

TREE FLORA of SABAH AND SARAWAK

Volume One

edited by
E. Soepadmo and K.M. Wong



ITTO
International Tropical
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TREE FLORA
of
SABAH AND SARAWAK

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CHRYSOBALANACEAE

Ghilleen T. Prance

Royal Botanic Gardens, Kew, England

R. Brown in Tuckey, Narr. Exp. Congo (1818) 433; King, J. As. Soc. Beng. 66, 2 (1897) 275 (under Rosaceae); Ridley, FMP 1 (1922) 665 (under Rosaceae); Merrill, EB (1921) 287, PEB (1929) 92 (under Rosaceae); Masamune, EPB (1942) 324 (under Rosaceae); Backer & Backhuizen *f.*, FJ 1 (1964) 521 (under Rosaceae); Prance & Whitmore, TFM 2 (1973) 321 (under Rosaceae); Anderson, CLTS (1980) 292 (under Rosaceae); Cockburn, TS 2 (1980) 79 (under Rosaceae); Corner, WSTM 2 (1988) 615 (under Rosaceae); Prance & White, Phil. Trans. Roy. Soc. B. 320 (1988) 1; Prance, FM 10, 4 (1989) 635; Whitmore, Tantra & Sutisna, CLK 2, 1 (1990) 298.

Trees or shrubs. **Leaves** simple, entire, alternate, often coriaceous. Stipules small and caducous to large and persistent. **Inflorescences** racemose, paniculate or cymose; flowers bracteate and usually 2-bracteolate. **Flowers** actinomorphic (with a regular symmetry) to zygomorphic (with an irregular symmetry), bisexual or unisexual (in *Parastemon*, plant sometimes polygamo-dioecious), markedly perigynous; receptacle short to elongate; disc always present, forming a lining to the receptacle; calyx-lobes 5, imbricate, often unequal, erect or reflexed; petals 5, imbricate, usually caducous; stamens variable, 2–60, inserted on the margin of the surface of the disc, or basally adnate to it, forming a complete circle or, in zygomorphic flowers, unilateral, all fertile or some without anthers and then often reduced to small staminodes; filaments filiform, free, connate at the base or ligulately connate, included to far exerted; anthers small, dorsifixed, longitudinally dehiscent; gynoecium (ovary) basically of three carpels and gynobasic (inferior), but usually with only one carpel fully developed, attached to the base, middle or mouth of the receptacle-tube, sessile or with a short gynophore (stalk), pubescent or villous; carpel unilocular with two ovules or bilocular with one ovule in each locule, style filiform, *arising from the receptacle at the base of the carpel*, stigma distinctly or indistinctly 3-lobed, *ovules erect, epitropous* (with micropyle directed towards the base), tenuinucellate (with thin nucellus). **Fruit** a dry or fleshy drupe; endocarp various, thick or thin, fibrous or bony, often with a special mechanism for seedling escape, often densely hairy inside. **Seeds** erect, almost without endosperm; cotyledons plano-convex, fleshy, sometimes ruminant.

Distribution. A pantropical family of 17 genera and 520 species, of which over 400 in the Neotropics, 60 in Africa and 39 in Asia and the Pacific. In Sabah and Sarawak, the family is represented by 6 genera and 15 species all of which are trees.

Ecology. Found mainly in lowlands both in swamp and well-drained forests, to 1500 m. The flowers are pollinated mainly by insects and in a few cases by bats, and the fruits are dispersed by birds, mammals and water.

Uses. The wood is extremely hard and difficult to cut due to the presence of silica; therefore it is resistant to decay and to marine borers and is used for posts and marine piles. The wood of some species is used for general construction and firewood. The fruit of some species is

edible. The fruit of *Atuna racemosa* subsp. *racemosa* is used as a putty for caulking boats and the oil from this species is used in the Pacific in hair dressings.

Taxonomy. Although the family Chrysobalanaceae was described by Robert Brown in 1818 (In: J.K. Tuckey, Narrative of an expedition to explore the River Zaire, Appendix 5: 433–434) it has been placed as a tribe or subfamily of Rosaceae in most of the older and widely used systems of classification such as those of Bentham and Hooker, Engler and Prantl and Hutchinson. This is in marked contrast to the opinions of nearly all workers with a detailed knowledge of the group, especially of its anatomy. The Chrysobalanaceae differs from the Rosaceae in the gynobasic style, the basal, erect ovules which are tenuinucellate, in the presence of abundant deposits of silica in the wood, stem and leaf and in many wood anatomical characters such as the large oblique vessels, the banded oblique vessels, the banded parenchyma which is composed of long strands. The authors of modern evolutionary systems such as Cronquist, Thorne and Takhtajan consider the Chrysobalanaceae to be a separate family but still placed in the Rosales. Dahlgren and Thorne (Ann. Missouri Bot. Gard. 71 (1984) 633–699) suggested a relationship between Chrysobalanaceae and Myrtales. Although the resemblances between Rosaceae and Chrysobalanaceae are superficial, the family is best left in the Rosales until further evidence such as molecular studies show that it should be placed elsewhere. Further details about the taxonomy of the group can be found in Prance and White's paper (*l.c.*).

Key to genera

(based on flowers)

1. Flowers actinomorphic with ovary inserted in centre of receptacle; stamens included...2
Flowers zygomorphic with ovary inserted laterally on receptacle; stamens exerted (except in *Parinari*).....3
2. Stamens 7–10, all fertile.....**3. Licania**
Stamens 5, all fertile or 2 fertile and 3 sterile.....**5. Parastemon**
3. Stamens 6–10, included. Leaves usually with stomatal crypts.....**6. Parinari**
Stamens 10–40, exerted. Leaves never with stomatal crypts.....4
4. Stamens united into a ligule. Ovary unilocular.....**2. Kostermanthus**
Stamens free to base. Ovary bilocular.....5
5. Stamens 10–20. Inflorescence a raceme or sparsely branched contracted panicle.....**1. Atuna**
Stamens 25–40. Inflorescence a many-flowered corymbose panicle.....**4. Maranthes**

Key to genera

(based on fruits)

1. Fruits dehiscent by two lateral plates.....2
Fruits indehiscent or dehiscent by two basal stoppers.....3

2. Fruits bilocular (sometimes only 1 locule developing), 3–4 cm long.....**4. Maranthes**
Fruits unilocular, usually 1–1.5 cm long (2.5–3 cm in *P. grandifructus*).....**5. Parastemon**
3. Fruits dehiscing by two basal stoppers; exocarp lenticellate. Leaves usually with stomatal crypts beneath.....**6. Parinari**
Fruits indehiscent or opening by longitudinal lines. Leaves without stomatal crypts.....4
4. Fruits 1–1.3 cm long, unilocular, breaking open by longitudinal lines of weakness; exocarp smooth.....**3. Licania**
Fruits 3–6 cm long, uni or bilocular, indehiscent; exocarp verrucose-crustaceous.....5
5. Fruits unilocular. Stamens united into a ligule.....**2. Kostermanthus**
Fruits bilocular. Stamens free.....**1. Atuna**

1. ATUNA Rafin.

(an Amboinese vernacular name)

merbatu (Malay)

Sylva Tellur. (1838) 153; Kostermans, Reinwardtia 7, 5 (1969) 421; Prance & Whitmore *l.c.* 323; Anderson *l.c.* 292; Cockburn *l.c.* 81; Prance *l.c.* (1989) 665; Whitmore, Tantra & Sutisna *l.c.* 298.
Synonyms: *Cyclandrophora* Hassk., Flora Beibl. 1 (1842) 47; *Parinari* subg. *Cyclandrophora* (Hassk.) Blume, Mélang. Bot. 2 (1855) 10; *Parinari auct. non Aubl.*, Ridley *l.c.* (1922) 666.

Small to large trees, *ultimate shoots with complicated system of divaricate branching*. Stipules large, prominently keeled, lateral, persistent or subpersistent. **Leaves** *almost glabrous on both surfaces, often with minute papillae on venation giving beaded appearance, without stomatal crypts, with a pair of glands on midrib at or near base of lower surface; petioles eglandular*. **Inflorescence** *a raceme, or sparsely branched, contracted panicle*; bracts and bracteoles persistent, eglandular, not enclosing groups of flower-buds. **Flowers** bisexual; *receptacle obconical to cylindrical, as long as or exceeding calyx-lobes, hollow, hairy inside throughout, throat blocked by retrorse hairs; calyx-lobes 5, broadly ovate to lanceolate, tomentellous on both surfaces; petals 5, glabrous, exceeding calyx-lobes; stamens 10–20, posterior, inserted unilaterally on margin of disc, filaments free, exerted*; staminodes forming a barely visible denticular margin to throat; ovary inserted at mouth of receptacle tube, pilose on exterior, *carpel bilocular with 1 ovule in each loculus*. **Fruits** *large; epicarp glabrous, densely verrucose-crustaceous; mesocarp transversely fibrous; endocarp hard, thick, shortly and sparsely hairy inside, breaking up irregularly at germination; cotyledons large and strongly ruminant; germination cryptocotylar (with hidden cotyledon), eophylls alternate*.

Distribution. 8 species from Southern India throughout Malesia and to Fiji and Samoa in the Pacific. 3 species occur in Sabah and Sarawak.

Ecology. Usually found on well-drained mixed dipterocarp forest to 600 m.

Uses. Little used as a timber.

Key to *Atuna* species

1. Leaves broadly ovate, thickly coriaceous, cordate at base. Stamens *c.* 10...**1. *A. cordata***
 Leaves elliptic or oblong-lanceolate, chartaceous, rounded at base. Stamens 13–20.....2
2. Receptacle tube narrowly cylindrical. Leaves oblong-lanceolate. Stamens purple.....**2. *A. nannodes***

 Receptacle turbinate-campanulate. Leaves elliptic to oblong-ovate. Stamens white.....
**3. *A. racemosa***

1. *Atuna cordata* Cockburn *ex* Prance
 (Latin, *cordatus* = heart-shaped; the leaf base)

Fig. 1.

Brittonia 39 (1987) 364; Cockburn *l.c.* 82; Prance *l.c.* (1989) 667. **Type:** *Ahmad Talip SAN 47687*, Sabah, Lahad Datu (holotype K; isotypes L, SAN).

Tree to 40 m tall, the trunk often with thick buttresses. **Bark** smooth, grey-green, mottled white; inner bark hard, reddish brown. **Sapwood** ochre to red-brown, hard. Young branches glabrescent, inconspicuously lenticellate. *Stipules to 1.7 cm long, very early caducous.* **Leaves** coriaceous, *broadly ovate*, 4.5–12 x 3–9.5 cm; *cordate at base*, abruptly acuminate at apex, the acumen 1–3 mm long; glabrous and shiny above, glabrous beneath; midrib prominulous above, prominent beneath; lateral veins 9–12 pairs, lightly prominulous above, prominulous and glabrous beneath; petioles 1–3 mm long, thick, glabrous. **Inflorescences** of terminal and subterminal racemes, 4–8 cm long, borne in single or more often in paired branches, densely tomentellous on exterior, puberulous within; bracts and bracteoles ovate, tomentellous, early caducous. **Flowers** with *receptacles 5–7 mm long, conical to campanulate*, tomentellous on exterior, sessile; calyx-lobes slightly unequal, tomentellous on both surfaces; petals *c.* 7 mm long, obovate, glabrous; stamens 10, inserted on one side of ring, the filaments 10–12 mm long; ovary densely pilose, style slender, hirsutulous on lower portion. **Fruits** *c.* 6 x 5 cm, ovoid; epicarp verrucose-crustaceous; mesocarp *c.* 5 mm thick, fibrous, hard; endocarp thin.

