

TREE FLORA of SABAH AND SARAWAK

Volume One

edited by
E. Soepadmo and K.M. Wong



ITTO
International Tropical
Timber Organization



Government of Malaysia



Overseas Development
Administration, U.K.

TREE FLORA
of
SABAH AND SARAWAK

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GOVERNMENT OF MALAYSIA



INTERNATIONAL TROPICAL TIMBER ORGANIZATION



OVERSEAS DEVELOPMENT ADMINISTRATION, U.K.

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CONTENTS

Foreword	Page VII
Acknowledgements	IX
INTRODUCTION	
Background to the Tree Flora of Sabah and Sarawak Project (<i>E. Soepadmo</i>)	XIII
A Brief History of Botanical Collecting and Documentation in Borneo (<i>K.M. Wong</i>)	XXI
Biogeography and Ecology (<i>P.S. Ashton</i>)	XLIII
THE TREE FLORA PROPER	
1. Aceraceae (<i>A. Noorsiha</i>)	1
2. Alangiaceae (<i>A. Berhaman</i>)	5
3. Anisophylleaceae (<i>K.M. Wong & L. Madani</i>)	15
4. Araucariaceae (<i>P.C. Yii</i>)	27
5. Bignoniaceae (<i>A. Berhaman</i>)	33
6. Burseraceae (<i>K.M. Kochummen</i>)	45
7. Capparaceae (<i>Deborah Kennard</i>)	101
8. Celastraceae (<i>K.M. Kochummen</i>)	107
9. Chrysobalanaceae (<i>Ghilleen T. Prance</i>)	155
10. Clethraceae (<i>A. Berhaman</i>)	181
11. Connaraceae (<i>Lesmy Tipot</i>)	187
12. Cornaceae (<i>R.C.K. Chung</i>)	199
13. Datisceae (<i>E.J.F. Campbell-Gasis</i>)	209
14. Goodeniaceae (<i>K.M. Wong</i>)	213
15. Hypericaceae (<i>K.M. Wong</i>)	219
16. Illiciaceae (<i>Richard M.K. Saunders</i>)	227
17. Juglandaceae (<i>E.J.F. Campbell-Gasis</i>)	233
18. Monimiaceae (<i>P.C. Yii & Lesmy Tipot</i>)	245
19. Nyssaceae (<i>P.C. Yii</i>)	253
20. Ochnaceae (<i>K.M. Kochummen</i>)	257
21. Olacaceae (<i>Lesmy Tipot</i>)	271
22. Oxalidaceae (<i>R.C.K. Chung</i>)	287
23. Pittosporaceae (<i>John B. Sugau</i>)	297
24. Rhamnaceae (<i>Carsten Schirarend</i>)	305
25. Rhizophoraceae (<i>L. Madani & K.M. Wong</i>)	321
26. Rutaceae (<i>David T. Jones</i>)	351
27. Simaroubaceae (<i>Julius Kulip & K.M. Wong</i>)	421
28. Sonneratiaceae (<i>Othman Bojo</i>)	443
29. Staphyleaceae (<i>J.T. Pereira</i>)	453
30. Styracaceae (<i>R. Kiew</i>)	463
31. Trigoniaceae (<i>K.M. Wong</i>)	467
Abbreviations of Frequently Cited References	471
Commonly Used Abbreviations for Localities	473
Glossary	474
Index to Scientific Names	487
Index to Vernacular Names	506

CELASTRACEAE

K.M. Kochummen

Forest Research Institute Malaysia,
Kepong, Malaysia

Merrill, EB (1921) 354; Ridley, FMP 1 (1922) 443; Masamune, EPB (1942) 417; Browne, FTSB (1955) 76; Ding Hou, FM 1, 6 (1962) 227, FM 1, 6 (1964) 389, FM 1, 6 (1972) 930, Blumea 17 (1969) 97; Backer & Bakhuizen *f.*, FJ 2 (1965) 53; Smythies, CST (1965) 38; Burgess, TBS (1966) 73; Kochummen & Whitmore, TFM 1 (1972) 156; Cockburn, TS 1 (1973) 51; Anderson, CLTS (1980) 159; Wong, DMT (1982) 33; Corner, WSTM 1 (1988) 212; Ashton, MNDT 2 (1988) 87; Whitmore, Tantra & Sutisna, CLK 1 (1989) 42; Ng, MFR 34 (1991) 41.

Trees, erect or scandent shrubs or woody climbers; bole sometimes buttressed, rarely with pneumatophores. **Leaves** simple, decussate, opposite, sub-opposite, spiral or rarely alternate, sometimes black-dotted especially beneath, margin faintly toothed, wavy or entire. Stipules small, falling off early or absent. Incipient bracts absent except in *Microtropis*. **Inflorescences** axillary and/or terminal, sometimes extra-axillary or borne on the branches, thyrsoïd, paniculate, racemose, cymose or fasciculate, usually with bracts. **Flowers** regular, bisexual or unisexual (plants dioecious, rarely polygamous); *calyx* 4–5-lobed, lobes imbricate, rarely valvate, *persistent*; *petals* 4 or 5, imbricate, contorted or rarely valvate, falling off early, rarely persistent, *free or united at base*, sometimes united with the staminal ring, always larger than calyx-lobes except in *Perrottetia*; stamens 2–5, alternate with petals, filaments inserted on or on the inner side of the disc or on a basal ring (*Microtropis*), *anthers* 2-celled, longitudinally or laterally dehiscent, introrse or extrorse; *disc* often conspicuous, fleshy or membranous, cup-shaped, saucer-shaped or flat, entire, toothed, angled or lobed, extrastaminal or intrastaminal, rarely absent (*Microtropis*); *ovary superior or rarely semi-inferior*, partly or fully immersed in the disc, usually glabrous, sometimes with a tuft of hairs at top (*Bhesa*), rarely with papilla-like or fleshy subulate processes at the base (*Euonymus*), (1–)2–5-celled, rarely many-celled (*Siphonodon*), very rarely hollow at the top (*Siphonodon*), style distinct, or obscure or lacking, simple or divided to the base (*Bhesa*), stigmas simple or lobed; *ovules* usually 2 in each cell, sometimes 1 or 3–18, *anatropous*. **Fruits** drupes, capsules, or berries, surface smooth or spiny. **Seeds** erect or pendulous, sometimes winged, aril present or absent, when present usually partly or entirely enveloping the seed or forming a cushion-like structure situated at the base of seed or with *long, filamentous appendages* (*Sarawakodendron*), often orange or orange-red, rarely white; endosperm present or absent; cotyledons flat, foliaceous.

Distribution. About 90 genera and over 1000 species distributed in both hemispheres, predominant in the tropics and subtropics. In Malesia, 18 genera and c. 115 species, of which 15 genera and 70 species are recorded in Sabah and Sarawak.

Ecology. From lowland including mangrove and peat swamp, to montane forests to about 3200 m. Most members of the family have nectariferous disc in the flowers which are visited by various kinds of insect-pollinators. Seeds of species having brightly coloured arils

are dispersed by birds; the winged seeds of *Kokoona*, *Lophopetalum* and other taxa are dispersed by wind. The fruits of the mangrove tree, *Cassine viburnifolia*, have a corky mesocarp that facilitates dispersal by sea water.

Uses. Timbers of the genera *Kokoona*, *Lophopetalum*, and *Siphonodon* have commercial value. Some species contain alkaloids. Aborigines in Peninsular Malaysia make use of the bark of *Lophopetalum pallidum* in the preparation of dart poison. The ochre yellow middle bark of some *Lophopetalum* and *Kokoona* species burn readily and is useful tinder in the forest.

Key to genera

1. Woody climbers or scandent shrubs.....2
Trees, or erect shrubs.....6
2. Leaves spirally arranged.....3
Leaves opposite, decussate, or rarely spiral.....4
3. Woody climber. Ovary free from the disc.....
Celastrus L.
Gen. Pl. ed. 5 (1754) 91; Ridley *l.c.* 450; Ding Hou *l.c.* (1963) 233.
About 30 species, tropics and subtropics; 2 species in Sabah and Sarawak.
Leaves spirally arranged, margin toothed. Inflorescences cymose or paniculate.
Flowers unisexual, 5-merous, pedicel articulated; calyx bell-shaped; disc membranous or fleshy, cup-shaped; ovary superior, 3-celled; style columnar, stigma 3-lobed; *ovules 2 in each cell*. *Fruit* a 3-valved *capsule*, tipped by persistent style. Seeds 1–6, enveloped by crimson aril.
- Scandent shrubs. Ovary partially immersed in the disc.....
Maytenus Molina
Saggio Chile (1782) 177; Ding Hou *l.c.* (1962) 238.
About 225 species; tropics and subtropics of both the Old and New World. In Malesia 5 species, one of which, *M. emarginatus* (Willd.) Ding Hou, is present in Sabah; uncommon, known only by a single collection (*Sugau 34*) from Balambangan island.
Scandent shrubs with spines on leafy shoots. Leaves spirally arranged, margin toothed. Flowers in fascicles, unisexual, 4–5-merous; calyx-lobes deltoid; petals obovate or oblong, entire; disc rounded; stamens inserted on the margin of the disc; ovary partly immersed in the disc, 3-celled, style cylindric, stigma 3. Fruits a capsule. Seeds ellipsoid, red, subtended by white fleshy aril at the base.
4. Flowers with distinct disc.....5
Flowers without or with inconspicuous disc.....
Reissantia Hallé
Mus. Hist. Nat. Paris 30 (1958) 466; Ding Hou *l.c.* (1964) 400.
7 species, Old World tropics; 4 species in Sabah and Sarawak.
Leaves decussate, rarely subopposite. Inflorescences axillary. *Flowers bisexual*; calyx-lobes 5, imbricate; petals 5, imbricate; *disc inconspicuous*; stamens 3; ovary semi-

superior, 3-celled; style short; stigma obscure; ovules 2 (rarely 4–8) in each cell.
Fruits capsular consisting of 3 divergent separate follicles which split into 2 valves.
Seeds with basal more or less transparent membranous wing.

5. Fruits capsular with 3 follicles. Seeds winged. Petals with inflexed tip.....
Loeseneriella A.C. Smith
 Am. J. Bot. 28 (1941) 438; Ding Hou l.c. (1964) 397.
 26 species, Tropical Africa, Asia, Malesia, New Hebrides. In Malesia, 4 species of which 2 are present in Sabah and Sarawak.
Leaves decussate. Inflorescences axillary, cymose. *Flowers bisexual*; calyx deeply 5-lobed; *petals 5, thick with inflexed tip*; disc fleshy; *stamens 3*; *ovary superior or semi-inferior.* *Fruits capsular, with 3 divergent follicles, each dehiscing into 2 valves.* *Seeds usually with basal membranous wing.*

- Fruits drupaceous. Seeds embedded in pulp. Petals without inflexed tip.....
Salacia L.
 Mant. (1767) 159; Ridley l.c. (1922) 456; Ding Hou l.c. (1964) 404.
 About 150 species, pantropical; 33 species in Malesia of which 17 are found in Sabah and Sarawak. *Leaves decussate, subopposite or rarely spiral.* *Flowers bisexual*, axillary, in clusters or organised in cymes or panicles; calyx deeply 5-lobed or 3–5-lobed in apical part, and circumscissile at the base or lengthwise splitting or not lobed; petals usually 5, rarely 4 or 7; disc fleshy, ring-like, truncate-conical or flattened, occasionally cup-like; *stamens 3*, rarely 2; *ovary semi-inferior, 3-celled, rarely 2-celled, ovules 2–8 in each cell*; style distinct or obscure; stigma obscure. *Fruits drupaceous, 1–3-celled.* Seeds 1 to several, embedded in mucilaginous pulp.

6. Leaves alternate or spirally arranged.....7
 Leaves decussate, opposite, subopposite, or very rarely alternate or spiral.....10

7. Leaf margin toothed.....8
 Leaf margin entire.....9

8. Petals usually similar in size to calyx-lobes. Ovary not hollow in apical part...8.
Perrottetia
 Petals always larger than calyx-lobes. Ovary hollow in apical part.....10. **Siphonodon**

9. Leaves and twigs with pustules; petiole to 1.5 cm long, not swollen towards apex; stipules not prominent, leaving no stipular scars on twigs.....9. **Sarawakodendron**
 Leaves and twigs without pustules; petioles longer than 1.5 cm, swollen at the apex or both ends; stipules prominent, leaving scars on twigs.....1. **Bhesa**

10. Incipient bracts prominent. Disc absent.....7. **Microtropis**
 Incipient bracts absent. Disc present.....11

11. Trees confined to tidal rivers and mangroves. Ovary 2-celled.....2. **Cassine**
 Trees or shrubs of inland forests. Ovary 3 or 4–5-celled.....12

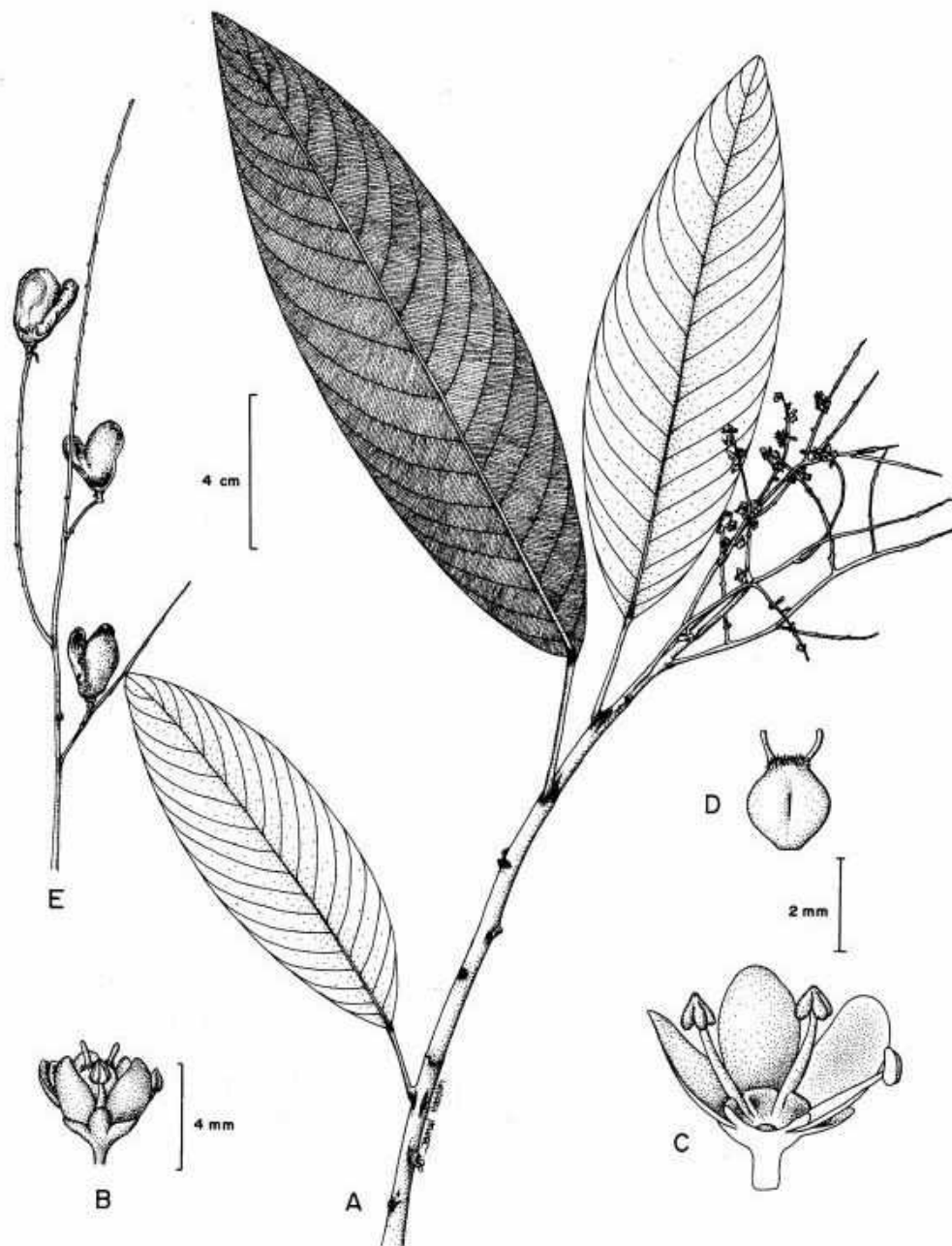


Fig. 1. *Bhesa paniculata*. A, flowering leafy twig; B, flower; C, flower with pistil removed; D, pistil; E, part of infructescence. (A from *SAN* 79200, B–D after FM 1, 6 (1962) 281, fig. 16, E from *SAN* 82521.)

12. Ovary 4–5-celled. Seeds not winged.....13
 Ovary 3-celled. Seeds winged.....14
13. Ovules 2 in each cell.....**3. Euonymus**
 Ovules 1 in each cell.....**4. Glyptopetalum**
14. Petals twisted and overlapping. Wing attached to the apex of seed.....**5. Kokoona**
 Petals imbricate. Wing surrounding seed.....**6. Lophopetalum**

1. BHESA Buch.-Ham. *ex* Arn.

(origin unknown, probably an English plant name)

Edin. New Phil. J. (1834) 315; Ding Hou, Blumea Suppl. 4 (1958) 149, *l.c.* (1962) 280; Kochummen & Whitmore *l.c.* 158; Cockburn *l.c.* 54; Anderson *l.c.* 159; Wong *l.c.* 22; Corner *l.c.* 213; Ashton *l.c.* 89; Whitmore, Tantra & Sutisna *l.c.* 42; Ng *l.c.* 43. **Synonym:** *Kurrimia* Wall. *ex* Arn., Nov. Act. Ac. Caes. Leop.-Car. 18 (1836) 328.

Medium-sized to tall trees; bole with buttresses, often fluted at base. **Bark** grey-brown, smooth to cracking and scaly; inner bark mottled cream and orange. **Sapwood** pale yellow. *Twigs* smooth, with distinct stipular scars. Stipules prominent, lanceolate, soon falling off and leaving scars on the twigs. **Leaves** spiral, entire, with silky sheen; intercostal veins fine, scalariform; petioles slender, longer than 1.5 cm, swollen at both ends or at the apex only. **Inflorescences** axillary, solitary or paired, paniculate or racemose; bracts falling off early; pedicels jointed. **Flowers** bisexual, 5-merous (rarely 4-merous); calyx deeply lobed, lobes imbricate or valvate; petals twisted; disc fleshy, entire or lobed; stamens 4–5, seated on or just below the disc; ovary superior, usually with terminal tuft of hairs, 2-celled, with 2 ovules in each cell, styles 2. **Fruit** a capsule, entire or 2-lobed, splitting into 2 valves or on one side only. **Seeds** 1–2 per cell, with bright orange-red or pink basal aril; endosperm copious; germination epigeal.

Distribution. 5 species; Sri Lanka and Malesia; 2 species in Sabah and Sarawak.

Ecology. Widely distributed from lowland to submontane forests to 1500 m.

Key to *Bhesa* species

Stipules to 3 cm long. Petioles strongly swollen at both ends. Intercostal veins distinct. Inflorescences usually paniculate. Disc deeply 5-lobed. Fruits two-lobed.....**1. B. paniculata**

Stipules to 1 cm long. Petioles only slightly swollen at apex. Intercostal veins faint to invisible. Inflorescence racemose. Disc entire or obscurely notched. Fruits not lobed, with pointed tip.....**2. B. robusta**

1. *Bhesa paniculata* Arn.

Fig. 1.

(Latin, *paniculatus* = having a loose, branched flower-cluster or inflorescence)

l.c. (1834) 315; Ding Hou *l.c.* (1958) 151, *l.c.* (1962) 282; Burgess *l.c.* 73; Kochummen & Whitmore *l.c.* 160; Cockburn *l.c.* 55; Anderson *l.c.* 159; Corner *l.c.* 213; Ashton *l.c.* 92; Whitmore, Tantra & Sutisna *l.c.* 42. **Type:** Wallich no. 4336, Penang (BO, K). **Synonyms:** *Kurrimia paniculata* Wall. ex Arn. *l.c.* 328; *K. luzonica* Vidal, Rev. Pl. Vasc. Filip. (1886) 88; *K. minor* Ridl., Kew Bull. (1938) 235.

