

NOTES ON BORNEO DIPTEROCARPACEAE

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INTRODUCTION

The family Dipterocarpaceae may be estimated to comprise more than 500 Malaysian species. More than half of these occur on the island of Borneo, which for this reason can be considered to be the centre of development. The lowland forests up to about 700 m (2100 ft) altitude are characterised mainly by their richness in Dipterocarps. About 50 different species occur, for example, in the forests of Sandakan Bay, North Borneo, of which 20 are common emergent trees, whereas in the Apas-Balong area near Tawau about

60 different species were found. The timber export from North Borneo finds for more than 90 % its source in Dipterocarps.

After preliminary studies by Symington, who visited the Colony during 1938, and by Wyatt-Smith (1952), this flora was more intensively studied by G. H. S. Wood, who was Forest Botanist in North Borneo from 1954–1957. Especially during the heavy flowering year 1955 he made extensive collections. His great ambition to become a monographer of the Bornean Dipterocarps could not be fulfilled owing to his tragic death in May 1957, [see B. E. SMYTHIES, 1960]. He left a manuscript about common Dipterocarps in North Borneo as well as unfinished descriptions of ten new species. An agreement has been reached between the Forest Botanist of Sarawak, Mr. P. S. Ashton, and myself to publish these new species in the course of our own studies of Borneo Dipterocarps [see ASHTON, 1962]. Meanwhile it has been possible for me to unravel a number of taxonomic problems, to discover new species, and to make extensive new collections with which I began immediately after my arrival in North Borneo (May, 1959) and with which I was especially successful during the good flowering season of 1960. The revision can only make slow progress owing to the fact that it often takes a long time before flowers and fruits are collected from a new species. A number of hill Dipterocarps, for example, probably did not flower since 1955. During 1960 flowering was mainly restricted to the East-Coast. This paper is a precursor of a book on North Borneo Dipterocarps (Part I of the Foresters' Flora on that region) which is at present in the press.

PARASHOREA

Parashorea tomentella (Sym.) W. Meijer, **nov. comb.**

Parashorea malaanonan (Blanco) Merr, var. *tomentella* Sym. in Gard. Bull. 9:338 (1938). Type Sand. Herb. prewar. coll. 4369 (KEP). *P. malaanonan* (Blanco) Merr. affinis, a qua foliis majoribus et subtus tomentosus, alis fructuum majoribus, stylo antherarum appendicibusque brevioribus differt.

Field studies of this taxon carried out during the 1959 flowering season on the East Coast of North Borneo made me realise that *Parashorea tomentella* differs in too many respects from the related *P. malaanonan* to be classified as a mere variety of the latter. Moreover in many localities the two taxa grow together without freely hybridizing. The area of distribution of the two taxa, moreover, is not identical. *P. tomentella* is more strictly bound to the East Coast than *P. malaanonan*; in some localities it is the most common timber tree. It may have evolved more recently than *P. malaanonan*. The contrasting characters of the two species are as follows.

P. malaanonan

Leafblades up to 15 × 7 cm, generally about 12.5 × 5 cm, smooth below; lateral nerves up to 10 pairs. Flowers with a style as long as the stamens, exceeding the sepals, hairy in lower third; appendage to connective longer than filament and anther; fruit wings about

12.5–15 cm long; sapling leaves 10–15 cm long with about 15 pairs of lateral nerves, elliptic oblong, with cordate base.

P. tomentella

Leafblades up to 19 × 9 cm, generally about 17 × 7 cm, lower face stellately hairy; main nerves 11–13 pairs. Flowers with a style shorter than stamens, not or hardly exceeding the sepals, hairy in lower half; appendage to connective shorter than the anthers. Fruit wings about 15–20 cm long. Sapling leaves large, up to 20 cm long, broadly ovate with 15–18 pairs of lateral nerves, with peltate base.

I saw only a few intermediate forms in the herbarium; they were all sterile. As a rule, it is easy to distinguish the two species in the field. These species are sometimes supposed to differ slightly in timber colour and in liability of bark scaling, but because they have too often been lumped together, we have not yet sufficient information about these points. It may be interesting to note that Symington (loc. cit) was already strongly inclined to accept the tomentose taxon as a new species.

Specimens examined of *Parashorea tomentella*.

NORTH BORNEO: Papar, Kimanis F.R. (A 1421, the only record from the West Coast); Sandakan, Sepilok F.R. (A 99, A 800, A 806, A 828, A 898, A 3519, A 4219 + seedlings, 16017, 16533 etc., SING 9309 + seedlings), Mile 15, Labuk Rd. (3896); Lungmanis (A 2320, A 2837); Lagsikan (A 3422); Segaliud (A 1100); Suan Lamba kechil River (A 1464); Kinabatangan, seen from Bilit to Tongud, Latangan (18005); Daramakot (18003); Kretam (A 1887, A 3137, A 3351, A 3536, 18204); Lahad Datu, Matrid Timber camp; Tawau, Tiger Hill (A 2044); Kalabakan (18703, A 4048, 17224–17228).

SHOREA

THE SUBDIVISION OF THE GENUS SHOREA

Basic studies for a modern subdivision of the genus *Shorea* were made by SYMINGTON [1943]. However, it seemed necessary to re-consider the status of the subdivisions, and to introduce a latin name for one of them. The genus comprises at least 200 species in Malaysia, and about 140 of them occur in Borneo. The subgroups are easily recognisable by characters of slash, timber, colour, weight, wood anatomy, inflorescences, flowers and, to a lesser extent, fruits. The largest group, with about 65 species, is the so-called Red Meranti group, which is also the most heterogeneous one. Nevertheless, this group is to be regarded as a natural one, which should have the same status as the subgroups *Anthoshorea*, *Shorea*, and *Richetia*. I fully agree with Symington in his Foresters Manual of Dipterocarps, who stated "there is ample justification, on botanical grounds for recognition of the Red Meranti group as a natural unit of comparable status of these other groups." This view has recently been supported by T. C. WHITMORE [1962] in a study of bark characters in Dipterocarps.

When we consider the whole division of the family in genera, which is largely based on the fruit structure, it does not seem justified to raise the subgroups to the rank of genera, but their rank would be underrated when we would call them sections. The rank of sections

can better be reserved to smaller groups within the main ones.

The following Conspectus of the genus seems to be the most appropriate one:

Shorea Gaertner f. 1805, type *S. robusta* Gaertn. f.

Subgenus *Shorea*. Inner-bark yellow to pink-ochre to brownish; hard heavy timber. Anthers 4-celled; appendage of the connective ciliate or barbate.

Section *Isopterae* (Scheffer ex Burck) Foxworthy in Phil. J. Soc. 57:291 (1938).

Section *Ciliatae* Symington. For. Man. Dipt.: 4 (1943).

Section *Barbatae* Symington in J. Mal. Br. R. As. Soc. 79:162 (1941).

Subgenus *Anthoshorea* Heim ex Brandis in J. Linn. Soc. (Bot.) 31:84 (1895). Inner bark laminated; timber white, rich in silica. Anthers 4-celled. Type: *S. talura* Roxb.

Subgenus *Richetia* Symington in Gardens Bull. 9:330 (1938). Inner bark and timber yellowish. Anthers 2-celled. Type: *S. richetia* Sym.

Subgenus **Rubroshorea** subgen. nov. (=turma "Red Meranti" Shoreae apud Symington);

Phloëma rufescens vel fuscens, corpus lignosum pallide vel obscure rubrum, leve ad mediocriter durum, corpusculis silicosis desinentibus, radiis sine utriculis resinosis (sicut *Rechetia*); antherae semper quadriloculares, appendices abortivae ad manifestae, saepe leves.

Inner bark reddish or brownish; timber light to dark red, exceptionally yellowish, light to medium weight or heavy. Flowers with 4-celled anthers provided with filiform or short appendages which are not prominently barbate or ciliate. Type: *S. parvifolia*.

It seems justified, as already indicated by Symington, to distinguish a number of subgroups of *Rubroshorea* (Red Meranti). The structure of the flowers, and especially the number and structure of the stamens, are of importance for a further division. The highest number of stamens (30-45) occurs in *S. ovalis*, where the filaments are filiform and the appendages vestigial. Between 20-30 stamens has *S. smithiana* and possibly also *S. waltonii*. All other groups have 15 stamens. A special type is represented by *S. parvifolia* and allied species (*S. ovalis*, *S. scabrida*, *S. teysmanniana*, *S. retusa*, *S. macroptera*, *S. ferruginea*, *S. rugosa*, *S. uliginosa* and *S. hemsleyana*), where the appendage of the connective is reflexed and rather short. The Kawang group section *Pinanga* of Brandis seems to be characterised by the fact that the stamens form a tube round the ovary (Ashton in litt.). Symington already recognised a section *Pauciflora*, with stamens provided with long smooth straight appendages, which includes *S. pauciflora*, *S. leptoclados*, *S. platyclados*, *S. palembanica* and *S. kunstleri*, all rather similar in leaf and timber characters. Finally a special group is formed by *S. venulosa* and an undescribed species from Sarawak (species N1), where the appendages are papillose.

The system proposed here in a more formal way than in Symington's paper, finds support also in recent studies on the bark structure by T. C. WHITMORE [1962].

SUBGENUS SHOREA

***Shorea exelliptica* W. Meijer nov. spec.**

Shorea subgen. *Shoreae* sect. *Ciliatae*. Folia ovate-elliptica usque oblonga, nervis utroque latere 12–15 (–20), pilosis vel scabridis, subtus lutescentia vel aureo-brunnea. Stamina 30; appendices antheris aequilongae ciliis praeditae. Ovarium pilosum; stylus ovarium aequans. Fructus alis ad $3\frac{1}{2}$ cm longis instructis.

Shorea exelliptica Symington non Burck. Foresters Manual of Diptero-carps: 13 (1943).

Type: Brunei, Belait-S 1641. coll. A. Rachman (duplicates in herb. Kuching, KEP, SAR, K, A, L, S, B.). Plate 1.

Tree growing to a large size, twigs rusty dark brown, tomentose when young, blackish when old. Stipules tongue-shaped, about 8×4 mm with blunt or acuminate apex. Leafblades elliptic to narrowly oblong, sometimes wider, oval-ovate, very variable in size, from 8×4.5 up to 17×10 cm, rather stiff coriaceous, apex short and acute; base rounded to cuneate or even slightly cordate; upper face drying pale brown; midrib sunken, hairy, brownish; lateral nerves brown, in 12–15 (20) pairs, strongly curved near the margin; tertiary nerves conspicuous as parallel brown lines; lower face dull yellowish cream or golden brownish; midrib strongly raised; tertiary nerves well visible; on younger leaves midrib, lateral nerves and tertiary nerves with tufts of stellate hairs mixed with simple hairs; in older leaves only rows of scabrid circular scales left. Petiole 1.8–2 cm. Sapling grey-brownish hairy; leaves thinner than in the adult stage.

Inflorescences consisting of 3–4 panicles rising from the axils of the uppermost leaves; each panicle about 7–13 cm long, covered with a light golden-brown soft tomentum of stellate hairs; branchlets subtended by deciduous bracts, which are about 1–2 cm long, each branchlet bearing 3–4 flowers. Flowers subsessile, in the bud about 1.5 cm long. Three outer sepals greyish with stellate hairs, ovate, about 3 mm long; the two inner grey silky hairy, about 2 mm long. Petals linear, about 1.5 cm long and up to 1.5 mm broad, grey sericeous on outer face and redbrown with minute hairs on inner face and with about 5 rather faint darkbrown nerves. Stamens 30, in three rows; filaments flat, broad in the middle, narrowed towards apex and base, margin in upper half with cilia; anthers 4-celled, subequal; appendage as long as the anthers, with 5–7 long pellucid cilia. Pistil about 3 mm long; ovary ovate-conical, densely silky-hairy; style erect, cylindrical, hairy in lower half, about as long as the ovary. Fruit with wings about 6.5 cm long; larger wings 3.5×1.3 cm; nut 1.5×1 cm. Tree with a rather irregularly fissured bark; outer bark dark brown; inner bark yellow brown, very hard, fine grained; sapwood orange brown; heartwood dark brown and heavy. Dammar dark honey-coloured. Seedling: leaves with ovate blades, about 7.6×5 cm, with caudate apex of 1.3 cm.

