescent,

- C. Stamens in 2 series; style short ..... *Enkleia*
- C. Stamens in 1 series; style several times as long as ovary ... *Linostoma*
- B. Erect shrub; inflorescence without leafy bracts;  
ovary glabrous ..... *Wikstroemia*

*Aquilaria malaccensis* Lamk.

Big tree; leaves glabrous beneath; flowers yellowish green, in branched umbels; fruit a small woody capsule. In the interior of old trees are found dark coloured resinous, fragrant masses for burning as incense. These resinous masses are called eagle-wood. Bukit Timah, Kranji, Gardens' Jungle (*Ridley in 1894*). Vern. Geharu, 沉香

*Aquil. hirta* Ridl.

Small tree; leaves tomentose beneath. Bajau (*Ridley 3837*, type!).

*Enkleia malaccensis* Griff.

Slender woody climber, densely covered with reddish hair; branches sometimes hook-like; leaves alternate; panicles spreading. In woods, Gardens' Jungle (*Sinclair 40196*), Bukit Timah.

*Linostoma pauciflorum* Griff.

Lofty woody climber; leaves opposite or nearly so; flowers light green, pendulous. Gardens' Jungle, Changi (*Ridley 1858*), Bukit Timah.

*Wikstroemia ridleyi* Gamble

According to Ridley (*Fl. Mal. Pen. 3:146*) this plant was "Brought from Penang in 1890, ran wild for some time in Tanglin, Singapore". Now still can be found in certain spots in Water Catchment Areas.

## 79. GONYSTYLACEAE

*Gonystylus maingayi* Hook. f.

Small to large tree; flowers in terminal inflorescence; capsule ovoid, thick-woody. Gardens' Jungle, Bukit Mandai, Chua Chu Kang, Water Catchment Areas, Bukit Timah (*Ridley in 1894*).

# VASCULAR EPIPHYTES OF SINGAPORE'S WAYSIDE TREES

by

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## INTRODUCTION

The planting of wayside trees in Singapore has been going on since the turn of the last century. Most of these trees have been exotic, while a few, indigenous. One old favourite is the *angsana*, *Pterocarpus indicus* Willd., a native of Peninsula Malaysia (Burkill, 1935). This tree provides excellent shade and was thus planted extensively along many roads. However, around 1914 there was an outbreak of a disease resembling that of the European elm variety. One by one these trees became infected and rows of them were cut down in an effort to contain the disease, but in vain (Furtado, 1935). Only a limited number of trees survived, scattered around the island. The three big trees at the Esplanade by Anderson Bridge are among these (Corner, 1952). Another common wayside tree is the mahogany, *Swietenia macrophylla* King. This tree was first introduced into the country from Sri Lanka in 1876 (Burkill, 1935). Around 1930-40 these trees were planted along many roads. Most are still in existence today. Grown alternately with these trees along most of these roads were the *jambu laut*, *Eugenia grandis* Wight. A native of Peninsula Malaysia, this tree was adopted in 1882 as a fire break and planted along those roads bordering *lalang* wastes and subjected to regular fires (Burkill, 1935). The only road left with an entire row of *jambu laut* along both sides appears to be Dalvey Road.

The rain tree, *Enterolobium saman* Prain ex King, which has an umbrella shape and casts excellent shade, has been in Singapore since 1876 when it was introduced from its native South America (Burkill, 1935). The tree has proved to be popular ever since and avenues of different ages of trees can be found in many parts of the island. On the other hand the *tembusu*, *Fagraea fragrans* Roxb., which is of Indo-Malaysian origin, was grown for its majestic beauty along the older roads and in private compounds. Today, old trees can be found mainly around the Tanglin areas. Another popular tree, the *batai*, *Albizzia falcataria* (L.) Fosberg, is fast growing and provides excellent shade. However, these trees are susceptible to damage by storms due to the shallowness of the root system and the softness of the wood. Because of this it has become unpopular and today a few old trees can still be found by certain roads while others are found growing wild in abandoned lands. The common *ru*, *Casuarina equisetifolia* J.R. & G. Forst., native to this region and a pioneer on sandy coast, was once extensively grown along Tanjong Rhu (Ridley, 1900), but no more. It was also once popularly grown in private compounds. It casts little shade but makes excellent wind-breaks. It is not commonly planted today but a substantial number can be found scattered around the island.

The population of Singapore's wayside trees has increased considerably since 1967 when the Government embarked on a campaign to turn the Republic into a garden city. Since then more than a quarter million trees have been planted (Anon., 1977). The current favourite is still the *angsana*, as besides

being a good shade tree, planting materials are abundant as cuttings strike root without difficulty. Other species of wayside trees include the yellow flame, *Peltophorum pterocarpum* Backer ex Heyne; the acacia, *Acacia auriculiformis* A. Cunn. ex Bth; the royal palm, *Roystonea regia* (H.B.K.) D.F. Cook and the flame of the forest, *Delonix regia* (Bojer ex Hook.) Rafin, among others.

Many of the wayside trees are infested with epiphytes, the older more so than the younger. Again, certain species of trees appear to be more heavily infested than others. On the other hand there are many trees that are entirely bare of epiphytes. According to Richards (1939) effective colonization by epiphytes only begins in the middle and late life of the trees. Working with two common wayside trees in Singapore, Johnson & Awan (1972) found that certain epiphytic species showed preference for host trees, probably because of their bark characteristics. In an effort to understand more about the epiphytic populations of the wayside trees, a qualitative survey was initiated in 1977 to study the distribution, species composition and association with the host trees. It is hoped that this study would lead to further work on the various quantitative aspects as well as on the autecology of the epiphytic species.

#### MATERIALS AND METHODS

Observations were made on the occurrences of vascular epiphytes on 11 common wayside trees along various main roads in Singapore. Only the number of species per tree was noted, no attempt was made to include quantitative information. The diameter of the tree trunk at breast height was recorded in every case. Trees with a diameter of less than 30 cm were excluded as these were considered too young to harbour any epiphytes. Each tree was examined from the ground. In most cases it was easy to identify the epiphytes as they usually occurred on the lower and bigger branches. The only difficulty was with *Pyrrisia*. Except for *P. longifolia* (Burm.) Morton with its distinctive long fronds, the other species like *P. varia* (Kaulf.) Farwell, *P. adnascens* (Forst.) Ching and *P. angustata* (Sw.) Ching could not be identified as the plants were sterile at the time of the survey. These were thus grouped under *Pyrrisia* spp. The species of trees examined were:

	<i>No. trees observed</i>
<i>Enterolobium saman</i> Prain ex King	160
<i>Eugenia grandis</i> Wight	223
<i>Swietenia macrophylla</i> King	217
<i>Peltophorum pterocarpum</i> Backer ex Heyne	96
<i>Fagraea fragrans</i> Roxb.	150
<i>Pterocarpus indicus</i> Willd.	138
<i>Acacia auriculiformis</i> A. Cunn. ex Bth.	122
<i>Casuarina equisetifolia</i> J.R. & G. Forst.	144
<i>Cocos nucifera</i> L.	200
<i>Albizzia falcataria</i> (L.) Fosberg	89
<i>Roystonea regia</i> (H.B.K.) D.F. Cook	154
<b>TOTAL</b>	<b>1,693</b>

## RESULTS AND OBSERVATIONS

The highest number of epiphytic species was recorded on *E. saman*. Of these 18 species, 11 were ferns and the rest phanerogams (Table 1). In addition, five species of phanerogams, not usually epiphytic, were found growing on the wayside trees examined. *Asplenium nidus* Linn., *Davallia denticulata* (Burm.) Mett., *Drymoglossum piloselloides* (Linn.) Presl. and *Pyrrosia* spp. were the common ferns and *Dendrobium crumenatum* Sw., the pigeon orchid, the common phanerogam. *Bulbophyllum vaginatum* (Lindl.) Rehb. f., another orchid, was common on *E. grandis*. The strangling figs, represented by *Ficus religiosa* Linn. and other *Ficus* spp. were reasonably common on most trees.

There was evidence of epiphytic preference for specific wayside trees. *Dischidia nummularia* R.Br. and *D. rafflesiana* Wall. were commonly found on *P. pterocarpum*; *B. vaginatum* on *E. grandis*; *Drynaria sparsisora* (Desv.) Moore on *E. saman*; *P. longifolia* on *F. fragrans*; and *Vittaria ensiformis* Sw. on *E. saman* and *E. grandis*.

*Platynerium coronarium* (Koenig) Desv., the stag's horn fern, at one time common, is now getting rare. Isolated plants were encountered on *E. saman*, *E. grandis*, *F. fragrans*, *A. auriculiformis* and *C. equisetifolia*. Of the total of 1693 trees examined, only 8 or slightly less than 0.5% had this fern on them.

Generally, the abundance of epiphytic species depended on the species of the wayside trees (Fig. 1). *E. saman*, *E. grandis* and *S. macrophylla* were more heavily infested with epiphytes than the other wayside tree. About 58% of *E. saman* and *E. grandis* trees sampled had three or more epiphytic species while the figure for *S. macrophylla* is 41%. With *P. pterocarpum*, *F. fragrans*, *P. indicus* and *A. auriculiformis*, about 69%, 55%, 55% and 56% respectively of the trees sampled had epiphytes on them. In the case of the other tree species, most of the trees had no epiphytes at all.

Older trees were more prone to epiphytic infestation than younger trees. Age was estimated from tree trunk diameter and only trees with a trunk diameter at breast height of more than 30 cm were included in the survey, as those with a lesser diameter invariably had no epiphytes on them. Thus those trees that were observed were at least 10–15 years old, as growth in diameter of these trees was estimated to be not more than 3 cm per year. Table 2 shows that in all nine species of trees (*R. regia* and *C. nucifera* were excluded as palms with a trunk diameter of more than 50 cm were rare), a higher percentage of trees with a trunk diameter of more than 50 cm had epiphytes on them. The difference between presence and absence of epiphytes was less obvious in the case of *E. saman*, *E. grandis* and *S. macrophylla*. *E. saman* had a high rate of infestation regardless of the diameter class while the other two species of trees were all more than 60 years old, and thus had their share of epiphytes. In addition to having a higher percentage of trees with epiphytes, older trees had more epiphytic species on them (Fig. 2). Of those trees sampled whose trunk diameter was more than 50 cm, 53% had three or more epiphytic species on them, compared to 24% of those trees with a diameter of 30–50 cm. Another point worth noting is that a higher percentage of the latter group had no epiphytes at all.

Table 3 lists the number of the various wayside trees that had only one epiphytic species. Of the 238 trees with only one epiphytic species, 65 had *D. piloselloides* while 83 had *D. crumenatum*. Looking at the data closer, it is

noted that of the 83 trees with the pigeon orchid, 43 are *S. macrophylla* and 23 *E. grandis*. Most, if not all the trees sampled belonging to these two species were more than 60 years old. The presence of *D. crumenatum* on trees of *S. macrophylla* and *E. grandis* thus indicates a later stage of succession. It is not a pioneer while *D. piloselloides* is, as this fern was usually found to be associated with relatively young trees. *P. longifolia* and *A. nidus* are also pioneers but these epiphytic ferns generally appear later than *D. piloselloides*.

## DISCUSSION

In growing trees for shade, pollarding is generally practised to encourage branching. Two, three or even four branches may arise at the point of the cut. The bases of these branches form rain channels along which rain water flows down the trunk. In certain cases a depression develops where the branches meet and water collects here. Dead leaves together with dust blown off the road also accumulate here and along the rain channels, especially if the bark is rough and flaky. These sites form the centres of epiphytic colonization (Fig. 3-6). Other sites include bark fissures, axils of large branches, the base of the tree and wound scars (Oye, 1924). The first plants to appear are the blue-green algae, followed closely by the bryophytes (Barkman, 1958). Under local conditions *D. piloselloides* is the first vascular epiphyte to colonize the trees. This fern does not grow along the rain channels or in the depression at the base of the main branches where moisture is readily available, but rather on the trunk itself or the surface of the main branches (Fig. 7 and 10). Once established, this fern may spread and cover more areas of the bark, and in extreme case even the twigs and leaves. On *F. fragrans* trees the pioneer is *P. longifolia* instead of *D. piloselloides*. Both these ferns are crassulacean acid metabolism plants (Wong & Hew, 1976) and together with their succulent fronds and stellate hairs covering the abaxial surface, are apparently sufficiently adapted to such habitats.

The presence of depressions at the axils of the main branches of the trees, with the accumulation of soil, paves the way for the establishment of saplings of other wayside trees which are normally not epiphytic. These are the "epiphyta ephemeralis" of Hosokawa (1968). *Nephrolepis biserrata* (Sw.) Schott., basically a ground fern but common on oil palms (Sands, 1926), was also found, although sparsely, on a number of wayside trees. This fern can be classified as "epiphyta occasionis", while the strangling figs, *Ficus* spp., common on many trees (Fig. 5), are actually false epiphytes or the "hemiepiphytes" of Hosokawa (1968).

Humus collecting ferns like *A. nidus* and *P. coronarium* (Fig. 3-6 and 11-12), are later pioneers, preparing the way for other epiphytes: *D. denticulata* growing from the root mass of the former (Fig. 11), *V. ensiformis* growing under the shade of the fronds of *A. nidus*, and *Ophioglossum pendulum* Linn. growing from the nest of *P. coronarium* (Fig. 11).

The stag's horn fern, *P. coronarium*, a common epiphyte of rubber trees (Anon., 1955), is slowly getting scarce. In the present survey, this fern was observed on 0.5% of the trees examined while only nine years ago Johnson & Awan (1972) reported finding them on 60 out of the 150 *F. fragrans* trees they examined. Of the 150 such trees observed in the present survey (these trees need not necessarily be the same as the earlier ones) only one was found to harbour *P. coronarium*. Old nests of this fern usually have *O. pendulum* growing from them (Fig. 11), which competes with its host for the supply of water held

within the nest. It appears that as the *O. pendulum* grows larger, it absorbs most of the water from the nest resulting in the eventual death of the host (Holtum, 1954). It is possible that the sparsity of the stag's horn fern may be due to death of the old plants at a faster rate than sporeling establishment. However, it is probable that the drastic reduction of the fern's population has been the result of their being physically removed, as excess water dripping from the nest can encourage rotting of the branches. Also, it has been reported that the water held by the nest provides breeding ground for mosquitoes (Anon., 1955).

About 53% of the trees examined harboured some species of epiphyte or other. Forest trees apparently are less infested with vascular epiphytes. Davis & Richards (1933, 1934) recorded epiphytes on only 16% of trees more than 5 m high and 38% of trees more than 14 m high in a number of plots sampled from a high forest in Guyana. The figures for rain forests of Sarawak are 11% to 13% (Richards, 1936) and of Nigeria are 15% to 24% (Richards, 1939). According to Richards (1957), the number of epiphytic species on a single tree is seldom very large, from 13 species recorded in Nigeria to about 15 species in Guyana. This is comparable to the 18 species recorded from the sample of *E. saman* trees examined in this survey. On the other hand Eggeling (1947) has observed as many as 40–45 species of phanerogams and ferns on one tree in Uganda. The epiphytic flora on *Dipterocarpus oblongifolius* Bl. growing along the banks of small rivers in Peninsula Malaysia is still richer. Henderson (1935) recorded as many as 87 orchid species and 40 other phanerogams and ferns on such trees during an expedition up one of the small tributaries of Sungei Sat and Sungei Ketil in Kelantan.

The extent of epiphytic infestation of the local wayside trees depends on the nature of the bark, the nature of the crown and the mode of branching. A smooth bark reduces the chance of epiphytic establishment as it is unable to trap the propagules. *A. falcataria* has a very smooth bark (Fig. 9) and only in very old trees are there any epiphytes. The same situation is seen with *R. regia* (Fig. 8). Epiphytes only manage to establish at the base of the trunk when the numerous prop roots have emerged to break the smoothness of the bark, or on the trunk when the smooth surface has been damaged. At the other extremes are the rough and flaky bark of *E. saman* (Fig. 6 and 10), *E. grandis* (Fig. 7) and *S. macrophylla* (Fig. 4).

The abundance of epiphytes on *E. saman* is also due to the mode of branching and the structure of the crown. The main branches grow out at an angle of 50–80° to the main axis. The ends of the branches bear leafy shoots which form the thin layer of foliage making up the umbrella-shaped crown. The inside of the crown is spacious and devoid of leaves, and this allows sunlight and moisture to get to the branches, where the epiphytes usually are (Fig. 3). The branching of *P. indicus* and the structure of the crown on the other hand discourage epiphytic growth. The branches grow at an angle of 10–30° to the main axis and bear numerous, slender and leafy shoots which hang down into the interior of the crown. This results in a dense and narrow-domed crown which is obviously not conducive to epiphytic growth. Most of the epiphytes on *P. indicus* are found around the main forks of the branches where light and moisture are available.

The branching of *E. grandis* and *S. macrophylla* does not encourage epiphytic infestation as the branches grow up at an angle of 30–40°. Branching is sparse in these trees as they had not been planted for shade and thus not subjected to

pollarding. The richness of epiphytes on these two species of trees can be attributed to their age, most of which are at least 60 years old. In the case of *F. fragrans* the sparsity of epiphytes is attributed to the nearly vertical branches or the branches growing horizontally for a short distance before turning upwards. Such branching provides poor sites for epiphytic establishment. The deeply fissured bark without being flaky obviously does not help in the trapping of propagules.

Another factor that encourages epiphytic infestation is the availability of moisture around the branches where the epiphytes usually are. In most trees dew is precipitated on the coldest surfaces, that is, the leaves. Thus the leaves are thoroughly wet at night while the branches remain dry (Geiger, 1950). In the case of *E. saman*, the leaflets begin to fold about one and a half hours before sunset and do not open until the same time after sunrise (Corner, 1952). This permits dew to settle on the branches and thus provides a supply of moisture to the epiphytes even during dry periods. Also, when the sky is overcast, the leaflets similarly close. During any subsequent rain the branches are sure to get wet. With other broad-leaved trees however, a considerable proportion of the rain clings on to the leaves. If the rainfall is less than 10 mm the water flowing down the trunk is negligible (Geiger, 1950). Downflow begins only after the rainfall is heavy and even in this case only about 20% of the total rainfall flows down the trunk. With needle-leaved trees the amount of rain that clings on to the leaves is higher than in the case of broad-leaved trees. The downflow of the water among such trees is less than 5% of the total rainfall even in the heaviest of storms. This is probably the case with *C. equisetifolia* where the epiphytic flora is extremely poor. Only when such trees have been subjected to some form of pollarding and side branches have developed can one find any epiphytes on the branches or trunks.

#### ACKNOWLEDGEMENT

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TABLE 1.  
PERCENTAGE OCCURRENCES OF EPIPHYTIC SPECIES  
ON 11 COMMON WAYSIDE TREES

EPIPHYTE	WAYSIDE TREE										
	<i>E. saman</i>	<i>E. grandis</i>	<i>S. macrophylla</i>	<i>P. pterocarpum</i>	<i>F. fragrans</i>	<i>P. indicus</i>	<i>A. auriculiformis</i>	<i>C. equisetifolia</i>	<i>C. nucifera</i>	<i>A. falcataria</i>	<i>R. regia</i>
<b>FERNS</b>											
<i>Asplenium nidus</i> Linn.	47	50	38	14	6	23	17	11	2	1	1
<i>Davallia denticulata</i> (Burm.) Mett.	39	41	44	0	4	12	3	5	0	0	0
<i>Drymoglossum piloselloides</i> (Linn.) Presl.	34	15	7	25	3	20	41	6	4	1	3
<i>Drynaria sparsisora</i> (Desv.) Moore	13	1	3	0	1	1	0	0	0	0	0
<i>Nephrolepis biserrata</i> (Sw.) Schott	1	1	0	0	0	1	1	0	0	0	1
<i>Ophioglossum pendulum</i> Linn.	1	0	0	0	1	0	0	0	0	0	0
<i>Phymatodes scolopendria</i> (Burm.) Ching	13	5	7	0	1	3	0	1	0	0	0
<i>Platynerium coronarium</i> (Koenig.) Desv.	3	1	0	0	1	0	2	1	0	0	0
<i>Pyrrosia longifolia</i> (Burm.) Morton	18	8	3	2	27	6	2	4	0	2	0
<i>Pyrrosia</i> spp.	38	17	14	16	2	9	8	4	1	1	0
<i>Vittaria ensiformis</i> Sw.	16	11	1	0	1	7	0	0	0	0	0
<b>PHANEROGAMS</b>											
<i>Bulbophyllum vaginatum</i> (Lindl.) Rehb.f.	4	43	1	0	0	1	0	0	0	0	0
<i>Dendrobium crumenatum</i> Sw.	47	56	85	28	16	8	2	2	3	0	0
<i>Dischidia nummularia</i> R.Br.	6	9	6	17	3	3	1	1	2	0	0
<i>Dischidia rafflesiana</i> Wall.	1	1	0	3	0	0	0	0	0	0	0
<i>Ficus religiosa</i> Linn.	2	0	0	0	0	0	2	0	0	0	0
<i>Ficus</i> spp.	18	14	7	9	16	12	13	2	0	1	2
<i>Hoya ridleyi</i> King & Gamble	3	5	1	0	1	0	0	0	0	0	0
<i>Cordia cylindristachya</i> Roem & Schult.	1	0	0	0	0	0	0	0	0	0	0
<i>Acacia auriculiformis</i> A. Cunn. ex Bth.	0	0	0	0	1	0	0	0	0	0	0
<i>Cinnamomum iners</i> Reinw. ex Bl.	0	0	0	0	1	0	0	0	0	0	0
<i>Eugenia grandis</i> Wight	0	0	0	0	0	1	0	0	0	0	0
<i>Ptychosperma</i> sp.	1	0	0	0	0	0	0	0	0	0	0
No. of epiphytic fern species	11	10	8	4	10	9	1	1	3	4	3
No. of epiphytic phanerogam species	7	6	5	4	4	4	4	3	2	1	1
No. of "non-epiphytic" phanerogam species	2	0	0	0	2	1	0	0	0	0	0



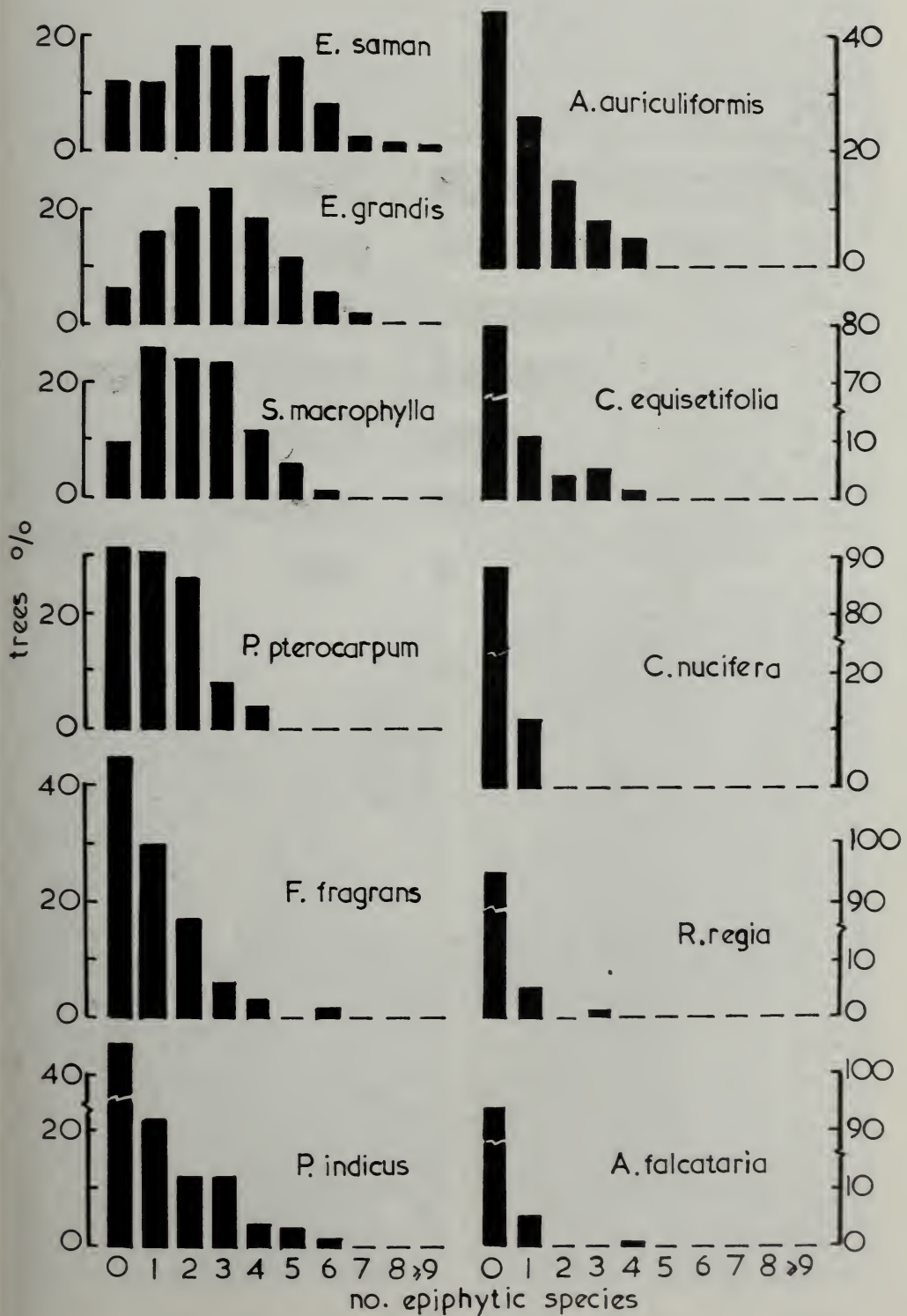


Fig. 1. Percentage occurrences of number of epiphytic species per tree for the 11 common wayside trees.

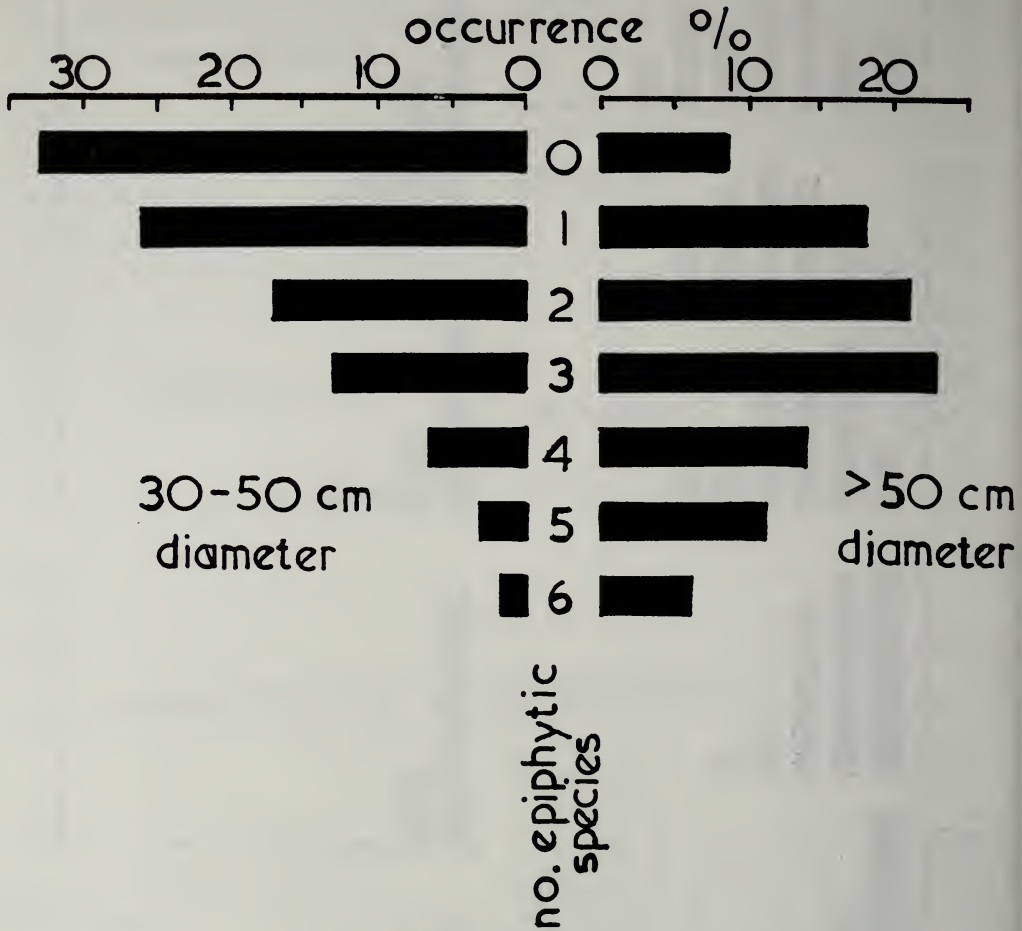


Fig. 2. Percentage occurrences of epiphytic species on trees with trunk diameters of 30-50 cm and >50 cm based on a survey of 704 and 402 trees respectively coming from seven species of tree (*E. saman*, *E. grandis*, *S. macrophylla*, *P. pterocarpum*, *F. fragrans*, *P. indiicus* and *A. auriculiformis*).

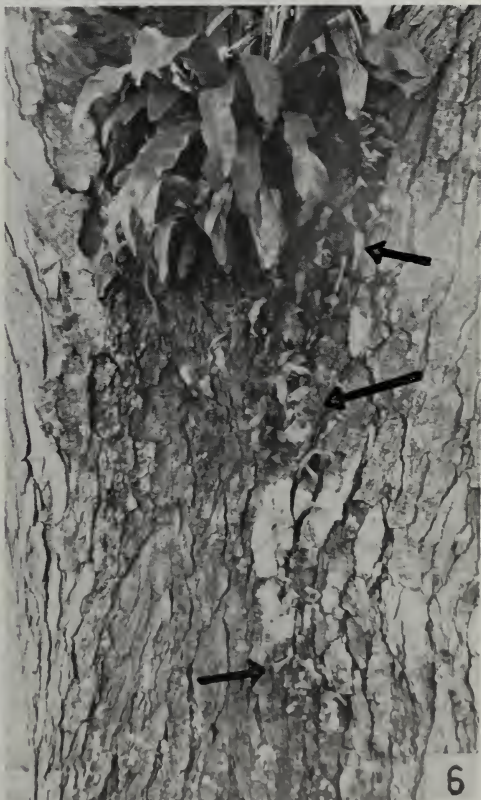


Fig. 3-6. Fig. 3. Nests of *Asplenium nidus* perching on the branches of the rain tree, *Enterolobium saman*. Fig. 4. An old nest of *Asplenium nidus* growing on the mahogany tree, *Swietenia macrophylla*. Note the flaky and scaly bark. Fig. 5. An old *Acacia auriculiformis* tree infested with *Asplenium nidus* and *Ficus* sp. Fig. 6. Close up of *Enterolobium saman* trunk to show the establishment of *Asplenium nidus* along the rain channel and *Pyrrhosia* sprouting along the trunk (arrowed) with wilted fronds as a result of drought.



Fig. 7-12. Fig. 7. *Drymoglossum piloselloides* growing on the rough and flaky bark of *Eugenia grandis*. Towards the left (arrowed) is *Hoya ridleyi*. Fig. 8. Trunk of *Roystonea regia* to show the smooth surface. Fig. 9. Smooth bark of *Albizia falcataria*. Fig. 10. Close up of *Enterolobium saman* trunk with its shallowly fissured and flaky bark and recent establishment of a young *Asplenium nidus* (arrowed, left) and *Drymoglossum piloselloides* (arrowed, right). Fig. 11. An old *Fagraea fragrans* tree infested with old nests of *Platycerium coronarium* (PC) from which grow *Ophioglossum pendulum* (OP), *Pyrrosia longifolia* (PL) and *Davallia denticulata* (DD). Fig. 12. The stag's horn fern, *Platycerium coronarium* with its nest and pendulous fronds.

# THE DELIMITATION OF THE GENUS *MAGNOLIA* (MAGNOLIACEAE)

by

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## SUMMARY

*Aromadendron* Blume, *Manglietia* Blume and *Talauma* Juss. are reunited with *Magnolia* Linn. as advocated by H. Baillon. Species of the first three genera from the Malay Peninsula and Thailand are renamed.

In preparing taxonomic accounts of the family Magnoliaceae for Tree Flora of Malaya (Keng 1973) and for the Flora of Thailand (Keng 1975), I followed closely the generic delimitation laid down by the late Mr. J.E. Dandy (1927, 1964) who kindly made available to me his unpublished lists of magnoliaceous plants from Malaya and Thailand and also critically read and commented on my manuscripts. On both occasions, I treated *Magnolia* Linn., *Manglietia* Blume, *Talauma* Juss. and *Aromadendron* Blume as separate genera. In Mr. Dandy's opinion, these four genera are well-defined ones. This can be better expressed in the following key (adapted from Dandy 1964, p. 54):

- A. Fruiting carpels dehiscent, not fleshy,
  - B. Carpels free, in fruit dehiscent along the dorsal suture,
    - C. Ovules 4 or more in each carpel ..... 1. *Manglietia*
    - C. Ovules 2 in each carpel (rarely 3-4 in the lower carpels) ..... 2. *Magnolia*
  - B. Carpels concrescent at least at the base, in fruit circumscissile and woody, the upper portions falling away either singly or in irregular masses, the lower portions persistent with the suspended seeds; stipules adnate to the petiole ..... 3. *Talauma*
- A. Fruiting carpels indehiscent, concrescent to form a fleshy syncarp; tepals 18 or more, subequal; connective-appendage very long, subequaling or longer than the anther-loculi; ovules 2 in each carpel; stipules free from the petiole ..... 4. *Aromadendron*

Previously I had my doubts about the validity of segregation of *Manglietia* and *Talauma* from *Magnolia*, and had discussed the matter with Mr. Dandy in August 1970 while visiting him at Tring, England during the time when he was recuperating from an operation. Very recently after examining several fully matured fruiting material of *Aromadendron*, I tended to agree with Baillon (1866, 1871) who considered *Magnolia* a much broader genus which includes *Manglietia*, *Talauma* and *Aromadendron*. The reasons are presented below.

Among the three, the weakest genus is *Manglietia* which differs from *Magnolia* merely in the number of ovules per carpel, and even that is not a clear-cut one (see Dandy's key above). When I raised this point during my visit, Mr. Dandy

smilingly replied that someone in the USSR (presumably he meant Dr. M.A. Baranova) studied the stomatal structures and supported the segregation.

Technically the difference between *Magnolia* and *Talauma* lies in their fruit character alone (see the key above). Without fruit, it is not possible to distinguish them. A case in point: In my treatment of a Thai species, *Magnolia craibiana* Dandy for the Flora of Thailand, the following note was added with the full endorsement of Mr. Dandy: "No fruiting specimens of this species has been seen, and its generic position is therefore in doubt. It may possibly belong to the genus *Talauma*, but until this can be proved by collection of the fruit there is no point in transferring it to that genus". (Keng 1975, p. 255).

Elsewhere I questioned the wisdom of separating genera merely based on fruit character. In my proposal of combining *Tutcheria* with *Pyrenaria* (Theaceae), I cited several similar examples such as: *Lobelia-Pratia* (Campanulaceae), *Buddleija-Nicodemia* (Loganiaceae), *Euphorbia-Elaeophoria* (Euphorbiaceae), and *Aloe-Lomatophyllum* (Liliaceae) which are segregated on their different nature of fruits (for details, see Keng 1972). It appears that *Magnolia-Talauma* complex falls into the same category.

*Aromadendron* and *Talauma* are so closely related that the former was reduced to the latter by several botanists such as Bentham (in Bentham and Hooker f.), Prantl (in Engler & Prantl), Miquel and others (for details see Dandy 1927). Their segregation was, however, upheld by Dandy on the grounds that *Aromadendron* differs from *Talauma* in: "(1) the indehiscent, fleshy fruiting carpels, (2) the free stipules, (3) the elongated peduncle, (4) the numerous tepals, and (5) the long connective-appendages" (Dandy 1927), p. 258). Among the characters mentioned, the stipules are either adnate to or free from the petiole in the genus *Magnolia* as defined by Dandy, the length of peduncles and connective-appendages are of quantitative value, the number of tepals is not consistent in any one of these taxa; thus the only crucial one is the fruit character as reflected in Dandy's key to the genera quoted in the beginning of this paper.

In examining the freshly collected, ripened fruit of *Aromadendron* (*A. elegans* Bl.) from Bukit Timah, Singapore, to my great surprise, the fruiting carpels are not fleshy. In fact they are dry, and dehiscing from within and breaking up into large or small, irregular pieces (plate 1). In the fully ripened specimens, only a number (35–50) of pink, succulent seeds remains, each attached to the persistent central axis by a thin but strongly elastic funicular cord. This is virtually indistinguishable from the fully matured fruits of *Talauma* which I had observed before.

Sometime ago, in response to my enquiry, Dr. J.E. Canright of Arizona State University, the foremost student of the Magnoliaceae, replied in a letter dated March 29, 1972: "I seriously doubt that you can separate *Magnolia*, *Manglietia*, *Talauma* (and perhaps others) on anatomical grounds, this includes woody anatomy, floral anatomy, nodal anatomy, seedling anatomy, leaf anatomy, and even pollen morphology" (personal communication).

It can thus be concluded that *Manglietia*, *Talauma* and *Aromadendron* (but not *Michelia*) should be merged with *Magnolia*, a view originally expressed by Baillon (1866, 1871) over a century ago. It saddens me a great deal that I could not discuss this point further with Mr. Dandy who passed away in 1976.

A list of newly combined names of *Magnolia* originally described under *Aromadendron*, *Manglietia* and *Talauma* from Malaya and Thailand is presented below:

*Magnolia betongensis* (Craib) H. Keng, comb. nov.

*Talauma betonensis* Craib) Kew Bull. 1925: 7; H. Keng in Whitmore, Tr. Fl. Mal. 2: 291, f. 5, 1973, and in Smitinand & Larsen, Fl. Thai. 2(3): 258, f. 41, 1975.

*Magnolia decandollii* H. Keng, nom. nov.

*Talauma candollii* Bl., Verh. Batav. Genootsch. 9: 147, 1823; H. Keng in Whitmore, l.c. 293, and in Smitinand & Larsen, l.c. 256 (non *Magnolia candolli* Link).

*Magnolia elegans* (Bl.) H. Keng, comb. nov.

*Aromadendron elegans* Bl. Bijdr. 8, 1825; H. Keng in Whitmore, l.c. 283, and Smitinand & Larsen, l.c. 252, f. 38.

*Magnolia hodgsonii* (Hook. f. & Thomas.) H. Keng, comb. nov.

*Talauma hodgsonii* Hook. f. & Thomas., Fl. Ind. 1: 74, 1855; H. Keng in Smitinand & Larsen, l.c. 258.

*Magnolia nutans* (Dandy) H. Keng, comb. nov.

*Aromadendron nutans* Dandy, Kew Bull. 1928: 183; H. Keng in Whitmore, l.c. 284.

*Magnolia siamensis* (Dandy) H. Keng, comb. nov.

*Talauma siamensis* Dandy, Kew Bull. 1929: 105; H. Keng in Whitmore, l.c. 293, and in Smitinand & Larsen, l.c. 257, f. 40.

*Magnolia singaporensis* (Ridl.) H. Keng, comb. nov.

*Talauma singaporensis* Ridl. Kew Bull. 1914: 323; H. Keng in Whitmore, l.c. 293.

*Magnolia villosa* (Miq.) H. Keng, comb. nov.

*Talauma villosa* Miq. Fl. Ind. Vat. suppl. 1: 366, 1860; H. Keng in Whitmore, l.c. 293.

#### ACKNOWLEDGEMENT

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PLATE 1.

A branch of *Aromadendron elegans* Blume (or *Magnolia elegans* H. Keng) with two fruit specimens, the one, a nearly matured, seemingly fleshy and succulent syncarp (in lower corner, detached); and the other, a fully matured syncarp with carpels dehiscing from inside and falling away in pieces and with seeds remaining on the central axis (in centre, attached). Collected from Bukit Timah Nature Reserve, Singapore on July 19th, 1978 by H. Keng and J.F. Maxwell; photographed by Mr. D. Teow. (Scale in 1 cm divisions).

# CLONAL PROPAGATION OF ARANDA, ASCOCENDA, CATTLEYA BY LEAF TISSUE CULTURE

by

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## INTRODUCTION

Monopodial orchids seem to differ from sympodial orchids in their response to tissue culture. We chose both monopodial orchids and sympodial orchids as material to study their proliferation ability by leaf tissue culture. Originally leaves of aseptic mericlone plantlets of Aranda Noorah Alsagoff (monopodial), *Cattleya bowringiana* x *C. forbesii* (sympodial) and Den. Alice Spalding (sympodial) were used. Subsequently, leaves of mature nursery plants of Aranda Wendy Scott, Aranda Christine No. 27, No. 130, Ascocenda Hilo Rose x Vanda Josephine (monopodial) and Den. Sunny (sympodial) were experimented with. Numerous plantlets from all, except the Dendrobiums, were successfully obtained by leaf tissue culture.

## MATERIALS AND METHODS

Leaves from Aranda Noorah Alsagoff and *Cattleya bowringiana* x *C. forbesii* mericlones were cut in the middle into two parts, so that one part contained the leaf tip and the other part contained the leaf base. Both parts of the leaf were cultured separately in test tubes of 3 different types of liquid media A, B, and C (Table I). All cultures were placed under continuous illumination with Sylvania Glo-Lux 30 w tube and agitated with back and forth movements of a shaker 16 hours a day at a temperature of 28°C.

Whole young leaves between 1 to 3 cm long and 0.5 to 1 cm wide were obtained from mature nursery plants of Aranda Christine No. 27 and No. 130, Aranda Wendy Scott, Ascocenda Hilo Rose x Vanda Josephine and Den. Sunny. The leaves were sterilized in a 10% chlorox solution for 15 to 20 minutes and suspended in medium C. Only Aranda Christine 130 was suspended in media A, B and C. The cultures were placed under the same condition as the above mentioned mericlone young leaves.

TABLE I  
MEDIA FOR LEAF TISSUE CULTURE

Medium A	#	Murashige-Skoog inorganic salts	full strength
		Thiamine	1.0 mg/l
		2-4-D	1.0 mg/l
		6-amino-benzyladenine	0.5 mg/l
		Sucrose	30.0 mg/l
		pH 5.0	

Medium	#		
Medium B		Vacin and Went inorganic salts	full strength
		Coconut water	500 ml/l
		Sucrose	20 g/l
		pH 5.0	
Medium C		Murashige-Skoog inorganic salts	full strength
		Thiamine	1.0 mg/l
		myo-Inositol	100.0 mg/l
		Glycine	1.0 mg/l
		Nicotinic acid	0.25 mg/l
		Pyridoxin HCl	0.25 mg/l
		2-4-D	2.0 mg/l
		6-amino-benzyladenine	2.0 mg/l
		Coconut water	150.0 ml/l
		Sucrose	30.0 g/l
		pH 5.0	

## RESULTS AND DISCUSSIONS

The results of leaf tissue culture are shown in Table II.

TABLE II  
RATE OF PROLIFERATION OF LEAF TISSUE CULTURE  
IN MEDIA A, B AND C

Leaf from Mericlone Plantlet:	Medium A	Medium B	Medium C
Aranda Noorah Alsagoff (monopodial)			
Leaf tip	—	—	—
Leaf base	—	++	+++
Cattleya bowringiana x C. forbesii (sympodial)			
Leaf tip	—	—	—
Leaf base	++	+	+++
Den. Alice Spalding (sympodial)			
Leaf tip	—	—	—
Leaf base	—	+	—
Leaf from Mature Nursery Plants:			
Aranda Wendy Scott (monopodial)			
Whole Leaf			+++
Aranda Christine No. 27 (monopodial)			
Whole Leaf			+++
Aranda Christine No. 130 (monopodial)			
Whole Leaf	—	++	+++
Ascocenda Hilo Rose x Vanda Josephine			
Whole Leaf (monopodial)			+++
Den. Sunny (sympodial)			
Whole Leaf			—

No proliferation

1 plantlet formed

—

+

Good proliferation

Excellent proliferation

++

+++

# Both media A and B are modified from Churchill et. al. *Orchid Dig* 34: 271-273 and *Amer. Orchid Dig.* 34: 100-113.

All leaf tips did not proliferate after culturing for a period of 9 weeks. Leaf tips in medium B were still alive but none of them proliferated. Leaf tips in medium A and C, turned brown and died. Leaf bases of *Aranda Noorah Alsagoff* proliferated in both media B and C (plate I). Leaf bases of *C. bowringiana* x *C. forbesii* proliferated in media A and C (plate II) but formed only one plantlet in medium B. Nine duplicates were made of all the above cultures and all showed consistent results. The whole leaves of mature plants of *Aranda Christine* No. 27, and No. 130 (plate III) *Aranda Wendy Scott* (plate IV) and *Ascocenda Hilo Rose* x *Vanda Josephine* all formed excellent proliferations in medium C. *Den Alice Spalding* (mericlone plantlet) and *Den. Sunny* (mature plant) all failed to proliferate. They did produce some callus-like tissue in solid medium C, but differentiated plantlets except for some leaf bases of *Den. Alice Spalding* which formed single plantlets in medium B.

All leaves which we were experimented with survived in medium B although they might or might not have produced proliferate bodies. Medium B contains quite a high concentration of coconut water (50%). There must be a compound in the coconut water which can prevent, in leaves in-vitro cultures, senescence and gradual death after excision from the mother plants. Zeatin, a kind of natural cytokinin in coconut water may take part in this role. 6-amino-benzyladenine in medium A does not seem to be as effective as coconut water in preventing excised leaves from senescing.

Excised monopodial orchid leaves turned brown and died after culturing in medium A, but survived and proliferated in both medium B and medium C which contain coconut water. Monopodial leaves may contain quite a high level of endoauxin, so that they easily senesce. . . and an extra amount of cytokinin is required to counteract this endoauxin reaction. This also could explain why proliferating bodies are formed in medium B which has no extra auxin added in the medium. In contrast to the above, *Cattleya* leaves may contain a lower level of endoauxin. 6-amino-benzyladenine in medium A is enough to prevent them from senescence. However auxin in coconut water alone is not enough to stimulate the formation of protocorms and additional auxin in the medium is required for the formation of proliferating bodies.

Medium C contains both coconut water and additional plant hormones. Thus both the monopodial orchids and *Cattleya* form proliferating bodies.

Since all the media, A, B, and C contain quite a high amount of plant hormones, or coconut water, the protocorm-like bodies were transferred to a regular liquid mericlone medium, namely Vacin and Went inorganic salt, 15% coconut water and no sugar, as soon as they formed, in order to minimise the chances of producing variants. These leaf protocorms are kept in this medium to serve as stocks.

When transferred to a solid medium the protocorm-like bodies all differentiated into plantlets. Numerous plantlets were produced from these leaf protocorms in a period of 9 months. They all have a normal appearance and many of them have already been transplanted into community pots in the nursery.