Medium-sized tree to 35 m tall, 50 cm diameter; bole often fluted at base. **Bark** grey-brown, smooth to cracking; inner bark orange-yellow. **Sapwood** pale white. **Twigs** pale brown to dark brown, 5–10 mm thick, with prominent stipular and leaf scars. Stipules lanceolate, c. 3 cm long. **Leaves** elliptic to oblong, rarely obovate, 5.5–27 x 2.2–13 cm; base cuneate or rounded, apex pointed or blunt; midrib flattened or raised above; lateral veins 5–20 pairs, prominently raised below, visible above; *intercostal veins scalariform, very close, faint above, distinct beneath*; petioles 1–9.5 cm long, strongly swollen at both ends. **Inflorescences** panicles, 10–37 cm long or racemes to 20 cm long, from axils of upper leaves. **Flowers** greenish yellow or dark purplish red, pedicels 2–3 mm long; calyx-lobes hairy outside; *disc deeply 5-lobed*; petals oblong or ovate, hairy inside; stamens 1.5–2 mm long, anthers triangular; ovary ellipsoid, styles free, about half as long as ovary. **Fruits** 2-lobed, red when fresh, drying dark brown, 1–2 cm long, with the biggest lobe c. 0.5 cm wide. **Seeds** 2–4, more than half covered with pink aril; cotyledons leafy.

Vernacular names. Sabah—*biku-biku* (Malay). Sarawak—*simun* (Iban). Brunei—*serunai* (Malay).

Distribution. S India, S Thailand, Sumatra, Peninsular Malaysia, Borneo and the Philippines. Common and widely distributed in Sabah and Sarawak. Also in Brunei and Kalimantan.

Ecology. Lowland, including mixed dipterocarp, heath, and peat swamp, to submontane forests to 1500 m. Submontane samples have comparatively smaller and thicker leaves. Flowering in March–May and August–October, fruiting in April–December.

2. *Bhesa robusta* (Roxb.) Ding Hou

(Latin, *robustus* = strong-growing, robust; the habit)

l.c. (1958) 152, *l.c.* (1962) 283; Kochummen & Whitmore *l.c.* 161; Anderson *l.c.* 159; Corner *l.c.* 214; Ashton *l.c.* 93; Whitmore, Tantra & Sutisna *l.c.* 42. **Basionym:** *Celastrus robustus* Roxb., Fl. Ind. 2 (1824) 395. **Type:** Roxburgh, *Icones* no. 2185 (K). **Synonyms:** *Kurrimia pulcherrima* Wall. ex Laws. in Hooker f., Fl. Br. Ind. 1 (1875) 622; *Kurrimia maingayi* Laws. in Hooker f. *l.c.* 622.

Medium-sized tree to 18 m tall and 40 cm diameter. **Bark** grey-brown; inner bark yellow. **Sapwood** pale. Stipules lanceolate, 5–10 mm long. **Leaves** elliptic or oblong, 7–9 x 3–4 cm; base cuneate, apex blunt or pointed; midrib raised above; lateral veins 11–15 pairs; *intercostal veins very faint to invisible*; petioles 1–3 cm long, slightly swollen at apex. **Flowers** in racemes, subsessile; calyx lobed, lobes broadly ovate to rounded; petals oblong to elliptic; *disc cup-shaped, subentire or obscurely notched*; stamens c. 2 mm long, attached beneath the outer margin of disc, anthers deltoid; ovary subglobose with tuft of hairs at apex, styles free, longer than ovary. **Fruits** ovoid, *not lobed*, c. 2 x 1 cm, apex pointed. **Seeds** 1, enveloped by aril, sometimes only the lower half; cotyledons fleshy.

Distribution. NE India, Bhutan, Chittagong, Burma, Andaman Islands, Thailand, Indo-China, Sumatra, Peninsular Malaysia, and Borneo. In Sabah and Sarawak, uncommon; in Sabah, known from 3 collections (*SAN A 6613*, *SAN 50057*, and *SAN 76690*) from Beaufort and Sandakan districts, and in Sarawak by one collection (*Beccari 2624*).

Ecology. Mixed dipterocarp forests at 300–600 m, on clay-rich soils.

Uses. Though of no commercial importance in Sabah and Sarawak, the timber is used in house-building in other countries where it occurs.

2. CASSINE L.

(origin and meaning unknown)

Gen. Pl. (1737) 338; Ding Hou *l.c.* (1962) 284; Backer & Bakhuizen *f. l.c.* 55; Kochummen & Whitmore *l.c.* 161; Anderson *l.c.* 159; Kostermans, Gard. Bull. Sing. 39 (1986) 177; Ashton *l.c.* 93. **Synonym:** *Elaeodendron* Jacq. *f. ex* Jacq., Ic. Pl. Rar. 12 (1782) t. 48.

Shrubs or small trees. **Leaves** *decussate*. **Inflorescences** axillary or extra-axillary cymes, with distinct peduncles. **Flowers** *bisexual*, 4–5-merous; calyx-lobes imbricate; petals free, imbricate; stamens 4–5, inserted on the disc or on its outer margin, filaments subulate, anthers introrse; disc prominent, fleshy, flat, orbicular or lobed; *ovary semi-inferior*, 2-celled, conical or flask-like, the base slightly united with the disc or partly immersed in it; *style very short or obscure*, stigma obscure or 2-lobed; *ovules 2 in each cell*, erect, attached at the base. **Fruit** a drupe, 1–2-celled. **Seeds** 1–2, not winged, without aril, with endosperm.

Distribution. About 80 species throughout the tropics, mainly in Africa; 2 species in Malesia of which only one is present in Sabah and Sarawak.

Ecology. In Sabah and Sarawak, confined to mangroves and banks of tidal rivers.

Cassine viburnifolia (Juss.) Ding Hou
(with leaves resembling those of *Viburnum*)

Fig. 2.

l.c. (1962) 286; Kochummen & Whitmore *l.c.* 161; Cockburn *l.c.* 54; Anderson *l.c.* 159; Ashton *l.c.* 93. **Basionym:** *Aegiphila viburnifolia* Juss., Ann. Mus. Hist. Nat. Paris 7 (1806) 76. **Type:** *Sine coll.*, s.n., Philippines (P). **Synonyms:** *Euonymus viburnifolius* (Juss.) Merr., Philip. J. Sc. 9 (1914) Bot. 312; *Elaeodendron subrotundum* King, J. As. Soc. Beng. 65, 2 (1896) 356.

Shrub or small tree to 10 m tall, 20 cm diameter. **Bark** yellowish grey, smooth. Twigs black. **Leaves** broadly obovate, 4–10 x 2–6 cm; base cuneate, *margin curled inwards*, *remotely minutely toothed*, *apex blunt to rounded*; lateral veins 4–6 pairs, faint; intercostal veins reticulate, equally prominent as the lateral ones; petioles 8–13 mm long. **Inflorescences** cymose, axillary. **Flowers** white, 4-merous; calyx-lobes broadly ovate to rounded, almost free; petals oblong to ovate-oblong. **Fruits** obovoid, often rhomboid in cross-section; mesocarp thick and corky. **Seed** 1, c. 6 x 3 mm, obovate to oblong.

Vernacular name. Sarawak—*barat-barat* (Malay).

Distribution. Andaman Islands, Thailand, Sumatra, Peninsular Malaysia, Borneo, Philippines, and Celebes. In Sabah known from Kudat, Sandakan and Tawau districts, and in Sarawak from the Rejang delta in 3rd. Div. Also in Brunei.

Ecology. Common on the banks of tidal rivers and mangrove channels near the inland limits of salinity. The fruits are dispersed by water.

3. EUONYMUS Tourn. ex L.

(Greek, *eu* = good, *onuma* = name; a plant name)

Gen. Pl. ed. 5 (1754) 91; Ridley *l.c.* (1922) 445; Masamune *l.c.* 417; Blakelock, Kew Bull. (1951) 232; Ding Hou *l.c.* (1962) 245; Backer & Bakhuizen *f. l.c.* 53; Kochummen & Whitmore *l.c.* 162; Cockburn *l.c.* 55; Anderson *l.c.* 159; Ashton *l.c.* 94; Whitmore, Tantra & Sutisna *l.c.* 42.

Shrubs or small trees. **Leaves** *opposite-decussate* sometimes with dark spots on the under surface; stipules lanceolate, falling off early. **Inflorescences** axillary, cymose; rarely flowers in fascicles (*E. javanicus*); pedicels jointed. **Flowers** *bisexual*, 5- or 4-merous; calyx deeply lobed, lobes imbricate, entire or minutely toothed; petals free, imbricate, spreading or reflexed; *disc prominent*, fleshy or thin, flat, 5- or 4-angled or 5- or 4-lobed or rounded, smooth or covered with fleshy papilla-like or subulate processes; stamens 4–5, inserted on the disc, *anthers* 2-celled, lateral or introrse, *dehiscence apical*, filaments obscure or distinct; *ovary semi-inferior* 4–5-celled, partly or wholly immersed in the disc, stigma obscure or discoid, *ovules mostly 2 in each cell*. **Fruits** *capsules*, usually (3–)4–5-angular or lobed, smooth or armed with rigid prickles, apex obtuse, acute, truncate or concave. **Seeds** usually black, not winged, partly or completely covered by orange aril.

Distribution. About 180 species, mainly in the tropics and subtropics. In Malesia, 12 species of which 5 are recorded in Sabah and Sarawak.

Ecology. In primary and secondary forests from lowlands to mountains to 3200 m.

Key to *Euonymus* species

(based on inflorescences and flowers)

1. Flowers 5-merous. Leaves without black gland-dots below.....2
 Flowers 4-merous. Leaves with black gland-dots below.....4
2. Petals fimbriate.....3
 Petals entire.....1. *E. acuminifolius*
3. Peduncles distinct.....3. *E. cochinchinensis*
 Peduncles obscure.....5. *E. javanicus*
4. Lateral veins of the leaves sunken above.....2. *E. castaneifolius*
 Lateral veins of the leaves not sunken above.....4. *E. glandulosus*

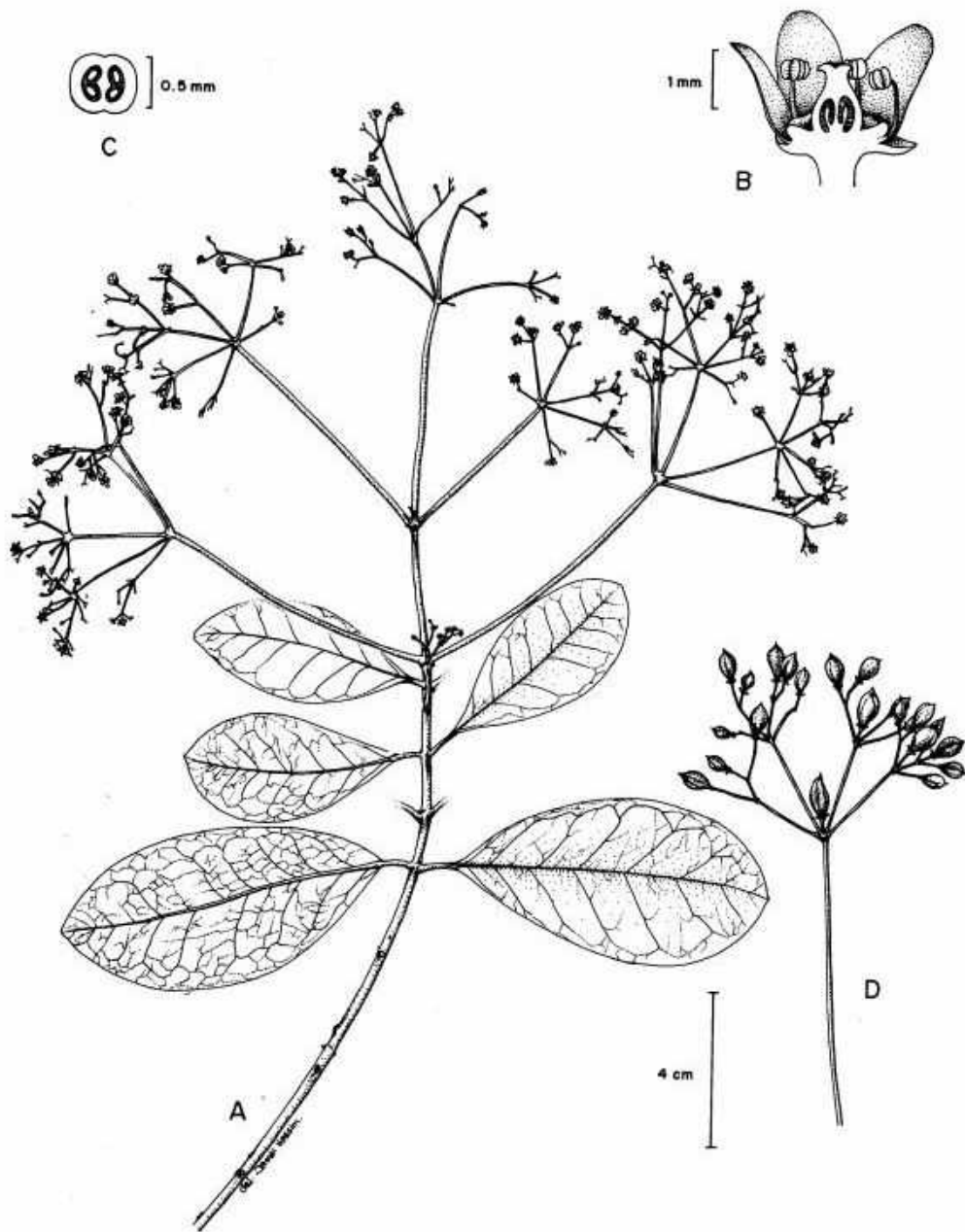


Fig. 2. *Cassine viburnifolia*. A, flowering leafy twig; B, half-flower; C, transverse section through ovary; D, infructescence. (A from *SAN* 61255, B & C after FM 1, 6 (1962) 285, fig. 18, D from *SAN* 38943.)

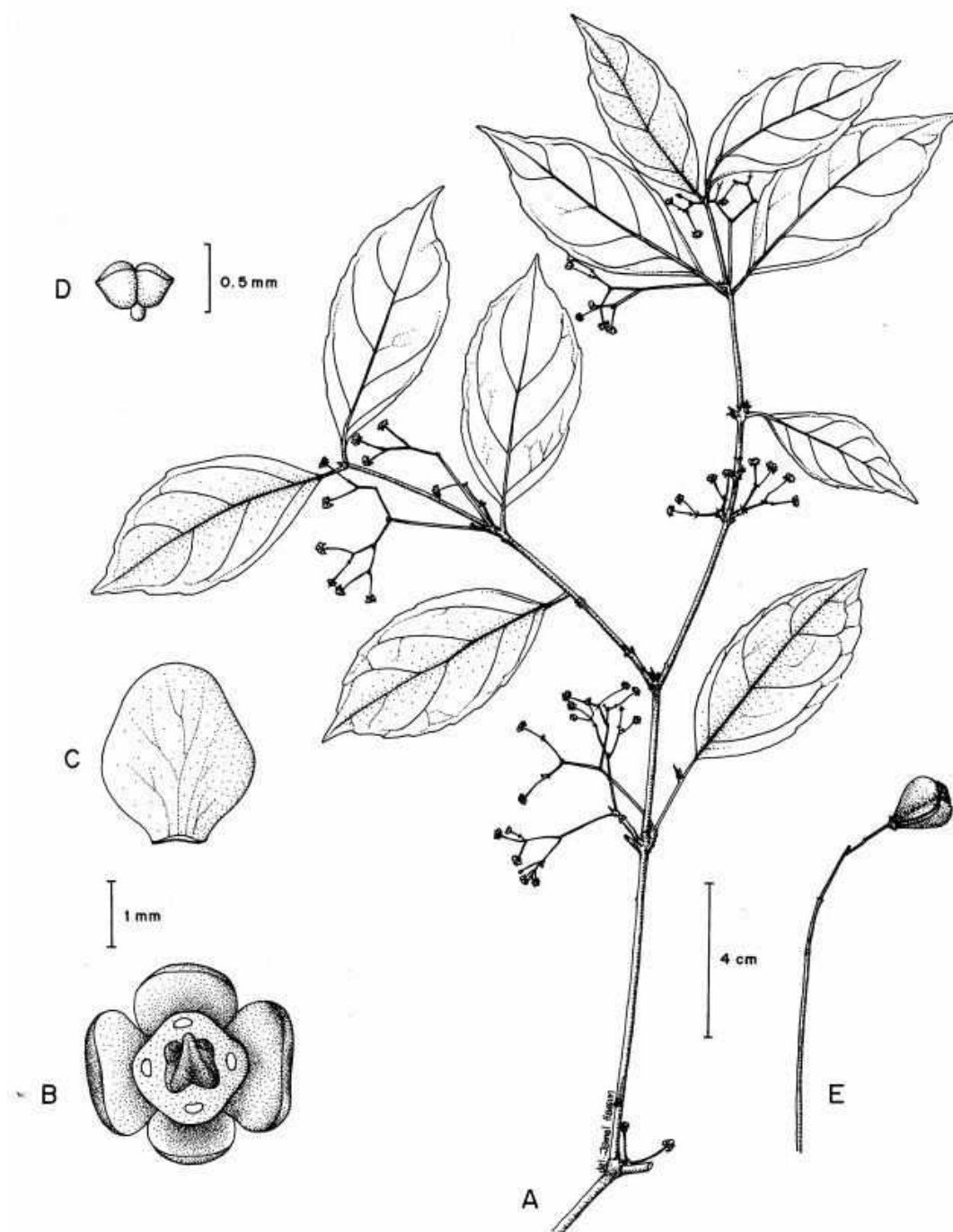


Fig. 3. *Euonymus castanaefolius*. A, flowering leafy twig; B, flower with petals and stamens removed; C, petal; D, young stamen; E, part of infructescence. (A from *SAN* 93113, B–D after FM 1, 6 (1962) 246, fig. 4, E from *S.* 47567.)

Key to *Euonymus* species

(based on leaves and twigs)

1. Leaf margin toothed.....2
 Leaf margin entire (sometimes faintly toothed in *E. cochinchinensis*).....3
2. Leaf lower surface with scattered black gland-dots. Lateral veins sunken above.....**2. *E. castaneifolius***
 Leaf lower surface without black gland-dots. Lateral veins not sunken above.....**1. *E. acuminifolius***
3. Twigs usually 4-angled. Leaf lower surface with scattered black gland-dots; margin strongly recurved.....**4. *E. glandulosus***
 Twigs not 4-angled. Leaf lower surface without scattered black gland-dots; margin not strongly recurved.....4
4. Leaf margin entire. Peduncle obscure.....**5. *E. javanicus***
 Leaf margin faintly toothed. Peduncle distinct.....**3. *E. cochinchinensis***

1. *Euonymus acuminifolius* Blakelock(Latin, *acuminatus* = long-pointed, *folius* = leaves)

l.c. 253; Ding Hou *l.c.* (1962) 251; Whitmore, Tantra & Sutisna *l.c.* 43. **Type:** *Bunnemeijer 581*, Sumatra, Ophir district, NW slopes of Mt. Talamau (BO). **Synonym:** *E. acuminifolius* Blakelock var. *borneensis* Blakelock *l.c.* 253.

Shrub to 4 m tall. Twigs 4-angled. **Leaves** membranous to chartaceous, ovate-oblong to lanceolate or elliptic to oblong, 7–10.5 x 2–4 cm, *lower surface without black gland-dots*; base cuneate, *margin toothed*, apex pointed, tip c. 2 cm long; *lateral veins* 4–6 pairs, arching near margin, *not sunken above*; petioles 2–6 mm long. **Flowers** in cymes, purplish red, 5-*merous*; calyx-lobes rounded, inner two usually larger; petals almost rounded, entire; disc obscurely 5-angular; stamens with very short filaments, anthers c. 0.5 mm long; ovary faintly 5-angled, stigma discoid, obscurely 5-angled. **Fruits** obcordate, distinctly 5-lobed, 1.5–2 x 1–1.7 cm. **Seeds** with aril at base.

Distribution. Sumatra, Borneo and Celebes. In Sabah uncommon, known only from Mt. Kinabalu (*Clemens 30350*, type of *E. acuminifolius* var. *borneensis*, and *Clemens 34478*). Not recorded from Sarawak.

Ecology. Montane forest at about 2700 m.

2. *Euonymus castaneifolius* Ridl.

Fig. 3.

(Latin, *castaneus* = chestnut-coloured, *folius* = leaves)

Kew. Bull. (1931) 36; *Masamune l.c.* 417; *Ding Hou l.c.* (1962) 251; *Cockburn l.c.* 56; *Anderson l.c.* 159; *Ashton l.c.* 94; *Whitmore, Tantra & Sutisna l.c.* 43. *Type:* Haviland 827, Sarawak, Kuching (holotype K; isotype BO). *Synonym:* *E. moultonii* Ridl *l.c.* (1931) 36, *Masamune l.c.* 417.

Small tree rarely reaching 12 m tall and 10 cm diameter. Bark grey-brown, smooth. Young twigs angled. Leaves drying to greenish grey, lower surface with scattered black gland-dots, elliptic to lanceolate, 7–17.5 x 3–5.5 cm; base cuneate, margin distantly faintly toothed, apex pointed; midrib raised above; lateral veins 6–10 pairs, sunken above, faint or rarely prominent below; intercostal veins invisible; petioles 10–15 mm long, drying to pale yellowish and wrinkled. Flowers in cymes, white, 4-merous; calyx-lobes rounded, inner pair largest; petals with few longitudinal veins; stamens inserted on the disc, anthers slightly depressed to oblong, ovary 4-angular towards the base. **Fruits** red on ripening, obovoid with truncate apex, 4-lobed at apex with 4 ridges, 10–18 x 7–10 mm, with persistent calyx. **Seeds** with cup-shaped aril at base.

Distribution. Sumatra and Borneo. Widely distributed in Sabah and Sarawak; also known in Kalimantan and Brunei.

Ecology. Lowland mixed dipterocarp forests on fertile clay-rich soils, near limestone and on basic volcanic rock to montane forests to 2700 m. Flowering in February–September and fruiting in January–March.

3. *Euonymus cochinchinensis* Pierre

(of Indo-China)

Fl. For. Coch. 4 (1894) t. 309 A; *Blakelock l.c.* 255; *Ding Hou l.c.* (1962) 248; *Whitmore, Tantra & Sutisna l.c.* 43. **Type:** *De Perry 4073*, Cochinchina, Trans Province (holotype P; isotype K). **Synonyms:** *Glyptopetalum scortechinii* King *l.c.* 345; *Euonymus philippinensis* Merr., *Philip. J. Sc.* 3 (1908) Bot. 238; *E. pahangensis* Ridl., *FMP* 5 (1925) 299.

Small tree to 12 m tall. Leaves chartaceous to subcoriaceous, elliptic, oblong or obovate, 4.5–16 x 2.5–7 cm, *lower surface without black gland-dots*; base cuneate to rounded, *margin entire or remotely toothed*, apex pointed; lateral and intercostal veins obscure or slightly elevated on both surfaces; petioles 3–8 mm. **Inflorescences** 3–10.5 cm long. **Flowers** greenish yellow, 5-merous; calyx-lobes fimbriate; *petals* broadly obovate *with fimbriate or toothed margins*; disc rounded and faintly 5-angled; stamen filaments flat, subulate; ovary narrowed towards apex, stigma obscure. **Fruits** broadly obovoid to subglobose, concave at apex, deeply 5-lobed. **Seeds** ellipsoid, 5–6 x 3–4 mm.

Distribution. Thailand, Indo-China, China (Hainan), Sumatra, Peninsular Malaysia, Borneo, Philippines, Celebes, Lesser Sunda Is., Moluccas and New Guinea. Uncommon in Borneo, known only by two collections (*Merrill 9644* and *Clemens 17445*) from Sabah.

Ecology. Coastal forests.

4. *Euonymus glandulosus* (Merr.) Ding Hou

(Latin, *glandulosus* = gland-bearing; black gland-dots on the leaf)

l.c. (1962) 251; Cockburn *l.c.* 56; Whitmore, Tantra & Sutisna *l.c.* 43. **Basionym:** *Glyptopetalum glandulosum* Merr., Philip. J. Sc. 12 (1917) Bot. 279. **Type:** Merrill 9547, Philippines, Palawan (holotype UC; isotypes BO, K).

Small tree to 5 m tall. Twigs terete to 4-angled. Leaves papery to leathery, elliptic to lanceolate or obovate, 4.5–12.5 x 2–4.5 cm, with scattered black gland-dots below; base cuneate, margin strongly recurved, almost entire, apex pointed; midrib raised above; lateral veins 4–5 pairs, *very faint to obscure*; *intercostal veins invisible*; petioles 5–8 mm long. **Flowers** *white or dark purple*, 4-merous; calyx-lobes almost rounded with faintly irregularly toothed margin, inner lobes thinner, larger and transparent; petals rounded to broadly obovate, with few longitudinal veins; stamens with very short filaments; disc obscurely 4-angled; ovary slightly 4-angled towards base. **Fruits** broad-obovoid, 10–18 x 10–15 mm, 4-lobed, *concave at apex*, smooth, yellow, ripening red. **Seeds** ellipsoid with disk-like aril at base.

Distribution. Borneo and Philippines. In Sabah, restricted to Mt. Kinabalu Park, but in Sarawak widely distributed.

Ecology. Hill and montane forests at 900–2700 m.

Ding Hou (*l.c.*) stated that the flowers are dark purplish but *SAN 37988* and *SAN 87659* have greenish or whitish flowers. *SAN 79981* from Mt. Kinabalu has thinner leaves with strongly toothed margins and with reddish flowers.

5. *Euonymus javanicus* Blume

(of Java)

Bijdr. (1826) 1146; Ridley *l.c.* (1922) 445; Blakelock *l.c.* 257; Ding Hou *l.c.* (1962) 248; Backer & Bakhuizen *f. l.c.* 53; Kochummen & Whitmore *l.c.* 162; Cockburn *l.c.* 56; Anderson *l.c.* 160; Ashton *l.c.* 95; Whitmore, Tantra & Sutisna *l.c.* 43. **Type:** *Blume, s.n.*, Java (holotype L; isotypes BO, K, SING.). **Synonyms:** *E. alatus* Elmer, Leaf. Philip. Bot. 4 (1912) 1484; *E. elmeri* Merr. *l.c.* (1917) 281; *E. coriaceus* Ridl. *l.c.* (1925) 299; *E. micropetalus* Ridl. *l.c.* (1925) 299.

Small tree to 15 m tall and 20 cm diameter. **Bark** grey-brown, smooth; inner bark pinkish. **Sapwood** yellowish. Twigs brownish. **Leaves** elliptic to oblanceolate, 7–15 x 3–6.5 cm, lower surface without black gland-dots; base cuneate, margin entire, not recurved, apex pointed; midrib raised above, pale yellow below on drying; lateral veins 5–7 pairs, *very faint* on both surfaces; *intercostal veins invisible*; petioles 0.5–1 cm long. **Flowers** yellowish, in clusters, 5-merous; peduncle obscure; calyx-lobes unequal, rounded; *petals* obovate or rounded with *fimbriate margins*; disc 5-angled; stamens with triangular anthers; ovary conical, style short, stigma obtuse. **Fruits** dark green, ripening red, broadly obovoid, 2–3.5 x 1.5–2.5 cm, with pointed tip and 5 well-developed ridges, stalk 1.5–2 cm long. **Seeds** black.

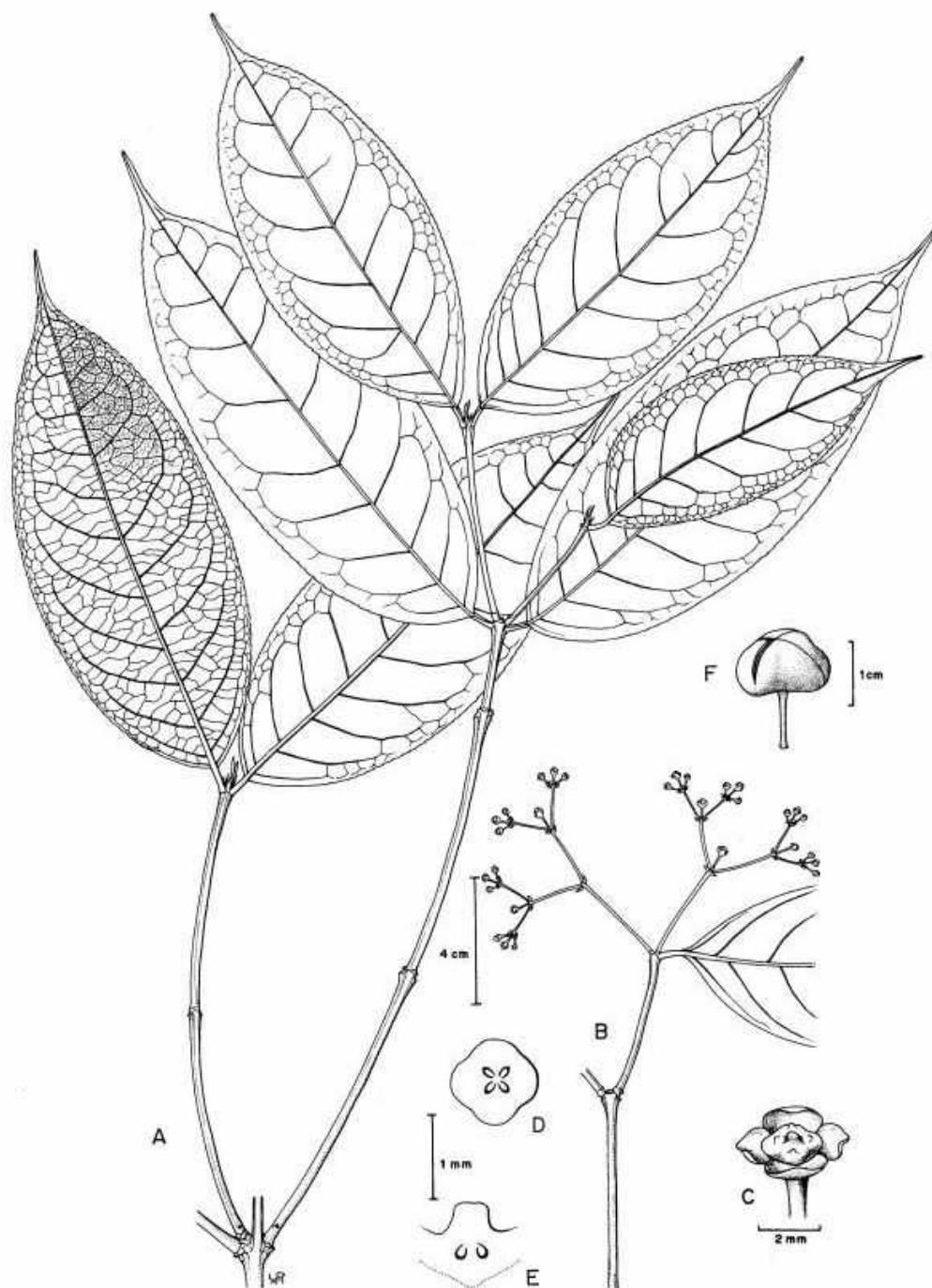


Fig. 4. *Glyptopetalum quadrangulare*. A, leafy twig; B, inflorescence; C, flower with stamens removed; D & E, ovary in longitudinal and transverse sections; F, fruit. (A from S. 16363, B from S. 34185, C–F after FM 1, 6 (1962) 255, fig. 7.)

Distribution. Nicobar Is., Burma, Thailand, Indo-China, Java, Borneo, Natuna Is., Philippines, Celebes, Lesser Sunda Isl., Moluccas, and New Guinea. In Sabah, known from Lahad Datu, Ranau, Tawau and Tenom districts. In Sarawak, uncommon, recorded from the Bukit Numpang and Tai Ton forests.

Ecology. Lowland (including limestone) to montane forests to 2400 m.

4. GLYPTOPETALUM Thwaites

(Greek, glypto = incised, petalum = petals)

in Hooker, J. Bot. Kew Misc. 8 (1856) 267; Ridley *l.c.* (1922) 446; Ding Hou *l.c.* (1962) 254; Kochummen & Whitmore *l.c.* 162; Anderson *l.c.* 160; Ashton *l.c.* 95.

Shrubs or small trees. **Leaves** opposite. **Inflorescences** cymose, axillary or extra-axillary. **Flowers** bisexual, 4-merous; calyx spreading, inner pair larger; petals free, fleshy with small appendage or depression inside; disc conspicuous, fleshy; stamens 4, inserted on the disc, near base of ovary, anthers opening apically; ovary semi-inferior, immersed in the disc, 4-celled, style obscure, stigma obscure, ovule one in each cell. **Fruits** capsules, when splitting leaving a persistent central columella. **Seeds** with fleshy aril at lower half.

Distribution. c. 20 species; India, Sri Lanka, Burma to Hainan, and Malesia. 8 species are present in Malesia; 2 in Sabah and Sarawak.

Ecology. Lowland to submontane forests to 1400 m.

Taxonomy. The genus is closely allied to *Euonymus* from which it differs in having only one ovule per ovary-cell.

Key to *Glyptopetalum* species

Leaf apex blunt or rounded. Twigs rounded.....1. *G. palawanense*

Leaf apex pointed. Twigs sharply 4-angled.....2. *G. quadrangulare*

1. *Glyptopetalum palawanense* Merr.

(of Palawan)

Philip. J. Sc. 26 (1925) 466; Ding Hou *l.c.* (1962) 257. **Type:** Forestry Bureau 29181, Philippines, Palawan (BO, K).

Small tree to 5 m tall. Twigs grey-green, rounded. **Leaves** leathery, drying to greenish yellow, obovate or elliptic, 10–14 x 5–8 cm; base cuneate, margin distantly toothed towards the upper half, apex blunt or rounded; midrib raised above; lateral veins 6–8 pairs, almost invisible below, faintly raised above; intercostal veins invisible; petioles 8–12 mm long. Flowers unknown. **Fruits** globose to depressed globose, c. 15 x 8 mm, 1–4-celled.

Distribution. Borneo and Philippines (Palawan). Uncommon in Borneo, known only from a sterile collection (Wong & Payne, *s.n.*, 27 April 1993) from Balambangan Island, off Kudat Peninsula, Sabah.

Ecology. Coastal limestone ridge.

2. *Glyptopetalum quadrangulare* Prain ex King

Fig. 4.

(Latin, quadrangularis = 4-angled; the twigs)

l.c. 345; Ridley *l.c.* (1922) 446; Ding Hou *l.c.* (1962) 257; Kochummen & Whitmore *l.c.* 162; Anderson *l.c.* 160; Ashton *l.c.* 95. **Type:** *King's collector 7106*, Perak (lectotype K; isoelectotype BO).

Shrub or small tree to 5 m tall, 5 cm diameter. *Twigs strongly 4-winged*. **Leaves** elliptic-lanceolate, 9–30 x 3–14 cm; base cuneate to rounded, *margin toothed from base to apex*, apex pointed; *lateral veins* 8–12 pairs, raised below, *sunken above*; intercostal veins reticulate; petioles 5–10 mm long. **Flowers** greenish yellow, in 12 cm long cymes; calyx almost divided to base, lobes reniform; petals suborbicular, fleshy, margin thinner, wavy; disc flat; stamens inserted near the base of ovary; ovary pyramidal, style and stigma obscure. **Fruits** c. 2 x 1–1.3 cm, depressed globose, sulcate, 3–4-celled.

Distribution. Burma, Sumatra, Peninsular Malaysia, and Borneo. In Sarawak uncommon, known only by two collections (*S. 16363* from Serian, and *S. 12549* from Bekup); not yet recorded from Sabah. Also known from Kalimantan.

Ecology. Lowland forests on limestone.

5. KOKOONA Thwaites

(*kookoon* = a Ceylonese plant name)

mata ulat (Malay), *bajan* (Iban)

in Hooker, J. Bot. Kew Misc. 5 (1853) 379; King *l.c.* 346; Merrill *l.c.* (1921) 354; Masamune *l.c.* 417; van Steenis, Sarawak Mus. J. 8 (1958) 437; Ding Hou *l.c.* (1962) 258, *l.c.* (1969) 105; Balan Menon, MF 17 (1964) 18; Backer & Bakhuizen *f. l.c.* 54; Smythies *l.c.* 38; Kochummen & Whitmore *l.c.* 163; Jansen *et al.*, Blumea 21 (1973) 153; Cockburn *l.c.* 56; Anderson *l.c.* 160; Wong *l.c.* 109; Ashton *l.c.* 97; Whitmore, Tantra & Sutisna *l.c.* 43; Ng *l.c.* 43; Kochummen, Sandakania 5 (1994) 51.

Small to very large trees; bole often with short buttresses. **Bark** grey to chocolate-brown, often with horizontal rings, smooth, cracking or fissured, *with large lenticels*; *middle bark ochre or orange*; inner bark pinkish or yellowish, fibrous. **Sapwood** white to yellow-brown with prominent pale bands. Twigs flattened at nodes, drying black. Stipules small. **Leaves** *decussate, occasionally subopposite or alternate*, margin entire, wavy or toothed. **Flowers** *bisexual*, in axillary panicles or racemes, *pedicels jointed*; sepals 5; petals 5, free, overlapping and twisted (contorted); disc conspicuous, fleshy, cup-shaped, corrugated or 5-lobed; stamens 5, inserted on the inner edge of the disc, *filaments abruptly narrowed towards the apex and transparent at the upper end*, anthers usually with prominent connective; *ovary superior or semi-inferior, 3-celled*, style obscure, stigma capitate, *ovules 6–16 in each cell*, in two rows down the central axis. **Fruits** *capsules*, 3-angled, 3-valved, splitting loculicidally. **Seeds** overlapping, flat, *with conspicuous membranous wing at the apical end*; endosperm absen; germination durian-type; cotyledons fleshy; seedlings with opposite leaves, without or with fine hair-like, deciduous stipules.

Distribution. 10 species; Southern India, Sri Lanka, Burma, Malesia. 8 species in Malesia of which 7 are present in Sabah and Sarawak.

Ecology. Found scattered in a wide range of inland forests including swamps to 1500 m.

Uses. The timber is a medium hardwood. It is easy to saw and cross-cut; suitable for heavy construction if treated and can be used as posts, beams, joints and railway sleepers. Also suitable for heavy-duty furniture, parquet-flooring, veneers, window and door-frames.

Taxonomy. The genera *Kokoona* and *Lophopetalum* are difficult to distinguish on vegetative characters alone. However, some species of *Kokoona* have wavy to toothed leaf margins and they dry with greenish tinge, while in *Lophopetalum* the leaves have entire margins and they usually dry to a dark brown colour. The important diagnostic character is in the seed which is surrounded by a membranous wing in *Lophopetalum*, while in *Kokoona* the wing is apical. There is a sharp difference in pollen grains between the two genera; pollen grains of *Kokoona* are single while that of *Lophopetalum* are in tetrads or polyads.

Key to *Kokoona* species

(based on flowers and fruits)

1. Fruit surface with abundant pustules. Twigs whitish.....**2. K. leucoclada**
Not this combination of characters.....2
2. Anthers with distinctly prolonged connective.....3
Anthers without or with obscure connective.....5
3. Connective longer than anther-cells.....**4. K. ochracea**
Connective shorter or as long as anther-cells.....4
4. Flower buds ovoid to globose; apex of calyx-lobes rounded or truncate....**3. K. littoralis**
Flower buds broad-ellipsoid; apex of calyx-lobes acute.....**1. K. coriacea**
5. Stamen filaments not broadened at base. Leaf margin strongly wavy and toothed toward apex.....**6. K. reflexa**
Stamen filaments with broad thickened base. Leaf margin recurved, entire or only slightly wavy.....6
6. Inflorescences many-branched. Stigmas not papillose. Leaf margin recurved; intercostal veins equally prominent as the lateral ones.....**5. K. ovatolanceolata**
Inflorescences with few short branches only. Stigmas papillose. Leaf margin entire or slightly wavy; intercostal veins very faint.....**7. K. sabahana**

Key to *Kokoona* species

(based on leaves and twigs)

1. Leaf-margin entire to faintly wavy.....2
 Leaf-margin toothed.....5
2. Twigs whitish. Leaves 6.5–10 cm wide; lateral veins 10–12 pairs....2. **K. leucoclada**
 Twigs blackish or dark-brown. Leaves to 6 cm wide; lateral veins 5–9 pairs.....3
3. Leaf-base almost rounded; margin strongly recurved. Common trees of peat and
 freshwater swamp forests.....5. **K. ovatolanceolata**
 Leaf-base not rounded; margin not recurved. Except for *K. sabahana*, usually not found
 in swamp forests.....4
4. Small pole-sized tree. Petiole to 7 mm long, channelled above.....7. **K. sabahana**
 Medium-sized tree. Petiole to 2 cm long, wrinkled on drying.....3. **K. littoralis**
5. Twigs strongly 4-angled. Leaves drying to dark brown above and purplish below.....
 1. **K. coriacea**
 Twigs not angled. Leaves drying pale yellow on both surfaces or pale greyish below.....6
6. Leaves when dry pale yellow on both surfaces; margin strongly wavy and distinctly
 toothed toward the apex.....6. **K. reflexa**
 Leaves when dry pale greyish below; margin shallowly toothed from the base to apex
 4. **K. ochracea**

1. *Kokoona coriacea* King

(Latin, *coriaceus* = leathery; the leaves)

l.c. 347; Ding Hou *l.c.* (1962) 261; Kochummen & Whitmore *l.c.* 164. **Type:** *Kunstler* 4226, Perak (holotype K; isotype BO). **Synonym:** *Lophopetalum coriacea* (King) Ridl. *l.c.* (1922) 450.