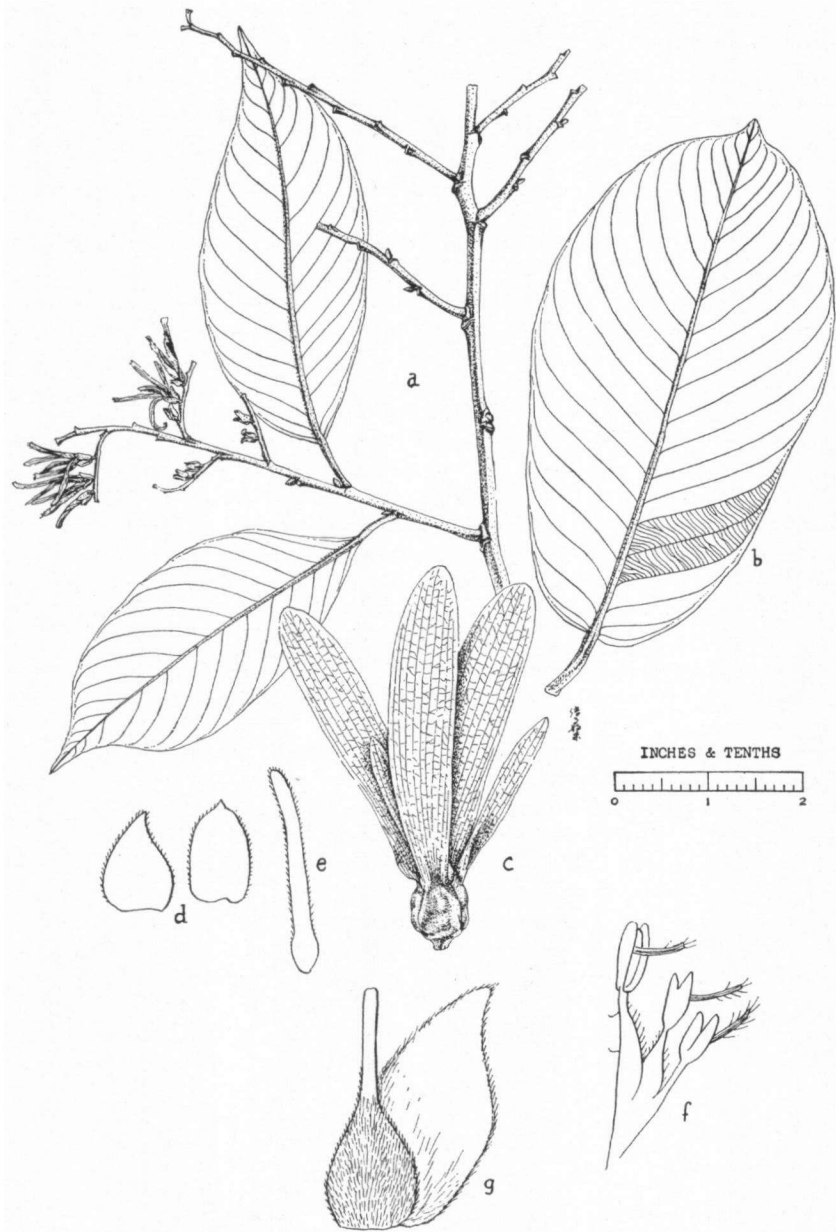


Plate 1. *Shorea exelliptica* W. Meijer. *a.* flowering branch; *b.* old fallen leaf; *c.* fruit; *d.* sepals; *e.* petal; *f.* stamens; *g.* pistil with one sepal attached. *a.*, *d-g.* after S 1641, Belait, Brunei; *b.* after SAN 24623, Labuk Road Base West at Sandakan, North Borneo; *c.* after SAN 17833, Apas Road, Tawan, North Borneo.

Specimens examined:

MALAYA

SOUTH KEDAH: Bongsu F.R. (KEP 46980).

PERAK: Dinding, Bruas F.R. (KEP 13591, 42552); Tandjong Tualong F. Reserve, (KEP 16201, 16269, 24469, 24471, 24638); Bulan F.R. (KEP 16586); Segari-Melintang F.R., Dinding (KEP 16810); Bubu F.R. (KEP 30750, 30894).

TRENGGANU: Jalan Kelantan, Batu 20 (KEP 46553); Timor Talan Kelantan, (KEP 53421); Besut, State Land (KEP 68708); Sungai Paka (KEP 26733, 26915); Ulu Pantang (KEP 4309); Sg. Besok Ulu Paka (KEP 44126).

PAHANG: Kuantan district, Boloh F.R. (KEP 6642); Aur F.R. (KEP 49969); Ulu Rompin, Gayong (KEP 3559); Ulu Rompin, Perak (KEP 14986, 14987); Ulu Rompin Pasir Bakoh (KEP 15760); Ulu Sg. Menchang F.R. (KEP 15638); Buloh F.R. (KEP 6642, 17363, 17378); Bukit Sejabar, G. Lesong F.R. (KEP 31663, 31664).

KUANTAN: Balah State Land (KEP 17223); Batu Sawah F.R. (KEP 17342, 17343, 29687, 31803); Tombing G. Lesong F.R. (KEP 31671, 65658); Bukit Goh F.R. (KEP 49856, 48861, the only fruiting collection made in Malaya!); Baloh cpt. 8 (KEP 43130).

JOHORE: Mersing F.R., Mile 30 Jemalong Rd. (KEP 77947); S. Kayu Aru, Mawai-Temalaang Rd. (SING 33559); Mile 6.5 Kluang Mersing Rd. (KEP 584); Meng kaloh Sedeli (KEP 5827); K. Luang F.R. (KEP 49209).

BORNEO

SARAWAK: Sibu, Sg. Miah (For. Dep. 001104); Miri (S 1432).

BRUNEI: Kuala Balalong (BRUN 796); Bukit Biang (S 3785); Bukit Bedawan (BRUN 880); Belait, Bukit Teraju F.R. (S 2114).

NORTH BORNEO: Tawau, Serudung (SAN 19559); Sg. Kimanis, Sebatik Island (SAN 19510); Balong area (SAN 16454); Apas (SAN 17833); Sandakan, Kinabatangan, Sg. Pin, Tongud; Bukit Sipitang (SAN 15165); Ulu Sipitang (SAN 16986).

***Shorea flava* W. Meijer nov. spec.**

Shorea subgen. *Shoreae* sect. *Ciliatae*. Folia ovata, longe acuminata, nervis utroque latere 8–10, distincte prominentibus, subtus lutescentia. Stamina 45; antherae ciliis longitudine aequantes; filamenta basi applanata, sparse ciliata. Ovarium pilosum, stylo sat brevi. Fructus 8–9 cm longus.

Type: Kuching—Santubang. SAR 9480, coll. Saidin. (duplicates in KEP, KEW, L, SING, BO). Plate 2.

Medium-sized trees; branches minutely ochre, fulvous hairy when young, drying black when old. Leaves with ovate blades (9) 10–12 (14) × (3.5) 4 × 5 (6) cm, when dry margin slightly recurved; apex long acuminate (tip about 15 mm long); base cuneate or rounded, often slightly decurrent into the petiole; upper face drying dark blackish brown, smooth; midrib slightly sunken; 8–10 pairs of lateral nerves, faint pinkish; tertiary nerves fine, more or less parallel; veins reticulate, distinctly visible with a lens; lower face often drying with a yellowish ochre colour, but sometimes dark grey-brownish; midrib prominent, reddish brown near base; lateral nerves prominent, often reddish-brown, diminishing in thickness near the margin; in the lower half of the blade often domatia in the axil of the lateral nerves; tertiary nerves and veins hardly visible on yellowish leaves. Petioles 1.5–2 cm, slender, greyish, wrinkled.

Inflorescences terminal and in the axil of reduced upper leaves,

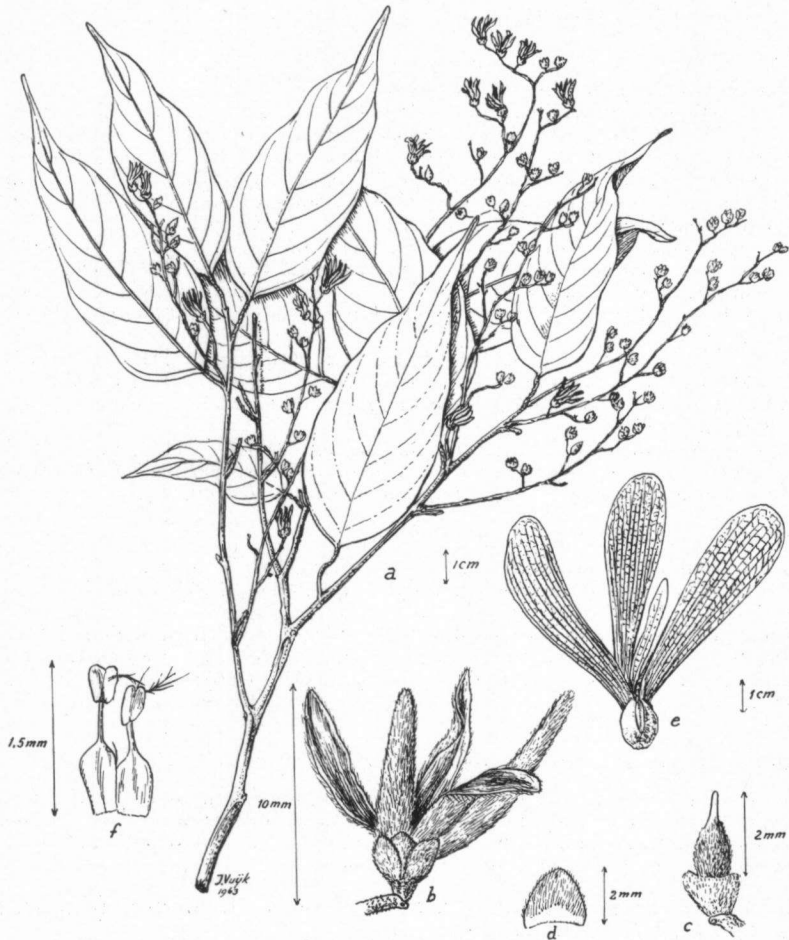


Plate 2. *Shorea flava* W. Meijer. a. flowering branch; b. flower; c. pistil; d. sepal; e. fruit; f. stamens. Fruit after SAR 10287, other figures after SAR 9480 (type).

greyish, minutely hairy, 1–2 times branched; main branches about 7–9 cm; about 3–5 flowers on the ultimate branches; pedicels about 1 mm, stellately grey-hairy. Flowers 10–12 mm; sepals triangular, grey stellately hairy on the outside, the 3 larger ones about 2 mm long; the 2 smaller ones 1 mm; petals white or yellowish linear, about 8 mm long, at exposed face sericeous, dark coloured at base, with about 10 nerves, near the base up to 2 mm broad; stamens 45, about 1.5 mm long; anthers as long as the appendages; appendages with bristles of about their length; lower half of filament broad and flat, occasionally with a few bristles; anthers sometimes also with some bristles; pistil about 2.5–3 mm long; ovary and stylopodium spindle shaped, hairy; style rather short. Fruit with wings 8–9 cm

long; nut globoid to ovoid, 2×1.5 cm, crowned by a remnant of the style; stylopodium 2 mm; base of calyx lobes covering two third of the nut; larger wings up to 18 mm broad. Trees are reported to be about 120 ft high; outer bark scaly grey-brown; corkcambium dull pale ochre brownish; inner bark pale ochre; sapwood pale ochre, hard.

They occur from sea-level up to about 600 ft altitude.

Specimens examined:

BORNEO

SARAWAK: Kuching, Santabong, coll. D. Carroll (SAR A 0700); Bako National Park, coll. Arzi (10116, 10287, 10288); coll. Abang Muss (10131); Tandjong Sg. Lakei, coll. Arzi (10286); Lundu G. Pueh, coll. Bojong (10053, 10055, 10056).

This species is also known from the East coast of Malaya where it is called Balau kuning. During June 1962 I was shown this tree by Mr. Kochummen in a Virgin jungle Reserve at Bukit Bauk, Dungun, Malaya (KER 94947), and also 23 Miles North of Kuala Trengganu near Sungai Tong. The leaves of *Shorea flava* resemble those of *S. glaucescens* Meijer; they are, however, more ovate and more symmetrical, yellowish instead of glaucous at the underside, and provided with more strongly raised lateral nerves.

Shorea glaucescens W. Meijer nov. spec.

Shorea subgen. *Shoreae* sect. *Ciliatae*. *Shoreae* materiali affinis, sed foliis nervis utroque latere 7-9 subtus parum prominentibus differt; staminibus 45-50.

Type: North Borneo, Sandakan, Sepilok Forest Reserve, Compartment 13 (SAN 15484, duplicates in Herb. K, L, SING, BO, SAR, KEP, PNH, FHO, BRI, Fl, A). Plate 3.

