

DIPTEROCARPACEAE

(P. S. Ashton, Arnold Arboretum, Harvard University)¹

Small or large *resinous* usually evergreen *trees*, usually buttressed, and often (if large trees) with flaky or fissured bark. Some or most parts with a *tomentum* of fascicled hairs, or sometimes single hairs, unicellular or multicellular glandular hairs, or multicellular, short or long lobed or peltate hairs. *Leaves* alternate, simple, margin entire or sinuate, not crenate, terminating \pm abruptly at the \pm prominent geniculate petiole, penninerved (in *Dryobalanops* and some *Hopea* nerves ∞ , dense and slender), often with domatia in axils between nerves and midrib or along midrib and (rarely) nerves; tertiary nerves scalariform or reticulate. *Stipules* paired, large or small, persistent or fugaceous, leaving small to amplexicaul scars. *Inflorescence* paniculate, racemose, rarely cymose; \pm regularly, rarely irregularly, branched, terminal or axillary; *bracts* and *bracteoles* paired, small or large, persistent or fugaceous. *Flowers* secund or distichous, bisexual, actinomorphic, scented, nodding. *Calyx* persistent, 5-merous; 2-5 sepals usually greatly enlarging into wing-like lobes in fruit; sepals either free to base, imbricate in bud, remaining so or becoming valvate in fruit, or fused at base, forming a cup or tube \pm enclosing the fruit, adnate to or free from it. *Corolla* 5-merous, contorted, base connate or free, usually partially or entirely unicellular hairy. *Stamens* 5-110, 1-3 verticillate or irregular, hypogynous or subperigynous, centrifugal; filaments compressed or filiform, free or connate, frequently cohering with petals on falling; anthers erect, 2-celled with (2-4) pollen sacs, introrse or laterally dehiscent; tapetal cells binucleate, pollen grains 2-celled at anthesis; connective with short or prominent appendage. *Ovary* superior or semi-inferior, 3-, rarely 2-, locular; style \pm thickened at base into a stylopodium, entire or trifid towards apex; stigma obscure or prominent, 3- or 6-lobed. Ovules 2(-3) in each loculus, axile, pendulous or laterally anatropous, bitegmic with ventral raphe and superior micropyle. *Fruit* indehiscent, 1-seeded; with woody pericarp and persistent \pm aliform sepals. Embryo-sac development of *Polygonum* type: endosperm of the nuclear type, embryo development normal, ripe seeds with or more usually without endosperm; cotyledons equal or more usually unequal and with one more or less enclosing the other, laminar or fleshy, entire or lobed, enclosing the radical. Germination epigeal or hypogeal; pericarp splitting irregularly or along 3 sutures.

Distribution. The newly described monotypic genus *Pakaraimaea* MAGUIRE & ASHTON (1977), locally found in the south of former British Guyana, makes the family pantropical, confined to the lowlands and hills of the tropics below 1800 m. Fig. 2. This genus represents a distinct subfamily *Pakaraimoideae*.

The second subfamily, *Monotoideae* is represented in Africa and Madagascar, with some 36 *spp.* of *Monotes* A.DC. and a few species of *Marquesia* GILG (cf. BANCROFT, 1935).

Subfamily *Dipterocarpoideae*, comprising 13 genera and some 470 *spp.* ranges from the Seychelles through Ceylon (where a proportionally large diversification exists) to the south of Peninsular India, and then to East India, Bangladesh, Burma, Thailand, Indo-China, to continental S. China (Yunnan, Kwangsi, S. Kwantung, Hainan) and through Malesia southeastwards to the D'Entrecasteaux Is. off S.E. Papua (not in New Britain and New Ireland), and northwards to the Batan Is. north of Luzon, Philippines.

(1) With some co-operation of the General Editor for the general chapters.

Drawings by Miss R. van Crevel (details) and Mr. J. van Os (habit) were made under supervision of Dr. M. Jacobs.



Fig. 1. Characteristic habit of the large *Dipterocarpaceae* with high unbranched bole and huge dome-shaped crown: *Shorea rubella* ASHTON, from Brunei (Photogr. ASHTON).

Fossils do not significantly extend subfamilial range in Asia and Malesia, but they do essentially so in East Africa. Fig. 2.

In Malesia 10 genera with 386 *spp.* occur, predominantly in the humid non-seasonal areas, absent only from the seasonal area encompassing the Lesser Sunda Is. east of Sumbawa as far as the Tenimber Is.

The local species diversity of these genera is very uneven, with a tendency to decline eastwards, as is shown by the total number of species per island. Fig. 3-4. See also Fig. 19, 28, 43, 65, and 79.

Three of the 10 genera are endemic in Malesia, viz the monotypic genus *Upuna* in Borneo, *Neobalanocarpus* in Malaya (& Pattani adjoining Kelantan in N. Malaya), and the genus *Dryobalanops* (7 *spp.*) on the Sunda shelf (Sumatra, Borneo, Malaya); the 7 others Malesia shares with continental Asia, and Ceylon (except *Anisoptera* and *Parashorea*). A further three are endemic to Southern India, Ceylon and the Seychelles.

Four genera range widely through Malesia and also have species (mostly few) in East Malesia (Celebes, Moluccas, and New Guinea), viz *Anisoptera* (11 *spp.*, 10 in Malesia), *Vatica* (65 *spp.*, 55 in Malesia), *Hopea* (102 *spp.*, 84 in Malesia), and *Shorea* (194 *spp.*, 163 in Malesia).

Of the remaining three *Cotylelobium* (6 *spp.*, 3 in Malesia) is known in Malesia only from the Sunda shelf islands, while *Dipterocarpus* (69 *spp.*, 53 or 54 in Malesia) and *Parashorea* (14 *spp.*, 10 in Malesia) occur on the Sunda shelf islands, but also in the Philippines.

Some of the Malesian genera formerly had in the Tertiary a wider distribution, e.g. *Dryobalanops* occurred in West Java and Southern India, *Dipterocarpus* in N.E. Africa, and *Anisoptera* (now only from Chittagong and Burma southeastwards) in India.

It is noteworthy that there are hardly any clear disjunctions in the generic ranges (apart of course from seas separating adjacent islands), the exception being that of *Cotylelobium*, with 1 *sp.* in Ceylon and further from S. Thailand to West Malesia which stems obviously from extinction. *Vateria* and its close ally *Vateriopsis* are confined to Ceylon and the Seychelles respectively; this huge oversea gap must be ascribed to ancient geomorphological processes.

Species ranges. I have (1972) discussed the relationship between the ecological and geographical ranges of dipterocarps, and speculated on their evolutionary significance. Patterns of Malesian dipterocarp distribution can be summarised as follows:

Widespread species. These form 4 principal categories: (1) The first, those which occur both in seasonal and non-seasonal zones, often tend to be gregarious in the former and occur there on a wider range of substrates; but in the latter they become local, scattered, and confined to deep fertile soils where leaching is least apparent, especially on basic and intermediate igneous rocks, calcareous shales, and around the base of limestone hills. *Shorea assamica*, *S. guiso*, *Dipterocarpus gracilis*, *D. hasseltii*, *D. kerrii* and *Anisoptera costata* serve as examples. — (2) The second category are those of wide West Malesian distribution in the non-seasonal zone, often including the Philippines; these occur on the granite of the Sunda core but spread through the region on other igneous rocks and on the deep clay soils of the shale and phyllite ridges of the great sedimentary geosynclines. — (3) Thirdly are those of freely drained yellow/red soils prone to drought and of moderate to low fertility, mostly of coastal hills and islands though some extend up inland ridge-tops; coastal N.W. Borneo is the present centre of distribution, but a relict distribution which frequently includes eastern coastal Malaya, and less frequently Riouw, Perak (W. Malaya), S. Borneo and rarely E. Sumatra suggests a more extensive former continuity of this habitat. — (4) Lastly are the minority of riparian species, many of which may be of recent origin, being rapidly dispersed by freshwater by means of their floating fruits.

What is said about the coherence of generic ranges holds also for species ranges which rarely show disjunct distributions (*Dipterocarpus retusus*, the continental *D. turbinatus* GAERTN. f., and *Shorea roxburghii* are notable exceptions), though several Ceylon species are vicarious with others in Malesia and similar distant vicarism occurs on either side of Wallace's line.

Endemicity. *Dipterocarpaceae* show a high rate of endemicity in the non-seasonal humid tropics not reflected in the more seasonal parts of their range. Fig. 4. This may be ascribed to their poor fruit dispersal in a windless climate, allowing easy isolation by natural barriers such as quite small river valleys (ASHTON, 1969, 1972), and rapid edaphic specialisation. Endemicity, both local and island-wide, is greatest in New Guinea (73% of 15 *spp.*) and Borneo (59% of 267 *spp.*), and high in the Philippines (46½% of 45 *spp.*); in Sumatra (11½% of 96 *spp.*) and Malaya (19% of 156 *spp.*) it is

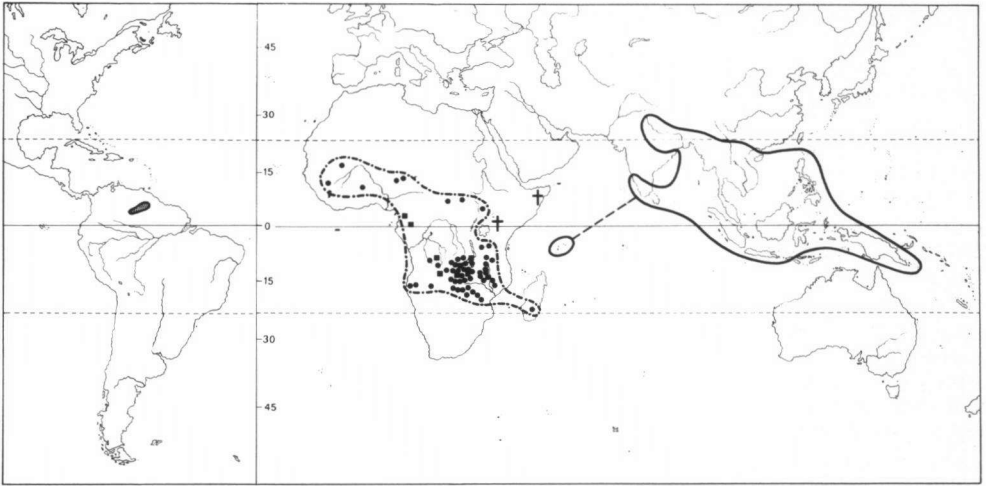


Fig. 2. Range of the *Dipterocarpaceae*: *Dipterocarpoideae* (line and 2 fossil sites in E. Africa), *Monotoideae* (2 genera, Afro-Madagascan, interrupted line, dots *Monotes*, squares *Marquesia*), *Pakaraimoideae* (monotypic genus in northern South America).

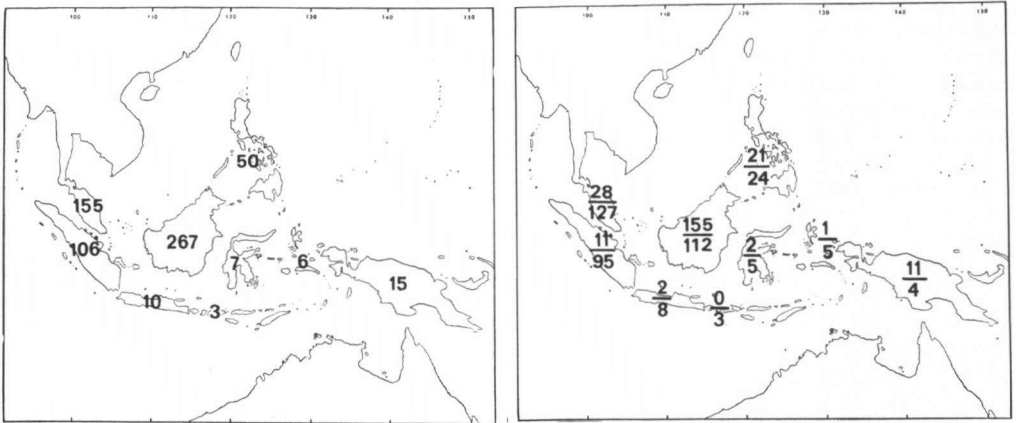


Fig. 3. Density map of *Dipterocarpaceae* in Malesia, total number of species in each island.

Fig. 4. Density map of *Dipterocarpaceae* in Malesia, segregated into endemics (above the hyphen) and non-endemics (below the hyphen).

surprisingly comparatively low. Explanations may possibly be sought in the central position within the Sunda shelf and the relative edaphic uniformity of Malaya and Sumatra, the prevailing archipelagic condition of the Philippines with only intermittent connections with Sundaland during the late Tertiary and Quaternary period, and the youthful physiography and hence edaphic diversity of New Guinea and Borneo. The close proximity of all Borneo to, and frequent absorption into, Sundaland and its central position in western Malesia have probably also led to periodic enrichment by immigration followed by local evolution in ensuing periods of isolation.

Literature: ASHTON, Biol. J. Linn. Soc. 1 (1969) 155; Proc. 2nd Aberdeen/Hull Symp. Mal. Ecol.

(1972) 35; BANCROFT, *Am. J. Bot.* 22 (1935) 511, f. 1 (map); MAGUIRE & ASHTON, *Taxon* 26 (1977) 341.

Fossils. Fossil data of the family have been surveyed by R.N. LAKHANPAL (1974). Fossil wood and leaf impressions which have been identified with the *Dipterocarpaceae*, and which anatomically apparently differ little from present day genera, have been recorded from both East Asia and Africa. The winged specimens, apparently fruits, called *Calycites*, from the Upper Cretaceous strata of the east coast of the United States, and compared by BERRY (1914) to *Dipterocarpaceae*, and *Woburnia*, a similar structure from the Lower Cretaceous of Bedfordshire (England) similarly compared by STOPES (1912) are both considered by BANCROFT (1933) to be too incomplete for determination. SCHWEITZER (1959) who studied and surveyed the records of fossil wood of *Dipterocarpaceae* considered, however, that the *Woburnia* wood is distinctly Dipterocarpaceous and does not differ very much from recent woods. WOLFE *c.s.* (1975) correctly pointed out that on the *Woburnia* site no other samples could be found and concluded, it seems correctly, that the specimen must have been mislocalised.

RASKY (1956) claimed to have found a flower in the Upper Miocene of Budapest, referred to *Monotes* (CHANDLER, 1964: 81). WEYLAND (1964) mentioned that fruit fragments from the Oligocene of the Zevengeberge and the Miocene of Oehningen would belong to the fossil *Monotes macranthus* (HEER) WEYLAND. KIRCHHEIMER (1957) was earlier of the opinion that these remains are too inadequate to warrant inclusion in *Monotoideae*. The only authenticated fossil fruit is that of *Dipterocarpus verbeekianus*, recorded by HEER (1874, 1883) from the Tertiary in Sumatra.

Leaf impressions. HEER (*l.c.*) recorded *Dipterocarpus* leaf impressions from the Tertiary in Sumatra; later authors have confirmed his conclusions. CRIÉ (1888) recorded Pliocene leaf impressions of a possible *Dipterocarpus* from Java, while SCHUSTER (1911) identified Pleistocene Javanese impressions as *Hopea fagifolia* (*H. sangal*) and *Vatica lanceaefolia* BL. EDWARDS (1923) recorded the modern Philippine species *Anisoptera thurifera*, *Shorea guiso* and *S. polysperma* from the Pliocene in Luzon. The records of dipterocarp leaves from the Tertiary of Labuan, North Borneo by GEYLER (1887) are not considered by BRANDIS (1895) or EDWARDS (*l.c.*) to merit inclusion. WOLFE (1972) claimed to have found an Eocene (para-)tropical flora in Alaska, in which also leaf impressions of *Anisoptera* occurred. Such a geographically remote record must require substantiation by more unequivocal material.

Wood. KRÄUSEL (1922, 1926) has recorded undoubted dipterocarp woods from the Tertiary (claimed then to be Miocene) of southern Sumatra and West Java, which have been associated by DEN BERGER (1923, 1927) with *Shorea* and *Dryobalanops*, his *D. spectabilis* and *D. javanica* being the only records of that genus from Java. KRÄUSEL's *Caesalpinioxylon palembangense* is considered by DEN BERGER, and later KRÄUSEL himself, to be *Shoreoxylon*. *Dipterocarpoxyton annamense* of COLANI (1919), from the Tertiary of Annam, is only tentatively accepted by EDWARDS. The specimen of *Dipterocarpoxyton* described by HOLDEN (1916) from Burma possesses uniseriate rays, unlike all Asiatic genera, and does not bear secretory canals throughout the wood; hence the identity is insufficiently grounded, but PRAKASH (1973) has subsequently confirmed the fossil genus from Burma. *Shoreoxylon* has been identified from the Tertiary of Assam by EYDE (1962), while Miocene fossil woods from the east coast of Southern India have been identified by NAVALE (1962) as *Anisopteroxyton*, *Dipterocarpoxyton*, *Hopeoxylon*, and *Shoreoxylon* and by him and AWASTHI (1971) as *Dryobalanoxylon*. Fossil wood from Quaternary sites, *c.* 10,000 years old, from the Siwalik hills, N. India, and from W. Bengal have been identified with *Anisoptera* by GHOSH & GHOSH (1958), and GHOSH & KAZMI (1958).

SCHWEITZER (1959), who made a major study of fossil wood of *Dipterocarpaceae*, gave maps of fossil sites. It is interesting that he identified fossil wood from Timor as *Shoreoxylon* — an island where the family does not now occur — and that he recorded *Dryobalanoxylon* from several places where the genus is at present absent, *viz* Cambodia, S. Sumatra, W. Java, and Ambon in the Moluccas.

It is agreed that no fossil wood is found older than the Miocene.

Pollen. J. MULLER's studies of pollen (1970) indicate that the thin walls do not preserve well, and the lack of distinctive sculpturing or other diagnostic characters combines to limit their value in the fossil record. It is noteworthy that he found the pollen percentage proportionally always low, even in stands on peat completely dominated by *Shorea albida* where it comprised only a few percent.

This is against expectation, and the reason is unclear. MULLER suggested that much pollen is devoured by thrips, but then the persistent exines should be found.

CHANDLER (1964: 36) mentioned (with a question mark) Oligocene pollen from the London Clay Flora, but she appeared far from assured of this identification as she remarked later (*l.c.*: 56) that she found the apparent absence of Dipterocarpaceous fossils strange. The identity of the pollen record (by MA KHIN SEIN) is very much doubted by J. MULLER.

MULLER (1964) found pollen of *Dipterocarpus* and *Dryobalanops* in the Tertiary of Borneo (Brunei), the first genus being represented from the Oligocene (MULLER, 1970), the latter from the Miocene.

The fossil record of *Dipterocarpaceae* in Asia and Malesia rests therefore on the wood fossils of several genera in India and West Malesia from the Tertiary (mostly Miocene and later) and the pollen records of the same age, but also on the presence of pollen of *Dipterocarpus* already in the Oligocene of Borneo.

Northeast African fossils. Fig. 2. In 1933 BANCROFT described *Dipterocarpoxyylon africanum* from the Tertiary beds near Mt Elgon (Kenya). In the same year CHIARUGI described three species of *Dipterocarpoxyylon* from the ?Plio-Pleistocene beds of Somaliland which SCHWEITZER (1959) later considered to be identical with *D. africanum* BANCROFT. The fossil woods collected by WEYLAND (1964) from the volcanic tuffs of Mt Elgon, of uncertain date but probably of late Tertiary and pre-Pleistocene times, also undoubtedly represent dipterocarp material and must be associated with the Asiatic subfamily and show strong evidence of being congeneric with *Dipterocarpus*, supporting CHIARUGI's identification. In 1935 SEWARD had described a few leaf impressions from the Nubian sandstone of Egypt as *Dipterocarpophyllum humei* and *D. zeraibense*; the age of the strata being uncertain but probably Tertiary. Finally LAKHANPAL (1974) mentioned that Prof. Y. LEMOIGNE had told him that he had found a dipterocarp wood in an Upper Tertiary deposit in Ethiopia to be described in a future paper.

Concluding, it is clear that *Dipterocarpoideae* were present in East Africa at least in the Upper Tertiary. It is difficult to imagine that they would have been derived from the Indian subcontinent, as according to geophysical theory this rafted block of land had by then hardly joined the Asian plate while, moreover, *Dipterocarpus* could hardly have migrated through the desert zones of S.W. Asia. Thus, even the poor fossil record presents formidable implications. The alternative is that *Dipterocarpoideae* were already earlier represented in N.E. Central Gondwanaland. It is a pity that the older fossil record in S.W. Asia and N.E. Africa is so scant, as this area is vital for understanding exchange of the Gondwana element and tropical S.E. Asia.

Literature: AWASTHI, Palaeobotanist 18 (1971) 229; BANCROFT, Føren. Førhøndl. 55 (1933) 59; Am. J. Bot. 22 (1935) 164; DEN BERGER, Verh. Geol.-Mijnb. Gen. Ned. & Kol. 7 (1923) 143; Bull. Jard. Bot. Botz III, 8 (1927) 495; BERRY, U.S. Geol. Surv. prof. paper (1914) 84; BRANDIS, J. Linn. Soc. Bot. 31 (Nov. 1895) 243; CHANDLER, London Clay Flora, Suppl. London, 1961, The Lower Tertiary Floras of Southern England. IV. Summary & survey of findings in the light of recent botanical observations (1964) 36, 56; CHIARUGI, Palaeontographica Hal. 32, n. 1 (1933) 106; COLANI, Bull. Serv. Géol. Indochine 6, n. 3 (1919) 2; CRIÉ, Samml. Geol. Reichsmus. Leiden I, 15 (1888) 1; EDWARDS, Geol. Mag. 60 (1923) 159, 409; EYDE, Palaeobotanist 11 (1962) 115; GEYLER, Vega-Exp. Vetensk. iskttagelser 4 (1887) 473; S.S. GHOSH & A.K. GHOSH, Sci & Cult. 24 (1958) 238; S.S. GHOSH & KAZMI, Sci. & Cult. 23 (1958) 485-487; HEER, Abh. Schweiz. Palaeontolog. Ges. (1874); Neue Denkschr. Allg. Schweiz. Ges. Gesammt. Naturw. 28 (1883) 1; HOLDEN, Rec. Geol. Surv. India 17 (1916) 47; KIRCHHEIMER, Die Laubgewächse der Braunkohlzeit (1957) 432; KRÄUSEL, Verh. Geol.-Mijnb. Gen. Ned. & Kol. 5 (1922) 231; Proc. Kon. Ak. Wet. A'dam, sect. sc., 25 (1922) 9; Leid. Geol. Meded. 2, n. 1 (1926) 1; LAKHANPAL, Birbal Sahni Inst. Palaeobot. Spec. Publ. 1 (1974) 30-39; MULLER, Abstr. 10th Int. Bot. Congr. Edinb. (1964) 271; Biol. Rev. 45 (1970) fig. 5 facing p. 435; NAVALE, Palaeobotanist 11 (1962) 66; PRAKASH, Palaeobotanist 20 (1973) 48-70; RASKY, Fossil plants from the marl formation of the environs of Budapest; Földt. Közl. Budap. 86 (1956) 167-179; SCHUSTER, Abh. K. Bayer. Ak. Wiss. M.-Ph. Kl. (1911) 25; SCHWEITZER, Palaeontographica 105B (1959) 1-66; SEWARD, Leaves of Dicotyledons from the Nubian Sandstone of Egypt; Min. Finance Surv. Dept. Egypt (1935) 1-21; STOPES, Phil. Trans. R. Soc. B 203 (1912) 75; WEYLAND, Lehrbuch der Paläobotanik ed. 2 (1964) 455; WOLFE in Graham (ed.), Floristics and Paleofloristics of Asia and Eastern North America (1972) 207-208, pl. 3, f. 3; WOLFE *c.s.* Ann. Mo. Bot. Gard. 62 (1975) 819.

Ecology. *Overall range.* Confined to tropical climates with a mean annual rainfall exceeding 1000 mm, and/or a dry season of less than 6 months. Most species do not occur above c. 1000 m where an important floristic transition occurs; a few are \pm entirely confined above 700 m. Above 1500 m records are spurious: a *Shorea* sp. in N. Sumatra at 1700 m and *Hopea beccariana* BURCK in Brunei at 1750 m. The subfamily geographical range is divisible into three climatic zones:

Savanna zone. A limited number of Indo-Burmese species are fire-tolerant: *Shorea robusta*, the Indian Sal, *S. roxburghii* and the Indo-Burmese *S. obtusa*, *S. siamensis*, *Dipterocarpus obtusifolius*, *D. tuberculatus* and *D. intricatus*. They are distinguished by their thick bark (the latter 3 are the only fissured members of their genus) and are the only dipterocarps to be deciduous for a more or less prolonged period during the dry season. They form single species or codominant stands on the well-drained plains, and dry hills (occasionally to 1400 m) of Central and East India, Burma, Thailand and Indo-China. Generally the fire-climax savanna woodlands (Dry Dipterocarp forests of CHAMPION, 1936) in which they occur grow on infertile, yellow skeletal hill soil and laterite bearing red soils in the plains in areas with less than 2000 mm mean annual rainfall and 3–5 months dry season; these forests do not exist in Malesia, but *Shorea siamensis* and *Dipterocarpus obtusifolius* occur, on dry rocky headlands and old secondary forest (schima-bamboo forests of SYMINGTON, 1943) respectively in Perlis, N.W. Malaya, where there are regularly 1–2 consecutive dry months at the end of each year. In the foothills of the sandstone mountains of Arakan and southern Cambodia the Dry Dipterocarp forests themselves extend, probably following the advent of man-induced fire, into areas with a dry season of but 1–2 months and more than 2000 mm rainfall, on porous yellow podsolic sands; here they are floristically impoverished, and of the dipterocarps only *D. intricatus* and *D. obtusifolius* remain. They flower annually shortly before, during, or after leaf fall during the dry season, and the ripe fruit fall after the coming of the following rains. Regeneration is abundant in disturbed forest; the saplings are cut back annually by fire and drought, the roots often becoming deep and extensive before a permanent leader is established. Mature trees sucker readily in response to damage. At the more humid climatic and edaphic ends of their range these species become more shortly deciduous or evergreen.

Malesian species occurring in the seasonal evergreen forest zone (there are three categories, species of wide distribution, *i.e.* occurring in both seasonal and aseasonal evergreen forest, species confined to seasonal forest marked with *, and species occurring on drought-prone sites in the aseasonal tropics marked with +):

ANISOPTERA	<i>ferrea*</i>	<i>farinosa*</i>
<i>costata</i>	<i>forbesii*</i>	<i>gratissima*</i>
<i>scaphula*</i>	<i>glabrifolia*</i>	<i>guiso</i>
<i>thurifera</i>	<i>gregaria*</i>	<i>henryana*</i>
COTYLELOBIUM	<i>griffithii</i>	<i>hypochra*</i>
<i>melanoxylon</i>	<i>helferi*</i>	<i>laevis</i>
DIPTEROCARPUS	<i>iriana</i>	<i>montigena*</i>
<i>baudii*</i>	<i>malibato</i>	<i>negrosensis</i>
<i>costatus*</i>	<i>novoguineensis</i>	<i>palosapis</i>
<i>dyeri*</i>	<i>odorata*</i>	<i>polita</i>
<i>gracilis</i>	<i>pedicellata</i>	<i>polysperma</i>
<i>grandiflorus*</i>	<i>philippinensis</i>	<i>roxburghii*</i>
<i>hasseltii</i>	<i>pierrei*</i>	<i>selanica*</i>
<i>kerrii*</i>	<i>plagata</i>	<i>siamensis*</i>
<i>littoralis*</i>	<i>sangal</i>	VATICA
<i>obtusifolius*</i>	<i>ultima*</i>	<i>bantamensis*</i>
<i>philippinensis*</i>	PARASHOREA	<i>cinerea*</i>
<i>retusus</i>	<i>malaanonan</i>	<i>flavovirens*</i>
HOPEA	<i>stellata*</i>	<i>lowii</i>
<i>acuminata</i>	SHOREA	<i>mangachapoi*</i>
<i>bilitonensis*</i>	<i>assamica</i>	<i>odorata</i>
<i>cagayanensis*</i>	<i>contorta</i>	<i>pachyphylla*</i>
<i>celebica*</i>	<i>falcifera</i>	<i>rassak</i>

Seasonal evergreen forest zone. The vast majority of dipterocarps are therefore confined to areas where the mean annual rainfall exceeds 2000 mm. The presence of even a short but regular dry season, which in N.W. Malaya, for instance, hardly exceeds a month, has a profound influence on both number and kinds of species present. 62 Malesian species occur where there is a regular season of at least one month with less than 100 mm rainfall, 25 appear to be confined there, and a further 9 extend into the aseasonal zone only on sandy, coastal and skeletal ridge soils prone to water stress; these figures exaggerate the species diversity of dipterocarps in any one region, for all but 7 of the species occur in only one of the three Malesian seasonal regions: the north-west of the Malay Peninsula and northern Sumatra, seasonal parts of the Philippines, and the Moluccas and New Guinea. The relative floristic poverty of dipterocarps in seasonal evergreen forest is reflected in the flora in general: STAMP (1925) cited merely 'at least 1000 tree species' in these forests in all Burma; an estimated 400 species occur in the seasonal evergreen forests on the southern flanks of the Cardamom mountains in southern Cambodia; by contrast 2,500 occur in the non-seasonal parts of lowland Peninsular Malaya. No estimates of the total species diversity of the seasonal evergreen forests in Malesia exist. Such areas are widespread in the Philippines, S. Celebes, some local parts of the Moluccas, and S. New Guinea. It is noteworthy that no fire-resistant or deciduous species of dipterocarps occur in Malesia, such as are known from certain tracts in continental S.E. Asia with Dry Dipterocarp forest.

East of Sundaland the dipterocarp flora becomes increasingly impoverished. See Fig. 3, 4, 19, 28, 43, 65, and 79. The fact that even in the non-seasonal New Guinean lowlands only a single section of *Hopea* has undergone an ebullition of speciation suggests that the poverty of dipterocarp species east of Wallace's line is in part due to probably geologically recent immigration there; clearly Makassar Straits must have been a formidable barrier, although it is, at its narrowest point only a mere 125 km wide, and southwards not exceeding 275 km. Two features underline this: firstly that Borneo possesses over 250 species and Celebes only 8, which can never be ascribed to climatic difference between Borneo and Celebes; secondly, of these 8 species there are 2 endemic (*Hopea celebica* and *Vatica flavovirens*), 2 are shared with the Moluccas (*Hopea gregaria*, *Shorea montigena*); *Shorea assamica* is a wide, from Assam to Malaya and Sumatra, with *ssp. philippinensis* in the Philippines, and *ssp. koordersii* in Celebes, the Moluccas and Philippines, and some doubtful sterile specimens in S.E. Borneo (represented in aseasonal parts of Borneo by the vicariant *S. agamii*); *Anisoptera costata* ranges from Burma to Borneo and Mindanao (one record); *A. thurifera* occurs in the Philippines, Celebes, Moluccas, and New Guinea; the last, *Vatica rassak*, ranges from Borneo to New Guinea, but is also found in the Sulu Archipelago joining Borneo and the Philippines just north of Celebes. None of these species which occur both west and east of Wallace's Line is not also found in the Philippines, suggesting that they spread along the Philippines over Wallace's Line and avoided Makassar Straits by marching northwards around it. In the south a single species, *Dipterocarpus retusus* transgresses Wallace's Line from Bali through Lombok to Sumbawa; if the fossil record of *Shorea* in Timor is correct too, a southern route eastwards via Java and the Lesser Sunda Islands, avoiding Makassar Straits, might also be imagined.

The tendency towards gregariousness persists into the seasonal evergreen forest zone, but is there more pronounced on impoverished soils and in areas probably colonised in geologically recent times. An example of the former are the *Dipterocarpus costatus* dominated forests on the impoverished sandstone soils of Arakan and southern Indo-China; this species also occurs between 700–1100 m in the mountains of S.E. Asia, but in non-seasonal Malaya ceases to be gregarious. This differential in gregariousness occurs also with several other widespread species, including *Anisoptera costata*, *A. scaphula*, *A. thurifera*, *Dipterocarpus gracilis*, *Shorea assamica*, *S. contorta*, *S. guiso*, and *S. hypochra*. In eastern Malesia several species are gregarious (see VAN SLOOTEN, 1952). The majestic stands of *kayu bapa* (*Shorea selanica*) on the hills of Buru below 1000 m and on the Sula Is. are celebrated. *Shorea assamica ssp. koordersii* is gregarious in Celebes, the Sula Is. and Obi; *S. montigena* becomes locally gregarious in Buru; *Anisoptera thurifera* is gregarious both in the seasonal zone of the Philippines and in New Guinea where it is grouped along the crests of steep-sided ridges below 800 m over large areas; in New Guinea *Hopea forbesii* is also often gregarious in the south-east.

Dipterocarp populations in these seasonal evergreen forests flower more or less regularly annually too, from November to March in the Indo-Burmese region including N.W. Malaya (e.g.

BURGESS, 1972) and also the Philippines. Flowering, and even more fruit set, is heavier in some years than others; not all individuals flower; in Thailand less than half the trees in a stand that are of flowering age normally flower in any one season and a minority of these flower in two consecutive seasons (SMITINAND's and personal observations). The developing fruit are much infected by beetle larvae while parakeets favour the ripe fruits. In *Dipterocarpus* many seasons may consequently pass without a single seedling becoming established. Germination is immediate on falling. Several species are shortly deciduous in seasonal evergreen forests including some, such as *Dipterocarpus gracilis* and *Anisoptera costata* which are evergreen in non-seasonal western Malesia, but none are deciduous for a prolonged period.

Mountains higher than 1000 m along the coasts and around the head of the great valleys of the seasonal Far East, even at latitudes higher than the normal range of lowland evergreen forests, collect cloud and comparatively humid though still seasonal conditions prevail on their slopes. The species occurring at these latitudes in the Indo-Burmese region and Java, *Dipterocarpus costatus*, *D. gracilis*, and *D. retusus*, occur also in the mountain forests of Malaya.

Non-seasonal humid zone. As this is the zone to which the great majority of Asian, including Malesian, dipterocarps are confined a review of the biological characteristics of the family here must prelude considerations of climatic and edaphic ranges of the species and their overall role in the forest communities.

Reproductive biology. A most important characteristic of the family in the non-seasonal zone is its flowering behaviour. Flowering does not occur annually, but at \pm irregular intervals and then of varying intensity though gregariously, species from most or all genera flowering in a single season (this includes those species that occur, and flower annually, in seasonal evergreen forests) (WOOD, 1956; McCCLURE, 1966; MEDWAY, 1972; COCKBURN, 1975). In a heavy flowering nearly all species in an area may flower, and the majority of individuals; more frequently probably less than half the individuals flower, though critical observations of this kind have only been made by BURGESS in the semi-gregarious species *Shorea curtisii* (1972). Gregarious flowering may occur in a single river valley or throughout a region as large as N.E. Borneo. The 1955 general flowering in Sabah was observed by WOOD, when over 2/3 of the 200 species then known in that state were collected fruiting, and when the only area not to experience a general flowering was the extreme south-east. His description summarises the main features seen in dipterocarp flowerings elsewhere in this zone. All genera flowered concurrently over a period of a few weeks in a single area, though there was a slight delay west of the Crocker range compared with the east, and one of as much as two weeks towards the upper altitudinal limits both in exclusively montane species (some of which flowered poorly or not at all) and in species of wide ecological amplitude. At the height of the flowering in Sepilok Forest Reserve, Sabah, 'the ground appeared to be carpeted in snow and the scent of the flowers pervaded the jungle'. Detailed observations showed great variation in the period during which anthesis occurred between closely related species; in some sections of *Shorea* it continued over a period from May until as late as August in the lowlands and November in the mountains. ASHTON (1969) observed that anthesis of individual species in *Shorea sect. Richetioides* in Andulau Forest Reserve, Brunei hardly overlapped, being sequential through the flowering season. CHAN & APPANAH (1980) have demonstrated, by meticulous phenological study of numbered wild trees, that species which flower early do so within 15 days, but flowering of the last species is over a period of 25 days. WOOD also observed that some, such as *Dryobalanops lanceolata*, flowered heavily over a short period, whereas in the taxonomically isolated *Shorea smithiana* anthesis occurred over a very long one; in *S. curtisii* stands it may continue over several months (BURGESS, 1972). Among the main canopy and emergent species WOOD noted that flowering was general and heavy over the whole crown, but in understorey species of e.g. *Hopea* and *Vatica* flowering was more sporadic and often restricted to a few branches. Young trees of canopy species do not flower at all until their sympodial crown is developed in direct sunlight. WOOD found that some species failed altogether to flower, several of which in *Parashorea* and *Vatica* were known to have flowered the previous year. It was of particular interest that, of the species that did not flower, the majority were either montane or in the peat swamps. In the latter habitat, mostly confined to the west coast, no dipterocarp flowered. From forestry records over many years and personal observations of flowering periodicity in *Shorea curtisii* and related species BURGESS concluded that local flowering is more frequent than generally supposed, and this has been supported by others (e.g. ASHTON *et al.*, 1979), though fruit set rarely

occurs following a minor flowering. Closely related species differ in flowering periodicity. *Dryobalanops aromatica* and *Shorea leprosula* populations, for instance, flower on average once every two years, while *S. parvifolia* flowers only half as frequently and the important hill forest species *S. curtisii* and *S. platyclados* at intervals not exceeding five years. In *Dryobalanops aromatica* and *Shorea curtisii* local flowering can be found somewhere in Malaya almost every year and sometimes occurs in two successive years in one area; this has also been observed in *Shorea sect. Pachycarpae* in West Sarawak (e.g. SMYTHIES, 1958). BURGESS observed that individual trees of *Shorea curtisii* do not, as a rule however, flower in two successive flowerings. He also observed that in *S. curtisii* the flowering in 1968 could be subdivided into two almost distinct periods during which two separate sets of individuals within a single gregarious population flowered. Planted dipterocarp trees, and trees in forests previously selectively felled, flower more frequently, and generalisations about dipterocarp flowering in natural conditions which are derived from observations on such trees can be misleading (e.g. SASAH *et al.*, 1979). *Vatica rassak* and *Shorea macrophylla* flower almost annually in the arboretum of the Forest Research Institute at Kepong (Malaya) as apparently do several species at Bogor and a *Shorea stenoptera* provenance in a remarkable trial plantation nearby in W. Java, in which all plants are said to have been derived from a single tree near Pontianak that was well known for its annual flowering.

Emergent species probably take many years to reach flowering age under forest conditions. At Kepong cultivated saplings of *Dipterocarpus oblongifolius* have flowered after only 7 months (KOCHUMMEN, 1961), but fruit was not set and cultivated trees there normally started flowering after 15–30 years (NG, 1966). TANG (1978) has recorded young trees of *Shorea leprosula*, growing following selective felling, to set viable fruit after 7 years.

The cause of flowering remains obscure. It can occur between March and July, with a peak in May, in Malaya and East Borneo; but a month or two later on average in N.W. Borneo. Both WOOD and BURGESS have shown that the commonly held belief that general flowerings follow a period of abnormal water stress is not consistently supported by data from rainfall stations; nevertheless the fact that many other families (e.g. *Burseraceae* and *Sapotaceae*) also flower unusually heavily in a good dipterocarp year (e.g. MEDWAY, 1972), indicates that an undefined climatic factor must be involved. PALMER (1979) rightly pointed out that the climatic trigger must be easily observable outside the forest as its effects are regional. NG (1978) has suggested that flowering may be initiated by a period of high irradiation. WYCHERLEY (1973) demonstrated highly significant statistical correlation between gregarious flowering of dipterocarps and preceding periods with both large diurnal temperature ranges and high maximum temperature indicating high insolation; he deduced that the latter is probably the main inductive factor, and this view is also supported by NG (1978). Heavy flowerings never occur in successive years. It appears possible therefore that accumulation of assimilates, including carbohydrates within the trees, takes place gradually following a flowering, so that in each subsequent year the threshold, over which the climatically induced trigger is effective, becomes lower until the combination of an adequate assimilate level and adequate climatic stimulation induces formation of inflorescence primordia; the intensity of flowering may thus be related to the degree to which the threshold is exceeded. Differential rates of inflorescence and flower development among the species leads to spacing in the periods of anthesis of individual species.

Pollination. No reference occurs in the literature. Meliponid bees (*Trigona spp.*) are, according to BURGESS, abundant in the crowns of flowering *Shorea curtisii* and other Malayan dipterocarps; CHAN & APPANAH (1980) have found them to be principal pollinators of *Dryobalanops* and *Neobalanocarpus*; as they are short distance foragers that tend to keep to a single crown, and as they are glabrous or sparsely hairy and very efficient at cleaning themselves, they are unlikely to be effective pollinators of trees that present many flowers at a time (D. H. JANZEN, comm.). SMITINAND reported to me that honey bees are abundant round *Dipterocarpus* crowns, but they have not been observed on the flowers of other genera. Thrips (*Thysanoptera*) frequent the flowers of many *Shorea* and *Hopea* (personal obs.; CHAN & APPANAH, 1980) and are undoubtedly pollinators. Geometrid moths and beetles visit some dipterocarp flowers at night, but have not been demonstrated to effect pollination. The very large numbers of flowers on each tree, and the spatial isolation of the understorey species, may be expected to lead to rarity of outcrossing; the infrequency of flowering and its intensity would tend to prevent vector numbers from reaching adequate levels for effective pollination even were they polylectic (promiscuous).

Fruiting. Perhaps as a result of these problems of pollination, few fruit develop on each many-flowered inflorescence, and in some years none, though heavy rain following anthesis is also generally regarded as disastrous (SMYTHIES) and the main determinant of a successful crop. The fruit are heavily parasitised by weevils of the genera *Alcydodes* and *Nonophyes*, also the scolidid *Poecileps* and some *Lepidoptera* (DALJEET SINGH, 1974), especially following minor flowerings when seedlings rarely become established. These beetles are apparently not host specific, and increase greatly and suddenly in numbers in flowering years though their life cycle is known to take 18 months. BURGESS (1969) estimated that c. 80% of *Shorea curtisii* seed on average is destroyed by these predators. The genus *Dipterocarpus* is particularly susceptible.

Fruit development. As a consequence of the above fruiting years are less frequent than flowering years. CHAN (1980) found in the 1976 flowering in West Malaysia that, though there was an interval of 61 days between the onset of anthesis in the first and last of six *Shoreas* in sect. *Mutica* growing together in Pasoh forest, fruiting started within 10 days of one another and the fruiting periods otherwise completely overlapped. This can be accounted to the fact that the period between anthesis and first fruit set was 82 days for the first to flower, 126 for the last. This phenomenon appears general in the family; differentials in rates of development vary between related species rather than between genera therefore. Together, these factors lead to occasional heavy fruitings in which enormous quantities of seed from a majority of species in an area are set \pm concurrently and germinate immediately on the forest floor.

Dispersal. Though the prolonged fruit sepals allow the fruit to gyrate and fall obliquely, once within the main canopy they fall in random directions and on average almost vertically; many get anchored in branches and die, and many main canopy and understorey species have re-evolved short fruit sepals. WEBBER (1934) observed fruit being dispersed up to $\frac{1}{2}$ mile in local high winds; MULLER (personal comm.) has once seen the coastal cantonment of the Brunei Shell Petroleum Company, a flat strip of cleared land behind the sea beach, inundated by the fruits of the *Shorea albida* trees that fringe it on the inland side, observing a dispersal distance of c. 2 km. Such events must be unusual and as RIDLEY (1930) noted, the vast majority of the fruit fall within 100 m of the parent tree under forest conditions. BURGESS (1969) estimated that over one half of the seed of the ridge-top species *Shorea curtisii* landed within 20 m of the parent tree. Even during a dry spell at Bogor and with strong southern wind VAN STEENIS observed dispersal of *Shorea* grown in the Botanic Garden over the large lawn in front of the palace not to exceed c. 500 m.

The fruit with their resinous pericarps are not favoured by many terrestrial animals, though wild pigs devour them voraciously. The occasional heavy fruiting years undoubtedly minimise predation and reduce seed mortality (BURGESS, 1969); he stated that damage by foraging ants is so severe in *Shorea curtisii* that successful germination only occurs in heavy seed concentrations.

Some 20 dipterocarp species in West Malesia alone characteristically grow on periodically swamped riverain alluvium and river banks. Most of these species, including *Dipterocarpus apterus*, *D. tempehes*, *Dryobalanops oblongifolius*, *Shorea macrophylla*, *S. palembanica*, *S. seminis*, *S. splendida*, *S. sumatrana*, *Vatica pauciflora*, *V. rassak*, and *V. umbonata* have large fruit with short sepals and thick pericarps, but with these exceptions the fruits do not present any obvious adaptation for dissemination by water. BURKILL (1922) briefly discussed the adaptation for water dispersal in *Vatica pauciflora* (*wallichii*) and *Shorea seminis* (*Isoptera borneensis*) and found that the fruit of the former floats for c. 22 days while that of the latter, when deprived of its corky sepals, sinks within 2 $\frac{1}{2}$ days. There is no evidence that dipterocarp seed can withstand sea water.

Conditions for germination appear to be crucial but have been little studied. Fruit of Malesian dipterocarps lacks dormancy, and attempts to induce dormancy by reducing water content and temperature have only had limited success (TANG, 1971; TANG & TAMARI, 1973). In general seed of *Dipterocarpaceae* is noted for its brief period of vitality; they do not stand drying out and seedling stages are clearly adapted to temperature, moisture, and light conditions of the primary forest. Dipterocarp seeds have no dormancy in nature and attempts at storage beyond a few weeks have failed in Malesian species. Indian foresters (e.g. GUPTA, 1936-38) have noted that *Dipterocarpus* seeds rarely survive where litter is thick on the forest floor, the radicle failing to penetrate it and drying up. The gregarious riparian Indo-Chinese *Dipterocarpus alatus* appears to regenerate only at prolonged intervals, when fruiting follows a flood in which the litter has floated away, leading to even-aged stands. BURGESS (1969 personal comm.) has germinated species in *Shorea* sect. *Mutica*



Fig. 5. Ground-carpet of seedlings of *Shorea multiflora* (BURCK) SYM., 9 months after flowering. Note the drip-tips. Brunei, Andalau For. Res., lowland dipterocarp forest, 100 m alt. (Photogr. ASHTON, Aug. 1959).

under controlled humidity conditions and found that species differ in their tolerance of dry conditions at germination: the coastal hill and ridge-top species *Shorea curtisii* is paradoxically highly sensitive to dry conditions at germination, though apparently more tolerant of water stress than related species at maturity. He estimated that 40% of *S. curtisii* seedlings fail to survive the first month following germination, and another 10% succumb in the following dry season *c.* 3 months later. Mortality in the life cycle is consequently greatest during fruit development and the 2–3 years following seedling establishment.

General ecology. Following successful establishment carpets of seedlings of a single species are seen around the boles of the parent trees. Fig. 5, 81. At this stage competition is therefore mainly intraspecific, and it is interesting that, though this is the period of maximal mortality, morphological and anatomical differences between allied species are at their least. Knowledge of the ecology of dipterocarp seedlings is almost entirely empirical, derived from silvicultural experience. SUNDERLAND (unpubl.) has demonstrated however that though seedlings of the slow-growing heavy hardwood *Shorea maxwelliana* and the fast growing light hardwood *S. leprosula* share compensation points, total daily net photosynthesis and rates of dark respiration are much higher in the latter. Though the former can survive under lower light intensities, neither can survive without the occurrence of sunflecks.

If, as seems probable, dipterocarps form complex *ectotrophic mycorrhizal associations* (HONG, 1979), then the clumped distribution imposed by their reproductive biology will facilitate and be enhanced by the events leading to the establishment of their rhizosphere associations. Many basidiomycetes are known to produce carpophores in response to drought; under lowland rain forest conditions carpophore formation appears to be, perhaps as a consequence, less frequent. In wetter areas it may be that reproduction is largely vegetative therefore, the mycelia persisting and

gradually spreading with the ever dispersing and coalescing clumps of the dipterocarp trees themselves.

Given all these conditions I conclude with MERRILL (1923) that "it becomes perfectly evident that, in order to explain the present distribution of *Dipterocarpaceae*, it is absolutely necessary to postulate previous land connections from India to New Guinea over which, at some time(s) in geologic history, it has been possible for certain species to march unimpeded."

The morphological differences by which the dipterocarp species are mainly recognised, in bark and twig as well as leaves, increase with age and reach their maxima once the crown has emerged into direct sunlight, branching becomes sympodial and the mature tree leaf is attained. In the largely understorey genus *Vatica* this differentiation does not occur and many species are difficult to identify unless fruiting. KENWORTHY (1969) demonstrated the physiological significance of various leaf characters of epidermal thickness, tomentum and wax deposits by which so many emergent species are distinguished. He found that in *Shorea curtisii* the stomata of the glabrous seedling leaves rapidly respond to water stress by closing, whereas in mature trees the stomata remained open at all times of day and are clogged by the abundant filamentous wax secretions that give the leaf undersurface of the species its characteristic appearance. The mature tree would act therefore as a giant wick and would have little control of water loss other than by the development of epidermal resistance. It is probable that the stomata are responsive in the freshly opened leaves, but rapidly become clogged by detritus and wax. It appears that leaf change, which is probably frequent and occurs at least once a year, is a crucial period which occurs only following times of rain when water stress is minimal. The conspicuous changes in colour and albedo as the leaves expand, and differences in these characters between individual trees, will create leaf temperature and hence transpiration differentials (SMITH, 1909). KENWORTHY (1971) also pointed out that the net, which is formed by the tertiary nerves and their associated sclerenchyma, effectively divides up the dipterocarp leaf into compartments like an aircraft wing, so that rigidity is maintained after prolonged drought or severe damage by predators.

Dipterocarp species vary greatly in *growth rates*; some, usually intolerant of low light intensities, show rapid growth rates and reach mature habit within 60 years under forest conditions; others, usually shade tolerant grow very slowly. The former probably have a life-span of *c.* 250, the latter perhaps in excess of 1000 years, judged on the basis of girth growth data.

Range in non-seasonal zone. Climates with at least 2000 mm mean rainfall and no regular season of pronounced water stress occur throughout Malaya, except the north-west, and in S.E. Peninsular Thailand (Pattani); throughout Sumatra except the north-west (Atjeh) and south (Lampungs); throughout Borneo except the extreme north-east (Kudat District) and south-east (particularly near Pleihari in the rain shadow of the Meratus mountains); down the eastern side of the Philippine archipelago from Cagayan Province of Luzon and including most of Mindanao; and throughout lowland New Guinea and adjacent islands immediately to the west but excluding the region around Port Moresby in the south-east and a belt in the south extending from the Fly River into West Irian (Okaba to Merauke and Wassi Kussa). Within this region there is still considerable variation in mean annual rainfall and its seasonality, and in some areas where seasonality is relatively pronounced the dipterocarp flora becomes somewhat impoverished and species of the seasonal evergreen forest become more abundant. Such is the case in eastern Luzon, much of eastern New Guinea, eastern Borneo, much of Sumatra, Pattani in Thailand and northern Malaya including Perak, Kedah, part of Kelantan and to a lesser extent Trengganu and northern Pahang and Selangor. There is also evidence of recent changes in the boundaries of these forests: this may explain the presence of *Shorea leprosula* and *S. parvifolia* in an outlier at Trang in Peninsular Thailand, for instance.

Role in succession. It can be readily explained why dipterocarps are generally absent in secondary forest in this zone, and why they take so very long to invade devastated land, for their very limited means of seed dispersal combines with their sensitivity to water stress at germination and early establishment to make them particularly unsuitable as colonisers. Colonisation is only known to occur successfully therefore on clay soils with a high water retaining capacity in moist hilly districts and periodically inundated alluvium (ASHTON, 1964). It is more difficult to understand why this should not be true in the seasonal evergreen zone; here not only is *Dipterocarpus alatus* a rapid coloniser of alluvium, but such species as *Anisoptera costata* and *A. thurifera* (R. JOHNS, unpubl.)

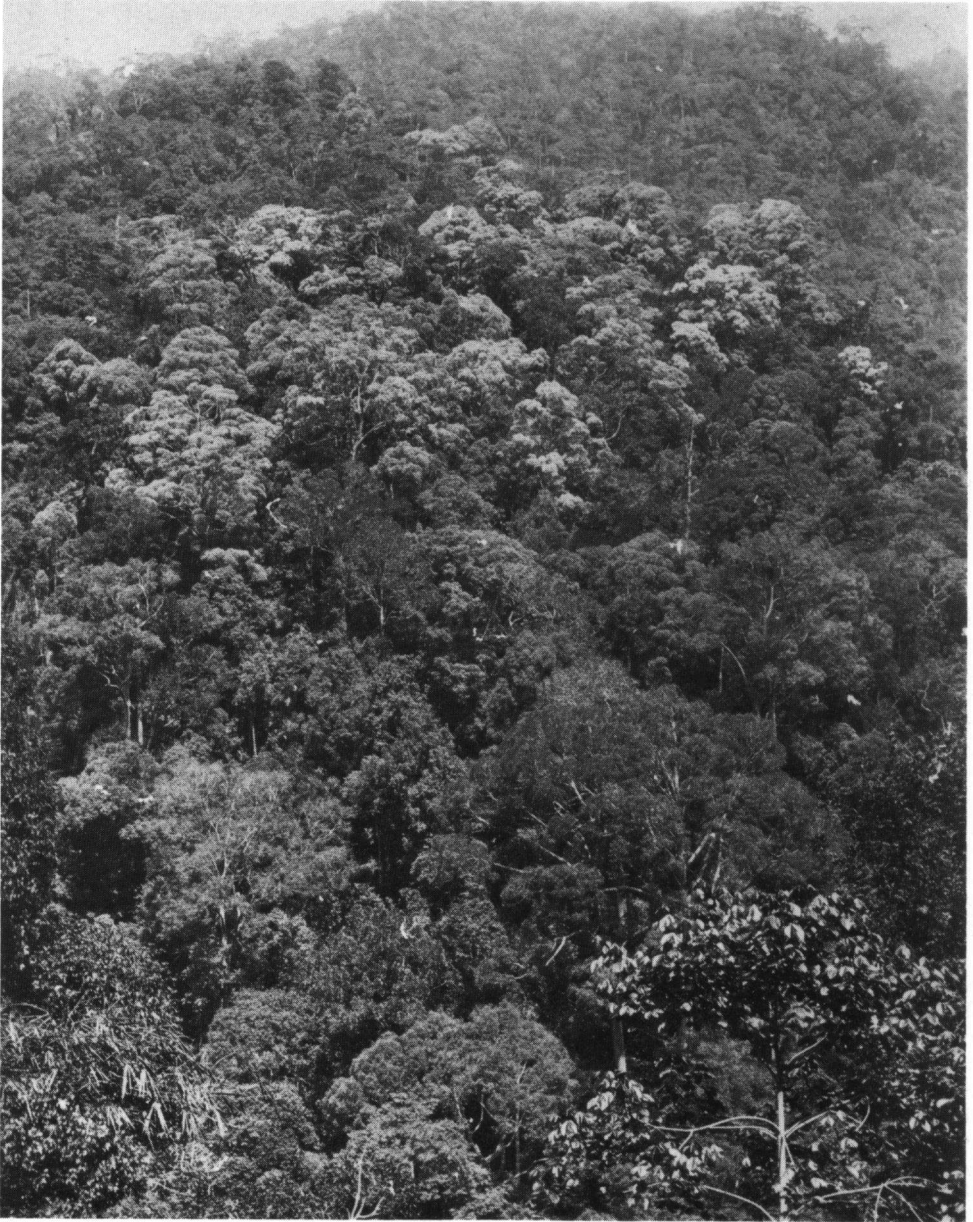


Fig. 6. Hill dipterocarp forest of *Shorea curtisii* DYER ex KING, *séraya*, at c. 900 m alt., in Malaya (Photogr. WYATT-SMITH).

actually increase in density in secondary forest. Germination studies of these species as well as those of the Dry Dipterocarp forests would be rewarding.

Edaphic conditions. As the role of the family differs entirely between the forests of the Sunda and New Guinea non-seasonal zones the two must be considered separately. In western Malesia (Sumatra, Malaya, Borneo and Philippines) *Dipterocarpaceae* dominate the forests on well-drained yellow and red soils below 1300 m; these forests have hence been termed Mixed Dipterocarp forest by me (1964). SYMINGTON (1943) had recognised that the coastal hills of Malaya bore a characteristic forest flora, many elements of which, such as *Shorea curtisii*, *S. ovata*, *S. glauca*, *Vatica mangachapoi*, *Hopea beccariana*, *Dipterocarpus fagineus* and *Anisoptera curtisii* also occur along inland ridges. Fig. 6. BURGESS has demonstrated that the two habitats share a pronounced tendency to prolonged periods of water stress differing from those of the semi-evergreen zone in their unpredictability.

Increased water stress may explain why trees isolated by felling operations so frequently die; death of mature trees in undisturbed forest on account of water stress has never been recorded. I observed (1968) the sensitivity of *Hopea enicosanthoides* to prolonged submergence however. I had earlier (1964) demonstrated that Mixed Dipterocarp forest on sedimentary rocks in Brunei varied considerably in structure and floristics and correlated this variation largely to environmental features that influence water status, including physiography and physical characteristics of the soil; in my view nutrient status had little part to play in differentiating the vegetation. I demonstrated a distinct floristic connection between the forests on very well drained yellow podsolic sands in Brunei and those of the Malayan coastal hills, whereas the inland lowland Malayan element was confined to clay soils, especially on broad low ridges.

My views were in conflict with those of SYMINGTON and WYATT-SMITH who found no consistent relationship between soils and forest variation in inland lowland Malaya. POORE (1968) confirmed their views in an intensive study of a limited area in Pahang, where he deduced that the commoner species had wide edaphic amplitudes and were interchangeable so that, once seedlings had become established, a process in which chance must play a large part, "possession is nine points of the law".

The conflict is largely resolved, and the lowland ecological range of the family more precisely defined, in my recent work. I have shown that these lowland forests can be categorised into two main groups: In one soil phosphorus levels in particular, and other elements to a lesser extent, are relatively high and the forests are floristically rather uniform; in the other phosphorus levels are low and the forests exhibit great variation which can be correlated with nutrient status (AUSTIN, ASHTON & GREIG-SMITH, 1972). These observations are consistent with the theory that dipterocarps are mycorrhizal. As soils with low nutrient levels are often those which are most freely drained, water stress and limiting nutrient levels tend to go hand in hand but it is apparent, as this is not always the case, that both factors have an important part to play in dipterocarp ecology. The low fertility soils are principally those of the Tertiary and Quaternary sands at the margins of the Sundaland continent, where the sediments have become impoverished by successive erosion and deposition cycles since the Cretaceous; the Malayan Peninsula hardly possesses rocks younger than the Cretaceous and this ancient land surface is covered by deep soils of moderate fertility, though even here a subtle correlation does in fact exist between physiographic and floristic variation (ASHTON, 1976).

I have (1964) described the floristic and structural role of the family in the lowland forests. They reach their zenith both in numbers of species and individuals on deep well drained yellow/red soils of intermediate fertility, where nutrient levels are apparently limiting but not severely so. In Heath forest on podsols dipterocarp diversity is much reduced and in peat swamp forests yet more so; in both single dominant species are frequent. Examples are *Shorea materialis* in Heath forest and *Shorea albida*, *S. balangeran* and *Dryobalanops rappa* in Bornean peat swamp forests. In the latter forests diversity increases from the centres of the domed oligotrophic bogs outwards as soil fertility increases, several species (*Shorea inaequilateralis*, *S. pachyphylla*, *S. platycarpa*, *S. teysmanniana*, *S. uliginosa*, and *Dipterocarpus coriaceus*) being found exclusively in the Mixed Peat Swamp forests of the margins (ANDERSON, 1963). Other species occur in both peat swamps and Heath forest, while some 30 species are almost entirely confined to Heath forest; the ecotone between Heath and Mixed Dipterocarp forest on yellow podsolic sandy soils is ill defined and many species are common to both. More surprising is the marked decrease in species diversity on well drained soils of highest

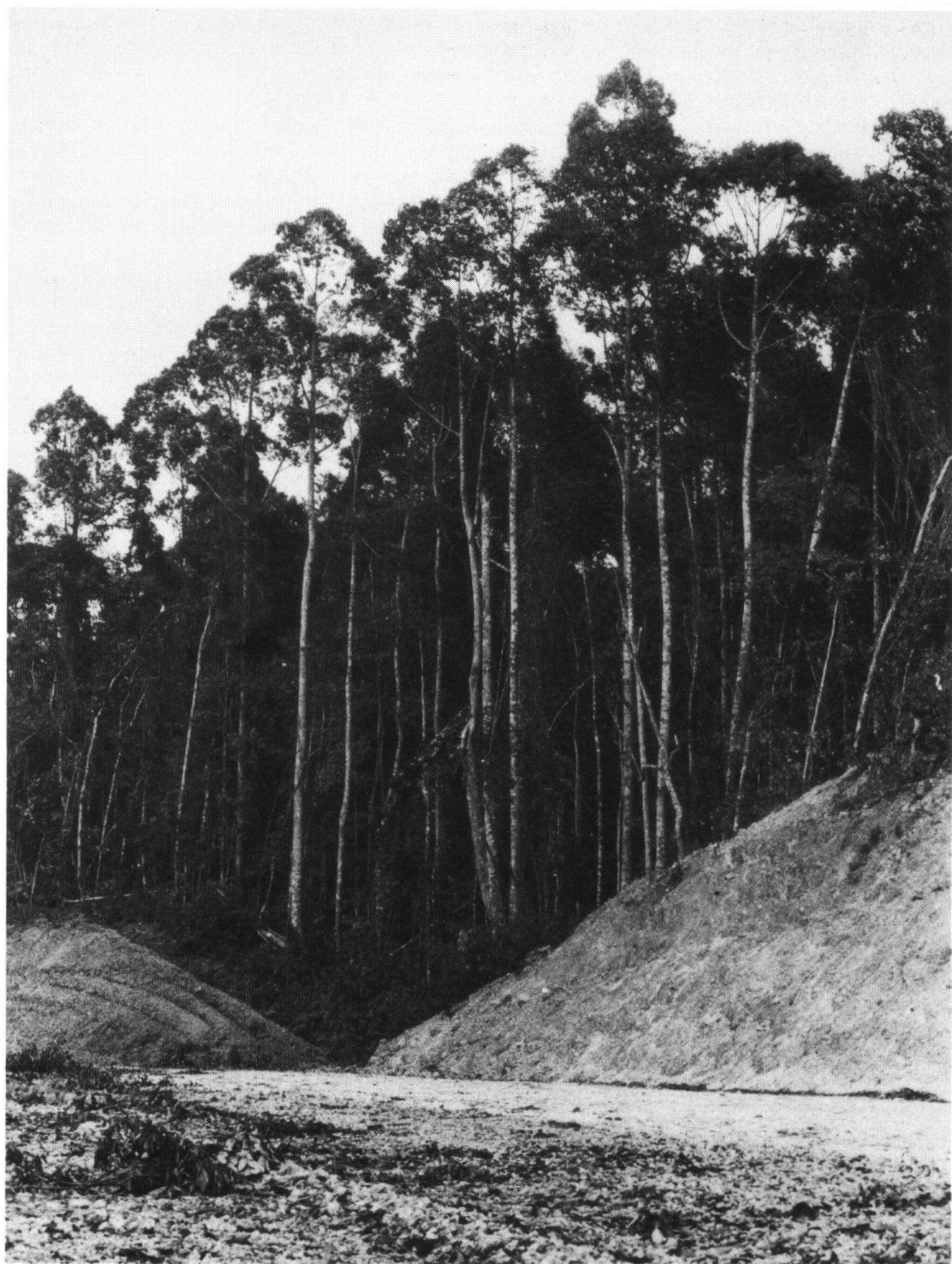


Fig. 7. Even-aged stand of mixed dipterocarp forest, with *e.g.* *Shorea almon* FOXW. and *S. polysperma* (BLCO) MERR. abundant in the canopy, recovering from total destruction due to a cyclone in 1944, in 1975. Note the pyramidal, monopodial juvenile crowns. Mindanao, Suriago del Norte (Photogr. ASHTON).

fertility; I have shown (1964) that there was a decrease in diversity on calcareous shales in comparison to sandstones, most marked on the shallow skeletal soils on the narrow ridges and steep slopes of the youthful N.E. Bornean physiography. Unpublished analyses from Sarawak show a further decrease in both density and diversity on deep fertile soils; here gregariousness also increases. The gregarious stands of *Shorea retinodes* on the slopes of the Barisan range, where soils have been much affected by Quaternary volcanic activity and landslips remain common, may be a comparable example. In some cases the explanation may partially lie in the isolation of these small distinctive habitats of geologically recent origin, preventing the rapid build-up of diversity. Fig. 7.

Low diversity and the presence of gregarious species also characterise excessively dry habitats in the non-seasonal zone. Thus *Shorea gratissima* is confined to and gregarious on rocky headlands; and *Dryobalanops aromatica* forms pure stands on coarse gravelly soils and yellow podsolic sands in Atjeh and Malaya.

The limestone dipterocarp flora is poor; though no species is known to be gregarious in the non-seasonal zone *Hopea ferrea* is so on the rocky hills of the Langkawi Is. No species appears to be confined to limestone, but species sometimes found on it include *Cotylelobium malayanum*, *Hopea aptera*, *H. billitonensis*, *H. cernua*, *H. dasyrrachis*, *Shorea guiso*, *S. havilandii*. In the seasonal north-west of the Malay Peninsula *Shorea siamensis* and *S. roxburghii* occur on it; and further north outside Malesia, where mineral soils accumulate over the rock, a wide range of dipterocarps may grow. Similarly, the dipterocarp flora on the soft coral limestones of eastern Mindanao does not seem to differ from that on other substrates, and their roots penetrate the soft rock itself.

The intrinsically unstable and specialised habitat of river banks also carries a characteristic dipterocarp flora of some 20 spp. in western Malesia. Most species are widespread but some (e.g. *Dipterocarpus oblongifolius*, *Hopea centipeda*) occur only on the rocky banks of rapid inland rivers, whereas others (e.g. *Vatica venulosa*, *Shorea seminis*) equally prefer alluvium along meandering rivers of the plains.

The many similarities between the ecology of the dipterocarps and the undoubtedly ectotrophic mycorrhizal *Fagaceae*, which assume dominance at high altitudes, is noteworthy.

Summarising: Comparatively few species are restricted to one vegetation type or one substratum or type of bedrock. For example, many *Vaticas* occur in alluvial forest and near rivers, but seldom exclusively so, and occur also on the hills, though they may be more common in the former habitat. *Hopea pentanervia* occurs on mixed peat swamp over sand, podsols and cuestas, plateaus and terraces near present or Pleistocene coastlines, and on ultrabasic rocks in N. Sabah; *Shorea polyandra* is found on fertile, clay-rich soils on calcareous shales, igneous and volcanic rocks; *Shorea scabrida* is found in freshwater swamp forest, on shallow peat overlying sand, and on skeletal soils on ridges and plateaus, in Heath forest and in Mixed Dipterocarp forest. This apparent diversity of habitats occupied nevertheless frequently conceals a common and sometimes rather specific edaphic range.

Others are more clearly confined to certain edaphic habitats and some of these are cursorily listed here:

Heath (kerangas) forest on podsols: *Cotylelobium burckii*, *C. malayanum*, *Dipterocarpus borneensis*, *Dryobalanops fusca*, *Hopea kerangasensis*, *H. micrantha*, *H. pterygota*, *H. vacciniifolia*, *Shorea coriacea*, *S. induplicata*, *S. materialis*, *S. pallidifolia*, *S. retusa*, *S. revoluta*, *S. venulosa*, *Vatica coriacea*, *V. parvifolia*.

On sandy soil the following are frequently recorded: *Anisoptera grossivenia*, *A. reticulata*, *Cotylelobium melanoxyylon*, *Dipterocarpus globosus*, *D. rigidus*, *D. sarawakensis*, *Dryobalanops aromatica*, *Hopea beccariana*, *H. coriacea*, *H. treubii*, *H. vesquei*, *Shorea acuta*, *S. crassa*, *S. dealbata*, *S. falcifera*, *S. flemmichii*, *S. geniculata*, *S. ladiana*, *S. laxa*, *S. rubella*, *S. rugosa*, *S. scabrida*, *S. stenoptera*, *Upuna borneensis*, *Vatica borneensis*, and *V. oblongifolia* ssp. *crassilobata* and *elliptifolia*.

In peat swamps the following species are characteristic, some being gregarious there: *Anisoptera marginata*, *Dipterocarpus coriaceus*, *Dryobalanops rappa*, *Shorea albida* (also in Heath forest), *S. balangeran* (also in Heath forest), *S. foraminifera*, *S. inaequilateralis*, *S. macrantha*, *S. pachyphylla*, *S. platycarpa*, *S. teysmanniana*, and *S. uliginosa*. Fig. 8, 96.

On ultrabasic soils the following are regularly recorded, but only the last is confined to them:



Fig. 8. Stands of large trees in peat-swamp of *Shorea albida* SYM., *alan*; road tracé to oil well in Seria, Brunei, at 5 m alt. (Photogr. ASHTON, 1960).

Dipterocarpus geniculatus ssp. grandis, *D. ochraceus*, *Hopea pentanervia*, *Shorea coriacea*, *S. tenuiramulosa*.

It will be noted that all examples given occur in Borneo and many are endemic there; this reflects the unusual habitat diversity as well as infertility of that island.

Altitude. The altitudinal limits of *Dipterocarpaceae* in the non-seasonal zone experience mean minimum monthly temperatures comparable to those at the northern margin of the family range at 22° N, in Yunnan, Kwangsi, S. Kwantung, and Hainan at c. 15° C. In areas of shallow soils, often of low base status, such as those derived from the sedimentary rocks at the margin of the Sunda shelf area in N.W. Borneo, altitudinal zonation of vegetation is obscured by variation in relation to soils except at the extreme altitudinal limits and on isolated summits. In Malaya such zonation is clearer, though the ecological relationship between the ridge and coastal hill flora has already been described. The increase in raw humus accumulation above 1000 m is associated with the marked affinity between the dipterocarp flora of the hill ridges and lowland podsollic soils. SYMINGTON (1943) summarised the altitudinal zonation of dipterocarp species in Malaya: He recognised a Lowland Dipterocarp forest zone below 300 m, with the coastal hills as a separate category, the former with 108 *spp.*, the latter with 27 of which 8 are shared; between 300–800 m are Hill Dipterocarp forests with 49 *spp.*, and between 800–1300 m (the altitudinal limit of dipterocarps in Malaya) are Upper Dipterocarp forests with 15 *spp.* Within the two hill types there are 7 exclusively hill species; of the rest 15 are exclusively coastal in the lowlands and of these 5 occur also in the Upper Dipterocarp forests; the remaining 35 occur in Lowland Dipterocarp forests generally, though of these but 4 are found in the upper zone. The existence of a small group of apparently obligatory hill species is not confined to Malaya; some are widespread in western Malesia, *Dipterocarpus retusus* extending eastwards to Sumbawa, while in Borneo there are a further 10 endemic montane taxa. A few ascend above 1000 m, for example to 1200 m: *Shorea carapae*, *S. revoluta*, *Vatica odorata ssp. mindanaensis*; to 1300–1350 m: *Shorea beccariana*, *S. flaviflora*, *S. platyclados*, *S. rubra*, *Vatica heteroptera*; to 1400 m: *Shorea longisperma*, *Vatica dulitensis*; to 1500 m: *Shorea monticola*, *S. ovata*, *Vatica oblongifolia ssp. selakoensis*; to 1600 m: *Shorea venulosa*; to 1650 m: *Hopea cernua*; to 1700 m: *Vatica granulata ssp. sabaensis*; to 1800 m: *Shorea platyclados* (Atjeh).

At their upper limits the dipterocarp forests give place to oak-laurel forests in Malesia; it is noteworthy that in Ceylon, where the *Fagaceae*, which share with *Dipterocarpaceae* gregariousness and well developed ectotrophic mycorrhizal associations but which become dominant above 1300 m, are absent, 9 exclusively montane species of the endemic taxa *Shorea sect. Doona* and *Stemonoporus* dominate the hill forests of the south-west up to 1700 m (ASHTON, 1972, 1977).

Synopsis: Role of dipterocarps in the frame of the forest. At their edaphic optimum in the lowlands dipterocarps may comprise more than 80% of all emergent individuals in the forest, and up to 40% of understorey trees. Under conditions of increasing proneness to aseasonal drought the emergent stratum becomes less dense, the understorey more so, and dipterocarps decrease their representation in both except where gregarious species occur. Under the most mesic conditions the emergent canopy becomes so dense as to be continuous, and the understorey consequently becomes diffuse in the low light intensity; here total dipterocarp density as well as relative density is reduced.

In the non-seasonal evergreen forests of New Guinea dipterocarps play an altogether subsidiary role. Only 14 *spp.* are so far known from these vast forests; 11 are endemic to New Guinea and adjacent islands, and 9 are confined to local areas within the island. One species of *Anisoptera*, one of *Vatica* and 12 of *Hopea* are represented. Only *Anisoptera thurifera* is truly emergent, and gregarious stands often give a distinctive profile to the steep-sided crests. Several *Hopeas*, among them *H. forbesii* and *H. iriana*, are canopy species, as is *Vatica rassak* in the more seasonal areas. The family as a whole shows a distinct though not exclusive preference for ridge tops, noticeable (though less markedly so) on the similarly youthful physiography of much of Borneo.

Single species as a rule individually merely play a minor part as contributors with many others to the overall role of the family. Gregarious or semi-gregarious populations occasionally occur in many, perhaps most, species including those of the understorey and are probably usually attributable to chance favourable conditions at the time of establishment. In Malesia they are habitual only in the species of the Dry Deciduous Dipterocarp (fire climax) forests, notably *Dipterocarpus obtusifolius*, and to a lesser extent those of seasonal evergreen forests including

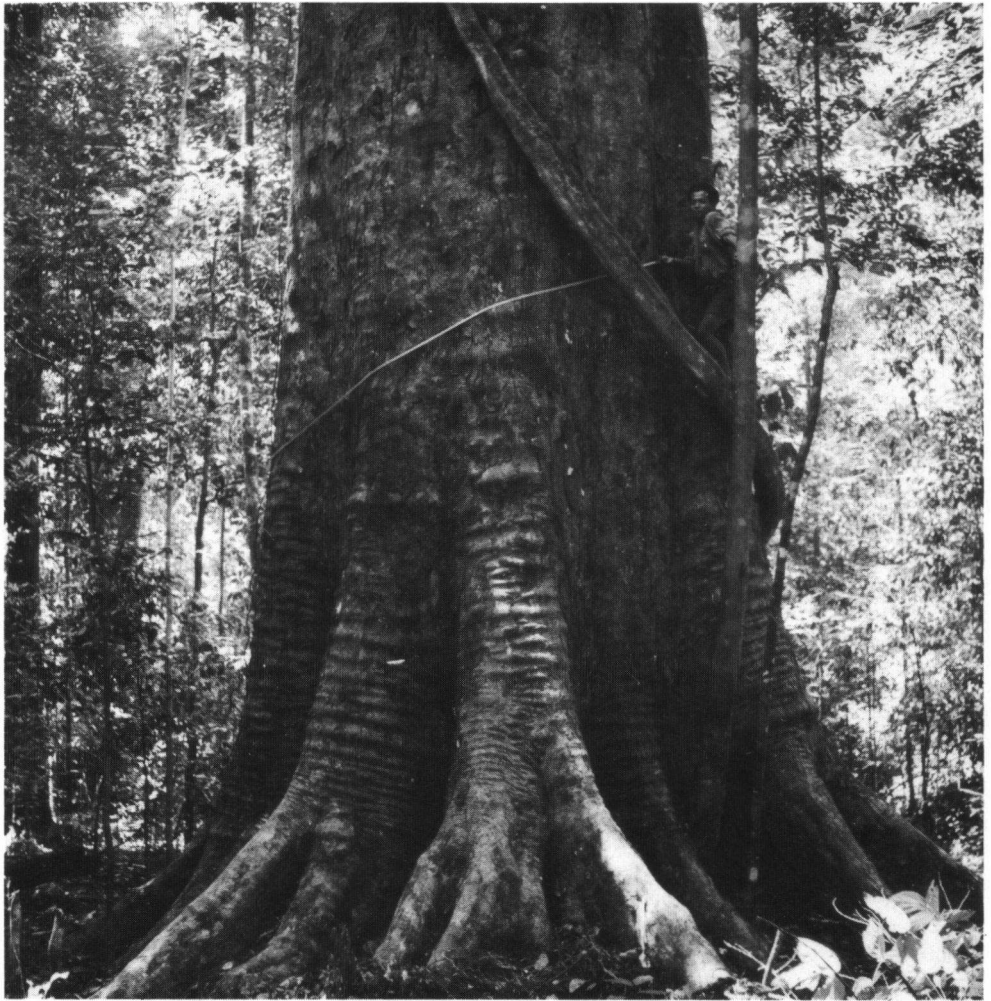


Fig. 9. Trunk-base of a colossal specimen of *Shorea superba* SYM. on basalt, half a mile south of Quoin Hill, Balong area, Tawau, Sabah, forest guard KAPIS BIN SISIRON at point of measurement: total height of tree 75 m, clear bole 27 m, girth at 4 m above ground $9\frac{1}{2}$ m = 3 m diam. (Photogr. G. H. S. WOOD).

Anisoptera costata, *A. thurifera*, *Dipterocarpus costatus*, *D. gracilis*, *D. grandiflorus*, *D. kerrii*, *Hopea ferrea*, *H. forbesii*, *H. glabrifolia*, *H. gregaria*, *H. pierrei*, *Shorea guiso*, *S. hypochra*, *S. roxburghii*, *S. selanica*, *Vatica cinerea* and *V. rassak* on the one hand; — and on the other in species of limiting soil conditions such as *Dipterocarpus elongatus*, *D. oblongifolius*, *Hopea ftuvialis*, *H. odorata*, *Shorea seminis*, *S. sumatrana*, *Vatica pauciflora*, *V. rassak* and *V. umbonata* on river banks and flood plains, — *Dryobalanops fusca*, *D. rappa*, *Shorea albida*, *S. balangeran* and to a small extent *Anisoptera marginata*, *Shorea inaequilateralis*, *S. platycarpa*, *S. teysmanniana* and *S. uliginosa* in peat swamps, — and *Anisoptera marginata*, *Cotylelobium burckii*, *C. malayanum*, *Dipterocarpus borneensis*, *Dryobalanops fusca*, *Shorea materialis* and sometimes others in Heath forest. Several factors, including chance, may have played a part in the origin and maintenance of the extensive gregarious stands of *Dryobalanops aromatica* (see VAN SLOOTEN, 1932; LEE, 1967) and *Shorea retinodes* (VAN SLOOTEN, 1949).

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Morphology. Habit. See Fig. 9, 21, 25, 32, 51, 53, 55, 80, 111, 112, 117. The bole can be cylindrical in cross-section, or fluted or ribbed, and is usually buttressed. See Fig. 29, 52, 59, 81. The buttresses can be small or large, thin with a sharp edge as in *Shorea sect. Shorea* generally, or thick with a rounded edge; the edge, from the soil surface to the apex where the buttresses merge into the bole, is usually concave, but is sometimes straight or convex; the buttresses can terminate more or less abruptly at apex and base, or continue as ribs up the bole as in *Anisoptera sect. Anisoptera* or superficial roots over the ground. Flying buttresses are convex-edged buttresses originating from the bole above the soil surface, and are differentiated from the stilt roots by being flat, therefore elongate in cross-section, as opposed to being terete or spherical in cross-section; stilt roots can be adventitious to the buttresses or arise from the bole. Flying buttresses and stilt roots are a particular feature of *Hopea*, and are found at least occasionally in a majority of species with the exception of those in *sect. subsect. Hopea*. Fig. 67, 71.

In the seasonal parts of S.E. Asia (Thailand, *etc.*) various species of *Dipterocarpaceae* have a capacity for suckering and produce new stems from trunk-bases after cutting. However, the Malaysian rain-forest species generally lack this capacity and regenerate merely from seed.

The mode of branching, and the leaf arrangement, changes ontogenetically. The seedling dipterocarp, after production of one or more pairs of opposite leaves, sends up a stem with spirally arranged leaves. From the axils of these leaves arise the lateral branches; the leaves on the branches are generally arranged distichously, consequently the branchlets are also alternately arranged and the branches occupy one plane (plagiotropy), ascending, descending, or horizontal. The sapling leader, or stem apex, grows continually at first, but soon adopts resting periods, growth proceeding in flushes that are not necessarily seasonal at this stage though often synchronised among members of a clump. The internodes are frequently longer towards the beginning of the growth flush than towards the end, so that the stem leaves in some species, particularly *Hopea sect. Dryobalanoides*, are largely bunched at the end of each growth stage of the leader; consequently the branches appear to arise in whorls and the sapling and pole sized tree assumes a 'pagoda shape' (CORNER, 1940); each flush of growth by the leader is coordinated with the sprouting of some of the axillary buds of the previous flush to form new lateral branches.

Young dipterocarps therefore conform either to Massart's model, that is, with rhythmic growth and branching, or approach Roux's, with continuous growth (HALLÉ, OLDEMAN & TOMLINSON, 1978).

The leaders have spiral leaf arrangement; if a leader dies or its growth is otherwise arrested at this stage, new leaders emerge not from axillary but from tiny subsidiary buds (NG, 1976); whether a single leader eventually achieves dominance over others varies with the species.

If the tree remains small, and never reaches the forest canopy, as in many *Hopea* species, it

frequently remains monopodial with this form of branching, and the crown remains lanceolate or conical. Fig. 7, 36. If the leader reaches the canopy the subsequent lateral branching generally become orthotropic, apical dominance is lost, the earlier plagiotropic branches die and are lost and a hemispherical or dome-shaped crown is formed. Fig. 1.

Alternatively, plagiotropic branches become orthotropic towards their tips (HALLÉ, *in pass.*). Many *Vatica* species, however, which never become tall enough to reach the forest canopy, become more or less sympodially branched and develop an irregular oblong crown; while *Parashorea macrophylla*, and some members of the *Shorea* sections *Mutica* and *Anthoshorea* remain monopodial for some time after they have emerged above the canopy and reached full height, and may even send up further vertical leaders, apparently from axillary buds from the plagiotropic side-branches. In most species with an emergent sympodial crown the leaves are spirally arranged on the branchlets, but in species that tend to branch low, such as the riverside species, those species in which some or all the branches become horizontal or pendant towards the apices, and the species with compressed twigs, the leaf arrangement is frequently or always alternate. If the branches are many and radiate from the bole apex, as in many emergent *Hopea* species, the crown of emergent species takes on an evenly hemispherical appearance. If the main branches are few and large but much branched towards the apices, the branchlets become bunched towards the ends of the large branches into more or less hemispherical groups and the crown assumes the appearance of a cauliflower head. If the twigs are stout and the leaves large the crown shape is uneven and the leaves tend not to be confined to the perimeter of the crown. Rarely, the branches become pendent at the apices and the crown becomes 'weeping' (e.g. *Shorea inaequilateralis*, *S. quadrinervis*). Fig. 111.

According to HALLÉ, OLDEMAN & TOMLINSON (1978) who have classified tree architecture into a series of 'models', trees do not change from one model to another during life. They placed the species of *Dipterocarpus* and *Shorea* they examined in Massart's model in which the trunk is orthotropic, the branches plagiotropic and in false whorls through rhythmic growth, and the position of flowers various; and in Roux's, which differs from Massart's in that trunk growth is continuous. From the foregoing description it would appear that the model may be mutable in dipterocarps, for growth eventually always becomes rhythmic though it may not start thus, and because in most emergent species successive branches become increasingly orthotropic with a change from alternate to spiral leaf arrangement. This change in branching pattern would not imply a change in model were such orthotropic branches arising through reiteration, that is from supra-axillary buds following damage to the leader; but this does not seem to be the case.

Bark. Fig. 9, 22, 24, 31, 45, 52, 69, 102, 113, 114. THORENAAR (1926) first systematically examined bark morphology in the family; SYMINGTON (1943) used bark characters extensively for field diagnosis. WHITMORE (1962) described how weathering processes and tangential strain during growth together act in conjunction with the growth of secondary phloem, expansion tissue developed from phloem rays, phloem proliferation tissue developed from the phloem parenchyma, and the periderms (each of which are laid down in several ways), to produce surface features distinctive of both species and higher taxa; these features change ontogenetically from an initial smooth surface. He thus rationalised bark description, which essentially comprises the surface pattern (the visual summation of surface configurations) and the slash appearance (the visual summation of the appearance of the inner and outer bark in oblique transverse section). Various degrees and types of fissuring develop through tangential strain, and of flaking on account of the disposition of the periderms. In a few taxa (e.g. most *Vatica*, and *Shorea* sect. *Pachycarpae*) the bark remains smooth; in others (e.g. *Anisoptera*, *Dipterocarpus*, *Shorea* sect. *Shorea* and sect. *Richetoides*) it almost always becomes distinctively flaky, while in yet others (e.g. *Shorea* subsect. *Mutica*) it becomes distinctively fissured. In one known instance (fissured-bark *Hopeas*) a distinctive bark configuration has no apparent taxonomic significance above the species level, and is not indeed even consistently developed within the species. Seven distinct bark types, in three groups differing in the amount of expansion tissue, were recognised; within each a number of categories exhibiting lesser structural differences were defined as bark manifestations; it is these that characterise taxa at generic and sectional level. In this account bark characters are summarised in generic and sectional descriptions where appropriate, but have been omitted from species descriptions; reliable bark descriptions of species can be found by reference to SYMINGTON and WHITMORE and also ASHTON (1964, 1968). In particular they contribute important definitive characters for the sections of *Shorea*.

Resin exudations from wounds in living bark and wood also differ in frequency, rate and mode of crystallisation, translucency and colour and sometimes form useful subsidiary characters for identification.

Roots. Fig. 10. Malesian dipterocarps lack taproots, though they are well known in *Shorea robusta* GAERTN. f., and reported from *Hopea parviflora* BEDD., both of India. The laterals are of two categories; an extensive branching system of superficial roots extending from the buttresses and proliferating into a dense mat of fine roots, found by SINGH (1966) and HONG (1979) in many Malayan species, and BAYLIS (with the author, unpubl.) in *Hopea iriana*, to be ensheathed in a dense ectotrophic mycorrhizal mantle; and a diffuse coarse sparsely branching system, consisting of lines of carrot-like 'sinkers' descending vertically from below the buttresses, sometimes also with obliquely descending branches from the principal superficial roots. In acid peaty soils the former are very well developed and the latter few; in fertile soils the converse; in deep fertile soils the latter can penetrate at least 5 m beneath the surface. ANDERSON (1961) has described the extremely specialised roots of the peat swamp species *Shorea albida* SYM. Here the buttresses give off a dense mat of roots c. 30 cm above the permanent water table, on which litter falls and raw humus accumulates; beneath there is a discontinuous cavity into which clumsy walkers easily fall; many stout roots descend from the lower surface of the main superficial roots through this cavity into the waterlogged peat substrate, anchoring the tree.

Ng (1975) has described the occurrence in nature of root grafting between species in several genera.

Buds. The dipterocarp resting bud is clad in appressed scales. Axillary buds are minute, except prior to shoot expansion, in most species, but terminal buds are evident in *Parashorea*, *Upuna* and *Anisoptera*, in most *Shorea* and in some species of other genera, while in *Dipterocarpus* they are generally large, sometimes resinous, and their shape and indumentum provide valuable species characters.

Parts of stem or leaf are frequently distorted in the young shoot, especially of saplings and young trees, by certain wasps into distinct *galls* (CORNER, 1963; ANTHONY, 1973, 1974) which may be globose and spinous, variously elongate and covered in umbricate fish-like scales, or merely simple swellings. These galls appear to have no taxonomic value, and at least three forms are found in *Shorea ovalis*.

Twigs. In most genera the twig surface, its diameter near the apex, its shape in cross-section, and the shape and size of the stipule scars can be specifically diagnostic.

Leaf. Though the stipules are frequently fugaceous, in some species (especially in *Dipterocarpus* and *Hopea subsect. Pierrea*) they are relatively persistent and the size and shape can be diagnostic. The size and shape of blade and petiole, and the number of nerves, is usually specifically diagnostic. The nerves are vertically transcurrent, bounded dorsiventrally by sclerenchyma to the epidermis. The type of nervation is diagnostic for some genera and sections. If the nerves are very many, slender, close, of equal length and straight to the margin with no discernable tertiaries, they are termed 'parallel' (*Dryobalanops*); if as above, but unequal in length, and curving before the margin, they are 'dryobalanoid' (some *Hopeas*); if the latter have distinct scalariform or reticulate tertiaries and the nerves are very unequal and divisible into main nerves and shorter intermediate secondaries they are termed 'subdryobalanoid' (some *Hopeas*). In *Cotylelobium* and *Anisoptera* the nerves curve distally and unite forming a looped intramarginal nerve. Tertiary nerves of penninerved species are generally scalariform but in most *Vatica*, *Anisoptera*, *Cotylelobium* and *Shorea sect. Richetioides*, and in a few other species, they are reticulate.

Domatia occur in various species of the genera *Vatica*, *Shorea* and *Hopea* (Fig. 64a, 73a); they are common in *Hopea* (cf. VAN SLOOTEN, 1941) and the saplings of *Shorea* in particular. They are often diagnostic for a species, and are a product of the plant itself. Domatia are usually confined to the axils of a few nerves towards the base of the midrib, but can extend the whole length, especially in saplings; in *Shorea platycarpa* and some others they form a continuous series flanking the midrib, while in young trees of *Shorea leprosula* they similarly flank the main nerves as well. Most frequently they are pore-like, sometimes hairy, sometimes with the cavity enlarged, pale and stoutly rimmed (e.g. *Hopea nutans*, *Shorea parvifolia*); sometimes they are scale-like as in *Shorea platycarpa* and *S. leprosula*. Young leaves are usually suffused with magenta anthocyanin pigments; in *Shorea sect. Richetioides* they are usually violet or dark crimson.



Fig. 10. Structure of root-system of *Shorea falcifera* DYER ex BRANDIS with dug-out profile beneath it, Kuantan, E. Malaya (Photogr. ASHTON, Sept. 1970).

Extrafloral nectaries occur in many genera on the leaf upper-surface, often near the margins and between vein divisions.

The *petiole* in mature leaves is thickened towards the apex into an umbo, often shrinking in the drying process. As an exception the blade is peltate in *Shorea peltata* and leaves of young specimens in *Shorea chaimana*, *S. laxa*, *S. polyandra* and some others. The umbo is obscure in *Dryobalanops* and some *Hopea* species.

Epidermis and indumentum. GUÉRIN (1907) examined the leaf and twig epidermis anatomically in many species and stated that from this alone most genera, and sometimes even species, can be distinguished. I found that epidermal characters rarely provided evidence for species diagnosis except where taxa were easily differentiated macroscopically; the size of epidermal cells, the thickness of the walls and the position of domatia relative to the surface as well as the indumentum varies more according to the part of the tree from which the leaf originates, and the age of the plant than between closely related species. Thus I confirmed GUÉRIN's conclusions that genera can sometimes be identified anatomically, but the method was not valuable at the species level. GUÉRIN also described long-stalked glandular hairs with unicellular heads on certain *Stemonoporus* species; they appear identical to the glandular hairs that densely cover the young parts and inflorescence of *Upuna*, and were also found, according to SYMINGTON (1941), among the indumental hairs of *Monotes*; RAO (1953) found such hairs on the calyx of *Shorea roxburghii* G. DON. Short-stalked glandular hairs with a multicellular head are a general feature common to most, if not all, *Dipterocarpaceae*; the base of the stalk is typically sunken in an epidermal pit. A dense indumentum of peltate emarginate scales occurs in *Anisoptera*, imparting a characteristic colour to the lamina undersurface and twigs. The number of cells in the head often varies with the age of the plant and therefore is of little value for diagnosis; thus in *Anisoptera marginata* they are at first 4-celled, later 8-celled.

Tomenta of evenly distributed unicellular hairs are present in nearly all species, though fugaceous in many. Unicellular papillae occur on the ovary, stylopodium or connectival appendage of some *Shorea* and *Hopea* species. In some *Shorea* species there is an indumentum of broadly lobed wax secretions; in *Hopea* and some *Shoreas* this covering is more sparse and with slender acute lobes. The macroscopic appearance is similar, except in colour, in all species; it is usually persistent, not easily rubbing off.

Hairs arranged in fascicles are almost universal among the *Dipterocarpaceae* though often fugaceous. The tufts may be short or long, sparsely or densely distributed; they may be of uniform length, producing an 'even' tomentum, or of two or more different sizes, producing a 'scabrid' tomentum. In all species tomenta tend to become shorter and sparser towards the margins and apices of organs; they are usually longest and most persistent on the leaf bud, and become successively shorter, sparser, and less persistent on twigs, petiole, leaf midrib below, primary nerves to tertiary nerves, and finally on the lamina surface itself. Thus many species possess persistently tomentose midribs and glabrescent nerves, but never *vice versa*. In some *Dipterocarpus* this trend is accompanied by a reduction in the bristles, while on the tertiary nerves the clusters are represented by a single long bristle and a basal cushion representing the greatly shortened other members.

Hairs are most persistent on the inflorescence, secondly on the bud scales. Though the tomentum tends to be longer, sparser, and more persistent in young trees, the colour and appearance furnishes important diagnostic characters.

Inflorescence. The typical form is a semi-pendent bracteate, apical, axillary or occasionally ramiflorous panicle once (if axillary) or twice (if terminal) branched in one plane with the flowers secund, shortly pedicellate and nodding, developed in acropetal succession. *Vateria*, *Upuna* and some *Vatica* possess cymes and the flowers are not secund; in *Vatica* the condition is clearly derived. In *Dipterocarpus* generally, and occasionally in other genera, the inflorescence is few-flowered and hardly or not branched. Most species bear apical as well as axillary inflorescences together on the same twig; a few rarely or never develop terminal inflorescences, and of these several *Hopea* and *Vatica* (e.g. *V. sarawakensis*) are strictly ramiflorous while some other *Vatica* (e.g. *V. venulosa*) and *Shorea* (e.g. *S. stenoptera*, *S. hemsleyana*) approach this condition.

Flowers. The centrifugal stamens originate from a number of common bundles independent from the gynoeceum. Fig. 11. The gynoeceum bundles break away from the common supply with the stamens before the stamen supply begins to branch. In all genera but *Upuna* and some *Stemonoporus*

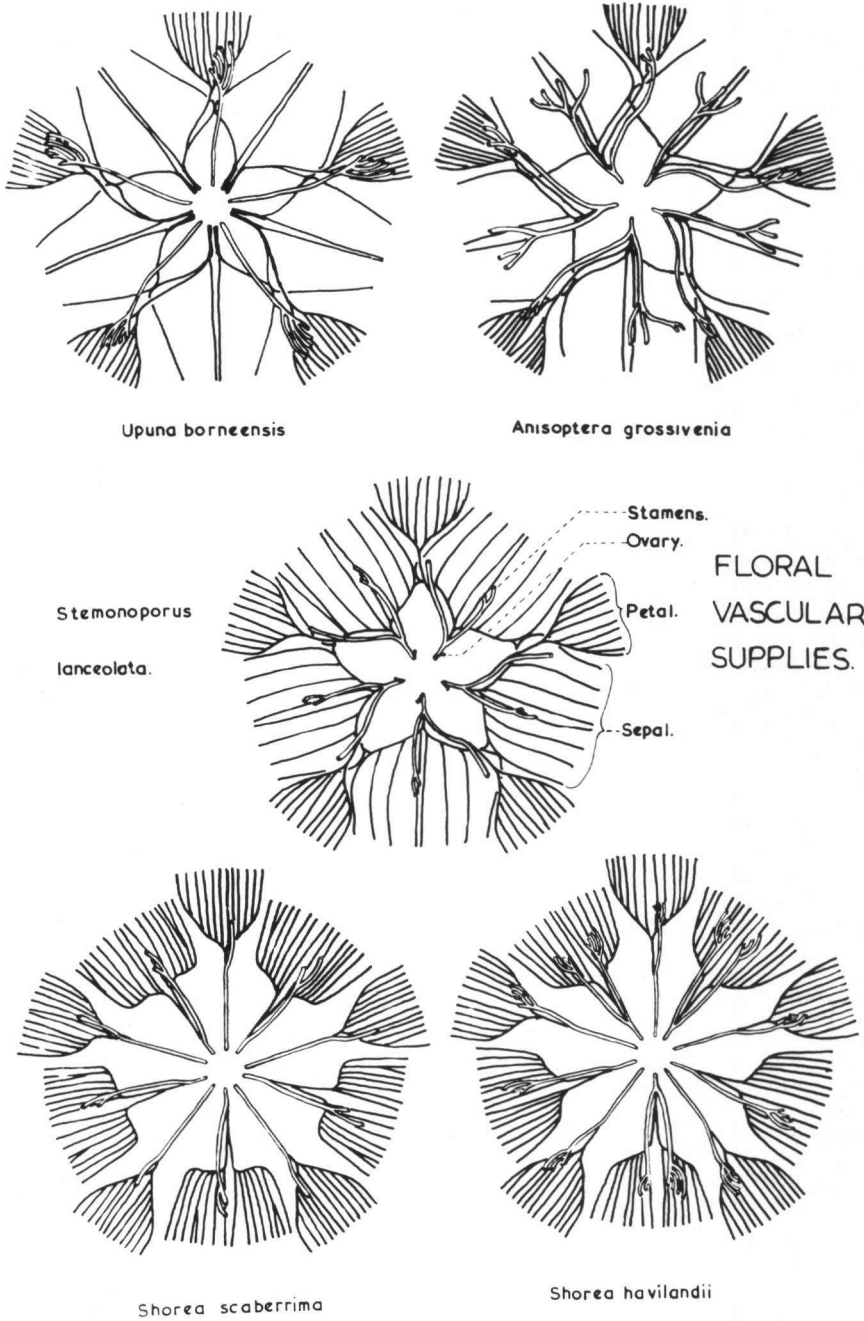


Fig. 11. Scheme of floral vascular supplies in five dipterocarp species.

(*Monoporandra*) of Ceylon the number of primary stamen bundles is 10. In *Upuna* they are independent of the perianth supply and continue between the perianth bundles in the pedicel; in other genera the 10 stamen bundles are associated with the 10 perianth members, though in some *Shorea* (e.g. *S. geniculata*) they appear not to unite within the length of the receptacle and pedicel. In all species where the number of stamens is more than 10 the stamen fascicles originating from the calyx supply are larger than those originating from the petals. In *Shorea*, *Hopea*, *Vatica* and *Cotylelobium* the petal and sepal bundles, together with the staminal bundles originating from them, are independent. *Upuna*, *Anisoptera*, *Vateria*, *Stemonoporus* and *Dipterocarpus* are alike in that a single lateral branch arises constantly from the left or right of each sepal bundle which supplies the petals; the staminal bundles from the sepal supply originate above this bifurcation.

In a recent paper C. WOON & H. KENG (1979) gave details with very numerous figures of the stamens in *Dipterocarpaceae*.

Flowers are usually small, except in *Dipterocarpus* and *Vateria*. The shape and size of the bud and the size and shape of the perianth members is diagnostic for some sections of *Shorea*. The number of stamens in species with less than 20 is constant in normal flowers; in those with more than 20 the number varies about a mean, but provides a useful specific diagnostic character. In *Shorea* the shape of the filament is an important section character, and in many genera the shape of the connectival appendage is diagnostic. The presence or absence of a stylopodium, the shape of the ovary and stylopodium and the size of the style relative to that of the ovary are often diagnostic for sections and sometimes species, particularly in *Shorea* and *Hopea*.

Fruit. The accrescent fruit calyx can usually be divided into two parts, the basal tube or cup, which is adnate to the ovary in *Anisoptera* and some *Vatica*, and the distal lobes; in *Shorea* and *Parashorea*, *Dryobalanops*, *Neobalanocarpus* and *Hopea* the sepals themselves are divided into the distal wing-like lobes, and the usually somewhat broadened, thickened, saccate base adpressed to the nut. In *Cotylelobium* and some *Vatica* the calyx cannot be so divided and only one measurement is then given in the text. The number of long and short lobes is generically constant, though most genera have representatives in which they are all short and equal; the latter condition is considered to be an independent, secondary parallel reversion; see under evolutionary trends. The length of the longer lobes, and rarely the length and size of the shorter lobes, can be specifically diagnostic.

The degree to which the calyx is united at the base into a cup or tube is generically constant, *Vatica* excepted. In *Dipterocarpus* the tube may be spherical, or with five ribs, wings or tubercles arising at the line of fusion of the calyx segments.

The size of the nut is often diagnostic. Its apex in *Hopea* bears the discernible remains and shape of the stylopodium if present in the flower.

The structure of the seed has been described by CORNER (1976). In *Upuna* (and also *Stemonoporus*, *Vateriopsis* and *Pakaraimaea*) there is a highly vascularised placentar region which is extended into a cup-shaped membrane in all but the last mentioned; this is the 'cupule chalazique' of HEIM (1892).

Embryology and germination. RAO (1953, 1956) described early ovular development in the Indian *Shorea robusta* GAERTN. f., *S. roxburghii* G. DON, *Vateria indica* L. and *Hopea wightiana* WALL. ex W. & A. One ovule only was found to develop. Embryo-sac development as of the *Polygonum* type. An initial oblique division of the zygote, followed by further oblique divisions of the daughter cells leads to a 4- or 8-celled pro-embryo, following which further division is normal. The endosperm is at first free nuclear. Fruit yielding more than one embryo were already known to BRANDIS; they are unusual, but occasionally occur in many species and genera, while individual trees are known by foresters to produce a high proportion. FOXWORTHY (1932) indicated that this is the general rule in *Shorea resinosa*. MAURY (1970a) found that each embryo developed from a separate ovule in two species of the African *Monotes* (though it was not known how many ovules had been fertilised) but in the gregarious riparian S.E. Asian *Hopea odorata* she was able (1970b) to confirm true polyembryony, with up to 12 embryos developing from a single ovule. She reported possible polyembryony also in the Malayan *Shorea parvifolia*; in several other Malasian species false polyembryony of the *Monotes* type was demonstrated (1968, 1970b) and in some true polyembryony suspected. KAUR *et al.* (1978) have now confirmed nucellar agamospermy in *Shorea ovalis* and *S. agami*, and strongly inferred it in *Hopea subalata* and *Shorea resinosa*.

PIERRE (1889-91), HEIM (1892), BRANDIS (1895), BURKILL (1917-25), SYMINGTON (1943) and



Fig. 12. Sapling of *Hopea dryobalanoides* MIQ. Note pendent leaves with drip-tips. Brunei (Photogr. ASHTON, 1958).

MAURY (1978) have described the diverse forms of mature embryo, the last three describing also germination and seedlings from studies of selected species. Consistent differences exist between some genera and sections, but many are obscured by bigger differences related to fruit size, which can vary between closely allied species. As MAURY (1978) showed, there can be much variation within species, and unusual forms are associated with distinctive habitats, as in the Dry Dipterocarp forest species *Shorea roxburghii* and *S. siamensis*, in which the germination is cryptocotylar. The cotyledons are large, \pm unequal (subequal in many species of *Shorea* sect. *Shorea*, *Richetioides*, *Pentacme* and some others, and in most *Vatica* and *Cotylelobium*); they are markedly unequal in *Dryobalanops*, *Neobalanocarpus*, and *Shorea* sect. *Anthoshorea*, and also in sect. *Doona* where one, large and ruminant, is retained within the pericarp at germination, while the other is small, laminar and photo-synthetic. Often the larger cotyledon is folded round the smaller, which \pm encloses the lignified placenta with the radicle lying outside. Both cotyledons are ruminant, much folded and remain within the pericarp in *Dipterocarpus* and *Stemonoporus*, the embryo being freed by elongation of the cotyledonary petioles; one is thus in *Shorea* sect. *Doona*; they are folded but become freed in *Anisoptera*, *Dryobalanops*, *Shorea* sect. *Anthoshorea* and some large-fruited *Vatica*. In some *Vatica*, and in *Cotylelobium* and *Stemonoporus* the cotyledons are lacinate. In *Shorea* sect. *Pachycarpae*, many species of sect. *Brachypterae* and some other large-fruited *Shorea* they are hastate, fleshy and prismatic, with the 2 inner faces flat and the outer convex; in many such species they remain within the pericarp until the embryo has rooted as in *Dipterocarpus*, with the embryo initially emerging by elongation of the cotyledonary petioles though unlike *Dipterocarpus* the cotyledons are ultimately freed. In typical medium or small-fruited dipterocarps (including some species of *Dipterocarpus*) germination is epigeal however, the cotyledons expand and become laminar, remaining yellowish or reddish (violet or magenta in *Shorea* sect. *Richetioides*) but photosynthesising to a limited extent.

The embryo usually remains small until immediately prior to germination, when the radicle rapidly elongates and bursts through the fruit apex, splitting the pericarp irregularly or (in most *Vatica* and in *Vateria*, *Stemonoporus*, many *Hopea* and *Dryobalanops*) \pm equally into 3 valves.

The first true leaves are opposite with interpetiolar stipules (except some *Vatica*), subsequent leaves spiral except in *Dryobalanops*, *Anisoptera*, *Vateria*, and occasionally others with 2 or more pairs of opposite seedling leaves. In *Anisoptera* the first 4 leaves sometimes appear in an estipulate whorl.

Seedlings and saplings. The first series of spirally arranged leaves in dipterocarp seedlings are characterised by their thinness, their long slender petioles, and their prominently acuminate apices (Fig. 5, 12); the tomentum, if present, is longer and sparser than in mature trees; stipules are narrower and more persistent. In *Dipterocarpus* the seedlings of all species are very similar in leaf shape and tomentum, though the stipule and resting bud tomentum already have the diagnostic characters that they possess in the mature tree. In most other genera the seedling is characteristic of the section and frequently the species. The seedling leaves give way rather abruptly to leaves resembling those of the mature tree but which are larger and more attenuate. This transitional stage is often absent in *Vatica* and *Hopea*, but persists until the crown emerges in canopy species.

Taxonomic importance of the structure of embryo and seedling. The potential taxonomic importance of the characters of the ripe embryo and the germinating seedling in the *Dipterocarpaceae* was indicated by HEIM (1892) and BURKILL (1920), and it has been in the Angiosperms as a whole by STEBBINS (1974), who claimed that "seedlings tend to be constant within genera and families, and to differ in a regular fashion between these categories, more than any other kind of characters."

In dipterocarps, these features in some cases confirm present concepts, and in others suggest some new relationships (MAURY et al., 1975; MAURY, 1978, 1979). The following characters have proved useful:

Ripe embryo. The position of the hypocotyl which, on meridian section, is implanted in the inferior half of the seed, in the superior half, in the middle, or in the apical quarter. When the free cotyledonary lobes are located towards the right side and the folding axis towards the left one, the hypocotyl is *dexter*; it can alternatively be *vertical* or *sinister*; the apical hypocotyl can be *horizontal-dexter* or *recurved-sinister*.

The cotyledonary folds, in equatorial section, are *covering* (folded as the pages in a book), or

encircling (rolled pages), or *juxtaposed* (a lateral half for each cotyledon). In meridian sections relative to the placental axis, the cotyledons are *piled-up* obliquely, or *parallel*, or *superposed*. The apex of the lamina can be folded towards the tip of the hypocotyl.

The lamina of the cotyledons are *entire*; or *lobate*, in which case there are two thick lateral lobes on both sides of the petiole, connected by a narrow, thin meridian zone (MAURY, 1978, vol. 2: p. 117) or *emarginate*, that is of intermediary shape. The lamina shape in each of these types can be *transverse* (type *Anthoshorea*: entire, type *Shorea*: bilobate), or *elongate* (type *Richetioides*: entire, type *Mutica*: bilobate), or *intermediate*. In each of these types, the lamina can be either thin or fleshy.

Germinating seedlings. The pericarp either splits under pressure or from the unfolding cotyledons and elongating hypocotyl, or dehisces independently prior to germination. The growth of the cotyledons terminates either before the pericarp splits, or later on during the development of the seedling. Cotyledonary nodes are characterized by the ratio of the number of gaps to the number of resin ducts per cotyledon. Stomata, when fully developed, provide further useful characters (MAURY, 1978, p. 154). In *Dipterocarpoideae* the cotyledons reach their final size in the ripe embryo. Germination leads only to unfolding of the cotyledons and the elongation of the hypocotyl. In this case, therefore, the ripe seed contains all the systematic and phylogenetic information that cotyledons can provide. The shape, structure, and organization of dipterocarpoid cotyledons are constant but only at generic and lower levels. Nevertheless, the interpretation of these characters is easier in seedlings when the cotyledons have fully unfolded, and when the phyllotaxy of the first node and the epidermal characters of the first true leaves provide additional information.

Monotoideae and *Pakaraimoideae* therefore share independent dehiscence of the pericarp, continued growth of the cotyledons following germination, apical folding of the cotyledons (not confirmed in *Pakaraimaea*) and albumen in the ripe embryo, in all these differing from *Dipterocarpoideae*. In the Asiatic subfamily, the group of genera *Hopea*, *Neobalanocarpus*, and *Shorea* (with imbricate ripe fruit calyx) appear to be differentiated from the group of the genera *Dipterocarpus*, *Anisoptera*, *Upuna*, *Cotylelobium*, *Vatica*, *Vateria*, and *Stemonoporus* (with valvate ripe fruit calyx). *Parashorea* in the former group, and *Dryobalanops*, which is in the latter on the basis of embryo characters, have subvalvate calyx in the ripe fruit.

Embryo and seedling characters provide novel insights in the presently recognized genera *Shorea* and *Parashorea* on the one hand, and *Vatica*, *Vateria*, and *Stemonoporus* on the other hand (MAURY, *l.c.*). On this basis, *Shorea sect. Doona*, *Pentacme*, *Anthoshorea*, *Shorea*, *Richetioides*, the combined *sect. Pachycarpae*, *Mutica*, *Rubella*, *Brachyterae*, and *Ovalis* (that is, *subg. Rubroshorea* MEIJER), and the genus *Parashorea* appear to be at the same taxonomic level. Within this grouping, *Shorea sect. Doona*, *Pentacme* and *Anthoshorea* form a subunit, *Shorea sect. Shorea*, *Richetioides*, and *Rubroshorea* another, while *Parashorea* stands alone but close to '*Rubroshorea*'. The *Rubroshorea* grouping is indeed much more heterogeneous than the others.

The relations between and within the genera *Upuna*, *Cotylelobium*, *Vatica*, *Vateria*, and *Stemonoporus* suggest that further discussion of *Vatica*, and also *Stemonoporus* might become justified. The affinities are stronger between *Upuna*, *Cotylelobium* and *Vatica sect. Sunaptea* and *Vatica p.p.* on the one hand, and between *Vatica sect. Vatica p.p.*, *Stemonoporus* and *Vateria* on the other hand. The complexity of the latter three groups (MAURY, *l.c.*) requires additional study.

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Anatomy. *Stem.* The whole family shares the combined characters of vested pits and the presence of tyloses. The *Dipterocarpoideae* are distinguished by two unique characteristics: The lateral (and apical also in *Stemonoporus*) leaf traces separate from the central vascular cylinder well below the node, passing up through the bark before entering the petiole; in *Dryobalanops* they arise at or even before the previous node. BURCK, PIERRE and HEIM used such characters extensively for taxonomic purposes, but BRANDIS was rightly cautious of such boldness before much more intensive examinations have been undertaken; it is likely that such characters could prove useful, especially at the species level. Vertical intercellular resin canals, scattered or in arcs, are universal also in the subfamily, and occur characteristically in the pith of internodes and leaf traces; in *Dryobalanops* there is a single central branching duct, in others varying numbers of peripheral ducts of varying or constant diameter. These would also merit intensive investigations.

The *wood anatomy* has been treated exhaustively by GOTTWALD & PARAMESWARAN who confirmed and extended the work of DESCH, demonstrating that the great diversity of wood anatomy provides valuable taxonomic characters at subfamilial, tribal, generic, infrageneric and sometimes species level. The accompanying Table 1 is modified from their work and summarises the

Table 1. Principal groupings of Malesian dipterocarps based on wood anatomy

	1	2	3	4	5	6	7	8	9	10	11	12	13
<i>Vatica</i> most spp.		+						+				+	+
<i>Vatica</i> § <i>Vatica</i> p.p.	+							+				+	+
<i>Cotylelobium</i>	+				+			+				+	+
<i>Upuna</i>	+						+	+				+	+
<i>Anisoptera</i>	+				+		+	+					+
<i>Dipterocarpus</i>	+				+			+					+
<i>Dryobalanops</i>	+				+								+
<i>Hopea</i>		+							+				
<i>Hopea ferrea</i>		+			+				+				
<i>Neobalanocarpus heimii</i>		+			+				+				
<i>Shorea</i> § <i>Pentacme</i>		+							+				
§ <i>Shorea</i>		+							+			+	
§ <i>Anthoshorea</i>		+			+				+				
<i>Shorea montigena</i>		+							+		+		
§ <i>Brachypterae</i> , <i>Rubella</i> , <i>Pachycarpae</i> , <i>Mutica</i>		+							+				
<i>Shorea leprosula</i> , <i>S. ovata</i> , <i>S. teysmanniana</i>		+							+	+			
§ <i>Richetioides</i>		+							+	+			
<i>Parashorea</i>		+							+				
<i>Parashorea smythiesii</i>		+							+	+			

Key to wood characters:

- | | | |
|---|-------------------------------------|------------------------------------|
| 1. Vessels solitary | 6. SiO ₂ frequent | 10. Resin canals in medullary rays |
| 2. Vessels grouped | 7. SiO ₂ absent | 11. Fibres thin-walled (< 3 μm) |
| 3. Uniseriate rays | 8. Resin canals scattered | 12. Fibres thick-walled (> 3 μm) |
| 4. Rays storied | 9. Resin canals in tangential bands | 13. Fibres with bordered pits |
| 5. SiO ₂ abundant, universal | | |

principal grouping they distinguished in Malesian taxa. The diameter of vessels, the size of rays, and the wood parenchyma distribution are also of more restricted diagnostic value.

Petiole. PIERRE, HEIM, MAURY, and other authors have used the petiolar anatomy, and particularly the arrangement of the vascular bundles as seen in transverse section at the distal end (the 'caractéristique'), as a guide to classification and species determination. HEIM in particular placed great weight on small differences observed in single specimens, as in his treatment of *Cotylelobium*. I have found that, though some genera possess a characteristic basic arrangement, variation within single species greatly exceeds variation between species except in some *Dipterocarpus*, and sections *Shorea* and *Hopea* of those genera, where the anatomy is very complex owing to the presence of several concentric arcs of vascular bundles. MAURY (1978) has shown that the sequential changes in petiolar anatomy in the first leaves of seedlings is distinctive at sectional and generic level.

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Palynology. The pollen grains in *Dipterocarpaceae* are mostly spherical and range in size from 17 μm (*Vatica havilandii*) to 87 μm (*Dipterocarpus humeratus*). *Pakaraimoideae* and *Monotoideae* are characterized by tricolporate pollen grains with a well developed endexine and a distinct foot layer. *Dipterocarpoideae* have tricolpate pollen grains which lack an endexine and possess a thin, often laminated basal layer which is probably homologous with a foot layer. Exine structure in *Pakaraimoideae* is reticulate-columellate with straight columellae, in *Monotoideae* reticulate-columellate with columellae inclined towards the centre of the lumina in a tilioid pattern. In *Dipterocarpoideae* exine structure varies between a) finely reticulate-columellate (*Hopea*, *Shorea*), b) a structure in which columellae and tectum are intimately fused, forming urn-shaped structures (*Dryobalanops*, *Dipterocarpus*) and c) a tilioid structure (*Vatica*). The surface of the muri may be crenelated (*Hopea*, *Shorea*, *Stemonoporus*), crotonoid (*Dryobalanops*, *Dipterocarpus*) or smooth (*Dipterocarpus*, *Vatica*). *Stemonoporus* is characterised by a fairly thick basal layer and operculate colpi. Within *Dipterocarpoideae* a relation between flower size and pollen size has been established. The large flowered genus *Dipterocarpus* has significantly larger pollen grains than genera with smaller flowers such as *Hopea*, *Shorea* and *Vatica*, while *Dryobalanops* is intermediate. Within the genus *Dipterocarpus* a similar correlation exists between size of flowers and of pollen. The pollen of *Pakaraimoideae* is of a generalised type, common in many Angiosperm families, but the pollen types of *Monotoideae* and *Dipterocarpoideae* are more specialized. In *Monotes*, the thick wall with well developed endexine and endoapertures may be related to the seasonal climate of dry evergreen forest to which the genus is adapted. In most *Dipterocarpoideae* the endexine and consequently also the endoaperture appears to have been lost, resulting in the development of a thin, very flexible wall, with slit-like colpate apertures only.

The presence of a tilioid exine structure in *Monotoideae* and *Dipterocarpoideae* indicates affinities with *Tiliaceae* (*Brownlowioideae*). The suggestion by KOSTERMANS that *Pakaraimoideae* is close to *Schoutenia* (*Tiliaceae*) is not supported by pollen morphology, since the latter genus has quite different triporate-echinate pollen. The pollen morphology in *Sarcolaenaceae* (*Chlaenaceae*) is also quite different from *Dipterocarpaceae*.

Literature: CARLQUIST, Brittonia 16 (1964) 231–254; KOSTERMANS, Taxon 27 (1978) 357–359; MAGUIRE *et al.* Taxon 26 (1977) 341–385; MAURY *et al.* Review Palaeob. Palynol. 19 (1975) 241–289. — J. MULLER.

Cytotaxonomy. Despite the ecological and economic importance of the *Dipterocarpoideae*, we have at present still rather a limited knowledge of their cytology.

JONG & LETHBRIDGE (1967) and JONG (1976), using the squash technique, established the occurrence of two main basic chromosome numbers, $x = 7$ and $x = 11$ among Indo-Malesian species in nine genera studied. This is in accord with earlier chromosome counts by ROY & JHA (1965) on

five Indian taxa representing four genera. Each basic number characterises a group of more or less related genera: $x=11$ the genera *Anisoptera*, *Dipterocarpus*, *Upuna*, *Vatica*, *Vateria* and *Stemonoporus*, and $x=7$ *Dryobalanops*, *Hopea*, *Neobalanocarpus*, *Parashorea*, and *Shorea*.

These observations are, however, at variance with those of TIXIER (1953, 1960) and PANCHO (1971). TIXIER published chromosome counts for some 13 Indo-Chinese taxa: $2n=12$ for *Pentacme* (reduced here to *Shorea* sect. *Pentacme*) and *Shorea*, and $2n=20$ for *Anisoptera*, *Dipterocarpus*, *Hopea* and *Shorea* (see Table 2). PANCHO (*l.c.*) reported also $2n=20$ in two Philippine species of *Dipterocarpus*. ROY AND JHA (1965) on the other hand, observed $2n=22$ in *Dipterocarpus alatus*, a species also studied by TIXIER (1953). That dysploidy or aneuploidy may exist within a genus or species remains however to be firmly established, partly because differences in chromosome counts appear to vary with observers rather than with taxa. No new basic numbers have yet been detected in recent cytological studies on some dipterocarps from the Malay Peninsula, Borneo and Ceylon (JONG & TAYLOR, unpubl.; SINGH, 1977).

The diploid numbers of one species of *Stemonoporus*, and two of *Vateria*, all $2n=22$, and three species of *Shorea* in the sections *Doona* and *Pentacme*, all $2n=14$, conform to taxonomic expectation (JONG, 1976; JONG & KAUR, 1979), thus confirming on the one hand the position of *Stemonoporus* and *Vateria* in the $x=11$ group of genera, and on the other ASHTON'S (1972) reduction of *Doona* and *Pentacme* to *Shorea*.

Similarity in chromosome number, it should be emphasized, does not necessarily imply resemblances in other features of the genome nor an unequivocal indication of close taxonomic affinity. Dipterocarp chromosomes like those of most other tropical hardwood species are small in size and rather uniform in morphology, and hence karyotypic variations are not readily discernible. Although certain differences for example in the number of satellited chromosomes and chromosome size have been noted by ROY & JHA (1965) among the five species they studied, the taxonomic value of such variation in the family however, has yet to be properly assessed from a wider and more representative sample (JONG & KAUR, 1979). *Neobalanocarpus heimii* (KING) ASHTON illustrates another important point: this taxonomically problematic species is diploid ($2n=14$) and has a highly irregular pattern of meiosis, at least in the single individual studied (JONG & LETHBRIDGE, 1967). Irrespective of the significance that might be attached to it (most probably a reflection of hybridity), such a meiotic pattern could not have been anticipated from an examination of somatic chromosomes. Thus meiotic information should be sought wherever possible in future cytological surveys, especially in taxonomically interesting taxa.

Polyploidy. Bearing in mind the difficulties involved in cytological sampling of tropical rain-forest trees, and the fact that much of the cytological information are based on cultivated specimens (often on only a single representative of a species), the available data indicate that polyploids are rare in the *Dipterocarpoideae*, although polyploid series are now known to occur in *Hopea* and *Shorea* ($2n=14, 21, 28$). *Hopea odorata* ($2n=14, 20$) and *Dipterocarpus tuberculatus* ($2n=20, 30$) are possibly examples of intraspecific polyploidy (see Table 2; also JONG, 1976; JONG & KAUR, 1979). *Hopea nutans* and *Shorea ovalis* ssp. *sericea* are both tetraploid, and cytologically the latter behaves as an autotetraploid (JONG & KAUR, 1979). A more extensive sampling might well disclose the existence of related diploid cytotypes in these two species. *Shorea ovalis* is morphologically variable, and it would be interesting to ascertain whether some of the distinct forms of this species are associated with any cytological variation.

Of special interest are triploid or near-triploid taxa of *Hopea* and *Shorea* (JONG, 1976; KAUR *et al.*, 1978), namely, *Hopea latifolia* (as *H. beccariana* in JONG, 1976), *H. subalata*, and *Shorea resinosa*, all $2n=3x=21$. *Hopea odorata* has $2n=20-22$.

In view of undecisive counts of $2n=20, 21$ and 22 encountered in root tips of *Hopea beccariana*, *H. subalata* and *H. odorata*, SOMEGO (1978) proposed that *Hopea* may be dibasic, with $x=7$ and $x=10$ or 11 , thus denying the possible occurrence of triploidy or near triploidy. ROY & JHA (1965) earlier published a diploid number $2n=14$ for Indian plants of *H. odorata* making the interpretation of $2n=20-22$ for the same species (growing in Kepong Arboretum) as a near-triploid more plausible.

The above species are able to produce viable seeds and, except for the first mentioned, also form a varying proportion of seeds containing multiple embryos.

That chromosome sterility resulting from triploidy or near triploidy can be circumvented by agamospermy has been inferred by KAUR *et al.* (1978) and JONG & KAUR (1979). Variations in the somatic number could of course be due to the presence of accessory chromosomes although such chromosomes have not previously been clearly identified in the *Dipterocarpaceae*.

The concurrence of triploidy and reproduction by seed points to the possible existence of agamospermy in these plants. Indirect as well as some embryological evidence (in the case of *Hopea subalata*) support such a deduction (KAUR *et al.*, 1978); conclusive evidence of nucellar polyembryony has come from tetraploid *Shorea ovalis ssp. sericea* (SINGH, 1977; KAUR *et al.*, 1978). Thus there appears to be a close association between polyploidy, multiple seedlings, and agamospermy and possibly with hybridity in the above mentioned cases; such a relationship is, however, by no means a universal one for there are diploids such as *Shorea agamii* ($2n = 14$) in which agamospermy is also suspected to be in operation (KAUR *et al.*, 1978; JONG & KAUR, 1979). This species also produces multiple seedlings in varying proportions.

Three of the taxa studied by TIXIER (1953, 1960) might possibly be triploid, but their chromosome numbers need confirmation: one form of *Dipterocarpus tuberculatus*, $2n = 30$; *Hopea odorata* and *Shorea obtusa*, both reported to have $2n = 20$.

All the chromosome numbers published to date pertain to genera in the subfamily *Dipterocarpoideae* and are listed in Table 2. Cytological information is not yet available for any member of *Cotylelobium*, nor of the subfamilies *Monotoideae* and *Pakaramoideae*.

Hybridisation. The triploid condition might have arisen in a variety of ways in the different taxa. In the case of *Hopea subalata*, known only from Kanching Forest Reserve in Peninsular Malaysia where a few small groups have been found (SYMINGTON, 1943) triploidy probably occurred as an isolated event. By contrast, in *H. odorata*, a riverbank tree of widespread distribution occurring in the evergreen forests of Indo-China, Burma, Thailand and northern Peninsular Malaysia (SYMINGTON, 1943; ASHTON, pers. comm.), diploid and near triploid cytotypes are known, and triploidy could have originated more than once in the different parts of its range, or alternatively it could have spread with the help of agamospermy from a single origin. A more careful study of these and other polyploids and their nearest relatives is required before greater understanding can be attained. Similarly, it is uncertain whether the triploids are derived from occasional union of haploid and unreduced gametes in a diploid cytotype, or from the habitual union of such gametes as known only in *Leucopogon juniperinum* (see SMITH-WHITE, 1955), or from hybridisation between diploid and tetraploid congeners. It is a well known fact that most triploids have low fertility (although they are rarely completely sterile, LEWIS, 1967), and are thus vulnerable to extinction unless they possess some means of ensuring their perpetuation at least in the short term. It has been inferred that agamospermy is the most likely mechanism (KAUR *et al.*, 1978), and that a combination of genes favouring apomixis could have been brought together through hybridisation. The origin of the tetraploid status of *Shorea ovalis ssp. sericea* is still uncertain, but the occurrence of chromosomal heterozygosity and agamospermy (JONG & KAUR, 1979) does strongly point to the involvement of hybridisation in its origin.

The possible hybrid nature of *Neobalanocarpus heimii* has already been mentioned (see also JONG & LETHBRIDGE, 1967; JONG, 1976) and further supportive evidence from meiotic examination of additional individuals as well as from embryological and other studies of its reproductive biology are required for a fuller understanding.

The best known dipterocarp interspecific hybrid in the aseasonal tropics is *Shorea leprosula* \times *S. curtisii*, both diploids of close affinity. The hybrid has been reported from several localities in Peninsular Malaysia and from Singapore. Intermediate forms between *Vatica rassak* and *V. umbonata* are found in unstable habitats where the ranges of the two species overlap in East Sabah. Also some collections of *Anisoptera costata* and *A. curtisii* suggest local hybridisation in N.W. Malaya. See further the notes under the species descriptions. Morphological hybrids are otherwise rare in the Lowland Mixed Dipterocarp forests (ASHTON, 1969) although they appear to be more common in the more seasonal regions, especially at zones of contact between allopatric taxa (examples given in text). There is at present, however, no cytogenetic information on any of the putative hybrids.

Literature: ASHTON, Bot. J. Linn. Soc. 1 (1969) 149–153; Blumea 20 (1972) 357–366; JONG in Burley & Styles (eds.), Tropical Trees: variation, breeding and conservation; Acad. Press (1976)

Table 2. Published chromosome numbers of the Dipterocarpaceae

Name	n	2n	Author
Anisoptera KORTH.			
<i>costata</i> KORTH. (as <i>A. cochinchinensis</i> PIERRE ex LANESS.)		20	TIXIER, 1953
? <i>laevis</i> RIDL.		22	JONG & LETHBRIDGE, 1967
<i>laevis</i> RIDL.		22	SOMEGO, 1978
<i>scaphula</i> (ROXB.) KURZ (as <i>A. glabra</i> KURZ)		22	SOMEGO, 1978
		20	TIXIER, 1960
Dipterocarpus GAERTN. f.			
<i>alatus</i> ROXB.		20	TIXIER, 1953
<i>alatus</i> ROXB.	11	22	ROY & JHA, 1965
<i>baudii</i> KORTH.		22	JONG & LETHBRIDGE, 1967
<i>cornutus</i> DYER		22	SOMEGO, 1978
<i>costatus</i> GAERTN. f. (as <i>D. artocarpifolius</i> PIERRE ex LANESS.)		20	TIXIER, 1960
<i>elongatus</i> KORTH. (as <i>D. warburgii</i> BRANDIS)		20	PANCHO, 1971
<i>intricatus</i> DYER		20	TIXIER, 1953
<i>kunstleri</i> KING (as <i>D. speciosus</i> BRANDIS)		20	PANCHO, 1971
<i>oblongifolius</i> BL.		22	SOMEGO, 1978
<i>obtusifolius</i> TEYSM. ex. MIQ.		20	TIXIER, 1953
<i>sarawakensis</i> SLOOT.	c. 22		JONG & LETHBRIDGE, 1967
<i>tuberculatus</i> ROXB.		20	TIXIER, 1960
<i>tuberculatus</i> ROXB. var.		30	TIXIER, 1960
<i>turbinatus</i> GAERTN. f.		20	TIXIER, 1960
Dryobalanops GAERTN. f.			
<i>aromatica</i> GAERTN. f.		14	JONG & LETHBRIDGE, 1967 SOMEGO, 1978
<i>oblongifolia</i> DYER		14	JONG & LETHBRIDGE, 1967 SOMEGO, 1978
Hopea ROXB.			
<i>beccariana</i> BURCK		20, 21, 22	SOMEGO, 1978
<i>glabra</i> W. & A. (as <i>H. wightiana</i> WALL. ex. W. & A.)		14	JONG & LETHBRIDGE, 1967
<i>latifolia</i> SYM. (as <i>H. beccariana</i> BURCK)		21	JONG, 1976
<i>nervosa</i> KING		14	SOMEGO, 1978
<i>nutans</i> RIDL.	14		JONG & LETHBRIDGE, 1967
<i>nutans</i> RIDL.		28	SOMEGO, 1978
<i>odorata</i> ROXB.		20	TIXIER, 1953
<i>odorata</i> ROXB.	7	14	ROY & JHA, 1965
<i>odorata</i> ROXB.		20, 21, 22	KAUR <i>et al.</i> , 1978 SOMEGO, 1978
<i>pubescens</i> RIDL.	c. 7		JONG & LETHBRIDGE, 1967
<i>sangal</i> KORTH.		14	SOMEGO, 1978
<i>subalata</i> SYM.		21	KAUR <i>et al.</i> , 1978
<i>subalata</i> SYM.		20, 21, 22	SOMEGO, 1978
Neobalanocarpus ASHTON			
<i>heimii</i> (KING) ASHTON	7	14	JONG & LETHBRIDGE, 1967 SOMEGO, 1978
Parashorea KURZ			
<i>densiflora</i> SYM.		14	SOMEGO, 1978
Shorea ROXB. ex. GAERTN. f.			
<i>acuminata</i> DYER		14	KAUR <i>et al.</i> , 1978 SOMEGO, 1978

Table 2. (Continued)

Name	n	2n	Author
(<i>Shorea</i>)			
<i>agamii</i> ASHTON		14	KAUR <i>et al.</i> , 1978
<i>argentifolia</i> SYM.		14	KAUR <i>et al.</i> , 1978 SOMEGO, 1978
<i>assamica</i> DYER			
<i>ssp. globifera</i> (RIDL.) SYM.		14	SOMEGO, 1978
<i>bracteolata</i> DYER		14	SOMEGO, 1978
<i>contorta</i> VIDAL		14	JONG & KAUR, 1979
<i>curtisii</i> DYER <i>ex</i> KING		14	JONG & LETHBRIDGE, 1967 SOMEGO, 1978
<i>gardneri</i> (THW.) ASHTON		14	JONG & KAUR, 1979
<i>glauca</i> KING		14	SOMEGO, 1978
<i>guiso</i> (BLCO) BL.		14	SOMEGO, 1978
<i>hypochroa</i> HANCE		14	SOMEGO, 1978
<i>leprosula</i> MIQ.		14	JONG & LETHBRIDGE, 1967 SOMEGO, 1978
<i>macrophylla</i> (DE VR.) ASHTON		14	KAUR <i>et al.</i> , 1978
<i>macroptera</i> DYER			
<i>ssp. macroptera</i>		14	KAUR <i>et al.</i> , 1978 SOMEGO, 1978
<i>maxwelliana</i> KING		14	SOMEGO, 1978
<i>mecistopteryx</i> RIDL.		14	SOMEGO, 1978
<i>multiflora</i> (BURCK) SYM.		14	SOMEGO, 1978
<i>obtusa</i> WALL.		20	TIXIER, 1953
<i>ovalis</i> (KORTH.) BL.		28	SOMEGO, 1978
<i>ssp. sericea</i> (DYER) ASHTON	14	28	JONG & LETHBRIDGE, 1967
<i>palembanica</i> MIQ.		14	SOMEGO, 1978
<i>parvifolia</i> DYER		14	KAUR <i>et al.</i> , 1978 SOMEGO, 1978
<i>pauciflora</i> KING		14	JONG & LETHBRIDGE, 1967 SOMEGO, 1978
<i>pinanga</i> SCHEFF.			
(as <i>S. compressa</i> BURCK)		12	TIXIER, 1960
<i>pinanga</i> SCHEFF.		12	TIXIER, 1960
<i>pinanga</i> SCHEFF.		14	JONG & KAUR, 1979
<i>platyclados</i> SLOOT. <i>ex</i> FOXW.		14	SOMEGO, 1978
<i>resinosa</i> FOXW.		21	KAUR <i>et al.</i> , 1978
<i>robusta</i> GAERTN. <i>f.</i>		14	RAO, 1954
<i>robusta</i> GAERTN. <i>f.</i>	7	14	ROY & JHA, 1956, 1965
<i>robusta</i> GAERTN. <i>f.</i>		14	NANDA, 1962
<i>roxburghii</i> G. DON			
(as <i>S. talura</i> ROXB.)	7	14	ROY & JHA, 1965 SOMEGO, 1978
<i>siamensis</i> MIQ.			
(as <i>Pentacme siamensis</i> (MIQ.) DC.)		12	TIXIER, 1953
<i>singkawang</i> (MIQ.) MIQ.	7		JONG & LETHBRIDGE, 1967
<i>smithiana</i> SYM.	7		JONG & LETHBRIDGE, 1967
<i>splendida</i> (DE VR.) ASHTON		14	JONG & KAUR, 1979
(as <i>S. martiniana</i> SCHEFF.)		14	SOMEGO, 1978
<i>stenoptera</i> BURCK		14	KAUR <i>et al.</i> , 1978
<i>sumatrana</i> (SLOOT. <i>ex</i> THOR.) SYM.	7		JONG & LETHBRIDGE, 1967
<i>trapezifolia</i> (THW.) ASHTON		14	JONG & KAUR, 1979
<i>Upuna</i> SYM.			
<i>borneensis</i> SYM.		22	SOMEGO, 1978
<i>Vatica</i> L.			
<i>cinerea</i> DYER		22	SOMEGO, 1978
<i>odorata</i> (GRIFF.) SYM. <i>ssp. odorata</i>			
(as <i>V. grandiflora</i> DYER)	11	22	ROY & JHA, 1965 SOMEGO, 1978

Table 2. (Continued)

(<i>Vatica</i>)	Name	n	2n	Author
	<i>pauciflora</i> MIQ. (as <i>V. wallichii</i> DYER) <i>rassak</i> KORTH.	11		JONG & LETHBRIDGE, 1967
	(as <i>V. papuana</i> DYER) <i>stapfiana</i> (KING) SLOOT.		22	JONG & LETHBRIDGE, 1967
			22	JONG & LETHBRIDGE, 1967

79–84; JONG & KAUR, Mém. Nat. Hist. Mus. Paris B 26 (1979) 41–49; JONG & LETHBRIDGE, Notes R. Bot. Gard. Edinb. 27 (1967) 175–184; KAUR, HA, JONG, SANDS, CHAN, SOEPADMO & ASHTON, Nature 271, n. 5644 (1978) 440–442; LEWIS, Taxon 16 (1967) 267–271; NANDA, J. Ind. Bot. Soc. 41 (1962) 271–277; PANCHO, Taxon 20 (1971) 794–795; RAO, Ind. For. 80 (1954) 551–552; ROY & JHA, Sci. & Cult. 22 (1956) 236–238; J. Ind. Bot. Soc. 44 (1965) 387–397; SINGH (née AWATAR KAUR), Unpublished Ph.D. Thesis, University of Aberdeen (1977); SMITH-WHITE, Heredity 9 (1955) 79–91; SOMEGO, Mal. For. 41 (1978) 358; STEBBINS, Chromosomal Evolution in Higher Plants; Edward Arnold, London (1971); SYMINGTON, Mal. For. Rec. 16 (1943); TIXIER, Rev. Cytol. et Biol. Veg. 14 (1953) 1–2; *ibid.* 22 (1960) 65–70. — K. JONG.

Phytochemistry. General chemical properties were summarised by HEGNAUER (1966). Production of oleoresins (balms, resins) is characteristic of most members of the family. Their volatile portion consists mainly of sesquiterpenes such as humulenes, caryophyllenes, copaënes, elemenes and guajenes (e.g. gurjunenes, apitonen); in some instances monoterpenoids predominate (i.e. borneol in the so-called 'Borneo camphor' from *Dryobalanops aromatica*). The sesquiterpene alcohol spathulenol occurs in balms of species of three of the four subgenera of *Shorea* (BISSET *et al.*, 1971). The resin fractions of the oleoresins are composed of triterpenoids and usually consist of neutral and acidic constituents. Dipterocarpol (= hydroxydammaradienone-II) is a ketonic tetracyclic triterpene alcohol having the so-called dammarane skeleton; together with similar compounds like dryobalanone it represents an outstanding feature of the subfamily *Dipterocarpoideae*. The dammarane skeleton is also present in a number of acidic resin constituents such as dipterocarpolic acid, dammarenolic acid (I) and shoreic acid (II). Other dipterocarpaceous resin triterpenoids possess the pentacyclic skeletons of ursolic acid (e.g. ursonic acid, asiatic acid, the lactonic compound B [III] *etc.*), oleanolic acid (e.g. oleanolic acid, hederagenin *etc.*) and betulinic acid (e.g. erythrodiol). Compounds I, II and III have an oxidatively cleaved A-ring; they represent so-called A-ring seco-triterpenes, which seem to be rather characteristic of dipterocarps. Many of the oleoresin constituents mentioned were described since 1966 (e.g. CHAN, 1969; CHEUNG, 1967, 1968; CHEUNG & FENG, 1968; CHEUNG & YAN, 1972; CHEUNG & WONG, 1972; GUPTA & SUKH DEV, 1971; HARRISON *et al.*, 1971; LANTZ & WOLFF, 1968). Some attention has been paid also to the phenolic constituents of leaves, barks, woods and seeds. Dipterocarps tend to produce proanthocyanidins (i.e. oligomeric catechins formerly called leucoanthocyanidins) and gallic acid derivatives. These polyphenolic compounds are building stones of condensed and hydrolysable tannins; both types of tannins are present in taxon-characteristic ratios and amounts in many members of the family. Two derivatives of gallic acid deserve mentioning. Ellagic acid, the dilactone formed on hydrolysis of ellagitannins, was shown to occur in leaves and seeds of many species and bergenin, a striking derivative of gallic acid, has been isolated up to this day from members of *Dipterocarpus*, *Shorea*, *Stemonoporus* and *Vateria* (BHRARA & SESHADRI, 1966; DESAI *et al.*, 1967, 1971; BANDARANAYAKE *et al.*, 1977). Most probably both compounds will turn out in future to represent good chemical characters of *Dipterocarpaceae*. The same may be true for *Hopea*-phenol, a phenolic constituent of barks and heartwoods, which is presently known from species of *Balanocarpus*, *Hopea* and *Shorea* (COGGON *et al.*, 1965, 1966; MADHAV *et al.*, 1967). *Hopea*-phenol was shown to be a condensation product of four molecules of the trihydroxystilbene resveratrol. It is chemically similar to the viniferin-type phytoalexins of *Vitis vinifera*. With regard to phenolic leaf constituents BATE-SMITH and WHITMORE (ex HEGNAUER, 1966) stressed the frequent occurrence of vicinal trihydroxylation (ellagic acid, gallic acid; B-ring in the flavonoids myricetin and prodelfinidin) in dipterocarps. As far as investigated, seed fats (oils) of *Dipterocarpaceae* are characterized by a

strong predominance of stearic and oleic acid. Sal fat (oil of seed kernels of *Shorea robusta*) was shown recently to contain also small amounts (c. 4%) of 9,10-epoxystearic acid (BRINGI, 1972).

BATE-SMITH & WHITMORE (1959) examined the phenols of fresh leaves in 28 species in 8 genera, giving attention to those compounds known to be of chemotaxonomic interest elsewhere. A grouping of genera was arrived at on the basis of the leucoanthocyanins present and their abundance which little reflected grouping established by traditional means; no clear grouping of *Shorea* species by their established sections was possible, though *Neobalanocarpus* was confirmed to closely resemble *Hopea*.

Recently taxonomic potentialities of chemical characters at an intrafamilial level were discussed by several authors. DIAZ *et al.* (1966) and BISSET *et al.* (1966, 1967, 1971) showed that the composition of the oleoresins (sesquiterpene-fractions, triterpene-fractions) is rather characteristic of the taxa *Shorea sect. Doona*, *Anisoptera*, *Cotylelobium* and *Upuna* and that in the genera *Dryobalanops*, *Dipterocarpus* and *Shorea* the chemistry of oleoresins might be helpful to classification beneath generic level. Subsequently BANDARANAYAKE *et al.* (1975, 1977) stressed the systematic importance of resin composition in dipterocarps. According to these authors the significant differences in resin composition between representatives of *Shorea sect. Doona* and other sections do not agree with the proposition to merge *Doona* with *Shorea*. Very little work was performed with representatives of the African subfamily *Monotoideae* (*Monotes*, *Marquesia*) which lack resin ducts and seem to deviate chemically in several respects (DIAZ *et al.*, 1966) from the Asiatic subfamily *Dipterocarpoideae*. At present a chemotaxonomic discussion of relationships between these subfamilies seems to be premature. The same is true with regard to the recently described New World dipterocarpaceous genus *Pakaraimaea* (MAGUIRE & ASHTON, 1977) which according to KOSTERMANS (1978) would belong to *Tiliaceae*. The chemical evidence (GIANNASI & NIKLAS, 1977) given for dipterocarpaceous affinity is inadequate. Confirmation of the preliminary results reported by the authors mentioned as well as extension of phytochemical research are needed before chemical characters can make a serious contribution to the classification of the taxa concerned. Regarding relationships of *Dipterocarpoideae* with other plant families, the opinion held in 1966 by the present author is still valid; we are not yet in a position to discuss relationships in terms of chemical characters. On morphological arguments relationships with members of *Malvales* are often postulated. Presently known chemical characters do not convincingly contradict such a classification, but they form by no means strong evidence for such an affinity.

Literature: BANDARANAYAKE *et al.*, *Phytochemistry* 14 (1975) 2043; *ibid.* 16 (1977) 699; BATE-SMITH & WHITMORE, *Nature* 184 (1959) 795–796; BHRARA & SESHADRI, *Curr. Sci.* 35 (1966) 486; BISSET *et al.*, *Phytochemistry* 5 (1966) 865; *ibid.* 6 (1967) 1395; *ibid.* 10 (1971) 2451; BRINGI, *Chemistry and Industry*, London (1972) 805; K. C. CHAN, *Phytochemistry* 8 (1969) 1051; H. T. CHEUNG, *Tetrahedron Letters* (1967) 2807; *J. Chem. Soc.* (1968) C, 2686; H. T. CHEUNG & M. C. FENG, *J. Chem. Soc.* (1968) C, 1047; H. T. CHEUNG & C. S. WONG, *Phytochemistry* 11 (1972) 1771; H. T. CHEUNG & T. C. YAN, *Austr. J. Chem.* 25 (1972) 2003; COGGON *et al.*, *J. Chem. Soc.* (1965) 406; *ibid.* (1966) 439; DESAI *et al.*, *Indian J. Chem.* 5 (1967) 523; *ibid.* 9 (1971) 612; DIAZ *et al.*, *Phytochemistry* 5 (1966) 855; GIANNASI & NIKLAS, *Taxon* 26 (1977) 380; GUPTA & SUKH DEV, *Tetrahedron* 27 (1971) 635, 823; HARRISON *et al.*, *J. Chem. Soc.* (1971) C, 2524; HEGNAUER, *Chemotaxonomie der Pflanzen* 4 (1966) 31–44, 446–448, 487–488; KOSTERMANS, *Taxon* 27 (1978) 357; LANTZ & WOLFF, *Bull. Soc. Chim. France* (1968) 2131; MADHAV *et al.*, *Phytochemistry* 6 (1967) 1155; MAGUIRE & ASHTON, *Taxon* 26 (1977) 341–385. — R. HEGNAUER.

Taxonomy. Historical review. The first mention of the family of great trees that dominate the lowland and hill-forests of the Far East in European literature is in the diary of MARCO POLO, who recorded visiting Fansur in Sumatra, considered to be the present Baros on the west coast, where the camphor tapped from the hinterland was at that time literally worth its weight in gold. Indeed, up till the mid-eighteenth century it was only the Sumatran camphor which attracted the attention of European travellers. It is mentioned in Dutch literature several times in the mid and late 17th and early 18th century. RUMPHIUS (1755) described the *Arbor Camphorifera* II occidentalis and also mentioned an *Arbor Koring* (1741), which MERRILL (1917) regards as *Dipterocarpus hasseltii* BL. (the name *këruing* and variations of it being the Malay and Indonesian generic name); MERRILL's evidence is meagre however. The camphor tree receives further mention from CHARLES MILLER (1778) who sent a specimen to BANKS from Sumatra.

Meanwhile LINNAEUS had received material from India of a plant that he described as early as 1737 as the genus *Vateria*, and in the 1st edition of *Species Plantarum* (1753) and 5th edition of *Genera Plantarum* (1754) as *Vateria indica*. This he placed in his Class Polyandria Monogynia between *Mesua* and *Thea*, and shortly after *Microcos*, *Tilia*, and *Elaeocarpus*. In 1771 he described *Vatica* in *Mantissa Plantarum*, placing it in Dodecandria Monogynia with *Befaria* MUTIS. DE JUSSIEU (1789) placed *Vatica* and *Vateria* under 'Genera alternifolia, hinc Guttiferis, inde Aurantiis affinis', with two other genera of undecided affinity — *Allophyllus* (now in *Sapindaceae*), and *Elaeocarpus*. The two then known genera were thus brought together for the first time. In 1824 A. P. DE CANDOLLE placed *Vatica* under *Tiliaceae*, but omitted mention of *Vateria*.

In 1825 SPRENGEL included *Shorea* GAERTN. and *Dipterocarpus* GAERTN. under Polyandria Monogynia, citing *Dipterocarpus* in the *Tiliaceae*. *Vatica* and *Hopea* ROXB. he included in Dodecandria Monogynia following LINNAEUS. In 1828 REICHENBACH placed the then known genera in his *Laurineae d. Pterigiae*, adopting the latter name after CORREA's genus *Pterigium* (1806), in which had been included *Dipterocarpus* and *Dryobalanops* GAERTN. described the year previously.

In 1825 however BLUME had created the family *Dipterocarpeae*, stating that it bore affinities to the *Tiliaceae* in the contorted corolla, and to the *Guttiferae* in the resin ducts, superior ovary, many stamens, and single exalbuminous seed.

LINDLEY (1836) put the '*Dipterocarpeae*' with *Sterculiaceae*, *Malvaceae*, *Elaeocarpaceae*, *Tiliaceae* and *Lythraceae* into his Alliance *Malvales*, commenting that BLUME had noticed affinities with *Guttiferae*. So did MEISNER (1837) who placed *Dipterocarpaceae* next to *Sterculiaceae*, *Tiliaceae* and the Madagascan *Sarcolaenaceae* (*Chlaenaceae*).

ENDLICHER (1840) on the contrary had put the family with the Class *Guttiferae*, with *Chlaenaceae*, *Ternstroemiaceae*, *Clusiaceae*, *Marcgraviaceae*, *Elatineae*, *Reaumuriaceae* and *Tamaricaceae*, thus far separated from *Tiliaceae*. He also erected the African genus *Lophira* BANKS ex GAERTN. (now *Ochnaceae*), which GUILLEMIN (1830) had considered a dipterocarp, into an order of its own, and reduced *Shorea* ROXB. ex GAERTN. to *Vatica* L. This classification was subsequently followed by LINDLEY (1846). BENTHAM & HOOKER (1862), besides accepting GUILLEMIN's conclusions on *Lophira*, included also *Ancistrocladus* WALL. PLANCHON (1849) had previously put both genera in a group of their own allied to the *Ochnaceae*. BENTHAM & HOOKER resurrected *Shorea*, and maintained the family in their Cohors *Guttiferales*, though stating its affinities to be with the *Tiliaceae* as well as the *Ternstroemiaceae*.

The first complete monograph of the family appeared in A. DE CANDOLLE's *Prodromus* (1868); he enumerated 126 species in 13 genera including *Monotes*; 27 years earlier KORTHALS (1841) had estimated the total known species at only 34. DE CANDOLLE again placed *Ancistrocladus* and *Lophira* in separate families; he further described the first known African dipterocarp as *Monotes africanus*, indicating by its name that the genus occupied an isolated place in the family. He claimed the affinities of *Dipterocarpaceae* to be with *Chlaenaceae* and *Ternstroemiaceae*, with *Lophiraceae* and *Ancistrocladaceae* as intermediate groups.

In 1874 DYER monographed the genera *Dipterocarpus* and *Dryobalanops*. BURCK (1887) made a study of East Indian dipterocarps based in large part on anatomical characters; he created no new genera but united the genera *Pentacme* DC., *Monoporandra* THW. and *Stemonoporus* THW. with *Vateria* and transferred part of the genus *Hopea* ROXB. to *Doona* THW.

HEIM's 'Recherches sur les Diptérocarpacées' (1892) remains to this day the most detailed study of the whole family. Though he frequently made anatomical studies of leaf, petiole, twig and fruit, he gave particular weight to the characters of the stamens, the embryo and to the 'caractéristique' (the arrangement of the vascular bundles as seen in transverse section in the petiole at the umbo). His system suffered because he was working at a time when herbarium collections were quite inadequate in quality and in numbers for his task. The result was unfortunate; whereas BURCK five years previously had recognised only 10 genera, HEIM maintained 30, in 8 series and 2 subseries; of these 13 genera were new though based altogether on only 17 species, of which 11 were described from single herbarium sheets. The genus *Cotylelobiopsis* HEIM, for instance, was described from a single sterile sheet in which the anatomy of the petiole was found to be unique in the family; the specimen, which is lost, appears to represent fallen leaflets of *Pseudosindora palustris* SYM. in the *Leguminosae*. *Cotylelobium melanoxydon* was represented under three binomials, each based on a single specimen. Of the 4 species recognised by HEIM in his genus *Richetia*, SYMINGTON (1933: 153)

later correctly reduced 3 to a single species already described by BURCK. The 4 genera united under *Vatica* by BURCK were redivided and placed in 2 series; *Monotes* DC. was removed to the *Tiliaceae*.

HEIM promised a more complete monograph at a later date, but in 1895 the *Dipterocarpaceae* were treated by BRANDIS and GILG for the Pflanzenfamilien; later in the same year BRANDIS also published an 'Enumeration of the Dipterocarpaceae . . .', based on the specimens at Kew and the British Museum. *Monotes* was reunited with the *Dipterocarpaceae*, while none of HEIM's genera were accepted and few of his species. They maintained but 16 genera, being a return to DE CANDOLLE's generic concept, with the addition of *Balanocarpus*, *Cotylelobium*, *Parashorea* and *Isoptera*, described subsequently to 1868; the reduction of *Petalandra* HASSK. to *Hopea*; and the maintenance of *Stemonoporus* separate from *Vatica*, under which name it had been reduced by DE CANDOLLE. They recognised 5 tribes in *Dipterocarpaceae sens. str.* following BRANDIS. Later GILG (1899) placed the African dipterocarps in a separate subfamily. His account in the 2nd edition of the Pflanzenfamilien (1925), which is the most recent of the whole family, is with this exception mainly a reprint of the 1895 account. In 1941 SYMINGTON described the genus *Upuna*; this genus necessitates a redefinition of BRANDIS's tribes, and this has been discussed by me (1978). Two tribes are now recognised in *Dipterocarpaceae* on the basis of the calyx, resin canal distribution and basic chromosome number. One includes BRANDIS's tribe *Shoreae* and *Dryobalanops*, while the remaining genera are contained in the other.

Subdivision of the family. The family is subdivided into three subfamilies (MAGUIRE & ASHTON, 1977), which can be distinguished as follows:

1. Anthers basifixed; pollen tricolpate; exine 2-3-layered. Sepals, if ampliate, then generally conspicuously unequal with 2-3 becoming alate in fruit. Ovary (2-)3-celled, each cell with 2 ovules. Wood, leaves and ovary with resin or secretory ducts; wood rays multiseriate. 13 genera: tropical Asia and Malesia **Dipterocarpoideae**
1. Anthers basi-versatile; pollen tricolporate; exine 4-layered. Sepals equally accrescent, papyraceous. Ovary (2-)3-4-(5-)celled, each cell with 2-4 ovules. Wood, ovary and, commonly, leaves without resin or secretory ducts.
 2. Petals longer than sepals. Anthers little or deeply basi-versatile, connective little or moderately projected as an apical appendage. Ovary 3-(4-)celled, each cell with 2 ovules. Wood rays dominantly uniseriate. 2 genera: tropical Africa and Madagascar (1 species).
Monotoideae
 2. Petals shorter than sepals. Anthers deeply basi-versatile, connective conspicuously projected as an apical appendage. Ovary 4-(5-)celled, each cell with 4 ovules. Wood rays dominantly biseriate. 1 genus: tropical America **Pakaraimoideae**

Recently KOSTERMANS (1978) suggested that *Pakaraimaea* would belong to *Tiliaceae* and might even be congeneric with *Schoutenia*. This opinion rests on a superficial comparison and his arguments are in part erroneous, e.g. on pollen and wood anatomy. It is now definitely proved that *Pakaraimaea* belongs to *Dipterocarpaceae* (MAGUIRE & ASHTON, 1980).

Subdivision of the Dipterocarpoideae. Two tribes are recognised:

1. Fruit calyx lobes valvate at base, calyx cup vasculature not overlapping in flower. Vessels usually solitary, resin canals scattered. Basic chromosome number (probably) $x=11$: *Vateria*, *Vateriopsis*, *Stemonoporus*, *Vatica*, *Cotylelobium*, *Upuna*, *Anisoptera*, *Dipterocarpus*
Tribe Dipterocarpeae
2. Fruit sepals expanded and imbricate at the incrassate cupped base, calyx cup vasculature \pm overlapping at margin in flower. Resin canals in tangential bands. Basic chromosome number (probably) $x=7$: *Dryobalanops*, *Parashorea*, *Hopea*, *Neobalanocarpus*, *Shorea*. **Tribe Shoreae**

The two large genera *Hopea* and *Shorea* differ in a single character of the fruit calyx, indiscernible in those species where the sepals are short and equal and which are assigned to their respective genera according to the flora characteristics by which their sections are defined. *Neobalanocarpus heimii*, with unique floral morphology and short subequal fruit sepals, is thus unassignable but in several ways intermediate.

Generic and infrageneric delimitation (for a review see ASHTON, 1979a). A wide range of characters of flower and fruit, leaf, bark and wood are available for distinguishing between dipterocarp genera.

In tribe *Dipterocarpeae* the Malesian genera are marked by their internal uniformity and a unity imposed by a large number of anatomical and morphological characteristics. This is particularly so of the large genus *Dipterocarpus*. *Vatica* and *Cotylelobium* differ principally in flower and wood structure, which are nonetheless rather uniform intragenerically; but it is remarkable that the two distinctive forms by which the two sections of the large genus *Vatica* are distinguished are identically repeated in *Cotylelobium* with a mere 5 species of which one, *C. lewisianum* (TRIM. ex HOOK. f.) ASHTON of Ceylon, has short, equal, reflexed fruit sepals and a thick-walled, loculicidally sutured pericarp. The monotypic *Upuna* is also very well distinguished, as is *Anisoptera* which nonetheless contains two uniform sections differing only in floral structure.

The remaining genera pose more or less considerable problems of definition. *Dryobalanops* and *Parashorea* are characterised by subequal typically long fruit sepals and are distinct anatomically and in leaf venation. *Parashorea* shares alone with *Dipterocarpus* in the family its plicate venation; *Dryobalanops* has unique leaf venation; each are further distinguished by a constant and characteristic floral and embryological structure. The remaining 253 Malesian species can be subdivided into 18 groups, of varying size and distinctiveness but generally great internal uniformity in diagnostic characters, on the basis of the androecium. In some, such as the large sections *Anthoshorea* and *Richetioides* (also *Doona*, endemic to Ceylon) of *Shorea*, these characters are correlated with equally constant and distinctive bark, wood, embryo and other characters. In others, such as *Hopea* subsect. *Hopea*, *Neobalanocarpus* and *Shorea* sections *Shorea*, *Pentacme* and *Neohopea* significant differences in floral, and in the case of *Hopea* fruit morphology, occur to distinguish them from one another, yet all share an essentially uniform leaf, wood and bark anatomy which often makes them impossible to assign in the field when sterile. The same is so of the wood of *Shorea* sections *Rubella*, *Brachypterae*, *Pachycarpae* and *Mutica*, though here each possesses distinctive bark manifestations, and indeed sections *Brachypterae* and *Rubella* more closely resemble in floral structure sect. *Anthoshorea* though differing significantly in wood and bark anatomy. We have here therefore a constellation of taxa, the most distinct of which approach the status of genera equivalent to, for instance, *Vatica* and *Cotylelobium*, the least not meriting more than subsectional status, yet all clearly part of a greater coherent group. Ideally all might be included in a single common genus *Shorea* of many sections, yet as generic definitions were formerly based on fruit calyx morphology the sections are presently included in two major genera, *Shorea* and *Hopea*, differing only in a single character, the number of aliform fruit sepals. Species therefore with short subequal fruit sepals — regarded in these taxa as a derived condition — are assigned to a genus according to their sectional characteristics. *Shorea isoptera*, however, of the monotypic sect. *Neohopea*, has 5 aliform subequal fruit sepals and unique floral morphology and is only assigned to *Shorea* owing to its overall resemblance in bark, wood and habit, to members of the type section; it would be undesirable to create a new genus for a single species in many respects intermediate between such similar genera. *Neobalanocarpus* likewise has short subequal sepals and unique floral morphology; it appears, on leaf characters, wood anatomy, biochemistry and habit to come closest to *Hopea*, but is kept separate for historical reasons and as perhaps the most celebrated forest tree of Malaya. *Hopea* and *Shorea* nevertheless are more or less recognisable as entities, the former being generally smaller trees and frequently stilt-rooted; foresters in tropical Asia would damn the botanist who undertook 86 nomenclatural changes in the quest of a spurious taxonomic ideal, and so would I.

Specific and infraspecific delimitation (for a review see ASHTON, 1978). The subfamily is mainly (though not exclusively) composed of morphologically well defined species in which with experience delimitation should present no difficulty. A main source of misinterpretation has been owing to the great difference in vegetative characters between the young and mature stages and hence to the lack of field experience on the part of many monographers. The early collectors frequently did not have the opportunity to collect leaf specimens from the crowns of the giant trees, and instead collected fallen fruit and saplings. Later authors were unable to establish the true identity of species described from such material, and redescribed material from the mature tree, when it became available, as a new species. This confusion is accentuated by the uniformity of flower and fruit within some sections, and the great value of leaf, tomentum and bark characters in diagnosis when the variability during the life of each species is understood.

Size differences are not by themselves sufficient to distinguish species, neither are therefore

differences of leaf size and shape together. Differences in fruit size are likewise unreliable and rarely correlate with other characters; collections from one tree in different years often exhibit great variation. A consistent discontinuity in leaf size, where correlated with differences in androecium or gynoecium, in qualitative (but not quantitative) characters of indumentum, with qualitative characters of the twig or stipule or with a discontinuity in the range in the number of leaf nerves does constitute an adequate criterion for separating species however.

In the absence of any possibility of proving interfertility taxa are designated as subspecies in the following circumstances:

(1) Where discontinuities occur in the range of quantitative characteristics of parts, or tomentum distribution and density, but no qualitative difference exists.

(2) If a series of clearly defined, but closely similar, taxa exist which occupy distinct geographical areas, even if intermediate forms are not known. The subspecies of *Dipterocarpus conformis* and *Shorea macroptera* serve as examples.

(3) If a series of closely similar taxa occupy distinct, but greatly overlapping, areas and in at least one area show intermediate forms. In *Shorea parvifolia*, for example, two subspecies are recognised with greatly overlapping ranges; a third form (the 'Perak form' of SYMINGTON, 1943) occurs in Malaya and in N.E. Borneo which possesses characters intermediate between the other two and may represent a hybrid between the two subspecies.

By contrast, though several forms of *Shorea pinanga* occur, apparently with different ecological ranges, the vast number of collections of this species show a bewildering range of more or less continuous variation, made more confusing as the varying characters, leaf size, number of nerves, and tomentum, also change much with the age of the plant; here subspecies are therefore not recognised.

Polymorphism of the latter type is unusual, tending to occur within Malesia in species within groups (such as *Shorea sect. Pachycarpae* and the New Guinea *Hopeas*) consisting of large numbers of species confined to a single geographical area, possibly undergoing active diversification at present. It is characteristic also of those species (e.g. *Shorea siamensis*, *Dipterocarpus obtusifolius*, *D. tuberculatus*, *Anisoptera costata*, and *A. thurifera*) which occur in both seasonal and non-seasonal climates and which become gregarious and regenerate freely in secondary forest or fire-savanna. Here too the only well authenticated hybrid populations between markedly dissimilar species of *Dipterocarpus* are known; examples are recorded by FOXWORTHY from Luzon, by KERR (1914) from Thailand, and by PARKER (1927) from Burma.

Notes are included after the descriptive texts, which elaborate on complex patterns of morphological variation in these taxa, including certain sections of *Shorea*, in which they prevail.

The apparently trivial yet remarkably constant differences which distinguish the multitude of species of non-seasonal western Malesia, their morphological uniformity as a rule, their tendency (see below, under evolutionary trends) in that region towards reduction of staminal size and number, their occasional flowering and the existence of polyembryony and triploidy open the possibility that apomixis may have become general under these climatic conditions. FEDOROV (1966, 1977), ASHTON (1969, 1977, 1978) and MEIJER (1974) have discussed the problem of dipterocarp speciation, but conclusive evidence is only now beginning to arrive (KAUR *et al.*, 1978).

Evolutionary trends within the family (for recent reviews see MAGUIRE & ASHTON, 1977; ASHTON, 1979b). *Fruit calyx*. Without resorting to theories to decide which characters are primitive, it is safe to assume that departure from regular actinomorphy in the dipterocarp flower must represent an advanced condition. This, as the family name suggests, occurs in the calyx following anthesis. The genera always possessing equal fruit sepals are the American subfamily *Pakaraimoideae* and the entire African subfamily *Monotoideae*, the short-sepalled *Vateria* L. of Ceylon and S. India, *Vateriopsis* of the Seychelles, *Stemonoporus* of Ceylon, and *Dryobalanops* with either short or aliform fruit sepals. *Vatica sect. Vatica* is also characterised by short equal fruit sepals, whereas in *sect. Sunaptea* they are unequal; species in the small genus *Cotylelobium* possess fruit identical to those of the latter section but for *C. lewisianum* (TRIM.) ASHTON of Ceylon in which they are as in the type section. In *Dipterocarpus*, *Parashorea*, and all sections of *Shorea* and *Hopea*, however, individual species occur also with short subequal fruit sepals: the evidence suggests that in these latter genera this condition is a secondary reversion: of the 66 species among these genera with short subequal sepals (3 in *Parashorea* and *Dipterocarpus*, *Neobalanocarpus*, 19 in *Hopea*, and 40 in

Shorea all but 8 are rare local endemics or confined to the island or country in which they occur. Of the 7 relatively widespread species all but 2 are typically riverine or swamp species; this fact, especially significant in a family usually characteristic of well drained land, suggests a secondary adaptation to water dispersal. Further, the group among these genera where the short-sepalled condition is most prevalent, and in which the non-riverine widespread species *Shorea multiflora* and *S. balanocarpoides* occur, is *sect. Richetioides* of *Shorea*. In the unique leaf nervation, the great restriction in most species of the tomentum so characteristic of the family, and in the characteristic reduction of the number of pollen-sacs from the usual 4 to 2, they give every indication of being an aberrant advanced group; this is supported by phytogeographic evidence, the section being large but confined to Malaya, Sumatra, Borneo and the Philippines. Again, some of these local endemics bear close resemblances to unequal-sepaled species of widespread distribution. As examples from many, *Shorea biawak* and *S. asahi*, both known only from northern Borneo have close affinities with *S. maxwelliana* and *S. laevis* respectively, both of which range through Borneo, Sarawak and Malaya.

According to CORNER (1949) an aril in an indehiscent fruit is a relic from a dehiscent state. SYMINGTON (1941) described a vestigial aril-like structure in *Upuna*, and considered that the 'cupule chalazique', which was observed by HEIM (1892) in dried material of *Stemonoporus* spp. as a cup-shaped process from the funicle, might also be an aril; this structure also occurs in *Vateriopsis*, and the highly vascularised placenta of *Pakaraimaea* may be homologous. No known dipterocarp has fruit dehiscent on the tree, but in *Marquesia*, *Stemonoporus* and *Upuna* the pericarp of the fallen fruit splits along three loculicidal sutures at germination and in the first two there is sometimes active recurving of the pericarp apex. The mature fruit of *Pakaraimaea* is unknown, but as the pericarp is extremely thin along its five angles it would appear to be capsular. Such sutures occur also in *Vateria*, *Stemonoporus*, *Dryobalanops oblongifolius* and in *Vatica* *sect. Vatica*. In other *Dryobalanops* and some *Hopea* sutures are not discernible but the pericarp often splits into 3 equal valves at germination; the pericarp of other dipterocarps is split more or less irregularly by the expanding embryo. Of the taxa with loculicidal sutures only *Upuna* has unequal fruit sepals; conversely all the natural groups within the Asian subfamily which have equal sepals as a constant character are included among those with sutures, and of these all but *Dryobalanops* have fruit sepals generally rotate or reflexed and shorter than the ripe seed.

Within *Dipterocarpoideae* there appears also to have been a reduction in the size of the seed and thickness of the pericarp. In *Vatica* *sect. Sunaptea* the fruit is small, the pericarp thin-walled, and the sutures obscure or absent. In the type section of *Vatica* most species have large fruit with thick-walled pericarps. Some, such as *V. vinosa*, *V. pallida*, *V. flavida* and *V. lobata* have fruit as small as those of *sect. Sunaptea*; these are further characterised by their comparatively thinner pericarp and obscure sutures. All however are local endemics except for the riverine *V. venulosa* which may well have extended its range rapidly and recently by water dispersal; hence they are unlikely to be ancient species. In other genera the same correlations prevail with the exception of the rather isolated genus *Dipterocarpus*, in which all the species have a large indehiscent nut enclosed in a calyx tube, the clearly recent and still diversifying *sect. Pachycarpae* of *Shorea* in which the largest fruited species are adapted to water dispersal, and a few other isolated *Shorea* species (e.g. *S. geniculata*) where the large fruit appears to be recent rather than ancient, but whose adaptive significance is not understood.

Stamens. The number of dipterocarp stamens may vary from 5 to c. 105. The most widespread number is 15; 10 occur in some *Hopea*, some species of *Shorea* *sect. Richetioides* and sometimes in abnormal flowers in *sect. Mutica*. The two *Stemonoporus* species formerly in *Monoporandra*, and a single Bornean species of *Vatica*, possess 5 only. Genera with many stamens as a characteristic are *Pakaraimaea*, *Marquesia*, *Monotes*, *Vateria*, *Upuna*, *Dryobalanops* and *Dipterocarpus*; it is usual also in the type section of *Anisoptera*, and *sect. Anthoshorea*, *Ovalis* and *Shorea* of *Shorea*. Phytogeographical evidence within Asia lends support to the suggestion that the primitive type had numerous stamens, and that genera with 15, 10 or 5 stamens reached these numbers by reduction. *Vateria* occurs in southern India, Ceylon, and the Seychelles whereas *Stemonoporus*, with 5 or 15, is endemic to the wet zone of Ceylon, *Anisoptera* *sect. Glabrae*, with 15 stamens, ranges from Burma and Indo-China through Malaya to Borneo, whereas *sect. Anisoptera* with many stamens occurs from Burma and Indo-China through Malaya and Sumatra, Borneo, the Philippines, and across

Wallace's line to New Guinea. Within *Shorea*, though the monotypic and probably advanced *sect. Ovalis*, with many stamens, occurs in Malaya, Sumatra and Borneo, the large *sect. Shorea* and *Anthoshorea* (with 15-~ stamens) are considerably more widespread than the equally large *sect. Mutica*, *Richetioides* and *Brachypterae* (typically with 10-15 stamens with the exception of two species). The former occur east of Borneo and the Philippines, and through India to Ceylon; the latter are confined to the everwet region of western Malesia with the exception of one species in the Moluccas. In this case a clear pattern emerges of a reduction of staminal number among local endemic species of the everwet zone, especially in the geologically recent region of lowland Borneo. The widespread species, often of the seasonal tropics and including the American and African subfamilies, retain the primitive condition. This pattern is most clearly seen within those groups in which staminal number is variable.

Wood anatomy. GOTTFWALD & PARAMESWARAN (1966) independently regard a characteristic type of multiple perforation, along with different stages of disintegration of the plate-membrane, in vessels of *Vateria* and certain species of *Vatica sect. Vatica*, and of spiral thickenings in vessel and parenchyma wells in the latter, as clearly indicating the primitive condition of the wood of these groups in the Asian subfamily. However, the aberrant type of multiple perforation plate, sporadically occurring in the woods of these taxa as well as the spiral thickenings to the vessel walls can — in the opinion of P. BAAS (personal comm.) — equally well be regarded as unusual specialisations in the *Dipterocarpaceae* of no phylogenetic significance whatsoever (*cf.* the occurrence of similar aberrant perforation plates in the wood of apple and pear trees, which cannot be interpreted as an argument that *Malus* and *Pyrus* are primitive in the *Rosaceae!*). On the basis of xylem anatomy *Stemonoporus* is closely allied with them, whereas *Upuna* is in many respects intermediate between them and *Anisoptera*, *Dipterocarpus* and *Cotylelobium*. *Shorea*, *Parashorea* and *Hopea* differ from other *Dipterocarpoideae* in their tangentially arranged resin canals (diffuse in other genera). Their conclusions on phylogenetic affinities are closely in accord with those derived from other evidence: "The evolutionary status within the (sub)family is characterised by a concentration of the non-advanced characters in the taxa outside the tribe *Shoreae*; thereby the genus *Dryobalanops* appears to form the connecting bridge. As a consequence, it is seen that in the extreme small south-west area of distribution a larger number of genera are present with relatively primitive characters than in the large Malesian region, usually regarded as the centre of origin of the family."

Petiole anatomy. The complex petiolar vascular supply, characteristic of many genera in the family, reaches its greatest elaboration in *Dipterocarpus*, *Vateria*, and the type sections of *Shorea* and *Hopea*. The supply is reduced to 3 peripheral bundles in many *Hopea sect. Dryobalanoides* and is relatively simple in the other sections of *Shorea*, but also in the putatively primitive *Vatica* however. It seems that the primitive condition was the complex one, but generalisations are difficult as the complexity also varies much according to the size of the petiole; large-leaved *Dipterocarpus* and *Shorea* (including species of *sect. Pachycarpae*) have very much more complex systems than small-leaved, and genera with slender petioles such as *Dryobalanops* and *Anisoptera* have simpler systems than *Dipterocarpus*, though more complex than most *Hopea* and *Shorea* (see *e.g.* MAURY, 1978). If the complex is more primitive, then *Hopea sect. Hopea* is nearest to the archetype in that genus. This is supported by the leaf nervation, which most nearly approaches the type typical of other genera, and by the bark morphology, which WHITMORE (1960) has shown to differ in no important way from that of *Shorea sect. Shorea*; these two sections both appear to be primitive in their genera, hence more nearly than others resemble the common ancestor and thus one another. They further both share a wider distribution than other sections in their respective genera.

Family affinities. Up to the time of BRANDIS's Enumeration (1895) *Dipterocarpaceae* had been variously associated with *Aceraceae* (GAERTNER), *Lauraceae* (REICHENBACH), *Theaceae*/*Ternstroemiaceae* (ENDLICHER, A. DE CANDOLLE), *Malvaceae* (LINDLEY), *Tiliaceae* (A. P. DE CANDOLLE, BLUME, SPRENGEL, MEISNER, LINDLEY, HEIM, BRANDIS, and GILG), *Sterculiaceae* (HEIM), and *Guttiferae* (DE JUSSIEU, BLUME, ENDLICHER, LINDLEY, BENTHAM & HOOKER, and HEIM). Since ENDLICHER the family has been more or less constantly put in the *Guttiferales*, this clearly allying it with *Guttiferae* and *Theaceae* and separating it from *Tiliaceae* in the Order *Malvales*. It should be remarked, however, that BENTHAM & HOOKER placed *Chlaenaceae* next to *Dipterocarpaceae* in cohorts *Guttiferales* which was immediately followed by cohorts *Malvales*, the only difference being

in the aestivation. This classification has been subsequently followed by BESSEY (1915), HUTCHINSON (1926), WETTSTEIN (1935), and PULLE (1950). LINDLEY (1836) at first placed *Dipterocarpaceae* in his Alliance *Malvales*, but in 'The Vegetable Kingdom' (1846) followed ENDLICHER's (1840) transfer to *Guttiferales*. HEIM (1892) claimed the affinities to be mainly with the *Tiliaceae*, but the only subsequent author to adhere to this view was HALLIER f. (1912) who placed them in his Order *Columniferae*, with marked affinities with *Tiliaceae* and *Elaeocarpaceae*. The *Columniferae* he considered to be derived from 'Protoberberidaceous' ancestors, and far removed from the *Guttiferales*, with Dilleniaceous ancestors.

The *Ancistrocladaceae* have been associated previously by many authors with the *Dipterocarpaceae* owing to the superficial similarity of their fruit with its 5-merous perianth, persistent aliform imbricate sepals, and the embryo with folded cotyledons enclosing the radicle and with the testa intruding between the folds. The unilocular ovary with single ovule, the leaf-nerivation, scandent habit, presence of thorn-hooks, and anatomy indicate to me that the affinity is not close.

Dipterocarpaceae share with *Guttiferae*, *Theaceae*, and also *Tiliaceae* centrifugal stamens, so that if CORNER's (1946) contention is correct all these families share a common ancestry, though the character gives no indication to which family the dipterocarps are most nearly associated.

With the *Theaceae* are shared the 5-merous perianth, imbricate persistent sepals, frequently contorted corolla, numerous hypogynous stamens, 2-celled anthers generally dehiscing longitudinally, superior generally 3-celled ovary with frequently 2 ovules per cell, axile placentation, and seeds with scanty endosperm. The absence, in *Theaceae*, of stipules, stellate, tufted or glandular hairs, connectival appendages, mucilage cells and usually resin canals and the frequently dentate leaves, indistinct leaf-nerivation, and short-sepaled fruit calyx, readily distinguish the two families.

It is the presence of intercellular resin canals which has principally led systematists to associate the *Dipterocarpaceae* with the *Guttiferae*; other characters in common are the vertically transcurrent-nerivation, the usually many hypogynous stamens, usually contorted corolla, usually racemose inflorescence, and persistent calyx with usually imbricate sepals. The absence of endosperm, which has frequently been cited as a factor allying the two, but not *Tiliaceae*, is erroneous; HEIM (1892) and others have already shown that some species in several groups retain endosperm at maturity of the seed.

Of the characters shared with the *Guttiferae*, those of the androecium are shared also with *Theaceae* and *Tiliaceae*, as also the contorted corolla and, in many, the-nerivation; the inflorescence in the *Tiliaceae* is also frequently racemose while conversely *Upuna*, *Monotes*, some *Vatica* and one *Parashorea* share the cymose inflorescence typical of most *Tiliaceae*; tribe *Dipterocarpeae* possesses a subvalvate flower calyx; in *Tiliaceae* the calyx is always valvate in flower. The resin canals are therefore the only character in common with the *Guttiferae* that are not also shared with some members of the *Tiliaceae*. Canals are confined to the medulla in the *Dipterocarpaceae*, unlike the *Guttiferae*.

Guttiferae differ notably in the absence of stellate or glandular hairs, the general presence of a hypodermis, the papillose lower epidermis, absence of stipules, frequently unisexual flower, absence of an appendage to the connective, absence of aliform fruit sepals, and opposite leaves (the alternate-leaved South American genera *Caraipa*, *Kielmayera*, *Haploclathra*, *Marila* and *Mahurea* are now considered to belong to the *Theaceae* or *Bonnetiaceae*). The leaf-nerivation in *Guttiferae*, with many indistinct lateral nerves, is very dissimilar from the prominent pinnate-nerivation of *Dipterocarpaceae*; *Dryobalanops*, and *Hopea sect. Dryobalanoides*, which are exceptional in sharing a-nerivation superficially similar to *Guttiferae*, cannot be considered primitive types in the family.

With the *Tiliaceae* the *Dipterocarpaceae* share the same stamen characters; the closely related *Elaeocarpaceae* bear connectival appendages similar to those of many dipterocarps; the genera *Grewia*, *Pentace*, and *Schoutenia*, inter alia, possess persistent, expanded, and wing-like fruit sepals. Characters shared with *Dipterocarpaceae* and *Tiliaceae* but not the previously discussed families are mucilage canals in cortex and cells in the epidermis of many, the mixed uni- and multi-seriate rays (except *Monotes*), the arrangement of bast fibres into outwardly tapering wedges, and the presence of a complex indumentum which may include single or tufted uni-cellular hairs, short or long stalked multicellular glandular hairs, and unicellular peltate or stellate hairs.

The floral vascular supply strikingly confirms the Malvalian allegiance (see VAN HEEL, 1966). CORNER (1976) has further found that the seed coat conforms to that of *Malvales*. These facts argue

against the family being included in the *Guttiferales* as opposed to the *Malvales*. The single anomalous character of the resin canals is absent from the subfamily *Monotoideae* and *Pakaraimoideae*. The *Elaeocarpaceae* are virtually always devoid of mucilage cavities; moreover the suggestion that elongate mucilage cells have phylogenetically developed into resin canals lacks any logical structural basis. The prominent pinnate nervation of dipterocarps, and frequently geniculate petiole, is so similar to that of the *Elaeocarpaceae* that leaves on the forest floor are sometimes almost unassignable. In the *Tiliaceae* the basal pair always send off lateral branches on the outer side; this is also found in some dipterocarps, e.g. in *Shorea robusta*, *Dipterocarpus nudus* and *D. stellatus*, and abnormally sometimes in other species. The dipterocarp leaf nervation, usually entirely transcurrent owing to the presence of columns of sclerenchyma, as in *Guttiferae* and *Ochnaceae*, is found sometimes also in *Tiliaceae*.

The genus *Monotes*, which with the genus *Marquesia* constitutes the African subfamily *Monotoideae*, was transferred to *Tiliaceae* by HEIM (1892); indeed *Marquesia excelsa* R.E.FR. was originally named (though not published) as a *Schoutenia*. The principal characters in which the *Monotoideae* differ from *Dipterocarpoideae* are the uniseriate rays, absence of resin canals but presence of elongate medullary mucilage cells, subversatile anthers with elongate slender filaments, and the tricolporate pollen with 4-layered exine. Of these all but the first are common in the *Tiliaceae*. The imbricate sepals, trilocular (in *Marquesia* incompletely septate as in *Dryobalanops*) ovary with two ovules in each cell, and pinnate nervation with unbranched basal nerves, are typical of *Dipterocarpaceae*. The cymose inflorescence is unusual in *Dipterocarpoideae*, but is widespread in *Tiliaceae*. BANCROFT (1935) examined the wood anatomy of *Monotoideae* and found it to be quite distinct from both families; this is confirmed by GOTTWALD & PARAMESWARAN (1966). The general facies is more similar to *Dipterocarpoideae*, but differences were considered by them sufficient to constitute a separate family. Resin was present in the wood as in *Dipterocarpoideae*, though not in intercellular canals. *Monotoideae* are thus a clearly defined group.

The recent discovery of a dipterocarp subfamily in the Guyana Highlands (MAGUIRE *et al.*, 1977) strengthens this link, for *Pakaraimaea* shares the stamen, pollen, calyx and many wood characters of *Monotoideae* (though the wood rays are predominantly biseriate), yet has a generalised Malvalian 4–5-celled ovary, each cell of which is 2–4-ovulate; in several respects therefore this South American relict must be regarded as archaic within the family.

Another family, *Sarcolaenaceae* (*Chlaenaceae*), endemic in Madagascar, has often been claimed to be a close relative of *Dipterocarpaceae*. MEISNER (1837) and BENTHAM & HOOKER (1862) had already placed them close to that family; so did HUTCHINSON (1926) and METCALFE & CHALK (vol. 1, 1950, 22). According to the studies of CAVACO (1952) and CAPURON (1970) they exhibit a far greater diversity than mostly admitted in handbooks, covering almost all characters of *Dipterocarpaceae*, in particular those of *Monotoideae*.

MAGUIRE *et al.* (1977) have pointed out that this family too has the indumentum and complex petiolar anatomy characteristic of *Malvales*, but shares with *Dipterocarpaceae* alone in this order an imbricate calyx, 3-celled ovary (here *Pakaraimaea* is the exception), and absence of paired basal leaf nerves; they also indicate that a distinct leaf nervation with looped intramarginal nerve, and a 1–2-layered hypodermis are shared by genera in both families; DE ZEEUW (*l.c.* 368) considered that the wood anatomy more closely resembles that of *Monotoideae* and *Pakaraimoideae* than theirs does even to *Dipterocarpoideae*; a resemblance to Tiliaceous wood exists too, but is more remote.

A preliminary anatomical study of *Eremolaena boinensis* also confirmed the presence of tufted hairs with a rosette of glandular hairs at their bases and possibly of peltate scales on the twigs. The anomocytic stomata, the bark anatomy, and the occurrence of mucilage cells in the mesophyll, pith and primary cortex together with the indumentum points to both Tiliaceous as well as Dipterocarpaceous affinities. In the wood anatomy, however, *Sarcolaenaceae* much more resemble *Monotoideae* of the *Dipterocarpaceae* than *Tiliaceae*: ray and fibre type agree well and most important of all *Eremolaena* shows vested pits: a very important taxonomic character found in all *Dipterocarpaceae* but not in *Tiliaceae* or other *Malvales*. METCALFE & CHALK say that the *Dipterocarpaceae* and *Sarcolaenaceae* differ by the absence of resin ducts in the pith of *Sarcolaenaceae*, but *Monotes* and *Marquesia* have not been examined in this respect, and could equally well miss these. Though *Sarcolaenaceae* and *Dipterocarpaceae* could be considered to represent different families, they appear to be distinctly allied at a higher level and could well belong

or have been derived from the same ancient Tiliaceous matrix in Gondwanaland (MAGUIRE *et al.*, 1977).

History of the Dipterocarpaceae. In concluding the preceding chapters it is tempting to speculate about the origin, dispersion, and development of this group in time.

The overriding contemporary concentration of dipterocarp species diversity of West Malesia prompted authors (from MERRILL, 1923, to MEHER-HOMJI, 1979) to suggest a Far Eastern origin for the family. The fossil evidence is ambivalent; PRAKASH (1972) and LAKHANPAL (1974) discussed the fossil history of *Dipterocarpaceae*. PRAKASH assumed an Asian origin for *Dipterocarpoideae*, but LAKHANPAL leaned toward a Gondwanic origin of the whole family, an idea originating with CROIZAT (1952). AUBRÉVILLE (1976) argued for a biphyletic origin, with *Dipterocarpoideae* of Laurasian, and *Monotoideae* of Gondwanic provenance.

Accepting the principle of continental drift one could rather easily imagine, on the basis of comparative anatomy and morphology, a southern Gondwana origin with the development of a 'Dipterocarpaceous ancestral stock' in a Gondwana-continent, possibly in the Upper Cretaceous. This implies of course a tropical to at least subtropical climate in a period long after the Angiosperms originated and had already strongly diversified.

The subsequent Atlantic split then provided the South American continent with a section of the dipterocarps of which *Pakaraimaea*, a generalised and in this sense archaic form within the family, as the sole survivor; the reason why this West Gondwana offshoot did not lead to a separate diverse and derived branch must remain obscure.

Also primitive in several respects was the other offshoot *Monotoideae*, which remained in a central position in tropical Africa where it is now represented with 2 genera and *c.* 40 *spp.* (with one which may have recently invaded Madagascar). Possibly from this same ancestral stock another plant family developed in Madagascar, *viz* *Sarcolaenaceae* as it seems *Monotoideae* are their closest allies.

The most successful 3rd offshoot was the *Dipterocarpoideae* of which the ancestors inhabited the eastern tropical part of Gondwanaland. According to trustworthy fossils they were at least present formerly in East Tropical Africa while *Vateriopsis* is a genus still found in the Seychelles, a relict on a surviving peak of the submerged part of the Deccan plate. Whether the Deccan plate sailed from S.E. Gondwanaland to the Laurasian shores of the Tethys with the dipterocarp pilgrim fathers to S.E. Asia on board remains to be confirmed by fossil evidence from the late Cretaceous or early Oligocene of India and East Africa, but the distribution and phylogeny of *Vateriopsis*, *Vateria* and *Stemonoporus* strongly suggest that it did.

Probably not long after the *Dipterocarpoideae* reached S.E. Asia, which must have been by the Oligocene according to the pollen records in Borneo, they rapidly diversified, as still shown by the present wide representation and endemism of supraspecific taxa in Ceylon. In all probability they were already rain-forest constituents, as most are at present in Ceylon, as they would also have been subject to oceanic (if more windy) conditions on a hypothetical rafted Indian subcontinent.

Migrating eastwards through S.E. Asia they finally invaded the Malesian area in the early Tertiary, as testified by the Oligocene pollen record in Borneo. By the Miocene they had become common, as shown by the abundance of fossil wood and their appearance as a regular constituent of the pollen record, and they have presumably retained this position till the present day.

In continental S.E. Asia they have come to thrive in both the everwet and seasonal regions. By their capacity for gregariousness and high stature they have overwhelmed the mixed lowland rain-forest and created the present majestic forest profile of the large islands of West Malesia.

The Philippines seem to have been close enough, and I would assume at least once connected with western Sundaland, to receive a generous supply. I do not believe that we can conclude from dipterocarp geography alone, though, that these islands have been intermittently invaded by dipterocarps as MERRILL (1923) discussed at length, though this would be compatible with the geomorphological instability of the region bordering the east of Wallace's line.

The land-connections between the Philippines and the Moluccas and New Guinea must have been similarly inadequate and intermittent and apparently did not allow *Parashorea*, *Dipterocarpus* *etc.*, to enter the East Malesian Province. The 4 genera in this province (Celebes, Moluccas, New Guinea) are: *Anisoptera*, *Hopea*, *Shorea* and *Vatica*. I accept DIELS's contention (1922) that the few dipterocarps of New Guinea represent a younger element in its flora, probably derived from the

northwest by way of the Philippines, Celebes and Moluccas. It is noteworthy that in New Guinea *Hopea* shows fairly high and probably young speciation.

In South Malesia there are only 5 genera present in Java with few (10) species, and in the western Lesser Sunda Is. only 2 genera with 3 *spp.* This paucity is ascribed to several causes; the volcanicity and long period of human habitation in the moist humid lowlands of Java precluded intensive collection there by the early Dutch botanists; further east poor land connections played a part, though much of the present distribution can be explained by the dry climatic conditions in the lowlands, for the petering out of the family eastwards is correlated with increasing drought; there appears to have been no capacity for development of drought-resisting species such as happened in continental S.E. Asia. It cannot therefore be safely concluded that South Malesia has not been a source area or invasion track of dipterocarps to New Guinea, particularly if the fossil *Shorea* record from Timor is correct.

Finally, there appears to have been a considerable extinction of dipterocarps in the Deccan Peninsula as shown by the range map (Fig. 2); *Anisoptera* and *Dryobalanops* have become extinct there, as has the latter also in Java. Whether *Parashorea* has ever occurred in the Deccan is uncertain, let alone the Bornean endemic genus *Upuna*.

The monotypic genus *Upuna*, endemic in Borneo, deserves special attention. It is primitive in several respects, notably it superficially resembles the primitive genus *Monotes* of a different subfamily while it shares a putative aril with the Ceylonese genus *Siemonoporus* and *Vateriopsis* of the Seychelles. It is most closely allied however to the Malesian genus *Anisoptera*, and to a lesser extent *Cotylelobium* and *Vatica*, especially in its wood anatomy. The presence, in Borneo, of *Upuna* emphasises that the story of dipterocarp development on its way east is undoubtedly more complicated than the simple panorama given above would imply, but the fossil record is unfortunately meagre.

All these characters correlate much more closely however with the aseasonal humid region of the Mixed Dipterocarp forests and, if we accept the view that they are derived (see f.f.), we must also accept the possibility that the subfamily originated in a seasonal tropical climate.

I firmly conclude from present knowledge of their reproductive biology, and in particular of the fruit dispersal, lack of seed dormancy, ecology of establishment and seedling ecology that the spread of dipterocarps must be overland. This is compatible with the hypothetical reconstruction above: the big Sunda islands, which were one continuous land area for most of the Pleistocene period are richest in dipterocarps, while the Celebes-Moluccan area could only intermittently have provided land bridges to convey the dipterocarps to New Guinea; its archipelagic geomorphology with frequently interrupted, partial land bridges seems to have impeded migration and prevented many genera from completing the course.

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Silviculture. The advanced silvicultural systems developed in Malaya are generally applicable in western Malesian Mixed Dipterocarp forests and are already described exhaustively by WYATT-SMITH (Mal. For. Rec. 23, 1963).

The principal silvicultural characteristics of dipterocarps in regions of Malesia where they are of economic importance are their absence of coppicing when mature, irregular gregarious flowering, poor fruit dispersal, lack of seed dormancy, high moisture requirements combined with a need for little litter and friable soil conditions at germination, the ability of saplings once established to persist for a number of years in the understorey in deep shade but the need for moderate to abundant light to effect rapid growth. Though species of the seasonal tropics have been successfully propagated by rooted cuttings (MOMOSE, 1978), species of the aseasonal zone have only been propagated with difficulty in this way. These and other characteristics vary among species and timber groups. Silvicultural methods have evolved partially in response to increased ecological understanding, partially owing to changes in forest economics and especially in timber values and labour availability and costs. Plantations and other artificial regeneration are presently generally too costly owing to the care required at and following germination and planting, and the necessity for subsequent weeding. Though enrichment planting, *i.e.* the supplementing of natural regeneration by planting in specially opened gaps or lines in naturally regenerating forest, is sometimes desirable owing to frequently patchy distribution of the preferred species it is doubtfully economically justifiable until cheaper and simpler methods of propagation are developed. The object of natural regeneration is to simplify forest composition so that trees are mostly restricted to a few economic species and the crop is of approximately even age. Originally improvement fellings were undertaken in unfelled forest. Later, in Malaya, the canopy was opened up prior to felling to ensure a satisfactory seedling crop at the time of felling; periodic low intensity fellings ensured retention of seed trees; eventually this proved uneconomic. In the meantime the development of improved preservation techniques combined with increasing labour costs to make the heavy hardwood species, which generally require at least 100 years to reach timber size, uneconomic to regenerate, favouring in particular the light red merantis that can be cropped on a cycle as short as 50-70 years.

Young trees larger than saplings are, as might be expected, poorly represented within the canopy in the forests of the Malay Peninsula and northern Borneo, and it is for this reason that the Malayan Uniform System of silviculture, which advocates a single clear felling every 50-70 years followed by regeneration of seedlings already established on the ground, is practised there. The Philippine Selection System, which advocates selective felling of large trees at approximately twice the



Fig. 13. Cutting timber of *Hopea dryobalanoides* MIQ. Tawau, Sabah, Kalabakan concession; tree 48 m tall, 80 cm diam. at 1½ m (Photogr. G. H. S. WOOD).

frequency of the fellings in the Malayan system, therefore relies on the existence of an adequate stock of young trees to form each successive crop. There is little quantitative published evidence that this always exists, but if it does it demonstrates a fundamental difference in structure and dynamics between Philippine and other Mixed Dipterocarp forests; this, if correct, may well be due to the more open canopy which might be associated with frequent wind damage in the typhoon zone.

Adequate regeneration persists on the ground between fruiting years in the better forests, and this is why the modern Malayan Uniform System relies on a single felling followed by more or less vigorous poisoning of undesirable species to create favourable light conditions for those preferred. The merantis and other light demanders are generally well able to survive beneath the ensuing dense growth of weed trees and woody climbers and eventually overtop them though this is reported not to be the case, or for the young trees to become misshapen as a consequence, on the most fertile soils where climbers are particularly dense, as in parts of E. Borneo. Under drier conditions, as on high ridges and sandy soils, less rigorous poisoning is essential; in Sabah and elsewhere where labour



Fig. 14. Forest ranger AMPON standing near logs of red and yellow *sēraya* (*Shorea spp.*), Kalabakan concession, Tawau, Sabah (Photogr. G. H. S. Wood).

shortages exist poisoning is often not undertaken yet the new crop is claimed still to be satisfactory. The system has to be used intelligently and modified according to local circumstances to succeed; it is ideal for the most productive lowland forests but for many others, especially many hill forests, a satisfactory system is still awaited. In the meantime present overexploitation of the Mixed Dipterocarp forests and abandonment of silvicultural operations is bound to lead to a future hardwood shortage at a time when a glut in agricultural export crops is predictable; then drastic price reversals will favour those who have maintained an adequate natural, or more especially silviculturally improved, forest estate.

Uses. *Timber*. Fig. 13–14. Presently the medium or light weight pinkish or reddish hardwoods known as *red mēranti* (Mal.), *red sēraya* (Sabah) or *red luan* (Philippines) are the chief export timber in Malasia; they are produced by *Shorea* sect. *Rubella*, *Brachypterae*, *Pachycarpae*, *Ovalis* and *Mutica*. They are used chiefly for light construction, furniture *etc.*, but also for veneers. They are liable to fungal attack in contact with the ground and do not take preservatives easily, though

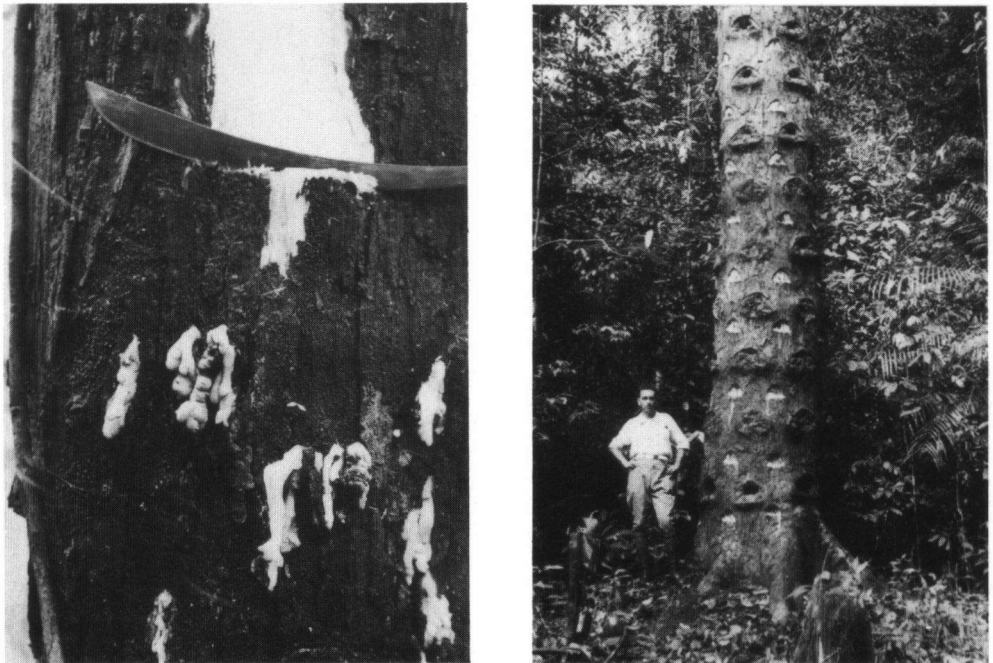


Fig. 15. Slash and resin drippings of *Hopea sangal* KORTH. Brunei (Photogr. ASHTON).

Fig. 16. Tapping of resin (*damar sibosa*) in trunk of *Shorea javanica* K. & V. New tap-holes filled with white resin in rows between older ones; with forest officer VERHOEF. Sumatra, distr. Baros, Kp. Sioidang (Photogr. J. BURER, 1937).

preserving their shape well on drying owing to their interlocked grain; they vary greatly in density between species, and sometimes within (*S. albida*). A similar timber, *yellow mēranti* from *Shorea sect. Richetioides*, is a less attractive tawny yellow and less valuable. The whitish timber of *white luan* or *white sēraya* (lighter *Parashorea spp.*, especially *P. malaanonan* in Sabah and the Philippines) is a major veneer wood; so also are the similar but siliceous *white mēranti* or *mélapi* (Sabah) derived from *Shorea sect. Anthoshorea*, and the equally siliceous *měrsawa* (Mal.), *pěnggirān* (Sabah), or *palosapis* (Philippines) derived from *Anisoptera spp.* *Kapur*, from *Dryobalanops*, is a popular pale brown light hardwood. Previously the durable heavy hardwoods were valued, but growth rates are too slow (see silviculture), extraction and milling too costly. *Chěngal* (*Neobalanocarpus*) of Malaya was celebrated for its durability and favoured by the Malays for boat as well as house building. *Balau* or *rěsak* (Mal.), *guijo* (Philip.) or *selangan batu* (Borneo), derived from *Shorea sect. Shorea* yield valuable heavy hardwoods for heavy construction and decking. Other such heavy hardwoods are derived from the larger *Vatica* and *Cotylelobium* known as *rěsak* (Mal.) and *narig* (Philip.), some *Hopea* known as *chengal*, *mengerawan*, *giam* (Mal.), *yakal* (Philip.), and from *Upuna*, called *upun batu* or *penyau* (Mal.).

Fat. The fruit of many *Shoreas*, and sometimes also *Dryobalanops*, have been boiled as a vegetable by villagers in many countries. The fruit of *Shorea sect. Pachycarpae*, and also *S. seminis*, *S. sumatrana*, *S. palembanica*, *S. scaberrima*, *S. hemsleyana*, *S. macrantha*, *S. singkawang* and sometimes other species are collected and exported. The seed contains up to 70% fat; the fat is similar to cocoa butter but has a higher melting point and is favoured in Europe for manufacturing chocolates and cosmetics, and in the past for soap, candles and tallow. In Borneo the fat was used for cooking, being stored as a stick owing to its high melting point. Soaking the seed in water

increases the fat content as well as killing predators and those treated in this way (Black Pontianaks of trade) are considered the best. The pericarp has a low nutritional value as animal food. The trees are rarely grown in plantation owing to the irregularity of fruiting, but could prove a major commodity if this problem were solved.

Resin. Fig. 15–16. The oleoresin of *Dipterocarpus* (*gurjun oil* of India; *kanyin oil* of Burma, *minyak kèruing* of western Malesia), destructively tapped by wounding and firing the bark and sapwood, is still used locally for caulking and varnish, being formerly an export commodity; it dries very slowly. The clear crystalline resins of *Neobalanocarpus* and several *Hopeas* (*damar mata kuching*) were formerly valued for varnish manufacture. The resin of *Shorea* is inferior, though used locally for tallow.

Camphor. *Dryobalanops aromatica*, and to a lesser extent *D. lanceolata* and *D. beccarii* yield a crystalline camphor which was being traded by Arabs in the 6th century and was already mentioned by MARCO POLO in 1299. The trade centred on the gregarious *D. aromatica* forest of North and East Sumatra and Johore; it was sought from hollows within the trunks by drilling into the wood and smelling; the trees were felled and chopped up to facilitate extraction. As few trees yielded any quantity the search was conducted with great mystery and a cult developed involving rites of exorcism and a camphor language to confuse malignant spirits. The other two species were tapped simply by drilling and scraping the wounds. Besides being exported the camphor was used for manufacturing perfume, incense and for embalming. *Dryobalanops* camphor is distinguished from others by the presence of d. borneol.

Other minor uses. The bark of many species is used locally for building the walls of farm huts, and the leaves of large-leaved dipterocarps provide thatch. Charcoal, prepared from the resin of several species, especially in *Shorea* sect. *Richetioides* was used for blackening teeth when this was fashionable. The bark of some *Vatica* and *Hopea* spp. was once used as 'laru', to prevent frothing during the boiling of *Arenga* syrup for sugar manufacture, and to arrest fermentation of toddy.

Selected literature: General: BURKILL, Dict. Pl. (1935) 162, 238, 284, 1187, 1254, 1663, 2222; HEYNE, Nutt Pl. ed. 2 (1927) 1093; MEIJER-DREES, Tectona 32 (1939) 954, 968, 986; MOMOSE, Mal. For. 4 (1978) 219. — *Timber:* DEN BERGER & ENDERT, Meded. Proefst. Boschw. 11 (1925) 98; DESCH, Mal. For. Rec. 14 (1941); PEARSON & BROWN, Commercial Timbers of India (1932); REYES, Techn. Bull. 7, Philip. Dept. Agr. (1938); TAMESIS & AGUILAR, Dept. Agr. Nat. Res. Pop. Bull. 44 (1935). — *Far:* ANDERSON in Williams *et al.*, S.E. Asian plant genetic resources, Bogor (1975) 217; BAL, Landb. 9 (1933) 211; ROWAAN, Landb. 13 (1937) 314; Indische Mercur 60, 27 (1937) 416; SMYTHIES, Sarawak Gaz. 84, 1206 (1958) 146. — *Resin:* BUCKLY, Mal. For. Rec. 11 (1932); ENDERT, Tectona 2, 28 (1935) 248; FONTANOZA, Philip. J. Sc. 54 (1934) 77; PARLIS, Bijdr. Kennis Oost-Indische Damarhars, Leiden (1933); RAPPARD, Tectona 30 (1937) 897; SASAKI, Mal. For. 43 (1980) 290 (seed storage and germination); SCHUITEMAKER, Tectona 26 (1933) 229; TAMARI, F.R.I. Research Pamphlet 69 (1976); TANG & TAMARI, Mal. For. 36 (1973) 38.

Notes. 1. The herbarium identification of dipterocarps must remain difficult, mainly for the reason that besides leaves also fruit and flowers are required.

The generic key is largely based on sterile characters and those of fruit; I have added an additional key to field groups which may be useful especially in the field.

Species of the genera *Cotylelobium*, *Dipterocarpus*, *Dryobalanops*, *Parashorea* and *Vatica* are also largely keyed out by means of sterile characters together with fruit. So are the species of the large genus *Hopea*, but in this key there are several leads, mostly for a few species, in which flowers are required.

In the largest genus, *Shorea*, leaf characters alone are only diagnostic at sectional level for *Richetioides*. Though bark and leaf characters together can provide a basis for keying out the vast majority of Malesian species, sections — and hence species — are impossible to key reliably without the valuable sectional characters provided by the former. This is because the combination of ontogenetic and phenotypic variability in leaf characters of these emergent trees, combined with the great number of species, makes it impossible to construct a key on this basis though the experienced taxonomist can still identify most by careful matching with named material, based on his knowledge of the intricate combination of subtle features by which the leaf of each species may be diagnosed at least when mature. In this genus flowers provide invaluable sectional, and in some

sections species characters, but fruit are only of limited value particularly for distinguishing the species with short fruit sepals from the rest.

I do not believe, therefore, that the dichotomous key provides a practical means of identifying sterile material in the larger genera.

In the forest it is a different matter, as SYMINGTON so excellently demonstrated. His, and all subsequent, keys to sterile material include the field characters of bark and wood. Such keys are practicable mainly on a provincial basis; they already exist for West and East Malaysia (SYMINGTON, 1943; MEIJER & WOOD, 1964; ASHTON, 1968); all but a handful of Bornean species are included in the latter two. They are not appropriate to a regional monograph, and this account therefore aims to provide the sound taxonomic base upon which forest botanists can build.

The species of *Anisoptera* and *Shorea* are here therefore mainly keyed out on sterile characters and flowers, though in *Shorea* there are a number of leads, mostly for a few species, for which fruit is required.

It would be an impossible task to frame two keys for each genus, one based on flower, the other on fruit characters: in *Vatica* and *Dipterocarpus*, for instance, keys based on sterile characters and flowers are impossible, while in *Shorea* reliance on either flower or fruit alone would be impossible (unless bark characters were included) though the key based on flowers would approach completeness. A reliable key based entirely on vegetative characters visible in the herbarium seems out of the question.

It is a rather unfortunate situation which we have to accept. Also local keys for the various islands would not bring much solution, since each of the three large Sunda islands harbours so many species.

2. As far as the vernacular names are concerned, I have selected only a limited number, as there is much overlapping.

3. BRANDIS, DYER, SYMINGTON, VAN SLOOTEN, I myself, and some other authors have entered in their works quite a number of unpublished names in the synonymy; they were not rarely taken up from herbarium labels where they were put from provisional identifications. They have here only been taken up if they were also taken up in the Index Kewensis.

4. As to the spelling of sectional and subsectional epithets I have adhered to priority of the original epithet given, which was either in the plural or singular.

KEY TO THE GENERA

1. Fruit calyx lobes valvate, not incrassate at base. Chromosome number $x=11$. Tribe DIPTEROCARPEAE.
 2. Base of calyx united into a tube enclosing at least the basal half of the nut.
 3. Connectival appendages stout, tapering, at most $1\frac{1}{2}$ x length of anthers to long-filiform. Nut free. Innovations not lepidote. Leaf without prominent intramarginal nerve; vernation plicate. Fig. 17-20
 1. **Dipterocarpus**
 3. Connectival appendages slender, at least 2 x length of anthers. Nut adnate to calyx tube. Innovations and leaf beneath densely peltate lepidote. Leaf with prominent looped intramarginal nerve; vernation not plicate. Fig. 27, 30 2. **Anisoptera**
 2. Base of calyx not as above.
 4. Branching of inflorescence truly cymose. Stamens at least 25. Fruit triangular in section. Fig. 33-34
 3. **Upuna**
 4. Branching of inflorescence racemose or subcymose. Stamens not exceeding 15. Fruit terete on section.
 5. Anthers linear, setose along the lateral margins. Style at least 2 x length of ovary. Leaf with distinct looped intramarginal nerve. Fig. 37, 40 4. **Cotylelobium**
 5. Anthers broadly oblong to subglobose, glabrous. Style less than 2 x length of ovary. Leaf without looped intramarginal nerve. Fig. 41-42 5. **Vatica**
1. Fruit calyx lobes \pm imbricate and with a distinctly incrassate central swelling at base. Chromosome number $x=7$. Tribe SHOREAE.
 6. Fruit calyx lobes all aliform, subequal, or all sort; fusing into a shallow cup at base. Nervation densely parallel. Fig. 48, 50 6. **Dryobalanops**
 6. Fruit calyx sepals not as above, unequal if aliform or short and subequal. Nervation not as above.
 7. Fruit sepals aliform, unequal, narrowly imbricate. Nut globose, verrucose, lenticellate. Vernation plicate. Fig. 54, 57 7. **Parashorea**
 7. Fruit sepals prominently imbricate. Nut ovoid, smooth. Vernation not plicate.

8. Stamens 15; anthers linear-lorate, with very short terminal connectional appendages. Fruit sepals short, subequal. Fig. 60, 61 8. *Neobalanocarpus*
8. Not as above.
9. Fruit calyx with 2 aliform and 3 short sepals; if they are all short and subequal then identifiable only by sectional characters of the flower. Fig. 62-76. 9. *Hopea*
9. Fruit calyx with 3 aliform and 2 short sepals, rarely 5 aliform, unequal; if they are all short and subequal then identifiable only by sectional characters of the flower. Fig. 77-116 10. *Shorea*

FIELD KEY TO PRINCIPAL FIELD GROUPS

1. Nerves curving round towards the margin and anastomosing to form a distinct intramarginal nerve.
2. Bark surface at first smooth, becoming scaly and distinctly scroll-marked, inner bark homogeneous pale brown. Leaf tertiary nerves indistinct; main nerves slender, hardly raised, petiole not swollen at base of lamina, not geniculate. Leaf undersurface lepidote 4. *Cotylelobium*
2. Bark surface irregular section fissured, flaking but not scroll-marked; inner bark distinctly tangentially laminated. Leaf tertiary nerves scalariform, well spaced, distinct; main nerves \pm prominent; petiole swollen at base of lamina, geniculate. Leaf undersurface densely lepidote 2. *Anisoptera*
1. Not as above.
3. Fresh leaves on crushing and cut wood \pm aromatic; leaf nervation parallel, nerves equal 6. *Dryobalanops*
3. Fresh leaves on crushing and cut wood smelling resinous, but not aromatic; nervation not as above.
4. Bark with large pale warty lenticels more or less densely dotted over the surface, or arranged in groups, more rarely in lines; leaf nerves straight, curving round only near the margin, usually distinctly undulate between each nerve owing to the slight persistence of the plicate folding in bud.
5. Bark surface yellowish to orange-brown or rust, rarely pink-brown, more or less smooth or flaky; terminal leaf buds prominent, stipule scars amplexicaul; petiole distinctly swollen at base of leaf; leaf coriaceous, not lepidote 1. *Dipterocarpus*
5. Bark surface mauve-brown to dark purplish brown or tawny brown; more or less closely shallowly fissured, later flaking in small oblong pieces; petiole not or hardly swollen at base of leaf; terminal buds usually small (excl. *P. macrophylla*); stipule scars short (excl. *P. macrophylla*, *P. malaanonan*); leaf thin, white-lepidote beneath at least in saplings and seedlings, frequently so in mature trees 7. *Parashorea*
4. Lenticels small, usually inconspicuous; leaf nerves \pm curved from their bases; leaf not folded, vernation not plicate.
6. Base cordate; leathery leaf undersurface with a dense felt of white hairs, with darker, pale brown, nervation; bark surface dark chocolate-brown, closely fissured and flaking; buttress low, rounded 3. *Upuna*
6. Leaf not cordate at base, or, if cordate, without white tomentose undersurface.
7. Buttresses low, rounded; bark surface smooth, pale grey-brown; inner bark homogeneous cream to pale brown; wood close textured, ray ends not glistening on tangential surface; leaf tertiary nerves generally reticulate, not drying black 5. *Vatica*
7. Bark surface, if smooth, chocolate and grey dappled and with thin buttresses; or, if pale brown, wood not dense, ray ends glistening on tangential surface; leaf tertiary nerves scalariform, or, if reticulate, drying black.
8. Leaf nervation dryobalanoid or subdryobalanoid. Fig. 64b-c many 9. *Hopea*
8. Leaf nervation not as above 8. *Neobalanocarpus*, some 9. *Hopea*, 10. *Shorea*
(For distinction between these and their sections, see other keys.)

1. DIPTEROCARPUS

GAERTN. *f.* Fruct. 3 (1805) 50; BL. Bijdr. (1825) 223; DC. Prod. 16, 2 (1868) 610; DYER, Fl. Br. Ind. 1 (1874) 294; J. Bot. 12 (1874a) 101, 152, t. 143-145, *incl. sect. Sphaerales, Angulati, Tuberculati, Alati et Plicati* DYER, *l.c.* 102, 103, 105, 107; VESQUE, C. R. Ac. Sc. Paris 78 (1874) 625; J. Bot. 12 (1874) 149; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 194; HEIM, Rech. Dipt. (1892) 24; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 24; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 250; L. G. DEN BERGER, Hand. Ned. Ind. Natuurwet. Congr. Batavia (1926) 400; SLOOT. Bull.

Jard. Bot. Btzig III, 8 (1927) 263; HEYNE, Nutt. Pl. ed. 2 (1927) 1093; PARKER, Ind. For. Rec. 16, 1 (1931) 1; BURK. Dict. (1935) 838; FOXW. Mal. For. Rec. 10 (1932) 56; Philip. J. Sc. 67 (1938) 245; SYM. Mal. For. Rec. 16 (1943) 153; BROWNE, For. Trees Sarawak & Brunei (1955) 102; SMITINAND, Thai For. Bull. 4 (1958) 1; ASHTON, Gard. Bull. Sing. 20 (1963) 233; BACKER & BAKH. *f.* Fl. Java 1 (1963) 328; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 230; ASHTON, Man. Dipt. Brunei (1964) 16; *ibid.* Suppl. (1968) 6; Gard. Bull. Sing. 31 (1978) 5; SMITINAND, Thai For. Bull. (Bot.) 12 (1980) 24. — *Oleoxyton* ROXB. Trans. Soc. Arts London 23 (1805) 413; WALL. Cat. (1828) n. 953, *nomen*. — *Pterigium* CORREA, Ann. Mus. Paris 8 (1806) 397, *p.p.*, *quoad P. costatum* (GAERTN. *f.*) CORREA; ENDL. Gen. Pl. (1840) 1013 ('*Pterygium*'). — *Mocanera* BLANCO, Fl. Filip. ed. 1 (1837) 446, *p.p.*, *quoad M. verniciflua* BLANCO. — *Dwaliella* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1892) 1011. — *Heimiatorna* PIERRE, Fl. For. Coch. 4 (1892) t. 259. — **Fig. 17–26.**

Medium-sized to large trees with thick, rounded, usually small and concave, sometimes tall and straight buttresses. *Crown* usually relatively narrow, even or irregular (not cauliflower-shaped), dome-shaped, frequently rather flat, open, with a few large strongly ascending twisted branches. *Bark surface* pale or dark grey to orange-brown, sometimes pink-brown; appearing smooth, shallowly patchily flaked; or appearing square-section fissured, shaggy, with persistent oblong flakes; \pm prominently densely warty lenticellate. *Twigs* variable, stout or slender, terete or compressed, glabrous or tomentose; with distinct, usually swollen and pale, amplexicaul stipule scars. *Stipules* large, hastate to lorate, obtuse, \pm succulent, caducous, characteristically carpeting the forest floor in the growing season. *Leaves* coriaceous, rarely thin, margin usually sinuate towards the apex; nerves prominent beneath, straight, curved only towards the margin, with traces of the plicate vernation remaining persistently between them, giving the lamina a corrugated appearance (*cf. Parashorea*); tertiary nerves scalariform; petiole distinctly geniculate, stout. *Inflorescence* racemose, short, stout, zig-zag, few-flowered, somewhat irregularly sparingly branched; bracts as stipules but smaller, fugaceous. *Flowers* large. Fig. 18. Buds ellipsoid. *Calyx* united round the fruit into a tube, but not fused to it; lobes valvate: 2 long, oblong to spatulate, \pm distinctly 3-nerved, and 3 short, or all 5 short. *Petals* large, narrowly oblong, strongly contorted, loosely cohering at base on falling, cream with a prominent pink stripe down the centre. *Stamens* 15–40, persisting at first in a ring round the ovary after the petals fall; filaments of variable length, broad, compressed, connate at base, tapering apically, latrorse, with 4 pollen sacs, the inner 2 somewhat shorter than the outer 2; appendage to connective short, stout to long filiform, slender, glabrous. *Ovary* enclosed in the calyx tube, the apex ovoid to conical, shortly tomentose; stylopodium cylindrical to filiform, shortly tomentose, narrowing gradually or abruptly into the glabrous filiform style. *Fruit* large. Fig. 17. *Calyx tube* becoming \pm distinctly constricted into a distal neck as the nut expands; lobes as in flower, but greatly expanded; *nut* ovoid, tomentose with a short acute apical style remnant. *Germination* hypogeal, the intricately folded subequal cotyledons remaining within the fruit and the plumule freeing itself by elongation of the cotyledonary petioles; seed sometimes albuminous at germination.

Distr. About 69 *spp.*, in Ceylon, India, Burma, Thailand, Indochina, and Yunnan and 53 or 54 species in Malaya, Sumatra, Java, Bali, Sumbawa, Borneo, Philippines and intervening islands. Fossil records from the Tertiary in E. Africa. Fig. 19.

Ecol. Evergreen forests and savanna woodland below 1400 m. Some species become semi-gregarious on river banks or alluvium (*D. apterus*, *D. elongatus*), podsols (*D. borneensis*), ridges (several species) and semi-evergreen forest of seasonal climates (*D. gracilis*, *D. costatus*). Seedlings mostly require high light intensities for survival; the genus is least common in dense valley forests.

Anat. One of the most clearly defined genera in the family; twigs with many resin canals, in 1-2 concentric rings, in the outer margin of the pith; leaf traces 3, arising in the distal $\frac{1}{2}$ of each internode with 12 stipule traces; distal end of petiole with 1-3 semicircles of vascular bundles, each with a resin canal, closed by an adaxial bar of collateral vascular tissue.

Taxon. The genus has since DYER (1874a) habitually been divided into five sections on the basis of the fruit calyx tube; *Sphaerales* (tube round in cross-section); *Tuberculati* (with 5 distal tubercles); *Angulati* (5-angled); *Alati* (5-winged) and *Plicati* (5-winged with the wings proliferated into folds thus obscuring the tube). These characters are not only uncorrelated with others, and thus do not appear to define natural groupings, but are inconsistent even within single species. Thus for example the winged fruit calyx tube of *D. zeylanicus* THW. is frequently angled, even smooth; the tuberculate fruit of *D. costulatus* and *D. kunstleri* are sometimes distally winged; the angled fruit of *D. globosus* is sometimes merely obscurely tuberculate and the narrowly winged fruit of *D. fagineus* is sometimes hardly more than angled, while the wings of that of *D. sublamellatus* are partially folded and place it in an intermediate position between *Alati* and *Plicati*. These sections are not therefore adopted in this account (cf. Gard. Bull. Sing. 20, 1963, 234).

Uses. Light to medium timbers absorbing preservatives readily; used for railway sleepers and heavy construction. The oleoresin is tapped in the semi-evergreen forests of Indochina and Burma, and sometimes elsewhere, for varnishes and tallow, but cutting into the bole and wounding the tissues by burning.

Note. Following Rec. 75A of the Code I have treated the generic name as masculine, and not as feminine as VAN SLOOTEN did.

KEY TO THE SPECIES

(sp. 54. *D. orbicularis* excepted)

1. Mature fruit calyx tube spherical, not angled, ribbed, tuberculate or winged. 1. *D. tempehes*
2. Fruit calyx lobes vestigial, subequal 1. *D. tempehes*
2. Fruit calyx lobes unequal, 2 expanded, aliform. 1. *D. tempehes*
3. Fruit calyx tube verrucose-lenticellate 2. *D. verrucosus*
3. Fruit calyx tube smooth. 2. *D. verrucosus*
4. Stamens 15 3. *D. crinitus*
4. Stamens at least 20. 3. *D. crinitus*
5. Shorter fruit calyx lobes less than 7 mm long, not recurved or revolute. Stamens 25. 4. *D. caudiferus*
5. Shorter fruit calyx lobes at least 8 mm long, prominently recurved and revolute. Stamens 30. 4. *D. caudiferus*
6. Twigs and buds densely ferruginous tomentose. 5. *D. validus*
7. Leaf blade glabrescent 5. *D. validus*
7. Leaf blade persistently tomentose beneath. 5. *D. validus*
8. Leaves 8-15 by 4-10 cm; tomentum short 6. *D. gracilis*
8. Leaves 17-32 by 8-17 cm; tomentum long, tufted 7. *D. baudii*
6. Twigs and buds buff or golden tomentose or glabrous. 6. *D. gracilis*
9. Leaf undersurface shortly densely persistently buff pubescent. 8. *D. obtusifolius*
9. Leaf undersurface sparsely caducously pubescent or glabrous. 8. *D. obtusifolius*
10. Nerves at most 14 pairs. 9. *D. rotundifolius*
11. Petiole at least 4 cm long. Fruit calyx tube ellipsoid. 9. *D. rotundifolius*
11. Petiole shorter than 4 cm long. Fruit calyx tube globose or turbinate. 9. *D. rotundifolius*
12. Leaf bud persistently pubescent outside. 9. *D. rotundifolius*
13. Leaf to 19 by 9 cm, ovate. Petiole 2.3-2.8 cm long. Twig persistently densely golden pubescent 10. *D. chartaceus*
13. Leaf to 13 by 5 cm, elliptic caudate. Petiole at most 2.5 cm long. Twig \pm glabrescent 10. *D. chartaceus*
12. Leaf bud glabrous outside. 11. *D. caudatus*
14. Inside of stipules densely pubescent. Nerves at most 11 pairs 12. *D. kerrii*
14. Inside of stipules glabrous. Nerves at least 11 pairs 13. *D. hasseltii*
10. Nerves at least 16 pairs. 13. *D. hasseltii*
15. Fruit calyx tube subglobose 14. *D. retusus*
15. Fruit calyx tube obturbinate. 15. *D. littoralis*

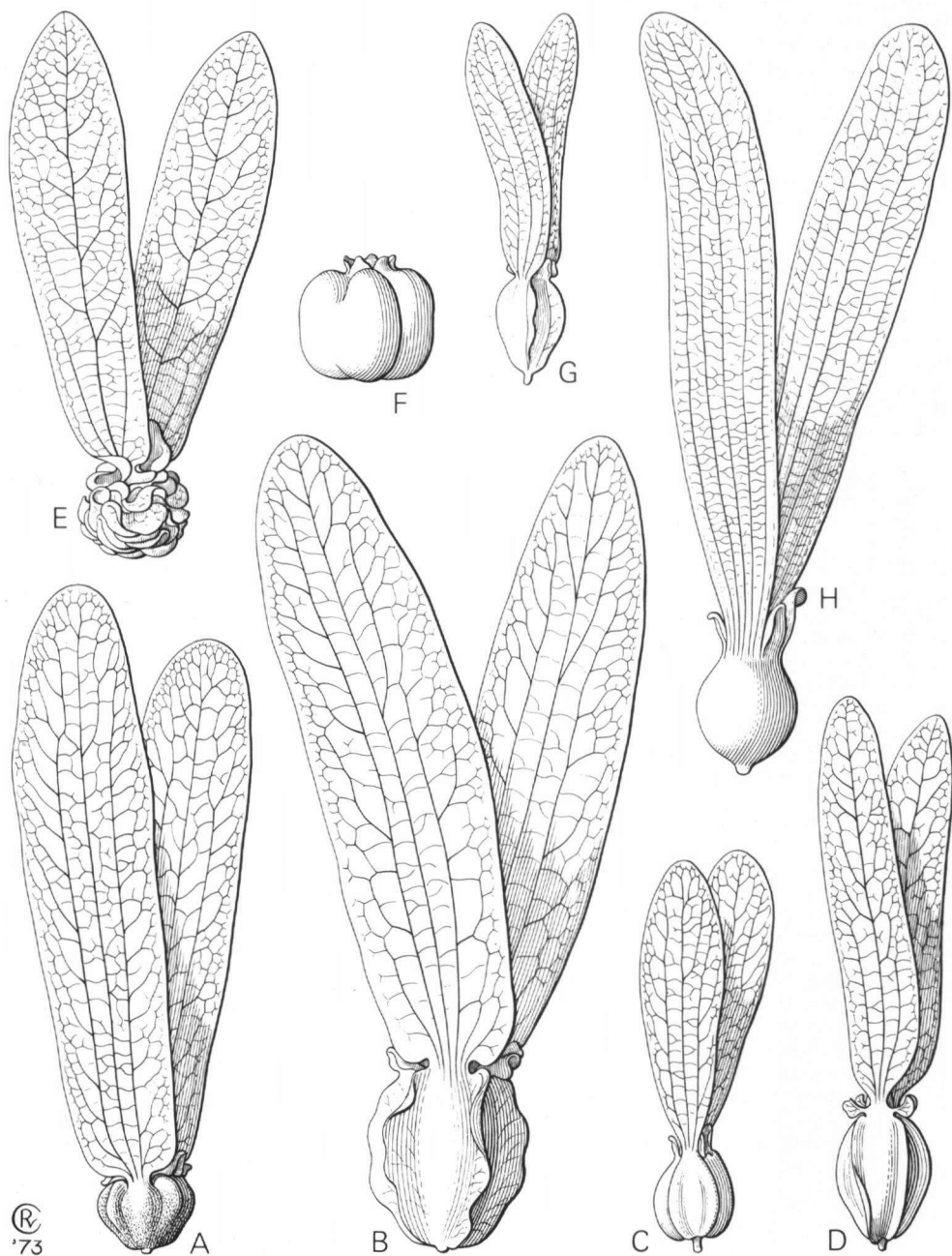


Fig. 17. Fruits in *Dipterocarpus*. All $\times \frac{1}{2}$. — A. *D. cornutus* DYER. — B. *D. grandiflorus* (BLCO) BLCO. — C. *D. acutangulus* VESQUE. — D. *D. kunstleri* KING. — E. *D. pachyphyllus* MEIJER. — F. *D. elongatus* KORTH. — G. *D. mundus* SLOOT. — H. *D. retusus* BL. (A KEP 77290, B anon. L sheet 955-159-403, C BNB 4890, D A 3705, E MUJIN 39208, F S 15131, G S 19046, H KOSTERMANS 18730).

- 1. Mature fruit calyx tube angled, ribbed, tuberculate or winged.
- 16. Fruit calyx tube narrowly elliptic-obovoid, with prominent, sharp or narrowly rounded ribs or wings typically confined to the distal half and ± terminating in tubercles. Leaf bud slender, falcate, densely minutely greyish stellate puberulent 16. *D. kunstleri*
- 16. Not as above.
- 17. Fruit calyx tube spherical, but with 5± prominent apical protuberances below the neck.
- 18. Fruit calyx tube ovoid 17. *D. applanatus*
- 18. Fruit calyx not ovoid.
- 19. Leaves with 11–16 pairs of nerves.
- 20. Leaf beneath pale ochraceous pubescent 18. *D. rigidus*
- 20. Leaf beneath glabrous.
- 21. Stipules pruinose outside, otherwise glabrous. 19. *D. costulatus*
- 21. Stipules tomentose outside 20. *D. globosus*
- 19. Leaves with more than 18 pairs of nerves.
- 22. Fruit calyx with 2 lobes aliform, more than twice as long as tube.
- 23. Leaf beneath glabrescent 21. *D. humeratus*
- 23. Leaf beneath densely cream lepidote 22. *D. cornutus*
- 22. Fruit calyx lobes subequal, vestigial 23. *D. elongatus*
- 17. Fruit calyx tube ± persistently angled, ribbed or winged.
- 24. Fruit calyx tube with 5 wings continuing from base to apex, greatly proliferated and intricately folded, obscuring the tube itself.
- 25. Leaf nervation beneath persistently yellow-brown hirsute. Twigs terete 24. *D. lamellatus*
- 25. Leaf nervation beneath glabrous. Twigs compressed.
- 26. Leaves ovate-lanceolate, margin revolute. Nerves 15–20 pairs. Petiole stout, tomentose 25. *D. lowii*
- 26. Leaves broadly ovate, margin not revolute. Nerves 10–12 pairs. Petiole slender, glabrous 26. *D. pachyphyllus*
- 24. Fruit calyx tube with 5 angles, ribs or wings, straight or undulate but not intricately folded.
- 27. Fruit calyx tube at least 1½ times as long as broad, distinctly ellipsoid.
- 28. Calyx tube angled rather than winged.
- 29. Leaves large, at least 15 cm long.
- 30. Leaves suborbicular. Nerves 9–12 pairs 27. *D. confertus*
- 30. Leaves ovate or elliptic. Nerves 24–30 pairs 28. *D. dyeri*
- 29. Leaves small, not exceeding 4 cm long.
- 31. Stamens 15. Leaf undersurface glabrescent 29. *D. fagineus*
- 31. Stamens 23–25. Leaf undersurface puberulent 30. *D. cinereus*
- 28. Calyx tube distinctly winged.
- 32. Fruit calyx tube densely pale buff puberulent, with very narrow undulate wings.
- 33. Nerves 6–8 pairs 31. *D. semivestitus*
- 33. Nerves 16–20 pairs 32. *D. oblongifolius*
- 32. Fruit calyx glabrous, wings if narrow straight.
- 34. Wings of calyx tube at least 8 mm wide, prominent.
- 35. Stamens 30 33. *D. grandiflorus*
- 35. Stamens 15.
- 36. Young twig, petiole and bud glabrous 34. *D. glabrigemmatum*
- 36. Young twig, petiole and bud pubescent 35. *D. palembanicum*
- 34. Wings of calyx tube at most 6 mm wide, narrow
- 37. Calyx tube wings most prominent in the distal half.
- 38. Calyx tube wings continuous from base to apex.
- 39. Leaf bud buff velutinate. Leaf undersurface sparsely so. Flower unknown 36. *D. fusiformis*
- 39. Leaf bud and leaf glabrous. Stamens 15 37. *D. mundus*
- 38. Calyx tube wings ± absent in basal ¼ of tube. Stamens 25. Leaf undersurface and bud pubescent 38. *D. borneensis*
- 37. Calyx tube wings not as above. Stamens 15 39. *D. nudus*
- 27. Fruit calyx tube less than 1½ times as long as broad, broadly ellipsoid to globose (sometimes with the wings decurrent with the pedicel and thus appearing narrowly ellipsoid).
- 40. Fruit calyx tube persistently pubescent.
- 41. Leaf and petiole glabrous 40. *D. geniculatus*
- 41. Leaves undersurface and petiole persistently tomentose.
- 42. Nerves at most 14 pairs 41. *D. costatus*
- 42. Nerves at least 15 pairs 42. *D. conformis*

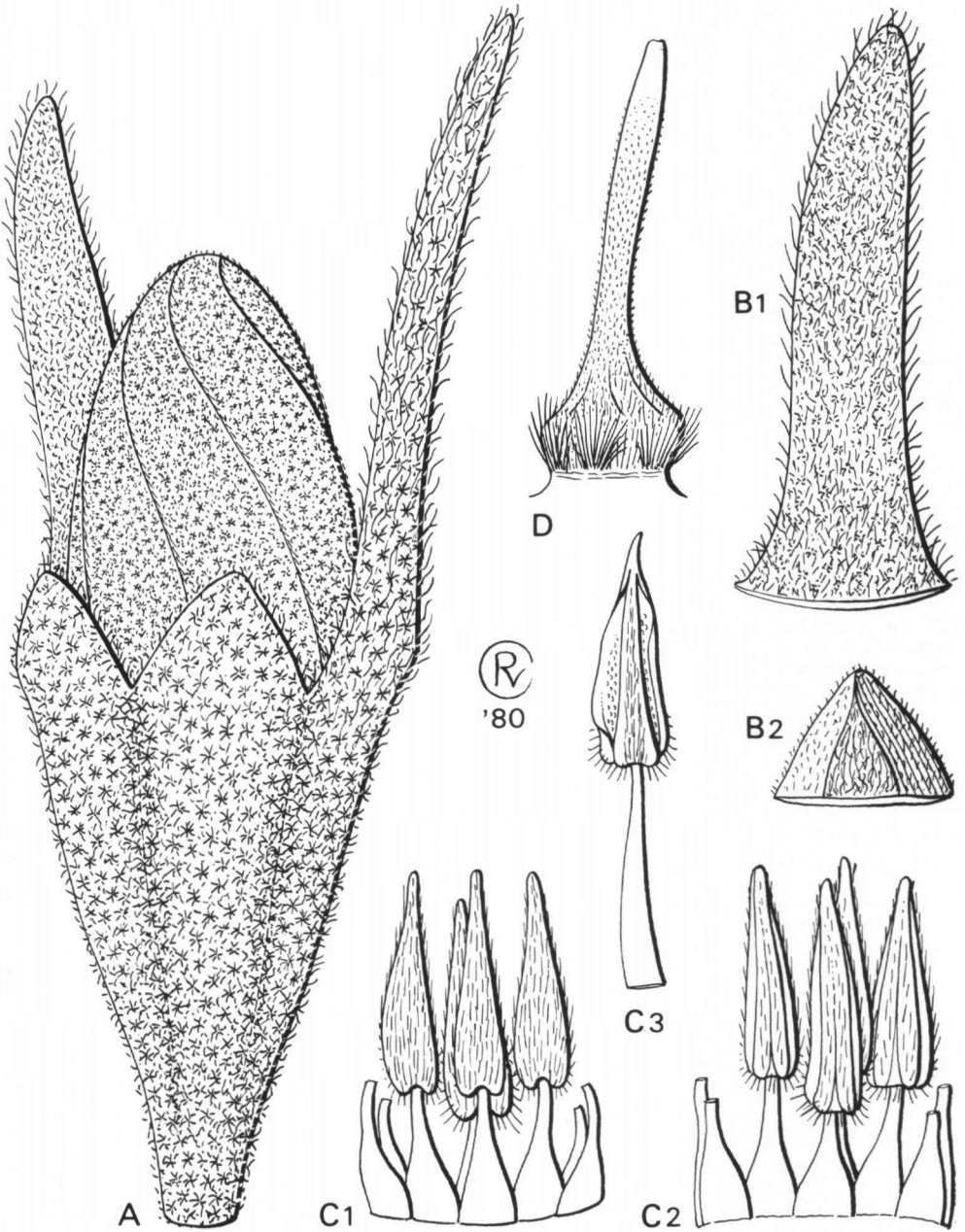


Fig. 18. Flower details in *Dipterocarpus*. All $\times 5$. — *D. verrucosus* FOXW. ex SLOOT. *A*. Bud, *B1*. outer sepal, *B2*. inner sepal, both from inside, *C1*. stamens from outside, *C2*. stamens from inside, *C3*. older stamen, *D*. pistil (JACOBS 5461).

- 40. Fruit calyx tube glabrescent.
- 43. Fruit calyx tube angled rather than winged 43. *D. acutangulus*
- 43. Fruit calyx tube distinctly winged.
- 44. Wings of calyx tube exceeding 10 mm wide.
- 45. Leaves glabrous. Wings of calyx tube not decurrent with pedicel 44. *D. sublamellatus*
- 45. Leaves densely tomentose beneath. Wings of calyx tube decurrent with pedicel.
- 46. Leaves prominently cupped 45. *D. concavus*
- 46. Leaves applanate 46. *D. stellatus*
- 44. Wings of calyx tube at most 9 mm wide.
- 47. Leaves obtuse, broadly obovate, obtuse or retuse 47. *D. sarawakensis*
- 47. Leaves not as above.
- 48. Wings of fruit calyx tube not continuous to base. Leaves large 48. *D. coriaceus*
- 48. Wings of fruit calyx tube continuous to base. Leaves medium-sized.
- 49. Wings of fruit calyx tube broadest distally, to 9 mm broad. Leaves prominently cuspidate 49. *D. cuspidatus*
- 49. Wings of fruit calyx tube not broadest distally. Leaves not cuspidate in mature trees.
- 50. Wings of calyx tube less than 3 mm wide, very narrow.
- 51. Leaves at most 10 by 4.5 cm 50. *D. eurynchus*
- 51. Leaves 10–19 by 4.5–9.5 cm 51. *D. ochraceus*
- 50. Wings of calyx tube to 8 mm wide, prominent.
- 52. Parts glabrous but for ovary 52. *D. perakensis*
- 52. Buds, twigs, petioles and nervation beneath densely persistent ochraceous pubescent 53. *D. philippinensis*

1. *Dipterocarpus tempes* SLOOT. *Reinwardtia* 5 (1961) 468, f. 4; MEIJER & WOOD, *Sabah For. Rec.* 5 (1964) 270, f. 43B; ASHTON, *Man. Dipt. Brun. Suppl.* (1968) 18, f. 3.

Twigs, leaf bud, stipule outside, and petiole very shortly densely evenly buff pubescent, leaf nervation beneath and stipule within sparsely so; nervation above caducously so. *Twigs* to 2 by 4 mm \varnothing towards the compressed apices, much branched, slender, becoming terete; stipule scars slender, dark. *Bud* to 12 by 3 mm, slender, lanceolate, acute. *Stipule* to 8 by 1.2 cm, lorate, acute. *Leaves* 6–12 by 3.5–8 cm, broadly elliptic to obovate, thickly coriaceous, with broadly cuneate base and acute to shortly abruptly acuminate apex; prominently persistently folded between the

9–12 pairs of sharply ascending nerves; nerves at 35°–40°; tertiary nerves very slender, densely scalariform; *petiole* 1–2 cm long, short, drying densely buff pubescent. *Raceme* to 2.5 cm long, very short, axillary, terete, densely shortly evenly buff pubescent, unbranched, bearing to 3 distichous flowers. *Flower bud* to 3 by 0.8 mm. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* c. 30, somewhat shorter than anther; anther narrowly oblong, tapering into the acicular appendage; appendage as long as anther, prominent. *Ovary* ovoid, pubescent; style filiform, pubescent except in the apical 1/3. *Fruit pedicel* vestigial. *Calyx* glabrous; tube to 4 by 4 cm, turbinate, with prominent but unraised pale lenticels; calyx lobes vestigial.

Distr. *Malesia*: Borneo (Kapas valley, Sarawak west of the Niah R., E. Sabah south to Kutei).

Ecol. Locally abundant, fresh water swamps and stream banks, clay rich alluvium.

Vern. *Kéruing tēpayan, k. asam, karup, bajan, bajan uhit, tempèhès.*

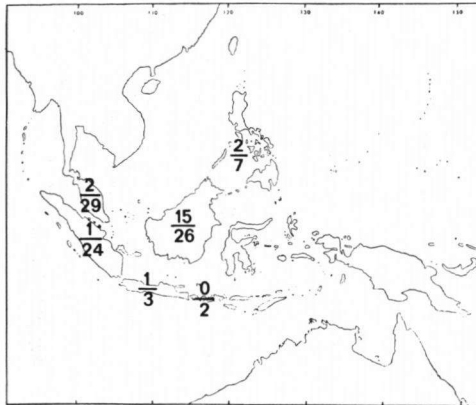


Fig. 19. Density map of *Dipterocarpus* in Malesia. Above the hyphen the number of endemics, below the hyphen the number of non-endemics.

2. *Dipterocarpus verrucosus* Foxw. ex SLOOT. *Bull. Jard. Bot. Btzg III*, 8 (1927) 293; SLOOT. in *Merr. Pl. Elm. Born.* (1929) 201; Foxw. *Mal. For. Rec.* 10 (1932) 71; SYM. *Mal. For. Rec.* 16 (1943) 189, f. 84B, 85; BROWNE, *For. Trees Sarawak & Brunei* (1955) 111; ASHTON, *Man. Dipt. Brun.* (1964) 46, f. 6–7, pl. 6 (stem); *ibid.* *Suppl.* (1968) 19; MEIJER & WOOD, *Sabah For. Rec.* 5 (1964) 272, f. 3C, 43A. — Fig. 18, 20.

Twig, petiole, midrib and nerves beneath densely caducous minute adpressed tufted gold-brown pubescent; leaf bud and raceme densely, stipules sparsely, persistently so. *Twig* 1.5–3 mm \varnothing apically, terete or slightly compressed; amplexicaul scars slightly swollen. *Bud* to 12 by 2–3 mm, acute, narrowly falcate to narrowly conical. *Stipule* to 8 by 0.8 cm, narrowly



Fig. 20. *Dipterocarpus verrucosus* SLOOT. *a.* Terminal bud and leaf of 7½ m high sapling, *b.* young inflorescence with stipules, *c.* stipules outside hairy, inside glabrous, *d.* older inflorescence without stipules, *e.* fruits, *f.* nut. All × ½ (*a* S 20286, *b-c* KEP 105026, *d* KEP 105157, *e-f* NT 429).

oblong, obtuse. *Leaves* 6–12 by 3.5–6 cm, ovate, coriaceous; base cuneate; apex subacute or with to 5 mm long acumens; nerves 9–14 pairs, prominent, well spaced, at c. 40°–50°; tertiary nerves well spaced, ± sinuate; *petiole* 1.2–2 cm long, geniculate. *Raceme* to 9 cm long, axillary, unbranched or singly branched, terete. Flower buds to 25 by 12 mm, fusiform. *Calyx* shortly densely pubescent; *corolla* typical. *Stamens* 15, exceeding style apex in bud; filaments as long as anthers, narrowly deltoid, applanate; anthers narrowly oblong, pubescent, tapering into the short broad obtuse connectival appendage. *Ovary* conical, tapering, pubescent; style glabrescent, as long as ovary, swollen below apex. *Fruit calyx tube* to 1.5 by 1.3 cm, globose to slightly ovoid, with 5–7 mm \varnothing neck, glabrescent, dotted with verrucose pale brown lenticles; 2 longer lobes to 9 by 2.2 cm, oblong to spatulate, obtuse, c. 3 mm broad at the non-revolute base, 3-nerved, the 2 laterals continuing at least $\frac{2}{3}$ of the length; 3 shorter lobes to 3 by 2 mm, narrow, revolute and recurved.

Distr. Malesia: Malaya (excepting more seasonal areas), Sumatra (Asahan and Indragiri in east, Kampar-Siak on west coast), Singkep, Borneo (West Borneo and Sarawak to S. W. Sabah, Tawau, Nunukan).

Ecol. Mixed Dipterocarp forest on clay rich soil, occasional on undulating land but locally common on ridges below 650 m.

Vern. Kéruing mərəh, k. chaiër (Mal.), *k. ladan, k. daun halus, ariung* (Sum.).

3. *Dipterocarpus crinitus* DYER, Fl. Br. Ind. 1 (Jan. 1874) 296; VESQUE, C. R. Ac. Sc. Paris 78 (March 1874) 627; DYER, J. Bot. 12 (April 1874) 103, 154; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 90; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 28; RIDL, Agr. Bull. Str. & F.M.S. 1 (1901) 55; Fl. Mal. Pen. 1 (1922) 214; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 273; ed. 2 (1927) 1095; BURK. J. Str. Br. R. As. Soc. 81 (1920) 58, fig.; Dict. (1935) 843; MERR. En. Born. (1921) 398; SLOOT, Bull. Jard. Bot. Btżg III, 8 (1927) 288; FOXW. Mal. For. Rec. 10 (1932) 66; SYM. Mal. For. Rec. 16 (1943) 175, f. 84A, 85, 89; BROWNE, For. Trees Sarawak & Brunei (1955) 108; ASHTON, Man. Dipt. Brun. (1964) 29, f. 6; *ibid.* Suppl. (1968) 13; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 246. — *D. hirtus* VESQUE, C. R. Ac. Sc. Paris 78 (March 1874) 627; J. Bot. 12 (1874) 151; DYER, J. Bot. 12 (1874) 154. — *D. tampurau* (non KORTH.) BURCK, Ann. Jard. Bot. Btżg 6 (1887) 198, p.p.; BROWNE, For. Trees Sarawak & Brunei (1955) 108. — Fig. 21.

Young twig, leaf bud, stipule outside and petiole persistently c. 3 mm long golden-brown tufted tomentose, shorter on nervation beneath, midrib above and margin; leaf fugaceous pubescent above. *Twig* c. 3 mm \varnothing apically, smooth. *Bud* 4–6 by 1.5–2 mm, small, oblong, obtuse. *Stipule* c. 3 by 0.5 cm, lanceolate, obtuse. *Leaves* 6–9 by 3–5 cm, elliptic, chartaceous, obtuse or shortly acuminate, base obtuse, margin revolute, persistently somewhat folded between the

13–15 pairs of nerves; *petiole* 1.5–2.5 cm long, slender. *Raceme* to 12 cm long, terminal or axillary, terete, golden long tomentose, unbranched or singly branched, branchlets bearing c. 4 flowers; *bracts* to 30 by 8 mm, linear, acute, sparsely tomentose outside, glabrous within. *Flower bud* to 3.5 by 0.8 cm. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* 15, shorter than the style; filaments short, anthers filiform, tapering; appendage as long as anther, slender, undulated towards the apex. *Ovary* ovoid-conical, shortly pubescent; style and stylopodium filiform, slender, 4–5 times as long as ovary, shortly pubescent but for the distal $\frac{1}{3}$. *Fruit* subsessile. *Fruit calyx* glabrous, tube 1.5–1.8 by 0.6–0.8 cm, neck 0.4–0.6 cm \varnothing ; two longer lobes to 8 by 1.5 cm, oblong, lanceolate, acute, prominently 1-nerved; 2 shorter lobes to 3 mm long, deltoid, acute.

Distr. E. Peninsular Thailand, and in *Malesia:* Malaya (excluding seasonal areas), Sumatra (Asahan, Indragiri, Bengkalis districts; Central Sumatra: Sibolga, W. Indragiri), Borneo.

Ecol. Widespread on undulating land and low hills, rarely to 850 m, on leached clay-rich soils in Mixed Dipterocarp forest.

Vern. Kéruing (m)empelas, tampurau, k. bulu, k. gombang, k. pèkat, k. mərəkuang, k. chaiër (Mal.), *ariung, simarhalung* (Sum.), *rèsak empelas* (Iban).

Note. Individuals, often in considerable numbers, of this species are well known in Malaya to flower and fruit outside general flowering years; the same occurs in Borneo. Though seedlings are usually common in the forest, as a rule very few seeds are viable.

4. *Dipterocarpus caudiferus* MERR. Philip. J. Sc. 29 (1926) 398; SLOOT, Bull. Jard. Bot. Btżg III, 8 (1927) 302; BROWNE, For. Trees Sarawak & Brunei (1955) 107; SLOOT, Reinwardtia 5 (1961) 459; ASHTON, Gard. Bull. Sing. 20 (1963) 236; Man. Dipt. Brun. (1964) 25, f. 6; *ibid.* Suppl. (1968) 11; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 239, pl. 20 (habit), pl. 24, f. 35. — *D. macrorrhinus* SLOOT, Bull. Jard. Bot. Btżg III, 8 (1927) 300, f. 3. — *D. kutaianus* SLOOT, Bull. Jard. Bot. Btżg III, 16 (1940) 437, f. 2; BROWNE, For. Trees Sarawak & Brunei (1955) 110.

Twig, leaf beneath and margin, petiole, raceme and young leaf bud sparsely, 2–2.5 mm long, ± fugaceous or caducous silky long tomentose; subsistent on young trees, occasionally persistent on bud, twig, and petiole. *Twig* c. 5 mm \varnothing , rather stout, terete; frequently rather verrucose and sometimes (usually in young trees) papery. *Bud* 10–25 by 3–5 mm, lanceolate, somewhat compressed. *Stipules* c. 7 cm long, linear. *Leaves* 11–20 by 5–15 cm, elliptic, thinly coriaceous, base obtuse or cuneate, apex prominently to 8 mm long acuminate; margin frequently sinuate towards the apex; midrib beneath often slightly verrucose; nerves 12–20 pairs, dense, straight, at c. 40°–50°; tertiary nerves densely scalariform, slender; *petiole* 3–4 cm long, rather long and slender, persistently hispid on the knee. *Raceme* to 15 cm long, terminal or axillary, terete, becoming angular on



Fig. 21. Habit of *Dipterocarpus crinitus* DYER, *këruing ampêlas*. Brunei (Photogr. ASHTON).

drying, simple or singly branched; *bracteoles* to 30 by 2.5 mm, linear, glabrous, caducous. *Flowers* distichous; *buds* to 5 by 0.8 cm. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* 25, shorter than the style; filaments short; anthers narrowly oblong, tapering apically; appendage to connective tapering, glabrous, slightly shorter than the anther. *Ovary* ovoid-conical, glabrescent; stylopodium twice as long as ovary, narrowly cylindrical, densely tomentose; style half as long as stylopodium, narrowly cylindrical, glabrous. *Fruit calyx* entirely glabrous; tube to 3.5 cm \varnothing and long, obturbinate, tapering abruptly at the base and gradually to the 0.8–1.3 cm \varnothing neck; 3 longer lobes 12–17 by 2–3 cm, oblong-lanceolate, obtuse, tapering to c. 5 mm broad at the base, prominently 3-nerved; shorter lobes 4–6 by 5–7 mm, deltoid, obtuse, undulate.

Distr. *Malesia*: Borneo (except S. and S.W.), Banguay I.

Ecol. Clay soils in Mixed Dipterocarp forests, on undulating land and hillsides below 800 m; sometimes semigregarious on fertile soils.

Vern. *Andri*, *damar laut*, *sëndara* (W. Borneo), *bajan*, *santiulit*, *têmpêhês* (S.E. Borneo), *kêruing puteh*.

Note. Geographically rather variable, especially in S.E. Borneo where the closely related *D. hasseltii* also occurs and can be difficult to distinguish from it when not in fruit.

5. *Dipterocarpus validus* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 36; WALP. Ann. 4 (1857) 335; MIQ. Fl. Ind. Bat. 1, 2 (1859) 498; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 84, 85; DC. Prod. 16, 2 (1868) 614; DYER, J. Bot. 12 (1874) 108, 153; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 202; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37; MERR. En. Born. (1921) 400; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 272; ASHTON, Gard. Bull. Sing. 20 (1963) 237. — *D. pilosus* (non ROXB.) F.-Vill. Nov. App. (1880) 20; VIDAL, Sinopsis (1883) pl. 14, f. d; FOXW. Philip. J. Sc. 6 (1911) Bot. 244, pl. 34; *ibid.* 13 (1918) Bot. 176; MERR. En. Philip. 3 (1923) 88. — *D. warburgii* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 32; FOXW. in Merrill, Leaf. Philip. Bot. 6 (1913) 1952; Philip. J. Sc. 13 (1918) Bot. 178; MERR. En. Philip. 3 (1923) 91; HEYNE, Nutt. Pl. ed. 2 (1927) 1098; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 305; FOXW. Philip. J. Sc. 67 (1938) 256; SLOOT, Reinwardtia 5 (1961) 473; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 273. — *D. affinis* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 31; WHITFORD, Bull. Bur. For. Philip. 10, 2 (1911) 70, pl. 72–73; FOXW. Philip. J. Sc. 6 (1911) Bot. 246, pl. 35; *ibid.* 13 (1918) Bot. 176; MERR. En. Philip. 3 (1923) 88. — *D. lasiopodus* PERK. Fragm. Fl. Philip. (1904) 22; MERR. Publ. Gov. Lab. Philip. 29 (1905) 30; En. Philip 3 (1923) 90; REYES, Philip. J. Sc. 22 (1923) 322, pl. 13. — *D. woodii* MERR. Philip. J. Sc. 29 (1926) 399; SLOOT, Bull. Jard. Bot. Btzg 8, III (1927) 303. — Fig. 22. Large pale barked frequently buttressed trees. Twigs, leaf buds, stipules outside, petioles and base of inflorescence densely \pm persistently evenly long rufous

tomentose, becoming distinctly tufted as the twigs and stipules expand; nerves and midrib beneath and inflorescence sparsely evenly puberulent. *Twigs* c. 6–10 mm \varnothing , terete. *Leaf buds* to 9 by 1.3 cm, lanceolate; *stipules* to 20 by 3 cm, lorate. *Leaves* 15–25 by 7.5–12 cm (to 40 by 20 cm in young trees), elliptic-oblong to ovate, coriaceous; margin undulate, prominently sinuate distally; base cuneate to obtuse (narrowly peltate in young trees); apex acute to prominently narrowly acuminate, to 1 cm long; nerves 22–28 pairs, straight, ascending at c. 50°, slender but prominent beneath, \pm shallowly depressed above; tertiary nerves densely scalariform, very slender, evident but hardly elevated beneath; midrib prominent beneath, \pm elevated above; *petiole* 3.5–5 cm long, prominently geniculate. *Raceme* to 14 cm long, \pm unbranched, axillary, bearing to 7 flowers. *Flower buds* to 30 by 9 mm; *stamens* c. 30, slightly shorter than style at anthesis; filaments slender, c. $\frac{1}{2}$ length of filiform auriculate tapering anthers; appendage acicular, slender, c. $\frac{3}{4}$ length of anthers; *ovary* small, ovoid, hirsute as also the basal $\frac{1}{2}$ of style; style stoutly columnar, c. 4 times length of ovary. *Fruit pedicel* expanding into the to 4 by 3.5 cm smooth turbinate calyx tube; 2 longer lobes to 25 by 3.5 cm, lorate-spatulate, obtuse, c. 5 mm broad at base; 3 shorter lobes to 6 by 6 mm, suborbicular, small, \pm recurved.

Distr. *Malesia*: Philippines (widespread), Borneo (Tenom north, and E. Coast of Sabah south-eastwards to river Barito).

Ecol. Common and frequently gregarious both in primary and secondary forest; on flat land, fresh water swamp and on river banks; occasionally on low hills to 300 m.

Vern. *Hagakhak* (Philippines), *kêruing kasugoi* (Sabah), *kambong*, *tampudaw*, *kaladan* (S.E. Borneo).

Note. There is some evidence of hybridisation with *D. kunstleri* in the Philippines.

6. *Dipterocarpus gracilis* BL. Bijdr. (1825) 224; Fl. Jav. 2 (1829) 20, t. 5; WALP. Rep. 5 (1845) 123; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 609; DYER, J. Bot. 12 (1874) 102; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 196; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 256; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 30; K. & V. Bijdr. 5 (1900) 117; MOLL & JANSSONius, Mikrogr. Holz (1906) 358; FOXW. Philip. J. Sc. 6 (1911) Bot. 248; *ibid.* 13 (1918) Bot. 177; *ibid.* 67 (1938) 249; KOORD. Exk. Fl. Java 2 (1912) 621; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 273; *ibid.* ed. 2 (1927) 1094, 1095; MERR. En. Philip. 3 (1923) 89; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 276; *ibid.* III, 16 (1940) 434; SYM. Gard. Bull. S. S. 9 (1938) 321; Mal. For. Rec. 16 (1943) 177, f. 85; SMITINAND, Thai For. Bull. 1 (1954) 5; *ibid.* 4 (1958) 31; BACKER & BAKH. f. Fl. Java 1 (1963) 329; ASHTON, Gard. Bull. Sing. 20 (1963) 235; Man. Dipt. Brun. (1964) 35, f. 6; *ibid.* Suppl. (1968) 15; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 250, f. 37. — *D. pilosus* ROXB. [Hort. Beng. (1814) 93, *nomen*]



Fig. 22. Close-up of bark, leaves and fruit of *Dipterocarpus validus* Bl. Sabah (Photogr. G.H.S. Wood).

Fl. Ind. ed. Carey 2 (1832) 615; WALP. Rep. 5 (1845) 124; DC. Prod. 16, 2 (1868) 614; DYER, Fl. Br. Ind. 1 (1874) 296; KURZ, Fl. Burma (1877) 115; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 244; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 27, *p.p.*; Ind. Trees (1906) 65; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 274, *p.p.*; TROUP, Silv. Ind. Trees 1 (1921) 39; GAMBLE, Man. Ind. Timb. (1922) 71; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251, *p.p.*; PARKER, Ind. For. Rec. (Bot.) 13 (1927) 15; PARKINSON, Burma For. Bull. 27 (1922) 25. — *Mocanera verniciflua* BLCO, Fl. Filip. ed. 1 (1837) 450. — *D. marginatus* KORTH, Kruidk. (1841) 64; WALP. Rep. 5 (1845) 124; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 37; MIQ. Fl. Ind. Bat. 1, 2 (1859) 499; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 613; DYER, J. Bot. 12 (1874) 105; BURCK,

Ann. Jard. Bot. Btzig 6 (1887) 212; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 38; MERR. En. Born. (1921) 399; SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 328, f. 10, *p.p.*; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 274; *ibid.* ed. 2 (1927) 1097. — *D. verniciflua* BLCO, Fl. Filip. ed. 2 (1845) 314; *ibid.* ed. 3 (1878) 217, t. 183; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 35; WALP. Ann. 4 (1857) 335; MIQ. Fl. Ind. Bat. 1, 2 (1858) 499; DC. Prod. 16, 2 (1868) 610; VIDAL, Sinopsis (1883) 15, t. 14 b; Rev. Pl. Vasc. Filip. (1886) 59; DYER, J. Bot. 12 (1874) 104; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 31; MERR. Philip. J. Sc. 1 (1906) Suppl. 97; *ibid.* 3 (1908) Bot. 114; Sp. Blanc. (1918) 268; En. Philip (1923) 91; Foxw. Philip. J. Sc. 6 (1911) Bot. 248; *ibid.* 13 (1918) Bot. 177; REYES, Philip J. Sc. 22 (1923) 321; HEYNE, Nutt. Pl. ed. 2 (1927) 1095. — *D. fulvus* BL. Mus. Bot. Lugd.-Bat.

2 (1852) 37; WALP. Ann. 4 (1857) 335; MIQ. Fl. Ind. Bat. 1, 2 (1859) 499; DC. Prod. 16, 2 (1868) 613; DYER, J. Bot. 12 (1874) 108; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 40. — *Anisoptera palembanica* MIQ. Sum. (1862) 191, 485; Ann. Mus. Bot. Lugd.-Bat. (1867) 85; DC. Prod. 16, 2 (1868) 616. — *D. hispidus* (non THW.) F.-VILL. Nov. App. (1880) 20. — *D. velutina* VIDAL, Rev. Pl. Vasc. Filip. (1886) 59; PERK. Fragm. Fl. Philip. (1904) 22; MERR. Philip. J. Sc. 3 (1908) Bot. 114. — *D. bancanus* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 196; BRANDIS J. Linn. Soc. Bot. 31 (1895) 31; HEYNE, Nutt. Pl. ed. 2 (1927) 1095. — *D. skinneri* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 91; BRANDIS, J. Linn. Soc. Bot. 3 (1895) 26; RIDL. Fl. Mal. Pen. 1 (1922) 214; CRAIB, Fl. Siam. Enum. 1 (1925) 137; HEYNE, Nutt. Pl. ed. 2 (1927) 1098; SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 294; FOXW. Mal. For. Rec. 10 (1932) 70, *excl. var. hirtus* RIDL.; BURK. Dict. (1935) 845. — *D. vanderhoevenii* K. & V. Bull. Inst. Bot. Btzig 2 (1899) 3; Bijdr. 5 (1900) 118; MOLL & JANSSONIUS, Mikrogr. Holz (1906) 356; KOORD. Exk. Fl. Java 2 (1912) 621. — *Shorea mollis* BOERL. Cat. Hort. Bog. 2 (1901) 110. — *D. angustialatus* HEIM, Bot. Tidsskr. 25 (1903) 43; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 365; CRAIB, Fl. Siam. Enum. 1 (1925) 133; FISCHER, Kew Bull. (1926) 457. — *D. schmidtii* HEIM, Bot. Tidsskr. 25 (1903) 43.

Twig, leaf bud, stipule outside, leaf beneath, midrib above and petiole densely persistently scabrid rufous tomentose. *Twig* c. 3 mm \varnothing apically, terete or slightly compressed, with minute cracks initiating from elongated lenticels. *Bud* 10–14 by 3–5 mm, narrowly conical, obtuse. *Stipule* c. 5 cm long, narrowly lanceolate. *Leaves* 8–15 by 4–10 cm, elliptic to ovate, base obtuse; apex shortly acuminate; nerves 12–20 pairs, usually dense, at 40°–50°; *petiole* 2–2.5 cm long. *Raceme* to 9 cm long, terminal or axillary, terete, shortly pale brown tomentose or glabrescent, singly branched. *Flower bud* to 25 by 8 mm. *Calyx* and *corolla* typical, calyx shortly tomentose. *Stamens* c. 30, exceeding the style; filaments short; anthers linear; appendage to connective c. 2 times length of anther, filiform, tapering, sparsely setose. *Ovary* ovoid-conical, tapering into the stylopodium; stylopodium and style slender, filiform, tomentose in the basal half. *Fruit calyx* glabrous; tube to 2 cm \varnothing , smooth, globose; 2 longer lobes to 14 by 2.5 cm, narrowly spatulate, obtuse, to 1 cm broad at base; 3 shorter lobes to 2.2 by 1 cm, ovate, constricted at base, the 2 sides becoming revolute back to back.

Distr. Andamans, Chittagong, Burma, S.E. and Peninsular Thailand, and in *Malesia*: Malaya, Sumatra, W. Java, Borneo (Sampit and the Rejang valley eastwards), Philippines.

Ecol. Very widespread, often gregarious in seasonal semi-evergreen dipterocarp forest on red soils; becoming scattered, rare, and confined to fertile red soils, in everwet areas (*cf. Anisoptera costata*), below 800 m.

Vern. *Këruing kesat*, *k. bungoh*, *k. daun halus* (Mal.), *wuluk bulan* (Jav.), *bembang* (Sum.). Philip-

pinas: *agan-an* (Bicol), *duha* (Ibn.), *kurimau* (Ibn.), *lalian* (Tag.), *lanutan* (Neg.), *lauan* (Zamb., Sul.), *pagsa hingau* (Tag.), *palamopang* (Tag.), *palohap* (Sbl.), *pamalalian* (Cag., Ibn.), *pamantulen* (Ilk.), *pamantuling* (Pang.), *Pamarnisen* (Ibn.), *panao* (Tag., Pang., Sbl., Ibn., Pamp.), *putsa hingan* (Tag.), *sitam* (Ibn.).

Note. Specimens from the Indo-Burmese region and northern Malaya, and also the Philippines are usually more shortly sparsely evenly pubescent.

7. *Dipterocarpus baudii* KORTH. Kruidk. (1841) 59, t. 5; WALP. Rep. 5 (1845) 123; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 36; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Sum. (1862) 485; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 609; SCHEFFER, Nat. Tijds. N. I. 31 (1870) 346; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 198; HEYNE, Nutt. Pl. ed. 2 (1927) 1095; FOXW. Mal. For. Rec. 3 (1927) 42; SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 273; PARKER, Ind. For. Rec. 16 (1931) 3; PARKINSON, Burma For. Bull. 27 (1932) 11; FOXW. Mal. For. Rec. 10 (1932) 64; BURK. Dict. (1935) 842; SYM. Mal. For. Rec. 16 (1943) 168, f. 85. — *D. dupreana* PIERRE in Lanessan, Pl. Util. Colon. Fr. (1886) 297; Fl. For. Coch. 3 (1889) t. 219; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 7, 28; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 358; RIDL. Fl. Mal. Pen. 1 (1922) 214; CRAIB, Fl. Siam. Enum. 1 (1925) 134. — *D. scortechinii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 91; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 28; BURK. J. Str. Br. R. As. Soc. 81 (1920) 55, fig.; HEYNE, Nutt. Pl. ed. 2 (1927) 1095; FOXW. Mal. For. Rec. 10 (1932) 64. — *D. pilosus* (non ROXB.) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 27, *p.p.*; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 244, *p.p.*; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 224; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251; FOXW. Mal. For. Rec. 3 (1927) 42.

Large tree. Leaf buds, stipules outside, twigs, petiole and inflorescences densely persistently long tufted rufous tomentose, leaf beneath and midrib above, ovary apex, calyx and petals outside shortly so; fruit calyx and leaves above glabrescent. *Twig* c. 4–6 mm \varnothing apically, stout. *Bud* c. 15 by 8 mm, lanceolate; *stipule* to 15 by 3 cm, lorate-lanceolate, becoming sparsely tufted tomentose after expansion, tinged red. *Leaves* 17–32 by 8–17 cm, \pm elliptic, thinly coriaceous, drying rufous below, dark purplish above; base narrowly obtuse; acumen to 2 cm long, tapering; nerves 14–28 pairs, ascending, stoutly prominent beneath; tertiary nerves dense; midrib prominent beneath, applanate above; *petiole* 3–5 cm long, c. 3 mm \varnothing . *Raceme* to 6 cm long, axillary, generally unbranched, bearing to 6 distichous flowers. *Flower bud* to 3 by 1 cm. *Stamens* 30, exceeding style at anthesis; filaments slender, $\frac{1}{2}$ length of the linear tapering anthers; appendage acicular, c. $\frac{1}{3}$ length of anthers; *ovary* small, ovoid, pubescent; style stoutly columnar, pubescent but for the apical $\frac{1}{3}$. *Fruit* subsessile, *pedicel* to 2 by 2 mm; *calyx tube* to 2 cm \varnothing , globose; 2 longer lobes to 18 by 3 cm, lorate, obtuse, c. 6 mm wide at base; 3 shorter lobes to 2 by 1 cm, elliptic.

Distr. Cochinchina, Cambodia, Burma, Thailand, and in *Malesia*: Malaya, Sumatra (Atjeh south to Padang highlands in W., and river Kampar in east, southwards to Peranap).

Ecol. Lowland forest, undulating land.

Vern. *Kéruing bulu*, *k. dadeh*, *k. sudoi*, *damar etoi*, *d. minyak*, *néram bukit*, *stui*, *térak* (Malaya); *lagan*, *kéruing*, *marakelawang* (Sumatra).

Note. Confused in the past with *D. gracilis*, from which it differs in longer tomentum and larger size of all parts. The related *D. elongatus* KORTH., and also *D. hispidus* THW. of Ceylon which differs in having a cordate leaf with at most 16 pairs of nerves, would appear to be geographical segregates.

8. *Dipterocarpus obtusifolius* TEYSM. ex MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 214; DC. Prod. 16, 2 (1868) 608; WALP. Ann. 7 (1869) 377; DYER, Fl. Br. Ind. 1 (1874) 295; KURZ, Fl. Burma 1 (1877) 115; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 7, 27; Ind. Trees (1906) 65, 701; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 358; RYAN & KERR, J. Siam Soc. 8 (1911) 3, *incl. var. subnudus* RYAN & KERR; TROUP, Silv. Ind. Trees (1921) 39; CRAIB, Fl. Siam. Enum. (1925) 136; PARKER, Ind. For. Rec. 16 (1941) 9; PARKINSON, Burma For. Bull. 27 (1932) 23; TARDIEU, Fl. Gén. I.-C. Suppl. 1 (1943) 338; SYM. Mal. For. Rec. 16 (1943) 184, f. 85; SMITINAND, Thai For. Bull. 1 (1954) 51, *incl. var. glabricalyx et var. vestitus* SMITINAND; ASHTON, Gard. Bull. Sing. 31 (1978) 7. — *D. vestitus* WALL. [Cat. (1828) 954; WALP. Rep. 5 (1845) 124; DC. Prod. 16, 2 (1868) 614, *nomen*] *ex* DYER, Fl. Br. Ind. 1 (1874) 295; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 270. — *D. punctulatus* PIERRE, Fl. For. Coch. 3 (1889) t. 221; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 29; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 357.

Small or medium-sized, usually misshapen and often coppiced tree with open crown and thick, corky deeply fissured bark. Twigs, leaf buds and petioles densely pale fulvous to buff hirsute or glabrous; leaf beneath and midrib above shortly densely evenly persistently buff pubescent, with the nervation more, or less (Malaya), hirsute; fruit glabrescent. *Twig* c. 7 mm \varnothing apically, stout. *Bud* to 20 by 6 mm, lanceolate, subacute; *stipules* to 7 by 1 cm, lorate, obtuse. *Leaves* 14–22 by 10–16 cm, broadly ovate, thickly coriaceous, prominently plicate, crenate in the distal $\frac{1}{2}$; base obtuse or subcordate; apex obtuse or subacute; nerves 14–20 pairs, stout, prominent beneath, ascending; petiole 2.5–4 cm long, c. 4 mm \varnothing , stout. *Flower bud* to 2.5 by 1.2 cm; *stamens* c. 30, \pm equalling style at anthesis; filaments lorate, tapering c. $\frac{1}{2}$ as long as the relatively stout tapering lorate anthers; appendage acicular, c. $\frac{3}{4}$ as long as anther; *ovary* ovoid, pubescent, surmounted by a slender columnar style \pm thrice its length and pubescent in the basal $\frac{1}{2}$. *Fruit pedicel* to 2 by 3 mm, short; *calyx tube* to 2.5 cm \varnothing , subglobose, smooth; 2 longer lobes to 15 by 3 cm, lorate-spatulate, obtuse, abruptly tapering to c. 8 mm broad at the subrevolute base; 3 shorter lobes to 15 by 10 mm, ovate, obtuse, subrevolute.

Distr. Burma, Thailand, Indochina, and in *Malesia*: N. W. Malaya (Perlis).

Ecol. Rare, in *Schima*-bamboo forests in *Malesia*. Elsewhere a characteristic and frequently gregarious fire-resistant component of the Dry Dipterocarp (savanna) forest.

Note. Very variable, especially in the amount and density of tomentum, the more glabrous form (*var. subnudus* RYAN & KERR) prevailing in the more humid areas including N.W. Malaya; in this respect resembling other dipterocarp species of the seasonal regions, e.g. *Dipterocarpus turbinatus*, *Anisoptera costata*, *Shorea siamensis*.

9. *Dipterocarpus rotundifolius* FOXW. Mal. For. Rec. 10 (1932) 73, pl. 4; BURK. Dict. (1935) 845; SYM. Mal. For. Rec. 16 (1943) 188, f. 85.

Twigs, leaf buds, stipules outside, petiole and leaf nervation beneath sparsely very long tufted golden tomentose (especially saplings and young trees) or glabrous; parts of petals exposed in bud and ovary densely shortly evenly buff puberulent. *Twig* c. 5 mm \varnothing apically, dark brown suffused with pale grey, minutely verrucose-lenticellate; stipule scars prominent. *Buds* to 4 by 2 cm, enormous, ellipsoid, obtuse; *stipules* to 9 by 5 cm, elliptic, obtuse, concave. *Leaves* 8.5–16 by 8–15 cm, broadly ovate to suborbicular, thickly coriaceous; base obtuse to cordate; apex subacuminate or more typically obtuse; margin undulate, subrevolute; nerves 11–(13) pairs, spreading, sharply prominent beneath, shallowly depressed above; tertiary nerves remotely scalariform, distinctly elevated beneath; *petiole* 4–10 cm long, 2–3 mm \varnothing , very long. *Flowers* solitary on the 6 cm long axillary peduncles, subtended and enclosed in a large, to 5 by 3 cm, elliptic obtuse concave subpersistent bract; *stamens* 30, greatly exceeded by style at anthesis; filaments slender, columnar, short; anthers long, linear, tapering, prominently auriculate; appendage acicular, slender, c. $\frac{1}{2}$ length of anthers; *gynoecium* puberulent but for the distal $\frac{1}{2}$ of the style; ovary small, ovoid; style slender, filiform, tapering, very long. *Fruit pedicel* to 5 by 4 mm, expanding into the to 18 by 14 mm fusiform-ellipsoid smooth *calyx tube*; 2 longer lobes to 9 by 2.5 cm, oblong, obtuse, c. 7 mm wide at base, 3-nerved, the lateral 2 nerves short and the central prominently laterally branched; 3 shorter lobes to 14 by 7 mm, elliptic, obtuse, subrevolute.

Distr. *Malesia*: Malaya (Perak, and Trengganu southwards on east coast).

Ecol. Local, in Mixed Dipterocarp forest on coastal hills.

Vern. *Kéruing mengkai*.

Note. A curious and distinct form which is clearly related to the widespread *D. crinitus*.

10. *Dipterocarpus chartaceus* SYM. Gard. Bull. S.S. 9 (1938) 322; Mal. For. Rec. 16 (1943) 169, f. 85, 86. — *D. skinneri var. hirtus* RIDL. Fl. Mal. Pen. 1

(1922) 215; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 295. — *D. skinneri* (non KING) RIDL. Fl. Mal. Pen. 1 (1922) 214, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 70, *p.p.*

Large tree. Twig, leaf bud, stipule, inflorescence, flower calyx, ovary apex and petals outside densely persistently shortly golden pubescent; leaf undersurface sparsely caducously so; fruit glabrescent. *Twig* c. 4 by 3 mm \varnothing , pale brown, somewhat compressed. *Buds* to 7 by 3 mm, lanceolate-falcate; *stipules* to 8 by 9.8 cm, lorate-lanceolate. *Leaf* 8.5–19 by 4–9 cm, elliptic-ovate or rarely obovate, crisply chartaceous drying pale mauve and somewhat lustrous; base cuneate; acumen to 1 cm long, tapering; nerves 10–12(–14) pairs, slender but distinctly elevated beneath, ascending; tertiary nerves densely scalariform, hardly elevated; *petiole* 2.3–2.8 cm long, c. 2 mm \varnothing , slender. *Raceme* to 6 cm long, axillary, singly branched or unbranched, bearing to 6 flowers. *Flower buds* to 22 by 8 mm, fusiform-lanceolate. *Stamens* 30, shorter than style at anthesis; filaments compressed at base, tapering rapidly and then filiform, c. $\frac{1}{2}$ length of the relatively short linear tapering anthers; appendage acicular, c. $\frac{3}{4}$ length of anther; *ovary* narrowly ovoid, pubescent, tapering into the long slender filiform style; style glabrous in apical *Fruit pedicel* c. 1 by 2 mm, short; *calyx tube* to 18 mm \varnothing , subglobose; 2 longer lobes to 13 by 3.2 cm, lorate, somewhat tapering distally, obtuse, c. 7 mm broad and revolute at base; 3 shorter lobes to 4 by 4 mm, orbicular, revolute.

Distr. Peninsular Thailand, and in *Malesia*: Malaya.

Ecol. Infrequent in lowland forest, sometimes in areas periodically inundated, especially in seasonal areas and near coast.

Vern. *Këruing kertas* (Mal.).

Note. The fallen leaf is crisp and papery, drying pale buff.

11. *Dipterocarpus caudatus* FOXW. Philip. J. Sc. 13 (1918) Bot. 177; *ibid.* 67 (1938) 256; MERR. En. Philip. 3 (1923) 89; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 302, 303; ASHTON, Gard. Bull. Sing. 31 (1978) 8.

a. *ssp. caudatus*.

Leaf bud and stipule outside shortly densely pale buff pubescent. Parts otherwise glabrous. *Twig* 1–3 mm \varnothing apically, slender, \pm compressed, smooth, with slightly swollen amplexicaul stipule scars. *Bud* 8–17 by 2–3 mm, narrowly falcate or linear; apex tufted with slightly longer hairs arising from the outer surface. *Stipule* c. 3.5 by 0.5 cm, linear, obtuse. *Leaves* 7–11 by 3.5–5 cm, broadly elliptic, \pm prominently plicate; base broadly cuneate; acumen to 1.2 cm long, prominent, narrow; nerves 9–12 pairs, prominent, at 35°–45°; *petiole* 1–1.5 cm long, slender. *Raceme* to 12 cm long, slightly compressed; unbranched or singly branched, the flowers secund, few; *bracts* unknown. *Flower bud* to 3 by 0.8 cm. *Calyx* and *corolla* typical, calyx puberulent. *Stamens* c. 30, shorter than the style;

filaments short; anthers short, linear, tapering; appendage to connective slightly shorter than anther, stout at base, tapering. *Ovary* conical, densely pubescent; style and stylopodium narrowly cylindrical, somewhat stouter and more densely tomentose in the basal half. *Fruit calyx* glabrous tube c. 2 cm long and \varnothing , slightly obovoid, glabrous, minutely lenticellate, tapering gradually to the pedicel, c. 1 cm \varnothing at the neck; 2 longer calyx lobes to 14 by 3 cm, oblong, 3-nerved, obtuse, rather abruptly narrowing to c. 5 mm broad at base; 3 shorter lobes 4–8 by 3–4 mm, variable, strongly recurved and revolute.

Distr. *Malesia*: S. E. Philippines (Mindanao, Luzon).

Ecol. Local in everwet zone.

b. *ssp. penangianus* (FOXW.) ASHTON, Gard. Bull. Sing. Sing. 31 (1978) 8. — *D. penangianus* FOXW. Mal. For. Rec. 10 (1932) 72, pl. 3 (germ. seeds); SYM. Mal. For. Rec. 16 (1943) 185, f. 85; ASHTON, Man. Dipt. Brun. (1964) 43, f. 6–7; *ibid.* Suppl. (1968) 16.

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

Distr. *Malesia*: Malaya (Perak, Penang, W. & E. Johore, Kelantan, Pahang), Singapore, Sumatra (Karimun, Musala), Borneo (Sarawak N.E. of river Rejang, S.E. Sabah).

Ecol. Coastal hills, locally frequent.

Vern. *Këruing gasing*, *k. dëran*, *songgi dëran*.

Note. Malayan collections are distinguished by their denser more persistent indumentum on twigs, and by their prominently lenticellate fruit calyx tube.

12. *Dipterocarpus kerrii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 93; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 28; BURK. J. Str. Br. R. As. Soc. 81 (1920) 55, fig.; RIDL. Fl. Mal. Pen. 1 (1922) 215; CRAIB, Fl. Siam. Enum. 1 (1925) 136; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 295; PARKER, Ind. For. Rec. 16 (1931) 15; PARKINSON, Burma For. Bull. 27 (1932) 19; FOXW. Mal. For. Rec. 10 (1932) 69; BURK. Dict. (1935) 844; Philip. J. Sc. 67 (1938) 253; SYM. Mal. For. Rec. 16 (1943) 181, f. 85, 92; SMITINAND, Thai For. Bull. 1 (1954) 4; *ibid.* 4 (1958) 38; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 259, f. 40. — *D. obconicus* FOXW. in Elmer, Leaf. Philip. Bot. 6 (1913) 1951; Philip J. Sc. 13 (1918) Bot. 178; MERR. En. Philip. 3 (1923) 90; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 299. — *D. perturbinatus* FOXW. Philip. J. Sc. 13 (1918) Bot. 177. — *D. cuneatus* FOXW. Philip. J. Sc. 13 (1918) Bot. 178; MERR. En. Philip. 3 (1923) 89; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 300.

Large tree. Parts of petals exposed in bud, inside of stipules and ovary apex densely silky cream pubescent, parts otherwise glabrous. *Twig* c. 3 mm \varnothing , subterete, blackish, minutely pale lenticellate. *Bud* to 12 by 3 mm, lanceolate-falcate, drying black; *stipule* to



Fig. 23. The sacred forest of Sangeh in Bali, bordering on rice-field, consisting of *Dipterocarpus hasseltii* BL. (Photogr. DE VOOGD).

8 by 0.5 cm, linear-lanceolate, subacute. *Leaves* 8–13 by 3.3–7 cm, \pm broadly elliptic, coriaceous, drying dark chocolate-brown; base cuneate; acumen to 5 mm long, short, nerves (7–)9–11 pairs, slender but prominent beneath, ascending; tertiary nerves densely scalariform, very slender and barely elevated beneath; *petiole* 2–2.8 cm long, slender. *Inflorescence* to 8 cm long, singly branched or unbranched, bearing up to 5 flowers. *Flower buds* to 2.5 by 1 cm. *Stamens* c. 30, exceeding style at anthesis; filaments filiform, slender, c. $\frac{1}{3}$ length of the short linear-lorate \pm tapering subauriculate anthers; appendage acicular, slender, c. $\frac{1}{2}$ length of anther; *ovary* small, ovoid, puberulent as also the basal $\frac{1}{2}$ of the stoutly columnar style. *Fruit pedicel* to 3 by 3 mm, stout. *Fruit calyx* to 3.5 cm \varnothing , globose to subturbinate, smooth; 2 longer lobes to 14 by 3 cm, lorate, tapering apically, obtuse, abruptly constricted to c. 8 mm wide and subrevolute at base; 3 shorter lobes to 1 by 1 cm, prominent, suborbicular, subrevolute.

Distr. Andamans, Burma, Peninsular Thailand and in *Malesia*: Malaya (Malacca and Pahang northwards, coastal towards south of range), Sumatra (Indragiri), N. Borneo (Sandakan area), Philippines.

Ecol. Semi-evergreen and evergreen coastal dipter-

ocarp forests in periodically or seasonally dry climates, on red lateritic soils, on undulating land and hills below 400 m; frequently gregarious.

Vern. *Kéruing gondol*, *k. chair*, *damar minyak* (Malaya), *apitong*, *panao*, *malapanao*, *palsahingan* (Philippines).

13. *Dipterocarpus hasseltii* BL. Fl. Jav. 2 (1829) 22, t. 6; KORTH. Kruidk. (1841) 65; WALP. Rep. 5 (1845) 123; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 609; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 196; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 30; K. & V. Bijdr. 5 (1900) 109; RIDL. J. Str. Br. R. As. Soc. 33 (1900) 42; *ibid.* 34 (1900) 94; MOLL & JANSSONIUS, Mikrogr. Holz (1906) 359; KOORD. Exk. Fl. Java 2 (1912) 620; BAKER f. J. Bot. 62 (1924) 10; CRAIB, Fl. Siam. Enum. 1 (1925) 135; HEYNE, Nutt. Pl. ed. 2 (1927) 1096, 1097; SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 280; *ibid.* III, 16 (1940) 436; FOXW. Mal. For. Rec. 10 (1932) 67; Philip. J. Sc. 67 (1938) 251; BURK. Dict. (1935) 844; Mal. For. Rec. 16 (1943) 180, f. 85, 91; SMITINAND, Thai For. Bull. 4 (1958) 35; BACKER & BAKH. f. Fl. Java I (1963) 329; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 255; ASHTON, Gard. Bull. Sing. 31 (1978) 8. — *D. tam-*

purau KORTH. Kruidk. (1841) 63; WALP. Rep. 5 (1845) 123; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 36; MIQ. Fl. Ind. Bat. 1, 2 (1859) 498; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 609; DYER, J. Bot. 12 (1874) 103; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 198, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 29; MERR. En. Born. (1921) 400; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 292, f. 1; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 274; *ibid.* ed. 2 (1927) 1098; *cf.* ASHTON, Gard. Bull. Sing. 20 (1963) 234. — *D. quinquegonus* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 36; WALP. Ann. 4 (1857) 335; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; MERR. En. Born. (1921) 400. — *D. pentagonus* DC. Prod. 16, 2 (1868) 610; DYER J. Bot. 12 (1874) 104; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 199; BRANDIS J. Linn. Soc. Bot. 31 (1895) 34; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 282. — *D. lampongus* SCHEFF. Nat. Tijd. N. I. 31 (1870) 146; DYER, J. Bot. 12 (1874) 102; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 197; BRANDIS, J. Linn. Soc. Bot. (1895) 31; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 272; ASHTON, Gard. Bull. Sing. 20 (1963) 236, *in obs. sub D. gracilis*. — *D. balsamiferus* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 37; MIQ. Fl. Ind. Bat. 1, 2 (1859) 498; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 613; DYER, J. Bot. 12 (1874) 108; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 203; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 40; K. & V. Bijdr. 5 (1900) 111; MOLL & JANSSONIUS, Mikrogr. Holz (1906) 357; HEYNE, Nutt. Pl. ed. 2 (1927) 1096. — *D. trinervis* (*non* BL.) FOXW. Philip. J. Sc. 6 (1911) Bot. 247; *ibid.* 13 (1918) Bot. 177; MERR. En. Philip. 3 (1923) 91. — *D. subalpinus* FOXW. in Elmer, Leaf. Philip. Bot. 6 (1913) 1950; Philip. J. Sc. 13 (1918) Bot. 177; *ibid.* 67 (1938) 255; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 283. — Fig. 23, 24.

Parts of petals expanded in bud and ovary apex densely persistently buff puberulent, calyx at first frequently so, nerves beneath sparsely so or glabrescent, otherwise glabrous. *Twig* *c.* 4 by 2 mm \varnothing apically, somewhat compressed, black. *Buds* to 20 by 5 mm, falcate-lanceolate, drying black; *stipules* to 12 by 1 cm, lorate-lanceolate, subacute. *Leaves* 9–16 by 5–10 cm, elliptic, subcoriaceous, prominently plicate; margin \pm prominently crenate; base cuneate; acumen to 1 cm long, short; nerves 11–14 pairs, slender but prominent beneath, ascending; *petioles* 2.5–4 cm long, slender. *Inflorescences* to 10 cm long, axillary, bearing to 4 \pm secund flowers. *Flower buds* to 3 by 1 cm, fusiform. *Stamens* 30, shorter than style at anthesis; filaments *c.* $\frac{1}{2}$ length of anthers, long, broad and compressed at base, rapidly tapering and filiform above; anthers linear, somewhat tapering distally; appendage acicular, very slender, *c.* $\frac{2}{3}$ length of anther. *Ovary* narrowly ovoid-lanceolate, tapering into the very long slender filiform style; gynoeceium puberulent except for the distal $\frac{1}{4}$. *Fruit pedicel* to 3 by 2 mm; *calyx tube* to 3 cm \varnothing , subglobose smooth; 2 longer lobes to 22 by 3 cm, lorate-spatulate, usually obtuse, 3-nerved, *c.* 9 mm wide at base; 3 shorter lobes to 15 by 13 mm, suborbicular, subrevolute, prominent.

Distr. Peninsular Thailand, and in *Malesia* around

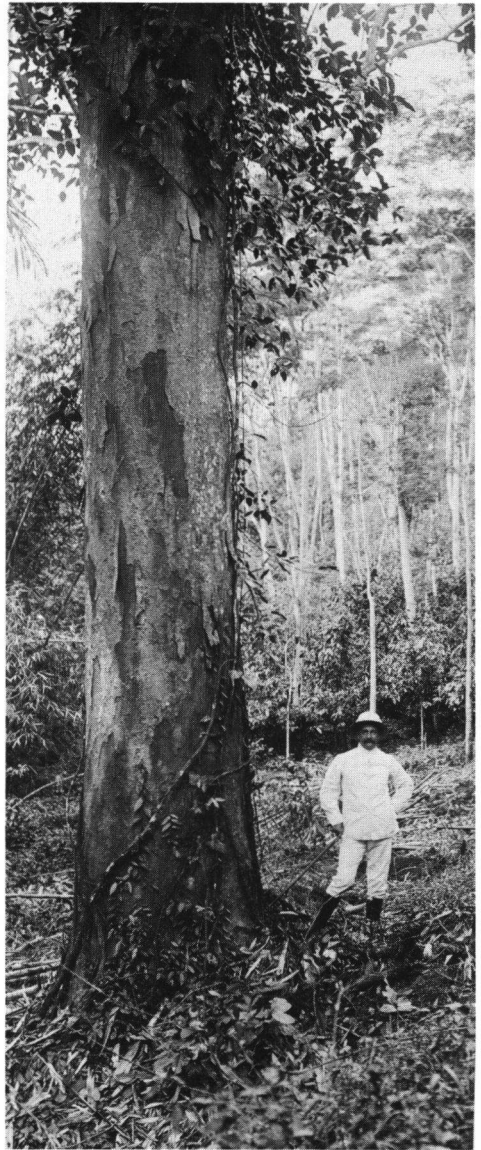


Fig. 24. Basal part of trunk of a relict tree of *Dipterocarpus hasseltii* BL. near a coffee estate, Getas, near Salatiga, Central Java (Photogr. ROEPKE, 1913).

the periodically dry borders of the everwet zone of the Sunda shelf: Malaya (Central and North), Sumatra (P. Simalur and Mentawai Is.), W. Java, Lesser Sunda Is. (Bali) and S. and E. Borneo to S.E. Sabah, Philippines including Palawan.

Ecol. Lowland dipterocarp forests on well-drained but moist fertile red soils in valleys and on hillsides, sometimes on calcareous soil, even limestone (Java); sometimes gregarious; to 600 m.

Notes. I agree with MERRILL (En. Philip. 3, 1923, 89) in reducing *D. subalpinus* FOXW., based on ELMER 13521 from Cabadbaran, Mt Urdaneta, Agusan Prov., Mindanao. FOXWORTHY (Philip. J. Sc. 67, 1938, 251) claimed that *D. subalpinus* differed from *D. hasseltii* in having smaller leaves and fruit without the distinctive large, suborbicular, shorter calyx lobes, in this resembling *D. gracilis* BL. The problem is confounded by the frequently unusually sparsely tomentose leaves of *D. gracilis* in the Philippines, especially at higher altitudes where *D. subalpinus* appears to prevail. However, the specimens presently available convinced me that Philippine material is within the range of variation of *D. hasseltii* from other parts of its range.

It is curious that, though this is clearly the species that is venerated in the sacred forest of Sanggeh, Bali collections from Lombok and Sumbawa Is., on a similar but clearly natural site in the former, appear to represent *D. retusus* (see there). I cannot distinguish these two species in Java or the Lesser Sunda Islands when young. Immature trees were seen to fruit abundantly in Sanggeh. There is the possibility of hybridization, in this part of the range, of these two otherwise very distinct species.

14. *Dipterocarpus retusus* BL. Cat. (1823) 77, cum tab.; Verh. Bat. Gen. K. W. 9 (1823) 178; Bijdr. (1825) 223; Fl. Jav. 2 (1829) 14, t. 2; WALP. Rep. 5 (1845) 122; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 609; DYER, J. Bot. 12 (1874) 102; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 197; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 256; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 30; K. & V. Bijdr. 5 (1900) 112; KOORD. Exk. Fl. Java 2 (1912) 21; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251, 256, fig.; HEYNE, Nutt. Pl. ed. 2 (1927) 1097; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 286; *ibid.* III, 16 (1940) 435; FOXW. Mal. For. Rec. 10 (1932) 69; SYM. Mal. For. Rec. 16 (1943) 187, f. 85; BACKER & BAKH. f. Fl. Java 1 (1963) 329; ASHTON, Gard. Bull. Sing. 31 (1978) 9. — *D. trinervis* BL. Cat. (1823) 78; Verh. Bat. Gen. K. W. 9 (1823) 178; Bijdr. (1825) 223; Fl. Jav. 2 (1829) 11, t. 1, incl. var. *elegans* BL. et var. *canescens* BL.; KORTH, Kruidk. (1841) 61; WALP. Rep. 5 (1845) 122; LINDLEY, Veg. King. (1846) 393; HASSK. Pl. Jav. Rar. (1848) 270; SCHNIZLEIN, Ic. 3 (1857) t. 213; MIQ. Fl. Ind. Bat. 1, 2 (1859) 496; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 608; SCHEFF. Nat. Tijd. N. I. 31 (1870) 346; BAILLON, Hist. Pl. 4 (1873) 204; Dict. Bot. 1 (1878) 562; Tr. Bot. Med. Pharm. 2 (1884) 816; DYER, J. Bot. 12 (1875) 102; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 195; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 256; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 29; K. & V. Bijdr. 5 (1900) 105; MOLL & JANSSONIUS, Mikrogr. Holz (1906) 354; KOORD. Exk. Fl. Java 2

(1912) 620; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 274; *ibid.* ed. 2 (1927) 1098; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251, 256, fig.; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 284; *ibid.* III, 16 (1940) 436; BACKER & BAKH. f. Fl. Java 1 (1963) 329. — *D. spanoghei* BL. Fl. Jav. 2 (1829) 16, t. 3; WALP. Rep. 5 (1845) 122; MIQ. Fl. Ind. Bat. 1, 2 (1859) 497; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 609; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 198, incl. var. *cordata* BURCK; HEYNE, Nutt. Pl. ed. 2 (1927) 1097. — *D. macrocarpus* VESQUE, C. R. Ac. Sc. Paris 78 (1874) 627; J. Bot. 12 (1874) 151; DYER, J. Bot. 12 (1874) 153; PARKER, Ind. For. Rec. (Bot.) 20, 15 (1934) 3. — *D. pubescens* K. & V. Bull. Inst. Bot. Btzg 2 (1899) 2; Bijdr. 5 (1900) 115; MOLL & JANSSONIUS, Mikrogr. Holz (1906) 359; KOORD. Exk. Fl. Java 2 (1912) 621; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 274; *ibid.* ed. 2 (1927) 1097. — *D. tonkinensis* A. CHEV. Bull. Econ. Indochine 20 (1918) 798. — Fig. 17H.

Medium-sized tree. Twigs, panicles, flower calyx and corolla outside shortly densely buff puberulent or glabrous; petiole, leaf bud and ovary densely persistently pale orange-rufous silky tomentose or glabrous, stipule caducously so, becoming tufted glabrescent on expanding; leaf glabrescent. Twigs c. 8 mm \varnothing apically, stout, becoming pale brown. Buds to 2.5 by 1 cm, ovoid-lanceolate, acute; stipule to 4 cm long, lanceolate, acute. Leaves 16–28 by 7–17 cm (to 50 by 70 cm in young trees), \pm broadly elliptic-oblong, coriaceous, prominently plicate, drying dark chocolate-brown; nerves 16–19 pairs, prominent beneath, \pm depressed above, ascending; tertiary nerves densely scalariform, very slender and hardly elevated beneath; petiole 2.5–7 cm long. Panicles to 10 cm long, unbranched, axillary. Flower bud to 3 by 1 cm, fusiform. Stamens 30, exceeding style at anthesis; filaments short, filiform; anthers long, linear, tapering; appendage acicular, slender, c. $\frac{1}{2}$ length of anther. Ovary small, ovoid, densely pubescent as also the basal $\frac{1}{3}$ of the stoutly columnar somewhat tapering style. Fruit pedicel to 3 by 4 mm, stout; calyx tube to 3.5 mm \varnothing , subglobose, sparsely minutely pale lenticellate, smooth; 2 longer lobes to 25 by 4.5 cm, obtuse, prominently 3-nerved, tapering abruptly to c. 12 mm wide at base; 3 shorter lobes to 2 by 1.5 cm, prominent, ovate-elliptic, obtuse, subrevolute.

Distr. Assam, N.W. Burma, N., S.E. & Peninsular Thailand, Tonkin, and in Malesia: Malaya, Sumatra (Gajo Lands, Angkola), Java, Lesser Sunda Is. (Lombok, Sumbawa).

Ecol. Moist evergreen mid-mountain forests, at 800–1300 m in Malaya and W. Java but at lower altitudes in seasonal areas, and as low as 100 m at Lakhimpur, Assam and Lombok; locally common or semi-gregarious.

Vern. *Këruing gunong* (Malaya), *pelahlar*, *palaglar* (Java).

Notes. The distribution, persistence and density of the tomentum is very variable, even within a single population, in E. Java and Burma; in Assam, N. Burma and N. Thailand even the leaves are typically

persistently pubescent beneath, while in Malaya it is uniformly glabrescent but for the buds and corolla.

The species, as here understood, has an interesting distribution: at the extremities of its range in mainland Asia and in the Lesser Sunda Is. (Lombok and Sumbawa) it occurs in a seasonal climate down almost to sea level and is relatively tomentose. In the everwet tropics of Malaya and W. Java it is confined to altitudes above 800 m and in the former is uniformly glabrescent but for the buds and corolla.

D. littoralis is clearly a segregate from the widespread *D. retusus*, endemic to the lowland forest of Nusa Kambangan I., adjacent to the coast of S. Central Java. I maintain it as a species. It would appear that the ecological and geographical distribution, and diversification, of the two must be explained in terms of regional Pleistocene history.

15. *Dipterocarpus littoralis* BL. Bijdr. (1825) 224; Fl. Jav. 2 (1829) 17, t. 4; KORTH. Kruidk. (1841) 62; WALP. Rep. 5 (1845) 122; MIQ. Fl. Ind. Bat. 1, 2 (1859) 496; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 609; DYER, J. Bot. 12 (1874) 102; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 198; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 30; K. & V. Bijdr. 5 (1900) 114; MOLL & JANSSONIUS, Mikrogr. Holz (1906) 348; KOORD. Exk. Fl. Java 2 (1912) 621; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 296, f. 2; BACKER & BAKH, f. Fl. Java 1 (1963) 329.

Young parts ± densely pale ferrugineous pubescent, persistent only on leaf bud, stipule outside and ovary, becoming sparse though subsistent on petiole and midrib above. Twigs 8–11 mm Ø, stout, terete, rough, with prominent large petiole scars. Bud c. 20 by 15 mm, ovoid-lanceolate. Stipule to 15 by 4 cm, lanceolate, acute, caducous. Leaves clustered round the twig apices, 16–25(–52 in young trees) by 10–18(–28) cm, broadly ovate, thinly coriaceous, ± prominently persistently plicate; base obtuse or cordate; apex shortly acuminate; nerves 19–24 pairs, straight, at 60°–70°, prominent beneath; tertiary nerves laxly scalariform, slender but distinctly elevated beneath; midrib prominent beneath, appanate or somewhat elevated above; petiole 3–9(–12) cm long, prominently geniculate. Inflorescences to 20 cm long, glabrous, axillary and crowded round the twig apices, lax, compressed, bearing to 3 flowers. Flower buds to 35 by 10 mm, prominently pedicellate. Stamens c. 30; filaments tapering, anthers narrowly tapering, auriculate, pubescent; appendages shorter than anthers. Fruit pedicel to 5 by 4 mm, prominent; calyx tube to 3.5 by 3 cm, obturbinate, smooth; 2 longer lobes to 24 by 4 mm, lorate, narrowly obtuse or subacute, c. 7 mm broad and somewhat revolute at base; 3 shorter lobes to 10 by 6 mm, obtuse, with revolute margins.

Distr. *Malesia*: Central S. Java (Nusa Kambangan I. in Banjumas Res.).

Ecol. Apparently common in the mixed lowland rain forest.

Vern. *Lalar*, *pēlahlar*, *kalahlar* (Jav.).

Note. Apparently a lowland segregate of the widespread submontane *D. retusus*. A collection at Leiden (DE VRIESE s.n. sub n. 902. 146–236) is presumably wrongly annotated as from Sumatra.

16. *Dipterocarpus kunstleri* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 96; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 148, t. 180; RIDL. Fl. Mal. Pen. 1 (1922) 217; HEYNE, Nutt. Pl. ed. 2 (1927) 1094, 1096; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 327; FOXW. Mal. For. Rec. 10 (1932) 83; BURK. Dict. (1935) 844; SYM. Mal. For. Rec. 16 (1943) 182, f. 85; ASHTON, Gard. Bull. Sing. 31 (1978) 10. — *D. speciosus* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 38; PERK. Fragm. Fl. Philip. (1904) 22; FOXW. Philip. J. Sc. 6 (1911) Bot. 250, pl. 37; *ibid.* 13 (1918) Bot. 178; *ibid.* 67 (1938) 261; MERR. En. Philip. 3 (1923) 90; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 265. — *D. exalatus* SLOOT. ex WOOD, Gard. Bull. Sing. 17 (1960) 486; Reinwardtia 5 (1961) 462; ASHTON, Man. Dipt. Brun. (1964) 31, f. 6; *ibid.* Suppl. (1968) 14; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 246, pl. 25b. — Fig. 17D.

Twig, lamina and petiole glabrous; leaf nervation puberulent or glabrous beneath; leaf bud and stipule outside persistently densely minutely pale grey adpressed puberulent, appearing grey lepidote. Twig to 5 mm Ø apically, terete or slightly ribbed and compressed; stipule scars prominent. Bud 12–15 by 2–3.5 mm, narrowly falcate, acute. Stipule to 7 by 0.8 cm, linear. Leaves 13–22 by 7–10 cm, elliptic to broadly lanceolate, base cuneate; apex shortly acuminate (more prominently acuminate in young trees); nerves 16–18 pairs, prominent beneath, at c. 40° to 50°; petiole 2–3 cm long. Raceme to 22 cm long, terminal or axillary, slender, glabrous, somewhat compressed, singly branched. Flower bud to 3.5 by 1.5 cm. Calyx and corolla typical, calyx glabrous. Stamens c. 30, somewhat longer than the style; filaments short, anthers linear, tapering; appendage to connective as long as anther, slender. Ovary ovoid-conical, shortly densely pubescent; stylopodium and style about 5 times as long as the ovary, tapering from the base, shortly tomentose but for apical ¼. Fruit calyx glabrous; tube to 5 by 2.5 cm, ellipsoid, tapering gradually to the base and to the strongly constricted c. 1 cm Ø neck; 5-ribbed or almost winged, the ribs c. 7 mm thick and 4 mm broad apically, either confined to the apical half or continuing to the base as shallow rounded ridges, terminating ± abruptly distally as obtuse tubercles; 2 longer lobes to 11 by 1.5 cm, of very variable length, sometimes no longer than shorter lobes, lanceolate, coriaceous, obtuse, tapering abruptly to the c. 5 mm broad base, 3-nerved, nerves indistinct; shorter lobes to 6 by 5 mm, small, recurved, somewhat thickened.

Distr. *Malesia*: Malaya (excluding seasonal area), Sumatra (Atjeh, Tapanuli, Palembang, in north, west and south-east; Simalur, Marsala, Banka), Borneo (S.E. Borneo, Sabah, Brunei, Sarawak N.E. of Rejang), Philippines (Luzon, Polillo, Negros, Samar, Basilan).

Ecol. Widespread, locally common, on undulating or flat land, especially near streams.

Vern. *Kéruing gombang, k. g. merah* (Mal.), *k. batu, k. jombor, k. minyak, lagan laweh, l. daun lebar* (Sum.), *k. rapak, k. simpur, k. kuntum puteh, karang, binawan, kambalong, tempudau, isak, tabuloh, karup* (Borneo).

Note. In N.E. and E. Borneo the calyx tube is ± obtusely ribbed and tuberculate distally, and the wings often (not always) short or even rudimentary. In the Philippines the species becomes very variable; in some collections the fruit calyx tube is continuously ribbed from base to apex and even winged suggesting hybridisation with *D. grandiflorus* (BLCO) BL.; in others the twigs and petioles are densely fulvous pilose as in *D. elongatus* KORTH., which grows with it there.

Individual trees observed in the field in Borneo are rather constant in the length of the calyx lobes, but geographical variation appears continuous and to some extent clinal, the lobes becoming shorter towards the south-eastern limits of its range. I cannot therefore recognize distinct varieties meriting taxonomic status.

D. speciosus BRANDIS, based on VIDAL 2160 (in fruit, K) from Luzon, is a specimen with tomentum typical of *D. kunstleri* and fruit similar though with narrower, more continuous ribs. I see no satisfactory solution other than to unite the two names.

17. *Dipterocarpus applanatus* SLOOT. Bull. Jard. Bot. Btzg III, 16 (1940) 443, f. 5; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 237, f. 34; ASHTON, Man. Dipt. Brun. Suppl. (1968) 11, f. 2, pl. 1 (stem-base).

Twig, base of inflorescence and inside of stipule shortly evenly pale buff pubescent, base of petiole caducously so; leaf bud and stipule outside longer tomentose, longest towards apices. *Twig* 5–11 mm Ø, stout, pale with prominent slightly depressed dark stipule scars. *Bud* 4–15 by 10–27 mm, broadly ellipsoid to falcate, acute or obtuse. *Stipule* to 5 by 2 cm, oblong, obtuse, concave. *Leaves* 12–30 by 9–20 cm, usually large, ± broadly elliptic, coriaceous but undulate; base obtuse to subcordate; acumen short, abruptly acuminate; nerves 11–15 pairs, prominent, at 45°–70°; tertiary nerves remote, subreticulate; *petiole* 3.5–6 cm long, to 4 mm Ø. *Flowers* unknown. *Raceme* to 2 cm long, terete but rugose on drying, glabrescent, singly branched or bifurcating, bearing distichous fruit at c. 3 cm intervals. *Fruit pedicel* to 3 mm long, tapering from base of calyx tube; *calyx tube* to 5 by 4.5 cm, glabrous, ovoid, bearing 5, to 8 mm wide, prominent sharp-edged ribs; ribs widest distally and there frequently undulate, sometimes absent basally; 2 longer calyx lobes to 19 by 4.5 cm, glabrous, lorate, obtuse, tapering abruptly at the somewhat revolute base; 3 shorter calyx lobes to 1 by 1 cm, suborbicular, completely revolute.

Distr. *Malesia*: Borneo (W. Sarawak, E. Sabah, Tidung and Bulungan).

Ecol. Locally common on sandy soils, especially in valleys and on flat land near coasts.

Vern. *Kéruing arong, k. daun besar*.

Note. Apparently a segregate from *D. kunstleri*; it may have arisen more than once from the parental species.

18. *Dipterocarpus rigidus* RIDL. J. Str. Br. R. As. Soc. 82 (1920) 171; Fl. Mal. Pen. 1 (1922) 217; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 347; Reinwardtia 5 (1961) 463; FOXW. Mal. For. Rec. 10 (1932) 76, pl. 5; BURK. Dict. (1935) 845; DESCH, Mal. For. Rec. 14 (1941) 64; SYM. Mal. For. Rec. 16 (1943) 187, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 110; ASHTON, Man. Dipt. Brun. Suppl. (1968) 16, f. 3, pl. 2 (habit & bark).

Twig, petiole, midrib above and leaf beneath shortly densely evenly pale ocherous pubescent, leaf above fugaceously so; leaf bud and stipule outside (glabrous within in mature tree) longer tomentose. *Twig* to 8 mm Ø apically, stout, terete, with slender stipule scars. *Bud* to 15 by 8 mm, conical, subacute. *Stipule* to 7 by 1 cm, lorate, subacute. *Leaves* 13–25 by 8–16 cm, ovate, thickly coriaceous, with broadly cuneate base; acumen to 1 cm long; nerves 12–16 pairs, at 40°–50°; nerves and midrib prominent beneath, depressed above; tertiary nerves scalariform, evident beneath; *petiole* 3–6 cm long, geniculate. *Raceme* to 15 cm long, terete, axillary, at first shortly evenly ocherous pubescent towards the base, glabrescent; unbranched or rarely singly branched, bearing distichous flowers at up to 3 cm intervals. *Flower bud* to 3.5 by 1 cm. *Calyx* and *corolla* typical; calyx glabrous. *Stamens* 24, slightly shorter than the style; filaments narrowly lorate, slightly tapering, exceeding length of anthers; anthers linear, tapering; appendage acicular, c. ½ length of the anther. *Ovary* ovoid, pubescent; style columnar, pubescent except for the apical ¼. *Fruit* glabrous. *Pedicel* 1 mm long, stout. *Calyx tube* to 5 by 4.5 cm, subglobose, with 5 tubercles (obscure at maturity) in the distal half; 2 longer calyx lobes to 18 by 5 cm, lanceolate to lorate, subacute, to 6 mm broad above the somewhat revolute base; 3 shorter lobes to 8 by 8 mm, suborbicular, revolute.

Distr. *Malesia*: E. Malaya (Trengganu southwards), Sumatra (Riouw Arch., Singkep, Lingga), Anambas Is., Borneo (Sarawak N.E. to Bintulu).

Ecol. Locally abundant on dry sandy soils on coastal hills.

Vern. *Kéruing chogan, k. utap, k. sungkit, k. pakat, k. kélawar, k. kéluang, k. merah, k. lékit, k. daun lebar, k. d. panjang* (Mal.).

Note. Sometimes difficult to distinguish from *D. costulatus* and *D. globosus*, both of which can be more or less tomentose when immature.

19. *Dipterocarpus costulatus* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 315, f. 7; *ibid.* III, 17 (1941) 105; FOXW. Mal. For. Rec. 10 (1932) 79; SYM. Mal. For. Rec. 16 (1943) 174, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 108; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 244, pl. 25a (seedlings); ASHTON, Man. Dipt. Brun. Suppl. (1968) 12, f. 2.

Vegetative parts of mature tree glabrous but for the densely shortly buff pubescent inner surface of bud-scales and stipules. Twigs and buds frequently pruinose. *Twig* to 7 mm \varnothing towards the apex, somewhat compressed at first, becoming terete, smooth; stipule scars slender, prominent. *Bud* to 30 by 6 mm, falcate, acute, slender. *Stipule* to 16 by 2 cm, lorate, subacute. *Leaves* 12–20 by 7–14 cm, broadly elliptic to ovate, thickly coriaceous, with prominently cuneate base, obtuse to shortly acuminate, persistently folded between the 11–14 pairs of prominent nerves; tertiary nerves slender, scalariform; *petiole* 3–6 cm long. *Raceme* to 20 cm long, terete, glabrous, bearing distichous flowers at to 4 cm intervals. *Flower buds* to 3 by 1.5 cm. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* c. 24, slightly shorter than the style; filaments about $\frac{1}{2}$ length of anther, compressed, tapering; anther linear, tapering apically into the acicular appendage; appendage somewhat less than $\frac{1}{2}$ length of anther. *Ovary* ovoid, densely pubescent; style columnar, pubescent except in the apical $\frac{1}{4}$. *Fruit pedicel* to 6 mm long, prominent. *Calyx* glabrous; tube to 1.5 by 2 cm, subglobose, bearing 5 prominent flange-like tubercles medially; 2 larger calyx lobes to 20 by 4 cm, broadly lorate, obtuse, with to 6 mm wide revolute constriction at the base; 3 shorter lobes to 7 by 6 cm, suborbicular, obtuse, revolute.

Distr. *Malesia*: Malaya (excepting seasonal areas), E. Sumatra (E. Atjeh, Langkat, Indragiri, P. Lingga), west and north-east Borneo (Lower Kapuas, W. Sarawak; Tawau Distr., Nunukan and Tidung).

Ecol. Local, on poor soils on flat and undulating land, rarely to 600 m.

Vern. *Këruing paya*, *k. kipas*, *k. pëkat*, *k. marakluang*, *k. ladan*.

20. *Dipterocarpus globosus* VESQUE, C. R. Ac. Sc. Paris 78 (March 1874) 627; J. Bot. 12 (1874) 151; DYER, J. Bot. 12 (1874) 153; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 200; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 33; MERR. En. Born. (1921) 398; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 304; *ibid.* III, 17 (1941) 98; BROWNE, For. Trees Sarawak & Brunei (1955) 109; ASHTON, Man. Dipt. Brun. (1964) 33, f. 6–7, pl. 5 (stem); *ibid.* Suppl. (1968) 15. — *D. beccarianus* VESQUE, C. R. Ac. Sc. Paris 78 (1874) 627; J. Bot. 12 (1874) 151; DYER, J. Bot. 12 (1874) 153; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 200. — *D. beccarii* DYER, J. Bot. 12 (April 1874) 103, t. 144, f. 16; *ibid.* (May 1874) 153, *incl. var. glabrata*.

Midrib and nerves below fugaceous pubescent; young twig, raceme and petiole \pm persistently shortly chestnut pubescent; leaf bud and stipule outside densely persistently long chestnut tomentose. *Twig* 5–8 mm \varnothing apically, stout, terete. *Bud* 1–2 by 0.8–1.2 cm, ovoid, acute. *Stipule* c. 7 by 0.7 mm, narrowly lanceolate, acute. *Leaves* 10–14 by 7–9 cm, thickly coriaceous, broadly ovate, with sinuate margin; prominently plicately folded between the nerves; base broadly cuneate; acumen c. 4 mm long, broad; nerves 12–14 pairs, well spaced, prominent beneath, some-

what oblique (20°–30° apically and 50°–60° basally); *petiole* 2–2.5 cm long, stout. *Flowers* unknown. *Raceme* to 8 cm long, stout, axillary, singly branched. *Fruit calyx tube* 2.5–3.5 cm long and broad, \pm ovoid, glabrous, sometimes unribbed, usually \pm 5-ribbed from the obtuse and often impressed base to the constricted c. 8 mm \varnothing neck; ribs obtuse or acute, most prominent, slightly tuberculate, distally; 2 longer lobes 11–15 by 2.5–3.5 cm, coriaceous, slightly twisted, oblong, \pm broader in the distal half, obtuse, gradually tapering to the flat c. 6 mm broad base, glabrous, with three subequal closely parallel nerves, prominent on the inner surface; 3 shorter lobes 4–5 mm long and broad, small, deltoid, \pm recurved, revolute.

Distr. *Malesia*: Borneo (Sarawak, Brunei, S.W. Sabah).

Ecol. Locally abundant on leached sandy soils in Mixed Dipterocarp forest on coastal hills below 400 m.

Vern. *Këruing buah bulat*.

Note. Differing principally from *D. rigidus* in the absence of tomentum at maturity (also minor fruit differences); in this bearing the same relationship as *D. humeratus* to *D. cornutus*.

21. *Dipterocarpus humeratus* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 308, 311, f. 4; THORENAAR, Med. Proefst. Boschw. 16 (1926) 108; ASHTON, Gard. Bull. Sing. 20 (1963) 237; Man. Dipt. Brun. (1964) 36, f. 6, pl. 12–13 (stem, bark); *ibid.* Suppl. (1968) 15; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 257, f. 39. — *D. validus* (non BL.) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37, p.p., *quoad specim.* FORBES. — *D. retusus* (non BL.) RIDL. Kew Bull. (1926) 60, p.p. — *D. gibbosus* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 311, f. 5. — *D. ursinus* SLOOT. Reinwardtia 5 (1961) 470, f. 5.

Young twig, petiole, midrib and nerves beneath persistently shortly cream pubescent; leaf bud and stipule outside long fulvous tomentose, the hair tufts becoming separated widely and partially caducous on the expanding stipule. *Twig* 1–1.2 cm \varnothing apically, becoming uneven and thinly flaky, terete. *Bud* to 5 by 1.5 cm, narrowly conical, obtuse. *Stipule* to 10 by 2 cm, narrowly lanceolate, obtuse. *Leaves* 20–38 by 12–23 cm, broadly ovate; base obtuse; apex obtuse to shortly acuminate; nerves c. 20 pairs, prominent, well spaced, at 45°–60°; *petiole* 4–6 cm long, stout, prominently geniculate. *Raceme* to 21 cm long, terminal or axillary, terete or slightly compressed, long golden-brown caducous tomentose at base, more shortly so distally; usually unbranched. *Flowers* remote, distichous; *bud* to 5 by 2 cm, large. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* c. 40, longer than style; filaments c. $\frac{1}{2}$ as long as anthers; anthers linear, tapering; appendage to connective as long as anther or slightly longer, slender. *Ovary* ovoid-conical, shortly pubescent; stylopodium 2–3 times as long as ovary, shortly pubescent the apex excepted. *Fruit* subsessile. *Calyx tube* to 4 by 3.5 cm, globose, glabrous, with 5 obtuse tubercles in the apical half, terminating

abruptly at the c. 2.5 cm \varnothing neck; 2 longer calyx lobes to 18 by 5 cm, oblong, obtuse, tapering abruptly at the to 1.2 cm broad revolute base, untwisted; 3 shorter lobes to 1.5 cm long and broad, broadly ovate, base subcordate, apex obtuse, revolute with the 2 halves back to back.

Distr. *Malesia*: North and East Sumatra (Langsa; Singkel, Tapanuli, E. coast, Palembang, Mentawai Is.), Borneo (S.E. Kalimantan, Sabah, N.E. Sarawak, Brunei).

Ecol. Local, on undulating land and ridges below 700 m.

Vern. *Këruing kerukup, k. latek bukit* (Mal.).

Note. Clearly closely allied to *D. cornutus*, from which it differs principally in the tomentum and smooth fruit calyx.

22. *Dipterocarpus cornutus* DYER, Fl. Br. Ind. 1 (1874) 296; J. Bot. 12 (1874) 103, t. 143, f. 15; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 93; BRANDIS, J. Linn. Soc. Bot. (1895) 32; RIDL, Fl. Mal. Pen. 1 (1922) 215; SLOOT, Bull. Jard. Bot. Btzig III, 8 (1927) 306; HEYNE, Nutt. Pl. ed. 2 (1927) 727; FOXW. Mal. For. Rec. 10 (1932) 75; BURK. Dict. (1935) 842; SYM. Mal. For. Rec. 16 (1943) 172, f. 85, 87, 88. — Fig. 17A.

Large pale-barked tree. Twigs, leaf buds, stipule outside, petiole, leaf beneath including nervation, midrib above, calyx, corolla outside and ovary apex densely persistently pale ochereous-cream puberulent, sometimes fulvous on twigs; fruit calyx glabrescent; leaf bud, stipule and base of inflorescence frequently also densely \pm caducously long rufous tufted tomentose, the short even indumentum persisting after the tufts drop. *Twig* c. 10 by 8 mm, stout, somewhat compressed, pale brown, sometimes becoming papery flaky. *Bud* to 6 by 1 cm, lanceolate, acute; *stipule* to 20 by 4 cm, lorate, narrowly obtuse. *Leaves* 15–30 by 7.5–18 cm, broadly elliptic to oblong-ovate, thickly coriaceous, cream beneath, prominently persistently plicate; base obtuse; apex obtuse or subretuse; nerves 18–21 pairs, prominent beneath; tertiary nerves very slender, hardly elevated, densely scalariform; *petiole* 5–8.5 cm long, c. 4 mm \varnothing , long, stout. *Inflorescences* to 28 cm long, to 5 by 3 mm \varnothing at base, axillary, somewhat compressed, unbranched, bearing to 10 distichous flowers. *Flower bud* to 3.5 by 1 cm, fusiform. *Stamens* 30, exceeding style at anthesis; filaments short, broad, applanate, deltoid; anthers c. 5 times length of filaments, broadly linear-lanceolate, tapering; appendage stoutly acicular, tapering, c. $\frac{1}{2}$ length of anther. *Ovary* ovoid, small, densely hirsute as also the basal $\frac{1}{2}$ of the stoutly columnar \pm capitate style. *Fruit* shortly pedicellate to subsessile; *calyx tube* to 2.5 cm long, to 3.7 cm \varnothing including the 5 prominent distal tubercles, subglobose, densely verrucose lenticellate; 2 longer lobes to 21 by 5 cm, oblong, narrowly obtuse, abruptly constricted to c. 2 cm wide and revolute at base; 3 shorter lobes to 15 by 15 cm, suborbicular, revolute.

Distr. *Malesia*: Malaya, N. Sumatra (Atjeh, Langkat), Borneo (S.E., from P. Laut to W. and E. Kutei).

Ecol. Lowland forest to 1000 m, on well drained flat or undulating land or hills; frequently common or semigregarious.

Vern. *Këruing gombang, k. dadek, k. (mara)këluwang, k. chaier, k. babi* (Malaya), *këruing, tampudau, tampurau, kapenkaluang* (Borneo).

23. *Dipterocarpus elongatus* KORTH, Kruidk. (1841) 62; WALP. Rep. 5 (1845) 123; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 36; MIQ. Fl. Ind. Bat. 1, 2 (1859) 498; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 83, 85; DC. Prod. 16, 2 (1868) 613; DYER, J. Bot. 12 (1874) 108; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 203; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 32, 40; MERR. En Born. (1921) 398; SLOOT, Bull. Jard. Bot. Btzig III, 8 (1927) 272; Reinwardtia 5 (1961) 473, 474; ASHTON, Gard. Bull. Sing. 20 (1963) 237. — *D. apterus* FOXW. Mal. For. Rec. 10 (1932) 77, pl. 6; BURK. Dict. (1935) 842; SLOOT, Bull. Jard. Bot. Btzig III, 16 (1940) 439, f. 3; SYM. Mal. For. Rec. 16 (1943) 167, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 107; ASHTON, Man. Dipt. Brun. (1964) 23, f. 6; *ibid.* Suppl. (1968) 11. — Fig. 17F.

Twigs, leaf bud, stipule outside and petiole with \pm dense, \pm caducous, very long red-brown tufted tomentum; leaf nervation below more sparsely so or glabrous. *Twigs* to 1.5 cm \varnothing apically, terete, red-brown, becoming cracked and thinly flaked. *Bud* to 6 by 1.5 cm, falcate, acute, glabrescent or remaining tufted as the stipule expands. *Stipule* to 15 by 2.5 cm, hastate, acute. *Leaves* 28–50 by 13–20 cm, elliptic, coriaceous; base obtuse; apex shortly abruptly acuminate; nerves 25–38 pairs, prominent beneath, the lamina persistently plicately folded between; tertiary nerves distant, scalariform; *petiole* 5–7 cm long, 0.5 cm \varnothing , stout. *Flowers* unknown. *Raceme* to 12 cm long, terminal or axillary, rigid, rarely branched, red-brown long tufted tomentose. *Fruit calyx tube* to 5 by 5.5 cm, at first tomentose, glabrescent, at first obovoid, becoming globose, with 5 obtuse distal tubercles, constricted to c. 1.5 cm \varnothing at neck; lobes equal, vestigial, to 8 mm long, becoming recurved, obtuse.

Distr. *Malesia*: Malaya (E. coast: Kelantan to Central and E. Johore and Singapore), eastern Sumatra (Serdang and Langkat Distr.), Lingga Arch., Anambas Is. (S. China Sea), Borneo (Sarawak N.E. of Rejang, Kapuas valley, S.E. Kalimantan).

Ecol. Fresh water swamp, usually on sandy, periodically well drained, soil; locally common in primary and secondary forest.

Vern. *Këruing latek, latek, k. babi* (Brun.), *k. gumbang* (Mal.), *k. pasir* (Sum.).

Note. Closely allied to the previous two species and differing from *D. humeratus* principally in the fruit.

24. *Dipterocarpus lamellatus* HOOK. f. Trans. Linn. Soc. 23 (1860) 159; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 611; WALP. Ann. 7 (1869) 377; DYER, J. Bot. 12 (1874) 107, t. 145, f. 22; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 202; BRANDIS & GILG in E. & P. Pf. Fam. ed. 1, 3, 6 (1895) 256;

BRANDIS, J. Linn. Soc. Bot. 31 (1895) 39; MERR. En. Born. (1921) 399; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 251; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 347; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 261, f. 41.

Large tree. Twigs, leaf buds, stipule, petioles, leaf nervation beneath, midrib above, petiole and inflorescences densely persistently pale yellow-brown hirsute; leaf surfaces and fruit calyx sparsely so. *Twig* c. 4 mm \varnothing apically, terete, \pm rugose. *Leaf bud* to 9 by 7 mm, ovoid, acute; *stipules* unknown. *Leaves* 13–16 by 6–9 cm, elliptic, thinly coriaceous, \pm boat shaped with the lower surface concave; base narrowly obtuse; acumen to 8 mm long, abrupt, slender; nerves 15–17 pairs, straight, ascending at c. 45°, slender but prominent beneath, shallowly depressed above as also the midrib; tertiary nerves laxly scalariform, slender but prominent beneath, evident above; *petiole* 3–4 cm long, c. 2 mm \varnothing , slender. *Inflorescence* to 6 cm long, axillary, apparently unbranched, bearing to 3 fruit (*flower* unknown). *Fruit pedicel* to 4 mm long, slender; *calyx tube* to 1.8 cm \varnothing including the 5 densely convoluted wings, subglobose; 2 longer lobes to 14 by 2.5 cm, spatulate, subacute, c. 8 mm broad at base; 3 shorter lobes to 14 by 7 mm, ovate, \pm revolute.

Distr. *Malesia*: Borneo (Sabah: Labuan (extinct), Beaufort).

Ecol. Rare in Mixed Dipterocarp forest on low hills near coast.

Vern. *Kéruing jarang*.

25. *Dipterocarpus lowii* HOOK. f. Trans. Linn. Soc. 23 (1860) 160; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 58; DC. Prod. 16, 2 (1868) 613; WALP. Ann. 7 (1869) 377; DYER, J. Bot. 12 (1874) 107, t. 145, f. 23; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 202; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 40; MERR. En. Born. (1921) 399; RIDL. Fl. Mal. Pen. Suppl. (1925) 291; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 344, f. 14–15; in Merr. Pl. Elm. Born. (1929) 201; FOXW. Mal. For. Rec. 3 (1927) 43; *ibid.* 10 (1932) 91; SYM. Mal. For. Rec. 16 (1943) 183, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 110; ASHTON, Man. Dipt. Brun. (1964) 37, f. 6, pl. 14 (stem, habit); *ibid.* Suppl. (1968) 15; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 261, f. 3b. — *D. undulatus* VESQUE, C. R. Ac. Sc. Paris 78 (1874) 626; J. Bot. 12 (1874) 151; DYER, J. Bot. 12 (1874) 153. — Fig. 25.

Twig, midrib and nerves below \pm densely \pm caducously shortly pale golden-yellow pubescent. *Twig* 2–3 by 5–10 mm \varnothing , compressed, with broad swollen stipule scars. *Leaf bud* c. 1.5 by 0.9 cm, broadly conical, frequently falcate, obtuse. *Stipule* to 4 by 3 cm, broadly deltoid, acute. *Leaves* 15–20 by 6–10 cm, ovate-lanceolate, thickly coriaceous, strongly folded between the 15–20 pairs of prominent nerves; margin revolute; base obtuse or cordate; apex obtuse or with to 6 mm long narrow acumen; *petiole* 1.5–3 cm long, stout, often wrinkled on drying. *Raceme* to 3 cm long, short, stout, terminal or axillary, terete, simple or singly branched, flowers distichous;

bracteoles to 15 by 10 mm, elliptic to ovate, subacute, densely shortly pubescent outside, puberulent within, fugaceous. *Flower bud* to 4 by 1.2 cm. *Calyx* densely golden-yellow pubescent, wings prominently undulate. *Corolla* typical. *Stamens* c. 30, shorter than the style; filaments short; anthers narrowly oblong; appendage to connective somewhat shorter than anther, stout at base, tapering. *Ovary* ovoid-conical, tapering, densely pubescent; stylopodium narrowly cylindrical, pubescent, tapering to the somewhat shorter glabrous filiform style. *Fruit calyx* glabrescent, tube c. 4 cm long and \varnothing (including wings), globose, completely hidden by the intricate folds of the 5 wings; 2 longer calyx lobes to 14 by 3.5 cm, broadly oblong, obtuse, somewhat revolute, hardly constricted at the base, concurrent with the wings of the tube, with one long median nerve and two shorter laterals; 3 shorter lobes 1.5–2 by 2 cm, broadly ovate, recurved and concurrent with the wings.

Distr. *Malesia*: Malaya (Perak, E. coast), P. Singkep, eastern Sumatra (Kuantan Distr., Langsa, Langkat, Batu Is.), Borneo (Kapas valley, Sarawak to Sabah; Tidung).

Ecol. Well-drained leached, usually sandy soils, in lowlands, especially on islands and near present and former coastlines on low hills to 400 m; locally common on ultrabasics in Sabah.

Vern. *Kéruing sol, k. hijau, k. daun panjang, k. batu, k. sindor* (Mal.), *bajan* (Sabah), *kawaan kaput* (W. Borneo).

Note. Specimens from Malaya north of Johore and from Sumatra and Singkep bear smaller leaves and more slender twigs and petioles.

26. *Dipterocarpus pachyphyllus* MEIJER, Acta Bot Neerl. 12 (1963) 351, pl. 15; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 265; ASHTON, Man. Dipt. Brun. (1964) 41, f. 6; *ibid.* Suppl. (1968) 16. — Fig. 17E.

Freshly opened young parts evenly shortly pale tawny tomentose, fugaceous on all but bud, stipule and raceme. *Twig* to 4 by 2.5 cm \varnothing towards apex, compressed, smooth, with prominent raised stipule scars. *Bud* c. 18 by 4 mm, linear, acute. *Stipule* to 4 by 1.2 cm, linear to deltoid, subacute. *Leaves* 9–17 by 5–9 cm, broadly ovate, thickly coriaceous; base obtuse to subcordate; acumen to 1 cm long, broad; nerves 10–12 pairs, distant, prominent, straight but curving abruptly at the margin and coalescing to form an indistinct intramarginal nerve; *petiole* 2–3.4 cm long, slender, prominently geniculate. *Raceme* to 5 cm long, terminal or axillary, terete, simple, flowers distichous. *Flower bud* to 15 by 5 mm. *Calyx* densely golden-tawny pubescent; wings prominently undulate. *Corolla* typical. *Stamens* 23–25, shorter than style; filaments as long as anthers, appanate at base, tapering; anthers narrowly oblong; appendage to connective somewhat shorter than anther, stout at base, tapering. *Ovary* narrowly ovoid, densely pubescent; stylopodium indistinct, tapering into style; style filiform, glabrous except at base, somewhat shorter than ovary and stylopodium. *Fruit calyx* entirely glabrous,



Fig. 25. *Dipterocarpus lowii* HOOK. f. (2 trees) as emergent in undisturbed profile of lowland dipterocarp forest, near Bt. Puan, Belait, Brunei, c. 20 m alt.; pineapple cultivation in foreground (Photogr. ASHTON, Jan. 1960).

pruinose; tube to 2.5 by 2 cm including wings, subglobose, completely hidden by the intricate folds of the 5 wings; 2 longer lobes to 13 by 3 cm, spatulate, subacute, with one long median nerve and two short laterals; 3 shorter lobes to 1 by 1.5 cm, broadly deltoid, recurved.

Distr. *Malesia*: Northern Borneo (Sabah, Brunei, Sarawak E. of the Lupar).

Ecol. Scattered on leached clay soils in Mixed Dipterocarp forest, undulating land and hillsides to 400 m.

Vern. *Këruing daun tebal, këruing sol padi*.

27. *Dipterocarpus confertus* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 322, f. 9; in Merr. Pl. Elm. Born. (1929) 201; Bull. Bot. Gard. Btzg III, 17 (1941) 104; f. 14; Reinwardtia 5 (1961) 62, f. 1; Foxw. Mal. For. Rec. 10 (1932) 62; BROWNE, For. Trees Sarawak & Brunei (1955) 108; ASHTON, Man. Dipt. Brun. (1964) 26, f. 6; *ibid.* Suppl. (1968) 12; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 242, f. 3a, pl. 26a (stem).

Young twig, leaf bud, stipule outside, petiole, nerves and midrib above, nervation beneath, and inflorescence persistently 1.5–3.5 mm long pale fulvous-brown tufted hispid; leaf surface caducously so. *Twig* 0.8–1 cm \varnothing apically, stout, uneven, cracked and marked by the thin alexicaul stipule scars. *Bud* 1.2–2 by 1–1.7 cm, broadly ovoid, obtuse or subacute. *Stipule* to 5 cm long and broad, broadly ovate, obtuse, caducous. *Leaves* (18–)22–35 by (14–)16–22 cm, broadly obovate to orbicular, chartaceous, concave; base obtuse or subpeltate, the lamina continuing as a slight ridge above the base of the midrib; apex obtuse or shortly acuminate; nerves 9–12 pairs, well spaced, at 45° to 60°; *petiole* 5–6 cm long. *Inflorescence* to 7 cm long, subcymose, singly branched or unbranched, short, bearing few distichous flowers; *bracts* and *bracteoles* to 25 by 5 mm, linear, obtuse, sparsely tomentose, caducous. *Bud* to 4 by 1 cm. *Calyx* and *corolla* typical, calyx shortly tomentose. *Stamens* c. 25, as long as style; filaments as long as anther, applanate at base, tapering and filiform below anther; anther narrowly oblong, stout, tapering; appendage almost as long as anther, stout at base, tapering and filiform at apex. *Ovary* small, ovoid-conical, densely pubescent; stylopodium indistinct; style 3 times as long as ovary, columnar, slender, tomentose except at apex. *Fruit* subsessile; *calyx tube* densely pale fulvous long tomentose, c. 3 by 1.7 cm, narrowly obovoid, with 5 indistinct ridges when mature, tapering basally to the pedicel, only slightly constricted apically; 2 long lobes to 14 by 3 cm, glabrous within, sparsely tomentose outside, oblong-lanceolate, obtuse, tapering to the constricted but non-revolute base, prominently 3-nerved; 3 shorter lobes to 1.7 by 0.7 cm, oblong, recurved distally.

Distr. *Malesia*: Borneo (S.E. Borneo, Sabah, Sarawak and Brunei).

Ecol. Mixed Dipterocarp forests below 800 m, sometimes common on low hills and undulating land.

Vern. *Tampudau* (S.E. Borneo), *këruing kobis* (Sabah, Sarawak).

Note. Sterile collections from Singkep could be either this species or *D. concavus*.

28. *Dipterocarpus dyeri* PIERRE in Lanessan, Pl. Util. Colon. Fr. (1886) 297; Fl. For. Coch. 3 (1889) t. 216, 217; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 33; PARKER, Ind. For. Rec. 16 (1931) 13; PARKINSON, Burma For. Bull. 27 (1932) 15; Foxw. Mal. For. Rec. 10 (1932) 79, p.p.; BURK. Dict. (1935) 843; SYM. Mal. For. Rec. 16 (1943) 176, f. 85.

Large pale-barked semi-deciduous tree. Leaf buds, stipules outside and ovary apex densely persistently long rufous silky velutinate, twigs, leaf nervation beneath and midrib above, inflorescence and calyx caducously \pm sparsely so. *Twig* 10–15 mm \varnothing apically, stout, pale brown, rugose, lenticellate; internodes short, the leaves densely clustered at the ends of the twigs. *Buds* to 25 by 15 mm, large, ovoid-lanceolate, acute; *stipule* to 15 by 2.5 cm, lanceolate, subacute. *Leaves* 16–40 by 7.5–14 cm, large, narrowly ovate to elliptic, coriaceous; base broadly cuneate to subcordate; acuminate to 5 mm long, short, broad, tapering; nerves 24–30 pairs, ascending, slender but prominent beneath as also the midrib; *petiole* 4–6 cm long, to 4 mm \varnothing , relatively slender. *Inflorescence* to 16 cm long, axillary, straight, borne in dense clusters behind the leaves, each bearing to 6 distichous flowers. *Flower buds* to 5 by 1.3 cm long, fusiform. *Stamens* c. 30, exceeding style at anthesis; filaments slender, tapering, \pm equal to the shortly lorate tapering distally fimbriate anthers; appendage acicular, somewhat shorter than anthers; *ovary* narrowly ovoid, surmounted by a slender columnar style c. 1½ its length. *Fruit pedicel* to 3 mm long; *calyx tube* to 4 by 3 cm, ellipsoid, with 5 narrow ribs running from the apex for ¾ its length; 2 longer lobes to 20 by 5.5 cm, oblong-oblancheolate, obtuse, c. 8 mm wide and somewhat revolute at base; 3 shorter lobes to 15 by 6 mm, ovate, subacute, revolute.

Distr. Cochinchina, Cambodia, S.E. and peninsular Thailand, Mergui, and in *Malesia*: Malaya (Perlis and N. Kedah).

Ecol. Semi-evergreen Dipterocarp forest and *Schima*-bamboo forests at low elevations in the seasonal zone, in moist sandy soil in valleys by streams but not normally alluvium.

Vern. *Këruing daun besar, k. etoi* (Malaya).

Note. PARKER observed hybridisation between this species and *D. alatus* ROXB. in peninsular Burma.

29. *Dipterocarpus fagineus* VESQUE, C. R. Ac. Sc. Paris 78 (March 1874) 625; J. Bot. 12 (1874) 149; DYER, J. Bot. 12 (1874) 152; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 200; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 94, p.p.; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 33; BURK. J. Str. Br. R. As. Soc. 81 (1920) 51, 53, fig.; MERR. En. Born. (1921) 398; RIDL. Fl. Mal. Pen. 1 (1922) 216, p.p.; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 318; Foxw. Mal. For. Rec. 10 (1932) 80; SYM.

Kew Bull. (1937) 318; Mal. For. Rec. 16 (1943) 177, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 108; ASHTON, Man. Dipt. Brun. Suppl. (1968) 14, f. 2; Gard. Bull. Sing. 31 (1978) 10. — *D. prismaticus* DYER, J. Bot. 12 (Apr. 1874) 104, t. 144, f. 17; *ibid.* (May 1874) 152. — *Duvaliella problematica* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 1009; Rech. Dipt. (1892) 72; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 263; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 258. — *D. pseudofagineus* FOXW. Mal. For. Rec. 10 (1932) 82; SYM. Mal. For. Rec. 16 (1943) 186, f. 85.

Young twigs, leaf buds, stipule outside (glabrous within) and petiole shortly evenly densely persistently pale golden-brown pubescent, occasionally glabrous; midrib on both surfaces sparsely so. *Twigs* c. 2 mm \varnothing near the apices, ribbed, smooth to rugulose. *Bud* to 10 by 2.5 mm, falcate, acute. *Stipule* to 20 by 3 mm, linear, caducous, sparsely pubescent outside, glabrescent within. *Leaf* 4–9(–12) by 1.5–4.0(–5.5) cm, narrowly elliptic to lanceolate; frequently glaucous beneath; base cuneate; acumen to 8 mm long, slender; nerves 8–10(–16) pairs, slender but elevated beneath, at 30°–40°; tertiary nerves slender, subscalariform; midrib appanate above, prominently terete beneath; *petiole* 11–17 mm long, slender, geniculate, drying buff pubescent. *Raceme* to 5 cm long, caducously shortly evenly golden-buff pubescent, unbranched or sometimes singly branched, bearing to 4 flowers. *Flower bud* to 20 by 6 mm, fusiform. *Calyx* glabrescent. *Corolla* densely golden-buff pubescent outside, sparsely so within. *Stamens* 15, shorter than style at anthesis; filaments slender, tapering, c. $\frac{1}{2}$ length of anther. *Gynoeceum* cinereous but for the distal $\frac{1}{3}$ of the style; ovary ovoid; style broadly columnar, somewhat tapering. *Fruit calyx* and *pedicel* glabrous. *Pedicel* to 6 mm long. *Calyx tube* to 10 by 8 mm, subglobose to ellipsoid, decurrent with pedicel at base, with 5 slender acute ribs continuous to base or confined to distal end; 2 longer lobes to c. 8(–20) by 1.5 cm, lorate, obtuse; 2 shorter lobes to 6 by 5 mm, deltoid, subacute. *Nut apex* densely golden-buff pubescent; style remnant 10 mm long, slender, pubescent.

Distr. *Malesia*: Malaya (Perak, Penang, coastal Pahang and Trengganu), N.E. Sumatra (Riouw-Lingga), Borneo (Sarawak).

Ecol. Hill forests, locally gregarious on ridges, especially at 500–800 m but down to 100 m near coast.

Vern. *Këruing pipit* (Mal.).

Note. Collections from low altitude, previously described as *D. pseudofagineus* generally, have longer leaves with more nerves, are generally glaucous beneath, and have fruit calyx ribs confined to the distal half. There is no discontinuity in the variation between the lowland and hill forms however and these species are therefore not regarded as distinct here.

30. *Dipterocarpus cinereus* SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 319, f. 8.

Large tree. Twig, leaf bud, stipule, petiole, leaf undersurface, panicle and ovary densely persistently

buff pubescent; hairs longer on buds and stipules; calyx thus at first, becoming sparsely so in fruit; parts of petals exposed in bud densely puberulent. *Twigs* c. 2 mm \varnothing apically, terete, rugulose, pale brown, much branched. *Buds* to 12 by 3 mm, lanceolate-falcate; expanded *stipule* not seen. *Leaves* 6–8 by 1.7–2.5 cm, lanceolate, thinly coriaceous, distinctly persistently plicate; base cuneate; apex shortly narrowly tapering-acuminate; nerves 8–9 pairs, steeply ascending at c. 40°, slender but distinctly elevated beneath; tertiary nerves densely scalariform, slender and obscure; midrib prominent beneath, shallowly depressed above; *petiole* 1.7–2.5 cm long, very slender. *Inflorescence* to 4 cm long, axillary, simple or singly branched, bearing 4–5 secund flowers. *Flower buds* to 22 by 8 mm, fusiform. *Stamens* c. 25, exceeding style at anthesis; filaments slender, somewhat longer than the narrow tapering anthers and appendage; *style* columnar, pubescent in the basal $\frac{1}{2}$. *Fruit pedicel* to 3 mm long, broadening into the to 14 by 10 mm broadly ellipsoid or obovoid, sharply though narrowly 5-ribbed, calyx tube; 2 longer lobes to 5 by 1.2 cm, broadly spatulate, narrowly obtuse, constricted to c. 4 mm broad at base; 3 shorter lobes to 5 by 5 mm, ovate, obtuse, \pm revolute.

Distr. *Malesia*: Central W. Sumatra (P. Musala).

Ecol. Lowland forest on leached soils, rather common.

Vern. *Lagan bras*.

Note. Clearly closely allied to *D. fagineus*, from which it differs principally in the number of stamens.

31. *Dipterocarpus semivestitus* SLOOT. Bull. Jard. Bot. Btzig III, 8 (1927) 342, f. 13; SYM. Mal. For. Rec. 16 (1943) 188, f. 85.

Parts glabrous but for densely puberulent inflorescence, fruit calyx tube, sparsely puberulent fruit calyx lobes, and densely pubescent ovary. *Twig* c. 3 by 2 mm, \pm compressed apically, slender, much branched, blackish, minutely pale lenticellate; stipule scars oblique. *Buds* to 8 by 2 mm, lanceolate-falcate, slender, drying black; *stipules* unknown. *Leaves* 5.6–11 by 2.5–6 cm, narrowly elliptic, coriaceous; margin somewhat undulate; base cuneate; acumen to 1 cm long, slender; nerves 6–8 pairs, steeply ascending, slender and hardly elevated beneath; tertiary nerves densely scalariform, hardly elevated beneath, set vertically to the midrib; *petiole* 1.4–2.2 cm long, slender. *Inflorescence* to 7 cm long, simple. *Flower* unknown. *Fruit* subsessile; *calyx tube* to 15 by 10 mm, narrowly obovoid, with 5 sharp undulating ridges or narrow, to 2 mm wide, wings; 2 longer lobes to 6.5 by 1.5 cm, spatulate, obtuse, c. 5 mm broad at base; 3 shorter lobes to 5 by 4 mm, elliptic, subrevolute.

Distr. *Malesia*: S. E. Borneo (Marabahan District), Malaya (Perak).

Ecol. Rare in lowland forest on low lying, perhaps almost swampy, land.

Vern. *Këruing padi*, *k. dadeh* (Malaya), *murtulang* (Borneo).



Fig. 26. The narrow-leaved seedlings of *Dipterocarpus oblongifolius* BL. Brunei (Photogr. ASHTON).

32. *Dipterocarpus oblongifolius* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 36; WALP. Ann. 4 (1857) 335; MIQ. Fl. Ind. Bat. 1, 2 (1859) 498; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 614; DYER, J. Bot. 12 (1874) 105; *ibid.* (1874) 152; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 201; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 95; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37; MERR. En. Born. (1921) 399; RIDL. Fl. Mal. Pen. 1 (1922) 216; CRAIB, Fl. Siam. Enum. 1 (1925) 136; ENDERT, Bot. Versl. M.O. Borneo Exp. (1927) 248; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 338; Trans. Natuur 17 (1928) 146, f. 9–10; FOXW. Mal. For. Rec. 10 (1932) 86; BURK. Dict. (1935) 844; CORNER, Wayside Trees (1940) 211; SYM. Mal. For. Rec. 16 (1943) 184, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 110; ASHTON, Man. Dipt. Brun. (1964) 39, f. 6, pl. 9 (seedlings); *ibid.* Suppl. (1968) 16; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 264; SRIVASTAVA, Mal. For. 40 (1977) 251, f. 1; CORNER, Gard. Bull. Sing. Suppl. 1 (1978) 44. — *D. stenopterus* VESQUE, C. R. Ac. Sc. Paris 78 (1844) 625; J. Bot. 12 (1874) 150; DYER, J. Bot. 12 (1874) 152. — *D. pulcherrimus* RIDL. Trans. Linn. Soc. Bot. 3 (1893) 283. — Fig. 26.

Twig, leaf bud, midrib on both surfaces, nervation beneath, petiole, and raceme densely ± evenly caducous pale yellow tomentose; persistently so on stipule outside, calyx and ovary. Twig 2–3 mm \varnothing apically, terete or ± compressed; amplexicaul stipule scars inconspicuous. Bud c. 20 by 3 mm, linear, compressed, acute. Stipule 10–15 by 1.5 cm, linear, obtuse. Leaves 14–18(–25) by 4–7(–9) cm, narrowly elliptic to lanceolate; base cuneate; apex gradually tapering; acumen to 1 cm long, slender; nerves 16–20 pairs, slender, at 40°–50°; petiole 1½–2 cm long. Racemes to 18 cm long, terminal and axillary, simple or singly branched, with distichous flowers; bracts to 20 by 2.5 mm, linear.

Calyx densely cream tomentose. Stamens 15, shorter than style; anther as long as the filament, narrowly oblong, tapering from the base into the glabrous stout appendage; ± shorter than anther; ovary conical, densely tomentose, tapering into the stylopodium, the latter twice as long as the ovary, narrowly-cylindrical, tapering into and ± twice as long as the filiform glabrous style. Fruit pedicel 1–2 mm long. Fruit calyx tube 25–30 by 7–9 mm, narrowly obovoid or fusiform, only slightly constricted at the c. 6 mm \varnothing neck, with 5 wavy, c. 1 mm wide, thin wings from neck to base; 2 longer lobes 10–12 by 1½ cm, narrowly spatulate, obtuse, 3–4 mm wide at base, 1-nerved with 2 small lateral nerves at the base; 3 shorter lobes c. 10 by 3 mm, narrowly deltoid to linear, obtuse, recurved. Saplings stenophyllous.

Distr. S. Peninsular Thailand (Pattani) and in Malesia: Malaya (all major east-flowing rivers; rare in Perak), Borneo (excepting most of Sabah).

Ecol. Gregarious on the banks of fast-flowing inland rivers, germinating and becoming established below the flood-line.

Vern. Neram (Mal.), laran (S.E. Borneo), ensurai, gansurai (northern Borneo).

Note. Leaves of seedlings are linear-lanceolate; cf. VAN SLOOTEN (1928) and SRIVASTAVA (1977). This species is so characteristic of swift-running streams in Borneo and Malaya, that CORNER (1940, 1978) gave the name neram rivers to this type.

33. *Dipterocarpus grandiflorus* (BLCO) BLCO, Fl. Filip. ed. 2 (1845) 314; *ibid.* ed. 3, 2 (1878) 218, t. 263; DC. Prod. 16, 2 (1868) 612; DYER, J. Bot. 12 (1874) 106, t. 145, f. 19; VIDAL, Sinopsis (1883) t. 14A; Pl. Vasc. Filip. (1886) 59; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 201; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 95; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 256; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37; RIDL. Agr. Bull. Str. & F. M. S. 1 (1901) 55; Fl. Mal. Pen. 1 (1922) 216; FOXW. Philip J. Sc. 6 (1911) Bot. 251, pl. 36; *ibid.* 13 (1918) Bot. 179; *ibid.* 67 (1938) 259; Mal. For. Rec. 10 (1932) 87; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 273; *ibid.* ed. 2 (1927) 1095, 1096; MERR. Sp. Blanc. (1918) 268; En. Born. (1921) 398; En. Philip. 3 (1923) 89; BURK, J. Str. Br. R. As. Soc. 81 (1920) 55; REYES, Philip. J. Sc. 22 (1923) 321; CRAIB, Fl. Siam. Enum. 1 (1925) 134; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 25; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 333; PARKER, Ind. For. Rec. 16 (1931) 5; PARKINSON, Burma For. Bull. 27 (1932) 17; BURK. Dict. (1935) 843; SYM. Mal. For. Rec. 16 (1943) 178, f. 85, 90; SMITINAND, Thai For. Bull. 4 (1958) 33; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 252, f. 38. — *Mocanera grandiflora* BLCO, Fl. Filip. ed. 1 (1837) 451. — *D. blancoi* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 35. — *Vatica trigyna* GRIFF. Notul. 4 (1854) 514. — *D. motleyanus* HOOK f. Trans. Linn. Soc. 23 (1860) 159; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 611; WALP. Ann. 7 (1869) 377. — *D. griffithii* MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 213; DC. Prod. 16, 2 (1868) 612; WALP. Ann. 7

(1869) 377; DYER, Fl. Br. Ind. 1 (1874) 299; J. Bot. 12 (1874) 107; KURZ, Fl. Burma 1 (1877) 116; RIDL. Trans. Linn. Soc. Bot. 3 (1893) 283; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 96; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37; Ind. Trees (1906) 701; GAMBLE, Man. Ind. Timb. (1922) 70. — *D. pterygocalyx* SCHEFF. Nat. Tijd. N. I. 31 (1870) 347; DYER, Fl. Br. Ind. 1 (1874) 298; HEYNE, Nutt. Pl. ed. 2 (1927) 1096. — Fig. 17B.

Very large hardly buttressed tree. Leaf bud, outside of stipule, parts of petals exposed in bud, ovary apex and sometimes twig densely evenly pale buff pubescent, parts otherwise glabrous. Twigs to 12 mm \varnothing , stout, becoming grey-brown; internodes short, the leaves clustered around the twig endings. Buds to 2 by 1 cm, ovoid, acute; stipule to 18 by 5 cm, oblong-lanceolate, subacute. Leaves 10–18 by 5–12 cm, ovate, coriaceous, \pm applanate; base obtuse or subcordate; acumen to 1 cm long, short, nerves 15–17 pairs, prominent beneath, spreading; tertiary nerves remotely scalariform, barely elevated; petioles 3–9 cm long, very long, slender. Inflorescences to 18 cm long, very long, slender, axillary, borne in dense groups behind the leaves, unbranched, bearing to 3 remote distichous flowers. Flower buds to 35 by 13 mm, fusiform. Stamens 30, exceeding style at anthesis; filaments broad, compressed, tapering, c. $\frac{1}{2}$ the length of the relatively short broadly linear-lanceolate tapering anthers; appendages acicular, c. $\frac{2}{3}$ length of anthers. Ovary tapering into the short stoutly columnar style; ovary and style puberulent in the basal half. Fruit pedicel to 2 by 4 mm, stout. Calyx tube to 7 by 3.5 cm, ellipsoid, with 5 pruinose, to 1.5 cm wide, prominent coriaceous wings continuous from base to apex; 2 longer lobes to 22 by 3 cm, oblancoolate-spatulate, obtuse, tapering abruptly to c. 1.3 cm wide at base; 3 shorter lobes to 2 by 1.5 cm, elliptic, subrevolute.

Distr. Andamans, Mergui, Peninsular Thailand, and in Malesia: Malaya, north-east Sumatra (Atjeh, Langkat, Bengkalis, P. Simalur, P. Musala, Riau Arch., Banka, Billiton), P. Karimata, Borneo (from lower Dayak in S.W. to Sabah in E.; incorrectly recorded by BROWNE, For. Trees Sarawak & Brunei (1955) 106 from Sarawak), Philippines (N.W. Luzon).

Ecol. Often common, becoming semi-gregarious, in more seasonal climates in Semi-evergreen Dipterocarp forests; on small islands and on coastal hills in less seasonal areas, and in Malaya occurring frequently with *Shorea curtisii* on inland ridges to 700 m.

Vern. *Këruing bëlimbing*, *k. pekat*, *meluit* (Malaya), *këruing*, *lagan bras* (Sumatra), *tampudau*, *bajan*, *këruing* (Borneo), *apitong* (Tag.).

Note. A remarkable relic from the once vast Semi-evergreen Dipterocarp forests of the Pleistocene Sundaland.

34. *Dipterocarpus glabrigemmatum* ASHTON, Gard. Bull. Sing. 31 (1978) 11. — *D. sp.* ASHTON, Man. Dipt. Brun. Suppl. (1968) 19.

Midrib and nerves sparsely pubescent, other vege-

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

Distr. Malesia: Borneo (Central Sarawak).

Ecol. Local, Mixed Dipterocarp forest, clay soil.

35. *Dipterocarpus palembanicus* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 336, f. 12; SYM. Mal. For. Rec. 16 (1943) 185, f. 85; ASHTON, Man. Dipt. Brun. Suppl. (1968) 16, f. 6–7, pl. 6 (stem), *p.p.*; Gard. Bull. Sing. 31 (1978) 11. — *D. alatus* (non ROXB.) FOXW. Mal. For. Rec. 10 (1932) 82.

a. *ssp. palembanicus*.

Twig, leaf bud and stipule outside densely fulvous hirsute; petiole midrib above and leaf beneath densely shortly puberulent; caducous on twigs and petioles, otherwise persistent. Twig 2–3 mm \varnothing , terete, with a rather papery, finely cracked surface. Bud 4–12 by 3–4 mm, shortly oblong to conical, obtuse. Stipule 2–3 cm long, narrowly hastate, acute. Leaves 10–14 by 5–9 cm, broadly elliptic to ovate, thinly coriaceous; base obtuse or cuneate, acumen short or to 2 cm long, narrow; margin undulate; nerves slender, dense, 12–14 pairs, at 35°–45°, tending to be persistently plicately folded between; tertiary nerves densely scalariform, slender; petiole 2–3 cm long, prominently geniculate. Raceme to 6 cm long, terminal or axillary, terete, tending to wrinkle on drying, unbranched or singly branched, the branchlets bearing distichous flowers. Bud to 3.5 by 1.5 cm. Calyx and corolla typical, calyx glabrous. Stamens 15; filaments compressed at base, slender, tapering; anthers linear, c. $1\frac{1}{2}$ length of filament, tapering apically; appendage to connective c. $\frac{1}{2}$ length of anther, filiform, tapering, reaching to $\frac{1}{2}$ length of style. Ovary ovoid, densely pubescent, tapering into style; style 3–4 times length of ovary, stoutly filiform, densely pubescent and ribbed in the basal $\frac{2}{3}$, otherwise glabrous. Fruit calyx glabrous; tube to 3.5 by 1.5 cm, narrowly ellipsoid, tapering gradually to the base and the c. 1 cm \varnothing neck; broadly 5-winged, the wings thin, to 8 mm broad, \pm obtuse or subcordate at base, with the margin folded over frequently at maturity; 2 longer calyx lobes to 10 by 3.5 cm, oblong, obtuse, base revolute, subcordate,

with 3 parallel nerves running down the whole length close to the centre; 3 shorter calyx lobes to 5 by 10 mm, broadly orbicular, strongly recurved, with narrow base and revolute undulate margin.

Distr. *Malesia*: Malaya (Trengganu, Central Johore), Singapore, Sumatra (Palembang), Borneo (Central Sarawak).

Ecol. Local, Mixed Dipterocarp forest on hills, clay soils, to 650 m.

Vern. *Kéruing ternek* (Mal.), *lagan daun halus* (Sum.).

b. ssp. borneensis ASHTON, Gard. Bull. Sing. 31 (1978) 11. — *D. palembanicus*: ASHTON, Man. Dipt. Brun. (1964) 41; MELJER & WOOD, Sabah For. Rec. 5 (1964) 266, f. 42.

Differing from *ssp. palembanicus* as follows: Twig, petiole, midrib (both surfaces) and nerves beneath densely shortly chestnut pubescent, caducous on twigs; persistent, long, on bud, stipule and petiole; lamina fugaceous pubescent. *Leaves* 7–11 by 3–6 cm, oblong to ovate, with 12–14 pairs of nerves; *petiole* c. 15 mm long. *Fruit calyx tube* to 5.5 by 2 cm, wings to 15 mm broad, undulate, auriculate at base and apex.

Distr. *Malesia*: northern Borneo (Central and N.E. Sarawak to E. Sabah and Nunukan I.).

Ecol. As *ssp. palembanicus*, and sometimes growing together with it.

36. Dipterocarpus fusiformis ASHTON, Gard. Bull. Sing. 31 (1978) 12.

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

Distr. *Malesia*: N.E. Borneo (Tawau area).

Ecol. Undulating well drained fertile soils; Mixed Dipterocarp forest; rare.

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

37. Dipterocarpus mundus SLOOT. Bull. Jard. Bot. Btzg III, 16 (1940) 446, f. 7; ASHTON, Man. Dipt. Brun. Suppl. (1968) 15, f. 3. — Fig. 17G.

Parts glabrous but for pubescent inner surface of stipules. *Twig* c. 2–3 mm \varnothing apically, terete, much branched; stipule scars slender, elevated but not prominent. *Bud* to 14 by 3 mm, slender, acute. *Stipule* to 4.0 by 0.6 cm, linear, caducous. *Leaves* 5.5–16 by 2.5–7.5 cm, narrowly elliptic to obovate; base narrowly obtuse; acumen to 8 mm long; nerves 8–10 pairs, straight, slender but prominent beneath, at 30° to 50°; tertiary nerves remotely subscalariform; midrib \pm appanate above, stout, prominent, terete beneath; *petiole* 1.6–3 cm long, slender, geniculate. *Raceme* to 6 cm long, terete to somewhat compressed, smooth, unbranched, bearing to 4 flowers. *Flower calyx* and *corolla* typical. *Stamens* 15; filaments short, compressed, anthers narrowly oblong; appendage to connective c. $\frac{1}{2}$ length of anthers, filiform, tapering. *Ovary* small, ovoid; stylopodium columnar, tapering, pubescent, ending in a short glabrous style. *Fruit calyx* and *pedicel* glabrous. *Pedicel* to 3 mm long, c. 1 mm \varnothing . *Calyx tube* to 3 by 1.2 cm, fusiform, bearing 5 wings, each to 7 mm wide, broadest in the distal half, incrassate; 2 longer lobes to 11 by 2.7 cm, oblong, tapering to an obtuse apex, c. 5 mm broad above the tube; 3 shorter lobes to 8 by 8 mm, broadly ovoid, obtuse, somewhat recurved. *Nut* narrowly ovoid, densely buff pubescent; style remnant to 8 mm long, filiform.

Distr. *Malesia*: Central Borneo (Kapuas, Rejang hinterland).

Ecol. Locally frequent on ridges, 400–600 m.

Vern. *Késurai bukit*.

38. Dipterocarpus borneensis SLOOT. Bull. Jard. Bot. Btzg III, 16 (1940) 445, f. 6; BROWNE, For. Trees Sarawak & Brunei (1955) 107; ASHTON, Man. Dipt. Brun. (1964) 24, f. 6, 7; *ibid.* Suppl. (1968) 11.

Young twig, petiole, raceme, midrib, nerves and sometimes tertiary nerves beneath sparsely shortly rust pubescent, mostly caducous; leaf bud and stipule outside densely persistently so, the hairs longer, pinkish buff. *Twig* 3–5 mm \varnothing apically, glabrous, smooth but for the paler amplexicaul stipule scars, occasionally rugulose. *Bud* 5–7 by 2.5–3 mm, ovoid, subacute. *Stipule* to 40 by 4–5 mm, linear, acute. *Leaves* 7–12 by 3–7 cm, broadly ovate to elliptic; base obtuse or broadly cuneate; acumen to 8 mm long; nerves 9–12 pairs, distant, at 50° at the lamina base, down to 20° at the apex, prominent; margin frequently undulate towards the apex; *petiole* 1.5–2.5 cm long, slender. *Raceme* to 6 cm long, singly or rarely doubly branched, terminal or axillary, terete or \pm compressed; *bracteoles* unknown. *Flower bud* to 4 by 1 cm. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* c. 25, shorter than the style; anthers short, narrowly sagittate; appendage stout, tapering, c. $\frac{1}{2}$ length of anther. *Ovary* conical, shortly densely pubescent; stylopodium and style c. 3 times length of ovary, densely tomentose except at apex, slightly

swollen medially. *Fruit calyx tube* to 1.5 by 1 cm, narrowly ovoid to ellipsoid, tapering gradually into the pedicel and to the c. 8 mm \varnothing neck, with 5 narrow c. 1 mm broad, c. 6 mm, long wings in the distal half terminating at the insertion of the calyx lobes; 2 longer lobes to 7.5 by 1.5–1.8 cm, chartaceous, oblong, obtuse, \pm abruptly constricted at the undulate margined base; 3 shorter calyx lobes c. 5 by 4 mm, revolute and recurved outwards.

Distr. *Malesia*: Eastern coastal Sumatra (Indragiri; Lingga Arch.: Singkep); Borneo (Sampit to Muara Tewe and Ulu Mahakam in S.E. Borneo; Sambas and Mampawah in W. Borneo; Sarawak and Brunei).

Ecol. Common in heath forest on podsols below 350 m; rare in mixed swamp forest.

Vern. *Lagan, kĕruing daun halus* (Sum.), *ompal, pĕndĕrawan, awang buah, bĕngkajarap, kĕruing sindor* (Borneo).

Note. Closely resembling *D. fagineus* but with the ridges of the calyx tube distinctly expanded into narrow wings distally, and with longer tomentum persisting on the nervation beneath.

39. *Dipterocarpus nudus* VESQUE, C. R. Ac. Sc. Paris 78 (March 1874) 626; J. Bot. 12 (1874) 150; DYER, J. Bot. 12 (1874) 152; BURCK, Ann. Jard. Bot. Botz 6 (1887) 201; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 38; MERR. En. Born. (1921) 399; SLOOT. Bull. Jard. Bot. Botz III, 8 (1927) 325; BROWNE, For. Trees Sarawak & Brunei (1955) 110; ASHTON, Man. Dipt. Brun. (1964) 38, f. 6, 7; *ibid.* Suppl. (1968) 16. — *D. pentapterus* DYER, J. Bot. 12 (Apr. 1874) 106, t. 144, f. 18; *ibid.* (1874) 152.

Glabrous but for the buff pubescent inside of stipules. *Twig* 3–4 mm \varnothing apically, slender, smooth, often tending to be triangular; with inconspicuous stipule scars. *Bud* 15–30 by 2–3 mm, linear, terete. *Stipule* to 6 by 0.5 mm, linear. *Leaves* 11–14 by 4–6 cm, narrowly elliptic, thinly coriaceous, margin undulate and \pm sinuate distally; base cuneate, apex to 6 mm long, acuminate; nerves 11–14 pairs, close, oblique (30°–40°); tertiary nerves widely spaced, scalariform but rather sinuate, at c. 90° to nerves; *petiole* 2–4.5 cm long, slender. *Raceme* to 18 cm long, terminal or axillary, glabrous, terete, becoming ribbed on drying, zigzag; simple or singly branched, with distichous flowers at wide intervals; *bracts* unknown. *Flower bud* to 4 by 0.9 cm, slender. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* c. 15, shorter than the style; filaments short; anthers narrowly oblong, tapering. *Ovary* ovoid-conical, densely tomentose; style and stylopodium about 3 times as long as ovary, filiform, slightly tapering, densely tomentose at base, glabrous at apex. *Fruit* glabrous; *calyx tube* c. 2.5 by 1 cm, ellipsoid to fusiform, broadest distally, the base constricted abruptly at the pedicel, slightly constricted at the c. 7 mm \varnothing neck; 5 winged, the wings incassate but acute, rather narrow and widest (c. 3 mm) distally, continuing the whole length of the tube; 2 longer calyx lobes to 9.5 by 3 cm, lanceolate, equally 3-nerved,

obtuse, tapering gradually to the 3–4 mm wide base; 3 shorter lobes c. 4 mm long and broad, small, obtuse, slightly revolute.

Distr. *Malesia*: N.W. Borneo (Sarawak and Brunei).

Ecol. Hillsides and ridges in Mixed Dipterocarp forest to 650 m.

Vern. *Kĕruing lichen*.

40. *Dipterocarpus geniculatus* VESQUE, C. R. Ac. Sc. Paris 78 (March 1874) 626; J. Bot. 12 (1874) 150; DYER, J. Bot. 12 (1874) 152; BURCK, Ann. Jard. Bot. Botz 6 (1887) 199; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 33; MERR. En. Born. (1921) 398; SLOOT. Bull. Jard. Bot. Botz III, 9 (1927) 317; *ibid.* III, 17 (1941) 99, f. 11; BROWNE, For. Trees Sarawak & Brunei (1955) 109; ASHTON, Man. Dipt. Brun. Suppl. (1968) 14. — *D. angulatus* DYER, J. Bot. 12 (April 1874) 104; *ibid.* (May 1874) 152.

a. *ssp. geniculatus*.

Young twig, leaf bud, stipule outside and raceme densely shortly pale cream tomentose; petiole and nervation beneath sparsely pubescent to glabrescent. *Twigs* to 7 mm \varnothing , with rows of large longitudinally elongated flat lenticels and conspicuous sinuate amplexicaul stipule scars. *Bud* c. 2.5 by 2 cm, broadly ovoid, acute. *Stipule* c. 6 by 2 cm, pink with a cream tomentum when fresh, broadly lanceolate, acute. *Leaves* 7–12 by 5–7 cm, elliptic to \pm obovate, coriaceous, lustrous above; base obtuse, apex obtuse or shortly acuminate; nerves 10–12 pairs, prominent beneath, well spaced, at 45°–55°; *petiole* stout, straight, 3–5 cm long. *Raceme* to 24 cm long, axillary, terete, straight, singly, rarely doubly branched, the flowers distant, distichous; *bracts* to 20 by 5 mm, narrowly lanceolate, acute, shortly pubescent outside, puberulent within. *Flower bud* to 3.5 by 1 cm. *Calyx* and *corolla* typical, calyx shortly densely cream tomentose. *Stamens* 30, shorter than the style; filaments as long as the anthers; anther rather short, narrowly oblong, tapering apically; appendage to connective somewhat shorter than anther, stout at base, tapering. *Ovary* ovoid-conical, shortly tomentose; style and stylopodium \pm twice as long as ovary, narrowly cylindrical, shortly tomentose basally, glabrous in the distal $\frac{1}{2}$. *Fruit calyx tube* shortly densely cream powdery tomentose, lobes sparsely so; tube c. 1.5 cm long and broad, obovoid, tapering to pedicel and constricted to 1.2 cm \varnothing at the neck; 5-ridged, the ridges 1 mm thick, stout, to 3 mm wide at the undulate distal ends, continuing from the neck to the pedicel; 2 longer calyx lobes to 12 by 2.5 cm, oblong, obtuse, tapering to the 6 mm broad strongly revolute base with one branching central nerve running to the apex and 2 shorter laterals; 3 shorter lobes c. 1 by 1.5 cm, cordate, the sides recurved.

Distr. *Malesia*: Borneo (Sarawak from the Kemena valley westwards, Lower Kapuas).

Ecol. Lowland dipterocarp forests on leached clay soils, to 400 m.

Vern. *Këruing kërubong, k. guntang, k. bëlimbing* (Mal.).

b. ssp. grandis ASHTON, Gard. Bull. Sing. 20 (1963) 240; Man. Dipt. Brun. Suppl. (1968) 14. — *D. geniculatus sensu* ASHTON, Man. Dipt. Brun. (1964) 11, f. 6, pl. 11 (habit, bark); MELJER & WOOD, Sabah For. Rec. 5 (1964) 248, f. 36.

Differing from *ssp. geniculatus* as follows: *Twigs* to 13 mm \varnothing ; *leaves* 20–35 by 12–16 cm, *petiole* 8–10 cm long; *2 longer fruit calyx lobes* to 15 by 4 cm.

Distr. *Malesia*: N.E. Borneo (Sarawak from Sibuti north-eastwards, Brunei, S.W. Sabah and Sandakan Distr.).

Ecol. As *ssp. geniculatus*, but confined to ultrabasic rocks in E. Sabah.

Vern. *Këruing kërubong, k. tangkai panjang*.

41. Dipterocarpus costatus GAERTN. f. Fruct. 3 (1805) 50, t. 187; ROXB. Hort. Beng. (1814) 42; Fl. Ind. ed. Carey 2 (1832) 613; BUCH.-HAM. Mem. Wern. Nat. Hist. Soc. 6 (1832) 299; WALP. Rep. 5 (1945) 124; DC. Prod. 16, 2 (1868) 610; KURZ, J. As. Soc. Beng. 43, 2 (1874) 98; Fl. Burma (1877) 117; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 98; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 35; Ind. Trees (1906) 66; GAMBLE, Man. Ind. Timb. (1922) 70; CRAIB, Fl. Siam. Enum. 1 (1925) 133; PARKER, Ind. For. Rec. 13 (1827) 4; FOXW. Mal. For. Rec. 10 (1932) 85; BURK. Dict. (1935) 842; SYM. Mal. For. Rec. 16 (1943) 173, f. 85. — *Pterigium costatum* CORREA, Ann. Mus. Hist. Nat. Paris 8 (1806) 397, t. 65 — *Shorea costata* PRESL, Rostl. 2 (1825) 66. — *D. angustifolius* W. & A. Prod. 1 (1834) 84; DC. Prod. 16, 2 (1868) 610. — *D. lemeslei* VESQUE, C. R. As. Sc. Paris 78 (1874) 626. — *D. insularis* HANCE, J. Bot. 14 (1876) 241; PIERRE, Fl. For. Coch. 3 (1889) t. 214; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37. — *D. artocarpifolius* PIERRE [ex LANESSAN, Pl. Util. Colon. Fr. (1886) 297, nomen] Fl. For. Coch. 3 (1889) t. 213; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 37. — *D. parvifolius* HEIM, Bot. Tidsskr. 25 (1903) 43; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 365; CRAIB, Fl. Siam. Enum. 1 (1925) 135.

Large unbuttressed tree. *Twigs*, leaf buds, midrib above, petioles, inflorescences, flower calyx and petals outside densely persistently evenly pale golden-brown pubescent, leaf beneath and fruit calyx sparsely somewhat caducously so. *Twig c.* 3 mm \varnothing apically, terete, pale brown, much branched. *Buds* to 10 by 4 mm, ovoid to lanceolate, acute; *stipule* to 5 by 1 cm, lorate, tapering and subacute apically. *Leaves* 5.5–17 by 2.8–7 cm, ovate or elliptic, usually small, coriaceous; base obtuse or broadly cuneate; acumen to 6 mm long, short; nerves 11–13(–15) pairs, ascending; tertiary nerves slender, elevated beneath; *petiole* 1.5–2.8 cm long, slender. *Inflorescence* to 7 cm long, singly branched or unbranched, bearing to 7 distichous flowers. *Flower buds* to 25 by 8 mm, fusiform. *Stamens* 18–20, shorter than style at anthesis; filaments short, lorate; anthers short, linear-lorate, tapering; appendage acicular, very slender. *c.* $\frac{3}{4}$ length of

anther; *ovary* ovoid, tapering into the columnar style; ovary and basal $\frac{1}{2}$ of style densely pubescent. *Fruit pedicel* to 3 by 2 mm; *calyx tube* to 2 cm \varnothing , \pm subglobose, with 5 continuous, to 2 mm wide, narrow coriaceous wings; 2 longer lobes to 11.5 by 2.5 cm, lorate-oblong, narrowly obtuse, *c.* 8 mm wide at the subrevolute base; 3 shorter lobes to 15 by 15 mm, suborbicular, revolute, prominent.

Distr. Andamans, Chittagong, Burma, Thailand, Cambodia, Cochinchina, and in *Malesia*: Malaya (from Negri Sembilan northwards).

Ecol. Scattered in Hill and Upper Dipterocarp forests, 600–1000 m, and down to sea level in seasonal areas in N.W. Malaya. Gregarious in lowland and hill Semi-evergreen Dipterocarp forest of S.E. Asia.

Vern. *Këruing marakuang, k. bukit* (Malaya).

Note. Allied to *D. glandulosus* THW. of Ceylon.

42. Dipterocarpus conformis SLOOT. Bull. Bot. Gard. Btzg III, 17 (1941) 102, f. 13.

a. ssp. conformis. — *D. confertus* (non SLOOT.) SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 324 (Sumatran coll.).

Young twig, leaf bud, stipule outside, petiole, raceme and leaf beneath persistently densely pale pink-brown velutinate; leaf above caducously so except on nerves and midrib. *Twigs* verrucose. *Bud c.* 8 by 4 mm, ovoid, obtuse. *Stipules c.* 15 by 6 mm, ovoid, acute, cupped, fugaceous. *Leaves* 20–24 by 12–15 cm, obovate, chartaceous; base obtuse or subcordate, narrowly subpeltate; acumen 4–8 mm long; nerves 13–15 pairs, at *c.* 60°–70°; *petiole* 5–6 cm long, slender, rugose. *Raceme* to 6 cm long, short, terminal or axillary, slender, ribbed on drying, unbranched or singly branched, bearing few distichous flowers; bracts unknown. *Flower bud* to 3 by 0.8 cm. *Calyx* and *corolla* typical, calyx shortly tomentose. *Stamens c.* 30, shorter than style; filaments almost as long as anther, slender; anther linear, short, tapering at apex; appendage to connective slender, tapering, almost equal in length to anther. *Ovary* ovoid to conical, long, glabrescent at base, long tomentose medially, shortly tomentose apically; style and stylopodium *c.* 4 \times length of ovary, slender, filiform, sparsely pubescent at base, otherwise glabrous. *Fruit calyx* \pm uniformly pubescent; tube *c.* 2.5 by 2 cm, ellipsoid, neck narrowed to 1–1.2 cm \varnothing ; with 5, to 10 cm wide, incrassate wings continuing from pedicel to neck, sometimes bent to one side but not undulate; 2 longer calyx lobes to 10 by 2 cm, oblong, obtuse, constricted abruptly to 7 mm broad at the base; 3 shorter lobes to 8 mm long and broad, ovate, not constricted at the base, revolute.

Distr. *Malesia*: northern half of Sumatra (Langsa, Atjeh, Ophir and Ayerbangis, W. Coast).

Ecol. Rare, lowland forests on hills.

Vern. *Këruing buah, lagan sanduk* (Sum.).

b. ssp. borneensis ASHTON, Gard. Bull. Sing. 20 (1963) 28; Man. Dipt. Brun. Suppl. (1968) 12. — *D. con-*

formis: ASHTON, Man. