

## LINACEAE (A.M.N. van Hooren & H.P. Nootboom, Leiden)

In this work *Linaceae sensu lato* have been split into three families: *Linaceae*, *Ixonanthaceae* and *Ctenolophonaceae*, among which the latter deviates most.

In order to elucidate distinction of the two segregated families of *Linaceae sensu lato* VAN HOOREN & NOOTBOOM (Blumea 29, 1984, 550) prepared the following diagnoses:

**Linaceae** — Lianas, trees, shrubs, or herbs. Tufted hairs absent. Stipules lateral. Leaves spirally or distichously arranged. Flowers hypogynous. Petals caducous, contorted. Disk absent (or traces of an extrastaminal disk present, *l.c.* 556 *sub Philbornea*). Filaments basally connate in a tube. Styles 3–5(–6), simple. Fruit a drupe or a capsule (sometimes with indehiscent mericarps). Seed not persistent, with slightly or not developed arillode. — Stomata paracytic.

**Ixonanthaceae** — Trees. Tufted hairs absent. Stipules lateral. Leaves spirally arranged. Flowers perigynous. Petals persistent in fruit, imbricate (*extra-Mal.* also contorted). Disk intrastaminal. Filaments free, inserted outside and against the disk. Style 1, simple. Fruit a capsule. Seed not persistent, with an obvious basal wing or suprahililar arillode. — Stomata paracytic.

**Ctenolophonaceae** — Trees. Tufted hairs present. Stipules interpetiolar. Leaves opposite. Flowers hypogynous. Petals caducous, contorted. Disk extrastaminal. Filaments free, inserted halfway on inside of disk. Style 1, apically bifurcate, with 2 stigmas. Fruit a capsule. Seed persistent on the columella after the valves have been shed, with hairy-papillose arillode. — Stomata anomocytic.

*Linaceae sensu stricto* are distinguished by several flower characters from the other two families, *viz.* disk absent or almost so, filaments connate at base, styles 3–5, and arillode absent or hardly developed. The distinction of these families is also sustained by wood and anatomical research (HEIMSCH & TSCHABOLD, 1972) and pollen morphological studies (SAAD, 1962; OLMANN, 1971). NARAYANA & RAO (1978) concluded that on the basis of floral morphology and embryology *Linaceae* are related to *Erythroxylaceae* and *Humiriaceae*, in addition to showing affinity with *Ctenolophonaceae* and *Ixonanthaceae*. In his studies on seeds, CORNER (1976) opposed an affinity with *Geraniaceae*, but suggested *Malpighiaceae* and possibly also *Oxalidaceae* as closer relatives.

Within *Linaceae sensu stricto* there are two distinct subfamilies, *Linoideae* and *Hugonioideae*. They can be distinguished as follows:

1. *Linoideae* — Erect herbs or small shrubs. Petals usually long-clawed. Stamens as many as petals, alternating with the same number of staminodes. Ovary 6–10-celled. Fruit usually a capsule. — Almost entirely confined to the northern hemisphere.
2. *Hugonioideae* — Trees or lianas with hooks, rarely shrubs, all ligneous. Petals not or hardly clawed. Stamens twice as many as petals. Ovary 3–5-celled. Fruit a drupe, rarely splitting finally in indehiscent mericarps. — Pantropical, but hardly on the northern hemisphere except in southern Southeast Asia.

In Malesia only *Hugonioideae* occur, and have not seldom been distinguished as a separate family *Hugoniaceae* (*e.g.* by EXELL & MENDONÇA, 1951; TAKHTAJAN, 1969; DAHLGREN, 1975; CRONQUIST, 1981). CORNER (*l.c.*) dwelt extensively on the anatomical structure of their seeds. In his opinion the simple tegmen of the *Linoideae* may be derived from the mesotestal construction in the *Hugonioideae*. The genus *Indorouchera* of the *Hugonioideae* may yield the most primitive pollen type in *Linaceae*.

**References:** CORNER, The seeds of dicotyledons 1 (1976); CRONQUIST, An integrated system of classification *etc.* (1981); DAHLGREN, Bot. Notis. 128 (1975) 119–147; EXELL & MENDONÇA, *Consp. florae Angolensis* 1, 2 (1951) 242–249, 390–392; HEIMSCH & TSCHABOLD, Bot. Gaz. 133 (1972) 242–253; NARAYANA & RAO, J. Ind. Bot. Soc. 57 (1978) 258–266; OLMANN, Pollenmorphologisch-systematische Untersuchungen innerhalb der Geraniales. Diss. Bot. 11 (1971); SAAD, Pollen et Spores 4 (1962) 65–82; TAKHTAJAN, Flowering plants. Origin and dispersal (1969) 226.

## SUBFAMILY HUGONIOIDEAE

Trees or lianas, rarely shrubs. Hairs, if present, simple, uniseriate, or multi-seriate with multicellular, glandular heads. Stipules lateral, caducous. *Leaves* simple, spirally or distichously arranged, pinnately nerved. *Inflorescences* an axillary or terminal compound panicle, raceme, corymb, or cyme, or an axile fascicle, few- to many-flowered, rarely 1-flowered. *Flowers* actinomorphic, pentamerous, bisexual, hypogynous, sometimes heterodistylous. *Sepals* basally shortly connate or free, quincuncially imbricate, subequal or unequal, flabellately nerved, persistent, often slightly indurated and enlarged in fruit. *Petals* free, rarely basally clasping, shortly or not clawed, contorted, flabellately nerved, caducous. Disk absent. *Stamens* 10, alternately shorter and longer; filaments basally connate in a tube; anthers dorsoversatile, 2-celled, introrse. Extrastaminal nectary glands adnate to staminal tube, up to 5, or absent. *Ovary* superior, 3–5(–8)-celled; styles 3–5(–8), free or basally connate; stigma capitate. Ovules 2 per cell, axile, collateral, pendulous, epitropous. *Fruit* a drupe, rarely splitting in pyrenes. *Seed(s)* 1 or 2 per cell, arillode hardly or not developed. Endosperm dry or fleshy, copious or scanty. Embryo straight or slightly curved.

**Distribution.** Pantropical; 5 genera, of which 2 small (*Hebepetalum*, *Roucheria*) confined to tropical South America, 1 (*Philbornea*) confined to Malesia, 1 Indo-Malesian (*Indorouchera*), and 1 in the Old World tropics (*Hugonia*, incl. *Durandea*), including Madagascar, with some three dozen species, eastwards extending as far as the Solomon Islands, Queensland, New Caledonia, and Fiji. In *Malesia* in all 5 *spp.*

**Ecology.** Tropical, everwet rain-forest, mostly in the lowland but locally ascending to 1500 m on Mt Kinabalu. As to latitude up to c. 20° N and 25° S (Madagascar).

The South American representatives are trees, the Old World ones predominantly lianas, rarely shrubs in New Caledonia. Sometimes the lianoid species may remain shrubs or small trees as long as no support is available to climb. As soon as a support is present, the plants climb by means of stout, woody, curved climbing hooks (branch metamorphosis), which wind around the support and considerably thicken afterwards.

**Vegetative anatomy.** The *Hugonioideae* are leaf anatomically very strictly defined by their shared possession of subsidiary cells which are lobed underneath the stomatal guard cells and cristarque cells (cells with Ca-Oxalate crystals and a unilaterally thickened, sclerified cell wall); paracytic stomata are another constant feature of the group. This very unusual combination of characters induced VAN WELZEN & BAAS (1984) to advocate family status for *Hugoniaceae*, because the *Linoideae* (or *Linaceae*) lack this combination of characters. Most *Hugonioideae* have lignified guard cell pairs, but *Indorouchera* constitutes an exception and can be separated from the other two Malesian genera on account of its unligified cells.