Medium to large-sized trees. Twigs slender and glabrous. Stipules early deciduous. Leaves with obovate-elliptic blade, very variable in size, from 8×3 cm up to 15×9 cm; base often unequal, rounded or cuneate to slightly cordate; apex acuminate; midrib not very prominent, slightly raised and finely channelled, especially near the base of the blade, at upper and lower face dark brown or black; lateral nerves in 7-9 pairs, inconspicuous or slightly sunken at upper face, only slightly raised at lower face; tertiary nerves parallel, rather wavy, some branched; leaves often glaucous below, but not so in sapling and pole stage, dried dark brown, glossy at upper face. Petioles glaucous or black, 2-2.5 cm. Panicles terminal and axillary; main axis about 8-10 cm, generally whitish pubescent; lateral branchlets alternating, 1 cm apart, about 1.5-2 cm long, whitish pubescent, each bearing 5-7 flowers. Flowers about 2-3 mm apart, lanceolate in bud, about 12-14 mm long; pedicels about 0.1 mm. Sepals 1.5 mm long, ovate, obtuse, greyish stellately hairy on the outside. Petals linear oblong, contorted in bud, whitish greenish, yellowish near the base, pubescent on the outside, about 12 mm long. Stamens about 45-50; anthers pale brown, ovate-oblong, in upper part with cilia;

filaments about twice as long as the anthers, narrow linear in upper part, gradually broadened and flattened towards the middle, slightly narrower at base; appendage to connective about as long as the anther, ciliate. Pistil 3 mm long; style very short, cylindric, smooth; stigma

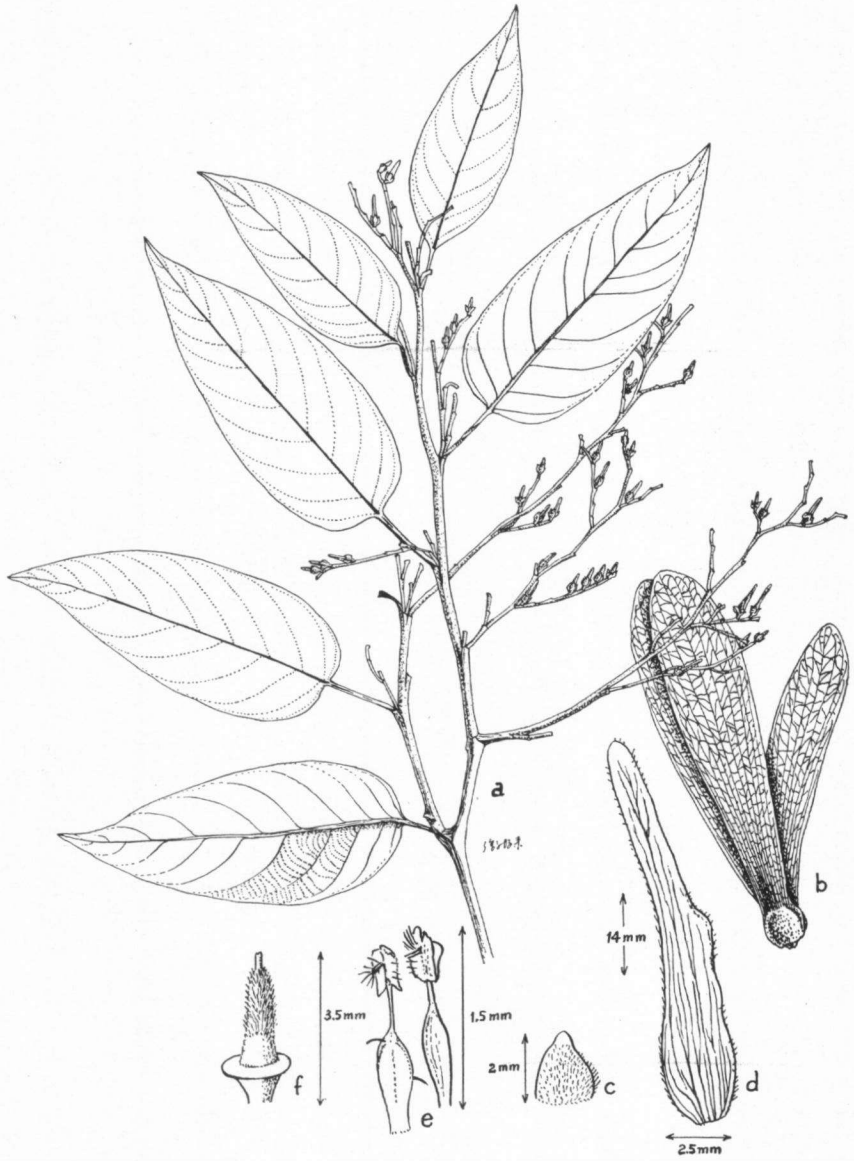


Plate 3. *Shorea glaucescens* W. Meijer. a. flowering branch; b. fruit; c. sepal; d. petal; e. stamens; f. pistil. a and b after SAN 15484, c-f after SAN 21701.

not enlarged; ovary slightly spindle-shaped, densely setose on the upper half, pale greenish-yellow when fresh. Fruit a 5-winged nut, about 8 cm long; the 3 larger wings about 7 cm long and up to 2 cm broad, slightly pubescent; base of calyx lobes enclosing the globular nut, which is acute at apex and about 1.5 cm in diameter (only young fruits seen). Trees with irregularly scaly to cracked fissured bark, peeling off in irregular patches. Outer bark dark brown; inner bark yellowish; sapwood about the same colour. The timber is a Selangan batu, somewhat lighter than that of *Shorea laevis*.

~~Specimens examined:~~

BORNEO

NORTH BORNEO: Beaufort Hill (SAN 15079, SAN 16962); Sandakan, Sepilok Forest Reserve (A 3148, A 3583, SAN 15484—the type—16523, 21701); on hills along Labuk River (SAN 20478); also seen near Telupid and near Sungai Paliu. The localities in Sepilok Forest Reserve are often quite near the mangrove on low hills. Isolated exposed trees have often crooked boles.

SARAWAK: Bintulu, Similajan Forest Reserve, coll. E.F. Brumig (SAR 8661), emergent tree in coastal kerangas.

This species has been confused with *Shorea glauca* King from the Malay Peninsula. It belongs however to section *Ciliatae*, while *S. glauca* is a member of the section *Barbatae*. It appears, in fact, to be more narrowly related to *Shorea materialis* Ridl. a species with leaves provided with more (10–12) pairs of lateral nerves and with a more distinctly cordate base, and with about 30 stamens in its flowers. There are reports of that species from Brunei and Sarawak which have to be studied carefully. I could study myself *Shorea glauca* and *Shorea materialis* in the field during a trip with Mr. Kochummen in East Malaya, June 1962.

***Shorea hypoleuca* W. Meijer nov. spec.**

Shorea subgen. *Shoreae* sect. *Ciliatae*, affinis generaliter *S. atrinervosae* et quoad foliis *S. seminis*, sed foliis subtus albido-ochroleucis, fructibusque alatis diversa.

Type: North Borneo, Sepilok Forest Reserve near Sandakan, coll. G. H. S. Wood (SAN 16048, dupl. K, A, L, SING, BO, PNH, SAR, BRI, KEP, FHO, Fl). Plate 4.

Medium-sized to large trees; branches rather angular, channelled; young part with a hairy ochre covering of scales, drying yellowish; buds small, globose or acute, covered with ochre scales. Leaves with ovate or elliptic-oblong blade, about 10–15 cm long and 4–7 cm broad; apex shortly acuminate, with retuse tip; base rounded or cuneate, often slightly asymmetric; upper face glossy, with the midrib slightly sunken; lateral nerves often with a bent near the midrib, ascending along the margin; tertiary nerves parallel, just visible; veins reticulate, only visible with a lens; lower face often covered with a thin yellowish-ochre or sometimes glaucous indumentum; costa and main nerves prominent, not covered by an indumentum; tertiary nerves fine, parallel; veins invisible. Petioles often bent, about 2–4 cm long, ochre or black.

Inflorescences consisting of terminal and axillary panicles; main axis about 10 cm long, brown with scattered whitish hairs; lateral branchlets about 2–3 cm long, each bearing about 7–10 flowers. Flowers 2–5 mm apart, about 1 cm long in bud; pedicel 0.5 mm; sepals ovate, obtuse, about 1.5 mm broad, pubescent on the outside; petals linear oblong, about 12 mm long, pubescent on the outside, about 1.5–2 mm broad at base and with 10 nerves; stamens about 30; anthers ovate; appendages to connective about as long as anther, with about 20 thin bristles; filaments twice as long as the anthers, gradually narrowed at apex, broadened and flat at the middle; pistil

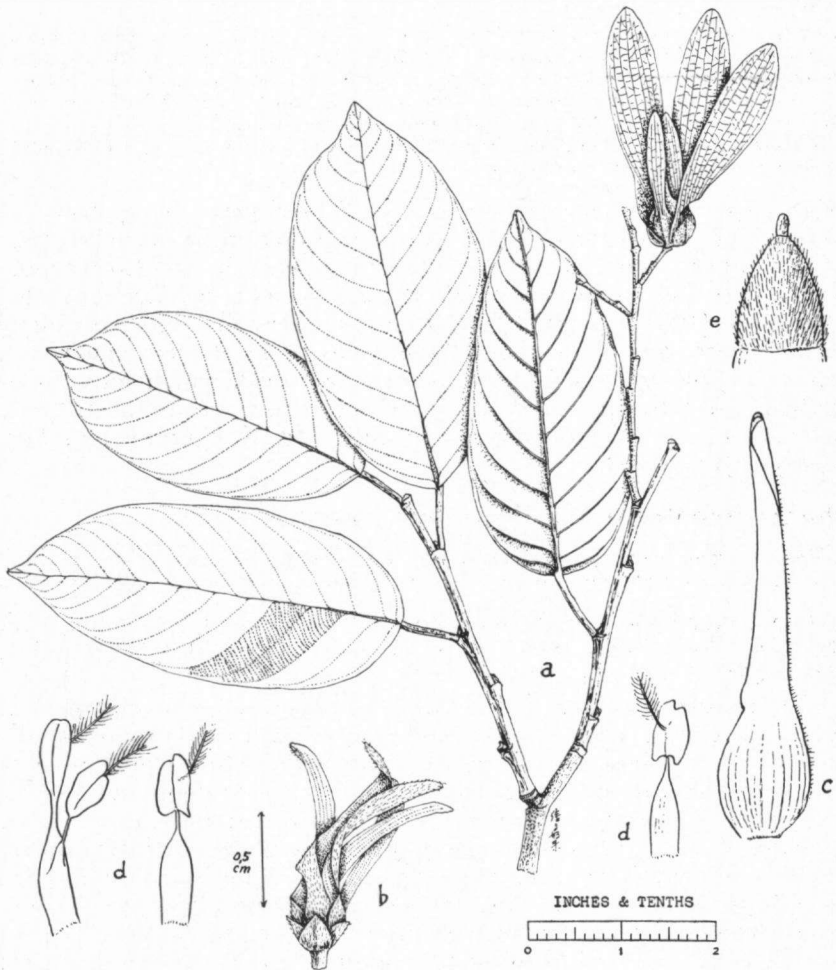


Plate 4. *Shorea hypoleuca* W. Meijer. a. fruiting branch; b. flower; c. petal; d. stamens; e. pistil. a after SAN 16048 Sepilok Forest Reserve, Sandakan; b–e after SAN 21502, Apas Road, Tawan, North Borneo.

about 2 mm long; style very short, cylindrical; ovary ovate, densely setose. Fruit: A five winged nut; the three larger wings redbrown, about 7 cm long and up to 2 cm broad, near apex slightly hairy; the two shorter wings linear, about 2 cm long; nut globose, pale ochre sericeous, about halfway covered by the calyx lobes, at apex with a short beak. Trees have scaly to fissured-scaly boles, rounded buttresses, a dull yellow inner bark, yellowish-ochre sapwood and dark-ochre heartwood.

Specimens examined:

BORNEO

SARAWAK: Gunung Lundu (SAR 7958, 10158); Lundu, Gunung Gading (SAR 7967 = 10175, 9553, 7967, 15360).

NORTH BORNEO: Beaufort, Padas Gorge Pangi (A 3667, A 4302, SAN 16937, 16989); Kudat, Balambangan (SAN 15559); Sandakan, Sepilok Forest Reserve (A 1688, A 3443, SAN 16048); Lahad Datu, Matrid Timber camp (A 221); Tawau, Elmer 21362, Quoin Hill area (SAN 19405), Apas-Balong area (SAN 16463); Mile 10-12, Apas Rd. (SAN 17838, SAN 17839, SAN 21502); Kalabakan (A 3667, A 4102, SAN 15250, SAN 15273); Sebatik Island, Sg. Kimanis (SAN 19520); Sg. Simpang Tiga (SAN 19641).

INDONESIAN BORNEO: East Kalimantan, Nunukan, 66. 23525, 66. 23520, 66.18211.