In our experiment, all leaf portions containing the leaf base produced proliferating bodies in medium C. We believe that the leaf bases have some young cells which may or may not have undergone cell division but are not fully expanded cells and hence are easily stimulated to become meristematic tissue. The leaf tip cells which we have used may have already matured to a certain extent so that

they are difficult to stimulate to become meristematic tissue. Very young leaf tips, such as the leaf primordia which we removed from a swollen (top or axillary) bud in our shoot tip culture did produce proliferate bodies in medium C.

We believe this success in leaf base portions is not because they have some of the meristematic tissue of the axillary bud attached to it, as surface sterilization with Clorox solution bleached the excised leaf base margins to a depth 0.1 to 0.2 cm and any attached meristematic tissue must have been killed before the culture procedure commenced.

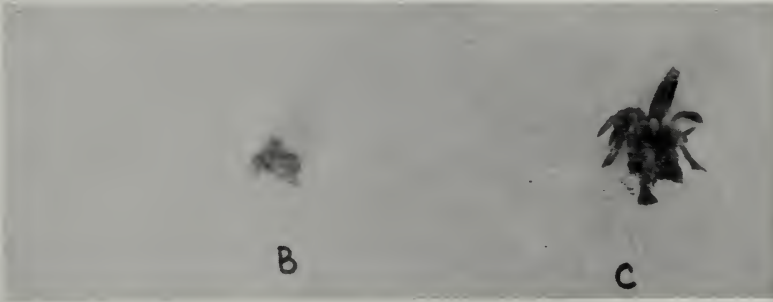


Plate 1. Leaf bases of Aranda Noorah Alsagoff proliferated in both media B and C (x 0.5).

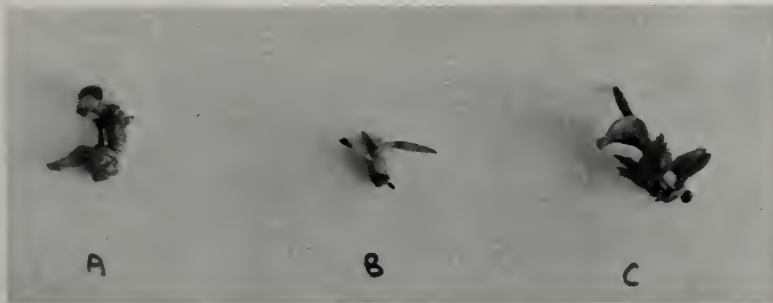
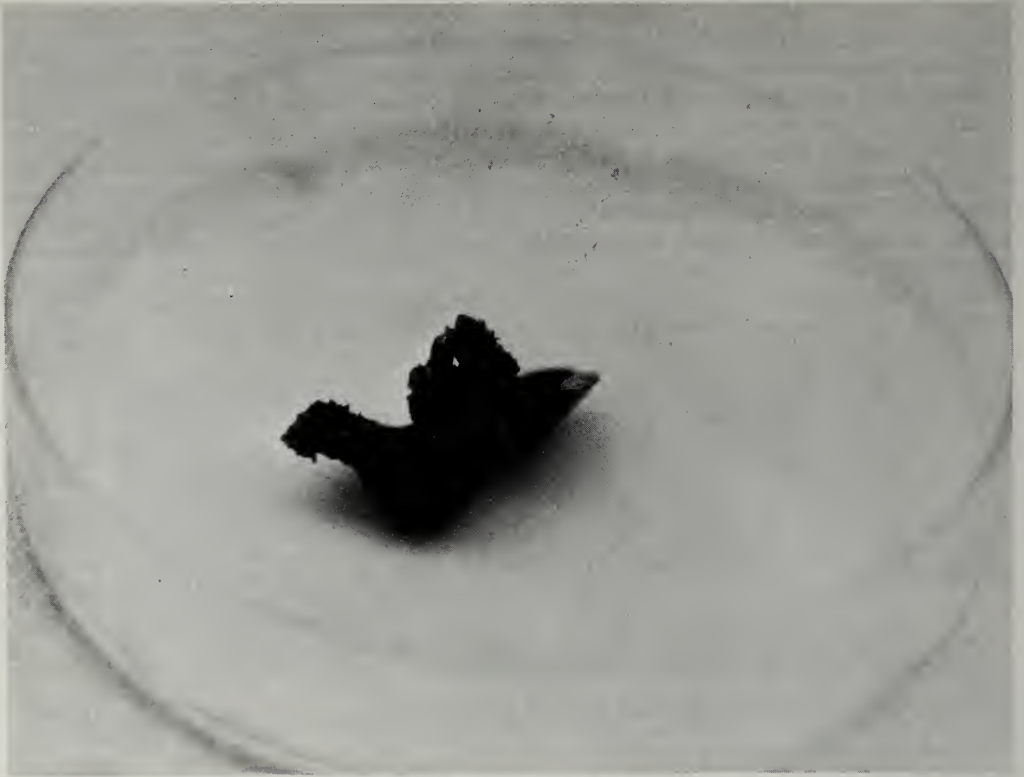


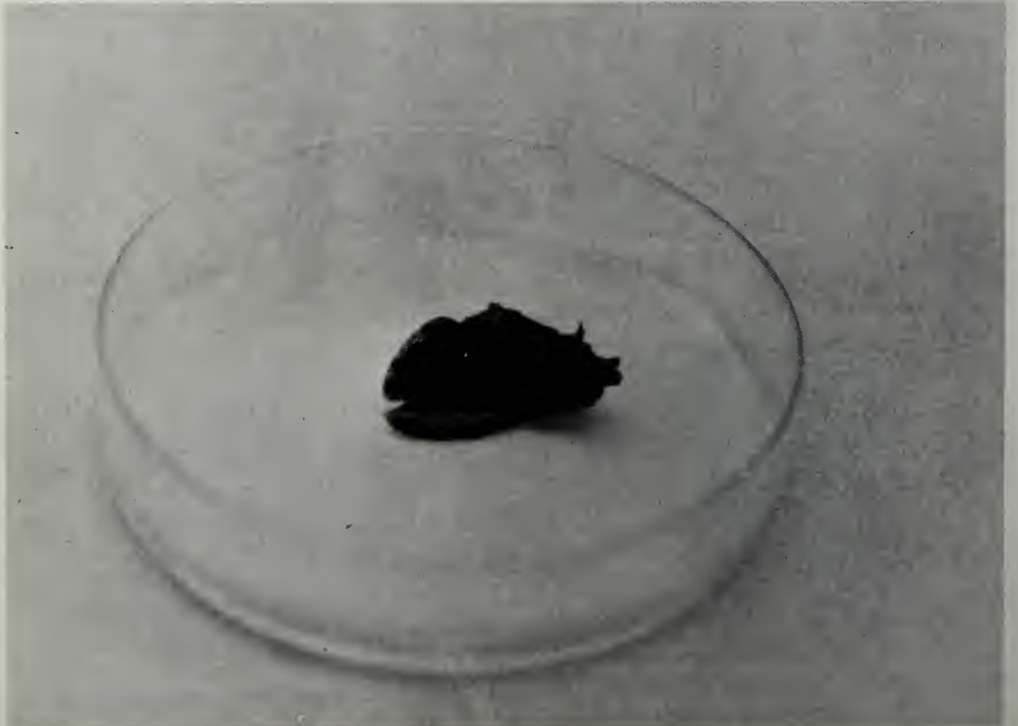
Plate 2. Leaf bases of *Cattleya bowringiana* x *Cattleya forbesii* proliferated in media A and C (x 0.5).



Plate 3. The whole leaves of mature plants of Aranda Christine No. 130 proliferated in both medium B and medium C (0.5).



**Plate 4.** The whole leaves of mature plants of *Aranda Wendy Scott* proliferated in medium C (x 1).



**Plate 5.** The whole leaves of mature plants of *Ascocenda Hilo Rose* x *Vanda Josephine* proliferated in medium C (x 0.8).

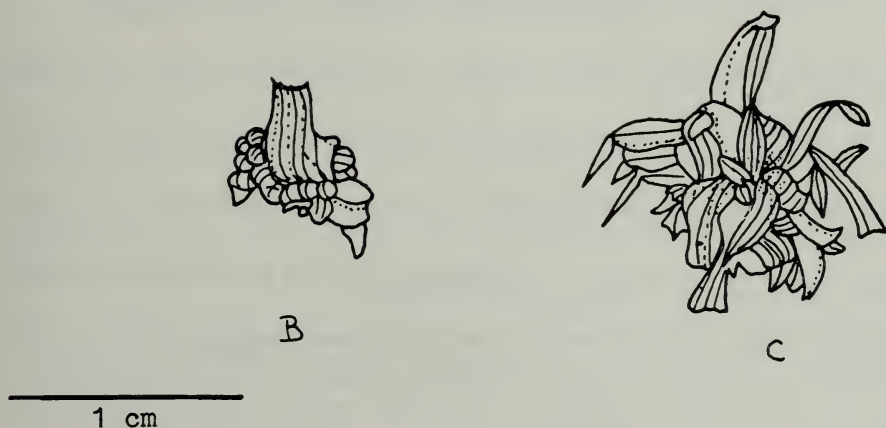


Fig. I. Leaf bases of Aranda Noorah Alsagoff proliferated in both media B and C.

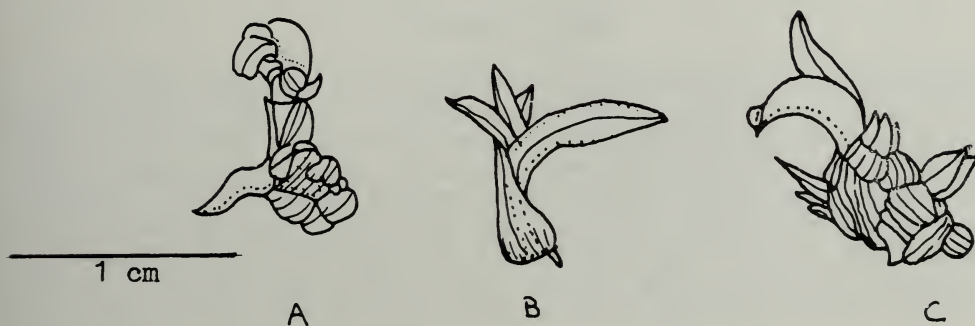


Fig. II. Leaf bases of Cattleya bowringiana x Cattleya forbesii proliferated in media A and C.

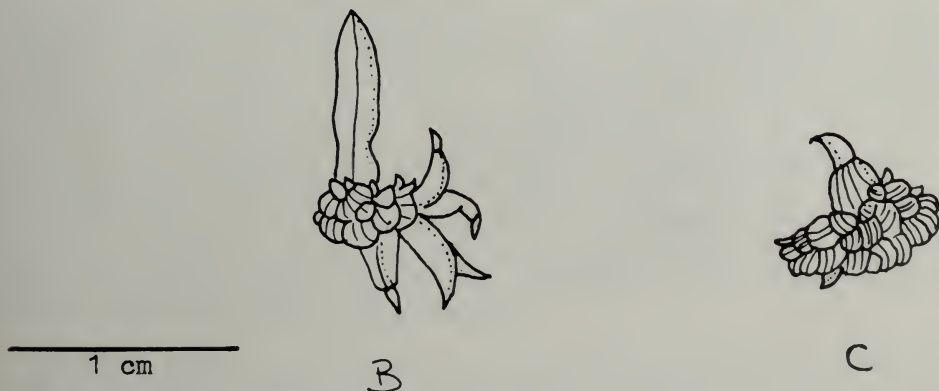


Fig. III. The whole leaves of mature plants Aranda Christine No. 130 proliferated in both medium B and medium C.

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# A REVISION OF *MEDINILLA*, *PACHYCENTRIA*, AND *POGONANTHERA* (MELASTOMATACEAE) FROM THE MALAY PENINSULA

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## ABSTRACT

The genera *Medinilla*, *Pachycentria*, and *Pogonanthera* have been thoroughly revised for the Malay Peninsula. Fourteen species and 3 varieties of *Medinilla*, including *Medinilla selangorensis* Maxw., which is proposed as a new species, with 12 new synonyms, and 3 new combinations; 3 species of *Pachycentria*, with 1 new combination; and *Pogonanthera pulverulenta* (Jack) Bl. are included. In addition to the taxonomic treatment (with keys and critical notes), the comparative morphologies of various salient organs, distribution patterns, and an index to collections are presented. Drawings of the calyx, petals, stamens, and other important structures have been prepared for all taxa.

## INTRODUCTION

This paper, the first in a planned series of revisions on Malayan Dissochaeteae (Melastomataceae), has been prepared in an effort to clarify much of the taxonomic confusion that has developed within the tribe throughout the years. In an overall attempt to eventually revise the entire tribe, three genera: *Medinilla*, *Pachycentria*, and *Pogonanthera* were studied first since their generic distinctions are clear, and the individual taxa in these three are relatively better delimited. Now that *Memecylon* (28 species and 3 varieties), *Pternandra* (4 species), and *Astronia* (1 species) have been completed for the Malay Peninsula it is hoped that I shall proceed to study *Dissochaeta*, *Diplectria*, *Macrolenes* (*Marumia*) and related genera.

## ACKNOWLEDGEMENT

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My work on this group could not have been started without the cooperation of Dr. Chang Kiaw Lan, Curator of the Singapore Herbarium, and Dr. Hsuan Keng (University of Singapore). Dr. Keng and Prof. Dr. A.N. Rao (University

of Singapore) offered their continued support and assistance during my research and preparation of this paper. Finally, I would like to thank Mr. Vijay Kumar Natarajan for his excellent drawings of all the taxa and Mr. Jumali Kafrawi for augmenting and arranging them for publication.

### *Medinilla*, Literary Review

Clarke (1879) has brief discussions of 11 species and 1 variety of *Medinilla* in the flora of British India where 5 species and the 1 variety were collected from the Malay Peninsula. These include: *M. rosea* Gaud. (description = *M. clarkei* King), *M. macrocarpa* Bl. (description = *M. radicans* (Bl.) Bl.), *M. hasseltii* Bl. (= *M. crassifolia* (Reinw. ex Bl.) Bl.), *M. hasseltii* Bl. var. *griffithii* Cl. (= *M. scortechinii* King), *M. rubicunda* (Jack) Bl., and *M. speciosa* (Reinw. ex Bl.) Bl. *Medinilla maingayi* Cl., listed under imperfectly known species, is now transferred to *Pachycentria maingayi* (Cl.) Maxw.

King (1900) included 10 species and 2 varieties of *Medinilla* for the Malay Peninsula; among these taxa he described 5 new species and 1 new variety. Among these 10 species I recognise 4 as being distinct, viz. *M. speciosa* (Reinw. ex Bl.) Bl., and 3 of the new species: *M. clarkei* King, *M. scortechinii* King, and *M. venusta* King. The other two of King's new species have been reduced in this paper: *M. scandens* King = *M. alternifolia* Bl., and *M. heteranthera* King = *M. varingiaefolia* (Bl.) Nayar. Two other species are now considered as synonyms: *M. hasseltii* (Bl.) Bakh. f. = *M. crassifolia* (Reinw. ex Bl.) Bl., and *M. perakensis* King = *M. clarkei* King. *M. maingayi* Cl. has been changed to *Pachycentria maingayi* (Cl.) Maxw., and King's description of *M. crassinervia* Bl. is incorrect and fits *M. radicans* (Bl.) Bl. Both varieties have been reduced, viz. *M. heteranthera* King var. *latifolia* King = *M. varingiaefolia* (Bl.) Nayar, and *M. hasseltii* Bl. var. *griffithii* Cl. = *M. scortechinii* King.

Ridley (1922) copied and summarized most of King's work and added 3 of his own new species: *M. pendens* Ridl., *M. pahangensis* Ridl. (= *M. clarkei* King), and *M. penduliflora* Ridl.; while reducing *M. chionantha* Stapf to *M. venusta* King var. *chionantha* (Stapf) Ridl. The only other taxonomic change Ridley made in his treatment of *Medinilla* was incorrectly reducing *M. hasseltii* Bl. var. *griffithii* Cl. to the type species. Stapf, in addition to *M. chionantha* which he described in 1906, also considered *M. gratiosa* Stapf as a new species in 1933. Both species are, in my opinion, synonyms of *M. venusta* King. *M. crassiramea* Hend., described in 1933 from a specimen collected in the Cameron Highlands, Pahang, is included in this paper as a variety of *M. clarkei* King.

In 1930 Craib described 4 new taxa of *Medinilla* from southern Thailand, viz. *M. elliptica* Craib and *M. elliptica* Craib var. *tetramera* Craib (both = *M. curtisii* Hk. f.), *M. emarginata* Craib (= *M. succulenta* (Bl.) Bl.), and *M. ferrata* Craib (= *M. laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw. These 4 taxa plus *M. penduliflora* Ridl. and *M. succulenta* (Bl.) Bl. were listed by Craib (1931) as having been collected in peninsular Thailand.

Henderson (1949, 1959) gives brief descriptions and excellent diagrams of 7 species of *Medinilla* from Malaysia, viz. *M. scandens* King (= *M. alternifolia* Bl.), *M. maingayi* Cl. (= *Pachycentria maingayi* (Cl.) Maxw.), *M. clarkei* King, *M. speciosa* (Reinw. ex Bl.) Bl., *M. scortechinii* King, *M. crassinervia* Bl. (description and drawing = *M. radicans* (Bl.) Bl.), and *M. hasseltii* Bl. (= *M. crassifolia* (Reinw. ex Bl.) Bl.).

Furtado (1963) discussed *M. pterocaula* Bl. and *M. radicans* (Bl.) Bl., however I do not believe that the former species is found in the Malay Peninsula. The 3 specimens that Furtado cited under *M. pterocaula* Bl. differ from the type collection (Blume s.n., from Java) at Leiden, which are, in my opinion, *M. radicans* (Bl.) Bl. I agree with Furtado in reducing *M. quadrifolia* Bl. to a synonym of *M. radicans* (Bl.) Bl. Nayar (1970) correctly transferred *Pachycentria varingiaefolia* Bl. to *Medinilla varingiaefolia* (Bl.) Nayar and renamed *Pachycentria speciosa* Ridl. as *M. bakhuizenii* Nayar (= *M. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw.).

In this paper 14 species and 3 varieties of *Medinilla* are enumerated. This includes 3 new combinations (all to varietal status), 12 new synonyms (not including 2 *in scheda* names: *M. clarkei* King var. *sumatrensis* Ohwi = *M. clarkei* King, and *M.holttumi* Hend. = *M. succulenta* (Bl.) Bl.), and *M. selangorensis* Maxw. — a new species.

*Medinilla curtisii* Hk. f., *M. laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw., and *M. rubicunda* (Jack) Bl. have been included since they have been collected on a few occasions from peninsular Thailand (the two former taxa) and Penang (the latter species).

#### Distribution

Seven taxa of *Medinilla* are only known from the Malay Peninsula, viz. *M. clarkei* King var. *crassiramea* (Hend.) Maxw. (Pahang), *M. laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw. (peninsular Thailand), *M. pendens* Ridl. (southern Johore), *M. penduliflora* Ridl., *M. scortechinii* King, *M. selangorensis* Maxw. (Selangor and Pahang), and *M. venusta* King. All of the other taxa have wider distributions, e.g. *M. curtisii* Hk. f. and *M. rubicunda* (Jack) Bl. — from the Indian sub-continent to the Malay Peninsula (the latter also in Sumatra); and *M. speciosa* (Reinw. ex Bl.) Bl. which is found from the Malay Peninsula to the Moluccas. Most of the other species have been collected in the Malay Peninsula, Sumatra, Borneo, and Java: 7 of which were discussed by Bakh. f. in his paper on the Melastomataceae of the Malay Archipelago.

#### Abundance

Based on herbarium material that I have studied, I have grouped the 17 taxa of *Medinilla* from the Malay Peninsula into 4 categories based on their relative abundance; very common, common, not common, and rare. *Medinilla clarkei* King and *M. crassifolia* (Rienw. ex Bl.) Bl. are very common species and have been found throughout the peninsula. *M. scortechinii* King, *M. speciosa* (Reinw. ex Bl.) Bl., *M. varingiaefolia* (Bl.) Nayar, and *M. venusta* King are common species and have been found in most of the Malaysian States, but not as frequently as the two very common species noted above. The following three species are not common; *M. alternifolia* Bl., *M. radicans* (Bl.) Bl., and *M. succulenta* (Bl.) Bl. The remaining 8 taxa are rare, and in 5 instances have only been collected on a few occasions in the type locality, e.g. *M. clarkei* King var. *crassiramea* (Hend.) Maxw. (Cameron Highlands, Pahang), *M. laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw. (Surat Province, Thailand), *M. pendens* Ridl. (Kota Tinggi, Johore), *M. selangorensis* Maxw. (Selangor, Pahang), and *M. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw. (Cameron Highlands, Pahang).

### Habit

*Medinilla alternifolia* Bl. is always a creeper, while *M. radicans* (Bl.) Bl., *M. crassifolia* (Reinw. ex Bl.) Bl. and *M. venusta* King, which usually grow as shrubs, have been recorded on a few collections as creepers. All the other 13 taxa have always been collected in flower or fruit as shrubs. While most taxa are usually epiphytes, 5 other taxa have, on occasion, been collected on the ground, viz. *M. clarkei* King, *M. clarkei* King var. *crassiramea* (Hend.) Maxw., *M. speciosa* (Reinw. ex Bl.) Bl., *M. varingiaefolia* (Bl.) Nayar, and *M. venusta* King.

### Branchlets and Stems

The branchlets and stems provide several useful characteristics in identification. The branchlets are either cylindrical or angled. Eleven taxa of *Medinilla* from the Malay Peninsula have exclusively cylindrical branchlets (and stems), e.g. *M. clarkei* King, *M. scortechinii* King, and *M. varingiaefolia* (Bl.) Nayar. *M. curtisii* Hk. f. and *M. succulenta* (Bl.) Bl. usually have cylindrical branchlets, but sometimes they are 4-angled. *M. penduliflora* Ridl. always has sharply 4-angled branchlets, while those of *M. speciosa* (Reinw. ex Bl.) Bl. are 4-angled to 4-winged. *M. radicans* (Bl.) Bl. has cylindrical to 2-grooved branchlets, and *M. alternifolia* Bl. has flattened and 2-grooved upper internodes. Whether the morphology of the branchlets is a result of the compression of 4-angled branchlets, thus giving a flattened and 2-grooved appearance, or expansion of a flattened internode is a morphological problem and should be investigated. Generally speaking, mature stems of *Medinilla* are cylindrical.

The texture of mature stems is also an excellent taxonomic aid since this is an obvious and usually constant feature of all taxa that I have studied. Six taxa have entirely smooth stems, e.g. *M. radicans* (Bl.) Bl., *M. speciosa* (Reinw. ex Bl.) Bl., and *M. varingiaefolia* (Bl.) Nayar. Gradation into pustulate stems is notable in *M. curtisii* Hk. f. and *M. pendens* Ridl. where the stems vary from smooth to sparsely pustulate. *M. alternifolia* Bl. has roughened, lenticellate stems; while the 8 remaining taxa always have distinctly and often densely pustulate stems, e.g. *M. clarkei* King, *M. crassifolia* (Reinw. ex Bl.) Bl., *M. succulenta* (Bl.) Bl., and *M. venusta* King.

The only taxa that have pubescent (furfuraceous) branchlets are: *M. alternifolia* Bl., *M. clarkei* King and *M. clarkei* King var. *crassiramea* (Hend.) Maxw. *M. laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw., according to Craib, has ferruginous branchlets, however the type collection at Kew is entirely glabrous. All the other 13 taxa have glabrous branchlets and stems.

### Leaves

The leaves of *Medinilla* provide one of the most useful taxonomic features which are constant for each taxon. Leaf arrangement is alternate in mature specimens of *M. alternifolia* Bl., however juvenile plants often have opposite leaves — one normal and one rudimentary. Eleven taxa have exclusively opposite leaves, e.g. *M. crassifolia* (Reinw. ex Bl.) Bl., *M. scortechinii* King, *M. succulenta* (Bl.) Bl., and *M. venusta* King. *M. selangorensis* Maxw. has opposite and 3-whorled leaves, however since I have seen only 5 collections of this species I am not entirely certain if this is a constant feature. Leaves in whorls of 3–4 (*M. clarkei* King and *M. speciosa* (Reinw. ex Bl.) Bl.) or 4–5 (*M. clarkei* King var. *crassiramea* (Hend.) Maxw. and *M. radicans* (Bl.) Bl.) are obvious features which immediately distinguish several taxa. All taxa except *M. alternifolia* Bl., which has serrulate blades, have entire blades.

The mid-nerve is always prominent and in *M. rubicunda* (Jack) Bl. and *M. succulenta* (Bl.) Bl. the only other longitudinal nerves are a pair of thin intramarginal ones. All the other taxa have at least 1 more pair of nerves which branch from near the base of the mid-vein. Eleven taxa have 1 pair of side nerves (3-plinerved) in addition to a pair of thin intramarginal ones, e.g. *M. crassifolia* (Reinw. ex Bl.) Bl., *M. pendens* Ridl., *M. radicans* (Bl.) Bl., *M. scortechinii* King, and *M. venusta* King. *M. clarkei* King has both 3 or 5-plinerved blades, while *M. clarkei* King var. *crassiramea* (Hend.) Maxw. is 5-plinerved. *M. alternifolia* Bl. is usually 5–7 plinerved and *M. speciosa* (Reinw. ex Bl.) Bl. has characteristically 2–4 pair of side nerves (5–9 plinerved).

Except for their length, the petioles are not a very useful structure for identification purposes. *M. penduliflora* Ridl., *M. scortechinii* King, *M. succulenta* (Bl.) Bl., and *M. venusta* King often appear sessile; however all the other taxa have distinctly petiolate blades. *M. speciosa* (Reinw. ex Bl.) Bl. can also be easily identified by its tuft of axillary bristles and unequal blade bases. All other taxa have minutely pilose or glabrous leaf axils and symmetric blades.

### Inflorescence

The inflorescence of most taxa of *Medinilla* is cymose and often arranged in a panicle of cymes, however *M. alternifolia* Bl. has a glomerulate inflorescence and solitary flowers are often found on some species, e.g. *M. pendens* Ridl., due to a reduction of the inflorescence axes. An umbellate arrangement, again due to a shortening of upper axes, is frequently seen in several taxa, e.g. *M. clarkei* King. The inflorescence is axillary in most taxa, however *M. curtisii* Hk. f., *M. speciosa* (Reinw. ex Bl.) Bl., *M. varingiaefolia* (Bl.) Nayar, *M. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw., and sometimes *M. venusta* King have terminal inflorescences. The inflorescence can either arise from leafy axils (e.g. *M. crassifolia* (Reinw. ex Bl.) Bl. and *M. penduliflora* Ridl.), from leafless nodes (e.g. *M. radicans* (Reinw. ex Bl.) Bl. and *M. succulenta* (Bl.) Bl.), or from either leafy or leafless nodes (e.g. *M. clarkei* King var. *crassiramea* (Hend.) Maxw. and *M. selangorensis* Maxw.). While the nature of the inflorescence is distinct for many taxa, I have not found it as useful as the leaves or flowers for identification purposes.

### Calyx

The calyx in all taxa except *M. pendens* Ridl. and *M. scortechinii* King, which have 5 (the former) or 4 (the latter species) undulate lobes, is completely truncate (*M. alternifolia* Bl., *M. crassifolia* (Reinw. ex Bl.) Bl., and *M. radicans* (Bl.) Bl.) or truncate with 4 (5 taxa) or 5 (5 taxa) cusps. *M. curtisii* Hk. f., *M. selangorensis* Maxw., and *M. venusta* King have both 4- and 5-merous flowers. The general shape is campanulate to cyathiform (e.g. *M. clarkei* King and *M. radicans* (Bl.) Bl.) or funnelform with a globose ovary (e.g. *M. varingiaefolia* (Bl.) Nayar). *M. clarkei* King var. *crassiramea* (Hend.) Maxw. and *M. selangorensis* Maxw. have furfuraceous calyces, while those of the other taxa are glabrous.

### Petals

The petals in *Medinilla* are typically thin and showy. The shape varies from ovate to sub-orbicular with an acute or broadly rounded tip and truncate base. The petals are asymmetric in many taxa (e.g. *M. clarkei* King, *M. crassifolia* (Reinw. ex Bl.) Bl., and *M. venusta* King). In accordance with the number of calyx lobes, each taxon has 4 (8 taxa) or 5 (7 taxa) petals. *M. curtisii* Hk. f., *M. selangorensis* Maxw., and *M. venusta* King have 4 or 5 petals.

### Anthers

The morphology of the anthers is a very important generic feature which easily distinguishes *Medinilla* from *Pachycentria* and *Pogonanthera*, however it is of limited use for identifying most *Medinilla* found in the Malay Peninsula. *Medinilla* has anthers with a dorsal crest or keel on the connective which is often spur-like near the filament, and a basal lobe-like extension at the base of each anther locule. *M. varingiaefolia* (Bl.) Nayar lacks a crest on its 4 long anthers, but the 4 short ones have a crest. *M. radicans* (Bl.) Bl., *M. variniaefolia* (Bl.) Nayar, and *M. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw. are the only taxa with dimorphic (4 long and 4 short) anthers from the Malay Peninsula. *M. curtisii* Hk. f., *M. selangorensis* Maxw., and *M. venusta* King have either 8 or 10 stamens, while 8 taxa have 8 stamens, and 7 have 10 stamens. The mature anthers in all taxa are slightly curved, 2-locular, and open with a single terminal, oblique pore at the tip of a thin rostrum.

### Extra-Ovarial Chambers

*Medinilla*, as with most other genera of the Dissochaeteae, has 8 or 10 (according to the number of stamens) cylindrical chambers between the calyx tube and ovary. These chambers are where the introrse bud anthers are inserted and with the elongation of the filaments, grow out of these chambers and eventually become erect. The chambers in *Medinilla* extend to about the middle of the ovary and are best seen in buds.

*Medinilla varingiaefolia* (Bl.) Nayar and *M. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw. are exceptional in that they do not have any extra-ovarial chambers or septa, and in this respect could easily be considered under *Pachycentria* (*P. varingiaefolia* (Bl.) Bl.). These two taxa are somewhat intermediate between the two genera since the shape of the calyx is more like that of *Pachycentria* than *Medinilla*. The anthers, as discussed above, of the two taxa convince me that they both should be included under *Medinilla*.

### Gynoecium and Fruit

The stigma in *Medinilla* is typically minute and the style is slender, glabrous, and rises to a level slightly above the tip of the anthers. The inferior ovary is 4–6 loculed with numerous ovules on a parietal placenta in each. The fruit is a berry which is globose or somewhat oblong (*M. radicans* (Bl.) Bl.) with a thin exocarp, fleshy (often juicy) mesocarp, and numerous seeds. I have not found the gynoecium or fruit to be very useful taxonomically since there are many vegetative features that can be used to identify fruiting material.

### Literary Review of *Pachycentria* and *Pogonanthera*

Clarke (1879), King (1900), Ridley (1922), and Bakh. f. (1943–45) all included *Pogonanthera pulverulenta* (Jack) Bl., on the basis of its unique anthers, as a distinct species ranging from the Malay Peninsula to New Guinea. *Pachycentria tuberculata* Korth. (= *Pachycentria constricta* (Bl.) Bl.) was included by King (1900) and Craib (1931) as the sole representative of the genus in the Malay Peninsula and Thailand, respectively; however Ridley (1922) added *Pachycentria speciosa* Ridl. (= *Medinilla varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw.). Bakh. f. discussed 6 species of *Pachycentria* from the Malay Archipelago including: *P. constricta* (Bl.) Bl., *Pachycentria microsperma* Becc., and *Pachycentria varingiaefolia* (Bl.) Bl. (= *Medinilla varingiaefolia* (Bl.) Nayar). He described as *sp. nov.* the other 3 species — all from New Guinea.

*Medinilla variniaefolia* (Bl.) Nayar should be included as a species of *Medinilla* rather than *Pachycentria* even though the shape of the calyx and absence of extra-ovarial chambers in this species are features of *Pachycentria*. The 8 anthers of *P. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw. are like those of *Medinilla*, while 4 anthers of the type species are like those of *Medinilla*, and the other 4 (long ones) are like *Pachycentria*. The size of the flowers of both taxa are larger than those of *Pachycentria* and on this feature alone the affinities lie with *Medinilla*. I have, therefore, accepted Nayar's transfer of *Pachycentria varingiaefolia* (Bl.) Bl. to *Medinilla varingiaefolia* (Bl.) Nayar. *Medinilla bakhuizenii* Nayar, except for the long anthers, is identical to *M. varingiaefolia* (Bl.) Nayar; therefore I have reduced the former to a variety of the latter, viz. *Medinilla varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw.

*Medinilla maingayi* Cl. has been recombined as *Pachycentria maingayi* (Cl.) Maxw. due to the shape of the calyx, absence of extra-ovarial chambers and septa, and the spurred (not crested or with locular appendages) anthers.

#### *Comparative Morphologies of Medinilla, Pachycentria, and Pogonanthera*

Vegetatively and with many structural features these three genera are very similar. Since *Pogonanthera* is not as closely related to *Medinilla* as *Pachycentria* is, the former has always been considered as a distinct genus and according to Bakh. f. consists of one polymorphic species, viz. *Pogonanthera pulverulenta* (Jack) Bl. *Pachycentria* and *Medinilla*, however, are easily confused and several species have been transferred from one to the other. The three species of *Pachycentria* and *Pogonanthera pulverulenta* (Jack) Bl. from the Malay Peninsula are all epiphytic shrubs with furfuraceous branchlets; opposite, entire, and 3-plinerved leaves; and small, 4-merous flowers, without extra-ovarial chambers or septa, *Pachycentria constricta* (Bl.) Bl. has flattened branchlets and a groove on each flattened face; while those of *Pachycentria microsperma* Becc. are flattened to 4-angled. The branchlets of *Pachycentria maingayi* (Cl.) Maxw. are cylindrical, and a cylindrical to 4-angled shape characterizes those of *Pogonanthera pulverulenta* (Jack) Bl. *Medinilla* has branchlets which range from cylindrical, flattened and 2-grooved, to 4-angled and 4-winged. Most taxa of *Medinilla* have glabrous branchlets, however 3 are furfuraceous. The branches and stems of *Pachycentria* and *Pogonanthera* are smooth, while those of *Medinilla* range from smooth densely pustulate. *Medinilla* is also more variable in having taxa with alternate (1 species), opposite, and whorled leaves: and 1 to 9 main nerves.

The inflorescence of the 3 species of *Pachycentria* and *Pogonanthera pulverulenta* (Jack) Bl. is cymose, as in most species of *Medinilla*; however solitary flowers are often found on specimens of *Pachycentria maingayi* (Cl.) Maxw. due to a reduction in the length of the inflorescence axes. The inflorescence is usually terminal in *Pachycentria* and *Pogonanthera*, but *Pachycentria maingayi* (Cl.) Maxw. and *Pachycentria microsperma* Becc. often have axillary inflorescences in addition to the terminal ones. *Medinilla* has both terminal and axillary inflorescences. While all species of *Pachycentria* and *Pogonanthera pulverulenta* (Jack) Bl. have 4-merous flowers, *Medinilla* has species with both 4 and 5-merous flowers (3 having both 4 and 5 merous parts).

The anthers provide the most useful means for distinguishing the 3 genera, however when considering individual species of *Medinilla* and *Pachycentria* other features (e.g. leaves, calyx, fruit) must be examined. *Medinilla* includes all species that have anthers (8 or 10, equal or unequal) with a connective crest or keel (often spur-like near the filament) and a linear or lobe like extension

at the base of each locule. The anthers of *Medinilla* have, therefore, 3 appendages. The three species of *Pachycentria* from the Malay Peninsula have 8 equal (other species having 10, sometimes unequal) anthers with a spur-like extension at the base, without any crest or locule appendages. *Pogonanthera pulverulenta* (Jack) Bl., in addition to the auricled base of the blades, has unique anthers which are inappendiculate and have a tuft of bristles on the lower part of the connective. *Pachycentria* and *Pogonanthera* both lack extra-ovarial chambers and septa, in contrast to *Medinilla* which has 8 or 10 chambers and septa (according to the number of stamens), except in *M. varingiaefolia* (Bl.) Nayar and *M. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw. which lack these structures, which extend to about the middle of the ovary. The absence of these chambers is an exception in the Dissochaeteae and is, therefore an excellent means, along with the anthers, to distinguish *Medinilla* from *Pachycentria*. *Medinilla maingayi* Cl., considered as such by King and Ridley, is certainly *Pachycentria* by virtue of the shape of the calyx, absence of extra-ovarial chambers and septa, and spurred anthers without locular appendages. I have, therefore, recombined the species as *Pachycentria maingayi* (Cl.) Maxw.

#### *Distribution and Abundance*

In relation to the 3 species of *Pachycentria* and *Pogonanthera pulverulenta* (Jack) Bl. with *Medinilla* from the Malay Peninsula, *Pachycentria constricta* (Bl.) Bl. is common and is found throughout the region. *Pachycentria maingayi* (Cl.) Maxw. and *Pogonanthera pulverulenta* (Jack) Bl. are not as common, however they have been collected from scattered localities throughout the Peninsula. *Pachycentria microsperma* Becc., while rare in the Malay Peninsula, is more common in Sumatra and Borneo.

#### *Generic Key to Medinilla, Pachycentria, and Pogonanthera*

1. Anther connective crested, often spurred at the base, locules each with a basal appendage extra-ovarial chambers 8 or 10, extending to about the middle of the ovary (except in *Medinilla varingiaefolia* (Bl.) Nayar and *M. varingiaefolia* var. *bakhuizenii* (Nayar) Maxw.) ..... *Medinilla*
1. Anther connective not crested, locules inappendiculate; extra-ovarial chambers not developed.
  2. Anther connective with a basal spur; locules each with up to 15 ovules; blades acute or rounded at the base ..... *Pachycentria*
  2. Anther connective with a tuft of minute bristles; ovules c. 25 in each locule; blades usually auricled at the base .....  
..... *Pogonanthera pulverulenta* (Jack) Bl.

#### MEDINILLA Gaudichaud

Gaudichaud, Voy. S.M. l'Ukraine (1892) 484; De Candolle, Prodr. III (1828) 167; Naudin, Ann. Sci. Nat. Ser. III: 15 (1851) 285; Triana, Trans. Linn. Soc. 28:1 (1871) 95; Clarke in Hk. f. Fl. Brit. Ind. II (1879) 546; Cogniaux in DC. Monogr. Phanero. 7 (1891) 572; King, J. As. Soc. Beng. 69, II: 1 (1900) 59 (Mat. Fl. Mal. Pen., 467); Ridley, Fl. Mal. Pen. I (1922) 801; Craib, Fl. Siam. Enum. I: 4 (1931) 699; Bakh. f., Rec. Trav. Bot. Neerl. 40 (1943-45) 147; Henderson, Malay Nat. J. 4: 3 & 4 (1949) 132 and Malay. Wild Fls. I (1959) 132; Furtado, Gard. Bull. Sing. 20 (1963) 118; Nayar, Blumea 18:2 (1970) 567.

Epiphytic, rarely terrestrial shrubs; erect, less frequently creeping; stems smooth or pustulate, generally cylindrical; leaves opposite, whorled, or in one species alternate; blades generally fleshy coriaceous; with 1, 3, 5, or 7 main nerves; flowers axillary or terminal, solitary or more commonly in cymose or umbellate inflorescences, generally showy and 4-5 merous; calyx campanulate or cyathiform to funnelform, truncate, often apiculate or shallowly lobed; petals thin, white or pinkish, sometimes asymmetric; stamens 8 or 10, uniform or dimorphic; anthers cylindrical, tapered to the tip and opening by a single terminal pore; connective crested or not, with a basal appendage; locules each with a basal appendage in the shape of a tubercle, hook, or claw; filaments flattened; extra-ovarial chambers 8 or 10, extending to about the middle of the ovary; ovary inferior, 4-6 loculed, ovules numerous; fruit a berry, generally globose with a distinct calyx remnant; exocarp thin, ripening red or violet; seeds few to numerous, ovate to oblong, hilum frequently flattened, testa usually finely reticulate.

*Medinilla*, according to Airy-Shaw (Willis, Dict. Fl. Pl. & Ferns), includes about 400 species ranging from tropical Africa, Madascagar, the Indian sub-continent, Malay Peninsula, Philippines, Malay Archipelago, and the Pacific islands.

Key to the Species and Varieties of *Medinilla*  
from the Malay Peninsula.

- I. Inflorescence terminal
  2. Calyx with 4 distinct cusps or 4 sub-marginal thickenings, petals 4.
    3. Stamens uniform ..... *M. curtisii* Hk. f.
    3. Stamens dimorphic.
    4. Blades acuminate, sub-coriaceous, connective of long anthers without an appendage ..... *M. varingiaefolia* (Bl.) Nayar var. *varingiaefolia*
    4. Blades obtuse, coriaceous, connective of long anthers with a basal spur ..... *M. varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw.
  2. Calyx with 5 cusps or 5 sub-marginal thickenings, petals 5.
    5. Branches 4-angled to 4-winged, smooth or with remote pustules.
    6. Nodes with setose bristles, leaves in whorls of 3 ..... *M. speciosa* (Reinw. ex Bl.) Bl.
    6. Nodes without bristles, leaves opposite ..... *M. curtisii* Hk. f.
  5. Branches cylindrical, densely pustulate ..... *M. venusta* King
- I. Inflorescence axillary, not terminal.
  7. Inflorescence glomerulate, primary axes several from each axil, plant a root climber, leaves on mature plants alternate ..... *M. alternifolia* Bl.
  7. Inflorescence paniculate, cymose, umbellate, or of solitary flowers; primary axes generally 1 in each axil, shrubby (or with *M. radicans* a root climber); leaves opposite or whorled.
  8. Inflorescence paniculate, cymose, or of solitary flowers; stamens uniform.

9. Calyx truncate or minutely 5-dentate, connective crested.
10. Stems and inflorescence axes cylindric or flattened; inflorescence up to 14 cm long.
11. Stems pustulate, sometimes only slightly; inflorescence 3–14 cm long.
12. Leaves whorled.
13. Anther locules inappendiculate, leaves in whorls of 3, blades decurrent ( $\frac{1}{2}$  to  $\frac{3}{4}$  total length) on the petiole ..... *M. selangorensis* Maxw.
13. Anther locules appendaged, leaves in whorls of 4, blades not or very shortly (1–2 mm) decurrent on the petiole.
14. Inflorescence axes and petioles glabrous or only sparsely furfuraceous .....  
*M. clarkei* King var. *clarkei*.
14. Inflorescence axes and petioles densely red brown furfuraceous .....  
*M. clarkei* King var. *crassiramea* (Hend.) Mawx.
12. Leaves opposite.
15. Blades decurrent on at least half the length of the petiole, calyx 6–9 mm long, fruit 8–9 mm wide ..... *M. venusta* King.
15. Blades not or only decurrent for  $\frac{1}{3}$  the length of the petiole, calyx 4–6 mm long; fruit c. 6 mm wide.
15. Pedicels c. 3 mm long, calyx 4 mm long, 3 mm wide, petals 5–6 mm long, 3 mm wide; anthers straight, 3–4 mm long .....  
*M. crassifolia* (Reinw. ex Bl.) Bl.
16. Pedicels c. 5 mm long, calyx 5–6 mm long 5 mm wide, petals 16–18 mm long, 9–11 mm wide; anthers "J" shaped, c. 8 mm long .....  
*M. laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Mawx.
11. Stems smooth, inflorescence 1.5–3 cm long ..... *M. pendens* Ridl.
10. Stems and inflorescence axes 4-angled, smooth; inflorescence (10) 16–32 cm long ..... *M. penduliflora* Ridl.
9. Calyx 4-denticulate to 4-lobed, connective not or only slightly crested.
17. Blades at least 6.5 cm long, inflorescence at least 1.5 cm long.
18. Inflorescence axes and calyx glabrous.
19. Inflorescence 6–12 cm long, multiflowered, axes flattened and often winged, axes distinct; calyx lobes broadly triangular .....  
*M. scortechinii* King
19. Inflorescence 1.5–2.5 cm long, few flowered, axes cylindric, 3d axes not developed, calyx with 4 cusps (often sub-marginal).
20. Upper branchlets slightly 4-angled to cylindric, smooth or with scattered pustules, petiole 1–3 mm long, calyx 3–4 mm long, 3 mm wide; petals 6–7 mm long, c. 4 mm wide ..... *M. succulenta* (Bl.) Bl.

20. Upper branchlets cylindric, smooth, petiole usually more than 3 mm long; calyx c. 5 mm long, 4 mm wide; petals 12–14 mm long, c. 6 mm wide ..... *M. rubicunda* (Jack) Bl.
18. Inflorescence axes and calyx minutely furfuraceous .....  
*M. selangorensis* Maxw.
17. Blades up to 3 cm long, inflorescence up to 1.5 cm long .....  
q.v. *Pachycentria maingayi* (Cl.) Maxw.
8. Inflorescence umbellate (secondary, etc. axes not developed), plant a root climber, stamens dimorphic ..... *M. radicans* (Bl.) Bl.
1. *Medinilla alternifolia* Bl., Mus. Bot. Lugd.-Bat. I:2 (1849) 19. *M. scandens* King, J. As. Soc. Beng. 69, II:1 (1900) 60; Ridley, Fl. Mal. Pen. I (1922) 801 syn. nov.