The wood anatomy of the Malesian *Hugonioideae* is incompletely known. *Indorouchera* has been recorded to have exclusively scalariform perforations; in *Hugonia* they are simple. The fibres have distinctly bordered pits like in all members (families or subfamilies) of the *Linaceae sensu lato*.

**References:** HEIMSCH, Lilloa 8 (1942) 83–198, pl. 1–17; HEIMSCH & TSCHABOLD, Bot. Gaz. 133 (1972) 242–253; METCALFE & CHALK, Anatomy of the dicotyledons 1 (1950) 268–279; VAN WELZEN & BAAS, Blumea 29 (1984) 453–479. — P. BAAS.

**Palynology.** Pollen grains in *Linaceae* are suboblate to prolate, and measure from 20 to 90

$\mu\text{m}$ . The apertural system is mostly tricolpate or tricolporate. In *Linum* also pantocolpate and pantocolporate pollen occur. *Anisadenia* and *Reinwardtia* pollen is always pantoporate. *Indorouchera* has inaperturate grains, which, however, actually represent a tritenuate condition.

In most genera the exine shows differentiation in sexine and nexine. In *Indorouchera* the exine is a thin, homogeneous sheet, covered by small verrucae. Otherwise, the sexine is granulate or baculate. Sometimes the tips of the bacula are fused to form a columellate-TECTATE sexine.

The macromorphologically distinct subfamilies *Linoideae* and *Hugonioideae* can be separated in a pollen morphological way too. Pollen of *Linoideae* is tricolpate, pantocolpate, or pantoporate, and has a more or less granulate sexine, while that of *Hugonioideae* is tricolporate (*Hugonia*, *Philbornea*) or inaperturate (*Indorouchera*), and mostly has a more or less baculate or a columellate-TECTATE sexine (SAAD, 1962). Generally speaking, subfamily *Linoideae* has more primitive pollen characters than subfamily *Hugonioideae*, although *Indorouchera* may yield the most primitive pollen type in *Linaceae*.

Following SAAD (*l.c.*) the pollen of the *Linaceae* is primitive within the *Geraniales*. Relationship of the *Linaceae* with *Ixonanthaceae*, as well as with *Erythroxylaceae* and *Humiriaceae*, is supported by pollen morphology (OLTMANN, 1971). However, pollen also indicates the distinctness of the *Linaceae* within this group of families. Pollen of *Ctenolophonaceae* appeared to be dissimilar to that of *Linaceae*.

*References*: OLTSMANN, Pollenmorphologisch-systematische Untersuchungen innerhalb der Geraniales. Diss. Bot. 11 (1971); SAAD, Pollen et Spores 4 (1962) 65–82. — R.W.J.M. VAN DER HAM.

Phytochemistry. See HEGNAUER, Chemotaxonomie der Pflanzen 4 (1966) 393.

#### KEY TO THE GENERA

1. Indumentum present, at least on the calyx. Styles 5(–6). Ovary 5(–6)-celled, locules all distinct in the fruit. Drupe with 2–4(–5) developed seeds ..... **1. Hugonia**
1. All parts glabrous. Styles 3–4(–5). Ovary 3(–4)-celled, only one, rarely 2 locules distinct in the fruit. Drupe usually with one developed seed.
  2. Resin absent. Leaves spirally arranged. Flowers in rather lax racemes or panicles ..... **2. Philbornea**
  2. Buds and stipules often covered by resin. Leaves distichously arranged. Flowers in axillary fascicles, subtended by often densely packed, imbricate bracteoles ..... **3. Indorouchera**

#### 1. HUGONIA

LINNÉ, Gen. Pl. ed. 5 (1754) 305; Sp. Pl. (1753) 675; STAFF in Hook. Ic. Pl. (1906) t. 2822; HALL, f. Beih. Bot. Centralbl. 39, 2 (1923) 43; HUB. WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 108; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 553, map. — *Durandea* PLANCH. in Hook. Lond. J. Bot. 6 (1847) 594, *nom. cons.*; HUB. WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 108. — *Hugonia sect. Durandea* (PLANCH.) BAILLON. Hist. Pl. 5 (1874) 48. — Fig. 1, 3.

Indumentum present at least on calyx. Stipules palmatifid-laciniate, pinnatifid or simple, entire or dentate. Leaves spirally arranged. Flowers in axillary or terminal more or less densely flowered racemes or leafy or leafless panicles, or axillary, in few-flowered cymes or solitary, rarely ramiflorous. Bracts and bracteoles present or not. Sepals free, unequal, rarely subequal. Petals shortly clawed or thickened at base. Nectary glands present or not. Ovary 5(–6)-