The leaves are very similar to those of *Shorea seminis* but more ochre-coloured at the lower face. The fruits are winged. Another related species is *Shorea atrinervosa*, which differs mainly in its blackish midrib and its more scaly bark and in details of the flower structure.

***Shorea leptoderma* W. Meijer nov. spec.**

Shorea subgen. *Shoreas* sect. *Ciliatae*, affinis *S. glaucescenti*, sed cortice tenue minute impressa (ut in cortice *Psidii guajavae* invenitur), foliis elliptico-oblongis, nervis 10-14 paribus differt.

Type: North Borneo, Sepilok Forest Reserve, Sandakan, Numbered tree 312 (SAN 21711, dupl. K, L, SAR, KEP). Plate 5.

Medium-sized trees. Twigs grooved when young, dark brown, with reddish brown lenticels and small greyish stellate hairs. Buds globose, pale reddish grey, covered with stellate and simple hairs. Stipules present only on young twigs, narrowly falcate, about 20 × 1 mm. Leafblade elliptic oblong, from 7.5 × 3.5 up to 15 × 8.5 cm, generally about 13 × 6 cm; apex acuminate; base rounded to slightly cordate; upper face drying pale reddish-brown, slightly hairy on midrib and base of main nerves (also in the sapling stage); midrib and the 10-14 pairs of lateral nerves slightly sunken; tertiary nerves parallel, fine, well visible; veins reticulate, distinct; lower face pale ochre-brown, with raised midrib and lateral nerves; tertiary nerves and veins well visible. Petioles blackish with grey tomentum, 1-1.4 cm.

Inflorescences consisting of terminal or axillary panicles, the latter in the axils of reduced leaves, 6-8 cm long, greyish stellately hairy, pinnately branched. Side branches with 8-12 flowers in dense rows; flowers subsessile, 1-2 cm long, about 4 mm long in bud. The three outer sepals about 1.5 × 1.5 mm, almost triangular with fimbriate

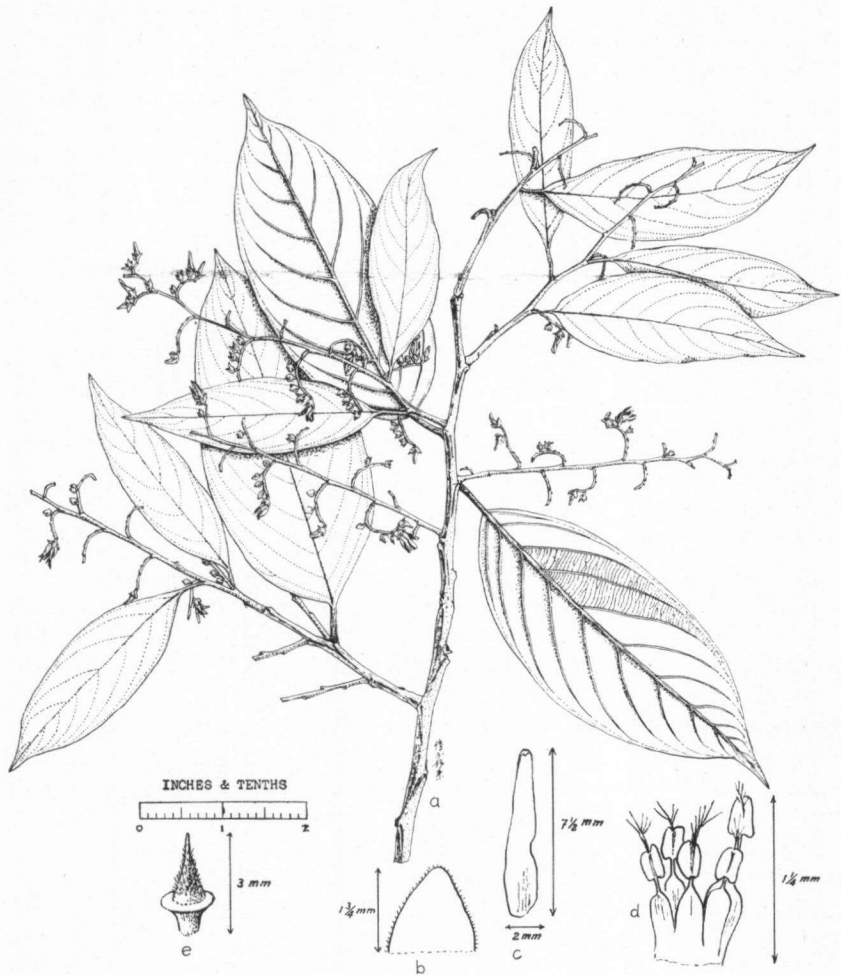


Plate 5. *Shorea leptoderma* W. Meijer. *a.* flowering branch; *b.* sepal; *c.* petal; *d.* stamens; *e.* pistil. All after SAN 21711 = numbered tree 312, Sepilok Forest Reserve, Sandakan.

margin; the 2 inner ones slightly smaller and with acute apex. Petals slightly contorted in bud, 4.5–5 mm long, greyish-brown hairy on the outer face, brown on the inner face. Stamens about 30; filaments with broad flat bases; appendage short, about 1/5 length of the anther or shorter; pistil 1.5 mm long, more or less pearshaped, hairy except on the short style. Fruits about 7 cm long; calyx tube about 1 cm; larger wings about 6 × 1 cm, light yellow with red tinge at the end when fresh. Bole up to about 100 ft high; outer bark thin dippled, covered with lenticels; inner bark pale brown; sapwood yellowish;

heartwood dark ochre, hard. This tree is locally named Selangan batu-biabas, because the dipped thin outer bark is similar to that of *Psidium guajava* = Jambu biabas. Collections were mostly made around the Sandakan bay (prewar: SH 4851, 4869, postwar A 1687, A 3647, SAN 20013, SAN 20459, SAN 20525, 21711), but we have also one specimen from Bukit Kretam (SAN A 4780) and G. H. S. Wood and I myself saw it at various localities near Tawaur Apas Balong area and near Quoin Hill. Trees start flowering after shedding the leaves.

***Shorea obscura* W. Meijer nov. spec.**

Shorea subgen. *Shoreae* sect. *Ciliatae*, affinis *S. glaucescenti*, sed cortice interna saturate rubro-brunnea, foliis ambitu minus variabilibus, basi magis symmetricis, nervis c. 7-9 paribus differt. Stamina 45; filamenta, antherae appendicesque ciliata.

Type: Bukit Sipitang 500 ft coll. G. H. S. Wood (SAN 15166, dupl. K, A, L, SING, BO, PNH, FHO, SAR, KEP, BRI). Other collections from Pulau Gaya near Jesselton (SAN 20651, 20785 and KEP 80300) and from Bukit Tamburango, Ranau (SAN 22379) and Tawau, Membalua Forest Reserve (SAN 22739, 22742). Plate 6.

Large-sized tree; twigs and young buds greyish with a dense covering of scales. Leaf-blades oval to oval-elliptic, 6×2.5 up to $9 (-12) \times 4 (-5)$ cm, reduced near inflorescence; apex acuminate; base rounded or cuneate; upper face dull ochre when dry; midrib slightly sunk; lateral nerves in about 7-9, but generally in 8 pairs; tertiary nerves very slender, generally wavy, parallel, some branched, slightly prominent; veins visible to the naked eye; lower face drying ochre or glaucous-green on sun-exposed leaves; midrib prominent, brownish especially near base or blackish on sun-exposed leaves; lateral nerves and tertiary nerves distinctly raised. Petiole 1.5-2 cm.

Inflorescence: terminal and in the axils of the upper leaves, 10-16 cm long; lower branches about 7 cm long, with about 3-6 side branches, each with 3-10 flowers. Main axis of the inflorescence greyish brown; side branches and calyces whitish stellately tomentose. Flowers subsessile, in the bud about 10 mm long and 2 mm broad; pedicels 0.5 mm, the 3 outer sepals ovate-oblong with acute apex, about 3 mm long; the 2 inner sepals 2.5 mm, more ovate, with thin margins; petals about 1 cm long, linear, whitish silky hairy on outer face, brown in lower half, whitish hairy near apex on the inner face and also near the base at centre, provided with about 12 brownish veins. Stamens about 45 in 3 rows, 1.5-2 mm long; filaments flat, broadened in the middle, with some bristles; anthers subequal, ciliate; appendages as long as the anthers, ciliate; pistil 3.5 mm long; ovary and style cone-shaped (with slight constriction) and appressed hairy except on the upper part of the style. Fruits about 7 cm long; largest wings $5-6.2 \times 1.4$ cm; nut globose 3×1.5 cm. Trees with scaly or flaking outer bark, on the slash with a light greyish or dull cream cork cambium, contrasting with the dark red-brown, inner bark which

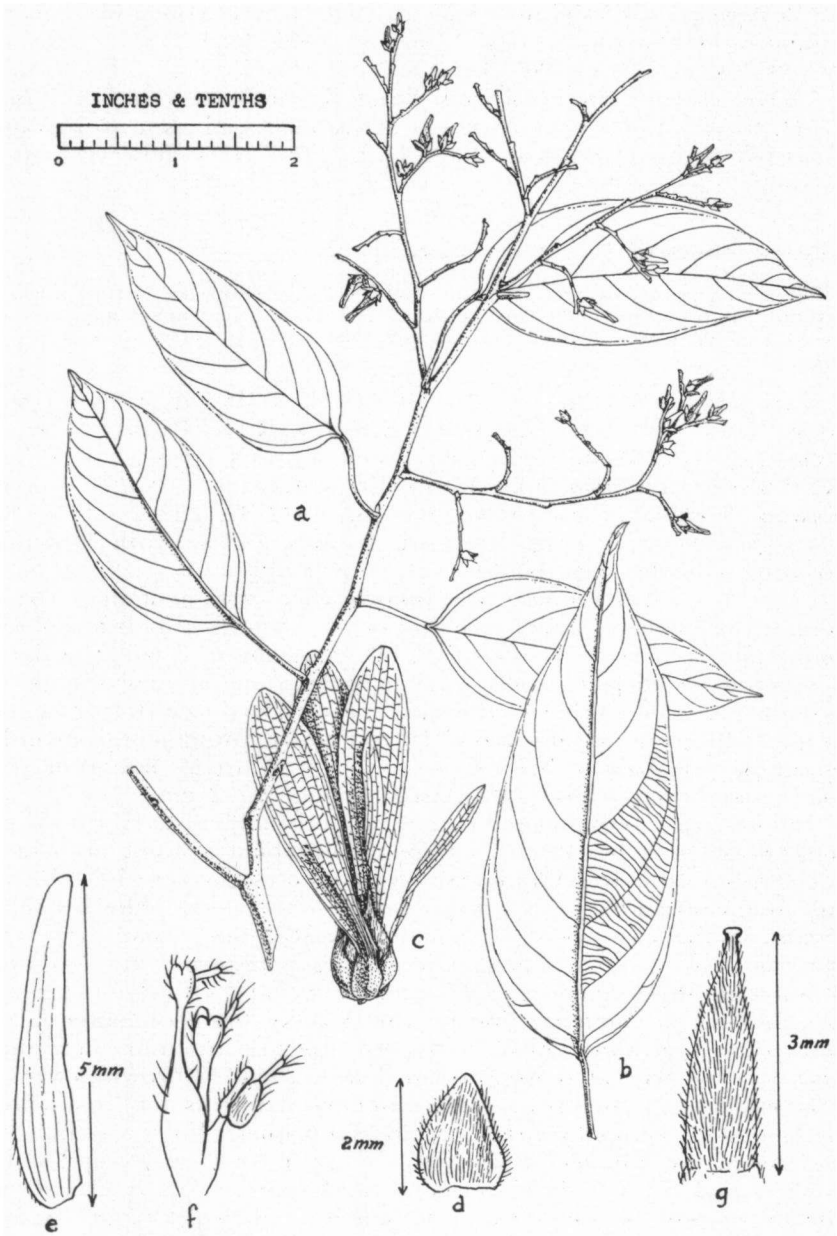


Plate 6. *Shorea obscura* W. Meijer. *a.* flowering branch; *b.* old fallen leaf; *c.* fruit; *d.* sepal; *e.* petal; *f.* stamens; *g.* pistil. *a, c-g,* after SAN 15166; *b.* after SAN 22739.

turns red-brown near the cambium; sapwood pale ochre, heartwood dark ochre to brownish, very hard.

This species is not yet very well known. The trees were often considered to belong to Selangan batu laut (*S. glaucescens*), because of the glaucous underside of adult dried leaves. The leaves are however more symmetrical than those of *S. glaucescens* and less variable in dimension, also generally smaller. The dark red-brown inner bark and the dark ochre to brownish heart-wood are the most characteristic field characters. The name *Shorea obscura* seems appropriate, because the identity of this tree was for a long time left in darkness and because the timber is a dark coloured Selangan batu (Balau).