Root climber, stem closely appressed to tree trunks, 5–12 m long, with many adventitious roots up to 6.5 cm long, firmly rooted in the ground, slightly compressed and 2-grooved, red-brown hispid when young; becoming cylindric and up to 1 cm thick with a roughened, rugose-lenticellate, glabrous, tan-brown epidermis; wood in x-section with many radiating cavities; leaves on juvenile plants frequently opposite, with one large and one rudimentary leaf at each node or alternate where the smaller leaf has not developed; thin, but thickening with size and maturity of the plant; larger blades lanceolate to narrowly elliptic, margin minutely and widely serrulate, often with setaceous cusps; acute at the tip; rounded and shallowly (1–2 mm), sometimes unequally, auriculate-cordate at the base; venation pinnate with 2–3 pair of main nerves arising from the mid-nerve near the base, lowest pair very thin and not reaching the tip, generally 3-nerved at the tip, nerves sunken above, slightly raised below, drying brown above, lighter brown below; petiole dorsally grooved, setose, 2–8 mm long, 1.0–1.5 mm thick; small leaves generally about 1/10 to 1/5 the size of the larger ones, often ovate otherwise having a similar margin, texture, etc. as the larger blades; petioles similar, but shorter; leaves of mature (flowering) plants from the main stem or on thinner branches, alternate (infrequently opposite), sub-coriaceous, fleshy, glabrous, serrulate broadly elliptic, ovate, or sub-orbicular; acute at the tip; acute or rounded, shortly decurrent, often unequally, at the base; venation pinnate, with 3–4 pair of nerves arising from the mid nerve near the base; lowest nerves intramarginal, thin, and incomplete; 5 (less commonly 3) nerved at the tip; nerves sunken above, raised and arching below; transverse venation pinnate, c. 20–25 pair, arising at 90° from the main veins, widely spaced, sunken above, raised below; 14–26 cm long, 7–15 cm wide; dull dark green above, pale green below, drying brown above, lighter brown and often with an olive hue below; petiole 5.5–20 cm long, 2–4 mm thick when dry, fleshy, glabrous, purplish-reddish; inflorescence glomerulate, on raised, irregular tubercles; 2–3 cm long, c. 1 cm wide, mostly from behind the leaves or in the axils of the oldest leaves; glabrous; primary axes numerous, especially from the lowest nodes, 5–20 mm long, c. 1 mm thick, unbranched with one node, or with 1–3 secondary axes 2–10 mm long each with 1 normal and sometimes 1 or 2 rudimentary flowers; pedicels 3–7 mm, or in solitary flowers up to 15 mm long, reddish; bracts squamose up to 0.5 mm long; calyx cyathiform-urceolate, truncate, smooth, glabrous, 7–8 mm long, c. 4 mm wide, green; petals 4, thin, ovate to oblong, acuminate at the tip truncate at the base, reflexed at maturity, sparsely hispid outside (especially in bud), glabrescent, 10–12 mm long, 6–8 mm wide, pinkish; filaments flattened, c. 6 mm long, 0.5 mm wide at maturity; anthers cylindric with a narrow and thin apical beak with one terminal pore, 5–6 mm

long, 1 mm wide, yellow; connective ridged and thickened, extended in a plano-convex or flattened spur, 1–2 mm long, often thickened; locules each with a minute claw at the base; stigma minute, curved to hooked; style cylindrical, minutely and sparsely hispid, c. 10 mm long, 1 mm thick, white; fruit sub-globose, 8–9 mm long, 6–7 mm wide, on primary axes up to 25 mm long, and pedicles 8–20 mm long; calyx remnant c. 1 mm high, areolus 4 mm wide; exocarp smooth, glabrous, white then orange, black or dark brown when dry, pericarp c. 0.3 mm thick; seeds numerous, ovate, c. 0.5 mm long.

Figure 1: a. calyx, b. petal, c. stamen.

Distribution: shaded evergreen forests in central and Southern Malaysia, Sumatra and Borneo.

Distinct from all other species of *Medinilla* in the region with its creeping habit, and in mature plants alternate leaves, serrulate blades, and glomerulate inflorescence.

King notes that *M. scandens* King merely differs from *M. alternifolia* Bl. in having a much shorter connective spur, larger leaves, and more flowers in each inflorescence. Unfortunately, only one specimen in the type collection of *M. alternifolia* (Blume s.n., from Sumatra) at Leiden has flowers, and these are merely scraps of a few crushed buds. The bud anthers do, however, appear identical to Kiah 32048, which is obviously *M. alternifolia*, from the Malay Peninsula. The branches and leaves of these two specimens are identical. The number of flowers per inflorescence is variable, and in many collections from Sumatra and Borneo this factor does not correlate with the size of the leaves. *M. scandens* King is, therefore, entirely identical to *M. alternifolia*. The only other species that could be confused with *M. alternifolia* Bl. are *M. bisetosa* Bakh. f. and *M. barbata* Bakh. f. — the former having smaller blades with invisible secondary venation, and the latter with furfuraceous leaves and calyx tube.

## MALAYSIA

*Perak* — Bujong Malacca: Curtis 3294; Bukit Kemunting, Taiping: Shah & Sidek 1182; Maxwell's Hill: Sinclair & Kiah 38804; Pandok Tanjong For. Res.: Spare 36301 (2243); Taiping Hills; Henderson 10393; Tapak: Ridley 14094; Tea Gardens: Ridley 2933; sine loco.: Cantley sn. Scortechini 150 (*syntype M. scandens* King).

*Trengganu* — Ulu Bendong. Kajang, Kemaman: Corner 30127; Kampong Bukit: Sinclair & Kiah 40448.

*Pahang* — Sungai Tahan: Shah 1415.

*Johore* — Mersing: Jumali & Heaslett 4448; Sungai Kayu: Kiah 32048, 32456, 32755, sn on 11 April 1936; Corner 32456, 32755.

2. *Medinilla clarkei* King, J. As. Soc. Beng. 69, II:1 (1900) 63; Ridley, Fl. Mal. Pen. I (1922) 803; *M. perakensis* King, l.c. 64 *syn. nov.*; *M. pahangensis* Ridl., J. Linn. Soc. 38 (1907–09) 310 *syn. nov.*; *M. clarkei* King var. *sumatrensis* Ohwi in *scheda* herb. Bogor, Leiden.

var. *clarkei*.

Epiphytic, rarely terrestrial, shrub up to 2.5 m tall; branches cylindrical, c. 2 mm thick, often climbing with the aid of adventitious roots, glabrous or sparsely furfuraceous, sparsely to densely pustulate, epidermis purple, drying tan to light brown.

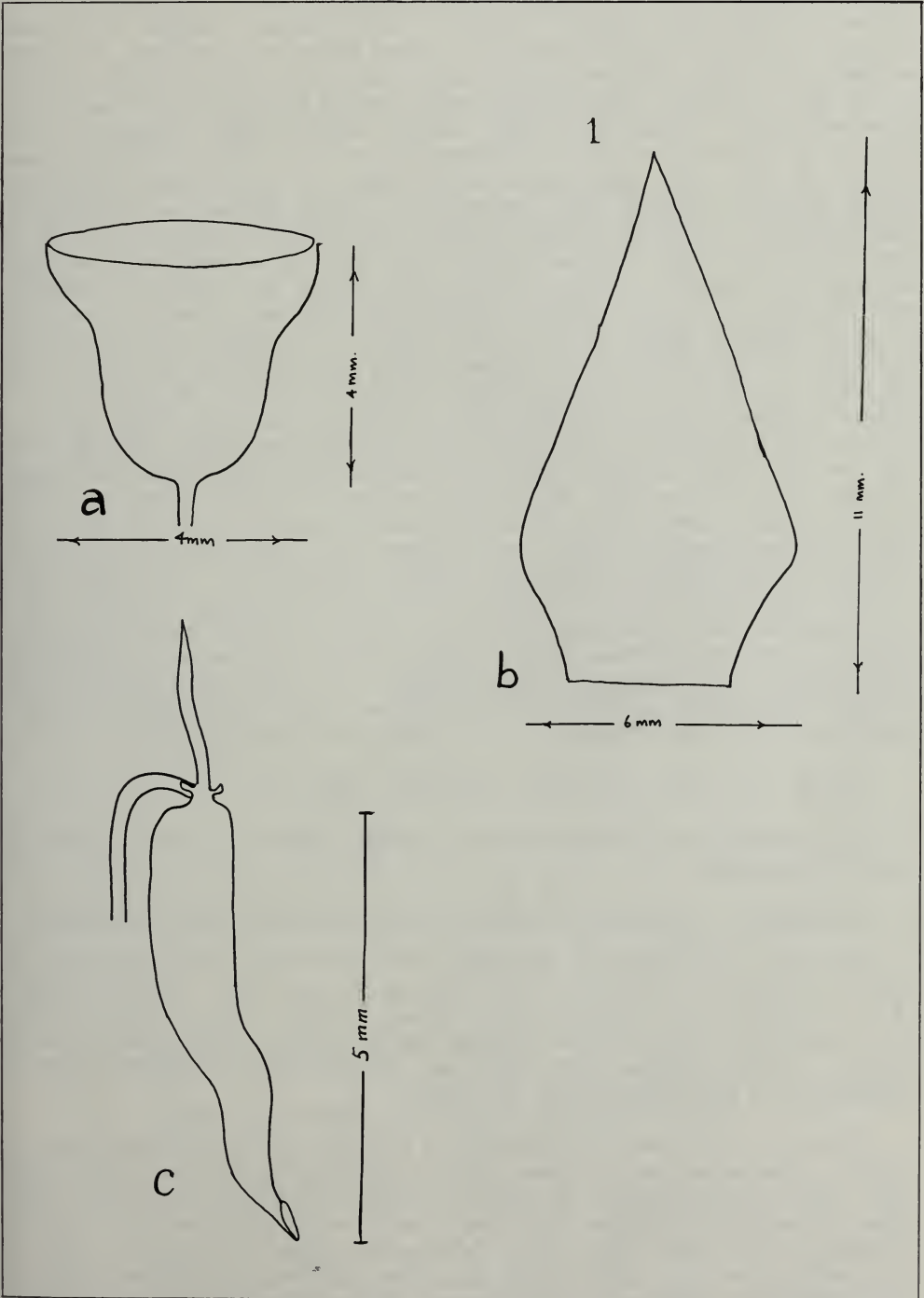


Figure 1. *Medinilla alternifolia* Bl., a-c Chew 346 (Sarawak).

wrinkled; stems up to 1 cm diameter, nodes prominent; leaves in whorls of 3 or 4; blades sub-coriaceous, elliptic, obovate to sub-orbicular, rounded at the tip, rounded or narrowed and decurrent, or in larger blades often shallowly (c. 1 mm) auricled at the base; midnerve sunken above, raised and tapering below, with one or two pair of thinner, often obscure, nerves arising from near the base (3 or 5 plinerved) which parallel the margin and in smaller blades disappear in the upper  $\frac{3}{4}$  of the blade; transverse venation obscure or invisible; 3.0–9.5 cm long, 1.0–5.0 cm wide; dark green above, whitish-green often tinted with red below; drying brown to blackish above, lighter brown below, texture on both surfaces roughened when dry; petiole cylindric, sparsely furfuraceous to glabrous, 0.6–3.5 cm long, 1.0–1.5 mm thick, frequently with a small patch of minute red-brown hairs in the axils, reddish to purple; inflorescence cymose, less commonly umbellate with reduced axes, rarely of solitary flowers, typically many flowered, from leafy or more commonly leafless nodes 2–6 (8) cm long; axes cylindric, smooth, sparsely furfuraceous to glabrous, pink to maroon; bracts and bracteoles lanceolate, acute, 0.5–0.75 mm long; primary axes generally solitary, (0.5) 1–4 cm long with 1–3 nodes; secondary axes 3–5, whorled, 0.6–1 cm long, 3d axes not developed or up to 5 mm long; pedicels 4–5 mm long; calyx campanulate, often widened at the rim, truncate with 5 thickened cusps or thickened points just below the margin; 3–6 mm long, 2–5 mm wide, pink or maroon; petals 5, thin, obovate, tip usually asymmetric and rounded with a thickened mucro, narrowed and truncate at the base, venation distinct, 6–14 mm long, 4–8 mm wide, pale pink to (waxy) white; stamens 10, infrequently 12, uniform; filaments flattened, 4–5 mm long, anthers 3–5 mm long, nearly straight or slightly curved, yellow, connective crested, often with a minute spur at the base, locules each with a curved to hooked appendage up to 0.5 mm long at the base; stigma capitate, minute; style slender, c. 5 mm long; fruit globose, 6–8 mm diameter, areolus slightly (c. 0.5 mm) raised, 4–5 mm wide; exocarp thin, whitish, yellowish, green, blueish-red, then purple when ripe; seeds numerous, ovate, hilum flattened, c. 1 mm long, testa finely reticulate.

Figure 2: a. calyx, b. petals, c. stamens. Plate 1.

The combination of whorled leaves, pustulate stems, and truncate calyx distinguish this species.

Distribution: Malaysia and Sumatra; generally above 1000 m elevation.

King (l. c. 64) noted that specimens of *M. clarkei* King were incorrectly referred by Clarke (Fl. Brit. Ind. II (1879) 547) as *M. rosea* Gaud. The descriptions of *M. rosea* Gaud. by Cognioux (Mono. Phan. 7 (1891) 573) and Bakh. f. (Rec. Trav. Bot. Neerl. (1943–45) 154) indicate that the species has fascicled, 4-merous flowers; smooth branches, etc. which are unquestionably different from the specimens that King described as *M. clarkei*.

*Medinilla clarkei* varies considerably in the shape and size of the leaves and King (l. c. 64) states that specimens with the largest leaves are from higher elevations. With many specimens on hand it is apparent that this is not true — both large and small leaved plants have been collected at all elevations up to 2300 m. Purseglove 4243, from Fraser's Hill, Pahang; has large leaves and was collected at c. 1600 m elevation; H.M. Burkill 835, from the Cameron Highlands, Pahang; also collected at c. 1600 m, has small leaves. The inflorescences of both specimens are c. 5 cm long. Ridley (l.c. 804) notes that specimens from Selangor have larger, thinner leaves with conspicuous nerves and larger cymes than specimens collected elsewhere which have small, fleshy leaves with no visible side nerves and dense cymes. Several specimens show that this observation is not always true,

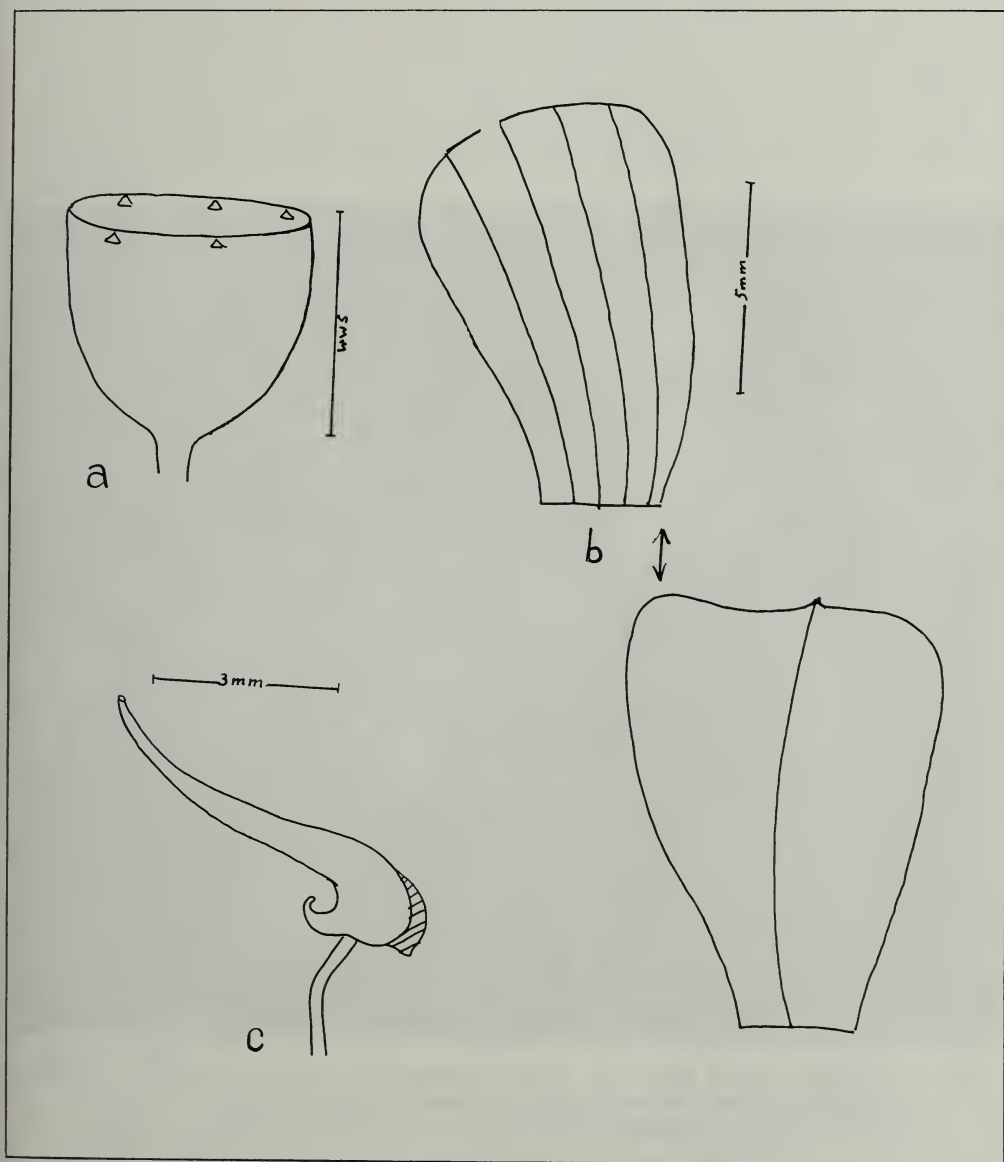


Figure 2. *Medinilla clarkei* King, a-c Jumali 710 (3917).



Plate 1. *Medinilla clarkei* King var. *clarkei*. Maxwell 78-150 from the top of Gunong Brinchang in the Cameron Highlands, Pahang on 14 April 1978.  
Photo: Dr. Ivan Polunin.

e.g. Derry 616 (Malacca), Haniff 3922 (from Gunong Kerbau, Perak at 2300 m), and H.M. Burkill 835 which have small leaves and a relatively large inflorescence; and Wray & Robinson 5312 (Pahang) which has large leaves and solitary flowers on primary axes 0.5 mm long. Ridley 16037, which has the largest leaves and most expansive inflorescence on any specimens examined, is from Pahang. Generally speaking there is no correlation between small leaves and the size of the inflorescence, however almost all the large leaved specimens have a large inflorescence.

*Medinilla pahangensis* Ridl. is identical to *M. clarkei* in flower structure, fruit, and seeds; and its small leaves with a relatively short inflorescence (up to 2.5 cm) also compare closely with some specimens of the latter. The isotype of *M. pahangensis* (Wray & Robinson 5396) is from Gunong Tahan, Pahang.

Ridley notes that *M. pahangensis* resembles *M. hasseltii* B1. (= *M. crassifolia* (Reinw. ex B1.) B1.) in general appearance, however these two species are only similar in having pustulate stems, similar inflorescences, and asymmetric petals. The opposite leaves, larger blades, truncate calyx which lacks cusps, and the different anthers of the latter are distinguishing features.

*Medinilla perakensis* King is distinguished on the basis of its larger, 5-nerved blades, longer petioles, and slightly longer inflorescences. The pustulate stem, whorled arrangement of the leaves, structure of the inflorescence, flowers, fruit, and seeds of this species and *M. clarkei* are the same. *M. perakensis*, in my opinion, is the same as *M. clarkei* since in several collections from Sumatra the two species are indistinguishable, i.e. specimens could be named as either one. Bunnemeyer 2877 and van Steenis 9576 have the typically large, 5-nerved blades of *M. perakensis*, but the latter specimen also has some 3-nerved blades which are characteristic of *M. clarkei*. Bakh. f. identified Bunnemeyer's collection as *M. clarkei*. *M. clarkei* is restricted to the Malay Peninsula and Sumatra with most collections having smaller, 3-nerved blades which match the type specimens of *M. clarkei*.

Ohwi identified two collections from Sumatra (van Steenis 8340, 9576) as *M. clarkei* King var. *sumatrensis* Ohwi. Both specimens are unquestionably *M. clarkei* which have slightly larger blades than in the syntypes. These two collections (378, syntype) were collected from 2000–2300 m elevation.

## MALAYSIA

*Perak* — Gunong Benom: Fed. Mal. States Mus. sn. 26 July 1925; Gunong Bubu: Ng 6153, Straits sn; Gunong Batu Puih: Wray 378 (*syntype M. perakensis* King); Gunong Bubu Puteh, Larut: Wray 412 (*syntype*), 3831 (*syntype*); Gunong Inas: Wray 4084 (*syntype*), Yapp 469; Gunong Kerbau: Haniff 3922, Robinson sn in June 1913; sine loc.: Cantley sn; *Scortechini* 243 (*syntype*), sn.

*Kelantan* — Gunong Rabong: Soepadmo & Mahmud 1096, Whitmore 20662.

*Trengganu* — Gunong Lawit Besut: Cockburn 8222; Gunong Mandi Angin: Whitmore 10290; Gunong Padang: Moysey & Kiah 31871.

*Selangor* — Bukit Kutu: Ridley 7314, 8031; Genting Highlands; Shah & Ali 2990; Gunong Mengkuang: Robinson sn on 18 Jan. 1913; Gunong Nuang: Whitmore 12189; Gunong Semangkok: Ridley 15607; Gunong Ulu Kali; Burn-Murdoch sn in 1910; Maxwell 78–80; Hulu Semangkok; Ridley sn; Ulu Saugat: Kloss sn in Feb. 1912.

*Pahang* — Cameron Highlands: H.M. Burkill 835; Chew 233, 791, 1245; Henderson 11024, Melville & Landon 4832, Nur 32556, Strugnell 23913; Symington 20996, 31011; Fraser's Hill: H.M. Burkill 2321; H.M. Burkill, Shah, Noor 2385; I.H. Burkill & Holttum 8557, Cubit 11141, D.F.O. 22494, Foxworthy 4803; Henderson 11225, 17876, 23324; Henderson & Nur 10536, Moe 77; Purseglove 4288, 5523; Shah & Noor 657; Gunong Benom: Fed. Mal. States. Mus. sn on 9 Aug. 1925, Strugnell 22316, Whitmore 3306, Keng & Hons. Stud. 6; Gunong Berembun: Ng 5901, Ogata 110268, Whitmore 15496; Gunong Brinchang: Maxwell 78-150; Gunong Jasar: Whitmore 15465; Gunong Tahan: Haniff & Nur 8028, Ridley 16037; Wray & Robinson 5312, 5396 (*type M. pahangensis* Ridl.); Gunong Tapis: Cockburn 11045, Symington & Kiah 28856; Gunong Terbakor: Henderson 10989; Kluang Terbang: Barnes 10866; Robinson Falls: van Balgooy 2648; Taman Negara: Soepadmo 902.

*Malacca* — Gunong Mersing: Ridley 32281; Mt. Ophir: Derry 616, Jumali 710 (3917), Maingay 769 (2732) (*syntype*), Ridley sn in Dec. 1898, Shah & Ahmad 3576; sine loc.: Griffith 2282 (*syntype*).

*Johore* — Gunong Ledang: Whitmore 12363.

3. *Medinilla clarkii* King var. *crassiramea* (Hend.) Maxw. *comb. nov.*; *M. crassiramea* Hend., Gard. Bull. Str. Settl. 7:2 (1933) 103.

Epiphytic (or terrestrial when on peat soil) shrub up to 2 m tall, branches cylindrical, often slightly ridged in places, densely red-brown furfuraceous, younger branches sparsely pustulate, c. 5 mm thick; older branches mostly glabrous, densely pustulate-tuberculate, up to 12 mm thick; epidermis drying khaki-tan, with a rugose texture; nodes thickened; leaves in whorls of 4 or 5; blades coriaceous, broadly illiptic, ovate, to sub orbicular, obtuse and frequently with a 1 mm long cusp which is often sunken (emarginate) at the tip; rounded and shallowly (2-4 mm) auriculate-cordate at the base; midnerve with 2 prominent and one thin (intramarginal) pair of nerves arising from near the base, sunken above, raised and tapering below; transverse venation obscure to invisible, especially below; immature blades sparsely furfuraceous above, more densely (especially on the nerves) below, glabrescent; 11-15 cm long, 6.5-9 cm wide; medium glossy green above, paler and dull green below; drying brownish, often with an olive-green hue above, brown below, texture roughened on both surfaces; petiole densely red-brown furfuraceous, less so with age, 2-5 cm long, 3-4 mm thick, axils provided with a dense cushion of red-brown hairs; inflorescence a panicle of cymes, up to 7 cm long and about as wide many flowered, from leafy or upper leafless nodes; axes cylindrical, spreading, densely red-brown furfuraceous; bracts and bracteoles lanceolate, acuminate, densely red-brown furfuraceous, c. 1 mm long; primary axes solitary, 3-4.5 cm long, c. 2 mm thick, with 1-3 nodes; secondary axes whorled, 1-2 cm long with 1 or 2 nodes; 3d axes not developed or 2-3 mm long; pedicels 1-2 mm long; calyx campanulate, truncate with 5 thickened cusps from below the rim, sparsely red-brown furfuraceous, glabrescent, 3-4 mm long, 3.5 mm wide; petals 5, thin, obovate to sub-orbicular, broadly rounded with a thickened cusp at the tip, narrowed and clawed at the base, 5-5.5 mm long, 3-5 mm wide (according to Henderson, l.c., 2 usually larger and broader than the other 3); stamens 10, uniform; filaments flattened, c. 3 mm long; anthers c. 2.5 mm long, slightly curved, narrowly crested with a minute claw at the base; locules each with a minute spur at the base; stigma capitate, minute; style c. 4.5 mm long; fruiting axes slightly longer and thicker; fruit globose, 3-4 mm diameter, areolus slightly (c. 1 mm) raised, c. 3 mm wide; exocarp thin, white flushed with pink, blueish when ripe; seeds numerous, c. 1 mm long, ovate, hilum flattened, testa finely reticulate, glossy tan.

Figure 3: a. calyx, b. petals, c. stamen, d. seed.

As Henderson notes in his description, this plant is very close to *M. perakensis* King (now a synonym of *M. clarkei* King) which has sparsely pustulate stems, 3–5 plinerved blades, and being glabrous, or nearly so, in all its parts. All three specimens of var. *crassiramea* in the Singapore collection are from the Cameron Highlands, which is within the range of distribution of *M. clarkei*. Since all the collections of *M. clarkei* at Singapore and Leiden have at the most sparsely furfuraceous branches, leaves, and inflorescences; all of which become glabrescent with age; var. *crassiramea* is distinct and can be easily separated on the basis of its pubescence. Generally speaking, the leaves of *M. clarkei* are smaller and 3-nerved, and specimens with larger, 5-nerved blades which were designated by King as *M. perakensis*, are also essentially glabrous. I have not seen any specimens that could possibly link *M. clarkei* and var. *crassiramea*; therefore I have considered the latter as a separate taxon.

*Pahang* — Cameron Highlands: Stone 8026; Gunong Batu Brinchang: H.M. Burkill 799, Henderson 23588 (*type*), Ng 5980, Sinclair 9947, Whitmore 15541.

4. *Medinilla crassifolia* (Reinw. ex Bl.) Bl., Flora 14 (1831) 511; *Melastoma crassifolium* Reinw. Bl., Bijdr. Fl. Ned. Ind. 17 (1826) 1075; *Medinilla crassifolia* (Reinw. ex Bl.) Bl. var. *hasseltii* (Bl.) Bakh. f., Rec. Trav. Bot. Neerl. 40 (1943-45) 189 and *Medinilla hasseltii* Bl. l.c. 513; King, J. As. Soc. Beng. 69, II: 1 (1900) 62; Ridley, Fl. Mal. Pen. I (1922) 802 *syn. nov.*

Epiphytic shrub up to 3 m tall, climbing, or scrambling; branchlets cylindric, glabrous, 1.5–2 mm thick; at first smooth, later with scattered, black pustules; stem cylindric, glabrous, sparsely to densely black pustulate, 5–8 mm thick, becoming more rugose with age; adventitious roots common from leafless nodes; blades coriaceous, opposite, glabrous, lanceolate or elliptic, acuminate at the tip (acumen 1.0–1.5 cm long), narrowed and somewhat rounded at the base, not or only slightly (1–2 mm) decurrent on the petiole; mid-nerve with a thin pair of intramarginal nerves from the base, 1–2 mm from the margin, and a more prominent pair of arching nerves from above the base, venation sunken above, raised and tapering below; transverse venation extremely obscure to invisible on both surfaces; (6) 10–19 cm long, (2) 3.0–8.0 cm wide; dark green, drying with a roughened texture on both surfaces, brown above, lighter brown below; petioles mostly cylindric to somewhat flattened, 6–8 mm long, 2.0–2.5 mm thick, glabrous, red, drying with a roughened texture; with a small, dense, axillary tuft of minute hairs which are lost with maturity; inflorescence cymose, glabrous, from leafy axils, 1–3 cm long, many flowered, bracts and bracteoles lanceolate, acute, c. 0.5 mm long; axes cylindric, or somewhat flattened, sparsely pustulate, red; primary axes 1 or 2 from each axil, 7–12 mm long, c. 2 mm thick, with 1–3 nodes, secondary axes whorled, 5–8 mm long with 1 or 2 nodes, 3 mm axes not developed or 1–2 mm long, pedicels c. 3 mm long; calyx campanulate to cyathiform, truncate, smooth, glabrous, 4 mm high, 3 mm wide; pink; petals 4 or 5, thin, obovate, asymmetric at the broadly rounded tip with an oblique, thickened cusp, venation distinct, 5–6 mm long, c. 3 mm wide, reflexed at maturity, creamy white or translucent white; stamens 8 or 10, filaments flattened, c. 3 mm long, purple; anthers cylindric, straight with a slight curve at the tip, mauve-purple, red; connective crested with an appendage; locules each with a linear lobe; connective and all three appendages black; c. 3–4 mm long; stigma capitate, minute; style slender, 6 mm long; fruit globose, smooth, glabrous, 6 mm diameter, on pedicels up to 6 mm long, areolus 4–5 mm wide; pericarp thin; immature fruit pink, red when ripe; seeds numerous, ovoid, hilum flattened, testa minutely reticulate, c. 1 mm long, light brown.

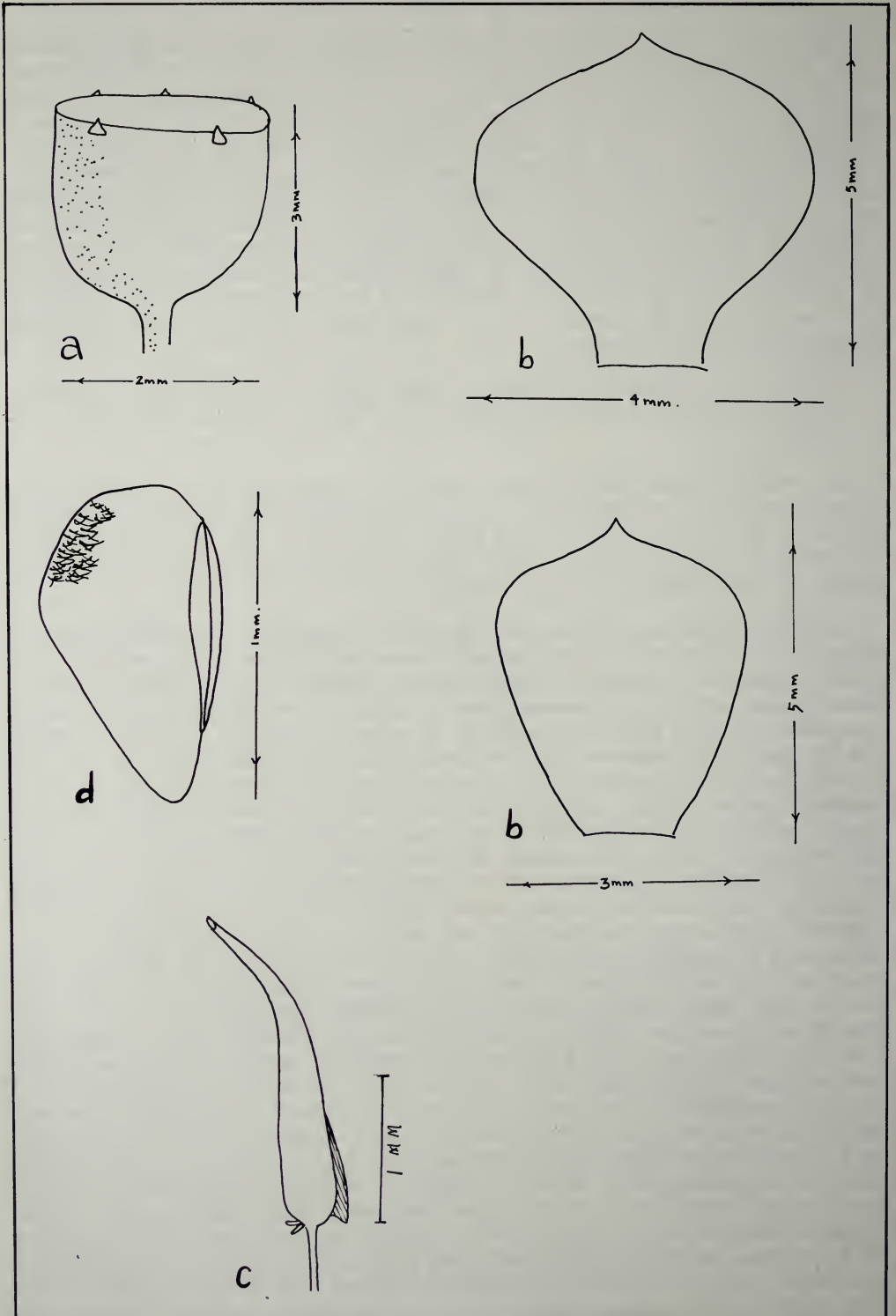


Figure 3. *Medinilla clarkei* King var. *crassiramea* (Hend.) Maxw., a-d Henderson 23588 (isotype).

Figure 4: a. calyx, b. petals, c. stamen.

Uses: leaves made into a medicine for headaches; leaves added to curries for a sour taste.

Habitat: shaded, moist evergreen forests up to c. 1500 m elevation; on rocks or trees.

Distribution: central Malaysia, Singapore, Sumatra, Borneo, and Java. Vernacular: akar nupal, assam lokan puteh (Negri Sembilan), assam bongkor (Johore) senudok ayer (Selangor).

This species is very closely related to *M. venusta* King (q.v.) which has larger flowers, different anthers, and sub-sessile leaves. *M. scortechinii* King (q.v.) is also very similar, but has a lobed calyx, longer inflorescence, and sub-sessile leaves. The anther appendages of *M. crassifolia* and *M. scortechinii* are nearly the same, however there is no connective crest with the latter. *Medinilla laurifolia* (Bl.) Bl., with a wider distribution from Sumatra to the Celebes, is another close species which differs in having smaller and thinner leaves, few flowered inflorescences, and larger flowers and fruit.

The holotype of *M. hasseltii* Bl. at Leiden is a fruiting collection which is virtually indistinguishable from many specimens of *M. crassifolia*. The calyx of *M. crassifolia*, especially in bud, is either entirely truncate or has 5 minute cusps. The areolus in mature fruit is truncate and I have not seen any specimens with distinct cusps. The type specimen of *M. crassifolia* var. *diaphana* (Bl.) Bl., which Bakh. f. (l.c. 188) correctly reduced to *M. crassifolia* differs from the holotype of *M. hasseltii* in having slightly longer petioles. The holotype of *M. crassifolia* is vegetative, however the petioles in this collection are also longer than those of *M. hasseltii*. Several collections identified by Blume and Bakh. f. as *M. crassifolia* have shorter petioles and in this respect could also be identified as var. *hasseltii* (Bl.) Bakh. f.

Collections from the Malay Peninsula clearly show that the length of the petiole is variable since in many collections it is difficult to say whether the specimen is *M. crassifolia* or var. *hasseltii*, e.g. Stone 4790, and Whitmore 12608. The flowers and fruit of the Malay collections show some variation in size and again it is not clear in some specimens as to which of these two taxa the specimen belongs.

Since I cannot adequately separate *M. crassifolia* from its var. *hasseltii*, especially with fruiting material, I have found no reason to retain the variety.

Ridley reduced *M. hasseltii* Bl. var. *griffithii* Cl. to a synonym of *M. hasseltii* Bl. The holotype of var. *griffithii* (Griffith 2282), from Malacca, is clearly the same as *M. scortechinii* King (q.v.).

#### MALAYSIA

*Kedah* — Gunong Bintang For. Res.: Sidek 267, 279.

*Perak* — Bruas, Dindings: Ridley sn in March 1896; Bujong Malacca: Curtis 3157, Ridley sn in Sept. 1898; Bukit Batu Suloh, Kinta Forest: Allen & Kadim 482; Changkat Jong For. Res.: Ng J 5645; Dindings: Curtis 3448; Gunong Bubu For. Res.: Hou 671, Whitmore 0640; Larut: King's collector 1961; Larut Hill: Curtis = 3448; Maxwell's Hill: Hardial & Samsuri 293; Pangkor, Dindings: Curtis 1642; Relau Tujor: Wray 1843; Slim Hills For. Res.: Whitmore 0850; Taiping Hill: Henderson 10112; Tea Gardens: Curtis 2715, Ridley sn in 1891; Taiping: King's collector 8507; Trolak For. Res.: Chelliah 104672.

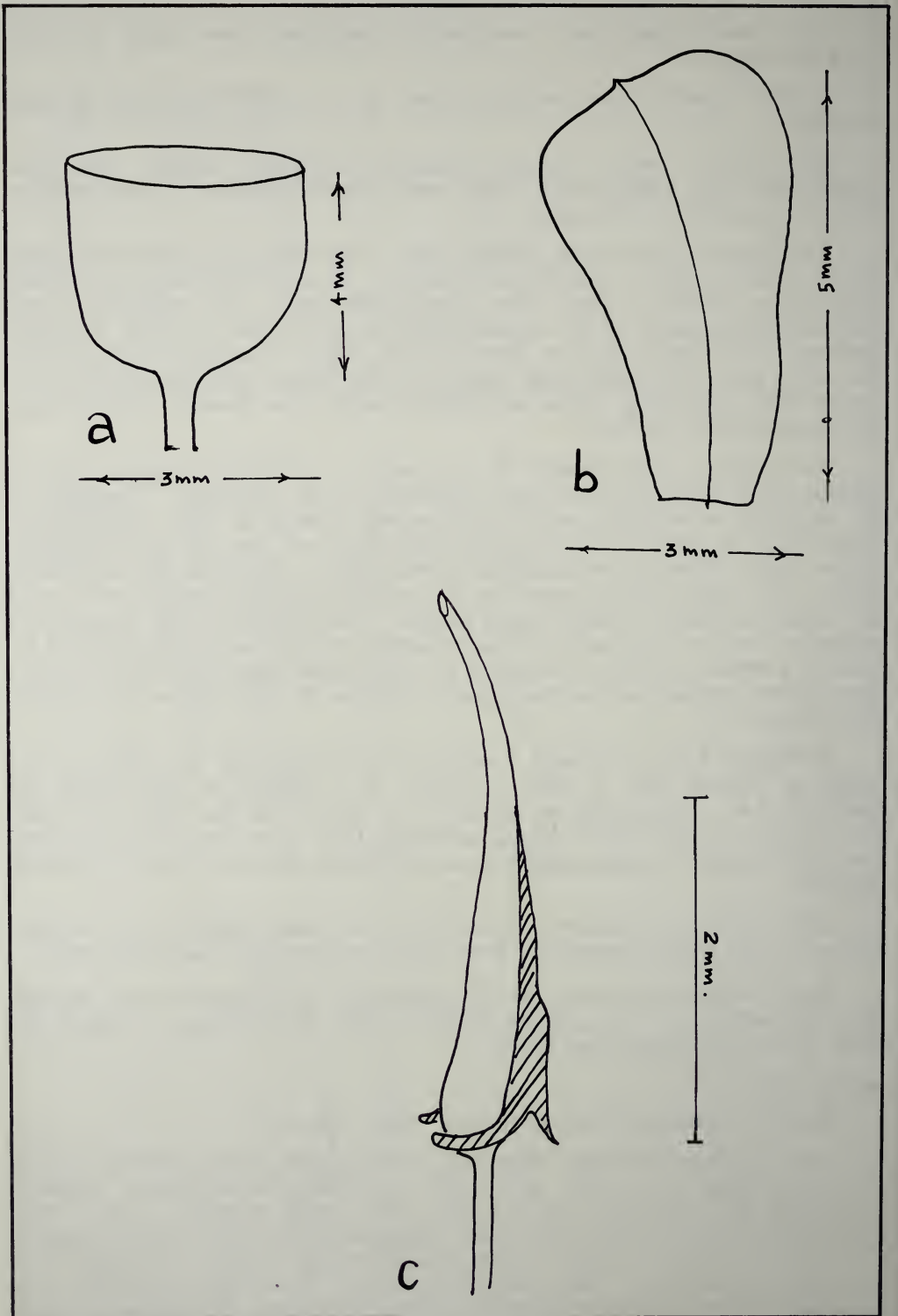


Figure 4. *Medinilla crassifolia* (Reinw. ex Bl.) Bl., a-c King's coll. 8507.

*Kelantan* — Gua Namik: Henderson 19726; Sungei Lebir: Henderson 29649.

*Trengganu* — Bukit Kajang, Kemaman: Corner sn; Gunong Padang: Whitmore 12608.

*Selangor* — Bukit Batu Berkingding, Kanching: Nur 34360; Gading For. Res.: Chelliah 98230; Kanching Reserve: Jaamat 12756; Klang Gates: Hume 7100; Kuala Lumpur: Curtis 2334; Rawang: Melville 4758; Semengon: Hume 8138; Sungai Tua: Loury sn; Telok For. Res., Klang: I. H. Burkill 6620, 7031; Ng 1974; Ulu Gombak: Jaamat 10922; sine loc.: Ridley sn. on 21 July 1889.

*Pahang* — Bentong: Best 13863; between Pekan and Ayer Tanar: I.H. Burkill & Haniff 17260; Pramon: Ridley 1055; Sabai Estate, Bentong: Shah 149; Sungai Tahan: Shah 1402; Tahan Reserve: Haniff & Nur 8076; Tahan River: Ridley sn in Aug. 1891.

*Negri Sembilan* — Bukit Sutu: Alvins 1981; Gunong Angsi: Nur 11763; Kupayang: Alvins 2205.

*Malacca* — Gunong Ledang: Ridley sn; Mardima Reserve: 2039; sine loc.: Maingay 797 (1419).

*Johore* — Alor Bukit: Hardial 539; Bukit Badak: Hassan & Kadim 38; Gunong Belumut: Holttum 10738; Gunong Muntakak: Nur 19970; Gunong Panti: H.M. Burkill 3428, H.M. Burkill & Sanusi 3170, Chew 732, Cockburn 7844; Holttum 18074, 19853, Jumali 14; Kuswata 425 sn on 1 Aug. 1960; Ridley sn in 1892, Samsuri 312, Stone 4790; Gunong Pulai: Best 7701, H.M. Burkill 2572, Keng 3298 (K778), Mat 371, Sinclair 39554; Hadyi Serawi: Ridley sn in Nov. 1900; Kota Tinggi: Shah, Noor, Shukor 2096; Kuala Sedili Road: H.M. Burkill 1961, 2669; Kadim & Noor 149. Shah & Noor 820; Kukut: Ridley 13251, sn in 1908, sn in 1909; Labis For. Res.: Jumali 4224 (K6685), Shah & Samsuri 1698; Layang Layang: Holttum 29351; Mt. Ophir: Whitmore 12301; Pengkalan Paja, Pontain: Ngadiman 36642; Sungai Juasseh, Labis: Shah & Shukor 2276; Sungai Kayu: Kiah 31980; Sungei Sedili: Corner 26054; Sungai Tahan: Ridley sn in April 1903; Taiping River: Ridley sn in 1894; Tanah Runto: Goodenough sn; Ulu Sungei, Segamat: Samsuri & Shukor 666; sine loc.: Lake & Kelsall sn in Oct. 1892.

*Singapore* — Cantley sn, Goodenough sn at Seletar in 1890; Ridley 273, 286, sn: in 1890, in 1892, in 1894, in 1909; Spare 904; Wallich cat. 4084.

5. *Medinilla curtisii* Hk. f., Gar. Chron. 20 (1883) 621, fig. 108; and Curtis's Bot. Mag. (1883) tab. 6730; *Medinilla elliptica* Craib, Kew Bull. 1930, 322 *syn. nov.*; *M. elliptica* Craib var. *tetramera* Craib, Fl. Siam. Enum. I: 4 (1931) 699 *syn. nov.*

Epiphytic shrub, youngest branchlets obscurely 4-angled or 4-lined, becoming cylindrical, smooth or with a few small pustules, drying khaki-tan, 2–3 mm thick, glabrous; leaves opposite, axils glabrous; blades sub-coriaceous, elliptic to ovate, acute at the tip, rounded and decurrent or shallowly (1–2 mm) cordate at the base, mid-nerve with one pair of prominent lateral nerves from near the base, intramarginal nerves very faint, c. 1 mm from the margin; 7–11.5 cm long, 3–4.5 cm wide, drying greenish above, brownish-greenish below; petiole 1.0–1.5 mm long, c. 2 mm thick, glabrous; inflorescence terminal, a panicle of cymes, many flowered, 4–5 cm long; axes 4-angled, often with 4 membranous wings, sparsely

furfuraceous, later mostly glabrous; bracts and bracteoles lanceolate, acute, up to 0.5 mm long, caducous; primary axes 1–3 at each tip, 1.5–2 cm long with 1 node; secondary axes 3–5, 6–10 mm long, 3d axes 4–6 mm long, pedicels 8–10 mm long; calyx campanulate, smooth, sparsely furfuraceous, glabrescent, c. 5 mm long, 4–5 mm wide, margin truncate with 4 or 5 sub-marginal cusps; petals 4 or 5, thin, obovate, broadly rounded and often asymmetric with a cusp at the tip, narrowed to a claw at the base, 11–12 mm long, 5–6 mm wide, pink or white; stamens 8 or 10, equal; filaments c. 9 mm long; anthers slightly curved, opening with a single pore at the thin, rostrate tip, c. 7 mm long, connective with a thin keel near the base which is often spurred, locules each with a thickened bulbous-oblong appendage, c. 0.5 mm long; stigma minute, style c. 14 mm long; fruiting axes slightly longer; fruit urceolate, c. 6 mm long, 7 mm wide, areolus c. 5 mm wide; exocarp membranous, drying tan; seeds numerous, ovoid, c. 1.5 mm long; testa finely reticulate, glossy tan.

Figure 5: a. calyx, b. petal, c. stamen.

This species is easily distinguished from all others in the region by its terminal inflorescence with 4-angled axes; smooth, angled branchlets; and opposite, sessile leaves. *M. venusta* King (q.v.) has similar inflorescences and flowers, especially the stamens, but differs in having pustulate branches. *M. scortechinii* King (q.v.) has larger, thicker blades, a 4-lobed calyx, and axillary inflorescences.

The holotypes of *M. elliptica* Craib (Kerr 16779) and *M. elliptica* Craib var. *tetramera* Craib (Kerr 12054) — both from peninsular Thailand, match the description and illustration of *M. curtisii* in Curtis's Botanical Magazine. *M. curtisii*, described from a specimen collected on the west coast of Sumatra by Curtis, is an apparently rare species since only a few collections of it exist. I have not seen any collections of this species from Malaysia, however, with a distribution from lower Thailand to Sumatra it is most probable that it grows in Malaysia.

The distinction of *M. elliptica* Craib var. *tetramera* Craib is, in my opinion, not justified since the number of flower parts is the only difference. Vegetatively and structurally the two taxa are identical. *M. venusta* King is similar in respect to having both 4 or 5-merous flowers.

## THAILAND

*Ranong* — Kao Panta, Chongdon: Kerr 16779 (type *M. elliptica* Craib)

*Surat* — Kao Nom Sao, langsuan: Kerr 12054 (type *M. elliptica* Craib var. *tetramera* Craib).

6. *Medinilla laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw. comb. nov.: *M. ferrata* Craib, Kew Bull. 1930, 323.