Medium-sized tree to 25 m tall, 35 cm diameter. **Bark** grey-white. *Twigs 4-angled* (somewhat like that of *Glyptopetalum quadrangulare*). **Leaves** leathery, *drying to dark brown above, and purplish below*, oblong, 11–13 x 5–7.5 cm; base cuneate, *margin toothed*, slightly recurved, apex pointed; midrib sharply keeled below; lateral veins 5–7 pairs, faint; intercostal veins invisible below; petioles c. 1 cm long. **Flowers** 5-merous, greenish yellow, fragrant; buds broad ellipsoid; calyx-lobes triangular, apex acute; petals with pale margin; *connective of anthers prolonged, almost as long as anthers*; free part of the ovary ovoid, gradually narrowed into an obscure style, stigmas globose. Fruits unknown.

Distribution. Peninsular Malaysia, Borneo. In Sarawak uncommon, known by a single collection (*S. 40130*) from Niah Cave National Park. Not yet recorded from Sabah.

Ecology. Lowland forest below 100 m.

This is the second collection of this species and a new record for Borneo. This species was until now known only from the type collected from Perak in Peninsular Malaysia.

2. *Kokoona leucoclada* Kochummen

(Greek, *leuco* = white, *cladus* = branch)

l.c. (1994) 51. **Type:** *Amin & Francis SAN 129399*, Sabah, Ranau (holotype SAN; isotypes K, L).

Medium-sized to large tree to 35 m tall, 20 cm diameter. Bark grey, smooth; inner bark pale brown. Sapwood ochre. Twigs whitish, youngest flattened, grooved in the centre. Leaves leathery, drying to grey-brown, elliptic to oblong, 16.5–20 x 6.5–10 cm; base cuneate, *margin faintly wavy*, slightly recurved, apex pointed; midrib raised above, keeled below; lateral veins 10–12 pairs, visible on both surfaces, distinctly looping near margin; intercostal veins reticulate, very faint; petioles 1–1.5 cm long. **Inflorescences** axillary, to 14 cm long, rachis rectangular, greyish. **Flowers** (immature) sessile, subtended by 5 bracteoles. **Fruits** c. 16 x 6 cm, with large pustules outside, on 20 cm long stalk. **Seeds** c. 12 x 2.5 cm.

Distribution. Endemic to Sabah. Uncommon, and known only from two collections, *SAN 129399* (the type) from Ranau and *SAN 61073* from Sandakan.

Ecology. Lowland forest.

The flowers are too young to give details of anther and ovary characters. The pustulate fruits and the white twigs distinguish this species from the others.

3. *Kokoona littoralis* Laws.

(Latin, *littoralis* = of the sea-shore)

in Hooker *f. l.c.* 617; Ding Hou *l.c.* (1962) 261; Burgess *l.c.* 73; Kochummen & Whitmore *l.c.* 164; Cockburn *l.c.* 57; Anderson *l.c.* 160; Ashton *l.c.* 100; Whitmore, Tantra & Sutisna *l.c.* 43. **Type:** *Maingay 396/2*, Malacca (holotype K; isotype BO).

Medium-sized tree to 27 m tall, 30 cm diameter, or rarely pole-sized treelet to 6 m tall and 2 cm diameter; bole slightly fluted with irregular hoops. **Bark** greyish or grey-brown with yellowish tinge, smooth to scaly. Twigs blackish on drying, slightly swollen at the nodes, youngest ones rectangular. **Leaves** thickly leathery, drying to dark green with purplish blotches above and pale yellowish below, elliptic-lanceolate to oblong or narrowly obovate, 5–20 x 1.5–6.5 cm; base broadly cuneate to rounded, apex pointed; *midrib faintly raised above*; lateral veins 6–9 pairs, very faint below, faint to inconspicuous above, looping and joining near margin; intercostal veins visible or invisible; petioles 0.5–2 cm long, wrinkled on drying. **Flowers** with yellow petals, pedicels 1–2.5 mm long; flower buds ovoid-subglobose, *calyx-lobes* semi-orbicular, *apex rounded or truncate*; petals broadly ovate, elliptic or suborbicular; *anthers with protruding connective to 1 mm long, slightly shorter*

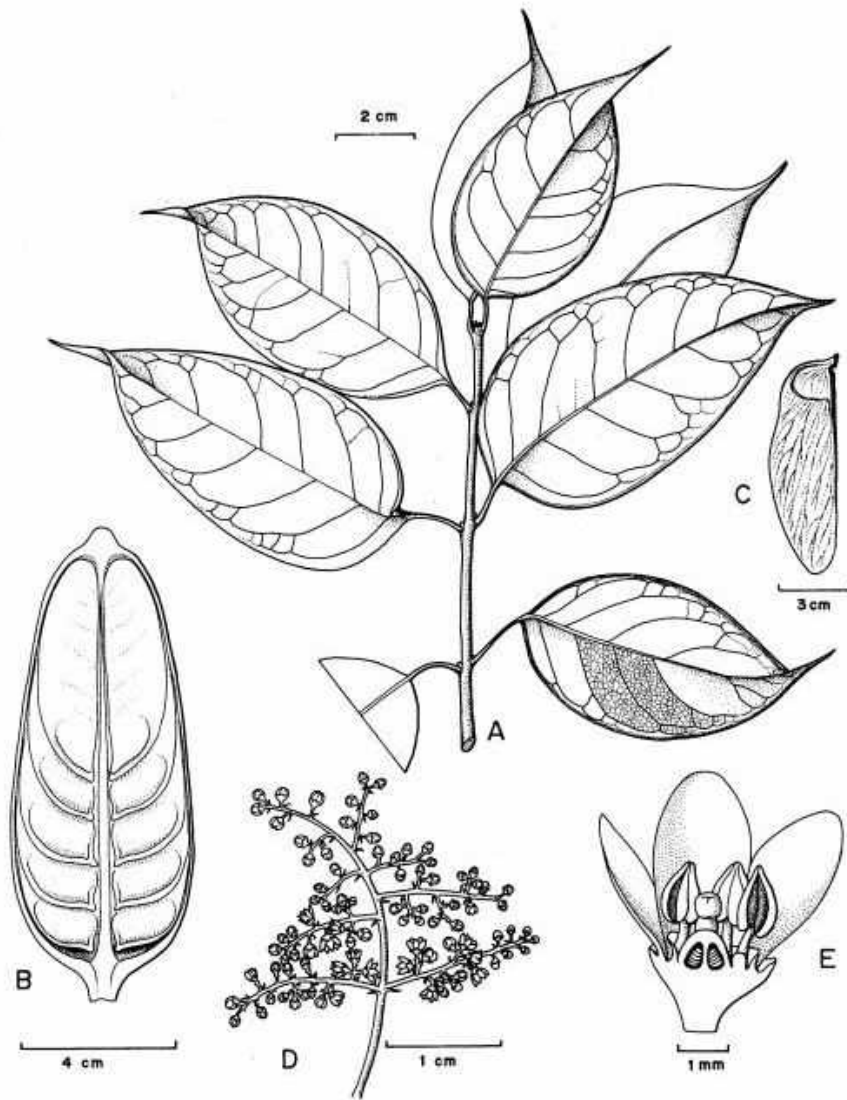


Fig. 5. *Kokoonia ovatolanceolata*. A, leafy twig; B, longitudinal section through fruit; C, seed; D, inflorescence; E, longitudinal section through flower. (A from *SAN A 1756*, B & C from *Anderson 9291* (22 November 1957), D & E after *FM 1, 6* (1962) 259, fig. 8.)

than the anthers; ovary triangular, style obscure, stigma capitate. **Fruits** 13–18 x 3–5.5 cm, base tapered. **Seeds** 7.5–12.5 x 2.5 cm (including wing).

Key to varieties

1. Leaves c. 20 x 6.5 cm, margin pinkish.....
 var. **longifolia** Kochummen
 l.c. (1994) 53. Type: *Wright & Ismawi S. 32289*, Sarawak, Limbang (holotype SAR; isotype K).
 Small tree to 18 m tall, 20 cm diameter. Bark greyish, smooth to scaly. Leaves thick-leathery, elliptic to lanceolate, c. 20 x 6.5 cm; petiole c. 2 cm long, channelled above; base cuneate, margin pinkish, apex pointed; midrib raised above; lateral veins 7–9 pairs, faint on both surfaces; intercostal veins laxly reticulate, very faint. Uncommon, known by a single collection (*S. 32289*) from Limbang, Sarawak. Lowland forest.
- Leaves to 11 x 6 cm, margin not pinkish.....2
2. Leaf apex blunt or rounded; intercostal veins invisible.....
 var. **bakoensis** Kochummen
 l.c. (1994) 53. Type: *Ding Hou 534*, Sarawak, Kuching (holotype SAR; isotype L).
 Small pole-sized tree to 6 m tall, 2 cm diameter. Leaves coriaceous, oblong with rounded or blunt apex, 5–11 x 1.5–4 cm; lateral and intercostal veins invisible. Locally frequent, known only from Bako National Park, Sarawak. Heath forest.
- Leaf apex pointed; intercostal veins visible.....
 var. **littoralis**
 Synonyms: *Lophopetalum dubium* Laws. in Hooker f. *l.c.* 616; *L. maingayi* Ridl. *l.c.* (1922) 450; *L. littoralis* (Laws.) Ridl. *l.c.* (1922) 450; *K. scortechinii* King *l.c.* 347; *K. lanceolata* Ridl., Kew Bull. (1938) 237, Masamune *l.c.* 417; *Solenospermum littorale* (Laws.) Loes., Notizbl. Berl. Dahl. 13 (1936) 223.
 Sumatra, Peninsular Malaysia, Borneo. In Sarawak, known from Semengoh Arboretum, Balingian, Belaga and Lundu. One sample was collected from G. Matang at 1000 m. Uncommon in Sabah with only 4 collections.

Ecology. Mixed dipterocarp forest on leached soils and heath forest to submontane forest to 1000 m, including limestone. Flowering in August–October and fruiting in May–July.

4. *Kokoona ochracea* (Elmer) Merr.

(Latin, *ochraceus* = yellow or yellowish brown; the colour of the flowers)

En. Philip. 2 (1923) 484, PEB (1929) 171; Masamune *l.c.* 417; van Steenis *l.c.* 438; Ding Hou *l.c.* (1962) 260; Burgess *l.c.* 74; Cockburn *l.c.* 57; Anderson *l.c.* 160; Ashton *l.c.* 101; Whitmore, Tantra & Sutisna *l.c.* 43. **Basionym:** *Ardisia ochracea* Elmer, Leaf. Philip. Bot. 5(1913) 1819. **Type:** *Elmer 12881*, Philippines, Palawan (holotype K; isotype BO).

Medium-sized tree to 30 m tall, 50 cm diameter. Twigs black, terete. **Leaves** elliptic to ovate or lanceolate, 7–13.5 x 3.5–6 cm, *drying pale greyish below*; base broadly cuneate, *margin shallowly toothed*, apex pointed; midrib raised or flattened above; lateral veins 5–8 pairs,

slightly raised on both surfaces; petioles c. 1 cm long. **Flowers** *almost sessile*, in 12 cm long panicles; calyx-lobes semi-orbicular; petals fleshy, ovate or elliptic, margin thin and transparent; anthers subglobose, *connective prolonged, longer than the anthers*; ovary conical, style obscure, stigma cylindrical. Fruits unknown.

Vernacular name. Sabah—*perupok kuning* (Dusun, Malay).

Distribution. Peninsular Malaysia, Borneo, and Palawan Is. In Sabah, reported from Kinabatangan, Lahad Datu, Tenom and Tawau districts. In Sarawak, collections were made from northeastern parts.

Ecology. Scattered in mixed dipterocarp forests at low altitude.

5. *Kokoona ovatolanceolata* Ridl.

Fig. 5.

(Latin, *ovatus* = egg-shaped, *lanceolatus* = tapering toward both ends; the leaf shape)

l.c. (1938) 236; Masamune *l.c.* 417; Ding Hou *l.c.* (1962) 261; Smythies *l.c.* 39; Cockburn *l.c.* 57; Anderson *l.c.* 160; Ashton *l.c.* 100; Whitmore, Tantra & Sutisna *l.c.* 43. **Type:** *Beccari PB 3471*, Sarawak (holotype FI; isotypes BO, K). **Synonym:** *K. scortechinii* (non King) Steenis *l.c.* 438.

Tree to 36 m tall. **Bark** smooth to scaly, hoop-marked. **Twigs** dark brown to blackish. **Leaves** ovate to ovate-lanceolate or elliptic, 7–11.5 x 4–5 cm; base rounded to broadly cuneate, *margin strongly recurved*, apex pointed; midrib flattened above; *lateral veins* 5–6 pairs, very faint on both surfaces and hardly distinguishable from the equally prominent reticulate intercostal veins; petioles 1–1.5 cm long, wrinkled and yellowish on drying. **Inflorescences** many-branched panicles, to 14 cm long. **Flowers** yellowish, fragrant, buds globose, c. 2 mm across; calyx-lobes suborbicular or reniform; petals ovate; anthers ovoid, *connective not prolonged*, filaments with broad thickened base; ovary ovoid, *style distinct*, stigma obtuse, not papillose. **Fruits** narrow-oblong, 10–17 x 3–5 cm. **Seeds** 7–11 x 2–2.5 cm (including wing).

Vernacular name. Sarawak—*bajan paya* (Iban, Malay).

Distribution. Endemic to Borneo. In Sabah, collected from Papar district and in Sarawak from Baram, Marudi and Sibul. Common in Brunei.

Ecology. Known from heath, peat and freshwater swamp forests.

6. *Kokoona reflexa* (Laws.) Ding Hou

(Latin, *reflexus* = recurved; the leaf tip)

l.c. (1962) 262; Burgess *l.c.* 74; Kochummen & Whitmore *l.c.* 164; Cockburn *l.c.* 57; Anderson *l.c.* 40; Ashton *l.c.* 101; Whitmore, Tantra & Sutisna *l.c.* 44. **Basionym:** *Lophopetalum reflexum* Laws. in Hooker *f. l.c.* 616. **Type:** *Maingay 383/2*, Malacca (holotype K; isotype BO). **Synonym:** *Hippocratea maingayi* Laws. in Hooker *f. l.c.* 625.

Emergent tree, to 50 m tall and 130 cm diameter; bole with stout buttresses. **Bark** dull grey-brown, smooth, hoop-marked, becoming scaly. **Leaves** elliptic to lanceolate, 5.5–11 x 2.5–4 cm; base cuneate, *margin strongly wavy and toothed towards the apex*; apex pointed; midrib

raised above; lateral veins 5 pairs, slightly raised on both surfaces; *petioles* slender, 7–15 mm long, *pale yellow on drying*. **Flowers** pale yellowish green; calyx suborbicular; petals ovate, or broadly elliptic; anthers oblong, *connective not protruding*, filaments not broadened at base; ovary ovoid, narrowed to an obscure style, stigma rounded with flat top. **Fruits** c. 12 x 3 cm. **Seeds** 9–11 x 2.5 cm including the wing.

Distribution. Sumatra, Peninsular Malaysia, and Borneo. Uncommon in Sabah, known from a single collection (SAN 64149) from Ranau. In Sarawak, locally frequent, recorded from Lundu, Semengoh, G. Gaharu, G. Matang, and Bako National Park.

Ecology. Mixed dipterocarp forests.

7. *Kokoona sabahana* Kochummen (of Sabah)

l.c. (1994) 55. **Type:** *Asik* SAN 129928, Sabah, Nabawan (holotype SAN; isotypes A, BO, K, L, OX, SAR, SING).

Small tree to 12 m tall, 10 cm diameter. **Bark** pale grey; inner bark brownish. **Sapwood** yellowish. Twigs dark brown to black, swollen at the nodes. **Leaves** elliptic to oblong, 7–11 x 4–6 cm, shiny, drying to yellowish brown; base broadly cuneate, *margin entire or slightly wavy, apex pointed or blunt*; midrib very faintly visible above; lateral veins 6–7 pairs, looping near margin, visible below, faint above; intercostal veins reticulate, faintly visible below; petioles 5–7 mm long, channelled above. **Inflorescences** axillary or terminal panicles, to 6 cm long, with a few branches. **Flowers** 5-merous; buds subglobose, c. 3 mm across; pedicels c. 2 mm long, articulated; sepals triangular; petals slightly obovate with pale margin; disc 5-lobed; stamens inserted within the disc, filaments broad and flat below, tapering towards the apex, *anthers without protruding connective*; ovary immersed in the disc, style distinct, *stigma* capitate, *with papillae at the top*. Fruits unknown.

Distribution. Endemic to Borneo. Uncommon, known only from 3 collections from Sabah, SAN 129928 (the type) from Nabawan, SAN 61465 from Tawau, and SAN 43778 from Sandakan.

Ecology. Lowland (including swamp) to hill forests to 600 m.

Close to *K. ovatolanceolata* from which it differs by the few-branched, short panicles, larger flowers, papillose stigma, and shorter petiole.

6. *LOPHOPETALUM* Wight *ex* Arn. (Greek, *lophos* = crested, *petalum* = petal)

perupok (Malay, Iban)

Ann. Mag. Nat. Hist. 1, 3 (1839) 150; Merrill *l.c.* (1921) 354; Ridley *l.c.* (1922) 447; Masamune *l.c.* 418; Browne *l.c.* 77; Ding Hou *l.c.* (1962) 262, *l.c.* (1969) 108; Backer & Bakhuizen *f. l.c.* 54; Balan Menon *l.c.* 18; Smythies *l.c.* 38; Burgess *l.c.* 76; Kochummen & Whitmore *l.c.* 165; Jansen *et al. l.c.* 153; Cockburn *l.c.* 58; Anderson *l.c.* 160; Wong *l.c.* 121; Ashton *l.c.* 102; Whitmore, Tantra & Sutisna

l.c. 44; Ng *l.c.* 44. **Synonym:** *Solenospermum* Zoll., Nat. Tijd. Ned. Ind. 14 (1857) 168, Masamune *l.c.* 419.

Small to very large trees to 45 m tall and 180 cm diameter; bole with or without buttresses, occasionally with pneumatophores. **Bark** similar to *Kokoona*. Twigs pale whitish, dark brown to blackish, often flattened at the nodes. **Leaves** *opposite or subopposite, margin entire*. **Inflorescences** axillary, peduncles distinct or obscure, *pedicels jointed*. **Flowers** *bisexual*, 5-merous (except ovary); calyx-lobes spreading, inflexed or reflexed; petals free, imbricate, inner surface partly covered with appendages or without; disc conspicuous, usually fleshy and flat, surface smooth or denticulate, 5-angular, rounded or 5-lobed; stamens 5, inserted on the disc, anthers introrse, pollen grains in clusters of fours (tetrads); ovary usually *semi-inferior, 3-celled*, style short, stigma obscure, *ovules 4–18 in each cell*, arranged in two series. **Fruit** a *capsule*, 3-angled. **Seeds** flat, surrounded by membranous wing; endosperm absent; germination as in *Kokoona*; cotyledons very thin, seedlings leaves minutely bistipulate, the first two leaves opposite, subsequent leaves alternate on the leader shoots but opposite on the branches.

Distribution. About 18 species; India, Burma, Thailand, Indo-China, Malesia, and Australia. In Malesia 15 species, 10 of which are in Sabah and Sarawak.

Ecology. Lowland (including swamp) to submontane forests to 1500 m.

Uses. The timber is a light hardwood. It is suitable for interior finishing, panelling, partitioning, furniture, veneers, plywood, boxes, crates and mathematical instruments.