SUBGENUS RUBROSHOREA

Shorea fallax W. Meijer nov. spec.

Shorea subgen. *Rubroshoreae* sect. *Pinangae*. Folia rigide coriacea, basi cordata, margine recurvata, subtus in costa valde prominente nervisque scabrida. Fructus breviter alati. A *S. oleosa*, cui similis, characteribus tamen foliorum, inflorescentiis magis ramosis, lobis corollae canaliculatis differt.

Type: North Borneo, Beaufort Hill, coll. G. H. S. Wood (A 1734, dupl. in Herb. K, A, L, SING, BO, PNH, FHO, SAR, KEP, BRI, FI). Topotype SAN 24645, Numbered tree 118. Plate 7.

Rather small-sized tree. Branches blackish brown, on the younger parts with prickly warts. Leaves with stiff coriaceous blade, about 15–22 × 8–10 (13) cm; base cordate; apex shortly acuminate, often splitting or curved sideways when pressed, upper surface with bluish waxy layer, drying dull olive brown, with strong, immersed hairy midrib and about 15–16 slightly immersed main nerves; lower face reddish brown, paler on the raised midrib, lateral nerves and tertiary nerves; margin rather strongly recurved, with the ascending lateral nerves joining along it; midrib, nerves and tertiary nerves sparsely scabrid with cushion-shaped warts; tertiary nerves near midrib curved towards it, further on parallel, almost invisible on the upper face.

Inflorescences with terminal and lateral branches; main axis drying dark brown, about 15–25 cm long, provided with prickly warts; lateral branches 5–15 cm, stellately hairy, with alternating greyish stellately hairy flowering branches of 1–1.5 cm length, which are densely beset with about 10 (ovate sericeous hairy) bracts (7 × 4 mm). Flowers almost sessile, about 8 mm in ripe buds; calyx 4 mm long, ochre-white; lobes acute, largest about 5 mm long, smallest 3 mm, setose and stellately hairy, corolla dropped in one piece, white, with a globular inflated hairy base and narrowly channelled contorted lobes, each separate lobe about 12 mm long and with 10 veins at base; stamens 15, adherent in a closed ring to the base of the corolla and of about 3 different lengths; anthers ovate; appendage about 3 times its length; filaments in the lower half flat, broadly shouldered

below the filiform upper half, about 2–2.5 times as long as the anthers; pistil at least 2 mm long; ovary brown, whitish setosely hairy, except along the broadest basal part; style cylindric, smooth, about as long as the hairy part of the ovary. Fruits: the three larger wings only about 2–3 cm long, redbrown, smooth: nut up to 2.5 cm, by 1.5 cm,



Plate 7. *Shorea fallax* W. Meijer. a. flowering branch and detailed nerves; b. flower; c. young fruit; d. pistil surrounded by stamens; e. stamens. All after SAN coll A 1734.

ovoid with pointed apex, ochre, sericeous, the lower half enclosed by the calyx lobes, saplings different from those of *Shorea oleosa* by being more rustbrown hairy on branches and stipules. Trees with non-fissured boles, a rather thin outer bark, pale redbrown cork-cambium, fibrous pale red-brown inner bark. Timber not yet studied. This species was at first confused with *Shorea scaberrima*, but a comparison of the leaves and flowers from authentic material showed that it is quite different. Specimens examined: Besides the type and topotype, also one collected near Telupid, Labuk River (SAN 24276).

The distribution of this species is still very imperfectly known. It looks much like *Shorea oleosa*, but the leaves are coarser with a more distinctly cordate base and recurved margin and fewer main nerves; the saplings have a different hairiness and the corollas have more distinctly channelled lobes. Moreover, the inflorescences are more compound.

***Shorea nebulosa* W. Meijer nov. spec.**

Shorea subgen. *Rubroshoreae*, affinis *S. cristatae*, sed foliis densius pubescentibus nervisque c. 15 paribus differt. Flores adhuc ignoti.

Type: North Borneo. Ranau, Poring above Hot Springs, coll. G. H. S. Wood and Charley Charington (SAN 16355, Dupl. K, A, L, SING, BO, PNH, FHO, SAR, KEP, BRI, FI).

Large tree; branches rusty brown, softly tomentose hairy at the younger parts; older parts scabrid with stiff patent warts. Stipules rather persistent, ovate-lanceolate, about 0.8–1.2 cm long, with about 5 nerves, and covered with pale reddish-brown warts. Leaves with ovate-oblong blades, variable in size, about 9–14 × (4) 5–8 cm; base rounded to slightly cordate; apex short, acute, often constricted; upper face drying dark olive-brown, smooth except on the slightly sunken rust-brown hairy midrib; lateral nerves fairly constant in 15 pairs, slightly sunken; tertiary nerves and veins almost inconspicuous, only visible with a lens; lower face drying red-brown, with raised midrib and main nerves which are provided with tufts of hairs, reduced to rather distinct dispersed tufts of stellate hairs on the widely distant tertiary nerves and veins; lateral nerves ascending and decreasing in thickness along the slightly recurved margin, except near the apex where they are joining; tertiary nerves slightly curved, more or less parallel, at right angles with lateral nerves, except near the midrib where they are bent. Petioles 1.5 cm long, scabrid-hairy.

Inflorescences and flowers not yet seen. Fruit about 9 cm long; larger wings up to 1.5 cm broad; nut enclosed for at least half its length. Trees with fissured boles and large steep rounded buttresses; corkcambium blackish brown; inner bark dark reddish brown, fibrous; sapwood yellowish-pinkish. Timber a Light Red Seraya.

Specimens examined:

BORNEO

NORTH BORNEO: Proposed Kinabalu National Park, Mt. Templer (SAN 22138); near Ranau, above Ladang Nungkop (SAN 22414, 14103); Ranau, Bukit Tampurango 2 Miles South of Ranau (SAN 22373, SAN 22374, 22375, 23698).

This tree is peculiar for the upper Dipterocarp forests on the West Coast between 2000–4000 ft altitude. Its geographical distribution is still imperfectly known. The species is most closely related to *Shorea cristata* and *Shorea parvi-stipulata*. From the latter it differs in the larger leaves and more coarse hairiness, and from the former in more hairy leaves with fewer lateral nerves.

***Shorea oleosa* W. Meijer nov. spec.**

Shorea subgen. *Rubroshoreae*. Innovationes sicut stipulae argenteo-griseae, scabridae. Folia foliis juvenilibus *S. smithianae* simillima, sed nervis c. 18–19 paribus, subtus scabridis diversa. Fructus breviter alati. Lignum ponderosum, valde resinosum.

Type: North Borneo, Padas George near Pangi, coll. G. H. S. Wood (SAN 15095, dupl. K, A, L, SING, BO, KEP, BRI). Plate 8.

Medium to large-sized trees. Twigs silvery greyish on the younger parts, provided with coarse short tufts of hairs and small lenticels. Stipules rather long persistent, about 1.5 cm long, with acute apex, also greyish. Leaves similar to young leaves of *Shorea smithiana*; blade elliptic oblong; apex shortly acuminate; base rounded to slightly cordate, very variable in size, from 10 × 5 cm up to about 25 × 10 cm; upper face drying olive-green brown; midrib sunken, hairy; lateral nerves in about 18–19 pairs, slightly sunken, also hairy; tertiary nerves only slightly visible; lower face with prominent midrib, lateral nerves and tertiary nerves, all scattered with the scabridly hairy cushions which occur also on the veins; midrib channelled near the base; lateral nerves ascending and becoming thinner near the margin, which is sometimes slightly recurved; tertiary nerves more or less parallel, some bent towards the midrib and 1–3 pairs springing from the midrib between two adjacent lateral nerves; veins fine, visible. Petioles about 1–1.5 cm long.

Inflorescence consisting of pendulous terminal and axillary panicles, 10–25 cm long; main axis and branchlets pale green when fresh, drying pale brownish, stellately pubescent; lateral branches alternating, about 2 cm apart, each about 2–3 cm long, bearing 5–10 flowers in the axil of cream-coloured oval-elliptic pubescent bracts (about 6 × 3 mm). Flowers about 3 mm apart, in bud about 7 mm long; pedicels 1 mm, like the branchlets and the calyx pale cream-coloured, setosely hairy. Calyx cup-shaped at base, about 6 mm long; the three larger lobes 3 mm long; apex acutely pointed; the two smaller lobes 2 mm long. Corolla dropped in one piece, cream-coloured at the bulbous base, which is about 3 mm wide and high; lobes dark yellow; larger petals about 7–8 mm long; margin rather undulate; base up to 3 mm broad, with about 10–12 nerves, parts which are exposed in bud covered with sericeous stellately hairs. Stamens 15, with adhering filaments of about 3 different lengths, anthers oval; appendage to connective about 2–3 times as long as the anthers; filaments filiform at apex, towards the middle strongly broadened and flattened. Pistil about 2 mm long, style glabrous, cylindrical; ovary ovate, narrowed and setose hairy at apex. Fruits:

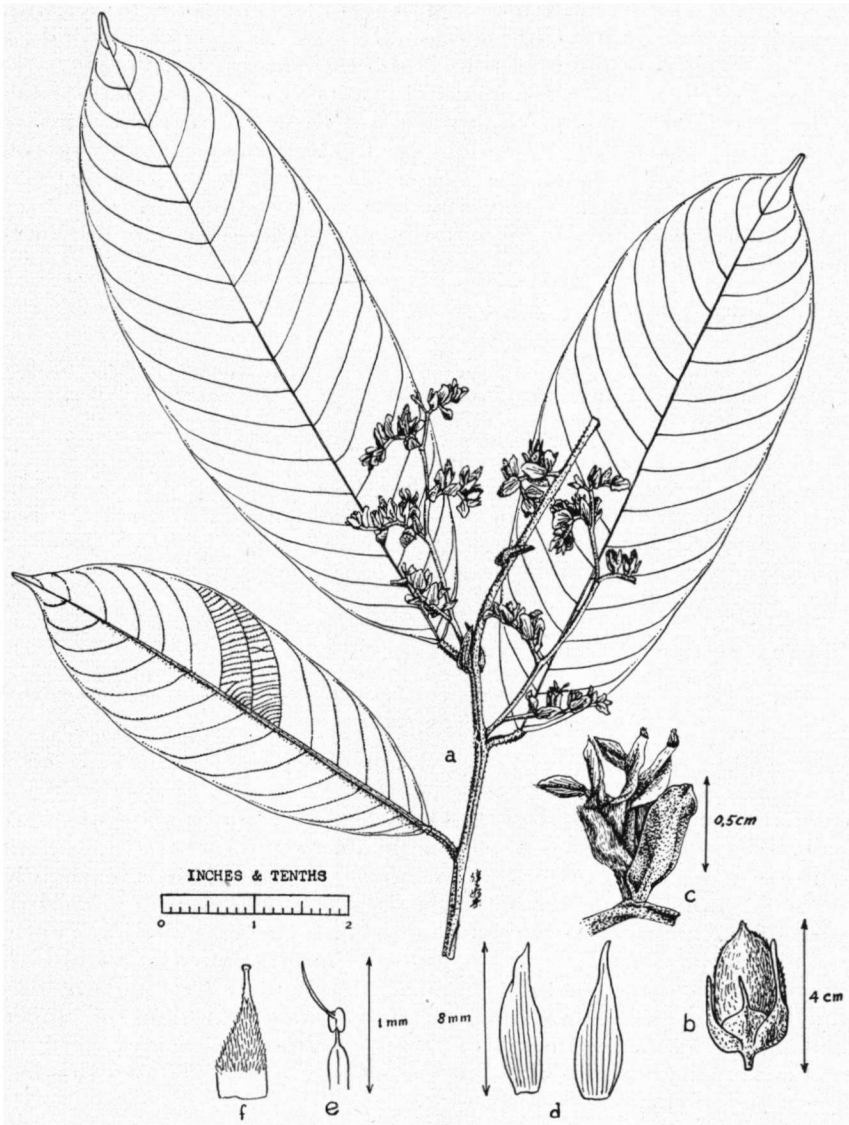


Plate 8. *Shorea oleosa* W. Meijer. *a.* flowering branch; *b.* fruit; *c.* flower; *d.* petals; *e.* stamens; *f.* pistil. *a-c.*, after SAN 15095; *d-f.*, after SAN 28687.

very shortly winged; the three larger wings about 2.3 cm long, up to about 0.8 cm broad, the 2 shorter ones linear, 1–1.2 cm long, 1 cm broad, sparsely provided with greyish scales; nut ovoid, often asymmetric, pale pinkish, greyish sericeous, about 2.5–3 cm long and 2 cm in diameter, about halfway exerted from between the darkbrown

broad bases of the calyx lobes. Stalk about 5 mm long. Trees with smooth or scaly bark with horizontal rings, thin outer bark, dark red-brown corkcambium and thick fibrous reddish-brown inner bark, the pale yellow-ochre to pinkish sapwood exudes abundant resin when trees are being cut; the timber is a Red Seraya. Fresh logs are said to be sinkers, an exception among Red Serayas. The species is in its fruits very similar to *Shorea fallax*. The latter however has more coriaceous, coarser leaves with a more distinctly cordate base and a more distinct recurved margin, and stipules which are brownish not whitish hairy.