Distribution. Endemic to Sabah; recorded from Lahad Datu, Karamuak, Mt. Tawai and Mt. Silam.

Ecology. Confined to hills and locally common on ultramafic rock to 1200 m.

2. *Atuna nannodes* (Kosterm.) Kosterm.

(Greek, *nanno* = dwarf; the comparatively small size of the tree)

Reinwardtia 7, 5 (1969) 422; Prance & Whitmore *l.c.* 325; Prance *l.c.* (1989) 667. **Basionym:** *Parinari nannodes* Kosterm., Reinwardtia, 7, 1 (1965) 50. **Type:** *Beccari PB 2955*, Sarawak, Mt. Matang (BO, K). **Synonym:** *Cyclandrophora nannodes* (Kosterm.) Kosterm. & Prance, Candollea 20 (1965) 122.

Tree to 20 m, usually smaller, unbuttressed. **Bark** smooth, dark grey. Young branches sparsely appressed hirsutulous-strigose, soon glabrous, obscurely lenticellate. Stipules narrowly lanceolate, acute, 6–12 mm long, strigose to glabrous, subpersistent. **Leaves** thinly coriaceous, *oblong-lanceolate*, 6.7–19 x 2.5–6 cm, glabrous on both surfaces, sometimes slightly

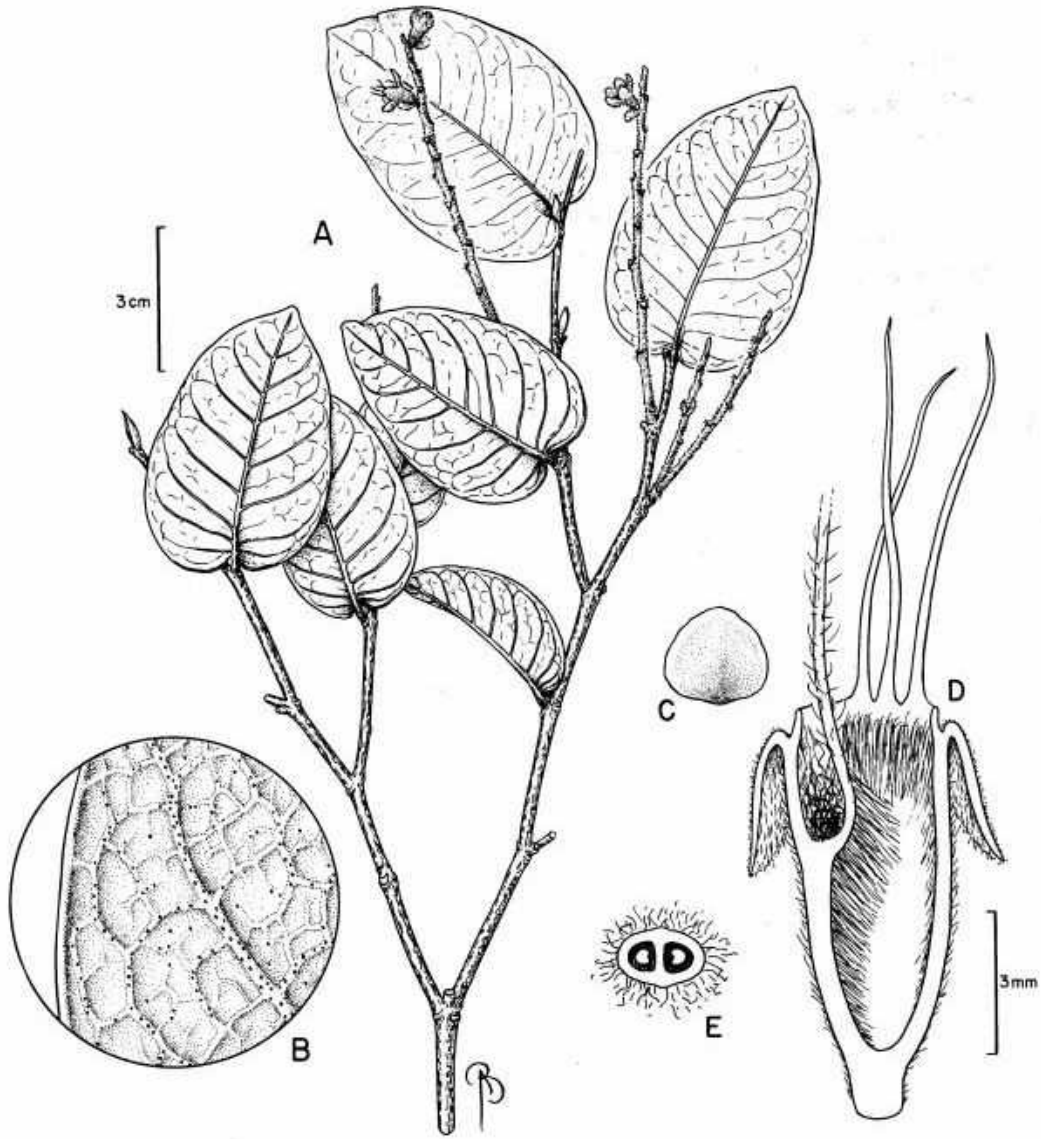


Fig. 1. *Atuna cordata*. A, flowering leafy twig; B, leaf lower surface; C, petal; D, flower in longitudinal section; E, ovary in cross section. (From *SAN* 47687.)

bullate above; rounded at base, long slender acuminate at apex, the acumen 7–22 mm long; midrib prominulous above, prominent beneath; lateral veins 10–12 pairs, arcuate, prominulous on both surfaces or sometimes prominent beneath; petioles 2–4 mm long, glabrescent, eglandular, the lower part swollen, usually curved. **Inflorescences** axillary racemes, 3–7 cm long, the rachis densely sericeous-tomentellous; bracts and bracteoles lanceolate, 3–7(–13) mm long, persistent, sericeous. **Flowers** with *cylindrical receptacle*, 8–13 mm long, *densely sericeous on exterior*, sessile; calyx-lobes to 6 mm long, unequal, acute, sericeous on exterior; petals white, spatulate to ovate, 8–12 mm long, narrowed to the base; *stamens 18–20, black to purple*, the filaments 10–15 mm long, slightly unilateral with tooth-like staminodes opposite; ovary pilose, style to 15 mm long, glabrous, stigma capitate. **Fruits** ellipsoid, 3–4 x 1.5 cm, slightly tapered to the base, crustaceous-verrucose on exterior; mesocarp 2–2.5 mm, fibrous, hard; endocarp thin.

Distribution. Peninsular Malaysia, Borneo (Sabah, Sarawak, Kalimantan). In Sabah known by collections from localities in the Sandakan, Semporna, Tawau and Tongod districts. In Sarawak, recorded from Bau and Kuching areas, 1st Div.

Ecology. Forest on well-drained soils to 500 m.

3. *Atuna racemosa* Rafin.

(Latin, *racemosus* = with a raceme-like inflorescence)

l.c. 153; Kostermans *l.c.* (1969) 422; Anderson *l.c.* 293; Cockburn *l.c.* 84; Prance *l.c.* (1989) 669. **Type:** *Rumphius Herb. Amb. 1 (1741) pl. 66.*

Tree to 35 m tall often with short buttresses. **Bark** smooth, grey to black, mottled; inner bark orange-brown, red-brown to brown, hard. **Sapwood** white, ochre to red-brown; heartwood red-brown. Young branches glabrous, dark red-brown, smooth or obscurely lenticellate when dry. *Stipules lanceolate, stiff, to 8–20 mm long, acute, glabrous to strigose, sub-persistent.* **Leaves** usually chartaceous, more rarely stiffly coriaceous, broadly ovate, elliptic, ovate-oblong, oblong or even lanceolate, 4.5–25(–35) x 2–11 cm; rounded, subcordate or subcuneate at base, acuminate at apex, the acumen 3–25 mm long; glabrous on both surfaces when mature, sometimes sparsely strigose beneath on lower portion when young; midrib prominent on both surfaces; lateral veins 9–13 pairs, prominulous above, prominent beneath, straight or arcuate; the venation conspicuously papillose and often giving leaf a scabrous or beaded appearance; petioles slender or thick, 3–7 mm long, pilose or puberulous, glabrescent or glabrous. **Inflorescences** of axillary racemes or little-branched with 2–3 racemose branches on short main peduncle, 5–15 cm long, the rachis and branches tomentellous or densely short sericeous; bracts and bracteoles ovate to oblong, acute, 3–8 mm long, persistent or caducous. **Flowers** with *receptacle turbinate-campanulate, 4–10 mm long*, tomentose to sericeous on exterior; pedicels 0.5–1 mm long; calyx-lobes ovate to ovate-oblong, 4–7 mm long, densely tomentellous on both surfaces or sericeous on exterior, tomentellous within; petals equal, ovate-oblong, *c.* 10 mm long, blue or white, caducous; stamens 13–20, pale blue, 8–15 mm long with tooth-like staminodes opposite; ovary pilose to densely villous, style equalling filaments, glabrous above, stigma small. **Fruits** *ellipsoid, subglobose to slightly pyriform, 5–7.5 x 3.5–4.5 cm*; epicarp crustaceous-verrucose; mesocarp fibrous, 5–11 mm thick; endocarp thin, 1–3 mm, densely pilose within.

Key to subspecies

Leaves 10–25 (–35) cm long, usually elliptic, oblong or lanceolate but sometimes ovate, chartaceous or thickly coriaceous, the apex long finely acuminate, acumen 6–25 mm long; petioles thick. Flowers 10–17 mm long. Medium-sized to large tree often with fluted bole....

subsp. **racemosa**

Synonyms: *Cyclandrophora glaberrima* Hassk. *l.c.* 47; *Parinarium glaberrimum* (Hassk.) Hassk., *Tijd. Nat. Ges. Phys.* 10 (1843) 147, Merrill *l.c.* (1921) 290, *l.c.* (1929) 92, Masamune *l.c.* 321; *P. scabrum* Hassk. *l.c.* (1843) 147; *P. elatum* King *l.c.* 280; *C. elata* (King) Prance in Kosterm., *Candollea* 20 (1965) 122; *Atuna elata* (King) Kosterm. *l.c.* (1969) 421.

Thailand to Sumatra, Peninsular Malaysia, Singapore, Borneo (Sabah, Brunei, Sarawak), Philippines, Celebes, Moluccas, New Guinea, New Britain, and the Pacific (Admiralty, Caroline, Solomon Islands, Fiji, Samoa). In Sabah common and has been recorded in most districts. In Sarawak uncommon and collected only from Baram district, and known from ecological plots at Bt. Raya, Rejang, Bt. Iju, Balingian, and Bintulu. Found mainly in well-drained mixed dipterocarp forests, to 600 m, but also occurs on riverbanks and freshwater and brackish water swamps, can be very common.