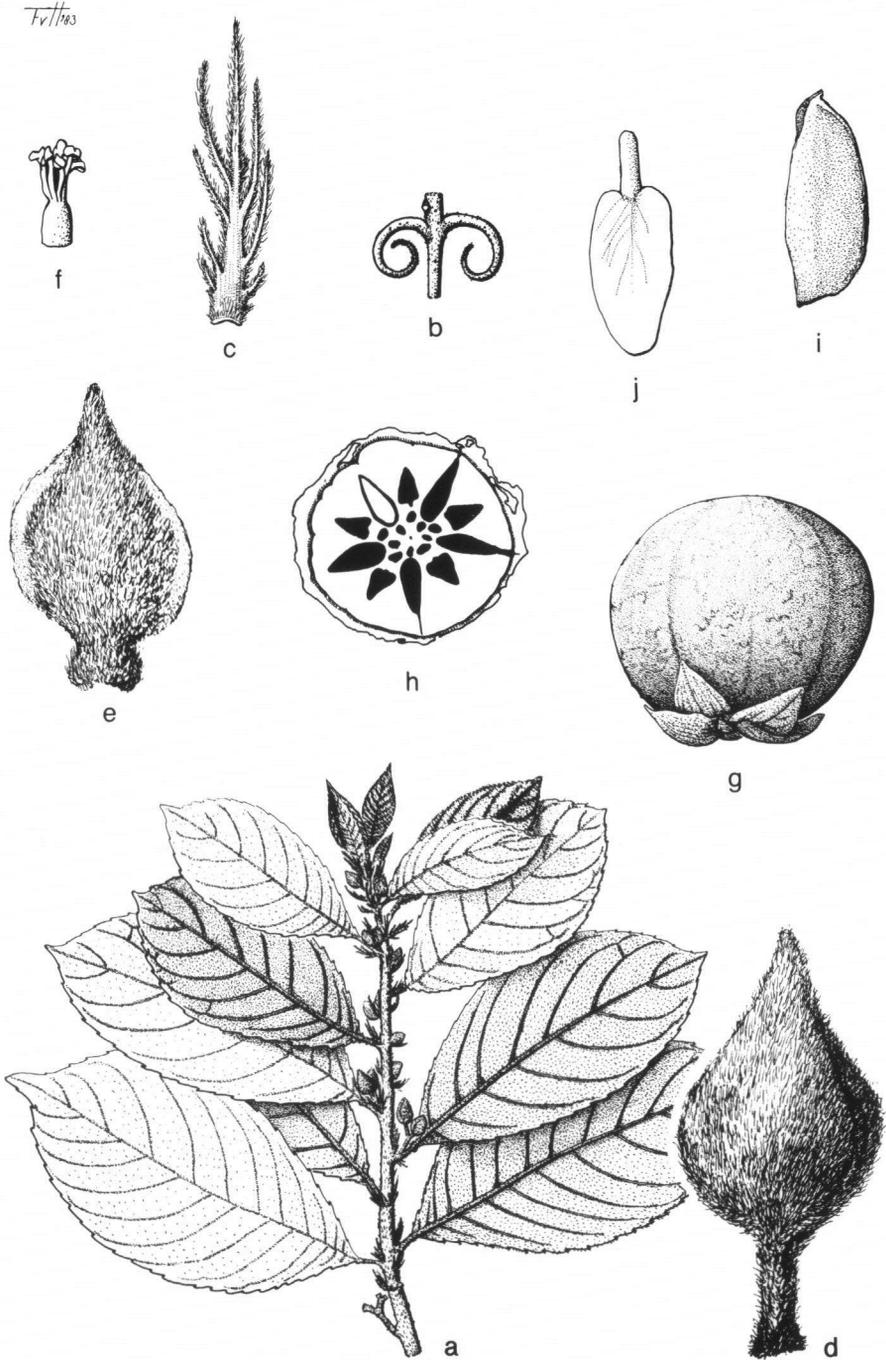


Fig. 1. *Hugonia costata* Miq. *a*. Habit,  $\times 0.5$ ; *b*. climbing hooks,  $\times 0.5$ ; *c*. stipules from inside,  $\times 3$ ; *d*. flower bud; *e*. innermost sepal; *f*. pistil (in bud), all  $\times 5$ ; *g*. fruit,  $\times 1.5$ ; *h*. fruit in CS,  $\times 1.5$ ; *i*. seed,  $\times 3$ ; *j*. embryo,  $\times 3$  (*a*, *c*-*j* FORBES 2978, *b* FORBES 2814).

loculed; styles 5(–6). *Drupe* (pseudo-)indehiscent or splitting into 5 pyrenes; endocarp woody, provided with more or less prominent longitudinal ribs, either compact and forming one stone with 5(–6) fertile locules alternating with as many interocular sterile cavities or divided into 5 thin, more or less obviously ribbed pyrenes which are separated by a fleshy mesocarp. *Seeds* 1 per locule, 2–4(–5) developed per fruit, apically attached. Embryo with fleshy endosperm.

*Distr.* About 40  *spp.*, in the Old World reaching from Senegal in the west to Fiji in the east and from Bombay in India at 20° N as far as Madagascar at c. 25° S; in *Malesia* 2  *spp.*, one in the west (Sumatra, Borneo) and a second one in the east (Moluccas, New Guinea).

They belong to two allopatric sections: *sect. Hugonia* possesses some 30  *spp.* in Africa, Mauritius, and 4  *spp.* in SE. Asia (Sri Lanka, Indonesia, Malesia); *sect. Durandea* (PLANCH.) BAILLON has 4  *spp.* in E. Malesia, Queensland, Solomons, New Caledonia (2 or 3 endemic), and Fiji.

*Ecol.* Mixed tropical forests; 0–1500 m (Mt Kinabalu).

#### KEY TO THE SECTIONS AND THE SPECIES

1. Young parts, twigs, stipules, petiole and nerves densely tomentose. Stipules digitately lacinate or pinnately lobed. Sepals 5–15 mm long. Petals 12–30 by 4–10 mm. *Drupe* usually indehiscent, sometimes finally septitidal. *Sect. Hugonia* ..... 1. *H. costata*
1. Young parts, stipules, petiole and nerves glabrous or with some very small scattered hairs. Stipules simple, entire or dentate. Sepals up to 3.5(–4) mm long. Petals 2.5–3.5 by 1.5–2.5 mm. *Drupe* splitting into 5 pyrenes. *Sect. Durandea* ..... 2. *H. jenkinsii*

1. *Hugonia costata* MIQ. Illustr. (1871) 67; BOERL. Handl. Fl. Ned. Ind. 1 (1890) 139; HALL, f. Beih. Bot. Centralbl. 39, 2 (1923) 45; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 555. — Fig. 1.

Liana. Tomentum appressed to patent, hairs up to 1 mm. Twigs densely tomentose when young, glabrescent. *Climbing shoots* often patent, some growing out to a leafy, sometimes fertile branch; first internodium 3–12 cm long; hooks (1–)2, subopposite or opposite, apically on the first internodium, 2.5–5 cm long, later thickening; at apex often with cataphylls. *Stipules* narrowly ovate to obovate, 5–10 by 2.5–3.5 mm, digitately lacinate up to 1/3, with 7–10 lobules. *Leaves* sparsely to densely tomentose, narrowly elliptic to obovate, sometimes asymmetric, (4–)6–18 by 2.5–7 cm; base obtuse to acute or cuneate; margin glandular-crenulate to crenate, glands caducous, conical; apex acuminate to cuspidate, acute to obtuse, acumen up to 1.5 cm; nerves 11–17 pairs, arching upwards and ending in the dense reticulation; petiole 3–14 mm, the margin with 1–3 conical glands on each side. *Inflorescence* an axillary (and terminal?) 3-flowered cyme, 1–1.5 cm, sometimes reduced to 1 flower, densely tomentose; bracts caducous, narrowly ovate to obovate, 10–15 by 2–3.5 mm, deeply digitately lacinate into 8 lobules. Pedicel 2–5 mm, articulate below the calyx. *Flowers* only known in bud. Buds ovoid, c. 8 by 5.5 mm. *Sepals* leathery, the 3 or 4 outer ones tomentose, boat-shaped, ovate, 9–10 by 5–6.5(–8.5) mm; inner ones 1–2 mm shorter. *Petals* boat-shaped, broadly ovate,

at least 10 by 7 mm. *Staminal tube* ± thickened at base, sometimes persistent in fruit; filaments ± hairy. *Ovary* 5- (or 6-)loculed, glabrous, cylindrical; styles 5 (or 6), exceeding the stamens, of different length. *Drupe* broadly obovate to globular, 18–23 by 20–24 mm; base with vascular openings absorbed into a navel with slightly prominent margin; mesocarp thick-fleshy, hard and strongly irregularly wrinkled when dry, adnate to the stone; endocarp woody, very hard, with thick radial septa, 5 (or 6) narrowly elliptic to narrowly ovate (in CS), seminal cavities and as many alternating, always empty, cordate, sterile cavities, 1.7 mm diam. *Seed(s)* 1 or 2, exarillate, ventrally attached, flattened obovoid, 11.5 by 4.5 mm, c. 1 mm thick; hilum not obvious; testa thin, 2-layered. Embryo straight; cotyledons obovate, 7 by 4 mm; radicle cylindrical, 3 by 0.8 mm. Endosperm copious, slightly granular.

*Distr. Malesia:* Sumatra (Palembang, Padang), Malay Peninsula (Lobis For. Res.), Borneo (Sabah, Kutai, E. Kalimantan). Fig. 2.

*Ecol.* Typically matures in late building gaps, well drained ridges, and flat upland areas; in Malaya on gently undulating ground in lowland forest at 100 m. Although rarely collected, according to LEIGHTON (coll. no. 1010) locally relatively common, 8 mature individuals/km<sup>2</sup>; on Mt Kinabalu at 1500 m.