Specimens examined:

BORNEO

NORTH BORNEO: Tawau, Kalabakan (A 4107), Apas-Balong (22868, 28687); Lahad Datu, Kalumpang, Bukit Mangkok (25389); Sandakan, Dent Peninsula, Sg. Dagat, base of Quoin Hill (SAN 27838).

The species is quite common near Tawau but has probably for a long time been confused with *Shorea smithiana*; it also occurs in the adjacent Indonesian Borneo. The resinous timber, non-fissured bark, greyish twigs and wingless fruits and leaves with 18 pairs of lateral nerves are suitable diagnostic characters.

***Shorea retusa* W. Meijer nov. spec.**

Shorea subgen. *Rubroshorea*; a *S. parvifoliae* foliis apice obtusis atque domatiis carentibus differt.

Type bb 29715, Muara Tewe, Indonesian Borneo (Herb. Bogor). Plate 9.

Medium-high trees; twigs darkbrown terete, sometimes with cigar galls. Leaves with obovate-elliptic blade, with a retuse apex and cuneate base, 6–8 cm long, and 2.5–4 cm broad; margin slightly recurved; upper surface smooth, drying pale brown, midrib immersed, with 10–12 pairs of lateral nerves; tertiary nerves parallel, faintly visible; lower surface reddish brown; midrib often dark-brown, strongly raised and slightly channelled; lateral nerves pinkish, distinctly raised, ascending along the recurved margin; in the upper half of the leaf sometimes some faint intermediate nerves; tertiary nerves very slightly raised; veins visible with a lens. Petioles slender, about 0.5–1 cm long.

Inflorescences terminal and in the axil of the upper leaves; branches minutely hairy; main branches up to about 10 cm long; secondary branches about 4 cm, the lower each with 3–4 side-branches of about 1.5 cm; ultimate branches with 5–8 flowers. Flowers sessile, about 1 cm long; calyx greyish sericeous; lobes triangular-ovate, about 2 mm long, with fimbriate margin; corolla lobes pale orange-yellow, linear-oblong, about 10 × 3 mm with about 10 nerves, sericeous hairy on the parts exposed in the bud. Stamens 15, in three rows, about 0.75–2 mm long; filaments flat and gradually broadened towards



Plate 9. *Shorea retusa* W. Meijer. a. flowering branch; b. bud; c. flower; d. petals; e. stamens; f. androecium with pistil; g. pistil; h. fruit after bb 29715, Muara Tewe, Indonesian Borneo. Plate prepared at Bogor under supervision of the late Dr. Van Slooten.

the base; anthers ovate; appendage about 2–3 times longer than the anthers, reflexed; pistil about 3 mm long; ovary hairy, gradually contracted at apex in a hairy stylopodium; style smooth; stigma knob-shaped. Fruits about 5 cm long; larger wings up to 1 cm broad. Trees with a deeply fissured darkbrown outer bark; inner bark dull brown or ochre; sapwood yellowish-brown; heartwood pinkish; buttresses rounded, symmetrical; crown with flat branches, with the leaves more or less in one plane.

Specimens examined:

BORNEO

SARAWAK: Kuching, Bako National Park, Telok Tajor coll. Ardzi (SAR 10270, duplicates in KEP, L and KEW), and many other coll. (SAR 9485, 10146, 10268, 10283, 10295); Setapok Forest Reserve coll. Egon (SAR A 0806 dupl. KEP), coll. Abang Muas (SAR S 2273), coll. Jacup (SAR 9833), coll. Bujong (SAR 9455); Kuching, Munggu Unjam Forest Reserve, coll. J. Wyatt-Smith (KEP 79318); Lundu, G. Puch, Forest Reserve (SAR 6237); Bintulu coll. Awang Kenta (SAR 1726).

NORTH BORNEO: Tawau, Kalabakan Forest Reserve, Sandstone ridge near Serudong River (SAN 19569, SAN 21504).

The type (from Indonesian Borneo) was already recognised as a new species by Dr. Van Slooten, on whose instigation a drawing was made which was found among his unpublished manuscripts. A duplicate of it was discovered in the Leiden Herbarium by Mr. P. S. Ashton (in litt.). The plate is so clear that there exist no doubt about the identity of the figured species. The latter belongs to the *Parvifolia* group of *Shorea* Subgenus *Rubroshorea*. The leaves are about the size and texture of those of *S. parvifolia*, but the apex is always retuse.

***Shorea venulosa* Wood ex W. Meijer nov. spec.**

Shorea subgen. *Rubroshoreae*; a *S. coriacea* foliis laevibus, ovato-ellipticis, costa subtus acute carinata, nervis 11–13 paribus differt. Stamina 15; appendices antheras 2½-plo superantibus, apice minute hispidae.

Type: Menggalong Forest Reserve, Sibubu River, Sipitang (SAN 15134 dupl. K, A, L, SING, BO, FNH, FHO, SAR, KEP, BRI, FI). Plate 10.

Medium-sized to large trees. Twigs slender, glabrous, terete, dark brown or almost black. Leaves with rather thinly coriaceous, ovate or ovate-elliptic blade, shortly acuminate at apex and rounded at base, from about 6 × 4 cm up to 9 cm long and 6 cm broad, glabrous, drying shiny reddish-brown or lividly green on upper surface, slightly less shiny red-brown on lower surface; midrib slightly depressed on upperface, prominent and rather sharply keeled beneath; lateral nerves in 8–15, but usually in 11–13 pairs, fine, not prominent, but visible on both surfaces; 1–2 short intermediate nerves often present between the main lateral nerves; domatia sometimes present; tertiary nerves parallel; veins minutely reticulate, scarcely visible to the naked

eye; petiole about 2.5 cm long, drying almost black, rugulose; the upper half frequently thicker than the basal one, bent at the junction.

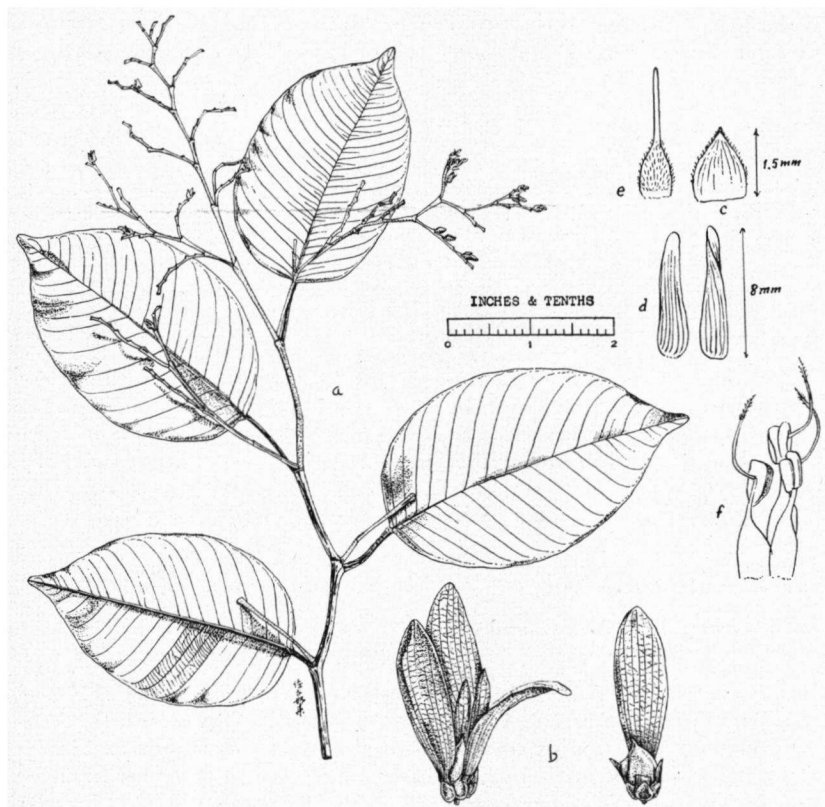


Plate 10. *Shorea venulosa* Wood ex W. Meijer. *a.* flowering branch; *b.* fruits; *c.* sepal; *d.* petals; *e.* pistil; *f.* stamens. *a.* after SAN 15134, *b.* after SAN 16384, *c-f.* after SAR 9486.

Inflorescences terminal and axillary in the axils of the upper leaves; main axis slender, up to 7 cm long, lower part pale brown and finely tomentose, upper part grey with a close short tomentum; branches slender, up to 1.8 cm long, grey with a close short tomentum, with 2-9 flowers, subtended by shortly tomentose, caducous bracts; pedicels about 1 mm, with paired ovoid bracteoles about 6 mm long. Sepals creamy-green, ovate-lanceolate, subacute at apex; the three larger ones about 2 mm long, densely tomentose with stellate hairs on the outside; corolla about 5 mm in diameter; petals linear-oblong 6-7 mm, pale lemon-yellow with about 10 nerves, sericeous tomentose on the parts which are exposed in the bud. Stamens 15; appendages about 2.5 times as long as the anthers, with small bristles at their apex; apex of filament filiform, base broadened; ovary and style about

3–4 mm long, lowermost part of style and ovary hairy; style about 1.5 mm long. Larger wings of the fruit about 6 mm long, up to 1.5 cm broad, strongly narrowed; nut oblong globoid, about 1.8×1 cm, towards the concave base broadened; base of calyx lobes enclosing about one third length of the nut; outer calyx lobes at base with grey scales.

Specimens examined:

BORNEO

SARAWAK: Kuching, Bako National Park (SAR 10252, 10143, 10269); Ulu Serait (SAR 10228); Santubong (SAR 9486); Setapok Forest Reserve (SAR 8933); Selang F.R. (SAR 9413); Lawas, Bukit Butong Rumah (SAR 5633, 5634).

BRUNEI: Bukit Biang (S 5777); Bukit Gelagus, Ulu Batu Apoi (BRUN 324).

NORTH BORNEO: Sipitang Ulu Moyah (SAN 16270); Bukit Sipitang (SAN 15175); Ranau, Proposed Kinabalu National Park (SAN 16359, SAN 16384); Lahad Datu, Mt. Silam (A 295, SAN 16171); Tawau, Serudong (SAN 21507).

Trees occur from sea-level up to about 4000 ft altitude. This species has also been recorded from the Merurong plateau in Sarawak and in North Borneo, Sandakan district from ultrabasic hills near Telupid, Meliau Range, Bidu Bidu Hills (near Sapi), Bukit Tingka and from a swamp forest near Lanas, Ulu Kinabatangan. The timber is a heavy dark Red Meranti (Seraya) of very attractive appearance.

***Shorea waltonii* Wood ex W. Meijer nov. spec.**

Shorea subgen. *Rubroshoreae*; affinis *S. smithianae*, sed cortice interna rubescente, foliisque majoribus nervis 18–22 paribus, subtus saepe albescentibus differt.

Type: North Borneo, Sepilok Forest Reserve, coll. G. H. S. Wood (SAN 16508, dupl. K, A, L, SING, BO, KER, BRI). Plate 11.

Large-sized tree; twigs on the young parts rather densely covered with hairy warts. Buds brown stellate hairy; stipules reddish-brown, large, up to about 2×1 cm, apex acute, with about 6 nerves, covered with circular hairy scales. Leaf blade elliptic to oblong, from about 10×5 cm up to 28×12 cm; apex rounded; base truncate or more usually subcordate; upper face drying olive-brown, slightly hairy along the midrib and sometimes also on the nerves and veins; midrib slightly depressed; lateral nerves in up to 18–22 pairs, flat; tertiary nerves parallel, in fine curved lines; veins numerous and finely reticulate, visible only with a lens; lower face drying brownish or often with a distinct glaucous grey layer; midrib and main nerves prominent, provided with sparse circular, slightly hairy scales; the latter sometimes also on tertiary nerves and veins. Petiole about 2.5–3 cm long, dark brown, finely rugulose and channelled.

Inflorescences and flowers not yet known. Fruits imperfectly known, at least 10×13 cm long; calyx tube about 2 cm long. Trees with fissured boles and stout buttresses; outer bark dark brown; cork-cambium red-brown; inner bark pale red-brown; sapwood pale yellowish-pink; heartwood pink. The timber is a Light Red Seraya of good quality, sometimes used for perahu.