Leaves 4.5–12 cm long, usually ovate or oblong-ovate, subcoriaceous or coriaceous, the apex bluntly acuminate, acumen 3–10 mm long; petioles thin. Flowers 8–11 mm long. Large trees with cylindrical bole.....

subsp. **excelsa** (Jack) Prance

l.c. (1989) 670. Basionym: *Petrocarya excelsa* Jack, *Mal. Misc.* 2 (7) (1822) 66. Type: *Kostermans & Anta 1136*, Bangka, Lobok Besar (neotype K; isoneotypes A, BO, L, SING). Synonyms: *Parinarium asperulum* Miq., *Fl. Ind. Bat., Suppl.* (1861) 307; *Cyclandrophora asperula* (Miq.) Prance ex Kosterm., *Candollea* 20 (1965) 130; *Cyclandrophora excelsa* (Jack) Kosterm., *Candollea* 20 (1965) 128; *Atuna excelsa* (Jack) Kosterm. *l.c.* (1969) 422; *P. villamilii* Merr., *Philip. J. Sc.* 10 (1915) Bot. 308, Anderson *l.c.* 294; *C. villamilii* (Merr.) Prance ex Kosterm., *Candollea* 20 (1965) 126; *A. villamilii* (Merr.) Kosterm. *l.c.* (1969) 422.

Sumatra, Peninsular Malaysia, Java, Borneo (Sabah, Sarawak, Kalimantan), N Celebes. In Sabah known from Beaufort, Lahad Datu, Lamag, Sandakan and Tawau districts. In Sarawak has been recorded in Lundu, Kuching, Serian, Miri and Kapit districts. Usually occurring in well-drained mixed dipterocarp forest, to 750 m, on ridges and hillsides, uncommon.

Uses. The fruit (cotyledon) of subsp. *racemosa* is grated and made into a putty for caulking canoes, widely used in the Pacific islands. An oil extracted from the seeds is used variously in different areas, e.g., to scent coconut oil and for hairdressing. The leaves are used to thatch the outside walls of houses in Fiji. The wood is used locally for posts and poles but is not of good quality.

2. KOSTERMANTHUS Prance

(A.J.G.H. Kostermans, 1907–1994, botanist of the

Forest Research Institute and Herbarium Bogoriense, Bogor, Indonesia)

Brittonia 31 (1979) 91; Prance & Whitmore *l.c.* 327; Anderson *l.c.* 293; Cockburn *l.c.* 85; Prance *l.c.* (1989) 675; Whitmore, Tantra & Sutisna *l.c.* 299. **Synonyms:** *Acioa auct. non* Aubl., Kostermans, *Reinwardtia* 7, 1 (1965) 9; *Parinari auct. non* Aubl.: *quoad P. heteropetala et P. myriandra, tantum.*

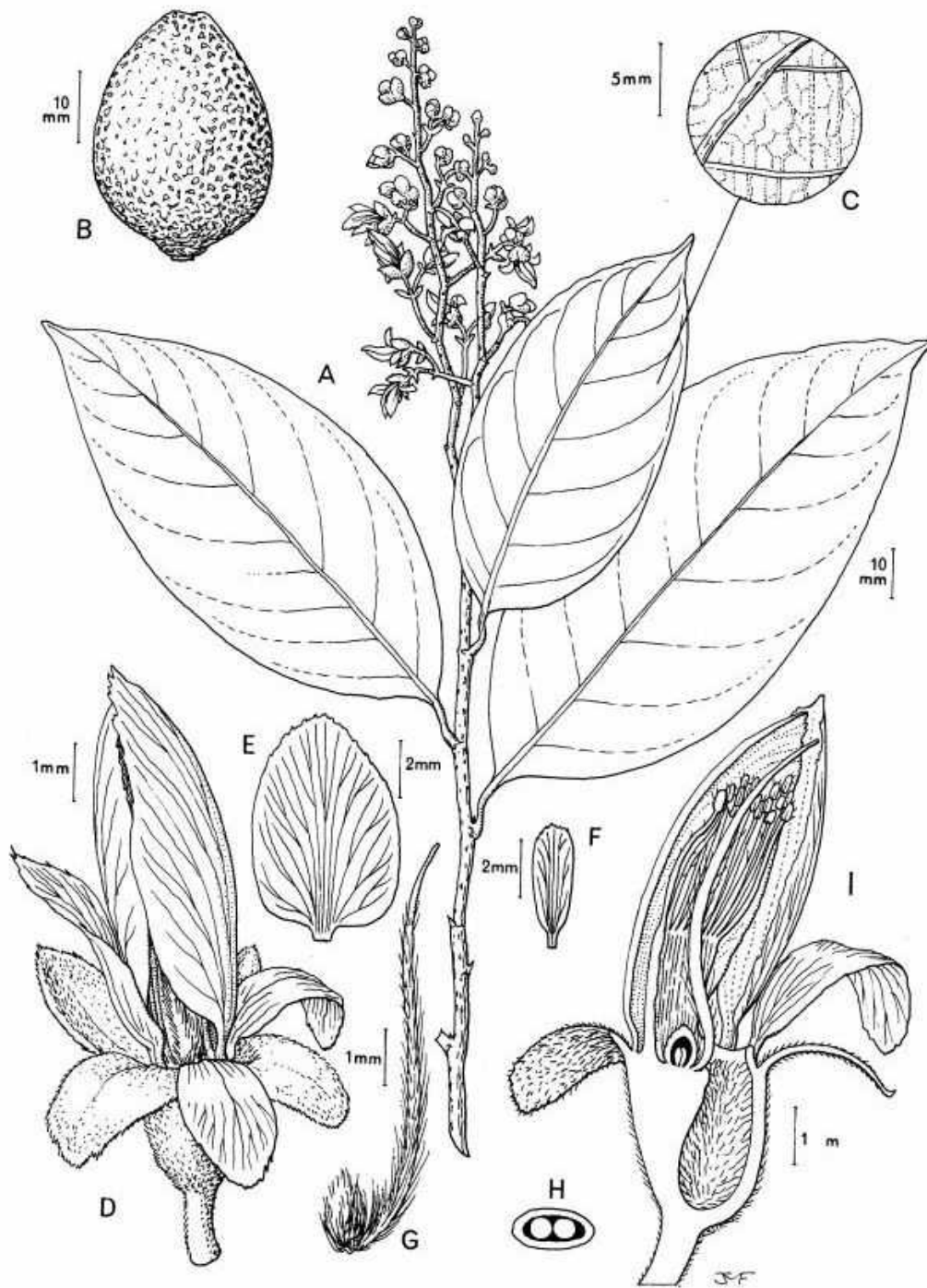


Fig. 2. *Kostermanthus heteropetalus*. A, flowering leafy twig; B, fruit; C, leaf lower surface; D, flower; E, large petal; F, small petal; G, ovary and style; H, ovary in cross section; I, flower in longitudinal section. (A & C from *Kostermans 13630*, B from *Elmer 21848*, D-I from *KEP 105046*.)

Large trees, ultimate shoots not divaricate. Stipules to 7 mm long, foliaceous, persistent, lanceolate to ovate. **Leaves** glabrous on both surfaces with *minute papillae on veins giving a beaded appearance*; petioles eglandular. **Inflorescence** an unbranched or little-branched terminal or axillary raceme with shortly stalked congested cymules proximally and singly inserted flowers distally; bracts and bracteoles small, suborbicular, persistent, eglandular, not enclosing groups of flower buds. **Flowers** bisexual, strongly zygomorphic; receptacle broadly obconic-campanulate, shorter than calyx-lobes, asymmetric, hollow, hairy on both surfaces, but throat not blocked by retrorse hairs; calyx-lobes 5, markedly unequal, suborbicular to ligulate, strongly imbricate; *petals 5, unequal in size and shape, the 2 posterior larger than the others, markedly unguulate and enclosing stamens in bud*; stamens 8–30, inserted unilaterally on margin of disc; *filaments united for half to three quarters of length into a strap*; staminodes 5–8, inserted opposite stamens; ovary inserted laterally at mouth of receptacle, unilocular with 2 ovules. **Fruits** large, hard; epicarp glabrous, crustaceous-verrucose; endocarp hard, thick, glabrous within, breaking irregularly on germination. *Cotyledons slightly ruminatae*.

Distribution. 2 species, one (*K. malayanus*) is confined to Peninsular Malaysia, the other (*K. heteropetalus*) is known from Sumatra, Borneo, the Philippines, and Celebes.

Kostermanthus heteropetalus (Scort. ex King) Prance
(Greek, *hetero* = uneven, *petalon* = petal; the unequal petals)

Fig. 2.

l.c. (1979) 91, *l.c.* (1989) 677; Anderson *l.c.* 293; Cockburn *l.c.* 85; Prance & White *l.c.* (1988) 152; Whitmore, Tantra & Sutisna *l.c.* 299. **Basionym:** *Parinari heteropetalum* Scort. ex King *l.c.* 283. **Type:** *Scortechini 2040*, Perak (BO, SING). **Synonyms:** *Parinarium myriandrum* Merr. *l.c.* (1929) 93; *Acioa heteropetala* (Scort. ex King) Kosterm., *Reinwardtia* 7, 1 (1965) 11.

Tree to 35 m tall, 2 m diameter, often with low small buttresses. **Bark** with small fissures and brittle flakes, grey-brown; inner bark pale red-brown to ochre. **Sapwood** pale yellow; heartwood red-brown with a wavy junction between it and sapwood. Young branches glabrous, lenticellate. Stipules 6–7 mm long, partly intrapetiolar, carinate, ovate, foliaceous, acute to acuminate, persistent to subsistent. **Leaves** coriaceous, usually elliptic-subovate to rarely lanceolate, 5–20 x 2.5–6 cm; cuneate to rounded at base, bluntly acuminate at apex; glabrous on both surfaces, *minutely papillose on venation of both surfaces giving a bead-like appearance*; midrib prominulous above, prominent beneath; lateral veins 6–10 pairs, arcuate, slender, prominent beneath; petioles 6–12 mm long, sometimes lightly alate from decurrent leaf margins, slightly flattened above, eglandular. **Inflorescences** little-branched, to 10 cm long, the rachis and branches lightly tomentellous; bracts and bracteoles ovate, acute, to 3 mm long, caducous. **Flowers** with a receptacle broadly campanulate, 2–3 mm long, tomentose on both surfaces; calyx-lobes fleshy, unequal, acute, to 7 mm long, pilose on both surfaces, reflexed in open flowers; *petals white-tinged pink, fleshy, elliptic, concave, largest up to 15 mm long, tomentellous on exterior, enveloping staminal ligule, the others much smaller to 6 mm long*; *stamens 25–30 united into a unilateral ligule for two thirds of their length, to 12 mm long, glabrous; anthers pubescent*; ovary densely pilose, style densely appressed pilose, stigma truncate. **Fruits** ovoid, unilocular, *c.* 4 x 3 cm; epicarp glabrous, crustaceous; endocarp hard, thick. *Cotyledons slightly ruminatae, c.* 1.5 x 3 cm.



Fig. 3. *Licania splendens*. A, flowering leafy twig; B, flower; C, flower in longitudinal section; D, ovary and style; E, petal; F, fruit in longitudinal section; G, fruit. (A-E from *S. 14958*, F-G from *Kostermans 6353*.)

Vernacular names. Sabah and Sarawak—*merbatu*, *rasak batu* (Malay).

Distribution. Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei and Kalimantan), the Philippines (Mindanao), and Celebes. In Sabah found in Beaufort, Keningau, Kota Marudu, Mostyn, and Tongod districts in the west, and in Lahad Datu, Sandakan, and Tawau districts in the east. In Sarawak widespread.

Ecology. Mixed dipterocarp forest on sandy clay soils, to 500 m.

Uses. The fruit is eaten in Celebes and Sumatra. The timber is easy to cut and is red when freshly cut turning brown with age. It is little used because of its tendency to rot.