Epiphytic shrub, often with adventitious roots, upper branchlets cylindrical, covered with small pustules and tubercles, texture very rough and wrinkled when dry, glabrous (ferruginous, exceptionally glabrous, according to Craib), 3–4 mm thick, drying greyish; older branches up to 8 mm thick, epidermis thin; leaves opposite, with a minute cushion of ferruginous hairs; blades sub-coriaceous, glabrous, elliptic, mid-nerve with 1 pair of prominent nerves from near the base, intramarginal pair very thin, c. 1.0–1.5 mm from the margin; obtuse to acute at the tip, narrowed and decurrent (c.  $\frac{1}{3}$  the length of the petiole) at the base; 7–18 cm long, 4–7.5 cm wide; drying with a roughened texture, olive-greenish above,

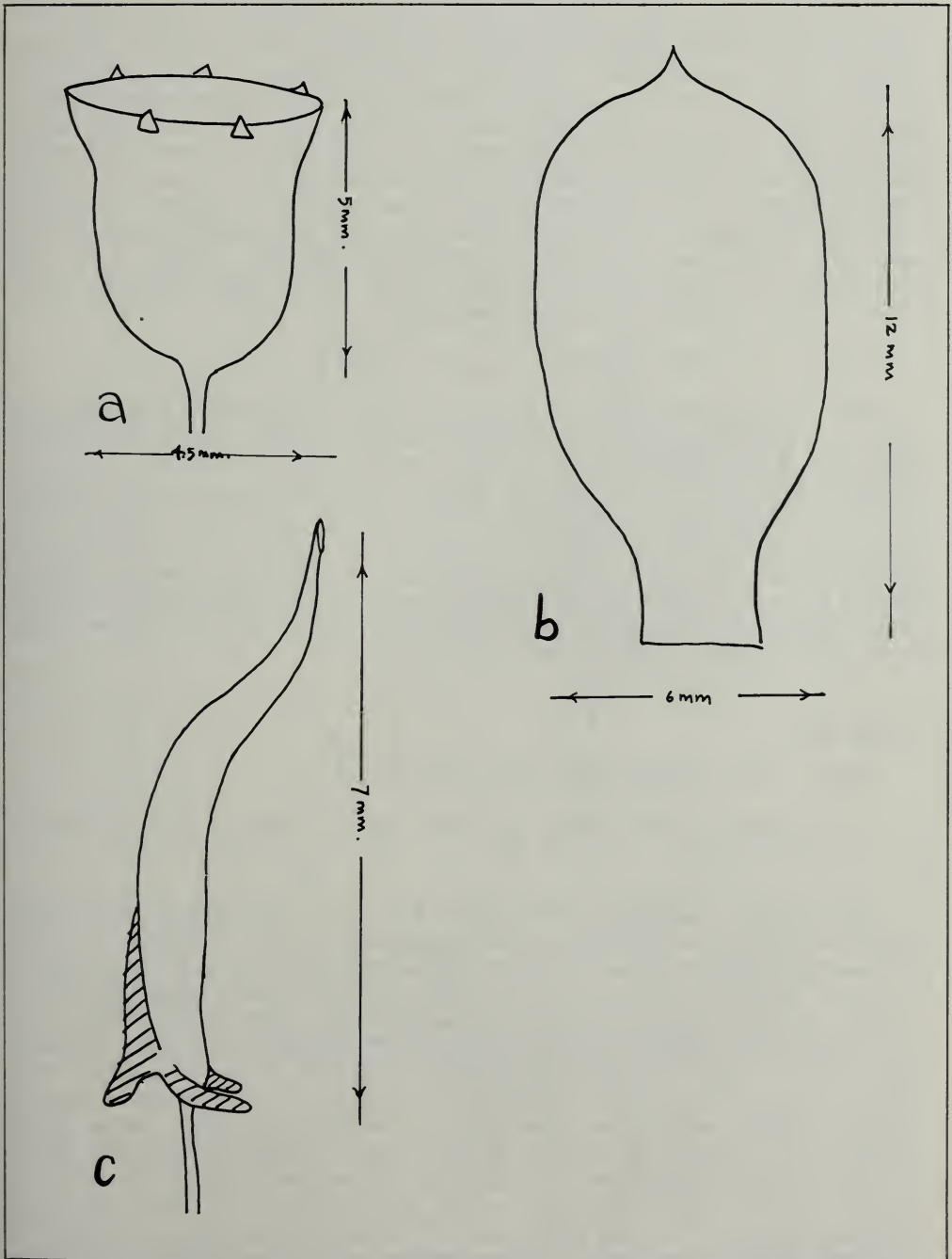


Figure 5. *Medinilla curtisii* Hk. f., a-c Kerr 16779 (holotype *M. elliptica* Craib).

lighter green below; petiole flattened and slightly grooved above, 8–18 mm long, c. 3 mm thick; inflorescence cymose; from thicker, leafless branches, 3–4 cm long with 5–10 flowers; axes slightly flattened, glabrous; bracts and bracteoles triangular, up to 0.5 mm long; primary axes usually solitary, 2.0–2–5 cm long, with 1 or 2 nodes; secondary axes usually developed, 1–5 mm long; tertiary axes not developed or up to 3 mm long, pedicels c. 5 mm long; calyx funnelform, smooth and glabrous, 5–6 mm long, c. 5 mm wide, margin truncate with 5 sub-marginal cusps; petals 5, thin, obovate, broadly and asymmetrically rounded with an oblique cusp at the tip, narrowed to a broad claw at the base, 16–18 mm long, 9–11 mm wide, white; stamens 10, equal, filaments flattened, c. 8 mm long, anthers “J” shaped, c. 8 mm long, narrowed to the single pored tip, connective with a keel-like crest, often extended into a spur c. 0.5 mm long, locules each with a thickened, bulbous-oblong basal lobe, 1.0–1.5 mm long; stigma minute, style flexed, c. 19 mm long; fruit campanulate, c. 6 mm diameter, truncate at the apex; seeds numerous, ovate, c. 1 mm long; testa finely reticulate, glossy tan.

Figure 6: a. calyx, b. petal, c. stamen. Plate 2.

This variety differs from var. *laurifolia*, which is found from Sumatra to the Celebes, in having larger leaves and more densely pustulate stems. The inflorescence and flowers, especially the anthers, of the two taxa are the same. *M. laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw. is remotely related to *M. crassifolia* (Reinw. ex Bl.) Bl. (q.v.) which has narrower leaves and smaller flowers. Var. *ferrata* may eventually prove to be the same as *M. laurifolia*, but since the type specimens differ from all collections of *M. laurifolia* that I have seen, I have reduced it to varietal status pending examination of more material of the two taxa. Craib indicated that *M. ferrata* has ferruginous branches, however the two sheets of the type collection at Kew are entirely glabrous.

#### THAILAND

Surat — Kao Nawng: Kerr 13253 (type)

7. *Medinilla pendens* Ridl., J. Str. Br. Roy. As. Soc. 61 (1912) 6 and Fl. Mal. Pen. I (1922) 803.

Epiphyte with hanging branches up to 1.5 m long, adventitious roots scattered, younger branches cylindrical, glabrous, fleshy, sparsely warty or smooth, 1.5–2.5 mm thick, drying khaki-tan; older branches leafless, more fleshy, with more warts, 3–4 mm thick, epidermis drying brownish; nodes prominent; blades fleshy coriaceous, opposite, on distal parts of the stems, lanceolate-ovate, acute to acuminate at the tip, rounded and generally shallowly (2–3 mm) cordate at the base; midnerve sunken above, slightly raised and tapering below, with 1 pair of thinner (often indistinct) basal nerves which disappear in the upper  $\frac{1}{2}$  of the blades; transverse venation invisible; dark, glossy green above, paler and glossy green below; drying brownish, often with an olive-green hue and with a roughened, reticulate texture on both surfaces; axils glabrous; in general appearance recalling the leaves of *Hoya*; 6–10 mm long, 2–3 cm wide; petiole fleshy, glabrous, 4–7 mm long, 1.5–2 mm thick, drying with a very rugose texture; inflorescence cymose, less frequently of solitary flowers; from leafy or upper leafless nodes, 1.5–3 cm long, spreading, glabrous, with about 6–10 flowers; axes cylindrical, dull crimson; bracts and bracteoles lanceolate, acute, glabrous, c. 1 mm long; primary axes solitary, 4–8 mm long, with 1 or 2 nodes (upper internode c. 1 mm long); secondary axes not developed or up to 4 mm long; pedicels 2–3 mm long; calyx urceolate, c. 4 mm long, margin undulate with 5 small teeth; petals oblong, spatulate, obtuse at the

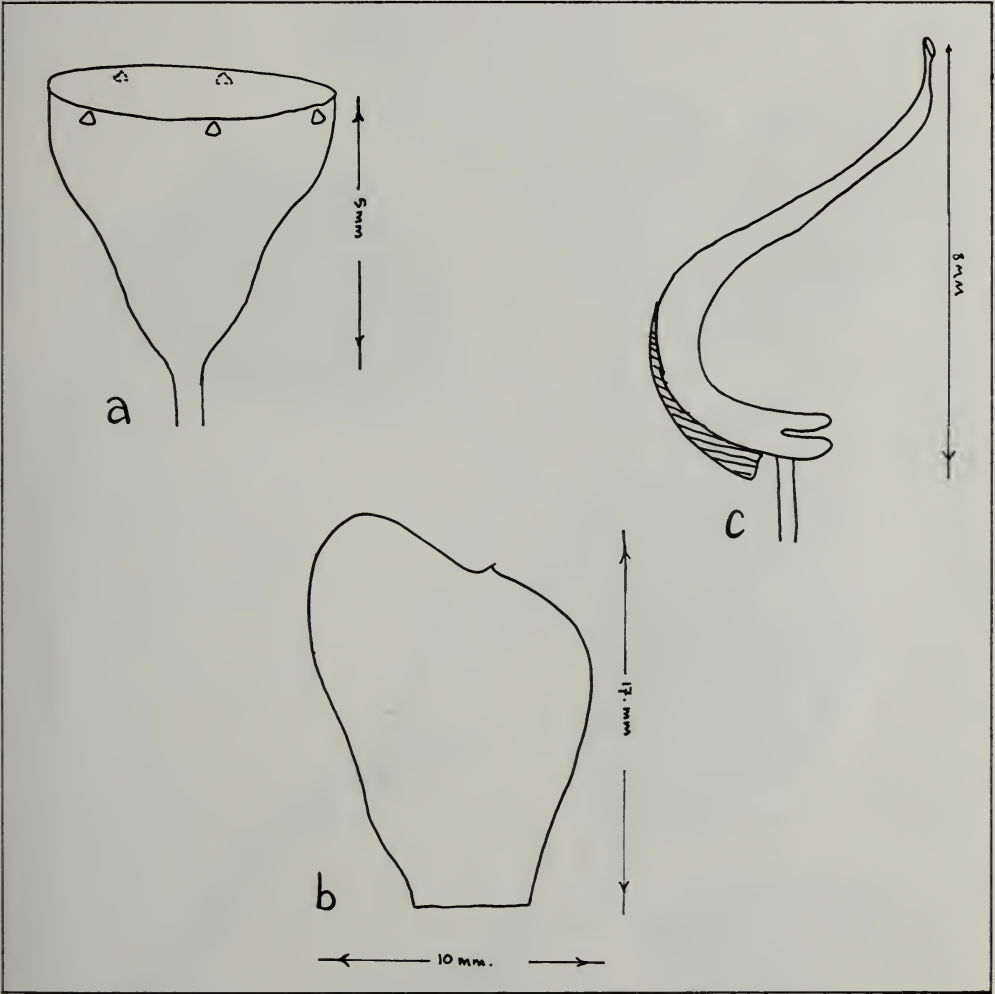


Figure 6. *Medinilla laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw., a-c Kerr 13253 (holotype).



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BOTANICAL SECTION  
MINISTRY OF COMMERCE AND COMMUNICATIONS  
FLORA OF SIAM.

Collector's No. 13253.  
Locality Kao Kwang, Surat  
Altitude 800 m  
Date August 10, 1927

Local Name  
Notes Epiphytic shrub; flowers  
white, evergreen forest.



Plate 2. Type collection of *Medinilla laurifolia* (Bl.) Bl. var. *ferrata* (Craib) Maxw. Kerr 13253, Kao Nawng, Surat; c. 800m; August 10th 1927; epiphytic shrub, flowers white, evergreen forest.  
Photo: Rijksherbarium, Leiden.

tip, c. 6.5 mm long, 3.5 mm wide, thin with visible venation, waxy white; stamens 8, glabrous; filaments slender, c. 3.5 mm long; anthers straight, c. 3 mm long, violet, connective with a short appendage near the base, locules each with a short, curved claw at the base; style short and slender; fruit elliptic to sub-globose, 7–9 mm long, 6–7 mm wide, areolus slightly (c. 0.5 mm) raised, c. 2.5 mm wide; exocarp thin, bright rose-red when ripe; seeds numerous, obovate (ovate), hilum flattened with a thick marginal ring, c. 1.5 mm long; testa finely reticulate, light brown.

Figure 7: a. calyx, b. petal, c. stamen, d. infructescence, e. seed.

From the habit and vegetative features, this species appears to be quite distinct. The fruit and seeds resemble those of *M. clarkei* King (q.v.) and *M. clarkei* King var. *crassiramea* (Hend.) Maxw. (q.v.), however both of these taxa differ greatly in other features, e.g. whorled leaves, pustulate stems, etc.

Ridley notes that *M. pendens* is close to *M. hasseltii* Bl. (now = *M. crassifolia* (Reinw. ex Bl.) Bl., q.v.) and at least with the fruit and seeds this is true. The structure of the inflorescence of *M. crassifolia* is essentially the same, however it is larger. There are also numerous vegetative differences, e.g. leaf shape and size, and 5-merous flowers. *M. pendens* is poorly known and I have included it in this paper since it appears to be a distinct species. It is only known from Kota Tinggi District, Johore. Ridley, s.n., the holotype of *M. pendens* at Kew consists of a few leaves and loose flowers, without any stems or inflorescences. The specimen, in general appearance, resembles *M. succulenta* Bl. (q.v.), however with incomplete and insufficient material of *M. pendens* I cannot comment further on the matter.

## MALAYSIA

### Johore

Kota Tinggi: Ridley s.n. Panti River, 15 Jan. 1910, *holotype* K; Corner s.n. S. Sedili, 3 miles north of Mawai; Sinclair 40352, 16th mile Kota Tinggi–Jemalmang Road.

8. *Medinilla penduliflora* Ridl., J. Fed. Mal. St. Mus. 4 (1911) 19, and Fl. Mal. Pen. I (1922) 804.

Epiphytic shrub up to 6 m tall; branches square, sharply 4-angled, glabrous, smooth, 2.5 mm thick, nodes slightly thicker; older branches similar, up to 7 mm thick, epidermis drying tan to brownish; blades opposite, coriaceous, glabrous, lanceolate-elliptic to ovate, acute at the tip; rounded and appearing sessile at the shallowly (1–2 mm) cordate base; midnerve with one pair of thinner nerves from near the base (3-plinerved); slightly raised above, prominently elevated below; intra-marginal nerve very faint, 1–2 mm from the margin; transverse venation faint above, not visible below; 9.5–17 cm long, 5–8.5 cm wide; drying dull tan-brown above, deep chocolate brown below, slightly roughened on both surfaces; petiole 2–3 mm long, 3–4 mm thick, glabrous; inflorescence a loose pendulous panicle of cymes from leafy axils (10) 16–32 cm long, glabrous; bracts and bracteoles lanceolate, acute, 0.5–0.75 mm long; axes 4-angled, red-brown; primary axes 1 from each node, 15–30 cm long, 1 mm thick at the base, with 2–3 nodes; secondary axes 3–6 per node, 1.5–3.5 cm long; 3d axes with 1 or 2 nodes, 0.5–1 cm long; 4th axes not developed or up to 2 mm long, each with 1 pedicel c. 2 mm long; calyx campanulate-urceolate, truncate, rim with 5 triangular thickenings below the margin, with 10 faint ribs, 5 mm high, 5 mm wide at the rim, *ovate*

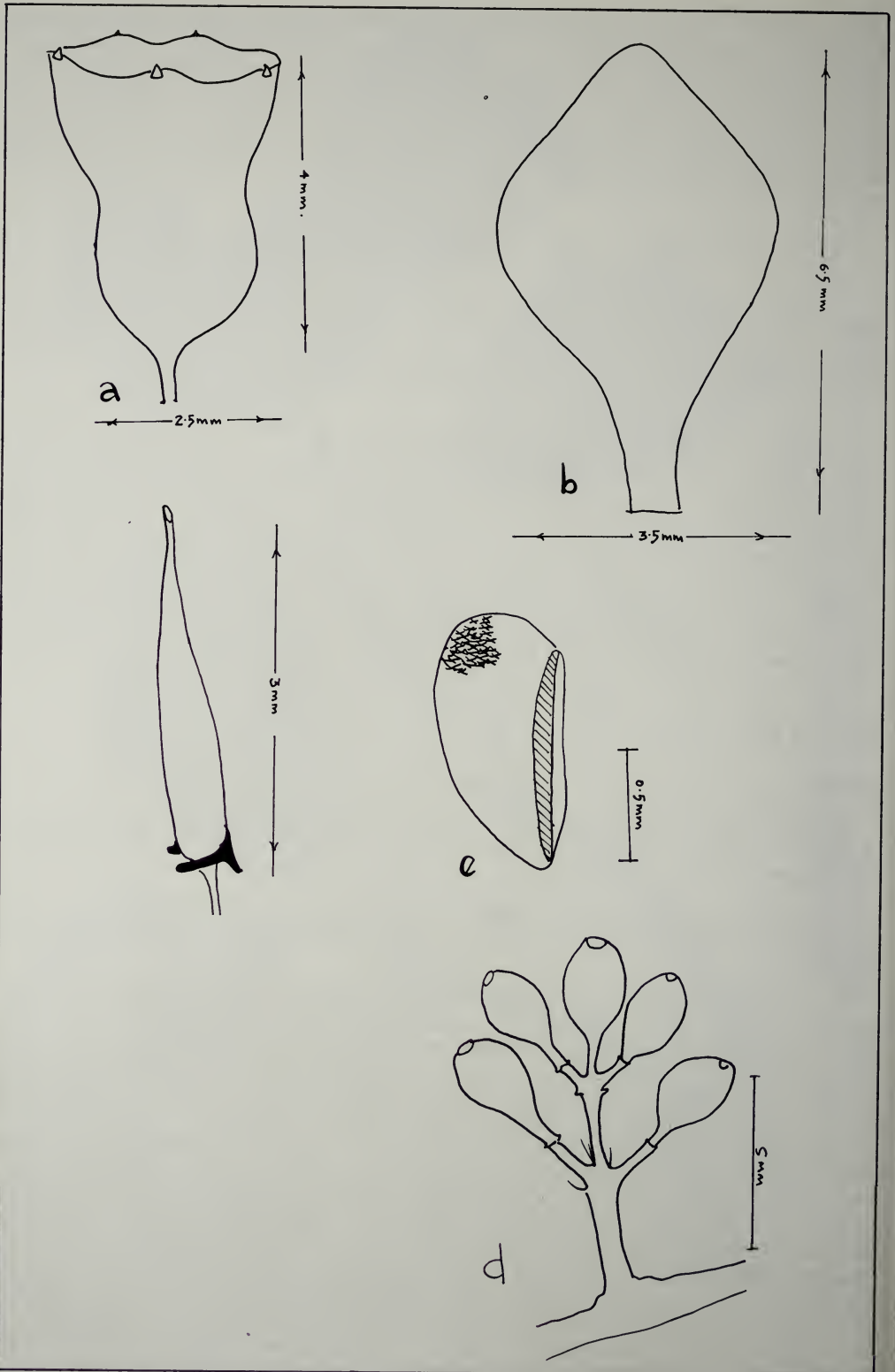


Figure 7. *Medinilla pendens* Ridl., a-c Ridley sn, Pantl River, Johore (holotype); d & e Corner sn, Sungei Sedili, Johore.

or red; petals 5, thin, broadly obovate, rounded with a minute cusp at the tip, clawed at the base, venation distinct, 8 mm long, 8 mm across at the widest point, reflexed at maturity, white; stamens 10, uniform; filaments flattened, c. 3.5 mm long; anthers curved, connective with a thin crest without any projection at the base, locules each with a rounded appendage; c. 6 mm long, golden-yellow; fruiting axes slightly thickened, pendent, red; fruit urceolate to sub-globose, glabrous, 7–8 mm long, 6–7 mm wide, areolus c. 0.5 mm high, c. 5 mm wide; exocarp membranous, pink turning purple, drying pinkish or black, sweet and juicy; seeds numerous, ovoid, c. 1.0 mm long, hilum flattened, testa minutely reticulate.

Figure 8: a. calyx, b. petals, c. stamen.

Distribution: lower peninsular Thailand to central Malaysia, above 1000 meters elevation.

The subsessile, 3-plinerved leaves; truncate calyx with 5 thickened points, and the winged connective of this species resembles those of *M. venusta* King (q.v.) which differs in having cylindrical and pustulate stems, a shorter (3–5 cm) inflorescence, and asymmetric petals.

The thick, smooth, quadrangular stems; and large inflorescence resemble *M. javanensis* (Bl.) Bl., but that species has thinner blades with prominent secondary venation, and anthers with a linear spur, c. 0.75 mm long on the connective. *M. javanensis* is found in Sumatra and Java.

*M. robusticaulis* Bakh. f. is also a closely related species which is only known from the type collection (Lorhing 6880) from Sumatra. The branches, leaves, and inflorescence of this species are similar to *M. penduliflora*, but the mature anthers differ by having little or no keel on the crest, but with a linear spur at the base of the connective. The petals are also narrower and larger. The blades of *M. robusticaulis* dry greenish, in contrast to the brownish colour of *M. penduliflora*, below. More material of both species is required to better understand this relationship. If the two species are the same, then *M. penduliflora* has priority.

#### THAILAND

*Krabi* — Panom Pencha: Keer 18728.

*Nakorn Sitammarat* — Kao Luang: Kerr 15498, Hennipman 3870, van Beusekom & Phengkhlai 987.

*Surat* — Kao Luang: Kerr 13262.

#### MALAYSIA

*Pahang* — Brinchang, Cameron Highlands: Symington 21018; Gunong Berumbum: Ridley 13688 (*type*); Taman Sedia, Cameron Highlands: H.M. Burkill 2840; Cameron Highlands: Batten-Pooll sn, Henderson 23621.

9. *Medinilla radicans* (Bl.) Bl., Flora 14 (1831) 509; Cogniaux in DC. Monogr. Phanero. 7 (1891) 573; Bakh. f., Rec. Trav. Bot. Neerl. 40 (1943–45) 160. *Melastoma radicans* Bl., Bijdr. Fl. Ned. Ind. (1826) 1069. *Medinilla radicans* (Bl.) Bl. var. *quadrifolia* (Bl.) Bakh. f. l.c. 161; *Medinilla quadrifolia* (Bl.) Bl. Furtado, Gard. Bull. Sing. 20 (1963) 118; *Medinilla crassinervia* Bl. *sensu* King not Bl., J. As. Soc. Beng. 69, II:1 (1900) 64 and Ridley, Fl. Mal. Pen. I (1922) 804; *Medinilla pterocaula* Bl. *sensu* Furtado l.c. 118.

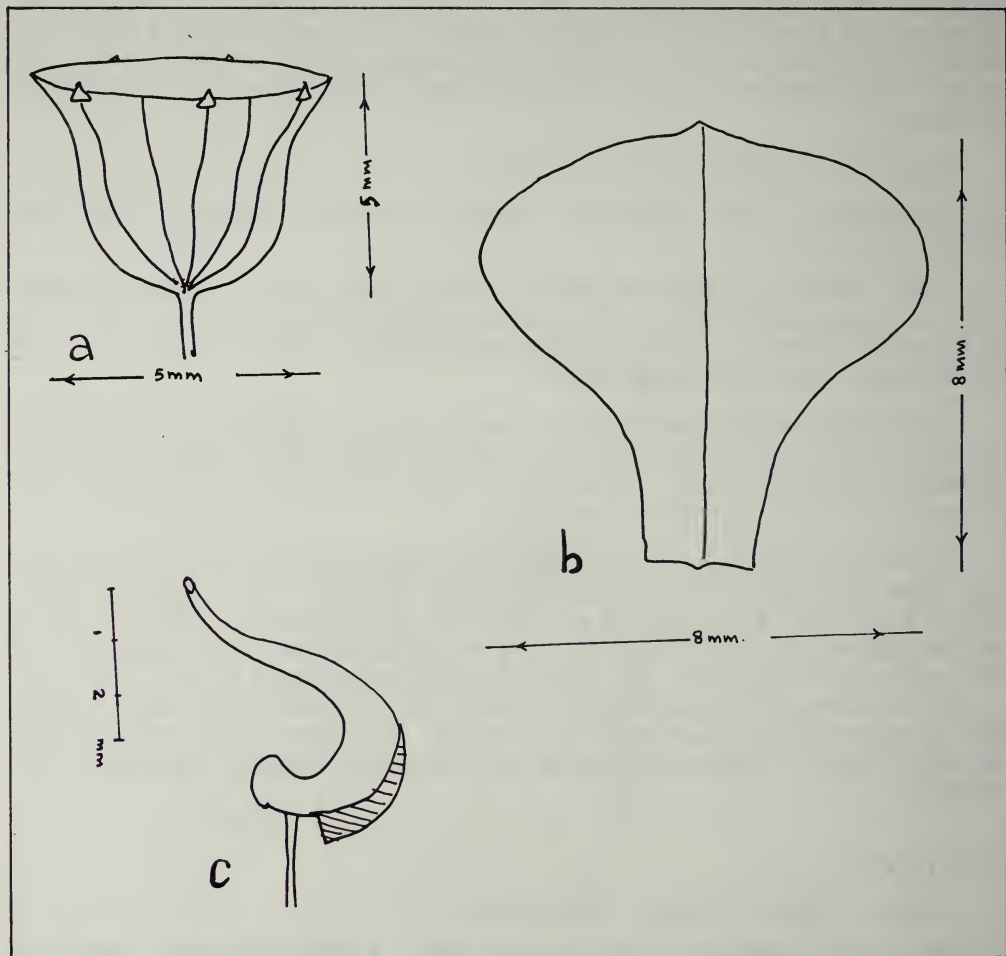


Figure 8. *Medinilla penduliflora* Ridl., a-c H. M. Burkill 2840.

Shrub, 2–3 m tall, often creeping; branches cylindrical, sometimes shallowly 2-grooved, smooth, glabrous, 2–3 mm thick, drying dark brown to blackish; older branches and stems cylindrical, frequently with adventitious roots from various parts, often slightly ribbed, drying with a striate to wrinkled texture, khaki-tan to light brown, up to 8 mm thick; nodes thickened; blades sub-coriaceous, in whorls of 4 or 5, glabrous, elliptic to obovate, acute at the tip, acute and decurrent at the base; mid-nerve distinct with or without a pair of side nerves originating from above the base (3-plinerved), sunken above, raised and tapering below; intra-marginal nerve, when present, c. 1 mm from the margin; transverse venation obscure to invisible; 7–16 cm long, 3–6.5 cm wide; drying tan-brown with a greenish hue and with a roughened texture above, brown to greenish and smoother below; petiole somewhat flattened or almost cylindrical, 1.5–3 cm long, 1.5 mm thick; inflorescence umbelliform, from leafless nodes, few (c. 6–8) flowered; axes cylindrical, smooth, glabrous; brown-reddish; primary axes 1 or 2 from each axil, 9–14 mm long, c. 1 mm thick, tip enlarged with clustered (radially arranged with one centrally located) pedicels 4–5 mm long; calyx cyathiform, truncate, glabrous, 8 mm long, 4 mm wide, drying tan with a roughened texture; petals 4, thickened, in bud oblong, rounded at the tip, truncate at the base, 8 mm long, 6 mm wide; stamens 8, 4 long and 4 shorter; bud filaments flattened, longer ones 7–8 mm long, shorter 4–5 mm; anthers all similar in shape, but differing in size, cylindrical, curved, tapered at the tip, longer ones 8–9 mm long, shorter 5–6 mm; connective at the base with a thickened, spatulate, grooved appendage c. 2 mm long; locules each with a thickened, oblong spur c. 1.5 mm long; stigma minute, style slender c. 6 mm long; fruiting axes slightly thicker; fruit urceolate, body 9–11 mm long, 8–10 mm wide; areolus 3–4 mm high, 4 mm wide, with a distinct annular disc inside; pink turning red when ripe, drying brownish with a roughened texture, pericarp c. 1 mm thick, gritty; seeds numerous, ovoid, smooth, testa without ornamentation, tan, c. 1 mm long.

Figure 9: a. calyx and corolla bud, b. petal, c. long stamen, d. short stamen.

Distribution: Malay Peninsula and the Malay Islands.

The whorled leaves and axillary, umbellate inflorescences distinguish this species. Allied to *M. radicans* is *M. pterocaula* Bl. which has winged branches, 3–5–7 nerved blades, and 5-merous flowers. *M. crassinervia* Bl. is also related but has few flowered cymes or solitary flowers, a lobed calyx, and 5–6 petals. *M. varingiaefolia* (Bl.) Nayar (q.v.) although it differs in other respects, also has has dimorphic stamens.

Bakh. f. has, with justification, reduced *M. quadrifolia* Bl. to a variety of *M. radicans* (Bl.) Bl. Furtado, solely on the basis of the literature and the limited number of specimens of both taxa in the Singapore collection, reduced *M. quadrifolia* Bl. to a synonym of *M. radicans*. Among these specimens only one (Strugnell 13007) is not in fruit and it only has buds. Therefore, I have not seen mature flowers of this species. Furtado is correct in his observation that uninerved (*M. radicans*) and 3-nerved blades (*M. quadrifolia*) are found on the same specimen (Ridley 8618, Burkill & Holttum 7866, Henderson & Nur 11101, and Shah 2800), while others are entirely 3-nerved (Goodenough 1637, Ridley s.n. from Semangkok, Selangor in Aug. 1905; and Strugnell 13006), or all uninerved (Strugnell 13007, 27890). Cogniaux and Bakh. f. in their descriptions of these taxa include several other differences, viz. *M. radicans* has smaller flower parts and ivory-white petals, while var. *quadrifolia* has larger flowers and red petals. Bakh. f. notes that the different venation of var. *quadrifolia* is the major distinction between these two

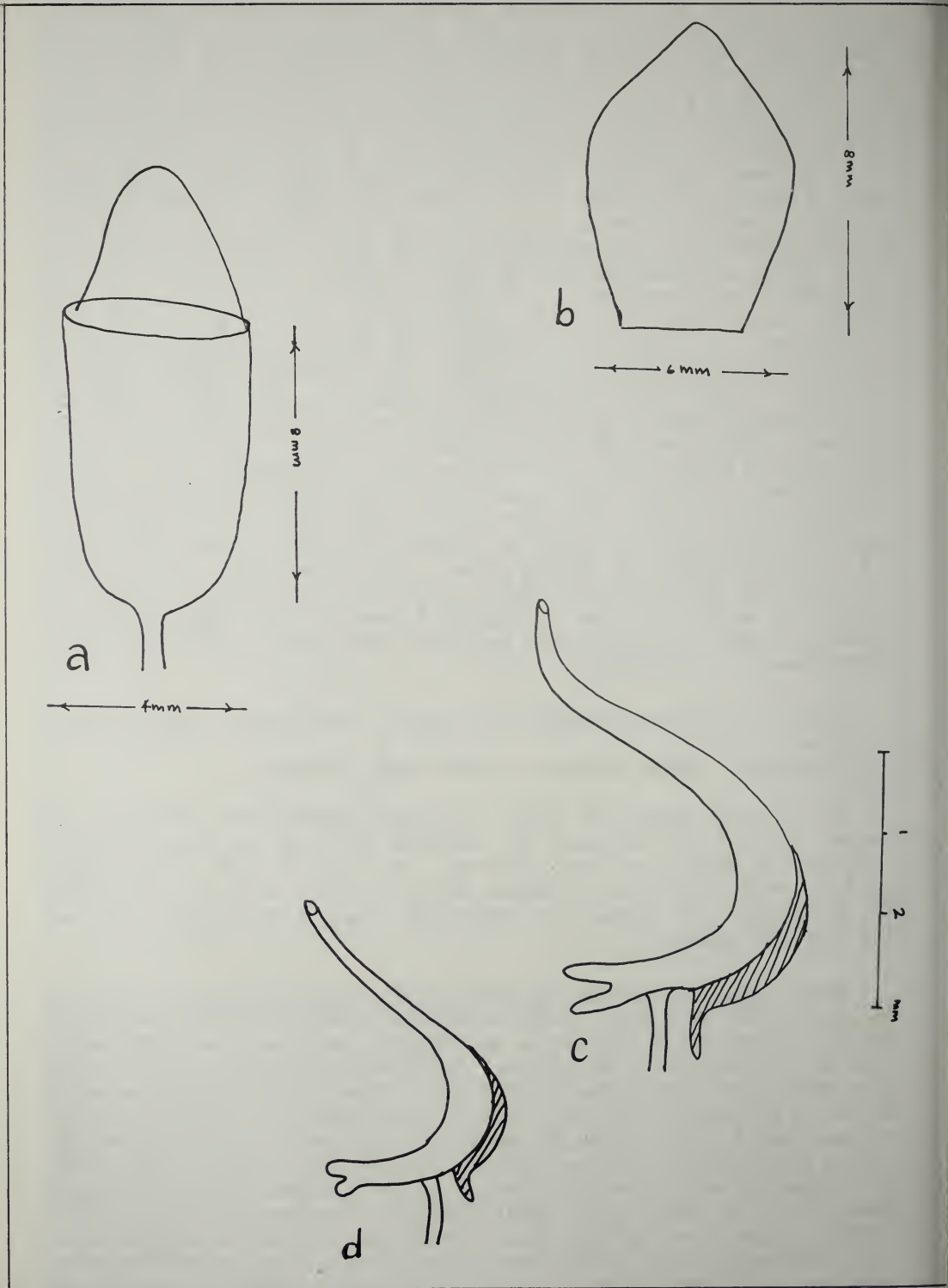


Figure 9. *Medinilla radicans* (Bl.) Bl., a-d Strugnell 13007.

taxa. In this respect, plus the fact that the venation is mixed on several sheets, I agree with Furtado that *M. quadrifolia* is the same as *M. radicans*. Examination of mature flowers of both taxa will probably confirm this reduction.

Bakh. f. doubts that the distribution of both taxa is beyond the Malay Islands. Finally, most of the specimens of *M. radicans* that I have studied were originally determined as *M. crassinervia* Bl.

Furtado, again on the basis of the literature and a few specimens in the Singapore collection, annotated several specimens which were originally identified as *M. crassinervia* Bl. as *M. pterocaula* Bl. (l.c. 118). According to Cogniaux (l.c. 575) and Bakh. f. (l.c. 156) *M. pterocaula* Bl. has quadrangular branches generally with 8 wings, 3–5–7 plinerved blades, a truncate calyx, 5 white petals, and lacks an annular disc inside the areolus. All of the specimens that Furtado annotated as *M. pterocaula* have branches that are either strongly ribbed or shortly winged. Some of the ribbed branches compare very closely with some of the branches of *M. radicans*, however none of the latter are winged. The leaves of all the specimens considered by Furtado as *M. pterocaula* have 3-nerved blades which are identical to those of *M. radicans*.

The inflorescence is also the same as in *M. radicans*, except that Wray 1821 has short (4 mm) secondary axes. The fruit in these specimens has a shorter areolus but there is a distinct annular disc inside. A specimen collected by Ridley (s.n. Batang Padang River, Perak in Dec. 1908), which Furtado annotated as *M. pterocaula*, has 4 loose stamens with curved anthers and appendages very similar to those of Strugnell 13007 which he labelled as *M. radicans*.

The specimens from the Malay Islands which Furtado annotated as *M. pterocaula* also do not differ significantly from those of *M. radicans* collected in the Malay Peninsula. Blume's long description and the excellent illustration by Rumphius in *Rumphia* I (1835) page 12 and plate 1 of *M. pterocaula* show the species as having multi (8) winged-undulate branches which become merely ribbed below. In Ridley's specimen (s.n.) from Batang Padang River, Perak (Dec. 1908) and less so with Wray 1821, the branches are winged but not undulate. Unfortunately, both of these collections are in fruit, thus I do not know what the flowers look like.

The other specimens which Furtado (l.c. 118) listed as *M. pterocaula* have slightly ribbed or nearly smooth branches. The illustration in *Rumphia* of the calyx, petals, and stamens of *M. pterocaula* compare closely with these specimens. From these specimens annotated as *M. pterocaula* that I have studied there is variation in the nature of the branches — from undulate-winged to nearly smooth. The other vegetative features, inflorescence and flower structures, and fruit appear to be the same. In fact, aside from the branches, it is difficult to distinguish these two species. From a comparison of the plates of *M. pterocaula* and *M. radicans* (plate 3) in *Rumphia* with the specimens at hand I cannot be certain that the two species are actually distinct since structurally they are nearly identical. With only one specimen of *M. radicans* that has flowers which can be examined (Strugnell 13007, buds) I am uncertain as to what variation in flower structure this species has. The mixed uninnerved and 3-nerved blades is one variation which has been resolved, but the differences in the stems and perhaps the dimorphic anthers requires further study. There is the possibility that one complex involving a single taxon is involved here, however nothing can be confirmed until I am able to examine more relevant material.

Therefore, since *M. radicans* is rather well represented in the Singapore collection, plus the fact that the specimens of *M. pterocaula* appear to be only slightly different; I have, for the moment, included the latter under the former.

I have not seen any specimens in the Singapore collection that could possibly be considered as being *M. crassinervia* Bl. which has pustulate stems and a lobed (capped) calyx. The anthers appear similar to those of *M. pterocaula*.

The specimens of *M. radicans* (Bl.) Bl. at Leiden all have uninerved blades which are very distinct from the 3-nerved ones of var. *quadrifolia* (Bl.) Bakh. f. *M. radicans* (*sensu stricto*) is found from Java to the Lesser Sunda Islands, while var. *quadrifolia* has a distribution from Sumatra to New Guinea. Apparently there is hybridization in central Malaysia where both uninerved and 3-nerved blades are not constant features. Maingay 799 and Wray 1821 (from Malacca and Perak, respectively) are both 3-nerved.

*Perak* — Waterfall: Wray 1821.

*Selangor* — Gading For. Res.; Chelliah 98231; 23rd mile Ginting Simpah: Strugnell 13006, 13007; Gunong Simpah: Strugnell 27890.

*Pahang* — Fraser's Hill: I. H. Burkill & Holttum 7866, Henderson & Nur 11101, Shah 2800; 15th mile Pahang Track: Ridley 8618; Keng & Hons.

Stud. 94.

*Selangor* — Semangkok: Ridley sn in Aug. 1905.

*Malacca* — Sine loc.: Maingay 799 (1689).

*Singapore* — Goodenough 1637.

10. *Medinilla rubicunda* (Jack) Bl., Flora 14 (1831) 512, Clarke in Fl. Brit. Ind. II (1879) 547, Cogniaux in DC. Mono. Phan. 7 (1891) 583; *Melastoma rubicunda* Jack, Trans. Linn. Soc. 14 (1825) 18.

Wallich cat. 4086, from Penang, is the only specimen of this species that I have seen from the Malay Peninsula. This collection, probably the oldest in existence since Jack's original specimens were destroyed, consists of budding material. Cogniaux (l.c. 583) cites several collections (Griffith 2284, J.D. Hooker from Sikkim, Hk. f. & Thomson from Khasia) of this species which I have examined at Leiden having mature flowers and fruit. In comparing these collections with specimens of *M. succulenta* (Bl.) Bl. (q.v.) it is obvious that the two taxa are very close, but there are several features which can be used to distinguish them. A basic problem is the fact that flowers of *M. succulenta* are sparse, thus I have only examined two flowering collections (Kerr 7773, and Holttum 24970) of it.

*M. rubicunda* has distinct petioles usually more than 3 mm long in contrast to *M. succulenta* where they are from 1–3 mm long. While the inflorescences of the two species appear to be the same, the flowers of *M. rubicunda* are larger. The calyx is c. 5 mm long, 4 mm wide; and the petals are 12–14 mm long and c. 6 mm wide. The branchlets of *M. rubicunda* are cylindric and smooth, while those of *M. succulenta* are frequently 4-angled and with some pustules. Finally, the fruit of *M. rubicunda* is distinctly urceolate, while those of *M. succulenta* appear to be globose.

Both species require a detailed study in order to properly understand their exact relationship. From the limited and incomplete material available I can merely suggest that the two taxa are very related and that *M. rubicunda*, if it still occurs in the Malay Peninsula, is rare and grows in the most western range of its distribution.

Clarke (l.c. 548) was of the opinion that *M. rubicunda* is very close to *M. hasseltii* Bl. (= *M. crassifolia* (Reinw. ex Bl.) Bl. (q.v.)) which differs in having thinner pustulate branches, thicker leaves, and 4 or 5 merous flowers.

Figure 10: a. calyx, b. petal, c. stamen. Plate 3.

11. *Medinilla scortechinii* King, J. As. Soc. Beng. 69, 11: 1 (1900) 62; *M. hasseltii* Bl. var. *griffithii* Cl. in Fl. Brit. Ind. II (1879) 547 syn. nov.

Epiphytic shrub, 1–3 m tall, often spreading, frequently on rocks and trees; or a climber; branches cylindrical, glabrous, usually smooth when young, 2.5 mm thick; older stems sparsely pustulate-tuberculate and up to 3.5 cm thick; epidermis dark brown to blackish and striate-ridged when dry; blades fleshy, coriaceous, opposite, glabrous; broadly lanceolate, elliptic, or ovate; acuminate at the tip (acumen 1–2 cm long), broadly rounded and shallowly (2–5 mm) auriculate-cordate at the base; mid-nerve with a very faint and incomplete intramarginal nerve from the base and one prominent pair of veins arising from near the base; 3 main nerves sunken above, raised and tapering to the tip; transverse venation pinnate from each of the 3 main nerves, c. 20–30 pair, very obscure to invisible on both surfaces; 11–23 cm long, 5.5–11 cm wide, dark green tinted with crimson; drying with a roughened texture, brown with a yellowish or olive hue above, brown below; petiole flattened, 2–4 mm long 3–5 mm wide, glabrous; inflorescence a lax panicle of cymes, 6–12 cm long, glabrous, multiflowered, from leafy or leafless nodes; axes flattened, often winged, orange-red; bracts and bracteoles lanceolate-ovate, acute, 1–4 mm long; primary axes 1–3 per axil, 1–6 cm long with 1–3 (infrequently more) nodes, 2–4 mm wide; secondary axes 2–5, whorled, 1.5–3 cm long 3d axes 1–2 cm long, 4th axes not developed or up to 5 mm long; pedicels solitary on the tip of each ultimate axis, c. 3 mm long; calyx campanulate, glabrous, lobes 4, broadly triangular, c. 0.5 mm long with a sub-apical cusp, lobes less distinct in mature flowers; c. 3 mm high, 2 mm wide, faintly 8 ribbed in bud, obscure with maturity; bright coral, orange-red; petals 4, thin, oblong, often asymmetric, rounded with a thickened mucro at the tip, clawed at the base, 6–8 mm long, c. 4 mm wide, reflexed at maturity; pink, orange-red; stamens 8, filaments flattened, 4–5 mm long; anthers cylindrical, curved, narrowed at the tip, 3–4 mm long, yellow, locules each with a linear, brown appendage, connective not crested but with a smaller brown spur-like appendage at the base; fruiting axes thickened and slightly longer; fruit globose, 6–8 mm diameter, areolus 4–5 wide exocarp thin, smooth, orange-red, blue-black, to purple when ripe; seeds numerous, ovoid; c. 1 mm long, finely and minutely reticulate.

Figure 11: a. calyx and corolla bud, b. petals, c. stamen. Plate 4.

Habitat: primary evergreen forests up to 1600 m elevation, noted on limestone.  
Distribution: central Malaysia.

This species is very close to *M. venusta* King (q.v.) which has more densely pustulate-tuberculate branches and stems, truncate calyx, smaller and white petals, different anthers, blades with acute bases (sometimes slightly cordate), and longer petioles. The relatively large, 3-plinerved leaves; large, complex, showy inflorescences, and asymmetric petals distinguish these two species from all others in the Malay Peninsula.

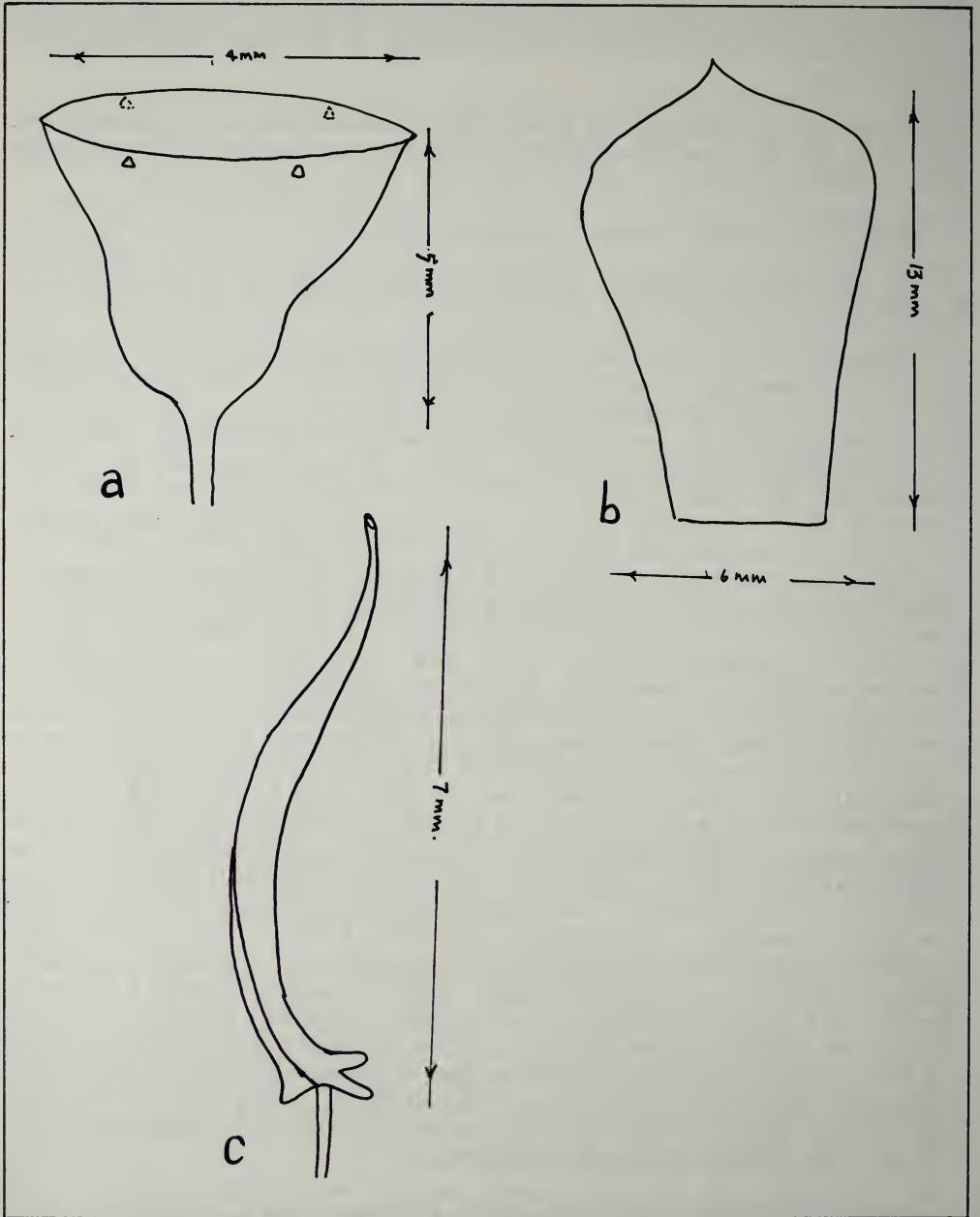


Figure 10. *Medinilla rubicunda* (Jack) Bl., J. D. Hooker & Thomson sn, Khasia.