Key to *Lophopetalum* species (based on leaves and twigs)

1. Leaves short-petioled or almost sessile.....2
 Leaves with distinct petioles.....3
2. Twigs rounded, not winged. Lateral veins 5–7 pairs, sunken above.....**2. L. glabrum**
 Twigs winged, lateral veins 10–15 pairs, not sunken above.....**8. L. sessilifolium**
3. Leaves drying to greenish brown above, lower surface with black gland-dots.....
 **1. L. beccarianum**
 Not this combination of characters.....4
4. Intercostal veins invisible below.....5
 Intercostal veins faint to distinctly visible below.....7
5. Blade thinly leathery, apex rounded or notched; lateral veins 4–6 pairs.....
 **9. L. subobvatum**
 Blade thickly leathery, apex pointed, blunt or rounded; lateral veins 4–11 pairs.....6

6. Petioles 2–2.5 cm long. Blade densely papillose below, margin curled inwards.....**5. L. pachyphyllum**
 Petiole 3–8 mm long. Blade not papillose below, margin not curled inwards.....**7. L. rigidum**
7. Intercostal veins prominently raised below.....**10. L. wightianum**
 Intercostal veins faint below.....8
8. Leaves pale whitish below. Twigs pale whitish.....**6. L. pallidum**
 Leaves not pale whitish below. Twigs dark brown to blackish.....9
9. Lateral veins 8–10 pairs. Petiole 1–1.5 cm long.....**3. L. javanicum**
 Lateral veins 10–15 pairs. Petiole 1.5–3 cm long.....**4. L. multinervium**

Key to *Lophopetalum* species
 (based on flowers and leaves)

1. Flower buds almost flat, or wider than long; petals without appendages on the inner surfaces.....2
 Flower buds conical or subglobose, longer than wide; petals with appendages on the inner surfaces.....5
2. Twigs distinctly 4-angled to winged. Inflorescences 18–50 cm long; pedicels 7–15 mm long.....**8. L. sessilifolium**
 Twigs usually rounded. Inflorescences to 15 cm long; pedicels to 9 mm long.....3
3. Disc dish-shaped, 5-lobed.....4
 Disc suborbicular, flat or obscurely 5-angled.....**7. L. rigidum**
4. Petioles 7–15 mm long. Leaves with black gland-dots below; lateral veins not sunken above.....**1. L. beccarianum**
 Petioles to 3 mm long. Leaves without black gland-dots below; lateral veins sunken above.....**2. L. glabrum**
5. Disc 4.5–9.5 mm in diameter at anthesis.....6
 Disc 1–3 mm in diameter at anthesis.....7
6. Leaves densely papillose beneath, intercostal veins invisible.....**5. L. pachyphyllum**
 Leaves not papillose beneath, intercostal veins prominent below.....**10. L. wightianum**
7. Disc with fleshy subulate processes around the base of filaments. Leaves pale whitish below.....**6. L. pallidum**
 Disc smooth or minutely papillose. Leaves not pale whitish below.....8
8. Leaf-apex rounded or notched; lateral veins 4–6 pairs.....**9. L. subovatum**
 Leaf-apex pointed; lateral veins 8–15 pairs.....9
9. Petals 1–1.5 cm long. Lateral veins 8–10 pairs.....**3. L. javanicum**
 Petals 1.5–3 cm long. Lateral veins 10–15 pairs.....**4. L. multinervium**

1. *Lophopetalum beccarianum* Pierre

Fig. 6A–D.

(Odoardo Beccari, Italian explorer and botanist, 1843–1920)

Fl. For. Coch. 4 (1894) sub t. 307; Merrill *l.c.* (1921) 354; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 266; Smythies *l.c.* 39; Kochummen & Whitmore *l.c.* 165; Cockburn *l.c.* 59; Anderson *l.c.* 160; Ashton *l.c.* 103; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** Beccari PB 2475, Sarawak (holotype FI; isotypes BO, K). **Synonyms:** *Lophopetalum scortechinii* King *l.c.* 350; *L. havilandii* Ridl. *l.c.* (1931) 37, Masamune *l.c.* 418.

Small to medium-sized tree, rarely to 36 m tall and 60 cm diameter. **Bark** grey-brown, smooth, hoop-marked; inner bark pale brown. **Sapwood** pale yellow. Twigs dark brown to black, rounded. **Leaves** ovate, elliptic or oblong, drying to greenish brown above, *with abundant black gland-dots below*, 4–30 x 2.5–9 cm; base cuneate, apex pointed or blunt; midrib raised above; *lateral veins* 5–8 pairs, visible below, faint above, *often pinkish when dried*; intercostal veins very faint; petioles 7–15 mm long. **Flowers** yellowish, in axillary panicles to 15 cm long; buds flat; pedicels c. 5 mm long; calyx-lobes triangular or suborbicular; petals suborbicular or broadly ovate, usually without appendages on inner side, sometimes with distinct veins; disc dish-shaped, 5-lobed; stamen filaments with cushion-like thickening at base; ovary pyramidal, style and stigma obscure. **Fruits** 5.2–11 x 3–3.2 cm. **Seeds** 4.5 x 1.5–1.2 cm (including wing).

Distribution. Peninsular Malaysia and Borneo. In Sabah and Sarawak frequent.

Ecology. Mixed dipterocarp forest to submontane forest to 1800 m, mainly on ridges and hillsides on clay-rich soils. Flowering in February–November.

2. *Lophopetalum glabrum* Ding Hou

Fig. 6E.

(Latin, *glabrus* = smooth; without pubescence)

l.c. (1962) 266; Anderson *l.c.* 160; Ashton *l.c.* 105; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** Rutten 83, E Borneo (holotype U; isotype BO).

Small tree to 15 m tall, 15 cm diameter. **Bark** grey-white; inner bark yellowish. **Sapwood** white. Twigs grey-brown, rounded. **Leaves** elliptic or oblong, 8–16 x 2.5–5.5 cm, without black gland-dots below; base cuneate, apex pointed; midrib raised above; *lateral veins* 5–7 pairs, raised below, *usually sunken above*, curving and joining near margin; intercostal veins reticulate, faint below, visible above; *petioles to 3 mm long, cracking*. **Flowers** yellowish, in branched panicles, to 9 cm long; buds flat; pedicels 5–7 mm long; calyx-lobes deltoid with pointed tips; petals suborbicular, without appendages inside; disc dish-shaped, 5-lobed; anthers suborbicular; ovary pyramidal, style and stigma obscure. **Fruits** reddish brown when fresh, obovoid, 10–12.5 x 3 cm, apex rounded, drying brownish, surface pustulate. **Seeds** 4 in each locule, c. 7.5 x 1.5 cm.

Distribution. Endemic to Borneo. Widespread in Sabah and Sarawak, also found in Brunei and Kalimantan.

Ecology. Mixed dipterocarp forests on clay-rich soils to 400 m. Flowering in April and September and fruiting in March.

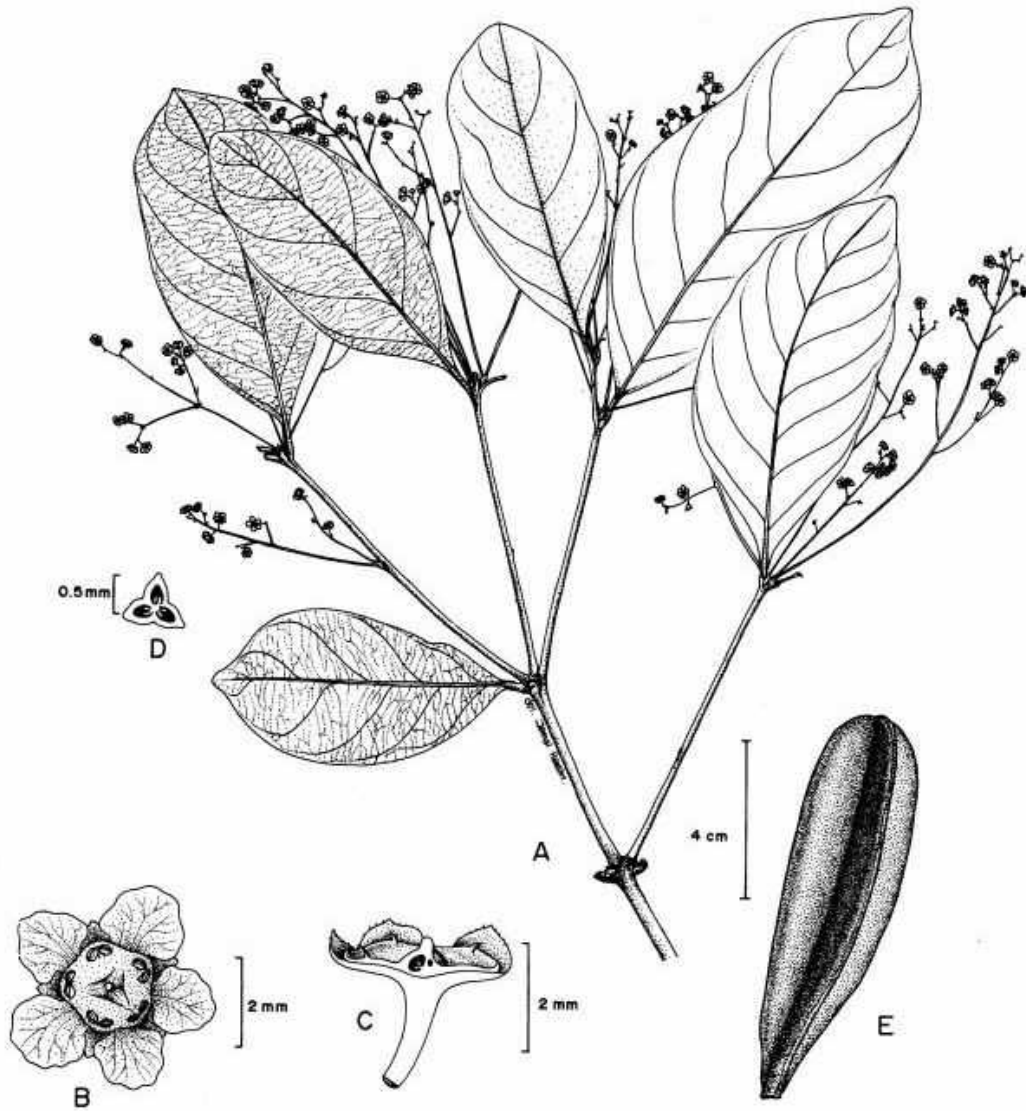


Fig. 6. *Lophopetalum beccarianum* (A–D) and *L. glabrum* (E). A, flowering leafy twig; B, flower, top view; C, longitudinal section through flower, with petals removed; D, transverse section through ovary; E, fruit. (A from SAN 16022, B–D after FM 1, 6 (1962) 263, fig. 10, E from SAN 91886.)

3. *Lophopetalum javanicum* (Zoll.) Turcz. (of Java)

Bull. Soc. Nat. Hist. Mosc. 36 (1863) 598; Ding Hou *l.c.* (1962) 269; Backer & Bakhuizen *f. l.c.* 54; Smythies *l.c.* 39; Burgess *l.c.* 77; Kochummen & Whitmore *l.c.* 168; Cockburn *l.c.* 60; Anderson *l.c.* 161; Ashton *l.c.* 104; Whitmore, Tantra & Sutisna *l.c.* 44. **Basionym:** *Solenospermum javanicum* Zoll. *l.c.* 169. **Type:** Zollinger 3254, Java (lectotype L; isolectotype BO). **Synonyms:** *Lophopetalum fuscescens* Kurz, J. As. Soc. Beng. 44, 2 (1875) 202; *L. oblongum* King *l.c.* 350; *L. oblongifolium* King *l.c.* 351; *L. intermedium* Ridl., J. Str. Br. R. As. Soc. 59 (1911) 85; *L. paucinervium* Merr., Philip. J. Sc. 20 (1922) 402; *Solenospermum paucinervium* (Merr.) Loes. *l.c.* 223; *S. oblongifolium* (King) Loes. in Engler & Prantl, Pfl. Fam. 2, 20b (1942) 162.

Medium-sized tree to 30 m tall, 90 cm diameter. **Bark** yellowish grey, smooth to cracking, lenticellate; inner bark pink. **Sapwood** pale. *Twigs strongly angled, often glaucous*, dark brown to black. **Leaves** *drying to dark brown*, not pale whitish beneath, elliptic to oblong or obovate, 8–15 x 4–7 cm; base cuneate, apex pointed; midrib raised above; *lateral veins 8–10 pairs*, raised below, faint to inconspicuous or sunken above; *intercostal veins* reticulate, *faintly visible below*, invisible above; petioles 1–1.5 cm long. **Flowers** in panicles; buds short-conical or subglobose; calyx-lobes spreading, margin ciliate; *petals with lobed appendages inside*; disc 1–3 mm across at anthesis; stamens with distinct (1.5 mm long) filaments; ovary triangular, narrowed into a cylindric style, stigma obscure. **Fruits** 4.8–11 x 2.5 cm. **Seeds** 6.0–6.5 x 1.3–1.6 cm.

Distribution. Thailand, Sumatra, Peninsular Malaysia, Java, Borneo, Philippines, Celebes and New Guinea. Common in Sabah and Sarawak.

Ecology. Lowland to hill and montane forests, mainly in mixed dipterocarp forests, sometimes by river banks and peat swamps. Flowering in March–June and fruiting in September.

Uses. The bark is used in Borneo as a constituent of dart poison.

There is a tendency of "witches broom" developing on the leafy shoots which can be mistaken for inflorescences. Blackish twigs, shorter petioles, inconspicuous intercostal veins and the absence of pneumatophores are good field characters to separate *L. javanicum* from *L. multinervium*.

4. *Lophopetalum multinervium* Ridl. (Latin, *multi* = many, *nervus* = veins; the leaves)

l.c. (1931) 39; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 270; Smythies *l.c.* 39; Burgess *l.c.* 77; Kochummen & Whitmore *l.c.* 168; Cockburn *l.c.* 60; Anderson *l.c.* 161; Ashton *l.c.* 105; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** Beccarii PB 3659, Sarawak (holotype FI; isotypes BO, K). **Synonym:** *Solenospermum aquatile* Ridl. *l.c.* (1938) 236, Masamune *l.c.* 419.

Tree to 36 m tall, 60 cm diameter; *bole with tall buttresses and pneumatophores*. **Bark** yellowish, smooth, lenticellate; inner bark pinkish. **Sapwood** whitish. Twigs dark brown, youngest ones angled. **Leaves** leathery, not pale whitish below, ovate to oblong or elliptic, 10–18 x 4–8 cm, *drying brownish*; base rounded, obtuse or broadly cuneate, apex pointed; midrib raised above; lateral veins 10–15 pairs, raised on both surfaces; *intercostal veins*

distinct below; petioles 1.5–3 cm long. **Flowers** in panicles, pink to dark reddish to purplish or yellowish or whitish; buds short-conical or subglobose; calyx triangular, margin ciliate; *petals with lobed appendages at the inner side near base*; disc 1–3 mm across at anthesis; *stamens filaments distinct, c. 1.7 mm long*. **Fruits** 4–8.5 x 1.5–2.5 cm, furfuraceous outside. **Seeds** c. 5 x 1.25 cm.

Distribution. Sumatra, Peninsular Malaysia, and Borneo. In Sabah and Sarawak widely distributed.

Ecology. Freshwater and peat swamp forests (very rarely in submontane forests at 1500 m). Flowering in March to August.

5. *Lophopetalum pachyphyllum* King

(Greek, *pakus* = thick, *phyllon* = leaf; thick-leaved)

l.c. 348; Ridley *l.c.* (1922) 448; Ding Hou, *l.c.* (1962) 267; Kochummen & Whitmore *l.c.* 168. **Type:** *King's collector 7525, Perak (BO, K).*

Medium-sized tree to 25 m tall and 30 cm diameter. Twigs stout, c. 1 cm thick, dark brown. **Leaves** thickly leathery, elliptic, *drying to greenish grey, densely papillose below*, c. 10 x 5 cm; base broadly cuneate, *margin curled inwards*, apex blunt; midrib raised above, lateral veins 6–7 pairs, very faint on both surfaces; intercostal veins invisible; petioles 2–2.5 cm long, stout, dark brown. **Inflorescences** panicles to 10 cm long, pedicels to 1 cm long. **Flowers** c. 1.5 cm across; buds short-conical or subglobose; calyx faintly 5-lobed; petals with small appendage inside; disc obscurely 5-lobed, 4.5–9.5 mm across at anthesis; stamens with distinct filaments; ovary ovoid. Fruits unknown.

Distribution. Sumatra, Peninsular Malaysia and Borneo. In Sarawak uncommon, known by two collection (*S. 6961* and *S. 16212*) from Bako National Park; not yet recorded from Sabah.

Ecology. Lowland forests near the coasts.

6. *Lophopetalum pallidum* Laws.

(Latin, *pallidus* = pale; the dry leaves)

in Hooker *f. l.c.* 615; Ridley *l.c.* (1922) 449; Ding Hou *l.c.* (1962) 268; Burgess *l.c.* 77; Kochummen & Whitmore *l.c.* 168; Anderson *l.c.* 161; Ashton *l.c.* 106; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** *Maingay 1389, Malacca (BO, K).* **Synonyms:** *L. curtisii* King *l.c.* 351; *Solenospermum pallidum* (Laws.) Loes. *l.c.* 225.

Tree to 45 m tall, 80 cm diameter. **Bark** grey, scaly; inner bark orange-brown. **Sapwood** whitish. *Twigs pale whitish*. **Leaves** *thinly leathery, glaucous below*, elliptic to narrowly obovate, 7–11 x 2.5–6.5 cm; base cuneate, apex cuspidate with short tip; midrib raised above, *pale whitish below*; lateral veins 8–10 pairs with short intermediate veins, very faint on both surfaces; intercostal veins very faint; *petioles* 1.5–2 cm long, *pale whitish*. **Flowers** in panicles; buds short-conical or subglobose; calyx semi-orbicular or triangular; petals with

fleshy lobed processes in the central part inside; disc 1–3 mm across at anthesis; *stamens surrounded by fleshy subulate processes of the disc*; ovary triangular, style cylindric. **Fruits** c. 15 cm long. **Seeds** c. 9 x 2.3 cm.

Distribution. Sumatra, Peninsular Malaysia, Borneo. In Sabah uncommon, known by only two collection (SAN 74348 and SAN 65428) from Sandakan and Tawau respectively. In Sarawak known from Bintulu, Bt. Mersing, Bt. Raya, and Kapit.

Ecology. Mixed dipterocarp forests on clay soils.

Uses. In Peninsular Malaysia the bark is used as an ingredient in making dart poison by the aborigines.

7. *Lophopetalum rigidum* Ridl.

(Latin, *rigidus* = stiff; the leaf texture)

l.c. (1931) 38; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 267; Smythies *l.c.* 39; Burgess *l.c.* 77; Cockburn *l.c.* 58; Anderson *l.c.* 161; Ashton *l.c.* 106; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** *Haviland 2236*, Sarawak, Kuching (BO, K). **Synonym:** *L. subsessile* Ridl. *l.c.* (1931) 37, Masamune *l.c.* 418.

Shrub or small tree, very rarely reaching 30 m tall and 40 cm diameter. **Bark** grey-brown, smooth, hoop-marked with vertical line of lenticels; inner bark purplish brown. **Sapwood** yellow-brown. *Twigs dark brown, rounded*. **Leaves** thickly leathery, drying to greenish brown or reddish brown, not papillose below, ovate-oblong, 4.5–21 x 2–4 cm; base broadly cuneate to rounded, margin not curled inwards, apex pointed or rounded; midrib raised above; lateral veins 4–11 pairs, visible below, faint to invisible above, looping near margin; intercostal veins invisible; petioles stout, 3(–8) mm long. **Flowers** yellowish green, in 10 cm long panicles, pedicels to 5 mm long; buds almost flat, suborbicular or obscurely 5-angled; calyx-lobes ovate or triangular, pointed, with small papilla-like processes outside; petals triangular or suborbicular, without appendages inside, with papilla-like processes outside; disc suborbicular, flat or obscurely 5-angled; stamens with small short-apiculate anthers; ovary pyramidal, style cylindrical. **Fruits** to 11 cm long, surface shortly tuberculate. **Seeds** c. 5.5 x 1.5 cm, including wing.

Distribution. Endemic to Borneo. In Sabah, recorded from Lahad Datu (common), Keningau and Ranau. In Sarawak, locally frequent.

Ecology. Freshwater swamps, peat swamps, *kerangas* swamps and also in montane forests to 2400 m.

8. *Lophopetalum sessilifolium* Ridl.

(Latin, sessile = stalkless, folium = leaves)

l.c. (1931) 37; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 265; Anderson *l.c.* 161; Ashton *l.c.* 107; Whitmore, Tantra & Sutisna *l.c.* 44. **Type:** *Haviland 1744*, Sarawak, Kuching (BO, K).

Small tree, rarely reaching 20 m tall, 20 cm diameter. *Twigs* dark brown, *strongly 4-angled to winged*. **Leaves** elliptic to oblong or lanceolate, 22–50 x 4.5–12 cm, drying to dark brown with brown gland-dots below and grey-brown above; base broadly cuneate to rounded, apex pointed, acumen to 2 cm long; midrib raised above; lateral veins 10–15 pairs, raised on both surfaces, with short intermediate veins; intercostal veins reticulate (rarely scalariform-reticulate), distinct below, faint above; petioles very short to almost absent, rarely to 1 cm long. **Flowers** yellow, in 18–50 cm long panicles, pedicels 7–15 mm long; buds wider than long; calyx-lobes triangular, pointed; petals suborbicular or deltoid with blunt apex, without appendages on the inner side; anthers obtuse; ovary immersed in disc without distinct style or stigma. **Fruits** with tuberculate surface, 7.5–10.5 x 3 cm. **Seeds** 3.8–4.5 x 1–1.3 cm.