3. LICANIA Aubl.

(intended to be an anagram of the local name in French Guiana—*caligni*)

Hist. Pl. Guiane Fr. 1 (1775) 119; Prance & Whitmore *l.c.* 328; Anderson *l.c.* 293; Cockburn *l.c.* 86; Prance *l.c.* (1989) 645. **Synonym:** *Angelesia* Korth., Ned. Kruidk. Arch. 3 (1854) 384.

Small to large trees. Stipules small, free, caducous. **Leaves** glabrous on both surfaces, *without stomatal crypts*; petioles eglandular. **Inflorescence** a panicle of cymules; bracts and bracteoles to 1.5 mm long, membranous, eglandular, not enclosing groups of flower buds. **Flowers** bisexual; receptacle campanulate, slightly asymmetric, tomentose on exterior and interior; calyx-lobes 5, acute, unequal; petals 5, small, not exceeding the calyx-lobes, not clawed; *stamens 7–10, all fertile*, inserted on margin of disc; *filaments glabrous, included*, slightly united at base; *ovary inserted at or near base of receptacle*, pilose on exterior; carpel unilocular, with 2 ovules, style pubescent at base, the stigma capitate. **Fruit** a small, fleshy drupe, narrowed to a shortly stipitate base; *epicarp smooth, not ridged, glabrous, not lenticellate*; mesocarp thin, fleshy; endocarp thin, hard, bony, breaking up in longitudinal lines during germination, tomentose within.

Distribution. 200 species in Neotropics, 1 species in West Africa and 3 species in Thailand and Malesia (Sumatra, Java, Borneo, the Philippines, and Papua New Guinea). In Sabah and Sarawak only 1 species recorded.

Licania splendens (Korth.) Prance

Fig. 3.

(Latin, *splendens* = shining; the shiny surface of the dried leaves)

Fl. Neotropica 9 (1972) 172, *l.c.* (1989) 646; Prance & Whitmore *l.c.* 328; Anderson *l.c.* 293; Cockburn *l.c.* 86. **Basionym:** *Angelesia splendens* Korth. *l.c.* 384, Merrill *l.c.* (1921) 290, *l.c.* (1929) 92, Masamune *l.c.* 324. **Type:** *Korthals, s.n.*, Sumatra (L).

Tree to 25 m tall. **Bark** smooth to scaly, flaking by small scales when old; inner bark red-brown. **Sapwood** pink, hard. Young branches sparsely lanate, soon glabrous. Stipules linear-lanceolate, to 3 mm long, caducous. **Leaves** 4–11 x 1.8–4.2 cm, oblong; cuneate at

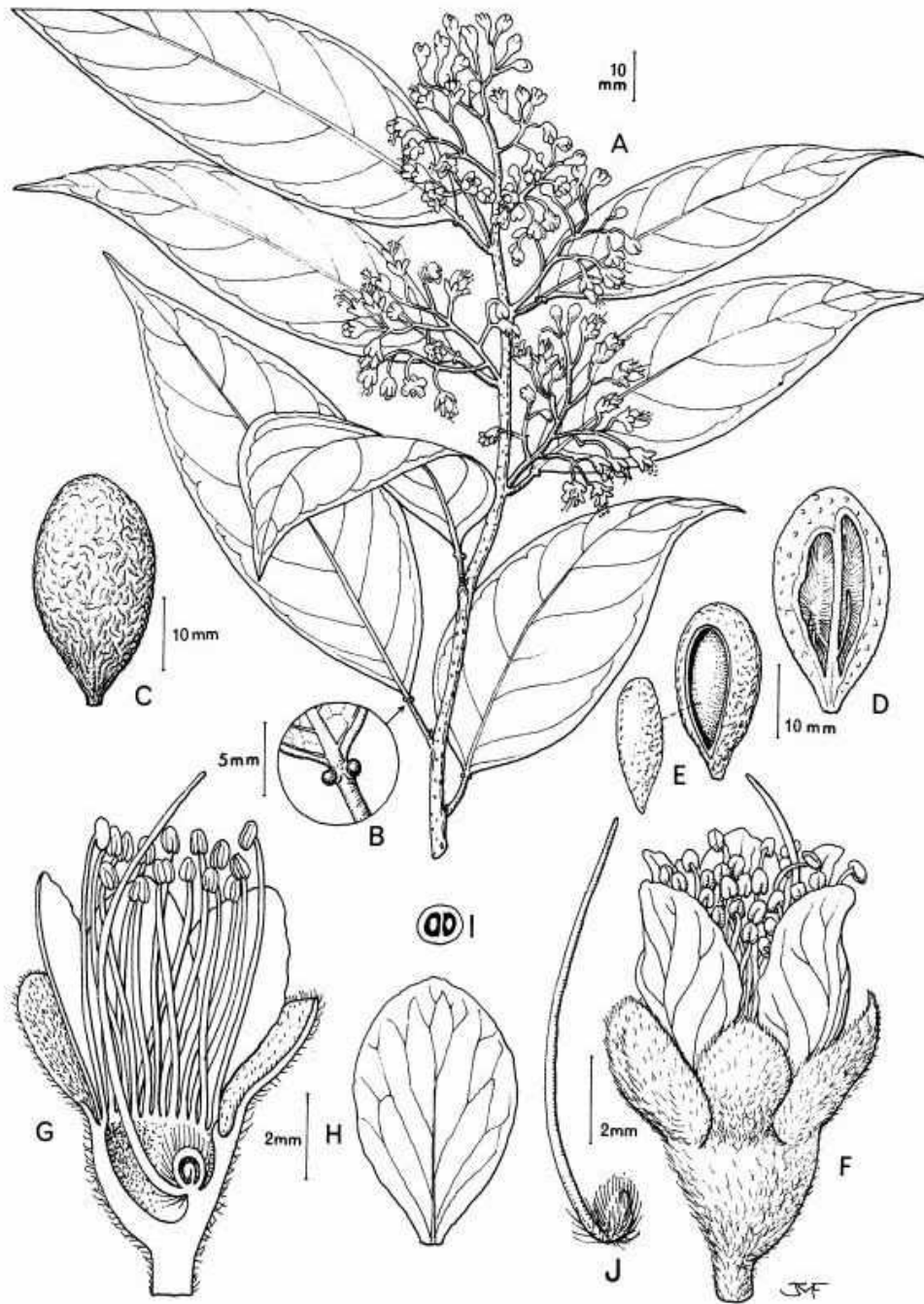


Fig. 4. *Maranthes corymbosa*. A, flowering leafy twig; B, leaf-base with glands; C, fruit; D, fruit in longitudinal section; E, fruit dehiscence; F, flower; G, flower in longitudinal section; H, petal; I, cross-section of ovary; J, ovary and style. (A-B and F-J from *SAN A 1888*, C-E from *Podzorski SMHI 816*.)

base, usually acuminate at apex; glabrous beneath; petioles 2–5 mm, canaliculate, glabrous when mature. **Inflorescences** terminal and axillary panicles of cymules, 1.5–14 cm long, the rachis and branches grey-puberulous. **Flowers** c. 2 mm long; receptacle campanulate, slightly swollen to one side, grey-tomentellous on exterior, tomentose within; pedicels c. 1 mm long; calyx-lobes acute, tomentellous on both surfaces; petals pubescent on exterior; stamens 7–10, slightly unilateral, the filaments glabrous; ovary at or near base of receptacle, unilocular, pilose on exterior. **Fruits** ellipsoid, 1–1.3 cm long; epicarp smooth, glabrous; mesocarp thin, fleshy; endocarp thin, hard, bony, breaking open by longitudinal lines of weakness, tomentose within.

Vernacular names. Sabah—*sampaluan*, *tampaluan* (Dusun).

Distribution. Thailand, Peninsular Malaysia, Java, Borneo (Sabah, Sarawak, Brunei, Kalimantan), the Philippines. In Sabah common, recorded in most districts. In Sarawak, known from Bintulu, Kuching, Lundu and Serian districts.

Ecology. Common tree of primary and secondary mixed dipterocarp forests in well-drained usually sandy soils on slopes and also in peat swamp and on seashores and in rocky places below 400 m.

Uses. The timber is strong, durable and resistant to marine borers and is used for saltwater piles, railroad ties, etc. However, it is extremely hard to work and requires special tools because of silica. The fruit is edible but is not widely used.

4. MARANTHES Blume

(Greek, *maraino* = to wither; the long-persistent withered calyx and stamens below the fruit)

Bijdr. (1825) 89; Kostermans, Candollea 20 (1965) 196; Prance, Bol. Soc. Brot. Ser. 2, 40 (1966) 183, l.c. (1989) 671; Prance & Whitmore l.c. 329; Anderson l.c. 293; Cockburn l.c. 88; Whitmore, Tantra & Sutisna l.c. 299. **Synonyms:** *Parinari auct. non Aubl.*; *Parinari* sect. *Sarcostegia* Benth. in Hooker, Niger Fl. (1849) 335, *pro parte*; *Parinari* subg. *Sarcostegia* (Benth.) Miq., Fl. Ind. Bat. 1, 1 (1855) 355, *pro parte*; *Parinari* subg. *Exitelia* Blume l.c. (1855) 10.

Medium-sized to large trees. Stipules deltate, intrapetiolar, stiff, caducous. **Leaves** glabrous on both surfaces when mature, with dense caducous cobweb-like indumentum when young, without stomatal crypts; *with paired glands at junction of lamina and petiole*; petioles eglandular. **Inflorescence** *a many-flowered corymbose panicle*; bracts and bracteoles eglandular, caducous, not enclosing flower buds in small group. **Flowers** bisexual; *receptacle* obconical, narrowed into pedicel, solid, *almost completely filled with nectariferous tissue*, short-tomentose to glabrous on exterior, glabrous within; calyx-lobes suborbicular, deeply concave, unequal; petals 5, not clawed; *stamens* 25–40, inserted on margin of disc, unilateral with tooth-like staminodes opposite to almost in a complete circle, filaments far exerted beyond calyx-lobes, in a tangled mass; ovary inserted laterally at mouth of receptacle, *carpel bilocular* with 1 ovule in each locule, style pubescent at base only, curved upwards, exerted. **Fruit** a large fleshy drupe; epicarp smooth, glabrous, not lenticellate; mesocarp fleshy; *endocarp very hard, fibrous with a rough exterior, densely tomentose within, with 2 lateral plates which break away on germination*; germination phanero-cotylar

(with exposed cotyledons); cotyledons fleshy, pale green; cataphylls absent; *first 2 eophylls opposite*, the others alternate or opposite.

Distribution. 10 species in tropical Africa, 1 in Central America, and 1 (*Maranthes corymbosa*) widespread in Malesia, Australia and the western Pacific.

Ecology. Lowland forest.

Uses. Wood hard and durable, used for posts and house building. Fruits of most species edible.

Maranthes corymbosa Blume

Fig. 4.

(Greek, *corymbos* = a cluster; the clustered inflorescences)

l.c. (1825) 89; Kostermans, *Candollea* 20 (1965) 107; Prance & Whitmore *l.c.* 330; Anderson *l.c.* 295; Cockburn *l.c.* 88; Prance & White *l.c.* 127; Prance *l.c.* (1989) 673; Whitmore, Tantra & Sutisna *l.c.* 299. **Type:** *Blume, s.n.*, Java, Prov. Krawang, near Tjiradja (L). **Synonyms:** *Parinarium corymbosum* (Blume) Miq. *l.c.* (1855) 356, Merrill *l.c.* (1921) 290, Masamune *l.c.* 325; *Exitelia corymbosa* (Blume) Blume, *Fl. Jav.* 1, Praef. (1828) 7; *Parinarium griffithianum* Benth. in Hooker *l.c.* (1849) 334.