Plate 3. Wallich catalogue 4086, the type collection of *Medinilla rubicunda* (Jack) Bl., collected on Penang in 1832. Photo: Rijksherbarium, Leiden.

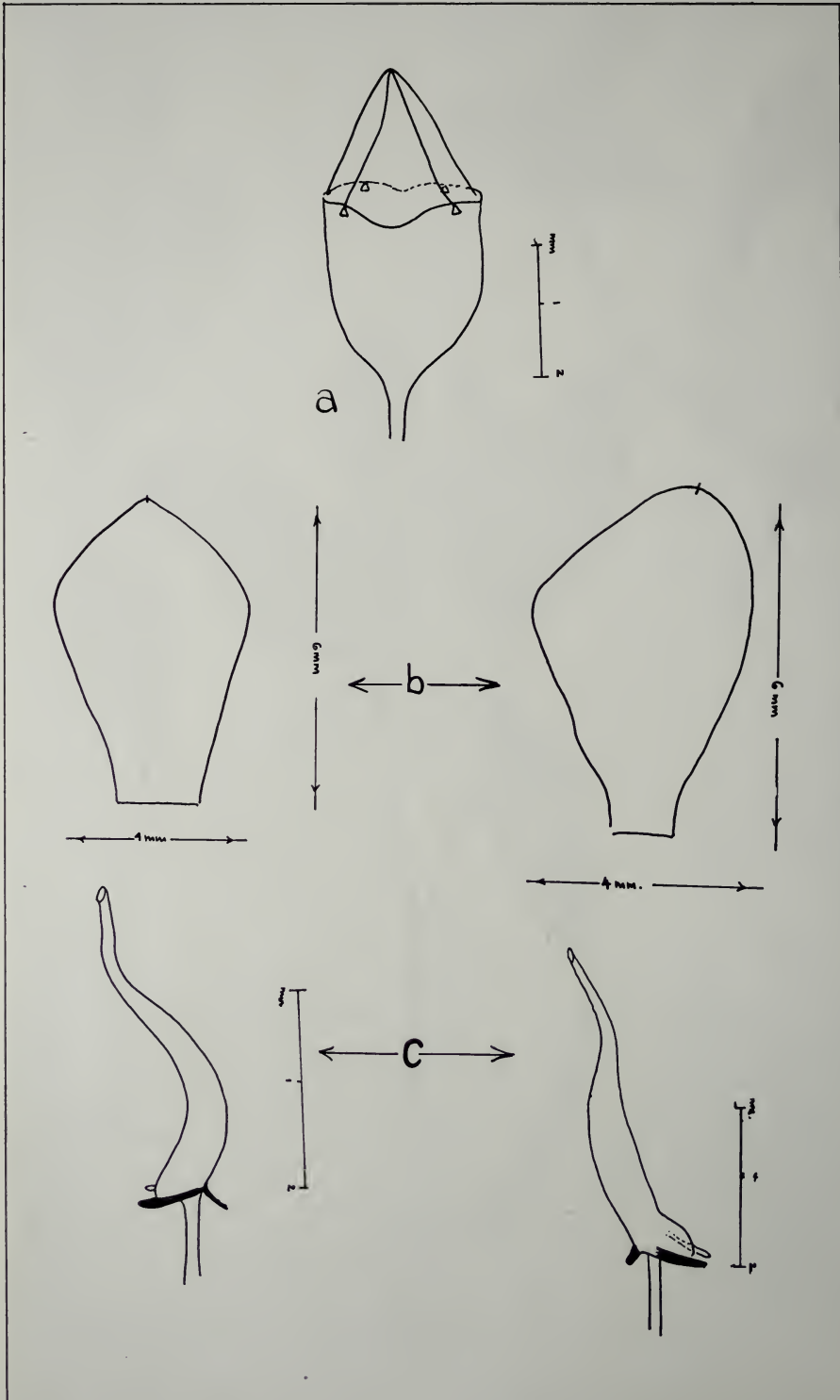


Figure 11. *Medinilla scortechinii* King, a-c Wray 1739 (syntype).



Plate 4. *Medinilla scortechinii* King. The bright red inflorescence, small flowers, and white petals distinguish this species.  
Photo: Dr. Ivan Polunin on Gunong Ulu Kali, Genting Highlands, Selangor in Dec. 1977, c. 1600m.

Another close taxon is *M. crassifolia* (Reinw. ex Bl.) Bl. (q.v.) which has nearly identical anther appendages, but differs in having a truncate calyx, shorter inflorescences with cylindrical axes, a crested connective, and distinctly petioled leaves.

King (l.c. 63) indicates that *M. scortechinii* is closest to *M. javanensis* (Bl.) Bl. which has acutely quadrangular branches, minute hairs in the leaf axils, 5-7 nerved blades, and terminal (rarely axillary) inflorescences.

The holotype of *M. hasseltii* Bl. var. *griffithii* Cl. (Griffith 2282; from Mt. Ophir, Malacca) has smaller leaves and a shorter inflorescence than many specimens of *M. scortechinii*, but with other specimens the comparisons are identical. Ridley incorrectly reduced var. *griffithii* to a synonymy of *M. hasseltii* Bl. (= *M. crassifolia* (Reinw. ex Bl.) Bl., q.v.).

*Perak* — Bujong Malacca: Ridley sn in Sept. 1898; Gunong Batu Puteh: Wray 391 (*syntype*); Hermitage: Curtis 1297 (*syntype*); Larut: King's collector 4188 (*syntype*); Maxwell's Hill: Curtis sn in Oct. 1900, Wray 1739 (*syntype*); Thaping Hills: Anderson sn on 13 March 1914, Derry sn in 1899; sine loc.: King's collector 307 (3677?) (*syntype*), Scortechini 622 (*syntype*).

*Kelantan* — Gua Hiuk: Henderson sn; Gua Musang: Stone 7522; Gunong Brong, Ulu Kelantan: Shah & Ali 2897.

*Trengganu* — Gunong Mandi Angin: Whitmore 12149; Ulu Brang: Moysey & Kiah 33829.

*Selangor* — Bukit Etam: Kelsall sn in Jan. 1891; Bukit Hitam: Ridley 7327;

Genting Highlands: Shah & Ali 2978, Maxwell 78-89a, Stone 11660.

*Pahang* — Boh Plantations, Cameron Highlands: Nur 32563; Fraser's Hill.

Addison 37383, H.M. Burkill 2034 Kalong 22372, Purselglove 4103, Soepadmo & Mahmud 9051; Stone 6266, 8663, 10780; Whitmore 8636; Gunong Benom Game Res., Ulu Krau: Ismail 97819; Gunong Tahan: Holtum 20608; Gunong Tapis: Chan 19900; Lubok Tamang: Henderson 10950; Penglet, Cameron Highlands: Henderson 23638; Sungei Yet, Fraser's Hill: Henderson & Nur 11135.

*Malacca* — Mt. Ophir: Griffith 2282 (*type M. hasseltii* Bl. var. *griffithii* Cl.) Keng 7043.

*Johore* — Lengor For. Res., Mersing: Whitmore 413.

12. *Medinilla selangorensis* Maxw. sp. nov.

*Frutex scandens, terrestris vel epiphyticus, rami cylindricus, glabris, pustulatis. Folia opposita verticillatae, axillis glaberrimis, coriacea, anguste ad late elliptica vel subobovata, glabra, 10-22 cm longa, 4-12 cm lata, basi secus petiolum,  $\frac{1}{2}$ - $\frac{3}{4}$  plo longitudine decurrentia, apice rotundata, nervis 5, marginalibus tenuibus, petiolo complanato, 1-2.5 cm longo. Inflorescentia paniculata, multiflora, 3.5-15 cm long, parce puberula vel furfuracea, axe primario solitario, complanato. Flores 4 vel 5 meri, calyce 4 vel 5 denticulato, sparse puberulo, 4-5 mm longo; stamina 8 vel 10, equalia, connectivo dorso carinato, loculis basi utisque appendiculata curvata bulbosa instructis vel inappendiculato. Fructe campanulati-globosi, 5-6 mm diametro.*

Shrub up to 2 m tall, epiphytic or terrestrial in mossy substrate, branches often climbing; youngest branchlets cylindrical, glabrous, with scattered pustules, 4–5 mm thick, epidermis drying tan, main stems up to 2 cm thick, bark c. 1 mm thick, roughly fissured, brown, pith hollow; leaves opposite or in most instances in whorls of 3, axils glabrous; blades coriaceous, glabrous, narrowly to broadly elliptic or somewhat obovate; obtuse or broadly rounded at the tip, narrowed and decurrent ( $\frac{1}{2}$  to  $\frac{3}{4}$  the length of the petiole) at the base, mid-nerve with 2 pair of nerves from near the base, lowest pair thinner and often disappearing below the tip; 10–22 cm long, 4–12 cm wide, drying dull greenish-brown on both surfaces and with a roughened texture; petiole flattened, 1–2.5 cm long, 4–6 mm wide, glabrous; inflorescence from leafy axils or on older leafless stems, in a loose panicle of cymes, many flowered, 3.5–15 cm long; axes somewhat flattened, red, furfuraceous; bracts and bracteoles lanceolate, acute, c. 1 mm long, furfuraceous; primary axes solitary, 1.5–9 cm long, 1–1.5 mm thick at the base, with 1 or 2 nodes; secondary axes 1–4 cm long with 1–3 nodes, tertiary axes 3–4 mm long pedicels 2–3 mm long; calyx campanulate, maroon, sparsely and minutely puberulous, 4–5 mm long, 4–5 mm wide, margin truncate with 4 or 5 sub-marginal cusps; petals 4 or 5, thin, obovate, broadly rounded (often irregularly so) with a cusp (often obliquely situated) at the tip, narrowed to the truncate base, 6–7 mm long, c. 4 mm wide, white and often tinged with pink; stamens 8 or 10, equal; filaments c. 3.5 mm long; anthers c. 3 mm long, light yellow, curved, with a keel-like connective crest and with or without a bulbous appendage at the base of each locule; stigma capitate; style slender, 4–5 mm long; fruit campanulate-globose, 5–6 mm diameter, light pink to red; seeds several, ovate, hilum flattened, c. 1 mm long; testa minutely reticulate, glossy tan.

Figure 12: a. calyx, b. petal, c. stamen, d. calyx, e. petal, f. stamen; and Plate 5.

Habitat: moist forests, 1600–2000 m elevation.

Distribution: Selangor, Pahang.

In several respects this species resembles *M. clarkei* King (q.v.), viz. cylindrical, sparsely pustulate branches, and structure of the inflorescence; but differs in having a generally smaller inflorescence, shortly decurrent to rounded or cordate blades, and different anthers. *M. clarkei* has leaves in whorls of 4 and usually glabrous inflorescences, in contrast to *M. selangorensis* which has leaves in whorls of 3 (sometimes opposite) and furfuraceous axes.

Ridley (Fl. Mal. Pen. I (1922) 804) cites the holotype of *M. selangorensis* under *M. perakensis* King which I consider a synonym of *M. clarkei* (q.v.). *M. selangorensis* is unusual in that it has both opposite and whorled leaves. More collections of this species are needed so that a more detailed understanding of its relationship with other species can be made.

Robinson sn from Gunong Mengkuang, which I have designated as the holotype (Kew), has 4-merous flowers, 8 stamens, and anthers with a curved and bulbous appendage at the base of each locule. Maxwell 78-80 from Gunong Ulu Kali in the Genting Highlands, matches this collection in all respects except that the flowers are 5-merous and there are 10 stamens which have inappendiculate locules.

While variation in the number of stamens (8 or 10) is known in *Medinilla* (e.g. *M. curtisii* Hk. f. and *M. venusta* King), the obvious differences in the anthers of the two specimens is difficult to resolve. Both are identical in all other respects, especially the puberulous calyx, and therefore cannot be confused with any other species of *Medinilla* from the region.

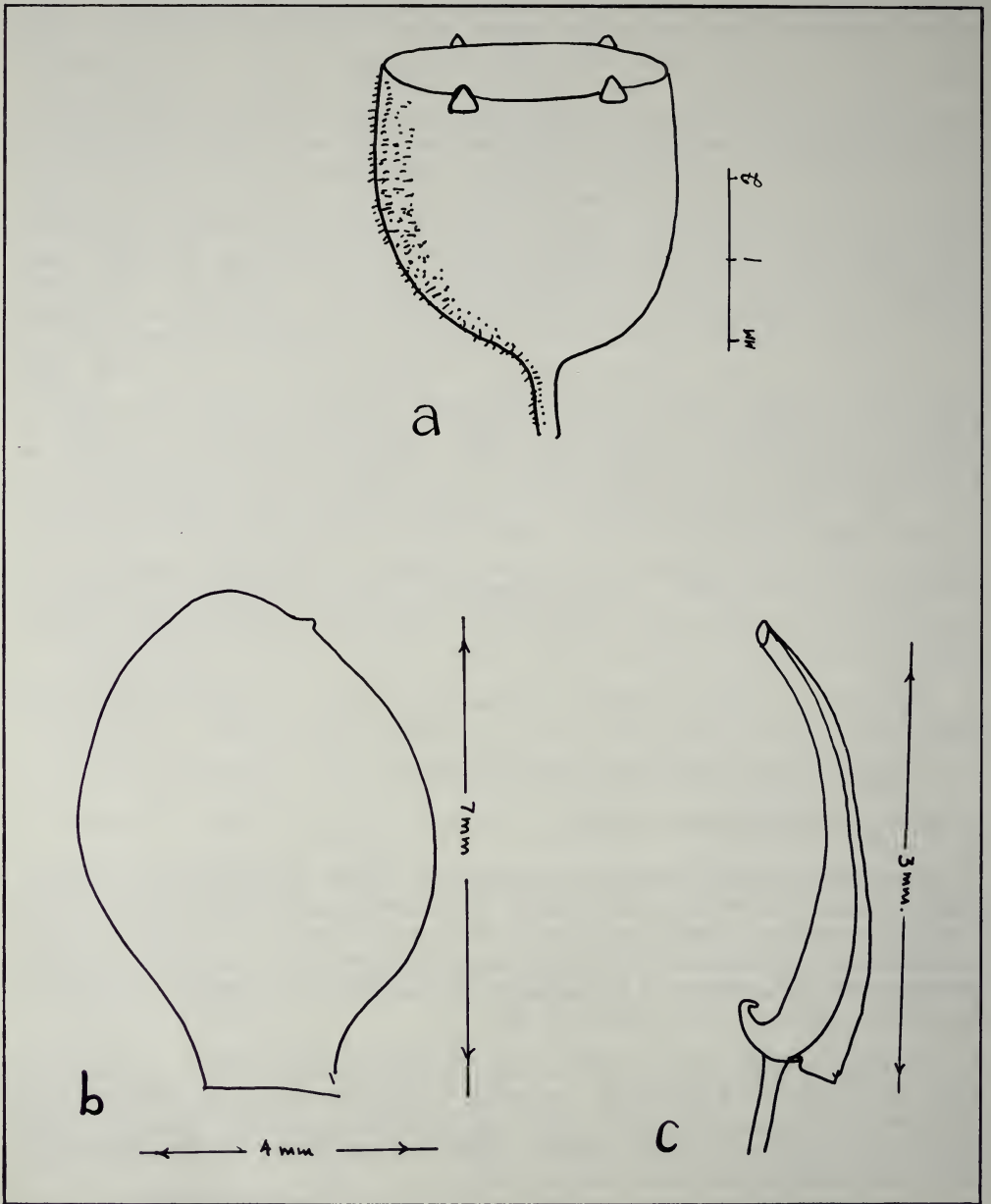


Figure 12. *Medinilla selangorensis* Maxw., a-c Robinson sn, Gunong Mengkuang (holotype).

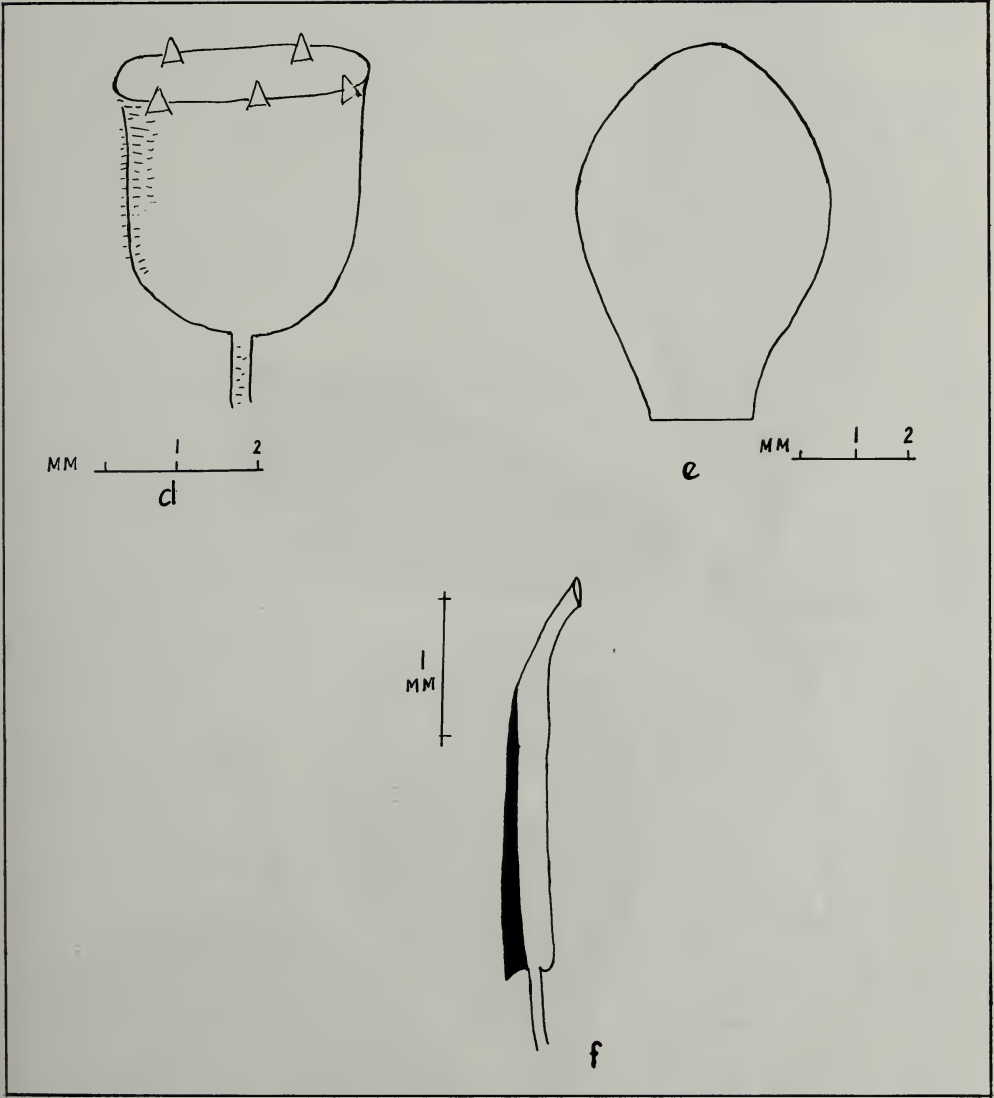


Figure 12. *Medinilla selangorensis* Maxw., d-f Maxwell 78-80.



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R.H. film 15 neg. 11

HERB HORT BOT REG. KEW.  
*Medinilla perakensis*  
 Gunong Mengkuang  
 Robinson  
 1913

Plate 5. *Medinilla selangorensis* Maxw., holotype at Kew. Collected by Robinson (sn) from Gunong Mengkuang, Selangor on 2 Feb. 1913. Cited by Ridley under *Medinilla perakensis* King (= *M. clarkei* King). Photo: Rijksherbarium, Leiden.

Allied species include *M. pendula* Merr., from the Philippines which has narrower, whorled leaves, and different anthers; *M. penduliflora* Ridl. (q.v.) which has 4-angled branches, sessile leaves, and 5-merous flowers; and *M. intermedia* Bl. which has bristly leaf axils.

*Selangor* — Gunong Mengkuang: Robinson sn on 2 Feb. 1913 (holotype Kew); Gunong Ulu Kali: Shah & Ali 2951, Flealey 8, Maxwell 78–80.

*Pahang* — Gunong Beramban: Maxwell 78–160.

13. *Medinilla speciosa* (Reinw. ex Bl.) Bl., Bijdr. Nat. Wet. 6 (1831) 256. *Melastoma speciosa* Reinw. ex Bl., Cat. Btzig. (1823) *nomen* and Flora 14 (1831) 515.

Shrub up to 3 m tall, epiphytic or terrestrial (frequently growing on rocks), or a woody climber; branches thickly 4-angled to 4-winged, epidermis smooth, glabrous, when dry khaki-tan and 7–10 mm thick, peeling off leaving a cylindrical, smooth to sparsely lenticellate, brownish surface; leaves glabrous, in whorls of 3 (rarely opposite or in whorls of 4); blades fleshy, sub-coriaceous, narrowly to broadly elliptic or obovate, acute at the tip; acute and decurrent, frequently unequally so, or not decurrent but shallowly (1–2 mm) and unequally auriculate at the base; venation pinnate with 2–5 pair of nerves (lowest pair intramarginal and often very faint) arising from the mid nerve in the lower  $\frac{1}{4}$  of the blade and arching with only the upper nerves reaching the tip, slightly raised near the base or completely sunken above, raised and tapering below, rugose when dry; secondary venation pinnate from each of the main nerves, very faint to invisible, reticulate; 20–33 cm long, 6.5–14 cm wide; dark green, veins often red below; drying with a roughened texture, dull brown above, lighter brown and often with an olive hue below; petiole 5–7 mm long, 3–4 mm wide, glabrous; nodes densely covered with numerous setaceous bristles 1–2 cm long, drying tan, glabrous; inflorescence a terminal panicle of cymes, glabrous, often pendulous, 12–27 cm long, 9–15 cm wide, many flowered; axes fleshy, 4-angled or 4-winged, glabrous, red; blackish or khaki-tan when dry; bracts whorled, lanceolate, acute, 5–10 mm long, 1–3 mm wide, reflexed; primary axes 10–23 cm long, 4–7 mm thick at the base when dry, with 3–5 nodes; secondary axes 2–6.5 cm long, 1.0–1.5 mm thick, with 1 or 2 nodes, longest at lowest node of the primary axis; tertiary axes 7–14 mm long, 4th axes usually not developed, up to 3 mm long; pedicels 4–5 mm long, pink to deep rose; calyx campanulate, glabrous, widened above the ovary, rim truncate with 4 or 5 thickened points not or minutely elevated above the rim, 4–5 mm long, 3–4 mm wide, pink or red; petals 4 or 5, thin, oblong, acute at the tip, narrowed to a broad claw at the base, 7 nerved from the base, lateral veins not reaching the tip, 10–12 mm long, 6–8 mm wide, white or pink; stamens 10, equal in size and shape, inflexed and inversed in bud; filaments flattened, c. 5 mm long, blue or pink; anthers curved, locules each with a bulbous spur, connective with a thickened ridge near the filament and ending in a short (c. 0.5 mm) appendage, 5–6 mm long, purple or violet with yellow spurs and appendage; style slender, c. 5 mm long, red; infructescence axes elongating slightly; fruit globose, glabrous, 6–7 mm diameter, narrowed to the areolus which is c. 5 mm wide and 1 mm high, smooth internally; exocarp and pericarp c. 0.25 mm thick; fruit red, violet, then purple when ripe; dark brown to blackish with a rugose texture when dry; seeds numerous, ovate, smooth, c. 1 mm long.

Figure 13: a. calyx, b. petal, c. stamen.

Vernacular: neualu (Raub, Pahang).

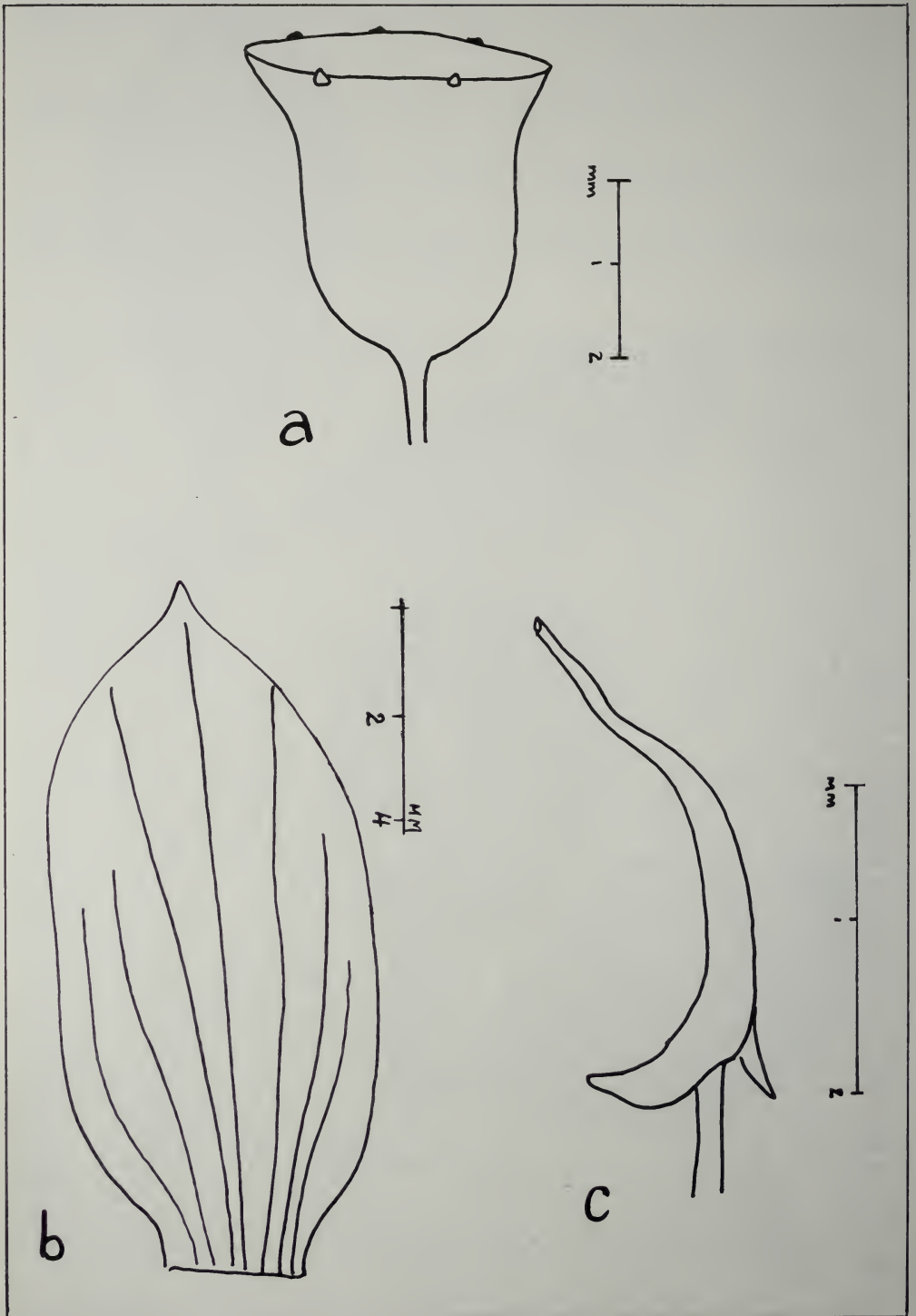


Figure 13. *Medinilla speciosa* (Reinw. ex Bl.) Bl., a-c Sinclair & Kiah 38789.

Habitat: shaded, moist areas.

Distribution: Penang, Pahang, Perak, Selangor; 500–1200 m.

The thick, 4-angled to 4-winged branches; large, terminal inflorescence with numerous flowers and multicoloured parts; whorled leaves; and bristly nodes distinguish this species.

#### MALAYSIA

*Penang* — I.H. Burkill 2673; Curtis 874, sn in May 1893; Penang Hill: Hullett 319; Ridley sn in Dec. 1895.

*Perak* — Bujong Malacca: Ridley sn in Sept. 1898; Gunong Bubu For. Res.: Hou 672; Jor Batang Padang: Henderson 10836; Larut Hill: Derry sn in 1900; Maxwell's Hill: Sinclair & Kiah 38789, Wray 3218; Taiping: Derry sn on 2 Oct. 1899; Tapah Hills: Ng 1286.

*Selangor* — Bukit Telaga, Semangkok Pass: Ridley sn on 21 June 1921; Pahang Track: Machado sn in 1903; 15th mile Pahang Track: Ridley sn in July 1897; Semangkok For. Res.; Chan 13301; Tras-Track: Ridley sn in Aug. 1904.

*Pahang* — Kuala Kubu Bharu: Calderbank 172; Pulau Tioman — Gunong Kajang: Kadim & Noor 592; Gunong Rokam: Nur 18792; Raub: Jinal 20369.

*Malacca* — Maingay 798.

14. *Medinilla succulenta* (Bl.) Bl., Flora 14 (1831) 513. *Melastoma succulentum* Bl., Bijdr. Fl. Ned. Ind. 17 (1826) 1070; *Medinilla emarginata* Craib, Kew Bull. 1930, 322 *syn. nov.*; *M. holttumi* Henderson in *scheda* Herb. Sing.

Epiphytic shrub; branches fleshy, cylindrical or slightly 4-angled, glabrous, smooth to sparsely lenticellate-pustulate, c. 2 mm thick; older branches with scattered adventitious roots, pustules more numerous, up to 7 mm thick; epidermis drying tan-brown, nodes prominent; leaves opposite, without axillary bristles or hairs; blades fleshy coriaceous, oblanceolate, elliptic, to obovate, acute to shortly (up to 5 mm) acuminate at the tip, narrowed and cuneate-decurrent, often shallowly auricled (petiole appearing winged) at the base; mid-nerve sunken above, raised and tapering below, with 1 pair of nerves arising from near the base (3-plinerved); transverse venation obscure to invisible; 6.5–20 cm long, 2.5–7.5 cm wide; drying brownish, often with an olive-green hue, on both surfaces, thin; petiole 1–3 mm long, 1–2 mm thick; inflorescence cymose, mostly from leafless nodes, glabrous, 1.5–2.5 cm long; axes cylindrical, fleshy, light pink; bracts and bracteoles lanceolate, acute, 0.5–0.75 mm long; primary axes 1 or 2 from each axil, with 1 or 2 nodes, 3–10 mm long; secondary axes not developed or 3–5 mm long, with 1 or 2 nodes; pedicels c. 3–6 mm long; calyx campanulate-urceolate, 3–4 mm long, c. 3 mm wide, with 4 sub-marginal cusps. orange; petals 4, thin, oblong-obovate, acute with a thickened cusp at the tip, truncate at the base, 6–7 mm long, c. 4 mm wide, white or pale pink; stamens 8, filaments c. 4 mm long, flattened, white; bud anthers cylindrical, straight, c. 5 mm long, mauve; connective slightly crested, with a linear appendage at the base, locules each with a shorter appendage; stigma capitate, style slender, c. 8 mm long; fruit globose, c. 5 mm diameter, areolus c. 2 mm wide, not or slightly raised; exocarp thin, bright pink to red when ripe. drying tan to blackish; seeds numerous, ovate to obovate, hilum flattened, c. 1.5 mm long, testa finely reticulate, brown-tan.

Figure 14: a. inflorescence, b. calyx and corolla bud, c. petal, d. stamen.

Distribution: lower peninsular Thailand, Malaysia, Sumatra, Java.

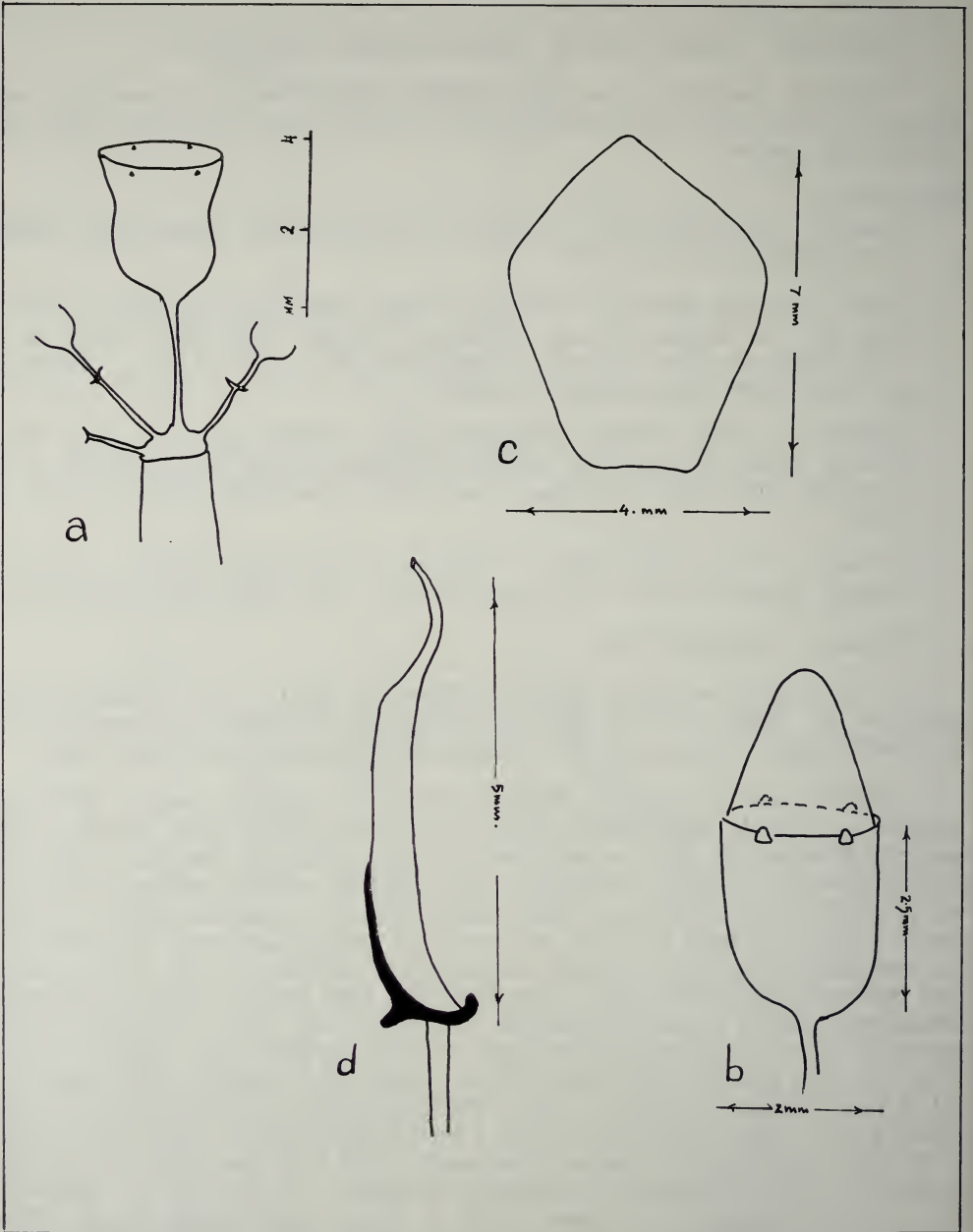


Figure 14. *Medinilla succulenta* (Bl.) Bl., a-d Kerr 7773 (holotype *M. emarginata* Craib).

The cylindrical, or nearly so, smooth branches; nearly sessile leaves which are thin when dry; small flowers, and globose fruit distinguish this species from *M. rubicunda* (Jack) Bl. (q.v.) and *M. crassifolia* (Reinw. ex Bl.) Bl. (q.v.).

The holotype of *M. emarginata* Craib (Kerr 7773, from Thailand) at Kew matches the holotype of *M. succulenta* (from Java) at Leiden. Craib notes that *M. emarginata* is closest to *M. scortechinii* King (q.v.) which has much larger, coriaceous leaves and a larger inflorescence. The alliance, in my estimation, is remote.

Nur 24970 in the Singapore collection is labeled *M. holttumi* Hend. which, as far as I can determine, was never published and is therefore an invalid (*in scheda*) name. This specimen matches other collections of *M. succulenta* at Singapore and Leiden.

#### THAILAND

*Pantani* — Betong: Kerr 7603; Kao Kalakiri: Kerr 7773 (type *M. emarginata* Craib).

#### MALAYSIA

*Perak* — Jor Camp: Henderson 10822; Ulu Temango: Ridley 14624.

*Kelantan* — Gua Panjang, Ulu Kelantan: UNESCO 629; Sungei Terang, Sungei Lebir: Henderson 29640.

*Selangor* — Ginting Simpah: Ridley, Robinson, Kloss sn in March 1917.

*Pahang* — 15th mile Jua Batu: Ridley sn; Sungei Sat, Ulu Tembeling; Henderson 22086; Sungai Teku: Holttum 20559; Tahan River: Ridley sn in July 1890.

*Johore* — Gunong Brechora: Holttum 10849; Gunong Panti: Ridley sn on 6 Dec. 1892; Kwala Kaching: Lake & Kelsall sn; Labis For. Res.: Rao 4236 (K6697); Sungai Endau: Holttum 24970, Nur 24970; Tanjong Tergamah: Fielding sn in Oct. 1892.

15. *Medinilla varingiaefolia* (Bl.) Nayer, *Blumea* 18 (1970) 569; *Melastoma varingiaefolium* Bl., *Bijdr. Fl. Ned. Ind.* 17 (1826) 1071; *Pachycentria varingiaefolia* (Bl.) Bl., *Flora* 14 (1831) 520 and *Bakh. f., Rec. Trav. Bot. Neerl.* 40 (1943-45) 126; *P. scandens* Ridl., *J. Mal. Br. Roy. As. Soc.* 1 (1923) 61; *Medinilla heteranthera* King, *J. As. Soc. Beng.* 69, II: 1 (1900) 61 *syn. nov.* including var. *latifolia* King l.c. 61 *syn. nov.*

var. *varingiaefolia*.

Shrub, often spreading, up to 3 m tall, epiphytic or terrestrial; roots frequently swollen or tuberous; branchlets cylindrical, smooth, succulent, glabrous, reddish, becoming ridged and grooved or wrinkled, 2–2.5 mm thick, dark purple-brown when dry; blades opposite, fleshy, coriaceous, glabrous, lanceolate to ovate, acuminate at the tip (acumen 0.5–1.0 cm long), acute to somewhat rounded and shortly decurrent (2–3 mm) at the base; venation 3 nerved from the base, nerves sunken above, raised (mid-vein more prominent) and tapering below, reddish; secondary venation pinnate from the mid-vein, usually invisible above, obscure to invisible

below; dark glossy green, often with a pinkish hue above, reddish below; drying with a roughened texture, light to dark brown above, darker brown and often with an olive hue below; 5.5–7 cm long, 2.0–5 cm wide; petiole 10–17 mm long, 1.0–2.5 mm thick, glabrous; inflorescence a panicle of cymes or of solitary flowers, terminal, 3–6 cm long; axes glabrous, succulent, red, rugose and tan-brown when dry; bracts and bracteoles linear-lanceolate, acute, 1–3 mm long, glabrous; primary axes 1–2 cm long with 1 or 2 nodes, c. 1.5 mm thick; secondary axes not developed (in solitary flowers) or up to 1 cm long, tertiary axes not developed or 5–8 mm long, pedicels 4–7 mm long; calyx tube cylindric or narrowed above the ovary, gradually widening and becoming funnellform, rim truncate to undulate, often thin, with a linear to triangular, acute cusps, ciliate or glabrous, c. 0.5 mm long; entire calyx 5–10 mm long, 4–6 mm wide, pinkish-tan to red, rugose and tan when dry; smooth internally; corolla buds conical to dome shaped, lobes imbricating to the right, tips 4, coherent in a pointed tip, glabrous; mature petals thin, oblong to ovate, acute and tipped with a thickened cusp, truncate at the base, 12–19 mm long, 7–9 mm wide, waxy white tinged with red or pink or cream in the upper half, pink-reddish in the lower part; stamens 7, 8 or 9, 3–4 long and 4 or 5 short, curved, glabrous, anthers yellow; filaments flattened, white, short ones, c. 6 mm long, long ones c. 10 mm long, locules of short anthers with a curved claw at the base, connective with a single dorsal projection (spur) near the filament, 5–7 mm long; long anthers 6–10 mm long, each locule with a bulbous claw, connective without a spur, stigma minute, extra-ovarial chambers and speta none; style slender, white, c. 20 mm long; fruit urceolate, capped by the persistent calyx, 7–9 mm wide, c. 10 mm long, areolus c. 5 mm wide, exocarp green turning red, glabrous, rugose when dry; pericarp c. 1/5 mm thick; seeds numerous, ovoid, c. 0.75 mm long, testa minutely papillose-reticulate, glossy tan.

Figure 15: a. calyx, b. petal, c. long stamen, d. short stamen. Plates 6 & 7.

Distribution: upland forests, 1000–2200 m elevation, Pahang, Perak, Kemaman.

The terminal inflorescence and unequal stamens distinguish this species from all other *Medinilla* in the region.

The type collection of *M. varingiaefolia* (Bl.) Nayar (Kuhl and van Hasselt s.n., from Java) at Leiden consists of 3 sheets all with fruit. As the flowers for this species were not available, Blume assumed that it was *Pachycentria* since the fruit of the two genera are similar. This species has only been collected on a few occasions from Java and Sumatra, thus the species was poorly known. Bartlett 6569, from Sumatra, has leaves and branches which match the type collection of *M. varingiaefolia*, and the specimen also has flowers which match those of King's coll. 3291 — a syntype of *M. heteranthera* King. There is no doubt in my mind that *M. heteranthera* is the same as *M. varingiaefolia*. Constant features of all flowering specimens of this species that I have examined are the four long anthers with an extension of each locule and unappendaged connective, and short anthers with locule appendages and a spurred connective. The leaves vary in texture from sub-coriaceous to coriaceous. *M. varingiaefolia* var. *bakhuizenii* (Nayar) Maxw. (q.v.) differs in having thicker, more obtuse leaves, a longer calyx, and a connective spur on the long anthers.

King mentions that *M. heteranthera* resembles *M. horsfieldii* Miq. (reduced by Bakh. f. (l.c. 187) to a synonym of *M. laurifolia* (Bl.) Bl.) which has a distribution from Sumatra to the Celebes, is an entirely different species which has

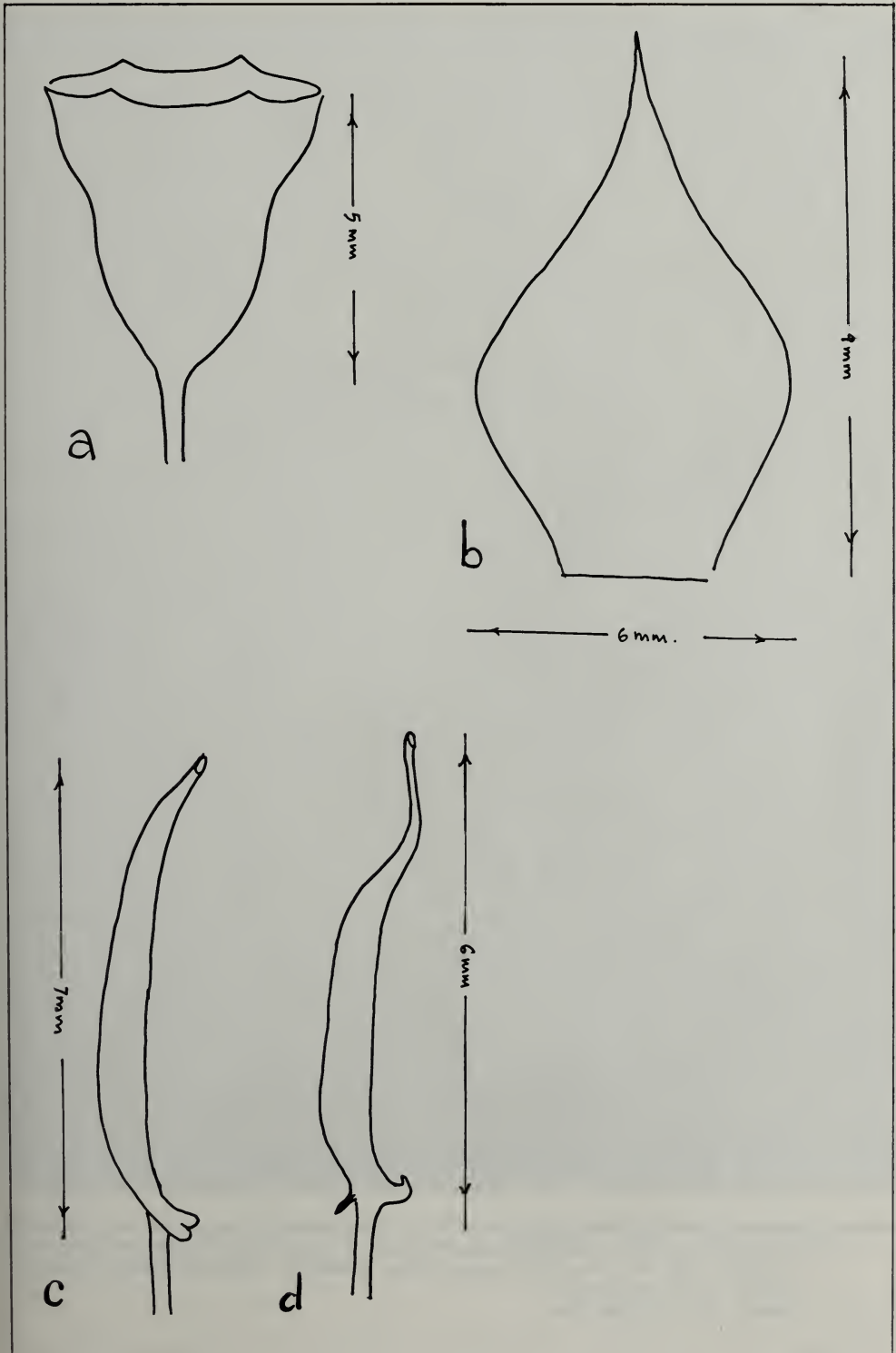


Figure 15. *Medinilla varingiaefolia* (Bl.) Nayar, a-d King's coll. 3291 (syntype *M. heteranthera* King).