Distribution. Endemic to Borneo. In Sarawak, locally abundant in the W Baram valley; also known from Bau, Kapit, Samunsam Wild Life Sanctuary, Semengoh Arboretum, Sg. Jeong, Sg. Kelawit and Sg. Temulan. Not yet reported from Sabah.

Ecology. Lowland forests by rivers. Flowering in February, September and October and fruiting in August and September.

9. *Lophopetalum subovatum* King(Latin, *sub* = somewhat, *ovatus* = egg-shaped; the leaf shape)

l.c. 349; Ridley *l.c.* (1922) 448; Ding Hou *l.c.* (1962) 271; Burgess *l.c.* 77; Kochummen & Whitmore *l.c.* 169; Cockburn *l.c.* 59; Anderson *l.c.* 161; Ashton *l.c.* 109; Whitmore, Tantra & Sutisna *l.c.* 45. **Type:** *Curtis 1501*, Penang (BO, K). **Synonym:** *Solenospermum apiculatum* Ridl. *l.c.* (1938) 235.

Medium to large-sized tree to 36 m tall, 75 cm diameter. **Bark** pale brown, cracking to scaly, hoop-marked; inner bark pinkish brown. **Sapwood** pale yellow. **Leaves** thinly leathery, drying to brownish, not pale whitish beneath, obovate to elliptic, 4.5–13 x 2.5–7 cm; base tapered, *apex rounded to notched*; midrib raised above; lateral veins 4–6 pairs, curving and joining near margin, faintly visible below, faint to inconspicuous above; intercostal veins invisible; petioles 5–15 mm long. **Flowers** in axillary panicles; buds short-conical or subglobose; calyx-lobes spreading, triangular; petals inside with small appendage on the upper half; disc 1–3 mm across at anthesis, smooth or minutely papillose; anthers deltoid, obtuse; ovary triangular, narrowed towards apex, style cylindrical. **Fruits** to 7 cm long. **Seeds** c. 4 x 0.6 cm.

Distribution. Sumatra, Peninsular Malaysia and Borneo. Frequent in Sabah and Sarawak.

Ecology. In mixed dipterocarp forests on leached clay-rich soils, on periodically inundated alluvium, undulating lands and ridges to 900 m.

10. *Lophopetalum wightianum* Arn.

(R. Wight, 19th Century botanist in India)

l.c. (1839) 151; Ding Hou *l.c.* (1962) 267; Kochummen & Whitmore *l.c.* 169; Cockburn *l.c.* 59; Whitmore, Tantra & Sutisna *l.c.* 45. **Type:** *Wight* (*Icon. t.* 162), S India, Malabar (K). **Synonyms:** *L. fimbriatum* Wight in Ridley *l.c.* (1922) 448; *L. winkleri* Loes. *l.c.* 221.

Emergent tree to 40 m tall, 100 cm diameter. **Bark** dark grey, fissured; middle bark whitish; inner bark purplish brown. **Leaves** elliptic to ovate, 10–18 x 5–7 cm, not papillose beneath; base rounded to wedge-shaped, *slightly peltate*, apex pointed; midrib raised above; lateral veins 6–12 pairs, pale below; intercostal veins prominent below; petioles 1.5–2.5 cm long. **Flowers** yellow, in panicles, pedicels 5–9 mm long; buds short-conical or subglobose; calyx distinctly 5-lobed; petals broadly ovate to rounded with wavy margin, appendages lamellate to cristate and attached to the lower half of petals; disc 4.5–9.5 mm across at anthesis; stamens with oblong apiculate anthers; ovary triangular, narrowed into style. **Fruits** to 15 cm long. **Seeds** c. 6 x 1.5 cm.

Distribution. India, Indo-China, Sumatra, Peninsular Malaysia, and Borneo. In Sabah, uncommon and recorded from Sandakan and Tawau only. Not yet recorded from Sarawak.

Ecology. Lowland forests to 200 m.

7. *MICROTROPIS* Wall. ex Meisn., *nom. cons.*

(Greek, *micro* = small, *tropis* = keel; a small keel on the inner side of the petal)

Pl. Vasc. Gen. Tabul. Diagn. (1837) 68; Ridley *l.c.* (1922) 443; Merrill *l.c.* (1921) 354; Merr. & Freem., Proc. Am. Acad. Arts. Sc. 73 (1940) 276; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 272; Backer & Bakhuizen *f. l.c.* 54; Kochummen & Whitmore *l.c.* 170; Cockburn *l.c.* 61; Anderson *l.c.* 161; Ashton *l.c.* 109; Kochummen, Sandakania 5 (1994) 55. **Synonyms:** *Microtropia* Reichb., Nomencl. (1841) 190; *Paracelastrus* Miq., Fl. Ind. Bat. 1, 2 (1859) 590.

Shrubs or small trees. *Terminal node with one or two pairs of prominent, subpersistent, reduced leaves (incipient bracts).* **Leaves** opposite, glabrous, *entire*. **Inflorescences** axillary or extra-axillary, dichotomous or paniculate cymes, sometimes in sessile clusters. **Flowers** *bisexual*, 5- or 4-merous; calyx-lobes almost free, imbricate, persistent, unequal in size, the outer 2 or 3 usually smallest, margin often thinner, transparent, *entire*, gnawed, irregularly split or fimbriate; *petals free or united*, imbricate; *disc absent*; stamens 4–5, filaments united at base into a ring or a short tube, the united part free from the petals or adnate to it, sometimes the stamens inserted in the mouth of corolla, anthers dorsifixed, usually introrse; *ovary superior*, cylindrical, conical or flask-shaped, 2-celled, ovules 2 in each cell, style very short or cylindrical, stigma obscure, rarely 2–4-lobed. **Fruit** a *capsule*, striated lengthwise, splitting along one side, apex with short beak, *calyx persistent*. **Seeds** usually 1, erect on a knob-like thickened hilum enveloped by aril, with endosperm.

Distribution. About 80 species, C America, SE to E Asia and Malesia. 20 species in Malesia, of which 14 are in Sabah and Sarawak.

Ecology. Lowland to montane forests to 2700 m, more common in montane forests.

Key to *Microtropis* species
(based mainly on leaves)

1. Leaves thickly leathery, margin distinctly curled inwards.....2
 Leaves thickly or thinly leathery, margin not distinctly curled inwards (except in *M. grandifolia* and *M. sarawakensis*).....4
2. Leaves greyish below; lateral veins and intercostal veins faintly sunken above.....**1. *M. argentea***
 Leaves not greyish below; lateral veins and intercostal veins not sunken above.....3
3. Petioles 7–10 mm long. Intercostal veins invisible below.....**2. *M. borneensis***
 Petioles absent or to 2 mm long. Intercostal veins visible below.....**9. *M. rigida***
4. Leaves drying to greenish yellow. Incipient bracts greenish.....5
 Leaves drying brownish. Incipient bracts brown.....7
5. Incipient bracts needle-like, c. 5 x 1 mm.....**10. *M. sabahensis***
 Incipient bracts elliptic, lanceolate or oblong, at least 4 mm broad.....6
6. Intercostal veins equally prominent as the faint lateral veins. Incipient bracts oblong or lanceolate.....**6. *M. kinabaluensis***
 Intercostal veins invisible or very faint. Incipient bracts elliptic or lanceolate.....**11. *M. sarawakensis***
7. Leaves to 4 cm long; base usually rounded to subcordate, apex blunt or rounded.....8
 Leaves longer than 4 cm; base cuneate, apex usually pointed.....9
8. Ovary ovoid-oblong.....**7. *M. ovata***
 Ovary conical.....**14. *M. wallichiana***
9. Incipient bracts foliaceous, 1.7–3 cm long.....**4. *M. grandifolia***
 Incipient bracts stiff, not foliaceous, to 12 mm long.....10
10. Leaves uniformly papillose below with scattered pustules.....**5. *M. keningauensis***
 Leaves not papillose, without pustules.....11
11. Inflorescences in sessile clusters.....**3. *M. fascicularis***
 Inflorescences distinctly stalked.....12
12. Petioles 0.7–1 cm long.....**12. *M. sumatrana***
 Petioles 1–2 cm long.....13
13. Ovary cylindrical, slightly constricted in the middle.....**13. *M. valida***
 Ovary conical, without constriction in the middle.....**8. *M. platyphylla***

Key to *Microtropis* species
(based mainly on flowers)

1. Inflorescences or infructescences in sessile clusters or condensed cymes; peduncle if present to 1 cm long.....2
 Inflorescences and infructescences with peduncle more than 1 cm long.....6
2. Lower surface of leaf uniformly papillose and with scattered pustules....**5. *M. keningauensis***
 Lower surface of leaf not papillose, without pustules.....3
3. Ovary cylindrical or ovoid-oblong.....4
 Ovary conical or gradually tapered to apex.....5
4. Ovary cylindrical with slight constriction in the middle. Petioles 1–2 cm long.....**13. *M. valida*** (in part)
 Ovary ovoid-oblong. Petioles absent or very short, to 2 mm long.....**7. *M. ovata***
5. Stigmas 4-lobed; ovary gradually tapered towards apex.....**3. *M. fascicularis***
 Stigmas not lobed; ovary conical.....**14. *M. wallichiana***
6. Leaves thickly leathery; margin distinctly curled inwards.....7
 Leaves thinly to thickly leathery; margin not distinctly curled inwards (faintly so in *M. grandifolia* and *M. sarawakensis*).....10
7. Petioles very short, to only 2 mm long or almost absent.....**9. *M. rigida***
 Petioles distinct, at least 7 mm long.....8
8. Lower surface of leaf greyish; lateral veins and intercostal veins sunken above.....**1. *M. argentea***
 Lower surface of leaf greenish brown; lateral veins and intercostal veins invisible above.....9
9. Incipient bracts 1.7–3 x 1.2–2 cm; petioles 2.3–6 cm long....**4. *M. grandifolia*** (in part)
 Incipient bracts to 5 mm long. Petioles 7–10 mm long.....**2. *M. borneensis***
10. Petals distinctly united, at least up to lower half.....**10. *M. sabahensis***
 Petals free or only slightly united at the very base.....11
11. Ovary cylindrical.....**13. *M. valida*** (in part)
 Ovary conical, flask-shaped or gradually narrowed towards apex.....12
12. Ovary flask-shaped.....13
 Ovary conical or gradually narrowed towards apex.....14
13. Incipient bracts ovate, 1.7–3 x 1.2–2 cm. Leaves 20–30 x 8.5–14.5 cm; petiole 2.3–6 cm long.....**4. *M. grandifolia*** (in part)
 Incipient bracts lanceolate or oblong, to 1.5 cm long. Leaves 11–24.5 x 3.5–9 cm; petiole 1–2 cm long.....**6. *M. kinabaluensis***

14. Stigmas 4-lobed; ovary gradually narrowed towards apex.....12. **M. sumatrana**
 Stigmas or apex of ovary not lobed; ovary conical.....15
15. Leaves thinly leathery. Incipient bracts green, lanceolate or elliptic.....11. **M. sarawakensis**
 Leaves thickly leathery. Incipient bracts brown, lanceolate.....8. **M. platyphylla**

1. **Microtropis argentea** Kochummen

(Latin, *argenteus* = silvery; the lower leaf surface)

l.c. (1994) 55. **Type:** *Lee S. 39980*, Sarawak, Belaga (holotype SAR; isotypes E, K, KEP, L, SAN).

Small tree to 5 m tall. *Incipient bracts* lanceolate, *stiff, brown, c. 5 mm long*. Twigs swollen at nodes, grey, rounded. **Leaves** thickly leathery, drying to pale green above, *greyish below*, elliptic, 10.5–12 x 5.5 cm; base cuneate, *margin prominently recurved*, with thick rim, apex shortly pointed, incurved; midrib prominently raised above; *lateral veins* 6–7 pairs, *invisible below, faintly sunken above*; intercostal veins invisible below, reticulate and faintly sunken above; petioles 0.7–1 cm long, wrinkled on drying. **Inflorescences** in cymes to 1.5 cm long; peduncles *c. 1 cm long*; buds globose, *c. 2 mm across*. **Flowers** white, *5-merous*; *sepals rounded with gnawed margins, wrinkled outside*; *petals united to more than half the length*, lobes oblong; stamens at mouth of corolla tube, filaments very short, anthers globose; ovary conical, apical part ridged with no distinct style or stigma. Fruit unknown.

Distribution. Endemic to Borneo. Uncommon, known only from the type specimen from Belaga, Sarawak.

Ecology. *Kerangas* forest on plateau at 700 m.

2. **Microtropis borneensis** Merr. & Freem.

(of Borneo)

l.c. 296; Masamune *l.c.* 418; Kochummen *l.c.* (1994) 63. **Type:** *Clemens 31742*, British North Borneo, Mt. Kinabalu (holotype A; isotypes B, BO, GE, N, UC).

Shrub or small tree. Twigs grey, youngest ones reddish brown and slightly angled. *Incipient bracts triangular, stiff, c. 5 mm long*. **Leaves** thickly leathery, drying to greenish brown on both surfaces, elliptic, 5.5–9 x 2.5–4.5 cm; base cuneate, *margin with thick rim, wavy and strongly recurved*, apex pointed; midrib prominently raised above; *lateral veins* 5–7 pairs, *very faintly visible below only*; *intercostal veins invisible*; petioles 7–10 mm long, wrinkled on drying. Inflorescences and flowers unknown. **Infructescences** with a peduncle *c. 2 cm long*. **Fruits** when fresh oblong, *c. 2 x 1.5 cm*, yellow, drying black.

Distribution. Endemic to Borneo. Locally abundant on Mt. Kinabalu in Sabah. In Sarawak, known from a single collection (*S. 40412*), from Lambir National Park.

Ecology. *Kerangas* and montane forests to 2400 m.

Taxonomy. Ding Hou *l.c.* 279 considered this a synonym of *M. platyphylla* Merr. After studying the types and other recently collected specimens of both species, I have come to the conclusion that *M. borneensis* should be reinstated as a distinct species.

3. *Microtropis fascicularis* Kochummen

Fig. 7.

(Latin, *fascicularis* = in a small bundle; the flower clusters)

l.c. (1994) 57. **Type:** *Lee S. 44277*, Sarawak, Lingga (holotype KEP; isotypes A, K, L, SAN, SAR).

Treelet to 2 m tall. *Incipient bracts stiff, brown, lanceolate, c. 7 x 1 mm, with sharp tip.* Twigs dark brown, rounded. **Leaves** leathery, *surface not papillose nor pustulate*, elliptic or oblong, 10.5–20.5 x 4–8.5 cm; base cuneate, margin slightly recurved, apex pointed; midrib raised above; lateral veins 10–12 pairs, looping near margin, very faint on both surfaces; intercostal veins reticulate, very close, visible on both surfaces; petioles 0.5–2.2 cm long, wrinkled on drying. **Flowers** in *sessile fascicles, 4-merous; sepals rotund, margin gnawed, c. 2 x 1.5 mm; petals free*, oblong to obovate, c. 1.5 x 1.2 mm; stamens free, anthers oblong, c. 1 mm long; ovary gradually tapered towards apex, striate, stigma 4-lobed. **Fruits** green when fresh, drying black, oblong or ellipsoid, 15–18 x 4–6 mm, with pointed tip.

Distribution. Endemic to Borneo. Uncommon, known by 5 collections from Sarawak.

Ecology. Mixed dipterocarp forest and *kerangas* forest, to 500 m, usually by streams. Flowering in December and fruiting in March–May.

4. *Microtropis grandifolia* Kochummen

(Latin, *grandis* = large, *folius* = leaf)

l.c. 1994) 59. **Type:** *Awa & Ilias S. 47380*, Sarawak, Lundu (holotype KEP; isotypes K, SAR).

Small tree to 5 m tall. **Twigs** brownish, youngest ones flattened. *Incipient bracts prominent, foliaceous, ovate to elliptic, 1.7–3 x 1.2–2 cm.* **Leaves** thinly to thickly leathery, elliptic, drying greenish brown on both surfaces, 20–30 x 8.5–14.5 cm; base broadly cuneate, margin faintly wavy, faintly curled inwards, apex pointed; midrib flattened to raised above; lateral veins 10–12 pairs, looping near margin, faintly raised on both surfaces with short intermediate veins; intercostal veins reticulate, faintly visible above; petioles 2.3–6 cm long, wrinkled on drying. **Inflorescences** paniculate cymes, c. 6–7 cm long; peduncles 2–3 cm long; bracteoles triangular, transparent. **Flowers** 4-merous; outer two sepals larger than inner 2, rotund; petals slightly united at base; anthers sessile, jointed at base on a staminal ring, connective slightly prolonged; *ovary flask-shaped*, style ridged, stigma 2–4-lobed. Fruits unknown.

Key to varieties

Leaves thinly leathery, margin slightly incurved. Petioles c. 3 cm. Stigmas 4-lobed.....

var. **grandifolia**

Endemic to Sarawak. Uncommon, known only by two collections (*S. 47380* from Bukit Panjo, Lundu, and *S. 34033* from Lubok Antu). Lowland and hill forests to 600 m. Flowering in May.

Leaves thickly leathery, margin strongly incurved. Petioles c. 6 cm. Stigma 2-lobed.....

var. **longipetiolatus** Kochummen

l.c. (1994) 59. **Type:** *Chai S. 34033*, Sarawak, Lanjak Entimau (holotype SAR; isotypes K, KEP, L, MO, SAN). Uncommon, known only from the type collection.

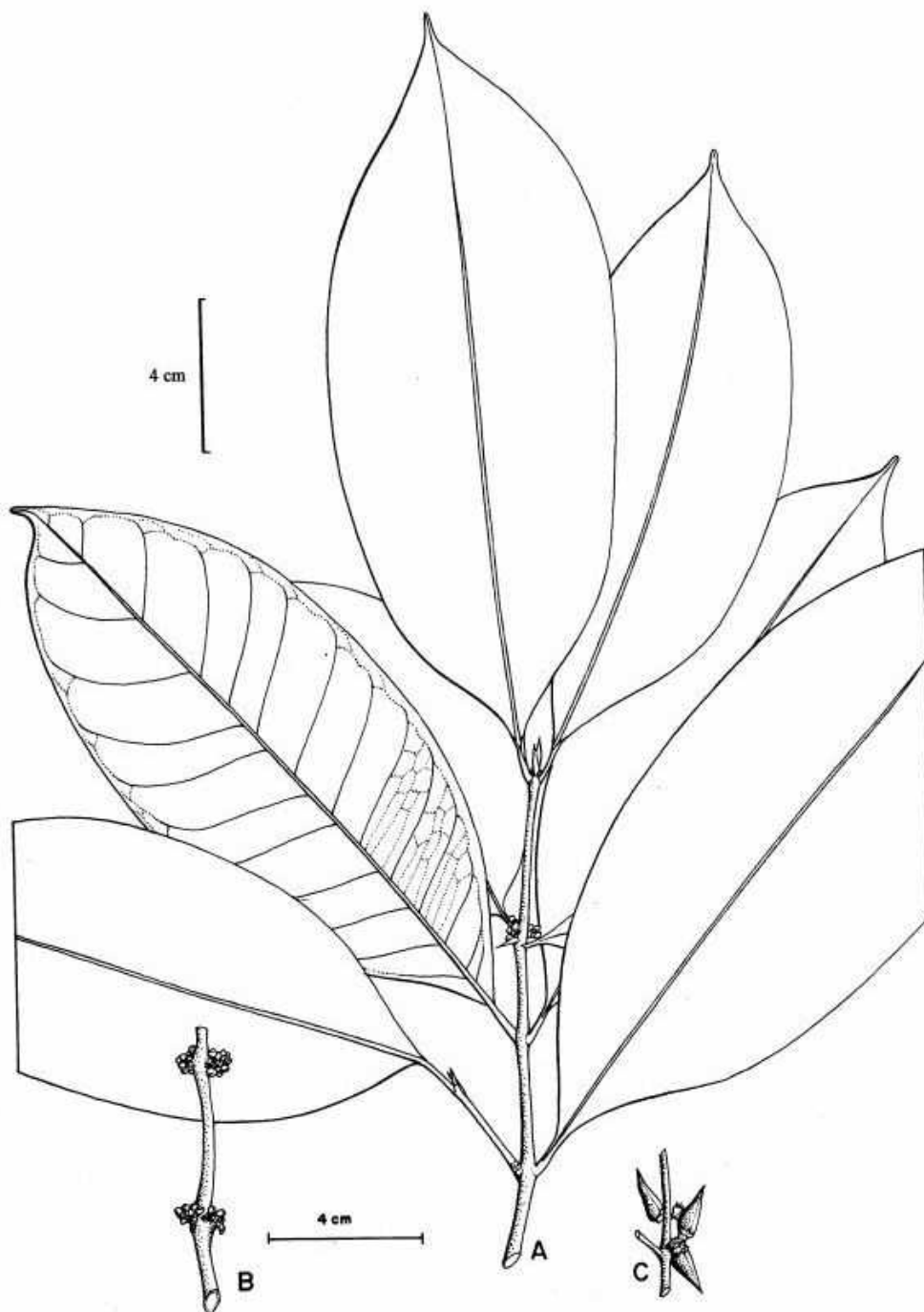


Fig. 7. *Microtropis fascicularis*. A, flowering leafy twig; B, fascicled inflorescence; C, fruits. (A & B from S. 44277, C from S. 36677.)