Tree to 30 m tall, 1.5 m diameter, unbuttressed. **Bark** smooth, grey-brown, lenticellate, often mottled with patches of lichen; inner bark red, thin. **Sapwood** pale white to pink; heartwood red-brown. Young branches red-brown, minutely white-lenticellate, glabrous. Stipules lanceolate, acute, 5–10 mm long, sparsely pilose on exterior, glabrous within, early deciduous. **Leaves** coriaceous, usually oblong-lanceolate to oblong-elliptic, 6.5–14 x 2.5–8 cm; cuneate at base, acuminate at apex, the acumen 8–20 (–30) mm long; glabrous when mature but often sparsely caducous arachnoid-lanate when young, *usually with 2 conspicuous prominent glands at junction of petiole and decurrent lower surface*; lateral veins 7–10 pairs, arcuate, prominulous on both surfaces; midrib plane above, prominulous beneath; petioles 4–9 mm long, glabrous when mature, flattened above. **Inflorescences** of *flattened many-flowered corymbose panicles*; rachis and branches sparsely pilose, glabrescent; bracts and bracteoles ovate to lanceolate, sparsely pubescent, caducous. **Flowers** with *receptacle turbinate, tapering into pedicels*, 2–4 mm long, grey-tomentose to glabrous on exterior, *glabrous within*; calyx-lobes fleshy, ovate to elliptic, obtuse, 2.5–4 mm long, unequal; petals white-tinged pink, glabrous, 3–6 mm long, caducous; *stamens 25–35, inserted in several rows on one side of throat*, with tooth-like staminodes opposite; ovary densely lanate and villous; stigma truncate. **Fruits** ellipsoid, 3–4 x 1.5–2 cm, tapered towards base; epicarp thin, glabrous on exterior when mature, sometimes lanate when young; endocarp *c.* 5 mm thick, densely lanate within, *bilocular* usually with seed in one locule only. Cotyledons plano-convex.

Vernacular names. Sabah—*bangkawang* (Dusun, Malay). Sarawak—*merbatu* (Malay).

Distribution. S Thailand extending east to Solomon and Caroline Islands and Australia. In Malesia: Sumatra, Peninsular Malaysia, Java, Borneo (Sabah, Sarawak, Brunei, Kalimantan), the Philippines, Celebes, Moluccas, New Guinea, New Britain and Admiralty Islands. In Sabah, widespread but in Sarawak, uncommon in mixed dipterocarp forest in the northern parts.

Ecology. In primary and secondary forests from the sea-coast to 1500 m on Mt. Kinabalu, Sabah. The fruit is eaten by many birds which probably disperse the seed and account for the wide distribution of this species.

Uses. The wood is used for house building and for posts and the fruit is edible.

5. PARASTEMON A. DC.

(Greek, *para* = near, *stemon* = stamen; both fertile and sterile stamens are located near one another at one side of the flower)

Ann. Sci. Nat. Bot. Ser. 2, 18 (1842) 28; Miquel *l.c.* (1855) 359; Merrill *l.c.* (1921) 290; Ridley *l.c.* (1922) 672; Corner *l.c.* 617; Masamune *l.c.* 324; Anderson *l.c.* 293; Cockburn *l.c.* 90; Prance *l.c.* (1989) 648; Whitmore, Tantra & Sutisna *l.c.* 299. **Synonyms:** *Diemenia* Korth. *l.c.* (1854) 388; *Trichocarya* Miq. *l.c.* (1855) 537, *pro parte*.

Trees or shrubs. Stipules small and triangular, caducous. **Leaves** glabrous on both surfaces, without stomatal crypts, with 2 small discoid glands at base of lamina; petioles eglandular. **Inflorescences** axillary or rarely terminal simple or sparsely branched racemes; bracts and bracteoles small, eglandular, not enclosing groups of flower buds. **Flowers** bisexual or unisexual; receptacle patelliform or shallowly cupuliform, shortly hairy within; calyx-lobes 5, acute, subequal; petals 5, not exceeding calyx-lobes, not clawed; stamens either 5 and all fertile or 2 fertile with 3 staminodes, the filaments glabrous, shorter than the calyx-lobes; ovary centrally inserted at base of receptacle, glabrous or densely hairy on exterior, carpel unilocular, with 2 ovules, style filiform, puberulous towards the base, with 3 large undivided lobes at apex or 1 obscure lobe and 2 large, sometimes deeply divided lobes. **Fruit** a drupe, 1.5–3 cm long, with 2 large lateral plates which break away on germination to allow seedling escape; epicarp smooth, not lenticellate; endocarp thin, hard, bony, smooth on exterior, glabrous within.

Distribution. 3 species in the Nicobar Islands, Sumatra, Peninsular Malaysia, Borneo, Moluccas, New Guinea, and Admiralty Islands. 2 species in Sabah and Sarawak.

Ecology. Lowland and swamp forests.

Key to *Parastemon* species

Leaves with 5–6 pairs of lateral veins. Fruit 2.3–3.5 cm long.....1. **P. grandifructus**

Leaves with 8–11 pairs of lateral veins. Fruit 1–1.5 cm long.....2. **P. urophyllus**

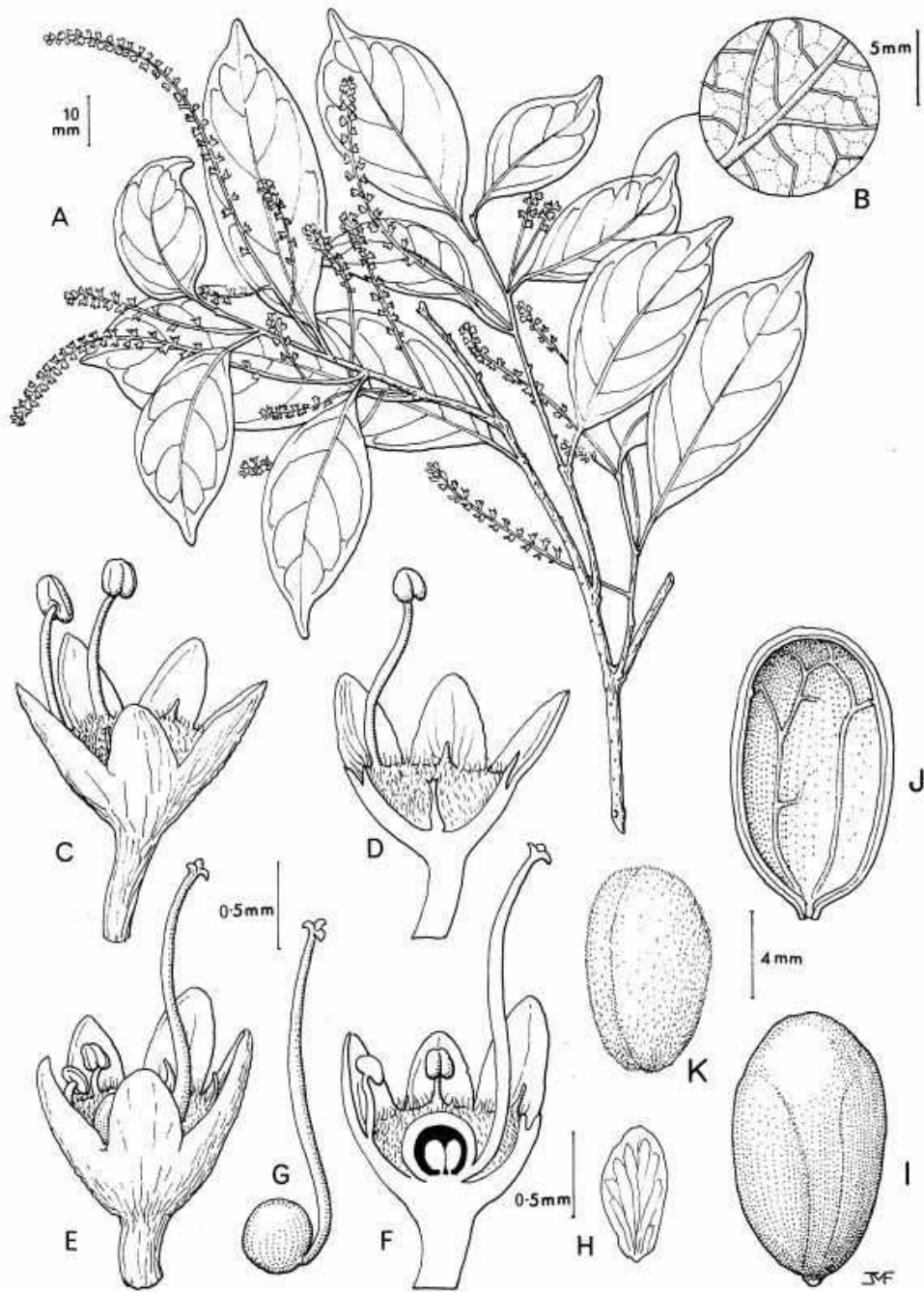


Fig. 5. *Parastemon urophyllus*. A, flowering leafy twig; B, leaf lower surface; C, male flower; D, male flower in section; E, female flower; F, female flower in section; G, ovary and style; H, petal; I, fruit showing plate of dehiscence; J, interior of fruit; K, cotyledons. (A–B and E–H from Anderson S. 9803, C–D from Carrick et al. JC/42, I–K from SAN 67203.)

1. *Parastemon grandifructus* Prance

(Latin, *grandis* = large, *fructus* = fruit)

Brittonia 39 (1987) 366, l.c. (1989) 650. Type: Wright & Ismawi S. 32320, Sarawak (L).

Tree to 30 m tall, 30 cm diameter; trunk lightly buttressed to 1 m high. Young branches glabrous. Stipules caducous. **Leaves** coriaceous, glabrous on both surfaces, elliptic to narrowly elliptic-oblong, 5–8.5 x 1.8–3.2 cm; cuneate at base, with a long-cuspidate acumen at apex, the tip 10–16 mm long; midrib prominent above, prominulous or plane beneath; lateral veins 5–6 pairs, prominulous above, plane beneath; petioles 5–8 mm long, glabrous, slightly canaliculate, slightly swollen at base. **Inflorescences** of axillary and terminal racemes, the rachis glabrous. **Flowers** (seen in fruiting specimens): calyx-lobes 5, acute, glabrous on exterior, glabrous within except for a few hairs around base; receptacle glabrous on exterior in fruiting condition; style persistent below fruits, the stigma bifid or trifid. **Fruit** ellipsoid, 2.3–3.5 x 1.3–1.5 cm; epicarp smooth, glabrous; mesocarp thin, *c.* 0.25 mm; endocarp thin, hard, bony, *c.* 0.25 mm thick, glabrous within, opening by 2 lateral plates 1.9–2 cm long.

Vernacular names. Sabah—*kayu ajung, mandailas* (Dusun). Sarawak—*ngilas* (Iban, in common with *Xanthophyllum*).

Distribution. Endemic to Borneo (Sabah and Sarawak). In Sabah known from Beaufort Hill and Lumat Estate in the Beaufort district. In Sarawak found in Bau, Kapit, Kuching and Limbang districts.

Ecology. Lowland forests, including swamp and heath forests, to 150 m.

2. *Parastemon urophyllus* (Wall. ex A. DC.) A. DC.

Fig. 5.

(Greek, *aura* = tail, *phyllon* = leaf; the cuspidate apex of the leaf)

l.c. 208; Miquel *l.c.* (1855) 359; Merrill *l.c.* (1921) 290; Ridley *l.c.* (1922) 672; Corner *l.c.* 617; Masamune *l.c.* 324; Browne, FTSB (1955) 308; Anderson *l.c.* 293; Cockburn *l.c.* 90; Prance & Whitmore *l.c.* 331; Prance *l.c.* (1989) 649; Whitmore, Tantra & Sutisna *l.c.* 300. **Basionym:** *Embelia urophylla* Wall. ex A. DC., Trans. Linn. Soc. Lond. 17 (1837) 131. **Type:** Griffith, *s.n.*, Malacca (K). **Synonym:** *Parastemon spicatum* Ridl., J. Str. Br. R. As. Soc. 75 (1917) 29, Merrill *l.c.* (1921) 290, Masamune *l.c.* 324.

Tree to 35 m tall often with small buttresses. **Bark** brownish, smooth, becoming slightly cracked and fissured with age. Young branches glabrous, waxy resinous when young. Stipules triangular, *c.* 1 mm long, caducous. **Leaves** thinly coriaceous, narrowly oblong, 2.5–8 x 1.4–2.5 cm; cuneate at base, *cuspidate-acuminate at apex, the tip 5–15 mm*; midrib plane above, prominulous beneath; lateral veins 8–11 pairs; petioles 4–5 mm long, canaliculate, glabrous. **Inflorescences** of axillary and rarely terminal racemes or occasionally slightly branched, 4–14 cm long, the rachis glabrous. **Flowers** unisexual (*plant polygamodioecious*), *c.* 1.5 mm long; *receptacle broadly cupuliform to flattened saucer-shaped*, glabrous on exterior, tomentose within; pedicels to 2 mm long; calyx-lobes acute, glabrous on exterior; petals 5; *stamens 2 fertile and 3 sterile staminodes opposite; ovary inserted at base of receptacle*, pilose on exterior, unilocular, style pilose at base, glabrous above, the stigma trifid. **Fruits** ellipsoid, 1–1.5 cm long; epicarp smooth, glabrous; mesocarp thin, hard; endocarp thin, hard, bony, glabrous within, *opening by 2 lateral plates*.

Vernacular names. Sabah—*mendailas* (Dusun). Sarawak—*mengilas*, *gilas* (Bidayuh).

Distribution. Nicobar Islands, Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan). In Sabah found in Beaufort, Keningau, Papar and Sipitang districts in the west, and in Lahad Datu and Sandakan districts in the east. In Sarawak widespread and recorded in most districts.

Ecology. Characteristic component of peat swamp forest where it is a common large tree, but also wide-ranging into *kerangas*, more open scrub forest, and secondary forest on poor soils.

Uses. The wood is hard and very heavy; grain straight or interlocked. It is used for general construction, posts and as a firewood.

6. PARINARI Aubl.

(a vernacular name in French Guiana)

merbatu (Malay)

l.c. 204; Merrill *l.c.* (1921) 290, *l.c.* (1929) 92; Masamune *l.c.* 325; Backer & Bakhuizen *f. l.c.* 521; Kostermans, Reinwardtia 7, 1 (1965) 147; Prance & Whitmore *l.c.* 332; Anderson *l.c.* 294; Cockburn *l.c.* 90; Prance *l.c.* (1989) 654; Whitmore, Tantra & Sutisna *l.c.* 300. **Synonym:** *Parinarium* Juss., Gen. Pl. (1789) 342; *Petrocarya* Schreb. in Linnaeus, Gen. Pl. ed. 8, 1 (1789) 245; *Parinarium* subg. *Petrocarya* (Schreb.) Miq. *l.c.* (1855) 352.

Small or large trees or rarely shrubs. Stipules small to large, persistent or caducous. **Leaves** usually with stomatal crypts, filled with pubescence on lower surface or rarely glabrous, or lanate pubescent without crypts; *petioles* usually with 2 circular glands above. **Inflorescence** a many-flowered complex cyme or cymose panicle; *bracts and bracteoles* eglandular, usually concealing flower buds individually and in small groups. **Flowers** bisexual; *receptacle* subcampulate to cupuliform, slightly swollen to one side, tomentose on both surfaces; calyx-lobes 5, deltate, acute, densely hairy on both surfaces; petals 5, as long as or shorter than sepals, caducous; *stamens* 6–10, unilateral, the filaments glabrous, included, with c. 6 minute staminodes opposite; ovary inserted on upper half of receptacle-tube below mouth, pilose on exterior, carpel bilocular with 1 ovule in each locule, style arcuate, included. **Fruit** a fleshy drupe; epicarp verrucose; endocarp thick, with a rough fibrous surface, with 2 basal obturators for seedling escape.

Distribution. Pantropical with 18 species in the Neotropics, 6 in Africa and 15 in tropical Asia, Malesia and the Pacific. 7 species in Sabah and Sarawak.

Ecology. A wide range of lowland forest and one species in submontane forest.

Uses. The wood is hard and heavy and is little used, the fruits of most species are edible.

Key to Parinari species

1. Stomatal crypts absent from leaf underside; leaf underside glabrous or with a persistent lanate pubescence and then with large persistent stipules 7–20 mm.....2
 Stomatal crypts present on leaf underside; leaf underside lanate or at least pubescent in crypts; stipules usually small or if larger then early caducous.....4
2. Leaf underside glabrous; stipules small and caducous.....3
 Leaf underside densely lanate pubescent, but when removed no stomatal crypts present; stipules large and persistent, 7–18 mm long.....**4. P. elmeri**
3. Leaves elliptic to oblong or obovate-elliptic, 9.5–20.5 x 4.5–8.5 cm; lateral veins 11–16 pairs. Panicles large and silvery pubescent.....**1. P. argenteo-sericea**
 Leaves ovate, 5–9 x 2–4.5 cm; lateral veins 7–11 pairs. Panicles small and subsericeous brown pubescent.....**2. P. canarioides**
4. Leaves with 20–33 pairs of lateral veins.....**6. P. oblongifolia**
 Leaves with 10–19 pairs of lateral veins.....5
5. Petioles 14–20 mm long. Leaves with metallic sheen above.....**5. P. metallica**
 Petioles 3–10 mm long. Leaves without a metallic sheen.....6
6. Leaves rigidly coriaceous, often broadest well below middle point; midrib and often lateral veins lightly impressed on upper surface. Receptacle *c.* 5 mm. Fruits ovoid, 7–8 cm long.....**7. P. rigida**
 Leaves chartaceous, broadest at or above middle; midrib and lateral veins prominulous above. Receptacle 3–3.5 mm. Fruits ellipsoid, 3.5–4.5 cm long.....**3. P. costata**

1. Parinari argenteo-sericea Kosterm.

(Latin, *argenteus* = silvery, *sericeus* = silky; the pubescence of the flowers and inflorescence)

Reinwardtia 7, 1 (1965) 47, 158; Cockburn *l.c.* 91; Prance *l.c.* (1989) 656; Whitmore, Tantra & Sutisna *l.c.* 300. **Type:** Wood SAN 16175, British North Borneo, Lahad Datu (holotype BO; isotypes A, BRI, K, KEP, L, SING).

Tree to 35 m tall. **Bark** brown, lenticellate, hard; inner bark red, hard, *c.* 1.2 mm thick. **Sapwood** yellow. Young branches glabrous, dark purplish brown, with numerous lenticels. Stipules lanceolate, to 8 mm long, tomentose on exterior, early caducous. **Leaves** chartaceous, oblong, elliptic to subovate-elliptic, 9.5–10.5 x 4.5–8.5 cm, *glabrous on both surfaces, without stomatal crypts beneath, usually 2 glands beneath at base near junction with midrib*; rounded at base, acute to shortly acuminate at apex, the tip 7–10 mm long; midrib lightly impressed above except near base, prominent beneath; lateral veins 11–16 pairs, plane above, prominent beneath, erect-patent; petioles 5–9 mm long, eglandular, glabrous, rugulose. **Inflorescence** a lax, much-branched, terminal panicle, 9–15 cm long, the rachis and branches densely grey sericeous-tomentose; bracts and bracteoles ovate, acute, densely tomentellous on exterior, glabrous within except near apex, caducous. **Flowers** with receptacle campanulate, markedly gibbous, densely grey-tomentellous on exterior, 2–3 mm long, narrowly ovate, densely grey-tomentose on exterior, tomentellous within; petals spathulate, *c.* 2 mm long, caducous; fertile stamens 7–8, base forming a conspicuous fused ring with opposite tooth-like staminodes; ovary densely pilose, style pilose, stigma truncate. **Fruits** ovoid, 7–8 x 4.5–5.5 cm; epicarp densely lenticellate; mesocarp thin, fleshy;

endocarp extremely hard and thick (1–8 cm thick), woody, granular, and very irregularly ridged, with 2 small locules in centre, densely lanate within.

Distribution. Endemic to Sabah, known from a few collections from the Lahad Datu, Sandakan, and Tawau districts.

Ecology. Lowland forest to 100 m and forest along rivers.

2. *Parinari canarioides* Kosterm.

(resembling the genus *Canarium*)

New & Crit. Mal. Pl. (For. Dept. Bur. of Planning Bogor, Indonesia) 3 (1955) 25; Reinwardtia 7, 2 (1965) 159; Anderson *l.c.* 294; Cockburn *l.c.* 93; Prance *l.c.* (1989) 656; Whitmore, Tantra & Sutisna *l.c.* 300. **Type:** *Kostermans 7152*, Kalimantan, Tanjong Bangko (holotype BO; isotypes A, BISH, BRI, CAL, CANB, K, L, LAE, MEL, NY, P, PNH, SAN, SING).

Tree to 60 m tall, trunk often buttressed to 1.5–2.5 m. **Bark** smooth, irregularly fissured and flaking, dark red-brown; inner bark pale red-brown. **Sapwood** dull yellow to pink; heartwood brownish red. Young branches sparsely puberulous soon becoming glabrous, grey-brown. Stipules linear, acute to 5 mm, hirsute, early caducous, present on very young leaves only. **Leaves** chartaceous, ovate, 5–9 x 2–4.3 cm, glabrous on both surfaces when mature, without stomatal crypts beneath; rounded to subcordate at base, acuminate at apex, the tip 5–12 mm long; midrib lightly impressed above, prominent beneath, sparsely pubescent when young; lateral veins 7–11 pairs, plane to prominulous above, prominent beneath, arcuate; petioles 3–7 mm, glabrous when mature, eglandular or with small rather inconspicuous central glands. **Inflorescences** dense-flowered axillary panicles to 4.5 cm long, the rachis and branches tomentose; bracts and bracteoles persistent, ovate, puberulous on exterior, caducous. **Flowers** with receptacle campanulate, *c.* 3 mm long, tomentose on exterior; pedicels 1–2 mm long; calyx-lobes elliptic, concave, *c.* 2 mm, acute, sparsely puberulous on exterior, densely tomentellous on interior; petals elliptic, obtuse, *c.* 2 mm, tapered to the base; fertile stamens 7–8. **Fruits** ellipsoid, 3.5–5 x 1.5–2.5 cm; epicarp densely to sparsely lenticellate; mesocarp fleshy, *c.* 1 mm thick; endocarp *c.* 5 mm thick, hard, marbled, densely lanate within.

Distribution. Sumatra, Borneo (Sabah, Sarawak, Brunei, Kalimantan), the Philippines (Palawan), and Celebes. In Sabah found in Kunak and Sandakan districts; widespread but scattered in Sarawak and Brunei.