Plate 6. *Medinilla varingiaefolia* (Bl.) Nayar var. *varingiaefolia* showing the tuberous roots and shrubby habit. Collected by Dr. Hsuan Keng from a sandstone outcrop in a thicket near the top of Gunong Bunga Buah, c. 1700m, Genting Highlands, Selangor in November 1977.  
Photo: Mr. Douglas Teo.



Plate 7. Branch and inflorescence of *Medinilla varingiaefolia* (Bl.) Nayar var. *varingiaefolia*, Maxwell 78-205; Tanah Rata, Cameron Highlands, Pahang; 16 April 1978. Photo: Dr. Ivan Polunin.

tan, pustulate stems; and equal stamens. The leaves of the two species are similar, however.

Bakh. f. (l.c. 148) divided *Medinilla* into two sections, viz. *Eu-Medinilla*, with species having a thick (1–2 mm) calyx tube, and unequal anthers; and *Hetero-Medinilla* having species with a thin (0.5 mm) calyx tube, and equal anthers. *M. varingiaefolia* has a thin calyx tube and unequal anthers; and does not, therefore, fit properly into either section. *M. teysmanni* Miq. is included, as an exception with unequal stamens, in *Hetero-Medinilla*. It is found in the Philippines, Celebes, and Moluccas; and is entirely different from *M. varingiaefolia*.

*Medinilla heteranthera* King var. *latifolia* King merely differs from the typical variety in having wider blades which are shortly (c. 1 cm) acuminate at the tip and caudate at the base. I have examined both syntypes of this variety and they do not differ from some of the specimens in the Singapore collection which have both narrow (typical variety) and var. *latifolia* blades (e.g. Williamson, s.n. from the Cameron Highlands, Jan. 1932; and Henderson 17919). The flowers of var. *latifolia* are the same as those of the typical variety. Since there are no structural or distinct vegetational characteristics of var. *latifolia* to maintain it as a separate taxon, I have reduced it to a synonym of *M. varingiaefolia*.

*Perak* — Guong Batu Patch: King's collector 8017 (syntype *M. heteranthera* King var. *latifolia* King); Wray 268 (syntype *M. heteranthera* King var. *latifolia* King); 397 (syntype *M. heteranthera* King); Larut: King's collector 3291 (syntype *M. heteranthera* King), 3644 (syntype *M. heteranthera* King), 6304 (syntype *M. heteranthera* King), 6904 (syntype *M. heteranthera* King); Larut Hill: Derry (Curtis 3707); Maxwell's Hill: I. H. Burkill & Haniff 12952, Ridley & Curtis 5346, Shah & Sidek 1044, Whitmore 12902.

*Trengganu* — Bukit Kajang, Kemaman: Corner sn.

*Pahang* — Cameron Highlands: H.M. Burkill 829; Chew 745, 1257; Henderson 17811, 17919; Nur 32673, Poore 1071; Rao Keng, Avadhani 53 (K8046); Symington 20918, 21002; Williamson sn in Jan. 1932; Fraser's Hill: I.H. Burkill & Holtum sn 16–30 Sept. 1922; Gunong Berembun, Cameron Highlands: Whitmore 15487; Gunong Sasar, Cameron Highlands: Whitmore 15575; Pine Tree Hill: Nur 11063; Tanah Rata: Maxwell 78–205, Samat 369.

16. *Medinilla varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw. *comb. nov.*, *M. bakhuizenii* Navar, *Blumea* 18 (1970) 569 new name for *Pachycentria speciosa* Ridl., *J. Fed. Mal. St. Mus.* 6 (1915) 149 and *Fl. Mal. Pen.* 1 (1922) 806.

This variety has one major structural feature which I feel merits distinction from the type species, viz. the presence of a spur on the connective of the long anthers. This is a constant feature, and in all flowering material of the type species that I have examined the long anthers lack any trace of a spur. This spur in var. *bakhuizenii* is c. 0.5 mm long. The locule appendages of the long anthers and morphology of the short anthers of the two taxa are identical.

The leaves of var. *bakhuizenii* are thick coriaceous, obtuse; and the calyx is longer with a more pronounced ovary and more acute calyx cusps. Fruiting material of the two taxa are identical. The variety is known only from a few collections from Pahang at elevations of 1100–1600 meters, and is found within the range of distribution and in similar habitats as the type species.

Figure 16: a. calyx, b. petal, c. long stamen, d. short stamen.

*Pahang* — Gunong Tahan: Ridley 16339 (type *Pachycentria speciosa* Ridl.); Pine Tree Hill, Fraser's Hill: H.M. Burkill, Shah, Noor 2376; Purséglove 4232.

17. *Medinilla venusta* King, J. As. Soc. Beng. 69, II:1 (1900) 61; *M. venusta* King var. *chionantha* (Stapf) Ridl., Fl. Mal. Pen. I (1922) 802, *M. chionantha* Stapf, Kew Bull. 1906, 73 *syn. nov.*; *M. gratiosa* Stapf, Kew Bull. 1933, 184 and Ballard in Curtis's Bot. Mag. 1935, tab 9386 *syn. nov.*

Terrestrial or epiphytic shrub, up to 5 m tall, or a climber; branches cylindric, covered with raised pustular tubercles, glabrous, epidermis at first brownish, then khaki-tan with age; 3–5 mm thick when dry; stem with more prominent pustules, otherwise similar to the branches, 9–14 mm thick; bark thin, smooth, finely fissured, tan; wood dense, pith hollow; leaves opposite, glabrous; blades coriaceous (often fleshy), narrowly to broadly elliptic, less frequently lanceolate, acute at the tip, gradually narrowed and decurrent or in larger blades shallowly (2–5 mm) auriculate or sub-cordate at the base; mid-vein with a prominent pair of nerves arising from near the base, and with 1 pair of intramarginal nerves 2–6 mm from the margin, main veins sunken above, raised and arching to the tip on the under-surface, often pustulate near the base; (10) 14–22 cm long, (3) 6.5–12 cm wide; transverse venation pinnate, very obscure to invisible on both surfaces; drying brown above, lighter brown below; with a rugose texture and frequently with an olive hue on both surfaces; petiole 2–8 mm long, 3–4 mm thick, often appearing sessile with decurrent blades, glabrous; inflorescence cymose, from leafless and leafy nodes, or terminal, few to many flowered, glabrous, 3–8 cm long; primary axes flattened, pink to red; primary axes 1–3 per axil, 1–5 cm long, 2 mm thick, generally with 1, sometimes 2 or 3, nodes; secondary axes 3–5, whorled, 1.0–1.5 (2.2) cm long, 3d axes not developed or up to 5 mm long; 4th axes nod developed or up to 2 mm long; pedicels 5–7 mm long, slightly longer in fruit; bracts and bracteoles lanceolate-ovate, acute, up to 0.5 mm long; calyx campanulate, glabrous, truncate, margin with 5 minute thickenings, not or very shortly raised (denticulate); 4–9 mm long, 4–6 mm wide, pink; petals 4 or 5, thin, elliptic-oblong, asymmetric, irregularly oblique and broadly rounded with a mucro at the tip, clawed at the base, 12–22 mm long, 7–14 mm wide, white often with a pink or red hue, reflexed at maturity; stamens 8 or 10, equal; filaments flattened, 6–8 mm long; anthers cylindric and curved, 6–7 mm long, c. 1 mm wide, whitish or yellow, narrowed at the apex, connective ridged with a keel-like wing near the base, or spurred; locules each with an elongate, bulbous appendage which is longer than the connective appendage, yellow or white; stigma capitate, minute; style slender, 10–18 mm long, red; fruit globose, 8–9 mm diameter, areolus 7–8 mm wide; exocarp pink to red, drying tan to black; pericarp c. 0.5 mm thick; seeds numerous, ovoid, finely and minutely reticulate, c. 1 mm long.

Figure 17: a. inflorescence, b. calyx, c. petals, d. stamens. Plates 8 & 9.

This species is distinct with its pustulate stems, opposite, 3-nerved blades, complex axillary or terminal inflorescence, and relatively large flowers. The closest relative is *M. scortechinii* King (q.v.) which has smoother branches, larger inflorescences, smaller flowers with a lobed calyx, and different anthers.

*M. javanensis* (Bl.) Bl., from Sumatra and Java, has similar leaves, but can be readily distinguished from *M. venusta* by the quadrangular, smooth or sparsely pustulate branches which dry tan, and smaller flowers. *M. verruculosa* (Bl.) Bl. has leaves and pustulate stems which resemble *M. venusta*, however most of its parts are red-brown furfuraceous, and the flowers are smaller. The leaf shape resembles that of *M. venusta*, but the blades are 5–7 plinerved and the secondary venation is much more prominent.

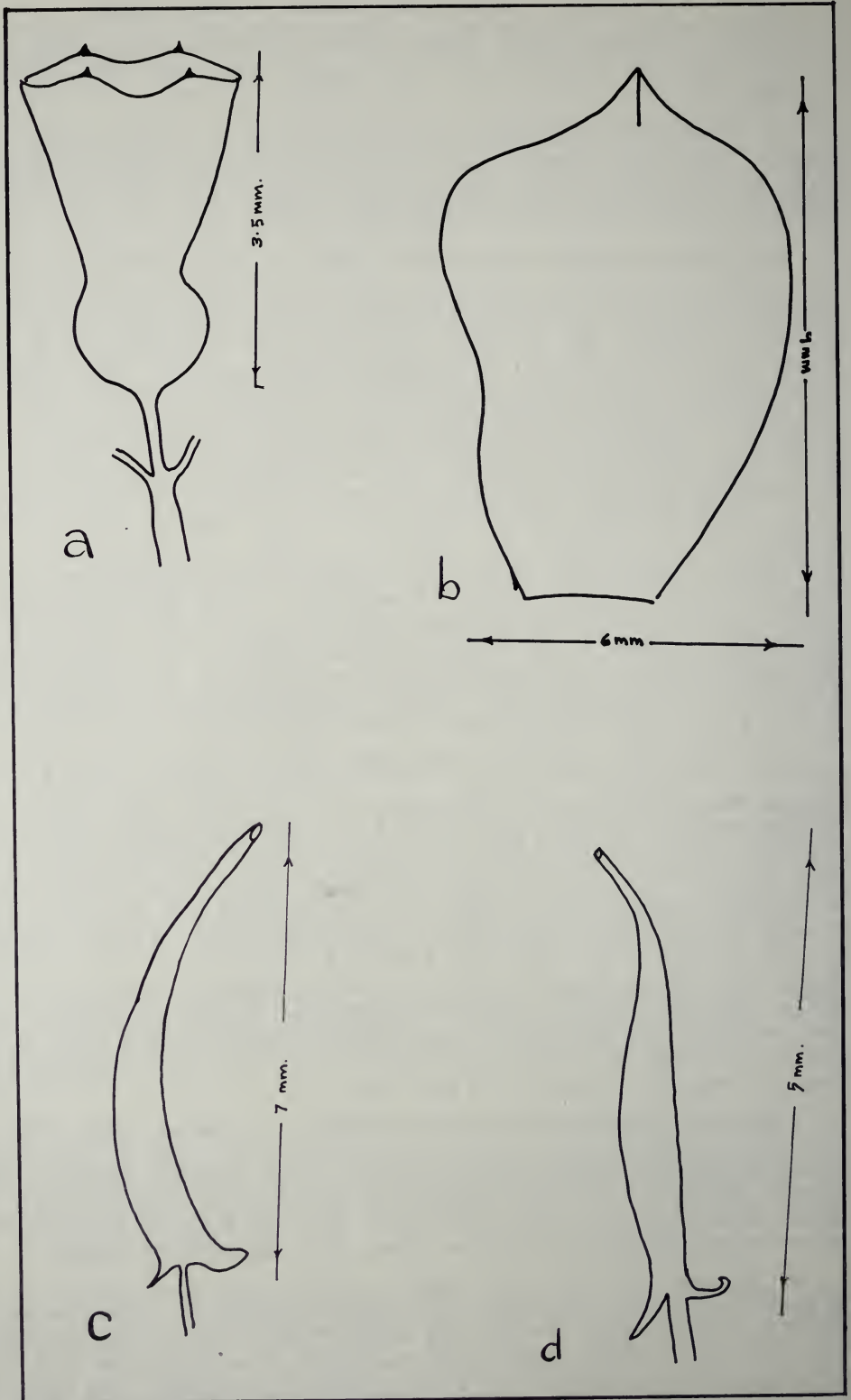


Figure 16. *Medinilla varingiaefolia* (Bl.) Nayar var. *bakhuizenii* (Nayar) Maxw., a-d Ridley 16339 (holotype *Pachycentria speciosa* Ridl.).

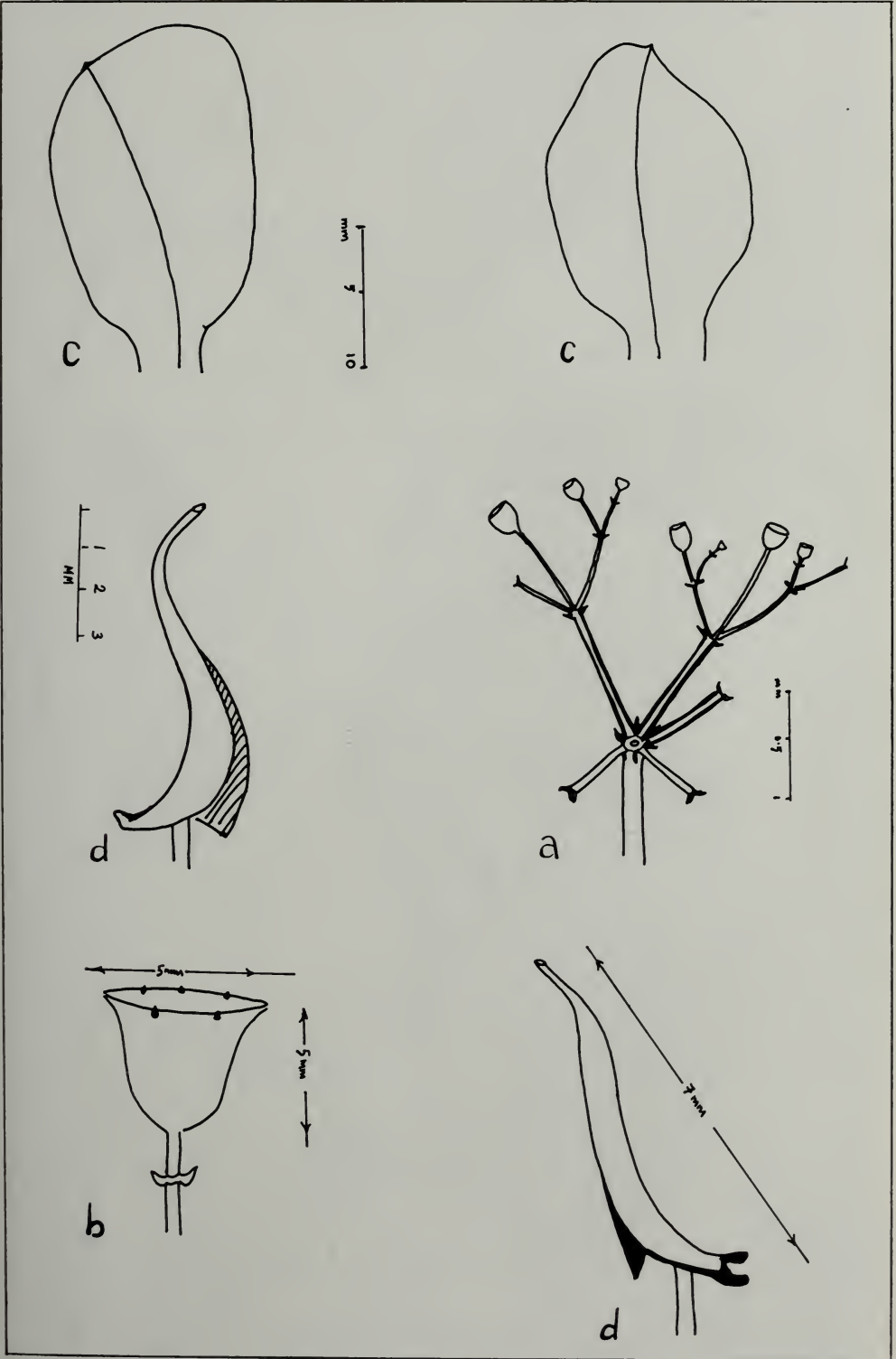


Figure 17. *Medinilla venusta* King, a & b H. M. Burkill 2880, c & d Sinclair & Kiah 38610.



Plate 8. Holotype of *Medinilla chionantha* Stapf (= *M. venusta* King) at Kew. Cultivated by Veitch from seeds sent by Curtis which were collected in Perak.



Herb. Lugd. Bat.  
 Kew cultus s.v.  
 Medinilla venusta King  
 Holtum 25. Jan 1933

cm  
 0  
 1  
 2  
 3  
 4  
 5

R.H. film 1/5 neg. 7

CULT. IN HORT. BOT. REG. KEW., A.D. 1933.

Printed in Great Britain by the University Press, Cambridge

*Medinilla gratiosa*, Less  
 Fraser's Hill  
 9/1/33  
 R. E. Holtum

M. Cotton, M. Chimanant, etc.  
 will you please name  
 the Medinilla sp. from  
 Fraser's Hill F. M. S. B. S. 1932

Plate 9. Type collection of *Medinilla gratiosa* Stapf at Kew. Cultivated at Kew from seeds sent by R. E. Holtum collected at Fraser's Hill. The species is now a synonym of *Medinilla venusta* King. Photo: Rijksherbarium, Leiden.

Another species, *M. chionantha* Stapf, is undoubtedly the same as *M. venusta* King, and Ridley considered it a variety of the latter. The main distinction of this variety is that it has 10 stamens. Stapf described this species from cultivated plants in England which were grown from seeds sent by Curtis from Perak. One specimen, Ridley s.n., from Thaiping Hills, Perak; has the note "doubtless var. *chionantha*" written on the sheet. Cantley 2011, from Maxwell's Hill, Perak; is perhaps another collection which represents Stapf's species. The stem, leaves, inflorescence, and calyx of these specimens which are most likely var. *chionantha*, do not differ from the holotype of *M. venusta* King. Other collections of which I am certain have 10 stamens include: Wray 700, Ridley 2932, Anderson 16, Sinclair & Kiah 38610, and H.M. Burkill 2880. These specimens, except for the number of stamens, do not differ from the type collection of *M. venusta* King. Stapf notes that *M. chionantha* is close to *M. longipedunculata* Cogn. and *M. succulenta* (Bl.) Bl. — the difference with *M. chionantha* being narrower, 3-nerved, basally long attenuate blades; with more and larger flowers on a shorter inflorescence. *M. longipedunculata* Cogn. has 5-nerved blades, a minutely 5-denticulate calyx, and smaller flower parts than the specimens of *M. venusta* King and *M. chionantha* Stapf that I have examined. *M. succulenta* (Bl.) Bl. (q.v.) has a shorter inflorescence; smaller, 4-merous flowers, a dentate calyx, and reddish-white petals.

Included in the Singapore and Leiden collections are specimens which, in respect to the pustulate stems, opposite leaves, and flowers are identical to *M. venusta* King. These specimens, however, have a terminal inflorescence which is structurally the same as those specimens of *M. venusta* with axillary inflorescences. The leaves of some of the specimens with a terminal inflorescence are smaller, however some collections have both small and the typically large blades common to the more common form of the species. The type collection of *M. gratiosa* has both terminal and axillary inflorescences.

Furtado, obviously confused by the terminal inflorescence, apparently did not examine the flowers of these specimens closely since they have the truncate calyx, 5 thin petals with asymmetric tips, and anthers which are identical to those of *M. venusta*. He annotated these specimens as "*Medinilla trinervia* vel affinis". The original identifications were *M. venusta* King or *M. hasseltii* Bl.

*Medinilla trinervia* Cogn. (Mono. Phan. 7 (1891) 596) with sharply 4-angled and smooth branches; and smaller, 4-merous flowers with unappendaged anthers is not at all like the specimens discussed here. On one sheet (Henderson & Nur 11246) Furtado noted that *M. curtisii* Hk. f. may be close since it has 5-merous flowers. However, *M. curtisii* has smooth branches and stems, and lacks an anther crest.

The type collection of *M. gratiosa* (3 sheets) is from a specimen grown at Kew from seeds collected at Fraser's Hill. It has smaller leaves and smaller flowers than *M. chionantha*, but otherwise the calyx, petals, and the 10 stamens are identical.

The narrow blades of *M. gratiosa* are not uncommon and in several collections, e.g. Stone 8326, H.M. Burkill 1991, both from Fraser's Hill, both lanceolate and elliptic blades are found on the same specimen.

Stapf notes that *M. gratiosa* is close to *M. curtisii* Hk. f., but that species has smooth, bluntly 4-angled branchlets; and sessile, cordate blades, Ballard, however, suggested a strong alliance with *M. chionantha*.

Distribution: lower peninsular Thailand to central Malaysia in evergreen forests 500–1700 m elevation.

*Kedah* — Langkawi Island: Kerr 21729.

*Perak* — Caulifields Hill: Wray 700: The Cottage: Ridley 2932: Larut: King's collector 2390 (*type*): Larut Hill: Anderson 16; Maxwell's Hill: I.H. Burkill sn in March 1924, I.H. Burkill & Haniff 12928, Curtis 2011 Hons. stud. Univ. Sing. 33, Sinclair & Kiah 38610; Thaiping Hill: Ridley sn; sine loc.: Curtis sn (*type M. chionantha* Stapf).

*Selangor* — Sungei Telum: Poore 525; Genting Highlands, Gunong Ulu Kali: Maxwell 78-89.

*Pahang* — Blue Valley, Cameron Highlands: Chew 1267; Fraser's Hill: Addinson sn in Sept. 1940, H.M. Burkill 1991; I.H. Burkill & Holtum 8430, 8554; J.C. (Carrick) 1607 (2537), Franck 1441, Henderson & Nur 11246, Kalong 22371, Keng, Chow, Hons. stud. 4744, Keng & Hons. Stud. 95, Kew Herb. sn (*type M. gratioiosa* Stapf); Purselove 4178, 5524; Samat 96, Shah 2741, Shah & Noor 736, Stone 8326, Watson 11515; Gunong Benom: Struggnell 22325; Gunong Jasar, Cameron Highlands: Whitmore 15566; Kuala Keria, Cameron Highlands: H.M. Burkill 2880; Sungei Bertam: Henderson 11123; Sungei Pauch Valley, Cameron Highlands: Chew 754; Tanah Rata, Cameron Highlands: Henderson 17738; Telom: Ridley 13690; Cameron Highlands: Nur 32924; Rao, Keng, Avadhani 66 (K8059).

#### PACHYCENTRIA Bl.

Blume, Flora 14 (1831) 519 and Bijdr. Nat. Wet. 6 (1831) 259; Naudin, Ann. Sci. Nat. ser. III; 15 (1851) 299; Triana in Trans. Linn. Soc. 28: 1 (1871) 89; Clarke in Hk. f. Fl. Brit. Ind. II (1879) 565 (*in nota*); Cogniaux in DC. Monogr. Phanero. 7 (1891) 605; King, J. As. Soc. Beng. 69, II: 1 (1900) 66 (Mat. Fl. Mal. Pen. 474); Ridley, Fl. Mal. Pen. I (1922) 805; Craib, Fl. Siam. Enum, I: 4 (1931) 701; Bakh. f., Rec. Trav. Bot. Neerl. 40 (1943-45) 120; Henderson, Malay Nat. J. 4: 3 & 4 (1949) 140 and Malay. Wild Fls. I (1959) 140; Nayar, Blumea 28:2 (1970) 567.

Epiphytic shrubs up to 2 m tall; lower stems and roots often irregularly swollen or tuberous, adventitious roots common; branchlets cylindrical, flattened and 2-grooved, or somewhat 4-angled, smooth and furfuraceous, glabrescent; leaves opposite, simple; blades sub-coriaceous to coriaceous, usually glabrous, entire, lanceolate to sub-orbicular, acute to rounded at the tip, narrowed at the base, mid-nerve with a single pair of thinner intramarginal nerves; petioles distinct; inflorescence cymose, often paniculate with tertiary axes, terminal, terminal and axillary, or of solitary flowers; axes flattened to 4-angled, furfuraceous, pedicels distinct; calyx funnellform, less frequently campanulate, narrowed to the globose ovary, minutely furfuraceous and often ribbed outside, up to 4 mm long, margin truncate with 4 cusps or lobes; petals 4, thin with visible venation, oblong to ovate, acute at the tip, truncate at the base, 3–6 long; samens 8, equal; anthers oblong, straight, opening with a single oblique pore at the tip. 2–3 mm long, connective with a basal spur, locules inappediculate; stigma minute; style slender, rising to a height slightly above the tip of the anthers, collared at the base; extra-ovarial chambers and septa none; ovary glabrous, 4-loculed, placentation axile with 4–8 many ovules on each; fruit a berry, globose, 4–6 mm wide, capped by the neck-like calyx tube (giving an urceolate appearance), exocarp smooth or papillose-muricate, epicarp soft and juicy or pulpy; seeds few to numerous, oblong to ovate, c. 0.75–2 mm long; testa finely reticulate.

KEY TO THE SPECIES OF *PACHYCENTRIA*  
FROM THE MALAY PENINSULA

1. Inflorescence a multiflowered panicle of cymes, 2–6 cm long; blades lanceolate to obovate, 4–12 cm long, 1–5 cm wide, ovules 3–4 or more than 10 in each locule...
  2. Calyx with 4 cusps, anthers spur glabrous; fruit smooth, seeds 10–15, oblong, 2 mm long... *Pachycentria constricta* (Bl.) Bl. (18)
  2. Calyx with 4 triangular lobes (c. 1 mm long), anther spur often pilose; fruit papillose-muricate, seeds more than 25, ovate, c. 0.75 mm long... *Pachycentria microsperma* Becc. (20).
1. Inflorescence of few flowered cymes up to 1.5 mm long, or of solitary flowers; blades obovate to sub-orbicular, 1.5–3 cm long, 1–2 cm wide, ovules 6–8 in each locule... *Pachycentria maingayi* (Cl.) Maxw. (19).

18. *Pachycentria constricta* (Bl.) Bl., Flora 14 (1831) 519; *Melastoma constrictum* Bl., Bijdr. Flor. Ned. Ind. 17 (1826) 1049; *Pachycentria tuberculata* Korth., Ver. Nat. Gesch. Bot. (1839–1842) 246, tab 63; King, J. As. Soc. Beng. 69 II:1 (1900) 66, Ridley, Fl. Mal. Pen. I (1922) 805 syn. by Bakh. f., Rec. Trav. Bot. Neerl. 40 (1943–45) 125, Henderson, Mal. Nat. J. 4:3 & 4 (1949) 140 and Malay. Wild Fls. I (1959) 140.

Epiphytic shrub up 100 cm tall, in trees or on rocks; lower stem and roots irregularly swollen or tuberous; upper branchlets somewhat flattened with a groove and 2 sharp ridges on each flattened side, later becoming cylindrical, smooth, red-brown furfuraceous, glabrescent, 2–3 mm thick; blades sub-coriaceous, glabrous, lanceolate, elliptic, to obovate, obtuse to acuminate at the tip (acumen up to 1 cm long), narrowed and shortly (1–2 mm) decurrent at the base; mid-nerve prominent, intramarginal nerve thin, 1–2 mm from the margin, often disappearing below the tip; secondary venation pinnate, distinct to invisible; 4–17 cm long, 1–6 cm wide; glossy green, drying greenish to olive-green, with a roughened texture above; often purplish and minutely areolate-rugose, drying tan to greenish below; petiole flattened, dorsally grooved, 5–15 mm long, 1.5–2 mm thick furfuraceous; leaf scars prominent; inflorescence a multiflowered, terminal, panicle of cymes, 2–6 cm long; axes flattened, striate, furfuraceous, often with a membranous wing, deep orange or pink to reddish; bracts and bracteoles triangular, 0.5–0.75 mm long, furfuraceous, persistent; primary axes solitary, 1.5–4 cm long with 1–3 nodes, secondary axes 7–12 mm long, tertiary axes up to 7 mm long, 4th axes not developed or up to 4 mm long, pedicels 1–1.5 mm long, red; calyx campanulate-funnelform, constricted above the globose ovary, c. 3 mm long, 2 mm wide, sparsely furfuraceous, margin truncate with 4 thickened cusps, pink, internal lines faint; bud petals dome shaped, rostrate at the tip, 3 mm long; mature petals 4, thin, oblong-obovate, acuminate and thickened at the tip, broadly clawed at the base, 5 mm long, 2 mm wide, white to pink, yellow, frequently with several colours, glabrous; stamens 8, equal, glabrous; filaments flattened, c. 2.5 mm long; anthers cylindrical, sometimes slightly curved at the rostrate tip, opening with single terminal pore, c. 2.5 mm long, pink to purple, connective with a curved, linear, whitish-cream spur (drying black), 0.5–0.75 mm long near the filament; stigma minute, style c. 6 mm long, glabrous, with a conical, glabrous, membranous sheath c. 0.75 mm long at the base; locules 4, ovules flat, 3–6 on each placenta; fruit globose — urceolate c. 5 mm long, 4–5 mm wide; areolus raised c. 1 mm, c. 2 mm wide, 4 calyx lobes

distinct; exocarp membranous, yellow to green, turning red, drying brownish with a roughened-muricate texture; seeds c. 10, oblong, c. 2 mm long; hilum grooved with a ridge on one side, about as long as the seed body; testa finely reticulate, tan.

Figure 18: a. inflorescence, calyx, style, ovary, and ovules; b. calyx and corolla bud, c. petal, d. stamen, e. seed.

Distribution: Burma, Malay Peninsula, Sumatra, Borneo, Java. Celebes.

This species is easily confused with *Pogonanthera pulverulenta* (Jack) Bl. (q.v.) which is immediately distinguished by having short auricles at the base of the blade, and setose bristles on the connective. The blades of *Pachymentria constricta* are entirely glabrous and often dry with a distinct, but minute, areolate-reticulate pattern below. Those of *Pogonanthera pulverulenta* are sparsely furfuraceous and usually dry with a roughened-papillose texture below. The fruit of *Pogonanthera pulverulenta* has a slightly raised areolus with ovoid seeds c. 0.5 mm long, while the areolus of *Pachycentria constricta* is raised about 1 mm, often giving the fruit an urceolate shape, and the seeds are oblong, c. 2 mm long.

*Penang* — Government Hill: Curtis 347 in March 1885, June 1885, in 1893, May 1898; = 347 in May 1898. Ridley = C (Curtis) 347 in July 1889; Penang Hill: Ridley sn, June 1898; Penara Bukit: Tahaya 21478; sine loc.: Goodenough 347.

*Perak* — Batu Togoh: Wray 2540; Temango: Ridley 14625; Ulu Bubong: King's collector 10569; Upper Perak: Wray 3422, 3434; sine loc.: King's coll. 1701.

*Kelantan* — Mandi Angin: Whitmore 12064; Sungei Lebir: Whitmore 4376; Sungai Lebir Kechil: Cockburn 7143; Ulu Lebir For. Res.: Suppiah 17712; Ulu Sungei Aring: Whitmore 4471.

*Selangor* — Sungei Lalang Kajang: Symington 24154.

*Pahang* — Gunong Tahan: Wray & Robinson 5327; Lubok Tamang: Henderson 11003, Robinson 10972; Sungei Sat. Ulu Tembeling: Henderson 22002; Tahan River: Ridley sn in Aug. 1891; Telom: Ridley sn in Nov. 1908; Wray's Camp: Ridley 16278.

*Malacca* — Gunong Mersing: Ridley sn.

*Johore* — Gunong Blumut: Holtum 10662, 10828; Gunong Panti: Rao 914; Suppiah 17817; Kampong Hubong, Endau: Kadim & Noor 356; Sungei Sedile, Mawai: Corner 32791; Tangong Bunga: Ridley sn in 1894.

*Singapore* — Seletar: Ridley sn in 1890; Sungei Morai: Ridley sn in 1892.

19. *Pachycentria maingayi* (Cl.) Maxw. *comb. nov.*; *Medinilla maingayi* Cl. in Fl. Brit. Ind. II (1879) 549, King, J. As. Soc. Beng. 69, II: 1 (1900) 471, Ridley, Ml. Mal. Pen. I (1922) 803, Henderson, Mal. Nat. J. 4:3 & 4 (1949) 139 and Malay. Wild Fls. I (1959) 139.

Epiphytic shrub up to 1 m tall, branches numerous, often with adventitious roots, creeping, or erect; basal roots frequently swollen and ant inhabited (myremocophylous); young branches cylindric, minutely furfuraceous, c. 1 mm

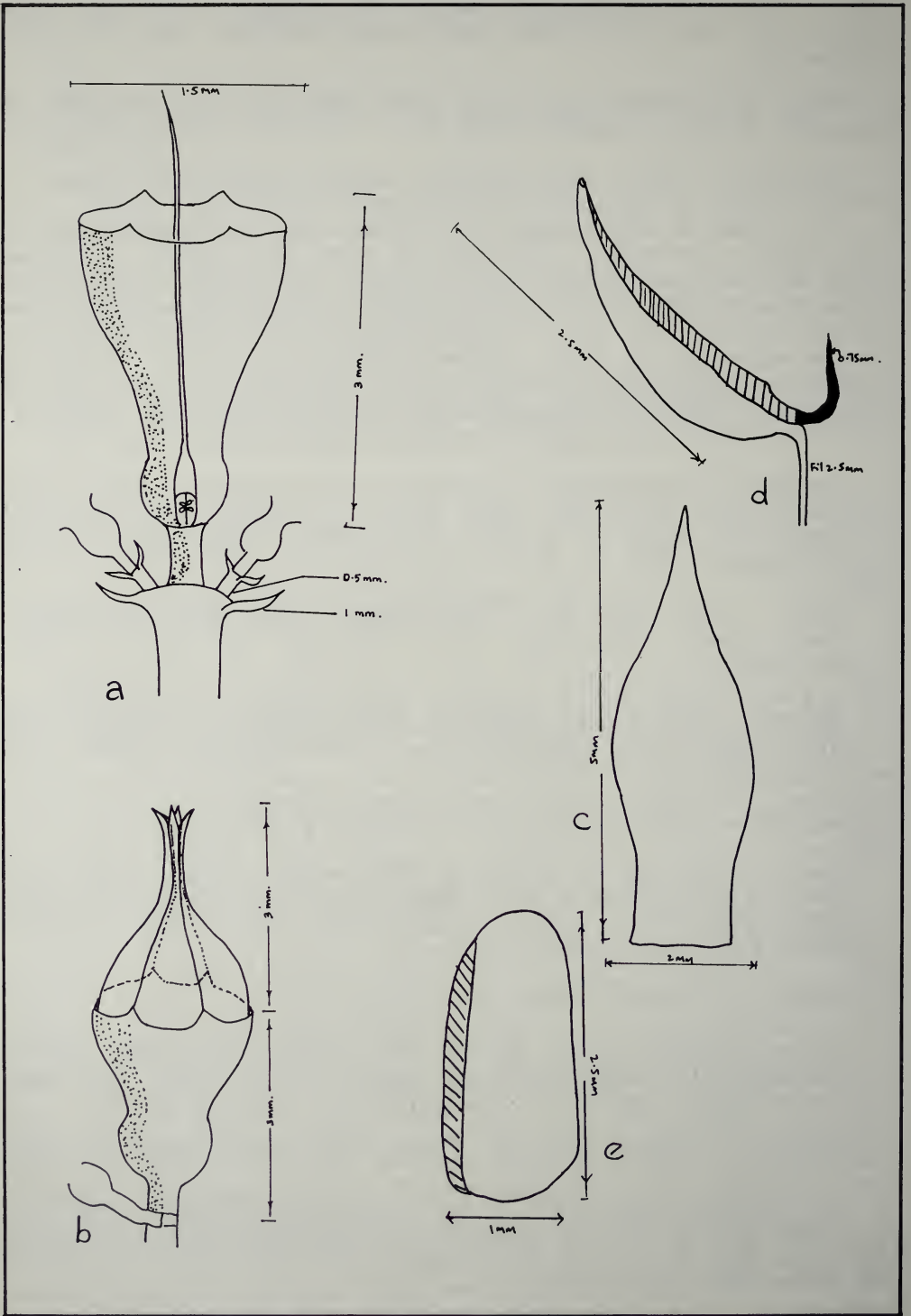


Figure 18. *Pachycentria constricta* (Bl.) Bl., a-d Curtis = 347, e Wray 3422.

thick, nodes swollen; older branches glabrous, 3–5 mm thick; epidermis smooth, drying tan to light brown; leaves opposite, numerous; blades thick coriaceous, sparsely furfuraceous, especially near the petiole, glabrescent; obovate to sub-orbicular, broadly rounded at the tip, narrowed, and decurrent at the base; mid-nerve sunken above, slightly raised below; intramarginal pair of nerves very faint to invisible, 0.5–1.0 mm from the margin; other venation invisible; 1.5–3 cm long, 1.0–2.0 cm wide; dark green above, green below, drying greenish with brown above, brown below, texture roughened on both surfaces; petiole 3–5 mm long, c. 0.75 mm thick, minutely furfuraceous, glabrescent; flowers terminal or axillary, solitary, paired, or in few flowered cymes; axes minutely furfuraceous, glabrescent, cylindrical, green; primary axes not developed or c. 1 mm long in solitary flowers, in cymes 1.0–1.5 cm long, c. 1 mm thick, with one node; secondary axes c. 1 mm long; pedicels c. 1 mm long; bracts and bracteoles ovate, acute, up to 0.5 mm long, furfuraceous; calyx campanulate, constricted above the globose ovary with a neck in between, 2.5–3 mm long, c. 1.5 mm wide, margin shortly 4 lobed with thickened cusps, red; petals 4, thin, oblong to obovate, acuminate-rostrate at the thickened tip, 3.5–4 mm long, 1.5–2 mm wide, white with red tips; stamens 8, equal; filaments flattened, c. 2 mm long, white; anthers 2–3 mm long, connective without a crest, provided with a short, thickened spur at the base, locules inappendiculate, rostrum thin and tubular, red; stigma capitate, minute; style slender, 4–6 mm long, glabrous, with a minute collar at the base; locules 4, each with 6–8 axile ovules; fruit globose, 5–6 mm diameter, capped by the raised (c. 1 mm) calyx remnant, areolus c. 2 mm wide; exocarp green turning red when ripe, pericarp soft and pulpy; seeds few, oblong, c. 2 mm long, testa shallowly reticulate.

Figure 19: a. branch tip, leaf, and calyx; b. petal, c. stamen (lateral view), d. stamen (front view).

Habitat: on various evergreen trees and bamboo, generally in shaded areas.

Distribution: central and southern Malaysia, Sumatra (east coast, rare).

*Medinilla maingayi* Cl. is, unquestionably a *Pachycentria* since it lacks extraovarian chambers and is without a connective crest and locule appendages. This species is very similar to *P. glauca* Triana found in Sumatra and Borneo (*type*: Lobb 1853 (Baccari 415), from Borneo), which has generally larger, thinner, and narrower leaves; and longer inflorescences. The flower structure of the two species is nearly the same except that *P. glauca* lacks a disc at the base of the style.

*Kedah* — Kedah Peak (Gunong Jerai): Robinson & Kloss 6055, Stone 8552.

*Perak* — Grik: I.H. Burkill 3845; Joh, Batang Padang: Henderson 10831.

*Pahang* — Pohoi River: Whitmore 362; Sungei Perting: I.H. Burkill & Haniff 16568; Tahan River: Ridley 2663; Ulu Sungai Sat: Shah & Noor 1802; Upper Perak: Wray 3781.

*Selangor* — Pahang Track: Ridley 8621.

*Malacca* — Gunong Mersing; Ridley sn on 7 June 1892; sine loc.: Maingay 807 (2960) (*syntype*).

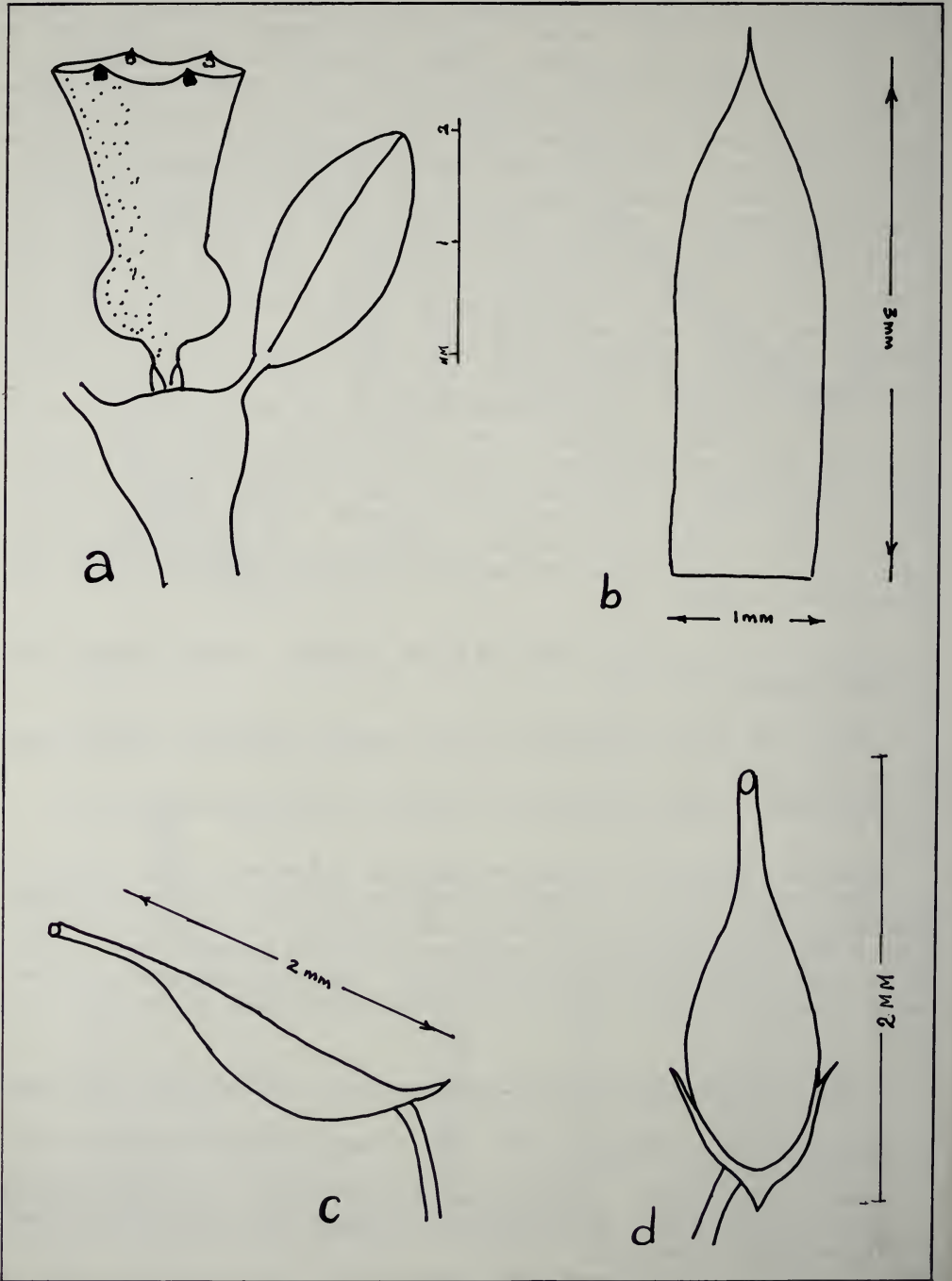


Figure 19. *Pachycentria maingayi* (Cl.) Maxw., a-d Maxwell 76-785.

*Johore* — Bukit Banang: Ridley sn in Nov. 1900; Gunong Panti: H.M. Burkill 3426, Ridley sn in Dec. 1892; Lombong Batu, Mersing: Tan sn; Mersing-Endau Road: Purseglove 5506; Rengam For. Res.: H.M. Burkill 1793; Sedenah: Ridley sn in 1908; Tana Runto: Ridley sn in 1890.

*Singapore* — Goodenough sn on 14 April 1890, Maingay 806 (3329) (*syntype*), Maxwell 76-825; Ridley 1652, 2018, sn in June 1889, Aug. 1889, in 1894.

20. *Pachycentria microsperma* Becc., *Malesia* II (1884) 238 and tab 58 fig. 1-9; Cogniaux in DC. *Monogr. Phanero.* 7 (1891) 609; Merrill, J. *Str. Br. Roy. As. Soc.* 86 (1921) 449; Bakh. f., *Rec. Trav. Bot. Neerl.* 40 (1943-45) 123.

Epiphytic shrub up to 2 m tall; branchlets slightly compressed and bluntly 4-angled, becoming cylindrical, smooth, minutely furfuraceous and glabrescent, c. 2 mm thick, drying tan; nodes distinct with prominent leaf scars; blades subcoriaceous to fleshy coriaceous, glabrous, lanceolate to oblong, acuminate at the tip (acume nc. 1 cm long), acute and decurrent at the base; mid-nerve with a pair of thinner nerves arising from near the base, secondary venation obscure, 7-10 cm long, 2-3 cm wide, drying olive greenish above, greenish to brownish below, surfaces often with a rugose to areolate texture when dry; petiole cylindrical with a dorsal groove, glabrous, 7-10 mm long; inflorescence terminal or axillary, composed of many-flowered paniculate cymes, 2-4 cm long, axes 4-angled, flattened, or cylindrical, glabrous; bracts and bracteoles triangular, acute, glabrous, 0.5-1 mm long, usually caducous; primary axes 1 or 2 per axil, 12-25 mm long with 1 or 2 nodes; secondary axes up to 10 mm long, 3d axes not developed or up to 5 mm long, pedicels c. 1 mm long; calyx tube funnelform above the globose base, c. 4 mm long, sparsely furfuraceous and ribbed outside, margin with 4 triangular, acute lobes, each c. 1 mm long; petals 4, lanceolate, acuminate, thin, with visible venation, c. 6 mm long, 2 mm wide, white; stamens 8, equal, glabrous; filaments flattened, c. 3 mm long; anthers oblong, c. 3 mm long, opening with a single pore at the tip of a thin rostrum, locules inappendiculate, connective with a minutely pilose or glabrous, curved spur c. 1 mm long; stigma capitate, minute; style slender, glabrous, c. 7 mm long, merging with the ovary in a basal sheath; ovules numerous in each of the 4 locules; fruit globose, c. 5 mm wide, with a thin neck c. 2 mm long, 1.5 mm wide, and the calyx remnant at the top, calyx remnant c. 2 mm wide with 4 inflexed lobes; exocarp thin, papillose-muricate, pale yellow turning red when ripe, drying blackish; seeds numerous, ovate, c. 0.75 mm long, minutely reticulate.