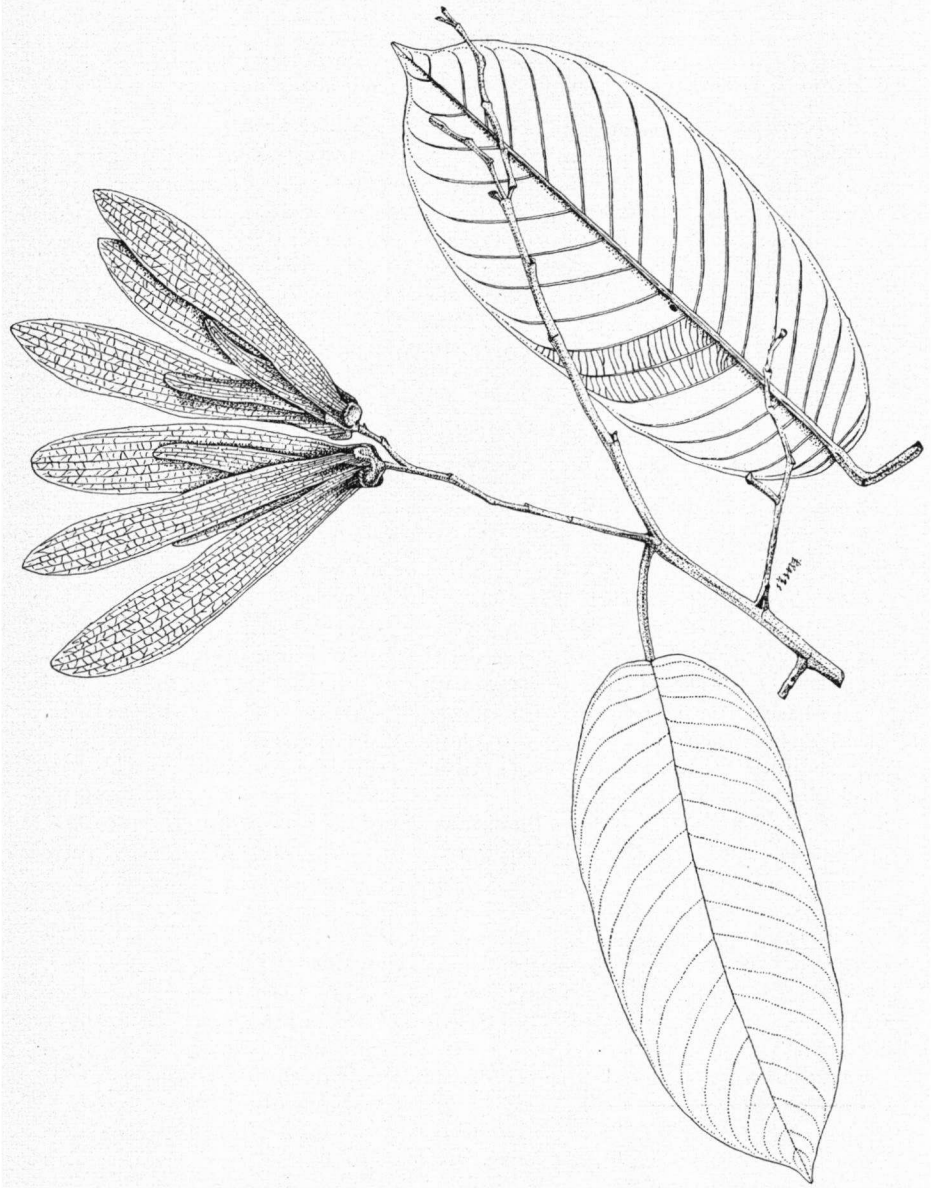


Plate 11. *Shorea waltoni* Wood, fruiting branch and adult leaf. After SAN A 2985 and SAN 16508.

Specimens examined:

BORNEO

NORTH BORNEO: Sandakan, Sepilok Forest Reserve (SAN A 2985, A 3513, SAN 16508, SAN 20601); Sandakan Bay, Bettotan (4396 prewar coll.); Labuk Road, Mile 18 (A 4698); Lungmanis (A 4098, SAN 16249, 16252, 16903, 17596, 17663); Kinabatangan, Supu Forest Reserve, (SAN 23371); also recorded from Gomantong Forest Reserve, Bukit Garam, Tidog and along the lower Sugut River.

This species has often erroneously been reported from other districts in North Borneo. It has, however, a very limited area of distribution in the lowland jungles of Sandakan District. The narrowly related *Shorea smithiana* differs in the more yellowish-brown inner bark and in the leaves with less numerous lateral nerves and with a less distinctly glaucous-grey underside, though they can sometimes also be glaucous.

The species was named by Mr. G. H. S. Wood after Mr. A. B. Walton, Conservator of Forests (1952-1954), who was a great promoter of Forest Botany in North Borneo.

SUBGENUS RICHETIA

***Shorea kudatensis* Wood ex W. Meijer nov. spec.**

Shorea subgen. *Richetia*; affinis *S. faguetianae*, sed cortice magis fissa foliisque crassioribus basi decurrentibus differt.

G. S. H. Wood (SAN 15363, dupl. K, A, L, SING, BO, PNH, FHO, SAR, KEP, BRI, Fl). Plate 12.

Medium-sized trees; branches terete, greyish-brown lenticellate, grooved, dark brown. Leaves with ovate-elliptic blade, about 10-13 × 5-8 cm; apex bluntly acuminate; base cuneate to rounded or slightly subcordate and somewhat decurrent towards the petiole, glabrous, drying olive-green; margin slightly undulate; upper face shiny; midrib prominent, especially at the base, drying pinkish or dark brown; lateral nerves in 6-9 pairs, rather distant, curving acutely upwards towards the margin; tertiary nerves parallel-reticulate, just visible; lower face dull; midrib prominent; tertiary nerves quite distinct.

Inflorescences consisting of panicles which are partly terminal and partly inserted in the axils of the upper leaves; panicles about 15 cm long, with greyish-yellowish stellately hairy branches; main axis with about 10 longer side branches, some of which have shorter branches just below their base; side branches about 1-3 cm long, twice branched, ultimate branchlets curved upwards, with about 3-5 flowers; pedicels about 1.5 mm long; calyx sericeous stellate-scaly hairy, about 1.5 mm long; lobes ovate; corolla lobes contorted, spreading, about 4 mm long, connate at their broadened bases; each lobe with about 5 nerves, apex at one side irregularly dentate; stamens (10-) 15 inserted on the corolla; anthers ovate; appendage about twice as long and in the upper half with short bristles; filaments with a strongly broadened flat base; pistil about 1 mm; ovary ovoid, densely setose; style glabrous, about half the length of the ovary. Fruits: the three larger wings

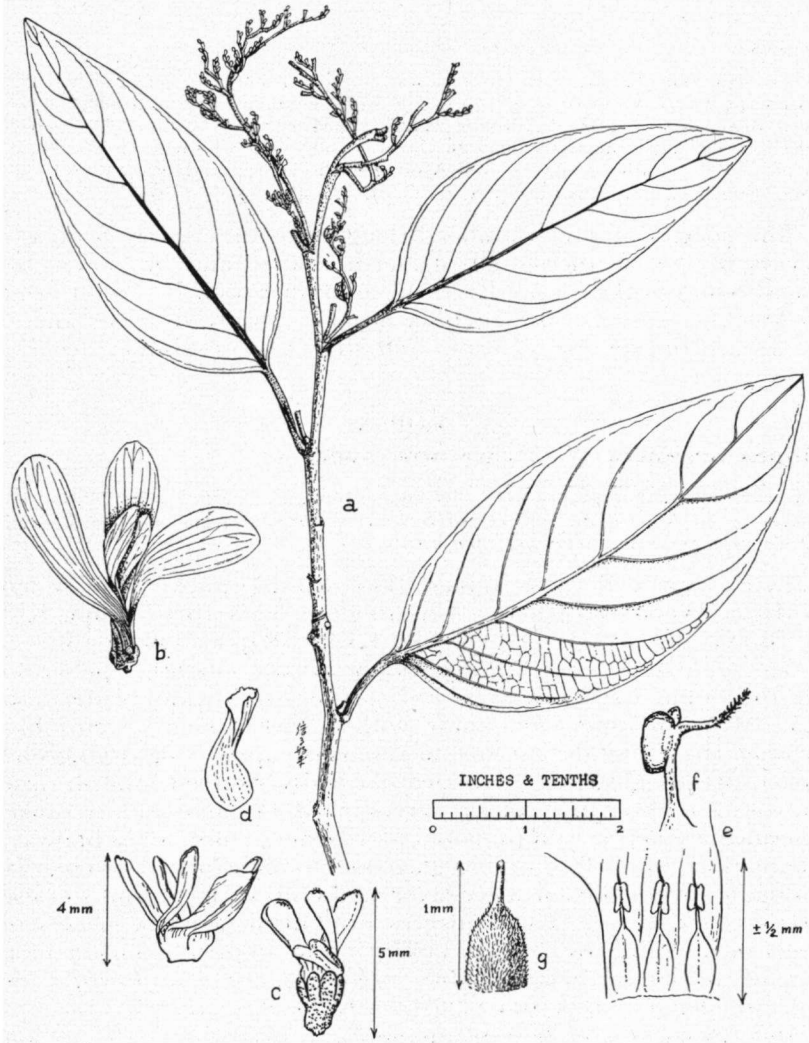


Plate 12. *Shorea kudatensis* Wood ex Meijer. *a.* flowering branch; *b.* fruit; *c.* flower; *d.* petals; *e.* stamens; *f.* anther with filament; *g.* pistil. *a* and *c-g* after SAN 15494, *b* after SAN 15363.

spatulate, up to 5 cm long, 6-nerved; the two smaller wings linear, about 4 cm long, 5-nerved; base of calyx lobes enclosing the nut; nut fulvous-tomentose, oblong-ovoid, about 2×0.8 cm, pointed at apex. Trees with deeply fissured bole and strong buttresses. Outer bark corky, brittle with a dark-brown outer layer and an ochre-brown inner layer; inner bark dull pinkish-ochre; sapwood light yellow.

Specimens examined:

BORNEO

NORTH BORNEO: Kudat, Labuan Forest Reserve (A 3067, A 3074, SAN 19890); Tamalang Forest Reserve (SAN 15552, 15363); Kedayan Forest Reserve (prewar coll., 6222, 6741, 5907); Timbang Batu, 32 Mile S. of Kudat (SAN 16425); Jesselton district, Kimanis-Bongawan (prewar coll. 5905); Kimanis Forest Reserve (SAN 15494); Labuan Island, coll. Motley (115, 116); Sandakan District, along lower Sugut River, Tagahan (SAN 20920).

This species produces timber belonging to the Yellow Serayas. It occurs in the Northern half of North Borneo and has never been found South of the Labuk River on the East Coast. It is most similar to *Shorea faguetiana*, but the bark is more deeply fissured, and the leaves are thicker, more ovate, and they have a distinct decurrent base.

HOPEA

Hopea argentea W. Meijer **nov. spec.**

Cortex distincte fissa; radices tabulatae elongatae, valde prominentes. Folia ovata, nervis principalibus 10-14 paribus, nervis intercalaribus conspicuis, in sicco subtus glauco-viridi, saepe argenteo-lucidula.

Type: North Borneo, Ranau, Hot Spring track, Mile 5, coll. G. H. S. Wood and Charley Charrington (SAN 16367, dupl. K, A, L, SING, BO, PNH, FHO, SAR, KEP, BRI, FI). Plate 13.

Medium-sized trees; branches brownish, slightly puberulous on the young parts. Leaves with rather stiff ovate blade, about $8.5 \times 4-5$ cm; apex acuminate with a rather long (1 cm) blunt acumen, base slightly cuneate to rounded; upper face drying olive-green, slightly glistening, wrinkled like a silver screen; midrib raised, brownish in lower half, lateral nerves in 10-14 pairs, slightly sunken; intermediate nerves well pronounced, reaching more or less halfway to the margin; lower face drying glaucous- to olive-green, covered with the same silvery broken waxy layer as the upper face; midrib raised, drying dark brown; lateral nerves prominent; tertiary nerves and veins only visible with a lens, except near midrib; domatia in the axil of the lateral nerves slightly oblong, hairy, rustbrown. Petiole 1.2 cm, slender, dark brown to nearly black.

Inflorescences and flowers unknown. Fruits about 6.5 cm long; nuts enclosed by the base of the calyx wings, about 12×0.8 cm, gradually pointed at apex; longer wings up to 1.2 cm broad. Trees with coarsely fissured boles, and steep, flat, non fissured, partly flying buttresses. Dammar white. Outer bark corky, brown, thick, laminated with black and brown layers, fibrous; cork cambium creamish or pale ochre; inner bark pale brown, finely laminated; sapwood pale ochre.