2. *Hugonia jenkinsii* F.V.M. Fragm. 5 (1865) 7; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 555 (with complete synonymy). — *Durandea pallida* K.SCH. in

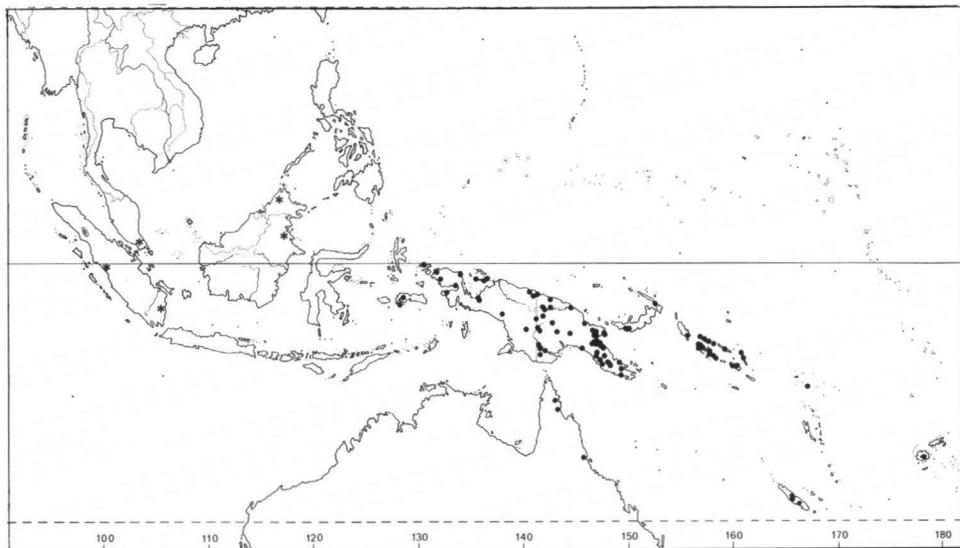


Fig. 2. Range of *Hugonia costata* Miq. (stars) and *H. jenkinsii* F.v.M. (dots).

K.Sch. & Holtr. Fl. Kaiser Wilhelm Land (1889) 56. — *Ancistrocladus pentagynus* WARB. Bot. Jahrb. 13 (1891) 383. — *H. pentagyna* (WARB.) K.SCH. in K.Sch. & Laut. Fl. Deut. Schutzgeb. Südsee (1900) 373; HUB. WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 100, f. 48. — *Durandea rotundata* K.SCH. in K.Sch. & Laut. Fl. Deut. Schutzgeb. Südsee, Nachtr. (1905) 278. — *Durandea pentagyna* (WARB.) K.SCH. l.c. — *Durandea jenkinsii* (F.v.M.) STAFF in Hook. Ic. Pl. (1906) t. 2822. — *H. robinsonii* MERR. Philip. J. Sc. 11 (1916) Bot. 277. — *Durandea pentagyna* var. *rotundata* (K.SCH.) LAUT. Bot. Jahrb. 52 (1915) 117. — *Durandea robinsonii* (MERR.) HALL. f. Beih. Bot. Centralbl. 39, 2 (1923) 41. — Fig. 3.

Liana to 40 m, rarely small tree to 3 m, or climbing shrub, up to 10 cm diam. *Climbing shoots* with first internodium (2.5–)6–18 cm, following internodia very short with some distichously arranged, reduced, linear to orbicular leaves, a few of these shoots with a long-peduncled, reduced inflorescence or a climbing hook, or the climbing shoot above the hooks growing out to a leafy and often fertile branch. *Hooks* distichously or subopposite, woody, (3.5–)6.5–8.5 cm long, apically often with bract-like organs, peduncles, cymes, or reduced leaves. *Stipules* entire, obtuse to acute, with or without glandular teeth, persistent or sometimes caducous, sometimes only present as a glandular tooth, subulate or triangular, 0.5–0.8 by 0.2–0.8 mm. *Leaves* glabrous (rarely some hairs on midrib), narrowly elliptic to obovate, sometimes broadly elliptic or ovate, sometimes asymmetric, (6–)11–27(–36) by (1.6–)3–9.5

(–11) cm; base cuneate, seldom rounded; margin often wavy, glandular-crenulate to crenate, apex acute to acuminate, rarely obtuse, acumen up to 2 cm; nerves 7–16 pairs, slightly arching upwards and almost reaching the margin, meeting in an often somewhat obscure intramarginal vein or in the dense reticulatfon; petiole 3–20 mm. *Inflorescence* an axillary or terminal compound panicle, sometimes a raceme; terminal panicles often leafy, cone-shaped to obovoid, (4–)12–18(–32) by (2.5–)1.5–14 cm with 5–25(–30) more or less closely set subinflorescences, sometimes up to 5(–8) pseudoterminal panicles together; axillary panicles patent, narrowly obovoid to broadly ellipsoid, (2–)6–11(–12) by (1–)2–6.5 cm, with (4–)10–23 subinflorescences; peduncle up to 6.5 cm; cymes up to 15, 0–5 times branched; bracts persistent, obtuse deltoid, (1.5–)2.5–5 by 0.2–1 mm, with 2–6 glandular teeth. Pedicel articulate and often thickened below the flower, 1.5–3 mm. Bracteoles like the bracts but smaller. *Flowers* heterodistylous, 7–9 by 5–9 mm. *Sepals* ± orbicular to transversely broadly elliptic, (1.8–)2–3(–4) by 2–4(–4.5) mm, shortly connate to free, appressed but patent in fruit, outer 2 smaller and thicker. *Petals* recurving during anthesis, narrowly elliptic to -obovate, 6–9.5 by 1.5–3(–4) mm; base often indistinctly 0.8 mm clawed. *Stamens* shortly persistent, obdiplostemonous, in short-styled flowers (4.5–)4.8–6 and (5–)5.5–7.5 mm, in long-styled flowers (2.5–)3.8–4.5(–4.8) and (3.8–)4.2–5(–5.8) mm; tube 1–1.5(–2) mm, partly persistent in fruit; base often irregularly thickened or marked by darker coloured

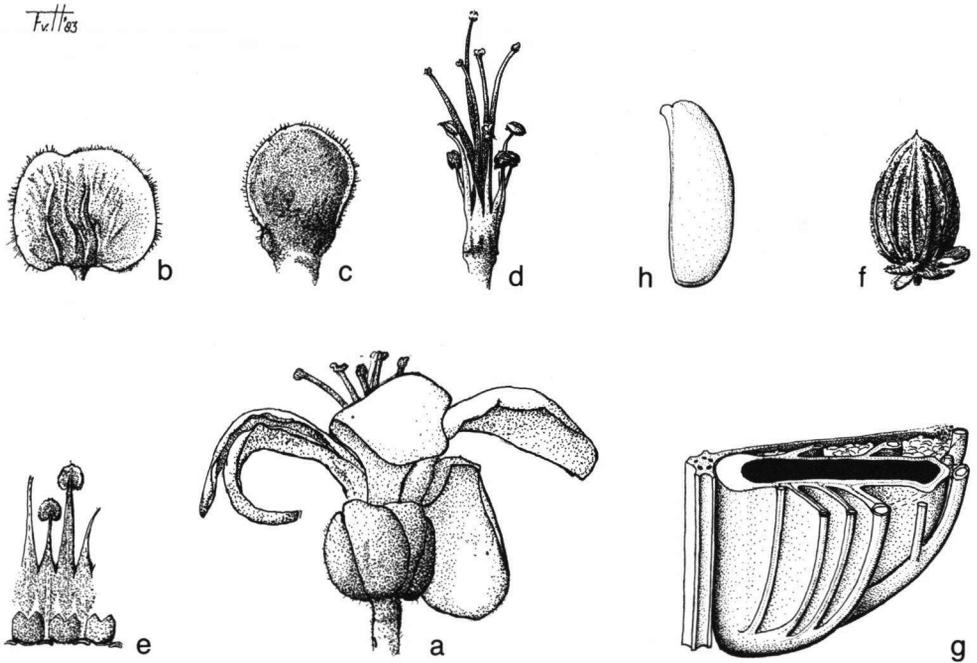


Fig. 3. *Hugonia jenkinsii* F.v.M. a. Flower,  $\times 4$ ; b. inner sepal,  $\times 5$ ; c. outer sepal,  $\times 5$ ; d. flower, sepals and petals removed,  $\times 4$ ; e. stamens with glandular thickenings at base of tube,  $\times 5$ ; f. fruit,  $\times 1.5$ ; g. pyrene,  $\times 6$ ; h. seed,  $\times 3$  (a-h BSIP 10657).