Figure 20: a. calyx, b. petal, c. stamen, d. fruit, e. seed.

Henderson 25242, which was collected on limestone, is the only specimen of *P. microsperma* Becc. that I have seen from the Malay Peninsula. This fruiting specimen is very similar to *P. constricta* (Bl.) Bl. (q.v.) in its vegetative characteristics, but differs in having papillose-muricate fruit with longer calyx lobes and smaller, more numerous seeds. Included in the Singapore collection are several flowering collections from Borneo annotated by Furtado as *P. microsperma* Becc. — all of which have larger calyx lobes similar to those on Henderson's specimen. The flowers otherwise are nearly identical to those of *P. constricta* (Bl.) Bl. except that Ridley sn from Bau, has a pilose connective spur. Bakh. f. notes that *P. microsperma* Becc. has smaller, ciliate petals; and a fimbriate connective spur. Main 1831, and Purseglove 4439 (collected on limestone) have both flowers and fruit, thus I have been able to get an idea of what the flowers of Henderson 25242 must have been like since the fruit and seeds of all 3 collections match.

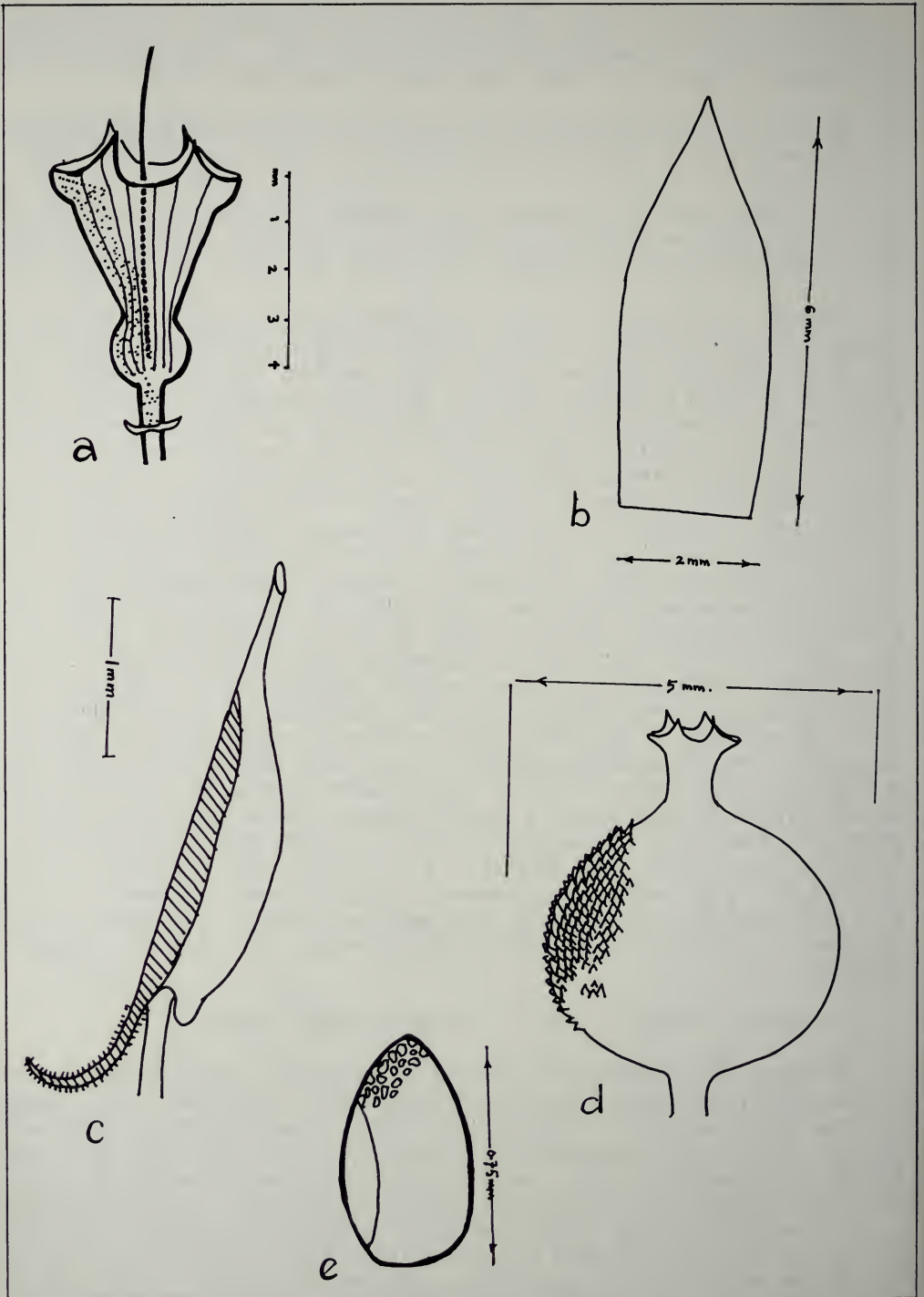


Figure 20. *Pachycentria microsperma* Becc., a-c Ridley sn, Bau, Borneo; d & e Purseglove 4439.

While these collections of *P. microsperma* Becc. may not exactly fit the description given by Bakh. f., they are distinct from *P. constricta* (Bl.) Bl. More work on *P. microsperma* Becc. is necessary since I am not exactly certain of its relationship with *P. constricta*. I have not seen any authentic collections *P. microsperma* Becc.

Pahang — Bukit Cheras: Henderson 25242.

### POGONANTHERA Bl.

Blume, Flora 14 (1831) 520 and Bijdr. Nat. Wet. 6 (1831) 261; Naudin, Ann. Sci. Nat. ser. III: 15 (1851) 302; Triana, Trans. Linn. Soc. 28: 1 (1871) 89; Clarke in Hk. f. Fl. Brit. Ind. II (1879) 550; Cogniaux in DC. Monogr. Phanero. 7 (1891) 609; King, J. As. Soc. Beng. 69, II:1 (1900) 65 (Mat. Fl. Mal. Pen. 473); Ridley, Fl. Mal. Pen. I (1922) 805; Bakh. f., Rec. Trav. Bot. Neerl. 40 (1943-45) 127, Henderson, Malay Nat. J. 4:3 & 4 (1949) 139 and Malay. Wild Fls. I (1959) 139.

Several species and varieties have been described, but according to Bakh. f. l.c. 128 there is only one polymorphic species which is found in the Malay Peninsula, Philippines, and the Malay Archipelago.

*Pogonanthera pulverulenta* (Jack) Bl., Flora 14 (1831) 521. *Melastoma pulverulenta* Jack, Trans. Linn. Soc. 14 (1825) 19. *Pogonanthera pulverulenta* (Jack) Bl. var. *grandiflora* Miq., Fl. Ned. Ind. I (1855) 553; *Pogonanthera reflexa* (Reinw. ex Bl.) Bl., l.c. 521, *Melastoma reflexa* Reinw. ex. Bl., l.c. 521; *Pogonanthera reflexa* (Reinw. ex Bl.) Bl. var. *squamulata* Korth. ex. Bl., Mus. Bot. Lugd.-Bat. I:2 (1849) 24; *Pogonanthera squamulata* (Korth. ex Bl.) Bl., l.c. (1849) 24, nomen. *Pternandra parasitica* Finl. & Wall. (Wall. cat. 4086, A & B).

Epiphytic shrub up to 1.5 m tall, on rocks or trees; branches cylindrical, often slightly 4-angled, densely red-brown furfuraceous, glabrescent, 2-3 mm thick; older branches smooth or with scattered pustules, mostly glabrous, up to 8 mm thick, bark grey-brown, thin, nodes prominent; leaves opposite; blades fleshy coriaceous, lanceolate, oblanceolate, elliptic, to obovate; at first minutely furfuraceous, glabrescent; acute to acuminate at the tip, narrowed and in larger blades shallowly (1-2 mm) auricled at the base; veins reddish, mid-nerve with 1 pair of very faint basal nerves (often invisible below); transverse venation obscure to invisible; 4.5-9.5 cm long, 1.0-3.5 cm wide; glossy light green drying dark brown-greenish above, tan to light brown below, texture roughened, often papillose below; petiole flattened and shallowly grooved, minutely red-brown furfuraceous, glabrescent, 5-9 mm long, 1.5-2 mm thick; inflorescence a terminal panicle of cymes, multiflowered, 5-12 cm long, spreading; axes flattened, often 4-angled, minutely red-brown furfuraceous, glabrescent; bracts and bracteoles lanceolate-ovate, acuminate, red-brown furfuraceous, 1.0-1.5 mm long; primary axes generally solitary, less frequently paired, 4-9 cm long, with 2-4 nodes; secondary axes 1-3.5 cm long with 2-3 nodes, tertiary axes 1-2.5 cm long with 1-3 nodes, 4th axes not developed or 1-4 mm long; pedicels 2-3 mm long; calyx campanulate c. 1 mm long, 1.5 mm wide constricted above the globose ovary which is c. 1 mm diameter, sparsely furfuraceous, red, margin truncate with 4 triangular lobes; petals 4, thin, oblong-obovate, acute at the tip, broadly clawed at the base, minutely papillose on both surfaces, 3 mm long, 1.5 mm wide, red; stamens 8, equal, white; filaments 1.5 mm long, glabrous;

anthers cylindric, slightly curved at the rostrate tip, c. 2 mm long, connective with a thickened zone near the base with numerous short bristles, locules and base of the connective inappendiculate; stigma minute, style c. 5 mm long, glabrous, with a villous, cushion-like collar at the base; septa and extra-ovarial chambers none; locules 4, ovules axile, minute, c. 25 in each; fruit globose, 5–6 mm diameter, capped by the distinctly raised (c. 0.5 mm) and widened calyx remnant; c. 3 mm wide; exocarp thin, smooth, green turning orange red, drying brown to black; seeds numerous, ovate, obtuse at both ends, c. 0.5 mm long, hilum concave; testa finely reticulate.

Figure 21: a. calyx, b. petal, c. stamen, d. style, collar, and ovary.

Distribution: Malay Peninsula to New Guinea, Philippines; recorded on limestone.

*Pachycentria constricta* (Bl.) Bl. (q.v.) is in most ways quite similar, but differs in having acute blade bases without auricles and the connective is without bristles, but has a basal spur. The blades of *P. constricta* are entirely glabrous and often dry with a smooth, minutely areolate pattern below. The fruit of *P. constricta* has an areolus c. 1 mm high and oblong seeds c. 2 mm long.

*Penang* — Pantai Aceh: Hardial 684; Waterfall Garden: Whitmore 20519.

*Perak* — Gunong Laba: Whitmore 0586; Larut: King's collector 3793; Lengong: Everett 14536; Pangkor Island; Whitmore 3010.

*Selangor* — Ulu Langat: Gadoh 834, 1683.

*Pahang* — Gunong Lesong For. Res., Rompin: Lindong 80964; Sungai Tahan: Shah 1405.

*Johore* — Bukit Badak: Hassan & Kadim 29; Gunong Blumut: Shah & Samsuri 2181; Bukit Paloh Estate: Shah & Kadim 372; Gunong Panti: Ahmad 319, Cockburn 7850, Jumali 4279 K6732, J. & K. K1019, Stone 4784; Kota Tinggi: H.M. Burkill 1817; Pulau Pemanggil, Bukit Batu Bau: Noor & Samsuri 21; Rengam For. Res.: H.M. Burkill 1790.

sine loc.: Franck 1003.

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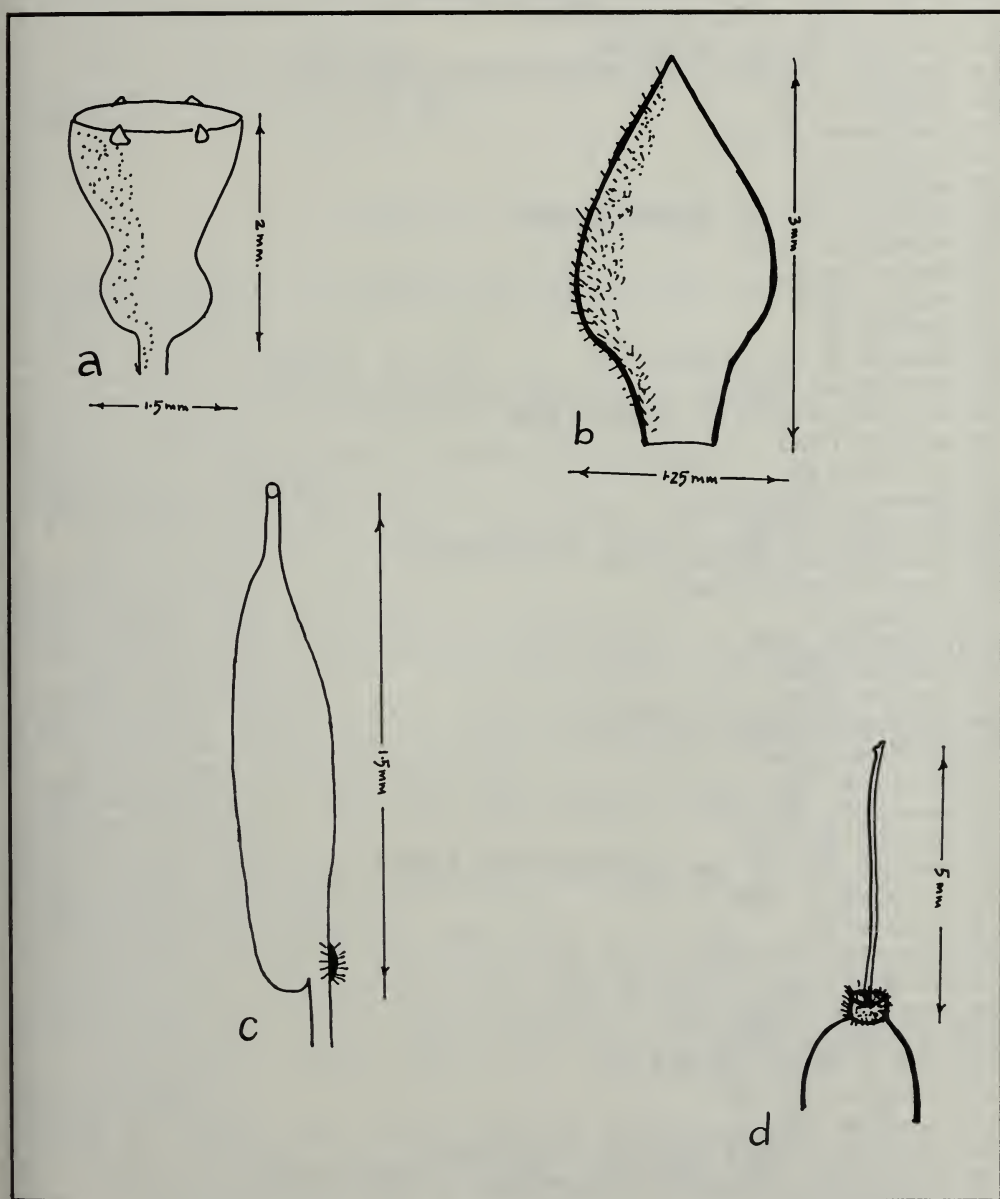


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 Tahaya 21478 (18)  
 Tan sn, Lombong Batu, Johore (19)  
 UNESCO 629 (14)  
 van Balgooy 2648 (2)  
 van Beusekom & Phengkhilai 987 (8)  
 Wallich cat. 4084 (4), 4086 (10)  
 Watson 11515 (17)  
 Whitmore 362 (19), 413 (11), 0586 (21), 0640 (4), 0850 (4), 3010 (21), 3306 (2),  
 4376 (18), 4471 (18), 8636 (11), 10290 (2), 12064 (18), 12149 (11), 12189 (2),  
 12301 (4), 12363 (2), 12608 (4), 12902 (15), 15464 (2), 15487 (15), 15496 (2),  
 15541 (3), 15566 (17), 15575 (15), 20519 (21), 20662 (2)  
 Williamson sn from Cameron Highlands, Pahang in Jan. 1932 (15)  
 Wray 268 (15), 378 (2), 391 (11), 397 (15), 412 (2), 700 (17), 1739 (11), 1821 (9),  
 1843 (4), 2540 (18), 3218 (13), 3422 (18), 3434 (18), 3781 (19), 3831 (2),  
 4084 (2)  
 Wray & Robinson 5312 (2), 5327 (18), 5396 (2)

#### ADDITIONAL COLLECTIONS

- Abdul 96 (17)  
 Carrick 601 (21), 663 (21)  
 Chin 201 (8), 243 (2), 275 (17), 528 (4), 1595 (11)  
 Kassim 8043 (21)  
 Lowry sn KLU 9017 (4)  
 Merton 4170 (3), 4171 (17)  
 Poore 225 (13), 525 (17), 698 (4), 756 (2), 1086 (21), 1242 (17), 4641 (4)  
 Rohani sn Fraser's Hill, Pahang on 17 June 1972 (11)  
 Siew Wei Hoe 21 (12), 182 (2), 294 (2), 399 (2)  
 Smith 504 (19)  
 Soepadmo 901 (18), 9051 (11)  
 Soepadmo & Mahmud 9051 (11)  
 Stone 2703 (19), 5641 (2), 5644 (3), 5670 (3), 5831 (18), 6031 (2), 6266 (11), 6486  
 (17), 7226 (3), 7228 (2), 8326 (17), 8386 (2), 8430 (12), 8552 (19), 8610 (19),  
 8758 (17), 9602 (17), 10738 (2), 11648 (4), 11762 (11), 12346 (12)  
 Univ. Malaya 8026 (3)

# THE INFLUENCE OF SUCROSE ON TISSUE CULTURES OF *ONCIDIUM GOLDIANA*, *DENDROBIUM ALICE SPALDING* AND *ARANTHERA BEATRICE NG*

by

\*IRAWATI

## INTRODUCTION

Tissue culture today plays an important role in the production of orchid clones throughout the world. This technique applied to orchid plants by Morel (1960) is still being perfected by other research workers. Research workers have used a wide range of media for their cultures but the perfect medium for each stage of orchid culture has still to be found.

This work is done to determine the beneficial or detrimental effects of sucrose in the culture medium.

## LITERATURE REVIEW

Many orchid hybrids have been successfully propagated by the tissue culture technique and various media have been used.

In most media, sugar (sucrose) is the source of energy. However, Kunisaki et. al. (1972) found that proliferating bodies and greener cultures of *Vanda* were obtained in medium devoid of sucrose. Singh (1976) mentions that in media containing lower concentration of sucrose and naphthalene-acetic-acid, growth was better than in media which contained the higher concentrations. Teo et. al. (1973), reports that better proliferation and greener tissues of strap-leafed *Vanda* were obtained on media devoid of sucrose but which had 15% by volume of coconut water incorporated in it. Hildebrandt and Riker (1953) working with callus tissue of marigold, sunflower and tobacco, found that 2 percent of sucrose was most beneficial for the tissue. Valmayor (1974) working on orchid embryo culture used 2 percent sucrose while Gamborg (1975) suggest a concentration of 2-4 percent.

Singh (1976) working with a range of media, observed that *Dendrobium* tissue cultures showed a better response in Vacin & Went and Knudson's C media when compared with other media.

Street (1973) mentioned that White & Kordan were able to culture callus of lemon fruit and isolated vascular cambia in the presence of a sugar and mineral salts alone, while Goh (1972/3) observed an enhancement in the rates of protocorm proliferation and subsequent differentiation with the use of growth regulators. Earlier workers have incorporated various growth regulating substances in the culture media. Scully (1976), Street (1973) and Singh (1976) used naphthalene-

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acetic-acid, while Steward and Button (1975) used 2,4 dichlorophenoxy-acetic-acid and 6-benzyl aminopurine. Gamborg (1975) found that thiamine was essential for the plant tissue cultures and Arditti (1974) modified Knudson's C by adding microelements to obtain better results.

To increase the availability of iron in the cultures, Murashige and Skoog (1962) added Na<sub>2</sub>EDTA to FeSO<sub>4</sub> and noted that the resultant FeEDTA was beneficial to the tobacco tissue cultures.

Oxidation of endogenous phenolic compounds often does limit the successful growth of cultures as observed by Morel (1974) while working with *Phalaenopsis* tissue cultures and Goh (1972/3) while working with *Aranda*. Lindemann et. al. (1970) suggest that the tissue should be cut under sterile distilled water to reduce the oxidation of the phenolic compounds. Reinert and Bajaj (1977) found that immersion of the tissue of coffee in an isotonic medium and antioxidant further prevented the oxidation of phenolic compounds. The antioxidant used was ascorbic acid, diethyldithiocarbamate, L cysteine HCl, dithiothreitol or Cleland's reagent and glutathione or mercaptoethanol. Meiklejohn (1953) mentioned that ascorbic acid acts as an antioxidant by providing a supply of readily available hydrogen.

#### MATERIAL AND METHODS

Three orchid hybrids growing at the Botanic Gardens were chosen for the experiment, they are:

- a. *Oncidium* Goldiana (*Onc. flexuosum* X *Onc. sphacelatum*).
- b. *Dendrobium* Alice Spalding (*Den. tokai* X *Den. undulatum*).
- c. *Aranthera* Beatrice Ng var. Conference Gold (*Renanthera storiei* X *Arachnis* Ishbel).

Young shoots of the *Oncidium* and *Dendrobium* hybrids about 10 cm long and 15 cm stems of the upper part of *Aranthera* hybrids were cut from their parent plants. The leaves and sheaths were removed carefully from the shoots/stems, to expose the axillary buds. The apical part of the shoot was removed as only the axillary buds were used in this experiment.

The stem portion with the axillary buds was then surface sterilized using a 10% solution of commercial chlorox, for a period of 15 minutes. Explants about 4 mm cubes of tissue which included the axillary bud, were aseptically cultured in the different media. The buds were cultured in 60 ml test tubes which contained 4 ml of culture media.

To prevent the oxidation of *Aranthera* tissues, the excision of explants was done with the stems submerged in sterile ascorbic acid solution having a concentration of 2.5%.

Liquid Vacin & Went medium and Knudson's C medium with or without sucrose were used. Vacin & Went medium was modified with 5 ml/l of a stock solution containing 5.57 g FeSO<sub>4</sub>·7 H<sub>2</sub>O and 7.45 g Na<sub>2</sub>EDTA per liter H<sub>2</sub>O; 1 mg/l NAA; 1 mg/l Thiamine; 0.2 mg/l 2,4-dichlorophenoxy acetic acid and 0.2 mg/l Benzyl adenine to encourage proliferation of tissues, while Knudson's C media had microelements incorporated as suggested by Arditti (1974). The experiment was arranged in randomized block design with 10 replicates for each treatment.

Growth measurements were made every 2 weeks to determine an increase in the volume of the tissues. Observations were also made on the colour of the tissues and a colour range of 0-4 was used (0 for brownish/dead; 1 - whitish/yellowish; 2 - light green; 3 - green; 4 - dark green).

Each tube containing an axillary bud was placed on an agitator and subjected to 40 agitations per minute for 16 hours per day. The cultures were exposed to continuous illumination of about 200 foot candles and a temperature of 27°C.

### RESULT

After a period of 11 weeks some of the *Oncidium* and *Aranthera* Beatrice Ng cultures survived. The percentages of survival are given in tables I and II.

TABLE I.  
*ONCIDIUM* GOLDIANA

	Modified Vacin & Went	Modified Knudson's C
+ sucrose	20	80
- sucrose	70	66.6

TABLE II.  
*ARANTHERA* BEATRICE NG VAR. CONFERENCE GOLD

	Modified Vacin & Went	Modified Knudson's C
+ sucrose	50	100
- sucrose	60	88.9

The surviving *Oncidium* Goldiana cultures did not show a significant difference between the 4 kinds of media both in size or colour (F test significant for 5% level).

However in *Aranthera* Beatrice Ng cultures there was a significant difference in their size and colour as given in table III.

TABLE III.  
THE MEAN SIZE (MM<sup>3</sup>) AND MEAN COLOUR SCORE OF  
*ARANTHERA* BEATRICE NG CULTURES

Treatment	Mean size (mm <sup>3</sup> ) (*)	Mean colour score (*)
Vacin & Went + sucrose	20 a	18. a
Vacin & Went - sucrose	32 ab	1.17 a
Knudson's C + sucrose	45 b	3.88 bb
Knudson's C - sucrose	41 b	4 bb

\*) the same letter means no significant difference.

It can be seen that in respect of mean size (mm<sup>3</sup>) and colour there is no significant difference in both media by adding or deleting sucrose, but they showed a significant difference in size (at 5% level) between Knudson's C media (with or without sucrose) and Vacin & Went media with sucrose.

However the two media (with sucrose or without sucrose) showed a high significant difference in their colour (F test of significance at 1% level).

### CONCLUSION

It was observed that there is no significant difference by including sucrose in the two kinds of media tried for the three orchid hybrids. It is perhaps that the sucrose content of the coconut water used in these media was sufficient for growth of the orchid culture at that stage.

The significant different was found in *Aranthera* Beatrice Ng between Knudson's C media (with or without sucrose) and Vacin & Went with sucrose. Colour showed a high significant difference between the two media (with or without sucrose).

### ACKNOWLEDGEMENT

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# THE INFLUENCE OF SOME GROWTH SUBSTANCES ON INDUCTION OF ROOTS AND SHOOTS OF RENANOPSIS LENA ROWOLD

by

\* SRI HARJOETI HARTONO

## INTRODUCTION

*Renanopsis* Lena Rowold (*Renanthera storiei* X *Vandopsis lissochiloides*) first raised in Hawaii by Oscar M. Kirch in 1948, is found growing at the Singapore Botanic Gardens. It is a monopodial type orchid with a thick woody stem. The plant produces large attractive inflorescences having dark red flowers with light orange markings. The inflorescences, often branched are about 100–135 cm long and each bears about 45–70 flowers.

Unfortunately, most of *R. Lena Rowold* plants do not produce sufficient roots along the stem and thus vegetative propagation by the normal method of cuttings is not possible. Monopodial orchids usually produce aerial roots along the stem and this is an important feature for vegetative propagation as cuttings made for propagation must have roots.

The aim of the experiment conducted at the Singapore Botanic Gardens recently was to promote the growth of shoots and roots by the application of growth substances on top cuttings, base cuttings and whole plants.

## LITERATURE REVIEW

Plant propagation through shoot and root induction has been investigated by previous workers on various types of plants.

Hartmann et. al. (1956) reported that synthetic root-promoting chemicals which have been found most reliable in stimulating adventitious root production in cuttings are 3-indolebutyric-acid (IBA) and naphthalene-acetic-acid (NAA); while Bowen et. al. (1975) found that IBA and NAA increased the number of roots and reduced the time taken for the first roots to develop on cuttings of *Pinus contorta* Dougl. Warmke (1950) observed that application of IBA and NAA on distal or proximal part of root cuttings of *Taraxacum officinale* Weber and *Chicorium intibus* L. stimulated abundant root formation. Kunisaki (1975) reported that a cytokinin, 6-(benzylamino)-9-(2-tetrahydropyryonyl)-9H-purine (PBA), promoted shoot emergence on the stem bases of *Ascocenda*, a monopodial orchid; while Stewart et. al. (1977) observed that another cytokinin, benzyl adenine (BA) induced the growth of lateral buds at the base of plant species of *Paphiopedilum* and its hybrids.

Scheaffers (1970) reported that axillary buds of tobacco under apical suppression are stimulated by benzyl adenine (BA) when applied in a lanolin paste or in an aqueous solution.

## MATERIAL AND METHODS

Three trials were conducted using plants of *R. Lena Rowold* (fig. 1) and in each trial, the growth substances were applied to a different part of the plant. The method of application was also different in each of the three trials.

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The treatments for all the trials were arranged in a Completely Randomized Design with five replicates for each treatment in trials I and II and four replicates for trial III as there was a shortage of plants.

### *Trial One*

Top cuttings measuring about 40 cm in length were dipped in the various growth substance solutions for a period of three minutes. For uniformity, the cuttings were dipped up to and including the second nodal area.

- Treatments: A — 5000 ppm naphthalene-acetic-acid.  
B — 5000 ppm indole-butyric-acid.  
C — 5000 ppm naphthalene-acetic-acid. +  
5000 ppm indole-butyric-acid.  
O — control.

The cuttings after treatment were planted in pots using a potting media of broken bricks and charcoal chips. Weekly observations were made to record the dates of root formation, the number of developing roots and their lengths. (Fig. 2 and 3).

### *Trial Two*

The basal portion of the potted plants from which the top cuttings had been used for Trial One were used for Trial Two. A wad of cotton wool soaked in the growth substance solutions was placed on the top of the cut surface and secured with the aid of rubber bands after covering the cotton wool wad with a small inverted polythelene bag. (Fig. 2 and 3).

- Treatments: A — 100 ppm benzyl adenine.  
B — 2500 ppm indole-butyric-acid + 100 ppm benzyl adenine.  
C — 2500 ppm naphthalene-acetic-acid +  
100 ppm benzyl adenine.  
O — control.

The cotton wool wads were removed 24 hours later and weekly observations were made to record the dates of shoot formation, the number of developing shoots and their lengths.

### *Trial Three*

Plants which varied in height from 80–140 cm were inoculated with the various growth substance solutions with the aid of a hypodermic needle. For each treatment, 5 ml of the solution was used and this was inoculated into the nodal areas of the sixth to the ninth leaf. Inoculation of the solution was extremely difficult as the stem was hard and the bulk of the solution ran down the stem of the plant.

- Treatments: A — 100 ppm naphthalene-acetic-acid.  
B — 250 ppm naphthalene-acetic-acid.  
C — 100 ppm indole-butyric-acid.  
D — 250 ppm indole-butyric-acid.  
E — 100 ppm naphthalene-acetic-acid +  
100 ppm indole-butyric-acid.  
F — 250 ppm naphthalene-acetic-acid +  
250 ppm indole-butyric-acid.  
O — control.

Weekly observations were made to record the dates of root formation, the number of developing roots and their lengths.

## RESULTS

Final results obtained at the end of a 14 weeks period are tabulated in tables I and II.

*Table I:* Number of roots produced (14 weeks).

Replicates Treatments	I	II	III	IV	V	Total	Average
A	6	5	3	2	9	25	5.0
B	2	2	2	5	2	13	2.6
C	4	3	7	3	2	19	3.8
O	0	2	4	3	1	10	2.0

By Fisher test of hypothesis for 95% level, number and length of roots recorded at the end of a 14 week period do not show any significant difference between treated and untreated plants. It is however observed that the treatment with 5000 ppm NAA produced the highest number of roots (Fig. 4 and 6), when compared with other treatments and the lowest number of roots was seen in the control (Fig. 4 and 6).

*Table II:* Average length of roots in mm (14 weeks).

Replicates Treatments	I	II	III	IV	V	Total	Average
A	82.0	38.4	61.6	3.5	75.0	260.5	52.1
B	115.0	82.5	37.5	63.0	75.0	373.0	74.6
C	56.7	13.3	51.0	68.3	8.0	197.3	39.5
O	—	60.0	5.2	45.0	15.0	171.2	34.2

The highest average length of roots is seen on the plants treated with 5000 ppm IBA (Fig. 5). Combination of 5000 ppm NAA and 5000 ppm IBA does not show any better effect on length of roots than the two other single application while number of roots produced is slightly higher than the treatment with 5000 ppm IBA and the control. Untreated plants do produce roots but have the lowest number of roots and these also have the lowest length average (Fig. 4 and 6).

### *Trial Two*

Final results obtained at the end of a 14 week period are tabulated in tables III and IV.



Fig. 1.

A potted plant of *Renanopsis* Lena Rowold. Roots are not found growing along the length of the plant.



Fig. 2.

*Left* — Top portion of plant used for Trial One.

*Right* — Basal portion of plant used for Trial Two.



Fig. 3.

*Left* — Trial One, top portion of plant potted after treatment.

*Right* — Trial Two, basal portion of plant with wad of cotton wool secured at the top.



**Fig. 4. Trial One.**  
*Left* — untreated.  
*Right* — treated with 5000 ppm NAA.



**Fig. 5. Trial One.**  
*Left* — treated with 5000 ppm IBA.  
*Right* — treated with 5000 ppm NAA  
 and 5000 ppm IBA.



**Fig. 6.**  
 Trial One.  
 Control and treatments A,B,C.



**Fig. 7.**  
 Trial Two.  
 Abnormal growth of roots on the  
 plants treated with 2500 ppm NAA  
 combined with 100 ppm Benzyl —  
 adenine.

Table III: Number of shoots (14 weeks)

Replicates Treatments	I	II	III	IV	V	Total	Average
A	1	0	0	2	1	4	0.8
B	4	0	0	0	0	4	0.8
C	0	2	1	0	2	5	1.0
O	0	1	1	1	1	4	0.8

Table IV: Average length of shoots in mm (14 weeks)

Replicates Treatments	I	II	III	IV	V	Total	Average
A	30.0	—	—	18.0	60.0	108.0	21.6
B	3.7	—	—	—	—	3.7	0.7
C	—	2.0	—	2.0	2.0	6.0	1.2
O	—	30.0	60.0	3.0	40.0	133.0	26.6

Results obtained at the end of a 14 week period do not show any significant difference between the various treatments and control. It is however observed that plants treated with 2500 ppm naphthalene-acetic-acid combined with 100 ppm benzyladenine produced abnormal growth of roots. The roots produced are about three times thicker than the normal (Fig. 7).

#### Trial Three:

Final results obtained at the end of a 14 week period are tabulated in tables V and VI.

Table V: Number of roots produced (14 weeks).

Treatments Replicates	A	B	C	D	E	F	O
I	1	0	0	0	1	0	3
II	1	0	0	1	1	0	0
III	0	0	0	0	0	0	3
IV	3	0	0	1	0	0	0
Total	5	0	0	2	2	0	6

Table VI: Average length of roots in mm (14 weeks).

Replicates Treatments	A	B	C	D	E	F	O
I	100.0	—	—	—	180.0	—	60.0
II	185.0	—	—	145.0	55.0	—	—
III	—	—	—	—	—	—	101.0
IV	100.0	—	—	106.0	—	—	—
Total	385.0	—	—	251.0	235.0	—	161.0

As shown in table V and VI, the number and average length of roots recorded at the end of the experiment (14 weeks) do not show any significant effect of growth substances when compared with the control.

## DISCUSSION AND CONCLUSION

It is observed that top cuttings which were soaked for three minutes in 5000 ppm of Naphtalene acetic acid produced the largest number of roots while those which were soaked in 5000 ppm indole-butyric-acid produced the longest roots though fewer roots were produced with this treatment. It has been shown that top cuttings of *Renanopsis* Lena Rowold which have no roots along their stem can be successfully grown without the application of growth substances but the use of growth substances like naphtalene-acetic-acid and indole-butyric-acid is preferable.

It is possible that the observation period was too short and had the experiment been conducted for a longer period of time, results obtained with the various treatments may have been significant.

## ACKNOWLEDGEMENT

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# THE TRENTEPOHLIACEAE OF SINGAPORE ISLAND

by

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## INTRODUCTION

The Trentepohliaceae are a family of aerial algae, abundant in the tropics but also found in temperate regions. They grow on rocks, soil, the bark of trees, or as epiphytes or parasites of leaves. The vegetative cells may appear green if the plant is growing in the shade but they are normally brick-red in colour due to a pigment, formerly known as "haematochrome," which is a mixture of  $\alpha$  and  $\beta$  carotenes (Tischer, 1936; Czyan & Kalb, 1960) dissolved in oil droplets in the cell. Pyrenoids are absent and starch is not formed, the product of photosynthesis being apparently a polyhydric alcohol, erythritol, (Bourne, 1958) which may occur in *Trentepohlia* in up to 1.4% concentration (Tischer, 1936). As in other terrestrial algae, large vacuoles containing water are absent.

## EARLY TAXONOMIC WORK

The earliest recognisable member of this family, *Byssus Jolithus*, was described by Schwenckfelt in 1600 as "Jolithus f. Lapis violaceus" — i.e. Jolithus variety violet stone. In *Species Plantarum*, 1753, Linnaeus included a mixture of blue-green algae and fungi in the genus *Byssus*, including Micheli's *Aspergillus* and *Botrytis*. However two of the twelve Linnaean species of *Byssus* may now be placed in the genus *Trentepohlia*. These are: - (i) *Trentepohlia aurea* which Linnaeus placed in the sub-genus *Filamentosae* and described as having golden or saffron-coloured filaments, growing on rocks and lacking a smell; and (ii) *Trentepohlia Jolithus* which he placed in the sub-genus *Pulverulentae* and described as blood-coloured, like wine, growing on rocks and with the smell of violets.

The genus *Trentepohlia* was defined by Martius in 1817. In 1824 C. Agardh divided this genus into (a) *Chroolepus* with rigid, solid, torulose filaments, having a powdery nature, and (b) *Trentepohlia* with flexible filaments, bearing sporangia at the ends of their branches. Species of *Trentepohlia* were described as purple, golden or verdigris coloured, while those of *Chroolepus* varied in colour including golden, blood-coloured, yellow-brown, reddish gold, greenish red, silky rose or black. *Chr. Jolithus* and *Chr. odoratus* were said to be perfumed, smelling of violets.

In 1849 Kützing put all species, except for a few doubtful ones, into the genus *Chroolepus* and reported an additional species *Chr. hercynicum* with the smell of violets. During the second half of the nineteenth century copious literature on *Trentepohlia* (*Chroolepus*) was concerned with the structure of the zoospores, the contents of the cell, the structure of the cell wall, sporangial forms and the part played in the constitution of lichens. This literature was reviewed by Karsten in 1891.

In 1870 Millardet (*vide* Engler et Prantl, 1897) described *Phycopeltis* as a new genus which he had found on the needles of *Abies pectinata*. It resemble *Coleochaete* in structure but contained the pigment "haematochrome." *Phycopeltis epiphyton* was also found on the leaves of *Hedera* and *Rubus* in Europe. These specimens were all epiphytic. In 1877 Cunningham found a pigmented parasitic species which he called *Mycoidea parasitica*. This new genus, *Mycoidea*, was found to be synonymous with De Toni's *Hansgirgia*, and later Hariot pointed out that the genus had been described by Kunze in 1827 as *Cephaleuros*, the names *Mycoidea* and *Hansgirgia* being superfluous.

The first account of the Trentepohliaceae of S.E. Asia was made by De Wildeman in 1891. This was a report on a collection made mainly in Java, Sumatra, New Guinea and Celebes by Mme. Weber van Bosse. De Wildeman stated that the previous taxonomic work on *Trentepohlia* based on the colour and odour of filaments had been defective since these properties depend on the circumstances of collection, surrounding vegetation and degree of desiccation. He divided the genus into (i) those with cylindrical cells, and (ii) those with oval, elliptical or round cells. In this work he stated that about 40 species of *Trentepohlia* are known, of which about a dozen occur in the East Indies including three endemic species. He placed all species in the genus *Trentepohlia* and within the two divisions of the genus based species definitions on width of cell, and position and type of sporangia.

Karsten (1891) described many new species of *Trentepohlia* for Java, as well as three new species of *Phycopeltis* and six new species of *Cephaleuros*. He also reported *Cephaleuros virescens* (*Mycoidea parasitica*) from Java. In his Prodomus (1897) and Supplement (1899) De Wildman listed 21 species of *Trentepohlia* from the East Indies together with an anomalous species, *Chroolepus* (non Agardh) *amboinensis*. This new concept of *Chroolepus* was defined by Karsten in 1891 as having a thallus like *Phycopeltis* with filaments like *Trentepohlia* arising from it.

By the beginning of this century the three genera *Trentepohlia*, *Phycopeltis* and *Cephaleuros* had been well-defined; *Chroolepus* Agardh had been dropped and the doubtful genus *Chroolepus* Karsten had been created. *Trentepohlia* was used for all species having free filaments, never forming a continuous thallus. *Phycopeltis* contained those species which had a flat thallus consisting of a single layer of cells, which was never parasitic and which might bear short upright filaments but never long hairs. In *Cephaleuros* the flat thallus had one to many layers of cells; it might be epiphytic or parasitic, and it bore elongated upright filaments terminating in pedicellate sporangia or forming long hairs.

In the genus *Trentepohlia* emphasis was placed on the degree of heterotrichy. De Wildeman (1900) classified species into (a) those with reduced prostrate growth, (b) those with well-developed erect and prostrate systems, and (c) those with only a prostrate system of creeping filaments.

#### MODERN WORK

Modern work (Hariot and Printz, 1939) has divided *Trentepohlia* into three sections: - (i) *Chroolepus* (which according to Borrelly, 1966, would be better named *Trentepohlia* since it contains the type genus, *T. aurea*) which is not distinctly heterotrichous, and does not bear unicellular hairs.

(ii) *Heterothallus* with primary filaments forming a rosette like *Phycopeltis* but far less organised and regular, and bearing upright filaments like *Trentepohlia*. Karsten's anomalous *Chr. amboinensis* should be included here.

(iii) *Nylandera* in which the filaments bear cylindrical unicellular hairs as in *T. peruana* (Kütz.) Printz.

The genus *Phycopeltis* is normally divided into (i) *Phycopeltis* with a regular disc of radial filaments not bearing upright hairs, and (ii) *Hansgirgia* with irregular disc with marginal indentations and lobes, sometimes bearing upright hairs.

*Cephaleuros* (including the monospecific *Chrooderma* Fristch, fide Borrelly, 1966) has about 12 species including some dangerous parasites of tea, coffee and other plants. Although keys normally separate epiphytic and parasitic species, and those with a single layered thallus from those with a multilayered thallus, no clear division of the genus has been proposed.

*Stromatochroon* is a new genus proposed by Palm in 1934. It consists of a swollen lobed structure found in the stomatal chamber of tropical plants from which a short filament emerges through the stoma. This filament may bear a sporangium. This monospecific genus has not been reported from S.E. Asia.

Akiyama, 1971, has reviewed the taxonomic criteria used at specific level in *Trentepohlia* which in the past has been based on cell shape and size; presence of hair-like cells; the branching pattern; cell-wall features; type of cell division; size, shape, type and location of sporangia etc. Size and shape of the cell varies with both climate and season, as does the length of hair-like cells in the section *Nylandera*. Most species of *Trentepohlia* have a wide range of shape of cell and cell-size in natural populations. It was however possible to distinguish some species from one another from scatter diagrams relating cell length to breadth in Brazilian material. In the species, *Trentepohlia monilia*, there was a correspondence between Japanese and Brazilian material. (Akiyama and Hirose, 1967; Akiyama, 1971).

#### TRENTEPOHLIACEAE OF SINGAPORE ISLAND

Singapore Island is roughly diamond-shaped and has a total area of 543 sq. k. (greatest length 40 k., greatest width 24 k.). Two-thirds of the Island is below 15.3 m. elevation and a single granite mass in the centre of the Island (Bukit Timah Hill) reaches to 160 m. The Island which lies at a latitude of 1° 21' N has a typical equatorial climate with lack of seasonal variation and heavy rainfall throughout the year. More rainfall falls on the Western than on the Eastern side of the Island.

Singapore Island was originally covered with tropical lowland dipterocarpous forest. Most of this was cleared for cultivation of pepper and gambier in the second half of the nineteenth century. These plantations were soon abandoned and the cleared forest area became covered with scrubland (belukar). Since the second world war the population has risen from 700,000 to over two million, and much of the belukar area has been used for building high-rise flats, factories, ship and timber yards. In an effort to conserve water and soil as well as to improve the appearance of the city, the Government has launched a tree-planting campaign. Trees are found along all major roads and in many other open areas. These trees provide favourable habitats for the various species of *Trentepohlia*, especially in the West of the Island. Because of the activity of planters in the last century, very little primary forest remains: the two existing areas being Bukit Timah Forest Reserve and a small area in the Botanical Gardens.

Although much work was done on the Trentepohliaceae of Indonesia by De Wildeman (1891, 1897, 1899, 1900) and Karsten (1891) there have been no previous accounts of the Trentepohliaceae of Singapore Island. *Trentepohlia Jolithus* has been recorded from Gunong Jerai (Kedah Peak) by Ratnasbathapathy (1972) in Malaysia and *Trentepohlia aurea* has been found in quadrat studies in the National Park, Kuala Tahan, Malaysia (Johnson, 1969). *Trentepohlia* is, however, extremely common in Singapore especially in the wetter Western part of the Island. Tree trunks, cement drains, buildings etc. are coloured with the brick-red rusty stain of *Trentepohlia*. Sometimes it is found on banks of earth where it contrasts with the red colour of the lateritic soil. It is occasionally found on rocky outcrops but, since most of the Island is alluvial or sedimentary, these are rare. On Bukit Timah Hill, where such rocky outgrowths do occur, the light intensity appears to be too low under the cover of the primary forest for *Trentepohlia*. *Trentepohlia* is rare in the deep shade of the primary forest but it is particularly common in open situations. If it grows in permanent shade it is green not red in colour, although the red colour can be detected microscopically. In very wet places it may be found growing over both stems and leaves forming a furry mat. Its presence in Singapore lichens has not yet been investigated.

*Phycopeltis* is common on leaves in the primary forest but is not found elsewhere. It occurs indiscriminately on a large number of different species, both monocotyledons and dicotyledons, particularly in the lower shrub layer. Humidity decreases from ground to canopy level in the forest. This appears to be correlated with the disappearance of *Phycopeltis* towards canopy level. *Phycopeltis* may even be found on some fern fronds. It is easily removed from the leaf surface by a knife or needle, and its removal does not damage leaf tissue in any way. It is usually brick-red in colour (in spite of the heavy shade in the forest), but green patches of cells may occur. These appear to be old cells, rather than cells affected by shade conditions.

*Cephaleuros* is extremely rare in Singapore, in contrast to its abundance in the tea estates in Malaysia. It has only been found once in this survey.

Many specimens of *Trentepohlia* were sterile when first collected and their identity was not immediately established. However after they had been dried in newspaper and kept for a few days, they often produced sporangia which was an invaluable help in their identification.

1. *Trentepohlia aurea* (L.) Martius forms cottony patches on the rough bark of *Fagraea fragrans* and *Eugenia grandis* or is terrestrial on banks of earth. Copious branching usually occurs, the angle of branching being 60–90°. Sessile, lateral and terminal pedicellate sporangia are plentiful in most specimens. Cells are cylindrical without constriction at the cross wall with average length 30u. and average width 18u. Sporangia are approximately 25u. in diameter. These dimensions correspond with those given by Akiyama for Brazilian material (1971). (Fig. 1).

2. *Trentepohlia monilia* De Wildeman (*Physolinum monilia*) (De Wildeman) Printz; *T. moniliformis* Karsten). Forming minute colonies of filaments, each of a few cells, 10 x 12u. on bark of *Jacaranda filicifolia* and *Casuarina equisetifolia*. Cells spherical, deeply constricted at cross walls. No reproductive cells. The cells are distinctly smaller than Brazilian material (Akiyama, 1971). (Fig. 2).