Specimens examined:

BORNEO

NORTH BORNEO: Proposed Kinabalu National Park, Ranau, Bukit Kulong, (SAN 24252); Hot Springs track, Mile 5 (SAN 16367, type); Bukit Kulimpisau, South

of Tambuyukon; Bukit Tampurango 2 Miles south of Ranau, (SAN 22095); Tawau, Kalabakan (A. 4049, SAN 22090); also seen in the Proposed Tawau Hill Forest Reserve along Ulu Balong path and on Mt. Andrassy.

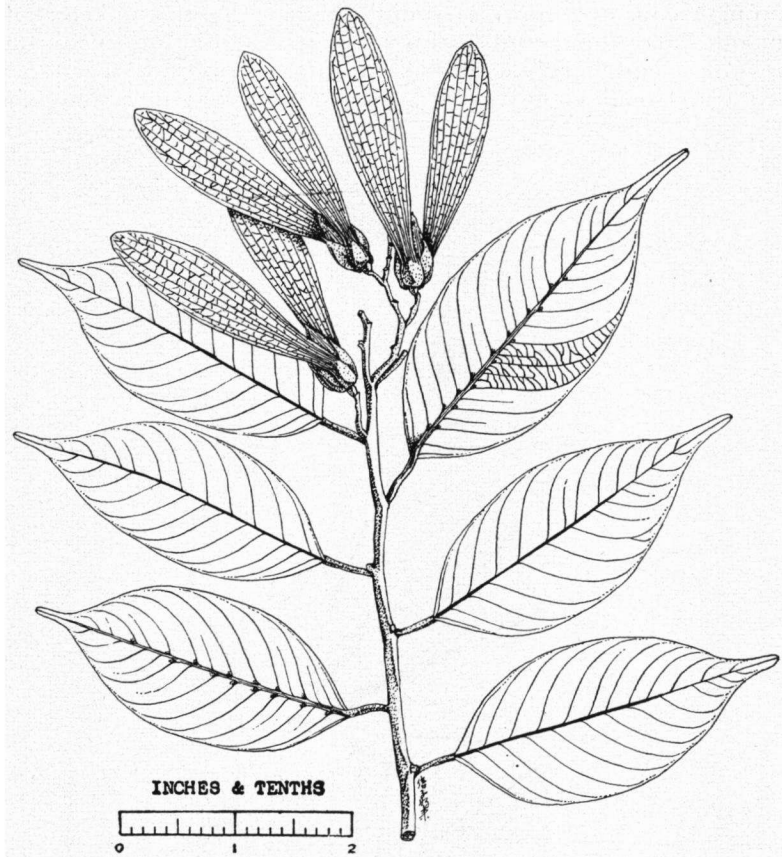


Plate 13. *Hopea argentea* W. Meijer. fruiting branch. after SAN 16367.

This is a tree from the hill and upper Dipterocarp forests. Its distribution is still imperfectly known. The silvery leaves with the very distinct intermediate nerves and the closely fissured bark are good diagnostics.

DIPTEROCARPUS

Dipterocarpus ochraceus W. Meijer **nov. spec.**

Affinis *D. acutanguli* (= *D. tawaensis*), sed cortice rubra haud fissa, fructum alis in tubo calycis margine tenuibus differt.

Type: North Borneo, Proposed Kinabalu National Park, Bukit Kulung near Ranau, 2000 ft (SAN 24200, duplicates in K, L, KEP, SAR). Plate 14.

Large trees; twigs on young parts and buds ochre, sericeous. Leaves with oval-elliptic blade, drying reddish brown, about 10–13 (15) × 5–8 (9) cm; apex shortly acuminate with blunt tip; base rounded to strongly cuneate; upper face dull; midrib slightly sunken, hairy to smooth; lateral nerves in 12–15 (16) pairs, slightly sunken; tertiary nerves and veins hardly visible, seen with a lens they seem to be dotted with small glands; lower face sericeously puberulous when

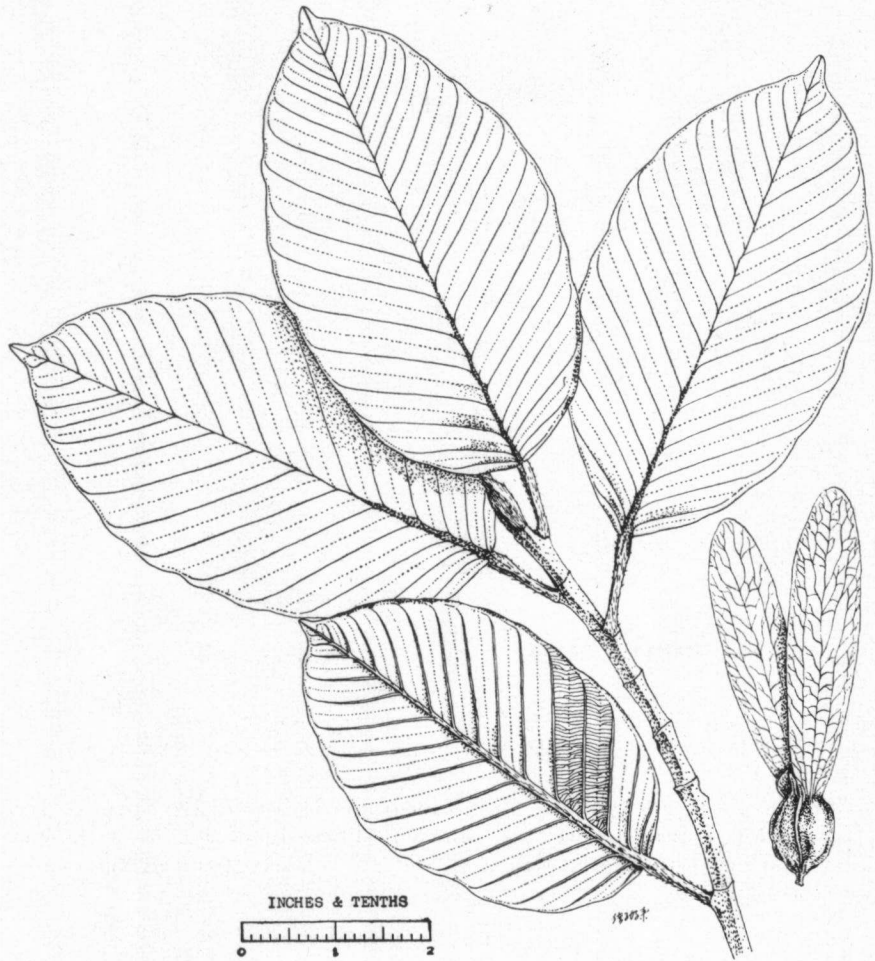


Plate 14. *Dipterocarpus ochraceus* W. Meijer. after SAN 24200, Ranau, North Borneo.

young, hairs persistent on the raised midrib and the lateral nerves; margin undulate, revolute; lateral nerves straight, only bent near margin; tertiary nerves and veins more distinct but still not very conspicuous, with the same glandular appearance. Old leaves more

glistening; lower face less hairy. Petioles 1.5–3 cm, sericeously hairy. Flowers unknown. Fruits about 10 cm long; the 2 larger wings red-brown, up to 1.5–1.8 cm broad, narrowed towards the base; calyx tube purplish red, 2–2.3 × 1.5–1.8 cm, with 5-sharp thin edges which are up to about 2–3 mm broad. Trees with rustbrown boles, bark dippled-scaly, densely covered with lenticels, inner bark and sapwood pale ochre.

Specimens examined:

BORNEO

NORTH BORNEO: Ranau, Bukit Kulong, 2000–2500 ft (SAN 20670, 20678, 20681 and 24200, Type); Bukit Tampurango, 3 Miles S. of Ranau, 2000 ft (SAN 22353, 22371).

This species looks at first sight very similar to *Dipterocarpus acutangulus* (= *D. tawaensis*), but the reddish-brown boles and the fruits are good diagnostic characters. It seems to prefer the upper Dipterocarp forests.

***Dipterocarpus pachyphyllus* W. Meijer nov. spec.**

Affinis *D. lowii*, sed foliis minoribus (5 × 2 usque ad 13 × 5 cm) fructibusque minoribus (c. 15 cm longis) ultro distributione geographica et oecologica differt

Syn: *Dipterocarpus lowii* var. *microphylla* Wood in sched. Type: North Borneo, Padas George near Pangl, coll. G. H. S. Wood (SAN



Plate 15. *Dipterocarpus pachyphyllus* W. Meijer. after SAN 15100, Beaufort, North Borneo.

15100 dupl. K, A, L, SING, BO, FNH, FHO, SAR, KER, BRI, FI).
Plate 15.

Large trees; twigs on the young parts densely covered. Leaves with ovate-elliptic blade, about 5×2 to 13×5 cm, gradually tapering to a rather short acumen; base rounded; margin slightly sinuate, glabrous, drying pale brown on both surfaces; midrib and nerves flat or slightly immersed above, prominent below; lateral nerves in 10–12 pairs; petioles about 2–2.5 cm, glabrous, black when dry. Flowers unknown. Fruits about 15 cm long; wings up to 12.5 cm long and 4.5 cm broad, blunt at apex and rather broad at base; densely crowded undulate ridges on the calyx tube. Trees with a dark brown, shaggy bole; buttresses symmetrical, partly branched; cork cambium pale ochre, slightly lighter than the inner bark; inner bark ochre-brown, brittle; sapwood ochre, after cutting soon exuding resin.

Specimens examined:

NORTH BORNEO: Tawau, Apas-Balong area, especially common on sandy Gading soils (SAN 16473), common in Kalabakan Forest Reserve near Selimpopan River, Dent Peninsula, near Sg. Dagat and Sg. Kapur, rather common in the interior jungles of Sandakan-Kinabatangan area, Sapi Forest Reserve, 16–25 Miles East of Telupid along Labuk Road trace, along Kinabatangan, Supu Forest Reserve (SAN 23370); Batu Kunok near Malubuk, East of Kuamut, Bukit Tingka near Karamuak, (SAN 23546); between Lanas and Tulit East of Keningau, Beaufort Hill (SAN 15053, SAN 16983); Tenom (KEP 80471); Padas George, Pangi (SAN 15100, the type); Sipitang, 3 Miles E. of Malaman (SAN 16433).

This species was first considered to be a small-leaved variety of *Dipterocarpus lowii*. In its outward form and ecology it shows however to be a distinct species. It avoids the ultrabasic areas in which *D. lowii* is often abundant. Not only the leaves but the *fruits* too are consistently smaller than those of *D. lowii*.

SPECIES EVOLUTION AMONG NORTH BORNEO DIPTEROCARPS

Borneo is an ideal country to study the distribution of species belonging to a large tropical family which is still in its more or less virgin structure. Even a small part of the island, like North Borneo, reveals some facts in the distribution of its Dipterocarps which might be of great interest from the point of view of the study of evolution. Besides a number of wide-spread species, there occur some with a very local small area which are to be considered as young species and whose origin from other species is very probably. Older species occur besides their younger offshoots.

Examples are:

“younger” offshoots

Shorea waltonii
 „ *flavescens*
 „ *kudatensis*
 „ *domatiosa*
Parashorea tomentella
Dipterocarpus pachyphyllus

“older” species

Shorea smithiana
 „ *pauciflora*
 „ *faguetiana*
 „ *atrineruosa*
Parashorea malaanonan
Dipterocarpus lowii

In all these cases the younger offshoots find their very limited areas inside the area of their ancestors. Differences between parent and offshoot are small but distinct, and include also small differences in ecological preferences.

It is not possible to explain these cases with any available theory of evolution and of the origin of species. The area where these species occur is now so thoroughly investigated for the distribution of Dipterocarps that only minor adjustments can be expected. We must accept that in one or another way these species found their origin in a mutation arising in a tree of the parent species, and that such a mutation was not blended out by back crosses with the parent.

It is quite remarkable that such young species can still be traced back to their parents by taxonomic study while wider-spread (older!) species often are more isolated from a taxonomic point of view. It seems not impossible that mutations which give rise to sterility barriers between parent and offspring are gradually followed by smaller changes released by the "basic" mutation. The divergences between parent species and offspring would thus become larger. I am aware that this is a very speculative hypothesis but phenomena like a gradual expression of characters are not unknown in genetics, and if this hypothesis is right, it should be possible to check it in one way or another by a detailed study of fossils. The whole pattern of distribution and abundance of Dipterocarps in North Borneo is thus that we must assume that new species have evolved here which started to live side with their "ancestors". There is no indication that competition between species occurred which caused the dying out of species in certain places.

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