5. *Microtropis keningauensis* Kochummen
(of Keningau, in Sabah)

l.c. (1994) 61. **Type:** *Fidilis* SAN 118405, Sabah, Keningau (holotype SAN).

Shrub or small tree. Twigs grey-brown. *Incipient bracts* brown, lanceolate, c. 10 x 2 mm, with distinct median ridge. **Leaves** leathery, drying brownish, *uniformly papillose below with scattered pustules*, elliptic, 11.5–23.5 x 4.5–8.5 cm; base cuneate, margin not curled inwards, apex pointed; midrib flattened above; lateral veins 9–12 pairs, looping near margin, distinct below, faintly visible above; intercostal veins reticulate, distinct below, almost invisible above; petioles 8–15 mm long, drying black. Inflorescences and flowers unknown. **Infructescences** almost sessile to 1-cm-stalked. **Fruits** yellowish green when fresh, black on drying, oblong, 2–2.3 x 0.7–0.8 cm, apex with distinct point.

Distribution. Endemic to Borneo. Uncommon, known by two collections only (SAN 118364 and SAN 118405), from Lanas, Keningau in Sabah.

Ecology. Lowland forest by stream and ridge top. Fruiting in October.

6. *Microtropis kinabaluensis* Merr. & Freem.
(of Mt. Kinabalu, Sabah)

l.c. 304; Masamune *l.c.* 418; Ding Hou *l.c.* (1962) 277. **Type:** *Clemens* 29518, British North Borneo, Mt. Kinabalu (holotype A; isotypes B, BO, GE, K, L, N, UC). **Synonyms:** *M. kinabaluensis* var. *acuminata* Merr. & Freem. *l.c.* 305, Masamune *l.c.* 418; *M. sterrophylla* Merr. & Freem. *l.c.* 305, Masamune *l.c.* 419.

Shrub or small tree to 5 m tall. *Incipient bracts* pale green, to 1.5 cm long, 0.5 cm broad, lanceolate or oblong. Young twigs slightly angled. **Leaves** greenish yellow on drying, leathery, elliptic-oblong, 11–24.5 x 3.5–9.5 cm; base cuneate to tapered, margin slightly recurved, apex pointed; midrib raised above; lateral veins 6–12 pairs, looping near margin, very faint on both surfaces; intercostal veins reticulate, equally prominent as lateral veins; petioles 1–2 cm long, drying wrinkled and yellowish. **Inflorescences** cymose panicles, to 5.5 cm long, peduncles 1.5–2.5 cm long. **Flowers** white; *calyx-lobes with 3–5 longitudinal veins; petals free, ovate or broadly elliptic; stamen filaments united at base*; ovary flask-shaped. **Fruits** red when ripe, oblong or ovoid to ellipsoid, 1.5–2 x 0.7–1 cm, faintly furrowed, crowned by the persistent style.

Distribution. Endemic to Borneo. Widely distributed in Sabah and Sarawak.

Ecology. Lowland to submontane forests to 1500 m.

7. *Microtropis ovata* Merr. & Freem.

(Latin, *ovatus* = egg-shaped; the leaf shape)

l.c. 297; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 279. **Type:** *Clemens 40046*, British North Borneo, Mt. Kinabalu (BM, BO).

Shrub to 3 m tall. *Twigs 4-angled. Leaves thickly leathery, under surface not papillose nor pustulate*, ovate to ovate-oblong, 4.5–10 x 2–7 cm; base rounded to cordate, *margin not curled inwards*, apex acute; lateral veins 5–9 pairs; *petioles very short to 2 mm long* or leaves sessile. **Flowers** in condensed cymes, peduncle very short; calyx-lobes suborbicular; petals free, ovate or ovate-oblong; *stamen filaments united at the lower half*; ovary ovoid-oblong, not constricted at the middle. Fruits unknown.

Distribution. Endemic to Sabah. Uncommon, known from Mt. Kinabalu only.

Ecology. Submontane forests at 1200–1500 m.

8. *Microtropis platyphylla* Merr.

(Greek, *platus* = broad, *phyllon* = leaf; broad-leaved)

Philip. J. Sc. 10 (1915) Bot. 319; Ding Hou *l.c.* (1962) 279. **Type:** *Loher 5779*, Philippines (BO, L).

Shrub or small tree to 10 m tall, 10 cm diameter. *Incipient bracts brown*, 4–12 mm long, lanceolate. **Leaves thickly leathery, not papillose nor pustulate beneath**, elliptic to lanceolate or ovate-lanceolate, 4.5–24 x 4.5–11 cm; base cuneate, *margin not curled inwards*, apex blunt to pointed; lateral veins 6–12 pairs; *petioles 1–2 cm long*. **Inflorescences** paniculate, *peduncles 1–1.5 cm long*. **Flowers** (4–)5-merous; calyx-lobes suborbicular or subreniform with gnawed margins; petals free, elliptic or broadly ovate, obtuse; stamen filaments united at base; *ovary conical, not constricted at the middle*, apex obtuse or notched. **Fruits** ovoid or ellipsoid, 1–2.5 x 1 cm.

Distribution. Borneo and the Philippines. Common in Sabah, but uncommon in Sarawak.

Ecology. Hill and montane forests to 2700 m.

9. *Microtropis rigida* Ridl.

(Latin, *rigidus* = stiff; the thick leaves)

l.c. 36; Merr & Freem. *l.c.* 297; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 278. **Type:** *Beccari PB 1702*, Sarawak (holotype FI; isotypes BO, K).

Small tree to 20 m tall, 15 cm diameter. *Incipient bracts lanceolate, c. 0.5 cm long, brown, stiff*. Twigs swollen at nodes. **Leaves thickly leathery**, elliptic-oblong, 7–12 x 2.5–6 cm, pustulate below; base obtuse, rarely cuneate, *margin curled inwards*, apex pointed; midrib raised above; lateral veins 5–7 pairs, very faint; intercostal veins reticulate, visible below, invisible above; *petioles very short to 2 mm long to almost absent*. **Inflorescences** to 2.5 cm long, peduncles 1–1.5 cm long. **Flowers** white; calyx-lobes suborbicular, sometimes irregularly split; petals free, oblong, obtuse; stamen filaments subulate, lower half united;

ovary globose, narrowed towards apex, style very short, *stigmas obscurely 4–6-lobed*. **Fruits** oblong, 12–15 x 7–9 mm, apex rounded with short persistent style.

Distribution. Endemic to Sarawak; uncommon and known only from Bako National Park, G. Santubong and Mulu National Parks.

Ecology. Lowland to submontane forests to 1000 m, including *kerangas*.

10. *Microtropis sabahensis* Kochummen (of Sabah)

l.c. (1994) 61. **Type:** *Banang SAN 51915*, Sabah (holotype KEP; isotype SAN).

Treelet to 5 m tall. Youngest twigs reddish brown. *Incipient bracts greenish, needle-like, c. 5 x 1 mm*. **Leaves** thinly leathery, elliptic, 13.5–20.5 x 3.5–7 cm; base cuneate, margin slightly wavy, apex pointed; midrib raised above; lateral veins 8–10 pairs, looping and joining near margin, faint on both surfaces; intercostal veins reticulate, very faint; petioles 1–1.5 cm long, drying greenish yellow. **Inflorescences** axillary, 3–4.5 cm long, cymose panicles, *peduncles 1–1.5 cm long*; bracteoles triangular, transparent. **Flowers** 4-merous; *sepals ovate, transparent, wrinkled outside; petals united half-way, lobes oblong with transparent margins; stamens seated on the mouth of corolla-tube*, filaments flat; ovary gradually tapered towards apex, slightly ridged towards apex, style indistinct, stigma distinct, 4-lobed. Fruits unknown.

Distribution. Endemic to Sabah. Uncommon, known only from the type collection from Kinabatangan.

Ecology. Lowland and seasonal swamp forests. Flowering in June.

Very similar to *M. kinabaluensis* but differing in the united petals, shape of ovary and the prominent stigma.

11. *Microtropis sarawakensis* Kochummen (of Sarawak)

l.c. (1994) 63. **Type:** *Ilias S. 36501*, Sarawak (holotype KEP; isotypes K, L, MO, SAN, SAR).

Small tree to 5 m tall, 10 cm diameter. *Incipient bracts green, elliptic or lanceolate, c. 10 x 4 mm*. Twigs reddish brown, rounded, youngest ones angular. **Leaves** thinly leathery, drying to greenish yellow, elliptic or oblong, 10–17 x 7.5 cm; base cuneate, margin wavy and slightly recurved, apex pointed; midrib raised above; lateral veins 7–9 pairs, very faint on both surfaces; *intercostal veins invisible to very faint*; petioles 1–1.5 cm long, channelled above, wrinkled and yellowish on drying. **Inflorescences** cymose panicles, 2–5 cm long, peduncles 1–1.5 cm long. **Flowers** 4- or 5-merous; *calyx-lobes suborbicular, transparent with few fine veins in the middle; petals free, imbricate, oblong, transparent; stamens with short filaments which are joined at the bottom by a staminal ring, connective slightly*

prolonged; ovary short conical, without distinct style, with wavy surfaced, and unlobed stigma. **Fruits** (immature) green when fresh, ovoid, 7–10 x 4–5 mm, apex with short style and stigma, calyx persistent.

Distribution. Endemic to Sarawak. Uncommon, known only by the type collection.

Ecology. Lowland forests by streams. Flowering in April and June, and fruiting in October.

The leaves are somewhat similar to those of *M. sabahensis*, but the shape and size of incipient bracts of *M. sarawakensis* distinguishes it from *M. sabahensis*. Furthermore, in *M. sabahensis* the stigma is distinctly lobed, and the corolla is united almost half way. In contrast, in *M. sarawakensis* the stigma is unlobed and the petals are free.

12. *Microtropis sumatrana* Merr.

(of Sumatra)

Pap. Mich. Acad. Sc. 19 (1934) 164; Merr. & Freem. *l.c.* 304; Ding Hou *l.c.* (1962) 279. **Type:** Rahmat 214, Sumatra (A, BO).

Small tree to 20 m tall and 20 cm diameter. **Bark** grey, smooth; inner bark pale grey. **Sapwood** pale white. *Incipient bracts lanceolate, to 12 mm long.* Twigs greyish. **Leaves** thinly leathery, pale below, dark brown on drying, *not papillose nor pustulate beneath*, elliptic, 6.5–11 x 3.5–5.5 cm; base cuneate, apex pointed; midrib flattened above; lateral veins 5–7 pairs, faint to distinct below, curving and joining near margin; intercostal veins laxly reticulate, faint; *petioles 0.7–1 cm long.* **Inflorescences** dichotomously branched, *peduncles 1–3 cm long.* **Flowers** with calyx-lobes irregularly split; petals free, oblong, obtuse; stamens united at the lower half; ovary gradually narrowed towards apex, stigma 4-lobed. **Fruits** oblong, 1.5–1.7 x 0.7–1.0 cm, with pointed tip, calyx persistent at base.

Distribution. Sumatra and Borneo. Uncommon, in Sabah known only from Sipitang, Tawau, and Mostyn.

Ecology. Lowland to submontane forests to 1050 m.

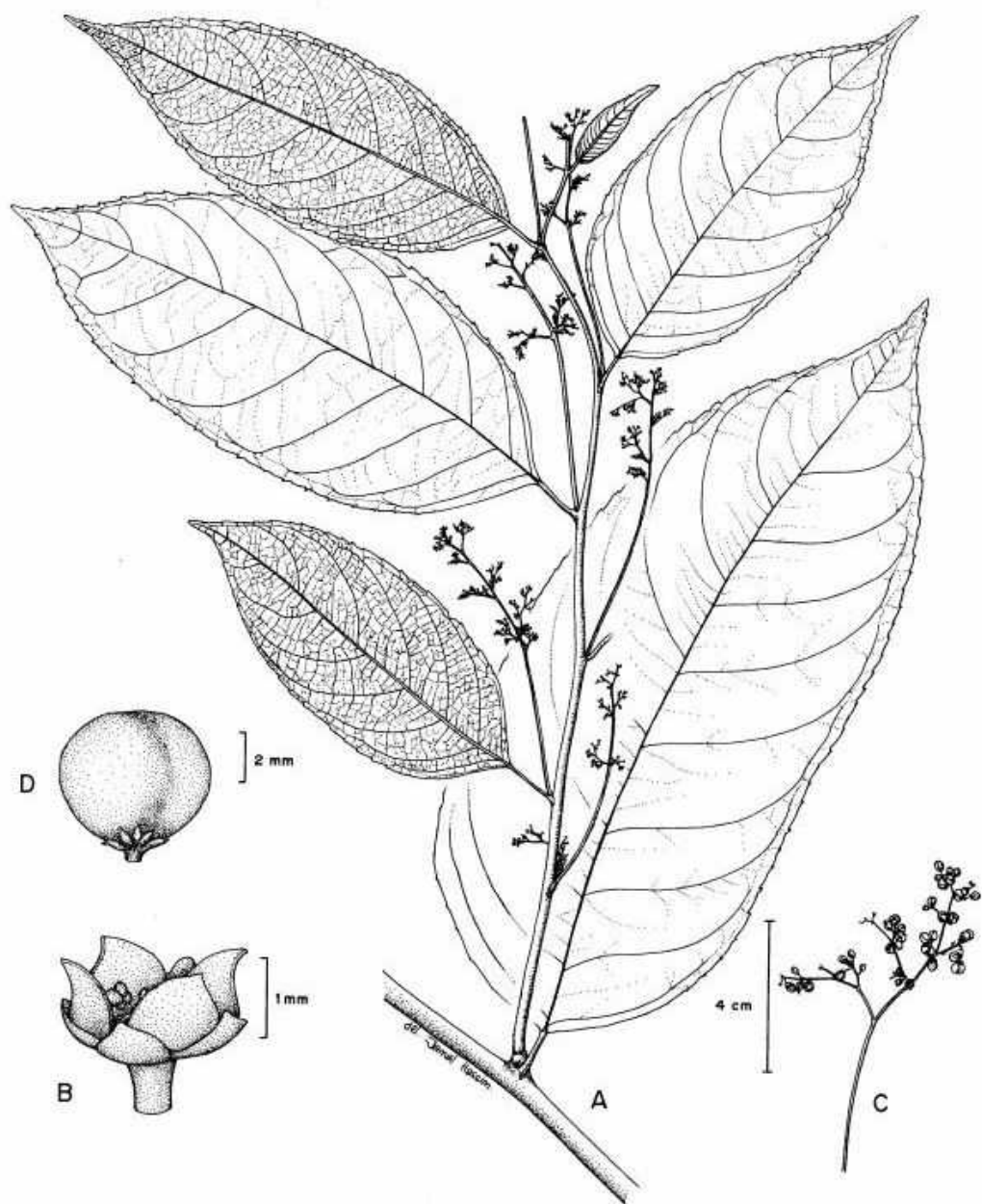


Fig. 8. *Perrottetia alpestris* subsp. *philippinensis*. A, flowering leafy twig; B, flower; C, infructescence; D, fruit. (A from *S.* 34060, B after FM 1, 6 (1962) 289, fig. 21, C & D from *S.* 43345.)

13. *Microtropis valida* Ridl.

(Latin, validus = robust-growing)

J. Str. Br. R. As. Soc. 75 (1917) 19, *l.c.* (1922) 445; Merr & Freem. *l.c.* 304; Ding Hou *l.c.* (1962) 276; Kochummen & Whitmore *l.c.* 170. **Type:** *Curtis 1331*, Perak (holotype K; isotype BO).

Synonyms: *M. bicolor* Merr. & Freem. *l.c.* 298; *M. pauciflora* Boerl. ex Merr. & Freem. *l.c.* 303.

Shrub or small tree to 5 m tall. Incipient bracts brown, *stiff*, 3–12 mm long. **Leaves** leathery, *under surface not papillose nor pustulate*, ovate to lanceolate or elliptic, 11–27 x 4.5–12 cm; base rounded to cuneate, margin not curled inwards, apex acute or acuminate; midrib raised above; lateral veins 6–14 pairs; intercostal veins reticulate, distinct on both surfaces; *petioles 1–2 cm long*. **Inflorescences** usually paniculate, rarely a simple cyme or fascicle, *peduncles 1–4 cm long*. **Flowers** 4(–5)-merous; calyx-lobes suborbicular, slightly wrinkled outside, margin transparent; petals free, elliptic or oblong, obtuse; *stamen filaments united at base*; *ovary cylindric, slightly constricted at the middle*, truncate or discoid at the top. **Fruits** ellipsoid, c. 2 x 1 cm, apex pointed and furfuraceous with persistent style.

Distribution. Sumatra, Peninsular Malaysia and Borneo. In Sabah and Sarawak uncommon, known by only two collections (SAN 75680 and SAN 44667) in Sabah, and three (including the type of *M. bicolor* by Beccari) collections in Sarawak.

Ecology. Lowland to submontane forests to 1350 m.

14. *Microtropis wallichiana* Wight ex Thwaites

(N. Wallich, 1786–1854, Superintendent, Calcutta Botanic Gardens)

En. Pl. Zeyl. (1858) 71; Ding Hou *l.c.* (1962) 279. **Type:** *Wight 528*, Ceylon (BO, K). **Synonym:** *M. suborbiculata* Merr. & Freem. *l.c.* 282, Masamune *l.c.* 419.

Shrub or small tree. *Incipient bracts brown*, 3–8 mm long. Twigs rounded to slightly angled. **Leaves** thickly leathery, elliptic, lanceolate or rounded, 3–18 x 1–6 cm, *lower surface not papillose nor pustulate*; base cuneate to rounded, margin not curled inwards, apex pointed, blunt or rounded and notched; midrib raised above; lateral veins 4–9 pairs, invisible above; intercostal veins reticulate, faint to invisible; petioles to 1.5 cm long, rarely very short. **Inflorescences** condensed cymes, less than 1 cm long, peduncles very short or absent. **Flowers** yellowish; calyx-lobes subreniform; petals free, fleshy; stamen filaments united at the lower part; *ovary conical*, longitudinally striate, *stigma not lobed*. **Fruits** oblong-ellipsoid or oblong-obovoid, c. 1 x 0.5 cm, furfuraceous, crowned by persistent style.

Distribution. Sri Lanka, Sumatra and Borneo. In Sabah, known from Mt. Kinabalu only; not recorded from Sarawak.

Ecology. Submontane to montane forests at 1250–2500 m.

The types of *M. wallichiana* and *M. suborbiculata* have some differences which require to be substantiated by examining more material. There is no conclusive evidence for their distinction, although it is doubtful if they are the same species.

8. PERROTTETIA Kunth

(G.S. Perrotet, 1793–1870, French botanist)

Nov. Gen. Sp. 7 (1824) 73; Merrill *l.c.* (1921) 354; Ridley *l.c.* (1922) 454; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 288; Backer & Bakhuizen f. *l.c.* 55; Kochummen & Whitmore *l.c.* 171; Anderson *l.c.* 161; Ashton *l.c.* 112. **Synonym:** *Caryospermum* Blume *l.c.* (1850) 175.

Shrubs or small trees. **Leaves** *alternate*. **Inflorescences** cymose, axillary. **Flowers** *bisexual*, rarely unisexual; calyx-lobes 5 or 4; *petals similar to calyx-lobes in size and shape*; stamens 5 or 4, inserted on the margin of the disc; *ovary semi-inferior*, mostly 2-celled, style 1; ovules two in each cell. **Fruit** a *berry*, globose, 2–4-seeded. **Seeds** covered with thin aril; endosperm thin; embryo small.

Distribution. About 15 species; China, Formosa, Malesia and America. Only one species in Sabah and Sarawak.

Ecology. Primary and secondary hill and montane forests to 2600 m.

Perrottetia alpestris (Blume) Loes.

Fig. 8.