3. *Trentepohlia arborum* (C. Ag.) Hariot (*T. hisporangiata* Karsten). Forming a cottony colony on the smooth bark of *Ficus benjamina* and *Acacia auriculiformis* or attached to cement drains and rocky outcrops. The filaments are well

developed and there is a distinct difference between the diameter of main and lateral branches. These may be extremely narrow and coil round the main axis when young. Cells are long and cylindrical without constrictions at the cross walls. Branching is usually at right angles. Cell size, average  $18.6 \times 46.2\mu$ . (main axis), is similar to Brazilian material. Although it may bear lateral or terminal single pedicellate sporangia, the species is best distinguished by the clustered groups of 2-5 pedicellate sporangia found at the apex of a swollen sub-terminal cell on a short side branch. (Fig. 3, 4, 5).

4. *Trentepohlia odorata* (Wigg.) Wittr. (*T. umbrina* Karsten). Forming a crustaceous or penetrating layer on drains or cement buildings, cells rounded to elliptical, with only slight constriction between them,  $9.0 \times 8.2\mu$ ., extremely powdery. Sporangia are terminal or intercalary, pear-shaped with a thick cell wall, about  $8 \times 12\mu$ ., opening by a terminal pore. Although the size and shape of cells corresponds to that recorded by De Wildeman from Java, the sporangia, while of the same form, are smaller. Javanese material was only found on the bark of trees. (Fig. 6).

5. *Trentepohlia* sp.

A specimen forming a haircoating on the bark of *Eugenia reticulata* has been found. All filaments are upright, only four to five cells long; each cell is about  $7.5-10\mu$ ., extremely small and torulose but with very thick rough wall. Sporangia appear to be terminal only. (Fig. 7).

6. *Phycopeltis treubii* Karsten.

Found on upper surface of leaves in primary forest but not elsewhere, e.g. on leaves of *Calophyllum inophyllum*, *C. pulcherrimum*, *Vitis gracillis*, *Pithecellobium dulce*, *Ficus benjamina* and *Lygodium circinnatum*. Forming irregular colonies by irregular radial growth of filaments. Each colony invaginated at margin; when colonies overlap concentric patterns are formed. Sporangia of two types (i) borne on a short filament arising at  $90^\circ$  to thallus, (ii) borne on the flat thallus by the swelling of the end cell of a filament. Cells usually red brown in colour but whole files of old cells may turn green or colourless giving a patterned effect visible to the naked eye. Cells very variable in size, about  $4.4 \times 7.5\mu$ . (This is slightly smaller than Javanese materials). Ascending filaments with four to six cells, usually narrow,  $2\mu$ ., but occasionally with a fat ascending filament  $4\mu$ . wide. Upright hairs are sparse. (Fig. 8).

7. *Cephaleuros virescens* Kunze (*C. mycoidea* Karsten; *Mycoidea parasitica* Cunn.)

On leaf of *Ixonanthes icosandra*, forming patches between the veins. Extremely difficult to remove without damaging leaf tissue. Thallus several cells thick, sub-cuticular with rhizoids fixing alga to leaf. Upright filaments breaking through cuticle and some bearing pedicellate sporangia. (Fig. 9).

#### CONCLUDING REMARKS

Although the genera *Trentepohlia* and *Phycopeltis* are common in Singapore Island in their respective habitats, there is little diversity of species. Only five species of *Trentepohlia* and one of *Phycopeltis* have been found, compared with 21 species of *Trentepohlia* and 3 species of *Phycopeltis* recorded by De Wildeman

from Indonesia. There are several reasons for this lack of diversity. The climate of Singapore is more equable than that of Indonesia and there are no definite wet and dry seasons. Species requiring temperature or humidity variations will not be able to grow. There are no mountainous regions or land over 160 m. Species like *T. Jolithus* which occur in the mountains will not be able to live here. In considering Singapore Island we are dealing with an extremely small area of only 543 sq. k. compared with the vast area of Indonesia with its numerous islands. Much of the Island is urban which reduces the variety of habitats available. The primary forest is very limited in extent. There is no limestone or calcareous rocks on which calcicoles could grow. Rocky outcrops are limited. Typical hosts of *Cephaleuros* such as tea and coffee are not grown on the Island.

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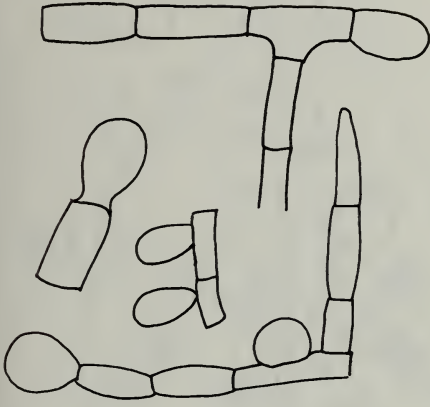


Fig. 1 *Trentepohlia aurea* (L.) Martius, filaments and sporangia (x 600)

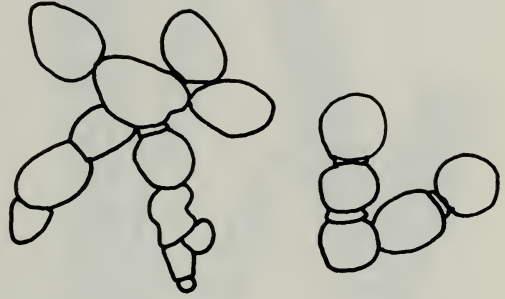


Fig. 2 *Trentepohlia monilia* De Wildeman, branching filaments (x 1,000)

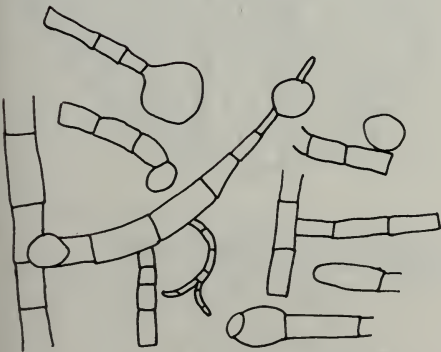


Fig. 3 *Trentepohlia arborum* (C. Ag.) Hariot, main and branch filaments of different diameters and sporangia (x 450)

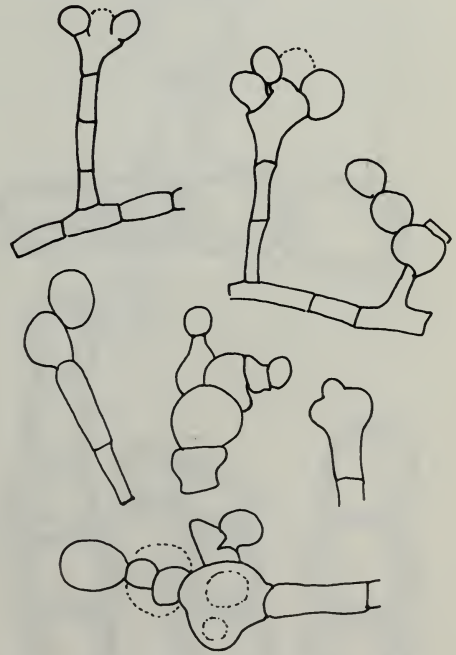


Fig. 4 *Trentepohlia arborum* (C. Ag.) Hariot, clustered groups of pedicellate sporangia on side branches. (x 450)

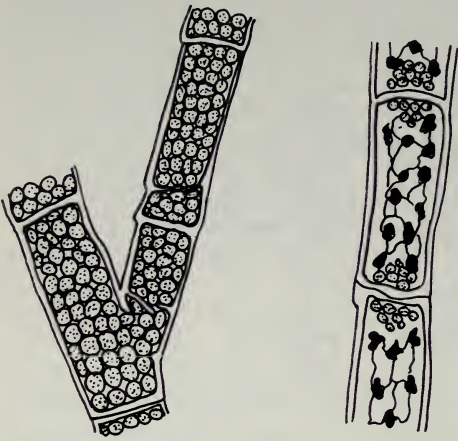


Fig. 5 *Trentepohlia arborum* (C. Ag.) Hariot, comparison of filaments in light (left) with copious production of oil drops containing carotene, and in shade (right) with few oil drops near cross wall and exposure of chloroplast. (x 1,000)

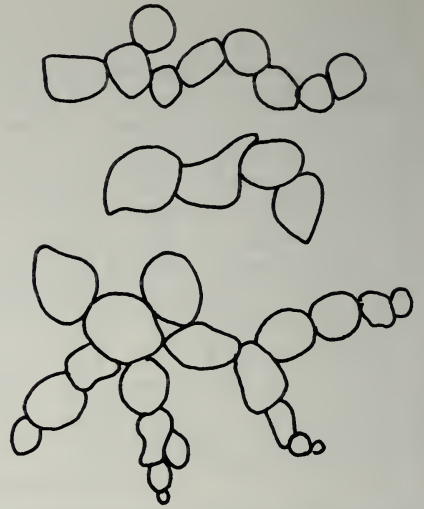


Fig. 6 *Trentepohlia odorata* (Wigg.) Wittr., branching filament with terminal sporangia (x 1,000)

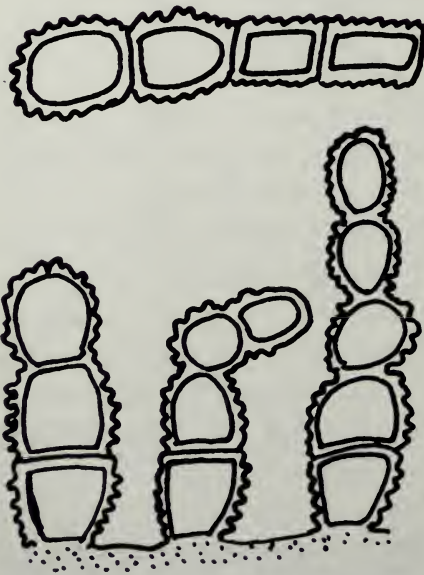


Fig. 7 *Trentepohlia* sp. found on the bark of *Eugenia reticulata* (x 1,200)

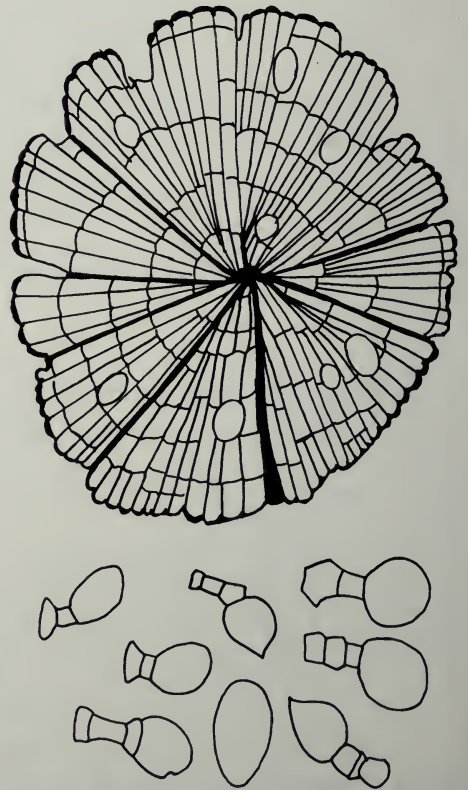


Fig. 8 *Phycopeltis treubii* Karsten, epiphytic plant on leaf (above) (x 1,000); ascending filaments (below with sporangia) (x 1,500)

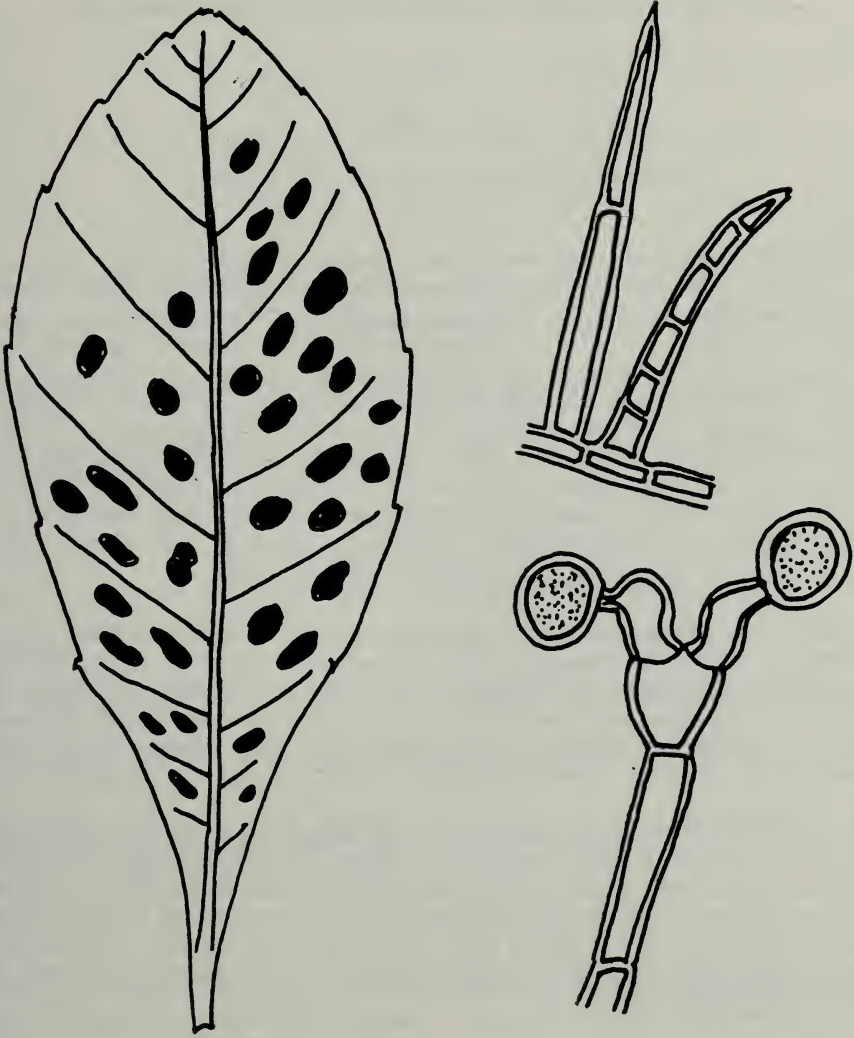


Figure 9. *Cephaleuros virescens* Kunze, parasite on leaf of *Ixonanthes icosandra* (x 1) (left); pedicellate sporangia and hairs (x 1,500).

## ANNOTATED LIST OF ALGAE OF SINGAPORE (I)

by

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The algae as a group has been grossly neglected in Singapore. To date the only taxonomic works available are those on euglenoids (Prowse, 1958; Skvortzov, 1968), diatoms (Prowse, 1962a), freshwater flagellates (Prowse, 1962b) and desmids (Prowse, 1957; 1969). The most comprehensive non-taxonomic study is that by A. Johnson (1973b) who recorded a total of 141 species of Chlorophyceae, 7 species of Xanthophyceae, 12 species of Chrysophyceae, 30 species of Bacillariophyceae, 9 species of Cryptophyceae, 15 species of Dinophyceae, 1 species of Chloromonadineae, 48 species of Euglenophyceae, 28 species of Cyanophyceae and 13 species of 'Zoomastigophora', all from the University of Singapore pond. In a further paper, on the distribution of freshwater algae (including the University of Singapore pond), A. Johnson (1978) recorded a total of 379 species from the various classes, 75 more than her previous communication.

Other studies on local algae include those occurring in other freshwater ponds (A. Johnson, 1966; D.S. Johnson, 1972); in soils (A. Johnson, 1962; 1973a); and in miscellaneous habitats (A. Johnson, 1974/75; A. Johnson & Awan, 1972). Studies on marine algae are limited, and these include those by Weber (1913-1928); Burkill *et al.* (1968); A. Johnson (1958, 1976); Lee, L.M. (1968); Lee S.K. (1966); Purchon & Enoch (1954); and Ku (1969).

It is the intention of this paper to list all species of algae that have been reported for Singapore, together with their locality, based essentially on the above-listed literature as well as on unpublished studies of this Department. Collections made by the Botanic Gardens are also included. Because of the limited taxonomic studies on algae, this list would, I am sure, prove to be useful to current as well as future researchers. For convenience, taxonomic arrangements generally follow Fritsch (1971, 1972).

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## 1. CYANOPHYCEAE

The cell contains no proper chromatophore, the photosynthetic pigments being diffused through the peripheral cytoplasm. Pigments include chlorophyll carotene, phycocyanin, and phycoerythrin. The colour of the cell is usually blue-green. Sugars and glycogen are the common products of photosynthesis. The cell is simple and does not contain a nucleus. All members have a membrane around the cell. Propagation is by simple division or other vegetative means.

The Class is divided into five orders of which four occur locally:

- 1.1. *Chroococcales*. Plants are unicellular, or where colonial, these are commonly palmelloid. Multiplication is by cell divisions and the formation of endospores.
- 1.2. *Chamaesiphonales*. Mainly unicellular or colonial epiphytes or lithophytes. Multiplication is by endospores or exospores.
- 1.3. *Nostocales*. Filamentous, often showing false branching. Heterocysts are commonly present, often with hormogones, hormocysts or akinetes.
- 1.4. *Stigonematales*. Filamentous, with true branching or dichotomous branching, often showing heterotrichous condition.

## 1.1. CHROOCOCCALES

## \* Key to the Genera

1. Cells with pseudofilamentous growth, of gelatinous, hemispherical or irregularly folded hollow thallus ..... *Placoma*
1. Cells unicellular or forming colonies, not forming filament-like growth ... 2
  2. Cells single, or a few together in a shapeless colony ..... 3
  2. Cells many in a single colony ..... 7
3. Cells spherical ..... 4
3. Cells elongate ..... 6
  4. Without individual mucilage envelope ..... *Synechocystis*
  4. With a distinct envelope ..... 5
5. Sheath vesicular ..... *Gloeocapsa*
5. Sheath not vesicular ..... *Chroococcus*
  6. Cell division transverse, with a firm vesicular sheath ..... *Gloeotheca*
  6. Cell division transverse, without such a sheath ..... *Synechococcus*
7. Cells without any regular or definite arrangement ..... 8
7. Cells with definite arrangement in distinct colonies ..... 13
  8. Cells in an amorphous mucilage, with or without a few distinct sheaths round the individual cells ..... 9
  8. Cells with distinct individual envelopes or sheaths, colonial mucilage not homogeneous ..... 11
9. Cells typically well packed into microscopic colonies of definite shapes, mostly planktonic ..... *Microcystis*
9. Cells loosely arranged, mostly not planktonic, forming macroscopic colonies ..... 10
  10. Cells spherical ..... *Aphanocapsa*
  10. Cells ellipsoidal to cylindrical ..... *Aphanothece*
11. Individual sheaths vesicular and broad, and formed one in another ..... 12
11. Individual sheaths not vesicular, cells spherical ..... *Chroococcus*
  12. Cells spherical ..... *Gloeocapsa*
  12. Cells ellipsoidal to cylindrical ..... *Gloeotheca*
13. Colony tabular or flat, cells in regular transverse and longitudinal rows ..... *Merismopedia*

\* Modified after T.V. Desikachary (1959). *Cyanophyta*. Indian Council Agricultural Research, New Delhi.

13. Colony a hollow sphere with cells arranged uniformly along the margin...14

14. Cells spherical, colonial mucilage homogeneous ..... *Coelosphaerium*  
 14. Cells pear-shaped or nearly spherical, colonial mucilage not homogeneous, cells with distinct mucilage sheaths ..... *Gomphosphaeria*

*Aphanocapsa elachista* West & West  
 Fish pond in Sembawang; catchment reservoirs.

*Aphanocapsa pulchra* (Kütz.) Rabenh.  
 University of Singapore and Nanyang University ponds; fish ponds in Sembawang.

*Aphanocapsa* sp.  
 University of Singapore pond.

*Aphanothece saxicola* Näeg.  
 In soils collected from branches of *Fagraea fragrans* and *Swietenia macrophylla*.

*Aphanothece stagnina* (Spr.) A. Br.  
 Fish ponds.

*Chroococcus giganteus* West  
 In soils collected from branches of *Swietenia macrophylla*.

*Chroococcus limneticus* Lemm.  
 Fish ponds in Sembawang.

*Chroococcus minutus* (Kütz.) Näeg.  
 Alluvial and cultivated soils; exposed sub-soils; fish pond in Sembawang.

*Chroococcus multicoloratus* Wood  
 Soil from Botanic Gardens jungle.

*Chroococcus pallidus* Näeg.  
 In soil collected from branches of *Swietenia macrophylla*.

*Chroococcus schizodermaticus* West  
 Grassland soils.

*Chroococcus turgidus* (Kütz.) Näeg.  
 Grassland and alluvial soils; exposed sub-soils; catchment reservoirs; fish ponds in Sembawang; University of Singapore pond; in soils collected from branches of *Fagraea fragrans* and *Swietenia macrophylla*.

*Chroococcus varius* A. Br.  
 Soil from Sunlit Path, MacRitchie Reservoir.

*Chroococcus* sp. 1  
 Soil from University of Singapore.

*Chroococcus* sp. 2  
 Belukar soils; exposed sub-soils.

*Coelosphaerium kuetzingianum* Näeg.  
University of Singapore and Nanyang University ponds; catchment reservoirs; fish ponds in Sembawang.

*Coelosphaerium naegelianum* Ung.  
Sembawang fish ponds.

*Gloeocapsa* cf. *compacta* Kütz.  
Catchment reservoirs; University of Singapore pond; fish ponds in Sembawang.

*Gloeothece* sp.  
University of Singapore pond; fish ponds in Sembawang.

*Gomphosphaeria aponina* Kütz.  
Fish ponds in Sembawang.

*Merismopedia minima* Beck.  
University of Singapore pond; Nee Soon swamp; fish ponds in Sembawang.

*Microcystis aeruginosa* Kütz.  
Cultivated soils; exposed sub-soils; fish ponds in Sembawang; catchment reservoirs.

*Microcystis robusta* (Clark) Nygaard.  
University of Singapore pond.

*Placoma* sp.  
Zone of high water reape tide to low water reape tide at Tanjong Teritip.

*Synechococcus aeruginosus* Näeg.  
Grassland and cultivated soils; exposed sub-soils; fish ponds.

*Synechococcus cedrorum* Sauv.  
Soil from MacRitchie Reservoir forest.

*Synechocystis aquatilis* Sauv.  
University of Singapore and Nanyang University ponds; fish ponds in Sembawang.

## 1.2. CHAMAESIPHONALES

### Key to the Genera

- |  |                     |
|--|---------------------|
| 1. Plants filamentous .....                                | <i>Endonema</i>     |
| 1. Plants unicells .....                                   | 2                   |
| 2. Reproduction by exospores .....                         | <i>Chamaesiphon</i> |
| 2. Reproduction by endospores .....                        | 3                   |
| 3. Apex of cell produced into a mucilage-bristle .....     | <i>Clastidium</i>   |
| 3. Apex of cell not produced into a mucilage-bristle ..... | <i>Stichosiphon</i> |

*Chamaesiphon fuscus* (Rostaf.) Hansg.  
Exposed sub-soils.

*Clastidium setigerum* Kirch.  
University of Singapore pond.

*Endonema* sp.

*Stichosiphon sansibaricus* (Hieron.) Drouet & Daly.  
University of Singapore pond; fish ponds.

### 1.3. NOSTOCALES

#### \* Key to the Genera

1. Trichomes without false branching or with incipient false branching ..... 2
1. Trichomes usually with false branching ..... 18
  2. Without heterocysts, spores commonly absent ..... 3
  2. Without heterocysts and spores ..... 9
3. Trichomes many in a sheath ..... *Microcoleus*
3. Trichomes without a sheath or singly within a sheath ..... 4
  4. Trichomes with a prominent sheath ..... 5
  4. Trichomes without a sheath ..... 7
5. Sheath mucilaginous ..... *Phormidium*
5. Sheath firm ..... 6
  6. Filaments not in bundles ..... *Lyngbya*
  6. Filaments mostly in erect bundles ..... *Symploca*
7. Trichomes more or less straight ..... *Oscillatoria*
7. Trichomes spirally coiled ..... 8
  8. Cells of trichomes not visible or unicellular ..... *Spirulina*
  8. Cells of trichomes clearly visible ..... *Arthrospira*
9. Trichomes differentiated into base and apex ..... *Microchaete*
9. Trichomes not so differentiated ..... 10
  10. Trichomes without a firm sheath ..... 11
  10. Trichomes with firm sheath ..... 17
11. Heterocysts present ..... 12
11. Heterocysts absent ..... 16
  12. Intercalary heterocysts generally in pairs ..... *Anabaenopsis*
  12. Intercalary heterocysts generally single ..... 13

13. Heterocysts commonly terminal, with a single large spore adjoining ..... *Cylindrospermum*  
 13. Heterocysts rarely terminal, generally intercalary ..... 14
14. End cells elongated, hair-like, colourless ..... *Aphanizomenon*  
 14. End cells not so ..... 15
15. Filaments single or in a formless gelatinous mass ..... *Anabaena*  
 15. Filaments generally in a definite colony ..... *Nostoc*
16. Trichomes attenuated, end cells often pointed ..... *Raphidiopsis*  
 16. Trichomes not attenuated, end cells not pointed ..... *Pseudanabaena*
17. Cells very short and discoid ..... *Nodularia*  
 17. Cells not discoid ..... *Aulosira*
18. Without an intercalary meristematic zone and generally without a terminal hair ..... 19  
 18. With an intercalary meristematic zone and a terminal hair ..... 20
19. False branches usually in pairs ..... *Scytonema*  
 19. False branches usually single and often next to a terminal heterocyst ..... *Tolypothrix*
20. Filaments in a spherical or hemispherical thallus ..... *Gloeotrichia*  
 20. Filaments free, simple or forming dichotomously branched corymbose thallus ..... *Calothrix*

*Anabaena anomala* Fritsch  
 Belukar soils.

*Anabaena azollae* Strasb.  
 Found in symbiotic association with the water fern, *Azolla caroliniana*, which occurs in the University of Singapore pond, catchment reservoirs, and fish ponds.

*Anabaena constricta* (Szaf.) Geitler  
 Fish pond in Sembawang; University of Singapore and Nanyang University ponds.

*Anabaena fertilissima* Rao  
 Alluvial and cultivated soils.

*Anabaena flos-aquae* (Lyngb.) Breb. ex Born & Flah.  
 Fish ponds in Sembawang; University of Singapore pond.

*Anabaena fuellebornii* Schmid.  
 Alluvial soils; fish ponds.

*Anabaena oryzaea* Fritsch  
 Grassland soils.

*Anabaena oscillarioides* Borg ex Born. & Flah.  
 Fish pond in Sembawang.

*Anabaena spiroides* Kleb.

Alluvial soils; fish ponds in Sembawang.

*Anabaena utermohlii* Geitler

Fish pond in Sembawang.

*Anabaena* sp.

Grassland soils.

*Anabaenopsis raciborskii* Wolosz.

Fish ponds in Sembawang; University of Singapore pond.

*Anabaenopsis tanganyikae* (West) Wolosz. & Miller

Fish ponds in Sembawang; University of Singapore pond.

*Anabaenopsis* sp.

University of Singapore pond.

*Aphanizomenon flos-aquae* (L.) Ralfs

Fish ponds.

*Arthrospira gomontiana* Setchell

Nee Soon swamps.

*Arthrospira jenneri* Stizenb. ex Gom.

University of Singapore pond.

*Arthrospira tenuis* Bruhl. & Biswas

Belukar soils; exposed sub-soils.

*Aulosira aenigmatica* Frémy

Exposed sub-soils.

*Aulosira pseudoramosa* Bharadw.

Soil from University of Singapore.

*Aulosira* sp.

Fish ponds.

*Calothrix* sp.

University of Singapore pond; fish ponds.

*Cylindrospermum sphaerica* Prasad

Disturbed soils.

*Cylindrospermum* sp.

University of Singapore pond; pond in Sembawang.

*Gloeotrichia echinulata* (J.E. Smith) P. Richter

In soil found on *Swietenia macrophylla*.

*Gloeotrichia* sp.

University of Singapore and Nanyang University ponds; catchment reservoirs; Nee Soon swamps.

*Lyngbya aestuarii* Liebm. ex Gom.

University of Singapore and Nanyang University ponds; Sembawang swamp.

*Lyngbya birgei* Smith

Exposed sub-soils; fish ponds in Sembawang.

*Lyngbya connectens* Bruhl ex Biswas

In soil collected from branches of *Swietenia macrophylla*.

*Lyngbya contorta* Lemm.

Fish ponds in Sembawang.

*Lyngbya digueti* Gom.

In soil collected from branches of *Swietenia macrophylla*.

*Lyngbya kuetzingiana* Kirch.

In soil collected from branches of *Swietenia macrophylla*.

*Lyngbya kuetzingii* Schmidle.

In soil collected from branches of *Swietenia macrophylla*.

*Lyngbya limnetica* Lemm.

Fish ponds in Sembawang; in soil collected from branches of *Swietenia macrophylla*; University of Singapore and Nanyang University ponds; Nee Soon swamps; catchment reservoirs.

*Lyngbya majuscula* Harv.

Intertidal pool at Pulau Hantu.

*Lyngbya martensiana* Menegh. ex Gom.

In soil collected from branches of *Swietenia macrophylla*.

*Lyngbya mucicola* Lemm.

Soil from exposed cleared building site.

*Lyngbya polysiphoniae* Frémy

Belukar soils.

*Lyngbya* sp. 1

Fish pond in Sembawang.

*Lyngbya* sp. 2

Soil from Sunlit Path, MacRitchie Reservoir.

*Lyngbya* sp. 3

Telok Paku beach.

*Lyngbya* sp. 4

University of Singapore pond.

*Lyngbya* sp. 5

Beaches at Labrador and Ponggol.

*Microchaete tenera* Thuret ex Born. & Flah.

Soil from University of Singapore.

*Microcoleus vaginatus* (Vauch.) Gom.  
Soil from University of Singapore.

*Nodularia spumigena* Mert.  
Fish ponds.

*Nostoc commune* Vauch. ex Born. & Flah.  
In soil collected from branches of *Swietenia macrophylla*.

*Nostoc microscopicum* Carm. ex Born. & Flah.  
Cultivated soils.

*Nostoc muscorum* Ag. ex Born. & Flah.  
Grassland soils.

*Nostoc punctiforme* (Kütz.) Hariot.  
Grassland soils.

*Nostoc* sp.  
University of Singapore pond; Nee Soon swamps.

*Oscillatoria annae* van Goor  
Alluvial and cultivated soils; exposed sub-soils.

*Oscillatoria chalybea* (Mert.) Gom.  
Grassland soils; exposed sub-soils.

*Oscillatoria chlorina* Kütz. ex Gom.  
Belukar and cultivated soils.

*Oscillatoria fremyii* de Toni  
Belukar and cultivated soils.

*Oscillatoria geitleriana* Elenkin  
Grassland soils.

*Oscillatoria jatorvensis* Vouk.  
Belukar, grassland, alluvial and disturbed soils.

*Oscillatoria limosa* Ag. ex Gom.  
Alluvial soils; exposed sub-soils; University of Singapore pond; Nee Soon swamps; fish ponds.

*Oscillatoria miniata* (Zanard.) Hauck ex Gom.  
Grassland, alluvial and cultivated soils.

*Oscillatoria obscura* Bruhl & Biswas.  
Grassland, cultivated and disturbed soils; exposed sub-soils.

*Oscillatoria okeni* Ag. ex Gom.  
Belukar and alluvial soils.

*Oscillatoria splendida* Grev. ex Gom.  
University of Singapore pond; catchment reservoirs; Nee Soon swamps.

*Oscillatoria subtilissima* Kütz.  
Grassland soils.

*Oscillatoria terebriformis* Ag. ex Gom.  
Grassland and cultivated soils.

*Oscillatoria* sp. 1  
University of Singapore pond.

*Oscillatoria* sp. 2  
Soil from University of Singapore.

*Oscillatoria* sp. 3  
Labrador; Ponggol.

*Phormidium angustissimum* West & West  
Soil from Botanic Gardens jungle.

*Phormidium laminosum* Gom.  
University of Singapore and Nanyang University ponds; Nee Soon swamps.

*Phormidium subincrustatum* Fritsch & Rich.  
Exposed sub-soils.

*Phormidium truncicola* Ghose  
Exposed sub-soils.

*Phormidium* sp. 1  
Beaches at Telok Paku and Ponggol.

*Phormidium* sp. 2  
University of Singapore pond.

*Pseudanabaena catenata* Laut.  
University of Singapore pond.

*Raphidiopsis curvata* Fritsch & Rich  
Fish ponds in Sembawang; University of Singapore and Nanyang University ponds; catchment reservoirs; Nee Soon swamps.

*Scytonema hofmanni* Ag. ex Born. & Flah.  
Cultivated soils.

*Scytonema javanicum* (Kütz.) Born ex Born. & Flah.  
Soils from exposed building site and University of Singapore.

*Spirulina gigantea* Schmidle  
University of Singapore and Nanyang University ponds; catchment reservoirs; fish ponds in Sembawang.

*Spirulina labyrinthiformis* (Menegh.) Gom.  
Alluvial soils..

*Symploca elegans* Kütz. ex Gom.  
Soil from exposed cleared building site.

*Tolypothrix fragilis* (Gardn.) Geitler  
Soil from University of Singapore.

*Tolypothrix phyllophila* West & West  
Disturbed soils; exposed sub-soils.

*Tolypothrix tenuis* (Kütz.) Johs. Schmidt em.  
University of Singapore and Nanyang University ponds; Nee Soon swamps; catchment reservoirs.

## 1.4. STIGONEMATALES

## \*Key to the Genera

1. Pedicellate heterocysts present ..... *Nostochopsis*
1. Pedicellate heterocysts absent ..... 2
2. Hormogones present ..... *Hapalosiphon*
2. Hormogones not known, endospores present ..... *Westiellopsis*

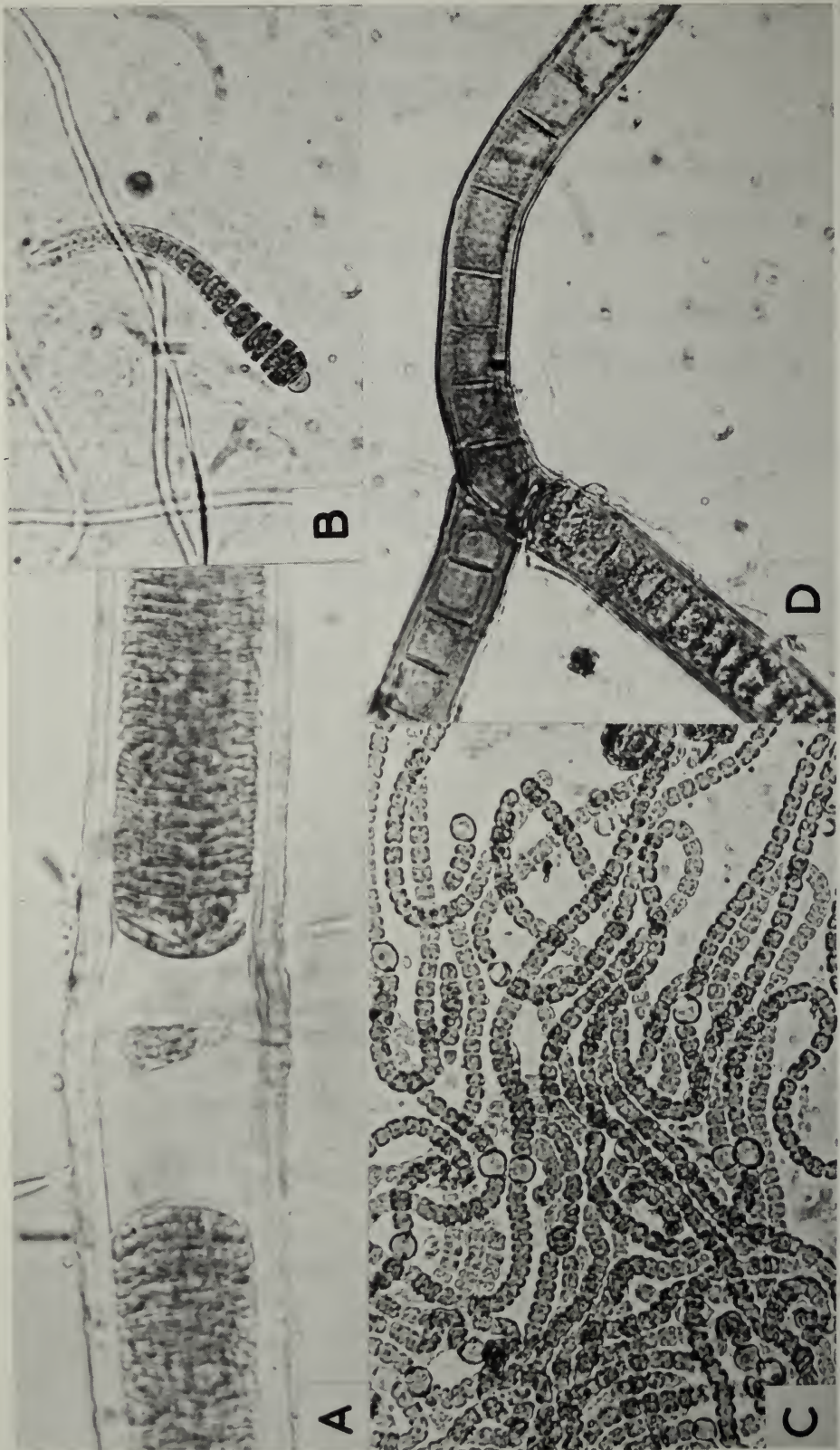
*Hapalosiphon fontinalis* (Ag.) Born.

University of Singapore and Nanyang University ponds; catchment reservoirs; Nee Soon swamps; fish ponds in Sembawang.

*Hapalosiphon welwitschii* West & West  
Grassland soils.

*Nostochopsis radians* Bharadw.  
Grassland soils.

*Westiellopsis prolifica* Janet  
Grassland cultivated soils.



A, *Lyngbya* sp. X 2800; B, *Calothrix* sp. X 1600;  
C, *Anabaena* sp. X 1600; D, *Scytonema* sp. X 1600.

# A PRELIMINARY REPORT ON THE TISSUE CULTURE OF *ACALYPHA WILKESIANA*

by

FU FAN MAY LAY, CHOO YON SEN AND HO SIEW HOONG

*Botanic Gardens, Singapore.*

*Acalypha wilkesiana* (syn. *A. tricolor*) is a shrub which has many varieties and hybrids. One hybrid which has variegated leaves of yellow and green colour is cultivated commonly as a roadside shrub all over the island. Propagation of this shrub is by stem cuttings.

Following the successful production of plantlets from tissue culture of stem internode callus of *Paulownia taiwaniana* (Fu, 1978) which is a woody species grown commercially for its timber a study was carried out to propagate this *A. wilkesiana* hybrid through tissue culture.

Stem cuttings of *A. wilkesiana* hybrid were collected. Internodal sections were cut and sterilised in chlorox solution. These internodal sections were then cultured aseptically in medium with 2, 4-dichlorophenoxyacetic acid (Table I). After 3 months callus formation was observed. These callus sections turned green and were eventually transferred to medium D (Table II) for further development. In medium D the callus differentiated and produced leafy shoots (Plate 1) in 6 months.

Further investigations are now being carried out on the tissue culture of *A. wilkesiana* hybrid the results of which will be published subsequently.

TABLE I  
MEDIUM FOR INDUCING CALLUS

	per litre
Murashige & Skoog inorganic salts	full strength
White organic compounds	half strength
Myoinositol	100 mg
Coconut water	150 ml
2, 4 dichlorophenoxyacetic acid	3 mg
Sugar	30 g
Agar	9 g
pH	5.2

TABLE II  
MEDIUM D FOR INDUCING LIVING SHOOTS

	per litre
Murashige & Skoog inorganic salts	full strength
Thiamine	0.4 mg
Myoinositol	100 mg
Sugar	30 g
Indoleacetic acid	0.5 mg
Kinetin	0.5 mg
Agar	9 g
pH	5.2

#### LITERATURE CITED

Fu, M.L. (1978). Plantlets from *Paulownia* tissue culture. Gard. Bull. Sing. 31(1): 61-66.

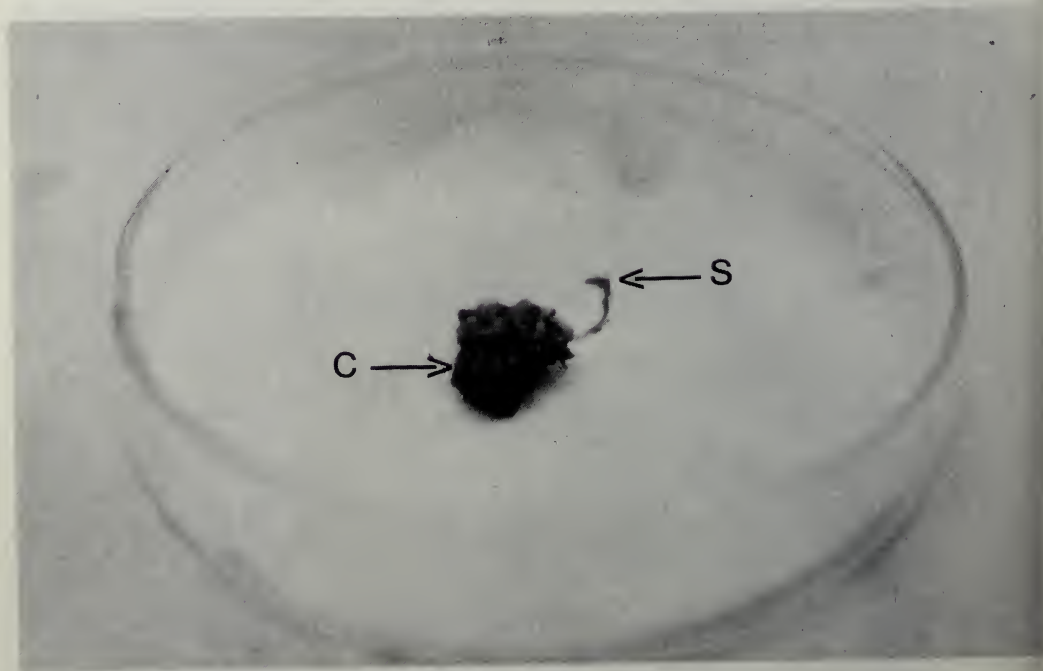


PLATE 1

Internodal section of *A. wilkesiana* with callus (c) and a shoot (s).

# PRELIMINARY INVESTIGATIONS ON THE PROPAGATION OF *EUGENIA GRANDIS* THROUGH TISSUE CULTURE

by

CHOO YON SEN, HO SIEW HOONG AND FU FAN MAY LAY

*Botanic Gardens, Singapore*

Most of the information available on tissue culture propagation of plants has been obtained from experiments of herbaceous and not woody plants. There have been only very few reports on the successful propagation of woody species through tissue culture.

An attempt has been made in the Botanic Gardens of Singapore to propagate *Eugenia grandis* through tissue culture.

*E. grandis* (Jambu Laut) is a majestic and lofty tree which can grow to a height of 25 to 30 metres. The crown has a dense foliage and can spread to a diameter of about 40 metres which makes it a very good plant for shade. It grows fast and is planted as a roadside tree in Singapore.

*E. grandis* seeds were collected and germinated in sand. The seedlings obtained from these seeds were used as plant materials for tissue culture experiments. Internodal sections of the seedlings were surface sterilised in chlorox and cultured in medium with 2, 4-dichlorophenoxyacetic acid (Fu Fan et al, 1978). Sections of the nodes and the shoot tips were also surface sterilised but were cultured in Ac medium (Table I).

TABLE I

Ac medium	
Murashige & Skoog inorganic salts	per litre half strength
Thiamine	0.4 mg
Myoinositol	100 mg
Coconut water	150 ml
Indoleacetic acid	5 mg
Kinetin	2.5 mg
Sugar	30 g
Agar	9 g
pH	5.2

The internodal sections developed callus which turned green in colour. The sections of the nodes and shoot tips in Ac medium produced roots and adventitious shoots (Plates 1 and 2) within 8 weeks.

Observations made so far indicate that through tissue culture it is possible to propagate *E. grandis*. Detailed results of current experiments will be published later.

## LITERATURE CITED

Fu, F.M.L., Choo, Y.S. and Ho, S.H. (1978). A preliminary report on the tissue culture of *Acalypha wilkesiana* var. green. Card. Bull. Sing. 31(2):



PLATE 1  
Nodal section of *E. grandis*  
showing roots (r).

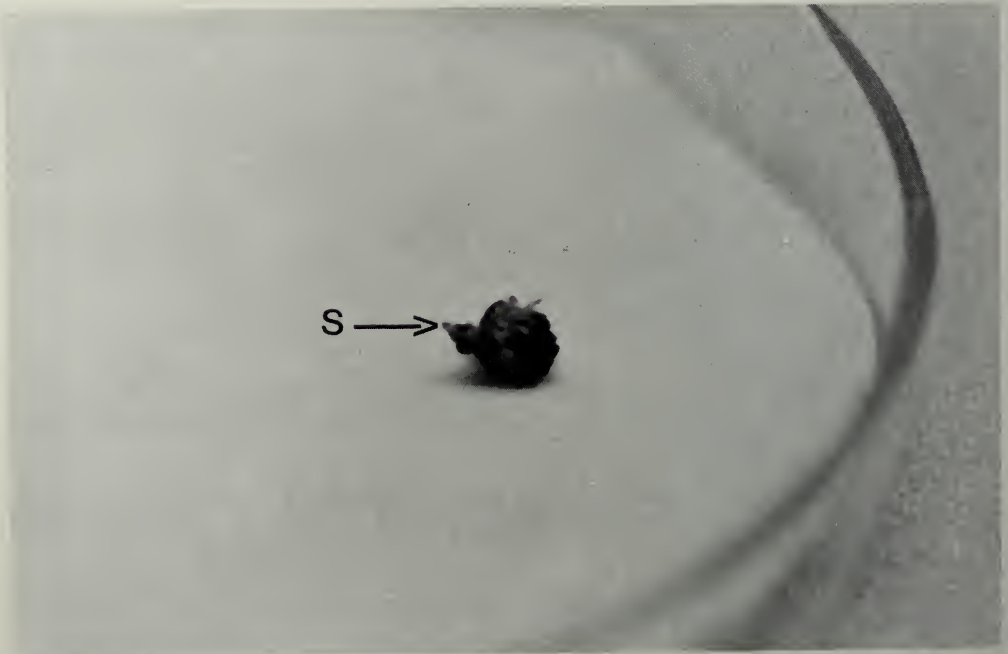


PLATE 2  
Nodal section of *E. grandis*  
producing a shoot (s).



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Singh, H. (1967). Sclereids in *Fagraea*. *Gard. Bull. Sing.* 22(2): 193–212.

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Eames, A. J., (1961). *Morphology of the Angiosperms*, 518 pp. McGraw-Hill Book Company Inc., New York, Toronto and London.

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