semi-ellipsoid, sometimes apically notched, staminal glands at the base of long or short stamens, these later becoming connate with each other; filaments triangular at base, apically filiform. *Ovary* 5-loculed, ovoid to broadly ellipsoid, 1–2 by 0.8–1.2 mm; styles 5, basally shortly connate and apically (in short- and long-styled forms) hooked or sigmoidly curved or (in long-styled forms) slightly arching to curving downwards, sometimes of different length, in short-styled flowers (1–)1.5–2.8 mm, in long-styled flowers (3–)3.2–3.5(–5.2) mm; stigma 2-lobed. *Drupe* 15-ribbed, ovoid to subglobose, (8–)10–13 by (7–)8–10.5 mm, splitting into 5 pyrenes; mesocarp fleshy, surrounding the pyrenes, between the pyrenes often disappearing thus giving rise to a false locule; endocarp bony, thin, 3-ribbed, ribs branching, the branches connected by bony septa, forming cavities filled with aerenchyma; septa and aerenchyma dissolving when ripe. *Seed* 1 or 0 in each pyrene, ventrally-apically attached by a short funicle, medially flattened, asymmetrically semi-ellipsoid, c. 8.5 by 3.5 mm; hilum and arillus not ob-

vious; testa thin, 2-layered. Embryo c. 8 by 3 mm; radicle flattened, arched, c. 1.5 by 2.5 mm. Endosperm fleshy.

*Distr.* W. Pacific (Fiji), Melanesia (Solomons, New Caledonia), Queensland; in *Malesia*: New Guinea, Moluccas (Ceram, Ambon). Fig. 2.

*Ecol.* Primary and secondary forests, often on well drained places or along rivers, also along estuaries or mangroves, locally rather scarce to common; up to 2000 m. *Fl.* Jan.–Nov.; *fr.* Feb.–Nov.

*Field notes.* Flowers fragrant to very strong sweet-scented with yellowish green to dark green sepals and bright golden yellow to orange petals. Filaments pale olive yellow to orange with deep purple to brown anthers. Styles pale yellow to pale orange with green stigma. Fruits golden yellow to light orange becoming pinkish red, red to brown or orange brown.

*Uses.* In Queensland the Tully River natives use the climbing hooks as fish hooks.

*Vern.* New Guinea: *agref*, Vogelkop, *abus*, Sepik, Waskuk, *eamuraka*, Sepik, Wagu, *quamo*, Wikahiri.

## 2. PHILBORNEA

HALL.f. Arch. Néerl. Sc. Ex. Nat. IIIB, 1 (1912) 110; in Fedde, Rep. 13 (1914) 414; HUB.WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 109; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 556. — Fig. 4.

Lianas with hooks. Indumentum absent. Stipules simple, entire. *Leaves* spirally arranged, rarely some leaves opposite. *Inflorescences* a rather lax flowered axillary or terminal raceme, sometimes ramiflorous. Bracts and bracteoles present. *Sepals* basally shortly connate, subequal. Disk absent; nectary glands not obviously present. Styles 3. Ovary 3-loculed. *Drupe* indehiscent, 1-seeded with 2 reduced locules. *Seed* ventrally attached, with arillode. Embryo straight. Endosperm scanty, fleshy.

Distr. Monotypic. *Malesia*: Sumatra, Borneo, Philippines.

Ecol. Periodically inundated soil and near rivers in the lowland.

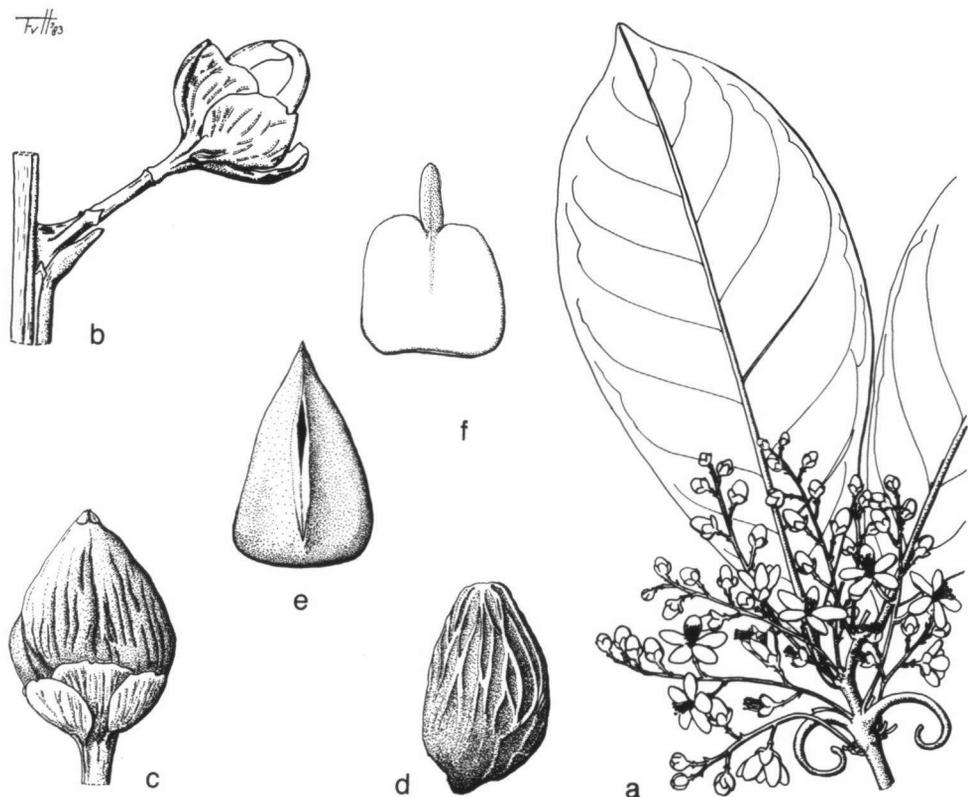


Fig. 4. *Philbornea magnifolia* (STAPP) HALL.f. a. Habit,  $\times 0.5$ ; b. bract, bracteoles, and flower bud,  $\times 5$ ; c. fruit; d. fruit, exocarp removed; e. seed; f. embryo; all  $\times 3$  (a after STAPP, b KOSTERMANS 21142, c-f RAHMAT SI BOEEA 5362).