(Latin, *alpestris* = growing above the limit of forest growth; its habitat)

in Engler & Prantl *l.c.* 220; Merrill *l.c.* (1921) 354; Ridley *l.c.* (1922) 454; Masamune *l.c.* 419; Ding Hou *l.c.* (1962) 288; Kochummen & Whitmore *l.c.* 171; Ashton *l.c.* 161. **Basionym:** *Celastrus alpestris* Blume, Bijdr. (1826) 1145. **Type:** *Blume, s.n.*, Java (BO, L).

subsp. **philippinensis** (Vidal) Ding Hou

l.c. (1962) 291. **Basionym:** *Caryospermum philippinensis* Vidal, Rev. Pl. Vasc. Philip. (1886) 89. **Type:** *Beccari PB 7770*, Sarawak (FI).

Shrub or small tree to 12 m tall. *Young twigs and petioles purplish when fresh, blackish on drying*. **Leaves** thinly leathery, elliptic or oblong, 10–20 x 4–8 cm; base cuneate or rounded, sometimes subcuneate, *margin prominently toothed*, apex pointed; midrib flattened above; lateral veins 8–12 pairs, raised below, sunken or flattened above; intercostal veins reticulate, distinct below, faint above; petioles 7–15 mm long, not swollen. **Flowers** white or light greenish, *4-merous*; calyx-lobes sparsely puberulous on both surfaces; petals puberulous on both surfaces; disc cup-shaped; stamen filaments longer than the disc; ovary conical, style short, stigma distinctly 2-lobed. **Fruits** globose or subglobose, 2.5–3.5 mm diameter, red. Seeds 3–4.

Distribution. Borneo, Philippines and Celebes. In Sabah, collected from Kinabalu National Park, Kalabakan and Lamag. In Sarawak, reported from Dulit Range, Mulu National Park, Bt. Rawan, Kapit and Lubuk Antu.

Ecology. Hill and montane forests to 2700 m, in open screes, usually on moist soils.

This subspecies differs from the other two (*alpestris* and *moluccana*) by its 4-merous instead of 5-merous flowers.

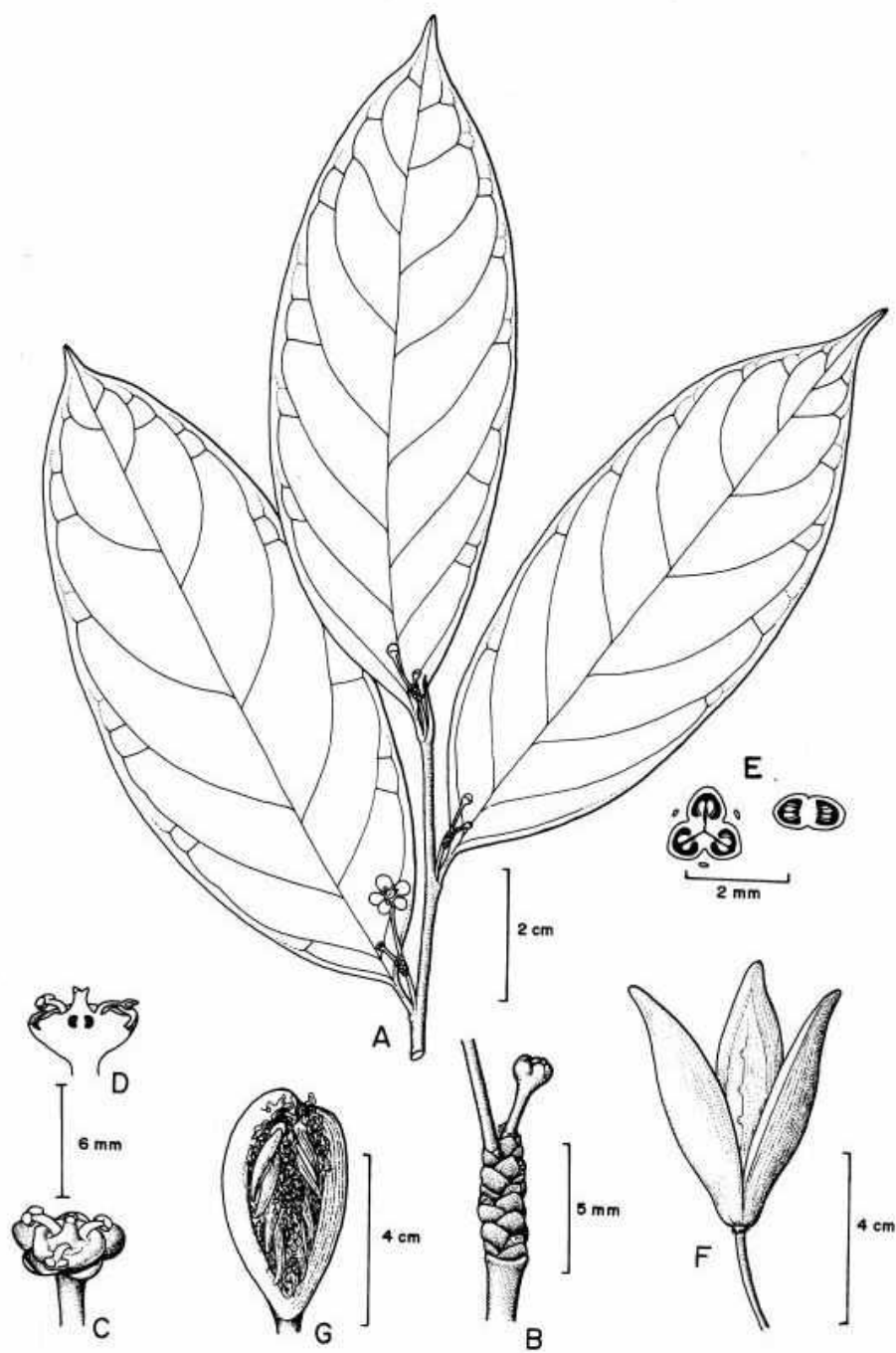


Fig. 9. *Sarawakodendron filamentosum*. A, flowering leafy twig; B, inflorescence; C, flower with petal removed; D, longitudinal section through flower; E, cross section (left) and longitudinal section (right) of ovary; F, dehiscent fruit; G, fruit valve with attached seeds. (All after FM 1, 6 (1962) 931, fig. 4.)

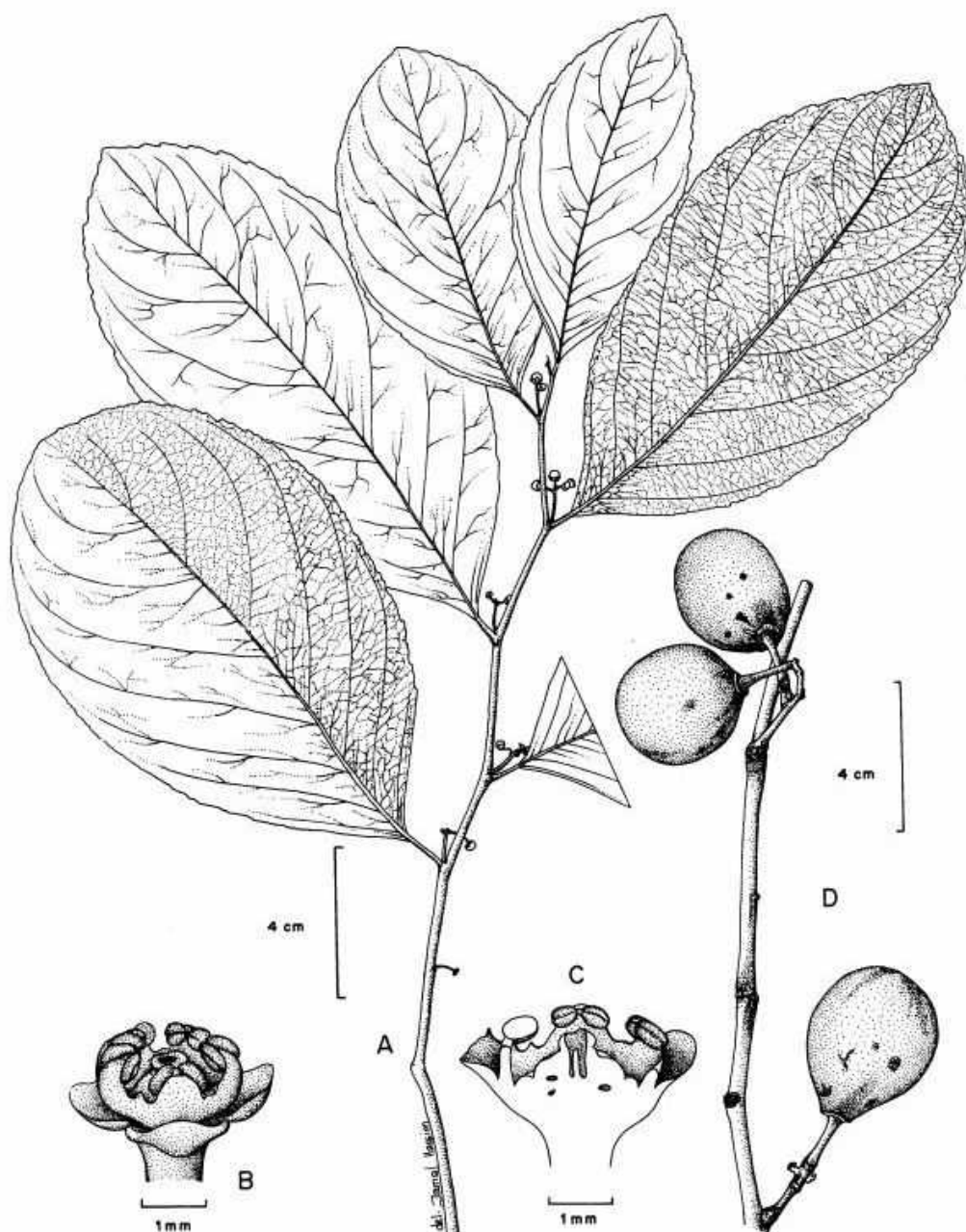


Fig. 10. *Siphonodon celastrineus*. A, flowering leafy twig; B, young flower with petals removed; C, longitudinal section through flower, with petals removed; D, fruiting twig. (A from *SAV* 55718, B–C after FM 1, 6 (1962) 395, fig. 24, D from *S.* 39801.)

9. SARAWAKODENDRON Ding Hou

(Greek, dendron = a tree; Sarawak tree)

Blumea 15 (1967) 139, *l.c.* (1969) 97, *l.c.* (1972) 930; Anderson *l.c.* 162.

Small trees. *Young twigs, petioles, midrib, leaf blades and floral parts with yellow pustules.* Twigs without distinct stipular scars. **Leaves** *alternate, entire*; petioles not swollen. Stipules inconspicuous. **Inflorescences** axillary, with condensed decussate bracts. **Flowers** *bisexual*; calyx 5-lobed, lobes imbricate; petals 5, imbricate; disc slightly 5-angular; *stamens* 3, inserted at the base of ovary, anthers extrorse, transversely dehiscent; *ovary semi-inferior, 3-celled, 3-angled*, stigma 3, ovules 8 in each cell, in 2 series, placentation axile. **Fruit** a *capsule*, dehiscent loculicidally into 3 valves. **Seeds** 6–8 in each cell, with endosperm; aril fleshy, cushion or caruncle-like at the chalazal end *which bears 1.5–2-cm-long simple or dichotomously branched, thread-like appendages arising from the base of funicle.*

Distribution. A monotypic genus, endemic to Sarawak.

Ecology. Lowland forests.

Sarawakodendron filamentosum Ding Hou

Fig. 9.

(Latin, *filamentosus* = thread-like; the appendages of the seed aril)

l.c. (1967) 141, *l.c.* (1969) 103, *l.c.* (1972) 932. **Type:** *Ding Hou* 333, Sarawak (holotype L; isotypes BO, SAR).

Small tree to 10 m tall, 15 cm diameter. **Leaves** drying to greenish yellow, elliptic to oblong or oblanceolate, 10.5–29 x 4–10.5 cm; base cuneate, apex pointed; midrib flattened above; lateral veins 4–8 pairs, faintly raised on both surfaces; intercostal veins reticulate, faintly visible below; petioles 0.5–1.5 cm long. **Inflorescences** 1–2.5 cm long, unbranched, few-flowered, peduncles to 1.3 cm long, pedicels 1.5–2 cm long, articulated near base. **Flowers** pale orange, floral parts fleshy; calyx-lobes semi-orbicular, slightly toothed along the margin; petals suborbicular with distinct reticulate venation and light brownish stripes or dots; disc flat, slightly 5-angular; stamens reflexed at anthesis. **Fruits** narrow ellipsoid, 3-angled, 6–8.5 x 2–3.5 cm, gradually narrowed towards both ends. **Seeds** 6–8 in each cell, 2–2.5 x 0.5 cm; embryo narrow-lanceolate, c. 18 x 4 mm; cotyledons foliaceous, free.

Distribution. Endemic to Sarawak. Uncommon, known by the following few collections: *Ding Hou* 133, *S.* 24506, *S.* 24897 and *S.* 24898 from the Nyabau FR, Bintulu; *S.* 18685 from Bako National Park; *S.* 42715 from Sri Aman, and *S.* 51508 from Bayai, 2nd Div.

Ecology. In mixed dipterocarp forest on yellow sandy humult ultisol soils and in *kerangas* forest.

The genus has similar floral characters as that of *Salacia* and in fruit characters it has similarities with *Kokoona* and *Lophopetalum*.

10. SIPHONODON Griff.

(Greek, *siphonos* = tube, *odontos* = tooth;
the hollow, columnar, toothed upper part of the ovary)

Calc. J. Nat. Hist. 4 (1844) 246; Ding Hou, Blumea 12 (1963) 36, *l.c.* (1964) 394; Backer & Bakhuizen *f. l.c.* 561; Kochummen & Whitmore *l.c.* 171; Cockburn *l.c.* 62; Anderson *l.c.* 162; Ashton *l.c.* 112; Whitmore, Tantra & Sutisna *l.c.* 45. **Synonym:** *Capusia* Lecompte, Bull. Mus. Hist. Nat. Paris 32 (1926) 95.

Trees. **Leaves** spiral or alternate. **Inflorescences** axillary, cymose, sometimes only one-flowered. **Flowers** 5-merous; *calyx-lobes* imbricate; petals imbricate, larger than calyx-lobes; stamens 5, sometimes alternating with 5 staminodes, united at lower part, anthers latrorse, connective distinct and broad; ovary *semi-inferior*, 3-celled, *upper half hollow* and with a style-like column arising from the bottom, *ovules* 1 in each cell, oblique or pendulous. **Fruits** drupaceous, with numerous bony 1-seeded pyrenes. **Seeds** flat, with endosperm; cotyledons flat, free.

Distribution. 7 species; SE Asia through Malesia to Australia; one species in Sabah and Sarawak.

Siphonodon celastrineus Griff.
(resembling Celastrus)

Fig. 10.

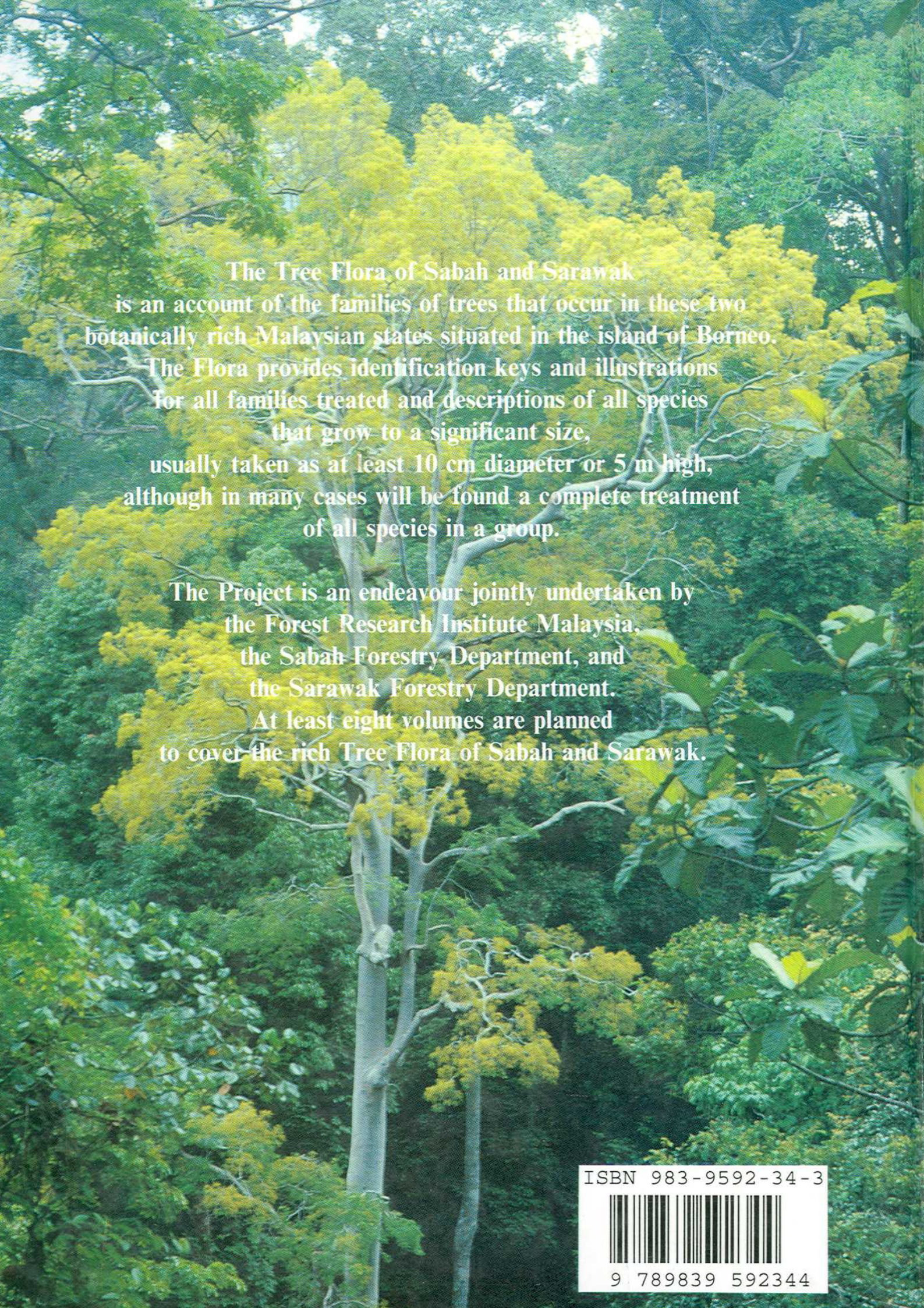
l.c. 247; Ding Hou *l.c.* (1964) 394; Backer & Bakhuizen *f. l.c.* 561; Kochummen & Whitmore *l.c.* 171; Cockburn *l.c.* 62; Anderson *l.c.* 162; Ashton *l.c.* 112; Whitmore, Tantra & Sutisna *l.c.* 45. **Type:** Griffith 9019, Penang (BO, K). **Synonyms:** *S. pyriformis* Merr. *l.c.* (1908) 240; *Xanthophyllum subglobosum* Elmer *l.c.* (1913) 1676.

Tree to 35 m tall, 70 cm diameter; buttresses to 2 m high. **Bark** usually grey-brown, smooth to scaly; inner bark yellowish. **Sapwood** pale. **Twigs** brownish, *zig-zag*. **Leaves** drying greenish yellow, lanceolate to elliptic or oblong, 8–15 x 3.5–7 cm; base cuneate, *margin toothed*, apex pointed; *midrib flattened above, yellowish below on drying*; lateral veins yellowish on drying; intercostal veins reticulate, distinct below, faint above; *petioles* 5–8 mm long, *drying yellowish*. **Flowers** cream-white; calyx-lobes almost rounded, 1–2 mm long; petals ovate with obtuse apex; stamens *c.* 1 mm long, filaments flat, united near base; ovary subglobose to conical, occasionally with 5 ridges towards the apex. **Fruits** subglobose to obovoid, 3–6.5 x 2–6 cm.

Distribution. India, Burma, Thailand, Indo-China, and Malesia. In Sabah, recorded from Lahad Datu, Ranau, Sandakan and Tawau. In Sarawak, collected from Belaga, Bau, Bt. Mersing, and Ulu Melinau.

Ecology. Mixed dipterocarp forests on fertile clay soils, especially near limestone and on basic volcanic rock. Uncommon. Fruiting in March–November.

This species can be confused with those of *Xanthophyllum* (Polygalaceae) but the toothed leaves at once distinguish this.



The Tree Flora of Sabah and Sarawak
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botanically rich Malaysian states situated in the island of Borneo.
The Flora provides identification keys and illustrations
for all families treated and descriptions of all species
that grow to a significant size,
usually taken as at least 10 cm diameter or 5 m high,
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of all species in a group.

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