Ecology. Primary and secondary mixed dipterocarp forests on well-drained clay-rich soils to 800 m.

Uses. Fruit edible.

3. *Parinari costata* (Kunth) Blume

(Latin; *costatus* = ribbed; the strongly veined leaf)

l.c. (1855) 10; Miquel *l.c.* (1855) 354; Merrill *l.c.* (1921) 290; Ridley *l.c.* (1922) 666; Masamune *l.c.* 325; Kostermans, Reinwardtia 7, 2 (1965) 179; Prance & Whitmore *l.c.* 333; Anderson *l.c.* 294; Prance *l.c.* (1989) 663; Whitmore, Tantra & Sutisna *l.c.* 300. **Basionym:** *Lepidocarpa costata* Korth. *l.c.* 387. **Type:** *Korthals, s.n.*, Sumatra (L).

Tree to 60 m tall, 90 cm diameter; trunk buttressed up to 2 m. **Bark** smooth to roughish, cracked, grey or brown, *c.* 0.5 mm; inner bark pale reddish to reddish brown with pale spots, 6–10 mm thick. **Wood** pale brown, darker towards centre. Young branches densely yellow-brown, appressed tomentellous becoming glabrous, with numerous small conspicuous lenticels. Stipules lanceolate, membranous, 3–7 mm long, pilose on exterior, early caducous. **Leaves** rigidly chartaceous, elliptic, subovate-elliptic, oblong-elliptic to oblong-lanceolate, 4–11.5 x 1.6–4.3 cm, glabrous above when mature but with sparse lanate covering when very young, *with stomatal crypts filled with grey lanate pubescence beneath*; rounded to subcuneate at base, acuminate at apex, the tip 3–5 mm long; midrib prominulous above, tomentellous towards base, prominent beneath; *lateral veins 10–19 pairs, arcuate, prominulous above, prominent beneath*; intercostal veins rounded or only slightly flattened; *petioles* 4–9 mm long, slender, thickly tomentose or tomentellous when young, soon glabrous, usually *eglandular or with 2 inconspicuous median glands*. **Inflorescences** of predominantly axillary or terminal few-flowered lax or dense panicles to 8 cm long, *the rachis and branches grey to brown appressed tomentellous or ferrugineous-villous pubescent*; bracts and bracteoles lanceolate, *c.* 2 mm long, caducous. **Flowers** with receptacle campanulate, slightly gibbous, grey-brown pubescent on exterior, 3–3.5 mm long; pedicels 0.5–1 mm long; calyx-lobes ovate, acute, 1.5–2 mm long, grey tomentellous on exterior; petals white, spatulate, 1.5–2 mm long, caducous, glabrous; stamens 7–8, with small tooth-like staminodes opposite, slightly unequal; style glabrous, stigma capitate. **Fruits** ellipsoid, to 3.5 x 4.5 cm; *epicarp* usually sparsely verrucose *or lenticellate*; mesocarp *c.* 2 mm, fleshy; endocarp hard, marbled, 3–5 mm thick, fibrous, densely lanate within.

Key to subspecies

Inflorescences and flowers sparsely to densely grey or brown appressed pubescent. Lowland plants.....

subsp. **costata**

Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan). Mixed dipterocarp forests on well-drained soils, to 300 m. In Sabah and Sarawak uncommon.

Inflorescences and flowers densely ferrugineous-villous pubescent. Usually at high altitudes

subsp. **rubiginosa** (Ridl.) Prance

Brittonia 39 (1987) 368, *l.c.* (1989) 663. Basionym: *Parinarium costatum* var. *rubiginosum* Ridl. *l.c.* (1915) 143; *Parinarium rubiginosum* (Ridl.) Ridl. *l.c.* (1917) 29, *l.c.* (1922) 668. Type: *Ridley 16016*, Malaya, Padang (holotype K; isotype SING). Synonym: *Parinari bicolor* Merr., Philip. J. Sc. 10 (1915) Bot. 309.

Burma, Peninsular Malaysia, Borneo (Sabah, Sarawak, Kalimantan). Submontane forests at 750–1000 m. Uncommon; in Sabah known from Mt. Kinabalu (*Clemens*

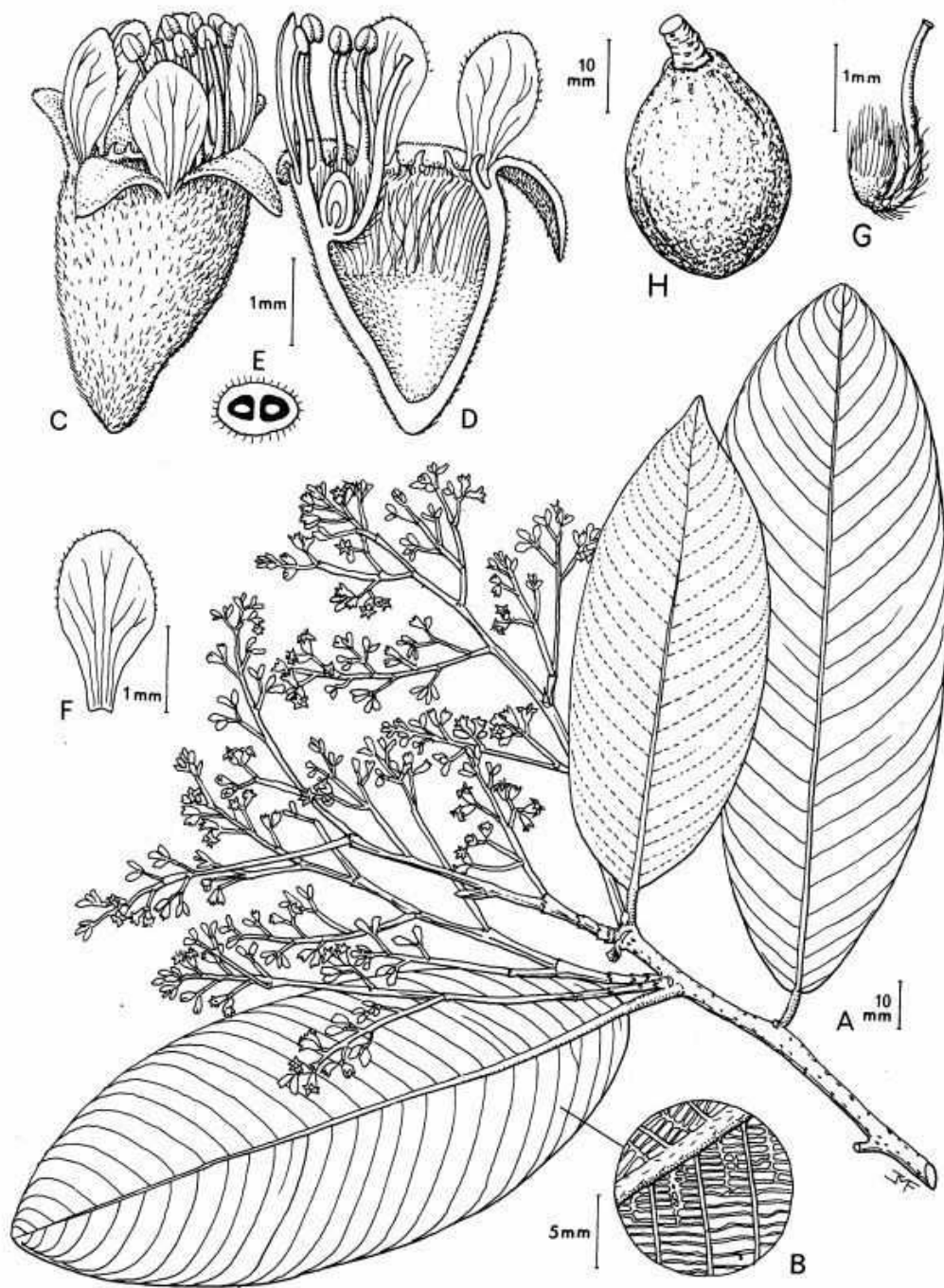


Fig. 6. *Parinari oblongifolia*. A, flowering leafy twig; B, leaf lower surface; C, flower; D, longitudinal section of flower; E, cross-section of ovary; F, petal; G, ovary and style; H, fruit. (A-G from Enggoh 7249, H from SAN 69261.)

50081), Sandakan district (*Puasa 669*), and in Sarawak from Similajau and Segan FR, Bintulu, 4th Div.

Distribution. Burma, Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak and Kalimantan), and the Philippines.

Ecology. Mixed dipterocarp to submontane forests on well-drained soils at 300–1000 m.

Taxonomy. Three subspecies are recognised, two of which occur in Sabah and Sarawak (as above), and a third in the Philippines.

4. *Parinari elmeri* Merr.

(A.D.E. Elmer, plant collector with the Bureau of Science, Manila, the Philippines)

l.c. (1929) 92; Masamune *l.c.* 325; Kostermans, *Reinwardtia* 7, 2 (1965) 161; Prance & Whitmore *l.c.* 335; Anderson *l.c.* 294; Cockburn *l.c.* 91; Prance *l.c.* (1989) 657; Whitmore, Tantra & Sutisna *l.c.* 300. **Type:** *Elmer 20806*, British North Borneo, Tawao, Elphinstone Province (holotype UC; isotypes BISH, BO, BR, C, DC, DS, F, GH, L, M, MO, P, S).

Tree to 30 m usually much smaller; trunk unbuttressed. **Bark** pale cream or grey and white mottled, roughened by green excrescences, soft, thin; inner bark orange, hard, *c.* 2.5 mm thick. **Sapwood** white, thin; heartwood straw coloured, hard. Young branches densely tomentellous soon becoming glabrous, obscurely lenticellate. *Stipules lanceolate, acute, to 18 mm long and 3 mm broad at base, lateral, tomentellous, persistent.* **Leaves** oblong to oblong-lanceolate, 5–18 x 1.5–7 cm, chartaceous to thinly coriaceous, glabrous above, densely pubescent beneath, without stomatal crypts; subcuneate at base, acuminate at apex, the tip 5–13 mm long; *midrib plane or slightly impressed* and pubescent above when young, prominent beneath; lateral veins 14–21 pairs, prominent beneath, curved at margin; *intercostal veins more or less parallel forming ladder-like reticulation*; petioles 1.5–6 mm long, tomentellous, glandular, but glands often obscured. **Inflorescences** of raceme-like reduced terminal and axillary panicles or cymules, 1.7–3 cm long, the rachis and branches densely brown-tomentose; bracts and bracteoles large, *c.* 2 mm long, ovate, persistent. **Flowers** with receptacle conical, gibbous, to 3 mm long, brown-lanate on exterior, pedicels 0.5–2 mm long; calyx-lobes ovate, acute, 2–3 mm long, lanate on exterior; petals white, oblong-ovate, 2–3 mm long, narrowed to the base; fertile stamens 7–9, with tooth-like staminodes opposite. **Fruits** oblong-ellipsoid, *c.* 6.7 x 3.7 cm; epicarp sparingly lenticellate.

Distribution. Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan), and the Philippines. Uncommon; in Sabah known from the type collection and from Kelumpang Hill, Lahad Datu district (*SAN 29329*), and Tawau district. In Sarawak only two collections from G. Silantek, 85th mile, Simanggang Rd., 2nd Div. (*S. 42636*) and Mt. Matang (*Clemens s.n.*) are known, but has been recorded from ecological plots at Bt. Mersing, Anap, and Nyabau FR.