1. *Philbornea magnifolia* (STAFF) HALL.f. Arch. Néerl. Sc. Ex. Nat. IIIB, 1 (1912) 110; in Fedde, Rep. 13 (1914) 415; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 556. — *Durandea magnifolia* STAFF in Hook. Ic. Pl. (1906) t. 2822; in Fedde, Rep. 5 (1908) 268. — *P. palawanica* HALL.f. Arch. Néerl. Sc. Ex. Nat. IIIB, 1 (1912) 110; in Fedde, Rep. 13 (1914) 415. — Fig. 4.

Twigs often roughened by many light coloured lenticels. *Climbing* shoots patent, first internode 6–12 cm, following internodia very short with caducous, reduced, broadly elliptic leaves. *Hooks* 2, (sub)opposite, woody, 1.5–5 cm. *Stipules* appressed to patent, triangular, sometimes gland-like, 0.3–0.5 by 0.2–0.3 mm. *Leaves* obovate or elliptic, rarely ovate, 7–20(–30) by (2–)4–10(–14.5) cm, sometimes asymmetrical; base gradually decurrent to the petiole; margin glandular-crenulate; apex broadly acute to obtuse or acutely acuminate, acumens up to 2.8 cm; nerves 7–14 pairs, slightly arching upwards to and along the margin, often meeting in an intramarginal vein; reticulation dense; petiole rather stout, often thickened, (3–)6–15(–25) mm. *Racemes* axillary from (often fallen) leaves or scales, or terminal, sometimes with some cymes, 7–15(–28)-flowered, (2–)3.5–9.5 by (1–)1.5–4 cm. Bracts narrowly triangular to rhomboid, 0.5–2 by 0.2–0.5 mm, usually with 2 triangular glandular teeth. Pedicels articulate in or above the middle, (2–)4–10(–15) mm. Bracteoles 2, persistent, very small. *Sepals* basally shortly connate, membranous, ± shell-shaped, 3–4 mm diam., the inner 3 sometimes lacinate up to 2/3. *Petals* recurving during anthesis, elliptic to obovate, 7.5–9 by 4–4.5 mm. *Stamens* obdiplostemonous, the long ones 5.5–6.2 mm and basally thickened, the short ones 1–1.5 mm shorter, 4.5–4.8 mm; staminal tube 0.5–1.5 mm. Filaments basally flattened. *Ovary* elliptic to obovoid-pyriform, 1–1.5 by 0.7–1.5 mm; styles free, apically sometimes slightly twisted; stigmas knob-shaped, 2-lobed. *Drupe* lengthwise wrinkled, often flattened

at one side, ovoid, 10–12 by (5–)7–10 mm, exocarp membranous; mesocarp thin-fleshy, ± 0.3 mm thick; endocarp leathery in basal and sterile half, tougher and with prominent, subreticulate, firm, ± 0.2 mm thick ribs in upper half of fertile part. *Seed* 1, smooth, flattened ovoid, 10–11 by 5.5–6 mm, ventrally attached by a long raphe, thickened around the raphe and along the whole length by an arillode; testa 0.2 mm thick; tegmen somewhat thinner. Embryo straight; cotyledons transversely broadly ovate, ± 6 by 6 mm; radicle cylindrical, 4.5 mm long.

Distr. *Malesia*: Sumatra, Borneo (Sarawak, E. Kalimantan), Philippines (Palawan). Fig. 5.

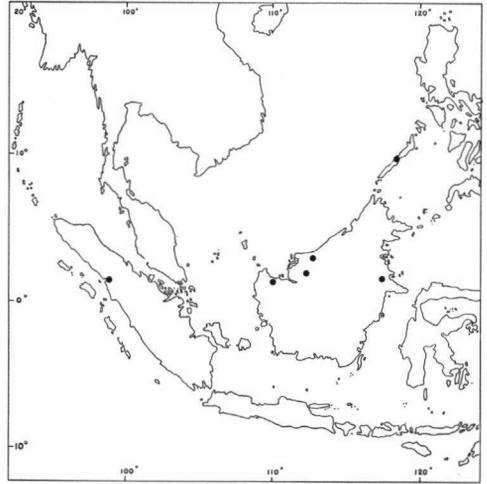


Fig. 5. Range of *Philbornea magnifolia* (STAFF) HALL.f.

Ecol. Periodically inundated soil and near rivers, up to 270 m.

Field notes. Petals bright yellow.

### 3. INDOROUCHERA

HALL.f. Beih. Bot. Centralbl. 39, 2 (1923) 50; HUB. WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 109; BACKER & BAKH.f. Fl. Java 1 (1963) 241; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 557. — Fig. 6–8.

Glabrous lianas, with hooks. Buds often covered with resin. Stipules simple, entire or dentate, often covered with resin. *Leaves* distichously arranged. *Flowers* in fascicles in the axils of (often fallen) leaves, rarely solitary, heterodistylous. Bracts absent. Pedicel densely beset with often numerous, ± spirally arranged, persistent, imbricate bracteoles and often covered with resin. *Sepals* free, unequal. *Petals* very thin. Nectary glands absent. *Ovary* 3(–4)-loculed;

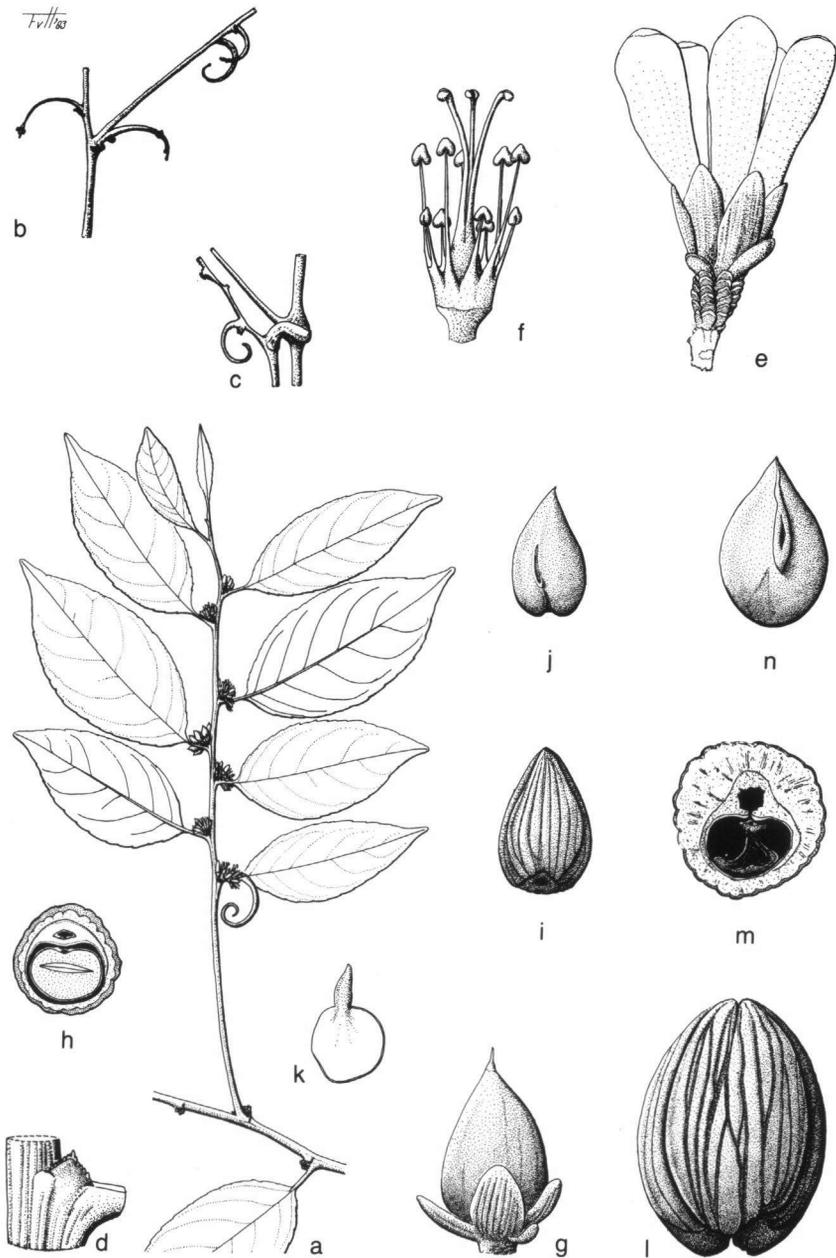


Fig. 6. *Indorouchera contestiana* (PIERRE) HALL.f. *a.* Habit; *b.* twig with climbing hooks provided with reduced inflorescence at apex; *c.* climbing hook, thickened after grasping a twig; all  $\times 0.5$ ; *d.* stipule,  $\times 12$ ; *e.* flower and bracteoles,  $\times 12$ ; *f.* flower, sepals and petals removed,  $\times 8$ ; *g.* fruit; *h.* fruit in CS; *i.* fruit, exocarp removed; *j.* seed; *k.* embryo; all  $\times 12$ . — *I. griffithiana* (PLANCH.) HALL.f. *l.* Fruit, exocarp removed; *m.* fruit in CS; *n.* seed; all  $\times 12$  (*a, d, g-k* HAVILAND 2840, *b* VAN NIEL 3607, *c* A 441 RAHIM, *e, f* Nbfd 2113, *l, m* DE WILDE & DE WILDE-DUYFJES 16540, *n* Meijer 7335).

styles 3–4(–5), basally connate to free. *Drupe* indehiscent, 1- (rarely 2-)seeded with 2 (or 1) reduced locule(s). *Seed* ventrally attached, arillate. Embryo straight or slightly curved. Endosperm copious, oily.

Distr. 2 spp., SE. Asia (India: Nicobars; ?Burma, Thailand, Cambodia, S. Vietnam); in *Malesia*: Sumatra, Malay Peninsula, Borneo, Java.

Ecol. Rain-forest, also along the seashore, estuaries and on sanddunes, up to 1500 m.

KEY TO THE SPECIES

1. Leaves elliptic to obovate; reticulation densely parallel in the whole leaf. Petals (5)–6.4–8.5 by 1.5–3 mm. Stigma knob-shaped. *Drupe* 4.5–6 by 3–4.5 mm ..... 1. *I. griffithiana*  
 1. Leaves often ovate, rarely elliptic; reticulation predominantly in the basal half laxly and (irregularly) parallel, in the apical half reticulated. Petals 4–5.5 by 1–1.8 mm. Stigma clavate, recurved. *Drupe* 4–4.5 by 2.5–3 mm ..... 2. *I. contestiana*

1. *Indorouchera griffithiana* (PLANCH.) HALL.f. Beih. Bot. Centralbl. 39, 2 (1923) 50, incl. var. *coriacea* HALL.f., l.c. 52; HUB.WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 109; BACKER & BAKH.f. Fl. Java 1 (1963) 242; COCKBURN, Tree Fl. Malaya 1 (1972) 306; Trees of Sabah 1 (1976) 204; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 557. — *Roucheria griffithiana* PLANCH. Hook. Lond. J. Bot. 6 (1847)

143; *ibid.* 7 (1848) 527; WALP. Ann. 1 (1849) 97; Hook.f. Fl. Br. India 1 (1874) 414; BOERL. Handl. 1 (1890) 140; KING, J. As. Soc. Beng. 62, ii (1893) 190; BOERL. Feestbundel (1894) 91, tab.; Ic. Bog. 1 (1897) 25, t. VII, f. 1–22; KOORD. Nat. Tijd. Ned. Ind. 60 (1901) 384; BACKER, Schoolfl. Java (1911) 163; KOORD. Exk. Fl. Java 2 (1912) 415; RIDLEY, Fl. Mal. Pen. 1 (1922) 323; Kew Bull. (1926) 60. — *Flacourtia*



Fig. 7. *Indorouchera griffithiana* (PLANCH.) HALL.f. in blossom. Njarumkop (NW. Kalimantan) (Photogr. Father A. ELSENER, 9 April 1964).

?*camptoceras* MIQ. Fl. Ind. Bat., Suppl. (1861) 288; BOERL. Feestbundel (1894) 91; Ic. Bog. 1 (1897) 27; KOORD. Exk. Fl. Java 2 (1912) 415; HALL.f. Beih. Bot. Centralbl. 39, 2 (1923) 50; SLEUMER, Fl. Males. I, 5 (1954) 77. — *Hugonia sumatrana* MIQ. Illustr. (1871) 68; BOERL. Feestbundel (1894) 91; Ic. Bog. 1 (1897) 27. — Fig. 61-n, 7, 8.

Liana, up to 30 m, rarely shrub or treelet, 4 m. Stem up to 3 cm diam. *Climbing shoots* with first internodium of 3–10 cm. *Hooks* 1 or 2 at the end of a climbing shoot or several (up to 5) distichously arranged in the axils of (often fallen) leaves or inflorescences, 3–5 cm long. Stipules triangular to ovate, 0.7–0.8 by 1.5–1.8 mm, crenate. *Leaves* elliptic to obovate, rarely ovate, (4–)7.5–11.5(–19) by (1–)2.5–4(–6.8) cm; base cuneate; margin glandular to crenate; apex obtusely caudate to acuminate, rarely rounded; acumen up to 2.5 cm; nerves (5–)7–10 pairs, ± arching upwards and almost reaching the margin; primary veins often subperpendicular to midrib and many of them ± parallel; reticulations

densely parallel and transverse to midrib; petiole narrowly sulcate above, (0.5–)1–2 cm. *Flowers* (1–)3–7(–10) together, heterodistylous. Pedicels articulate, 1–3 mm; bracteoles membranous, ovate, 0.2–1(–2) by 0.2–0.9(–2) mm. *Sepals* elliptic to ovate or orbicular, 1.8–2.5 by (1.5–)2–2.8 mm. *Petals* thin, in anthesis straight, elliptic to obovate, (5–)6.5–8.5 by 1.5–3 mm; base obtuse to very shortly clawed. *Stamens* in short-styled flowers 3.5–6 and 5–8 mm, in long-styled flowers 2.5–3.8 and 3.5–5.5 mm; staminal tube 0.6–1.3 mm, persistent in fruit. *Ovary* 3(–4)-loculed, rather smooth to 3–4-lobed when dry, cylindric, obovoid or globular, 0.8–1(–1.5) by 0.7–1(–1.5) mm; styles 3–4(–5), sometimes persistent in fruit, straight to sigmoidly curved in the middle, in short-styled flowers 1.2–2 mm, in long-styled flowers 3.2–5.5 mm; stigma flattened, knob-shaped, slightly 2-lobed. *Drupe* ± lengthwise ribbed when dry, ovoid to ellipsoid, 4.5–6 by 3–4.5 mm; exocarp membranous, 0.1–0.2 mm thick; mesocarp ± ribbed, fibrous-bony, 0.4–1 mm thick; endocarp bony, 0.3–0.4 mm thick. *Seed(s)* 1 (or 2), ventrally attached, semi-ovoid, 3–4.5 by 2.2–2.3 mm; arillus around the 1–2 mm long hilum, short, slightly thickened, funicular; testa thin. *Embryo* 3–4.3 by 1–2 mm; cotyledons straight or plicate, elliptic to broadly elliptic, 1.8–2.8 by 1–2 mm; radicle cylindric to flattened, straight to slightly curved, 1.1–1.5 by 0.4–0.5 mm.

Distr. India (Nicobar Is.), Thailand; in *Malesia*: Sumatra, Malay Peninsula, Borneo, Java. Fig. 9.

Ecol. Rain-forests, common, but rare in Java, the Nicobar Is. and Thailand; up to 1500 m. *Fl. fr.* Jan.–Dec.



Fig. 8. *Indorouchera griffithiana* (PLANCH.) HALL.f. Twig with hook and flowers at Njarumkop (NW. Kalimantan) (Photogr. Father A. ELSENER, 9 April 1964).

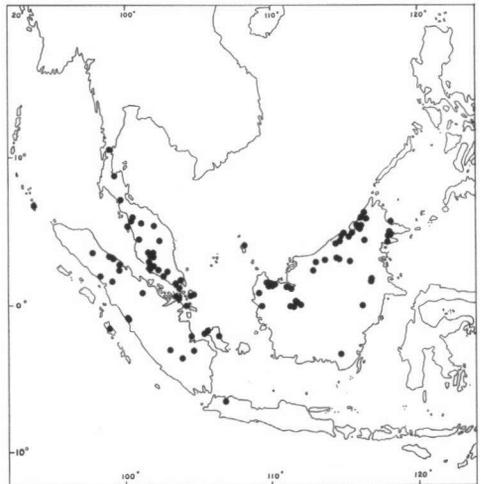


Fig. 9. Range of *Indorouchera griffithiana* (PLANCH.) HALL.f.

Field notes. Petals white to bright yellow, pale orange or reddish brown. Stamens yellow, anthers bright yellow, pistil light yellow. Drupe yellow to red, 8 mm diameter, with edible pericarp and tomato-like flavour.

Uses. According to SCHOLZ (in Engler, Syllabus 2, 1964, 243) the plant contains saponin-like constituents. They are used in mixtures for arrow poisons. See also BURKILL, Dict. 2 (1935) 1949. In Sarawak used for parang handles.

Vern. Sumatra: *andor pijom*, Tapanuli, *akar tandu*, *takkolan*, East Coast, *olor nanas*, *olor silayur*, *surango etem*, Simalur. Malay Peninsula: *akar garam garam*, *a. tenggadin*, Selangor. Borneo: *wa bakar*, Iban, *akar katjap*, Brunei, *dingkai*, Sabah, *akar tuai*, Kenya.

2. *Indorouchera contestiana* (PIERRE) HALL.f. Beih. Bot. Centralbl. 39, 2 (1923) 52; HUB. WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 110; VAN HOOREN & NOOTEBOOM, Blumea 29 (1984) 558. — *Roucheria contestiana* PIERRE, Fl. For. Coch. (1893) t. 281; GUILLAUMIN, Fl. Gén. 1.-C. 1 (1911) 586, f. 61-5 & 61-6. — *I. rhamnifolia* HALL.f. Beih. Bot. Centralbl. 39, 2 (1923) 52; HUB. WINKLER in E. & P. Nat. Pfl. Fam. ed. 2, 19a (1931) 110. — Fig. 6a-k.

Liana, up to 10 m, sometimes a shrub up to 4 m. Stem  $\pm$  1 cm diam. *Climbing shoots* patent, c. 45°, first internodium 3.5–7 cm, hooks 1 or 2 at the end of a climbing shoot or up to 3 in the axils of leaves or inflorescences, at the apex sometimes with reduced inflorescences, (0.5–)1.5–4.5 cm long. Stipules liguliform to shallowly triangular, 0.8–1.5 by 1–1.5 mm, entire to crenate. *Leaves* elliptic to ovate, 3–11.5 by 1.5–4.7 cm; base obtuse, rarely cuneate; margin glandular-crenulate; apex obtusely acuminate, rarely obtuse, acumen up to 1.5 cm; nerves (4–) 5–8 pairs; veins  $\pm$  perpendicular to midrib and many parallel; reticulation rather lax, irregularly parallel, predominantly in basal half and along midrib, densely reticulate in apical part of leaf; petiole 0.5–1 cm. *Flowers* in (1–)4–7(–14)-flowered fascicles. Pedicel articulate, 0.5–1.5 mm. Bracteoles membranous, ovate, 0.3–1(–1.5) by 0.3–1(–1.5) mm. *Sepals* elliptic to ovate, 1.7–2.5 by 0.7–1.6 mm. *Stamens* 1.8–2.2 and 2.5–3.5 mm; staminal tube 0.7–0.8 mm high. *Ovary* 3-loculed, rather smooth, cylindrical to ovoid, 0.8–1 by 0.6–0.7 mm; styles 2–3.5 mm; stigma clavate, recurved, slightly 2-lobed, c. 0.25 mm diam. *Drupe* ovoid, 4–4.5 by 2.5–3 mm; exocarp thin-fleshy, c. 0.2 mm thick;

mesocarp chartaceous,  $\pm$  lengthwise grooved, c. 0.2 mm thick; endocarp woody, crescent-shaped in CS,  $\pm$  0.2–0.4 mm thick. *Seed(s)* 1 (or 2), ventrally attached, semi-ovoid, 2.5–2.7 by 1.7–1.9 mm, often asymmetric; hilum narrowly elliptic,  $\pm$  1.5 mm long; aril indistinct, short,  $\pm$  thickened below the hilum; testa thin. Embryo 2.8–3 by 1.3–1.5 mm; cotyledons straight, broadly elliptic to  $\pm$  orbicular, 1.5–1.7 by 1.3–1.5 mm; radicle cylindrical to slightly flattened, 0.8–1 by 0.2–0.3 mm. Endosperm granular.

Distr. S. Vietnam, Cambodia; in *Malesia*: Borneo. Fig. 10.

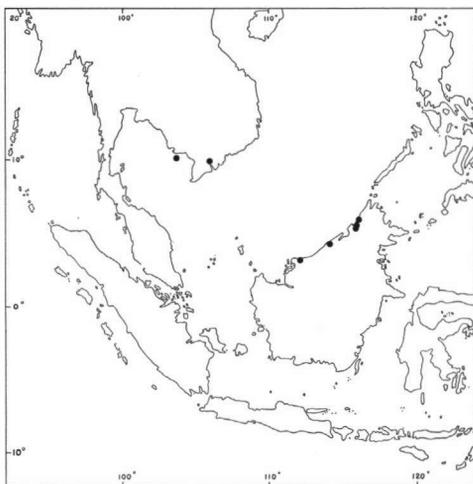


Fig. 10. Range of *Indorouchera contestiana* (PIERRE) HALL.f.

Ecol. Edge of young secondary forest and of swampy forest, rare; up to 10 m altitude. *Fl. fr.* April–June.

Field notes. Petals yellow, fruit red.

Uses. According to SCHOLZ (in Engler, Syllabus 2, 1964, 243) the plant contains saponin-like constituents. They are used in mixtures for arrow poisons. See also BURKILL, Dict. (1935) 1949. For details on chemical contents see HEGNAUER, Chemotaxonomie der Pflanzen 4 (1966) 397. On the label of CHIN 2829 is mentioned: 'a "T"-point can be made into a parang handle. The wood is tough, not excessively hard, and will not split easily.'

Vern. Borneo: *kait kait puteh*, Brunei.