Ecology. Mixed dipterocarp forests on well-drained soils to 900 m, including areas on ultramafic rock.

Uses. The wood is used for supports of Iban long houses.

5. *Parinari metallica* Kosterm.

(Latin, *metallicus* = metal-like; the metallic sheen on the upper surface of dried leaves)

Reinwardtia 7, 1 (1965) 49, 160; Cockburn *l.c.* 91; Prance *l.c.* (1989) 660. **Type:** Ashton BRUN 3267, Brunei, Andulau FR (holotype SAR; isotypes BO, K, L).

Tree to 20 m tall, unbuttressed. Young branches *appressed strigose* soon becoming glabrous, conspicuously lenticellate. Stipules ovate-lanceolate, acute, 8–15 mm long, densely brown-tomentose, membranous, early caducous. **Leaves** *thickly coriaceous*, elliptic, 8–17 x 4–9 cm, glabrous and *shiny with metallic sheen above when dry*, with dense stomatal crypts filled with hairs; rounded or subcuneate at base, apex rounded to shortly blunt-acuminate, the tip to 3 mm long; midrib plane above, prominent beneath; lateral veins 10–15 pairs, prominulous to plane above, prominent beneath, erect, curved only at margin; *petioles 14–20 mm long*, glabrescent, with inconspicuous glands near to lamina base, puberulous, glabrescent. **Inflorescences** of axillary little-branched panicles, 4–10 cm long, the rachis and branches densely brown tomentellous; bracts and bracteoles ovate, early caducous. **Flowers** with receptacle campanulate, slightly gibbous, 2–3 mm long, ferruginous, pubescent on exterior; pedicels *c.* 0.5 mm long; calyx-lobes lanceolate, acute, *c.* 1 mm long, tomentellous; petals lanceolate, glabrous; stamens *c.* 8 with short tooth-like staminodes opposite; ovary densely pilose, style glabrous, equalling stamens, stigma truncate. Fruits not seen.

Distribution. Endemic to Borneo (Sabah, Sarawak, Brunei). In Sabah found in Beaufort Hill FR, and in Sarawak in Semengoh Arboretum, Kuching, 1st Div., and Lambir Hills, Miri district, 4th Div.

Ecology. Mixed dipterocarp forests on deep sandy humult ultisol soils, to 300 m.

6. *Parinari oblongifolia* Hook. f.

Fig. 6.

(Latin, *oblongus* = rather long, *folius* = leaves; the leaf-shape)

l.c. 309; Ridley *l.c.* (1922) 335; Anderson *l.c.* 294; Cockburn *l.c.* 93; Prance *l.c.* (1989) 659; Whitmore, Tantra & Sutisna *l.c.* 301. **Type:** Griffith, *s.n.*, Malacca (K). **Synonyms:** *Parinarium borneense* Merr. *l.c.* (1929) 93, Masamune *l.c.* 325; *Parinari gigantea* Kosterm., Reinwardtia 7, 2 (1965) 182; Prance *l.c.* (1989) 660; **syn. nov.**

Tree to 40 m tall, trunk with low thick buttresses to 2 m. **Bark** smooth, grey to pale brown, very thin; inner bark reddish brown to brown, 6–12 mm thick. **Sapwood** white to pale yellow; heartwood reddish, hard. Young branches minutely tomentellous, with numerous pale, small, roundish lenticels. Stipules ovate to lanceolate, acute, 3–5 mm, pilose on exterior, early caducous. **Leaves** coriaceous, elliptic to *oblong*, 14–23 x 4–9 cm, glabrous above, *with stomatal crypts, filled with grey lanate pubescence beneath*; rounded to subcordate at base, shortly acuminate at apex, the tip 3–13 mm long; midrib plane above, glabrous when mature except at base, prominent, glabrescent beneath; *lateral veins 23–35 pairs, erect*, plane above, flattened and prominent beneath; intercostal veins prominulous, parallel and more or less ladder-like beneath; *petioles 9–17 mm long, thick-tomentellous when young, glabrescent, eglandular or glandular*. **Inflorescences** of large, spreading terminal panicles, 10–21 cm long, 7–12 cm broad, the rachis and branches yellow-grey tomentellous; bracts and bracteoles ovate, *c.* 3 mm long, early caducous. **Flowers** with

receptacle campanulate, slightly gibbous, *c.* 3 mm long, densely grey-tomentose on exterior; pedicels 1–3 mm long; calyx-lobes ovate, acute, 1.5–2 mm long, unequal, grey-tomentose; petals white to bluish, lanceolate to spatulate; narrowed towards the base, *c.* 2 mm long, glabrous; stamens 7–10, with tooth-like staminodes opposite; ovary pilose, style glabrous, stigma truncate. **Fruits** *ellipsoid*, 5–9 x 3–4 cm; epicarp densely lenticellate; mesocarp 1.5–2 mm thick; endocarp hard, marbled, 7–13 mm thick, fibrous, densely lanate within.

Distribution. Sumatra, Peninsular Malaysia, Borneo (Sabah, Sarawak, Brunei, Kalimantan). In Sabah found in Lahad Datu, Sandakan, Semporna, and Tawau districts; in Sarawak only recorded from sterile ecological collections from Santubong to Miri.

Ecology. Lowland rainforest, on river banks or in valleys, to 450 m.

7. *Parinari rigida* Kosterm.

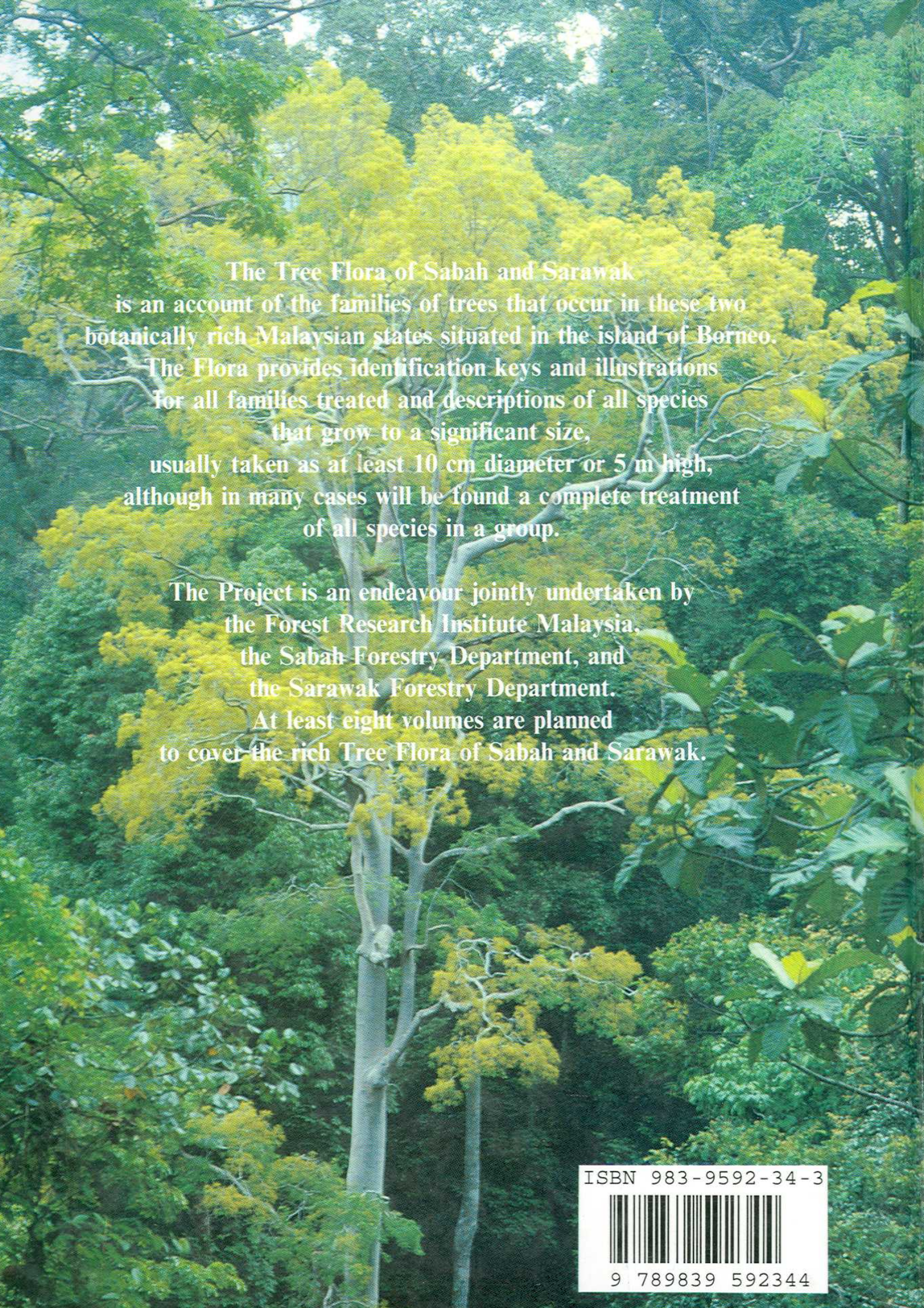
(Latin, *rigidus* = stiff; the thick coriaceous leaves)

Reinwardtia 7, 1 (1965) 53, 163; Prance *l.c.* 660. **Type:** *Sinclair & Kiah SFN 40773*, Malay Peninsula, Trengganu (SING). **Synonym:** *Parinari ashtonii* Kosterm., Reinwardtia 7, 1 (1965) 53, Anderson *l.c.* 294.

Tree to 30 m tall. **Bark** smooth. Young branches tomentellous soon becoming glabrous, obscurely lenticellate. Stipules caducous (not seen). **Leaves** rigidly coriaceous, elliptic to oblong-ovate, 7.5–23 x 3–8 cm, those near to inflorescence much smaller than others, broadest below mid point, glabrous and shiny above, sometimes slightly bullate, *the lower surface with stomatal crypts filled with pubescence, with 2 glandular areas at junction of midrib and petiole below*; rounded or subcordate at base, shortly and broadly acuminate at apex, the tip 3–17 mm long; midrib plane or impressed for upper portion above, prominent and appressed pilose beneath when young; *lateral veins 13–20 pairs, slightly impressed above*, prominent beneath, slightly curved at margins only; intercostal venation flattened or rounded, parallel; *petioles thick, 3–10 mm long, grey-pilose pubescent, rugose, with 2 small glands on mid-point of upper side*. **Inflorescences** of narrow terminal panicles to 13 cm long, the rachis and branches tomentose; bracts and bracteoles lanceolate, to 2 mm long, early caducous. **Flowers** with receptacle campanulate, slightly gibbous, *c.* 5 mm long, densely villous-tomentose on exterior; pedicels *c.* 1 mm long; calyx-lobes elongate triangular, 2–2.5 mm long; petals spatulate; stamens 6–8; ovary densely villous, style equalling stamens, stigma capitate. **Fruits** irregularly ellipsoid, *c.* 5 x 4 cm, tapered towards the base almost into a stipe; epicarp densely lenticellate; mesocarp thin, fleshy; endocarp thick, woody, marbled, lanate within.

Distribution. Sumatra, Peninsular Malaysia, Borneo (known only from Lundu, Kuching and Miri districts in Sarawak).

Ecology. Heath and swamp forests, lowlands to 1400 m.



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botanically rich Malaysian states situated in the island of Borneo.
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for all families treated and descriptions of all species
that grow to a significant size,
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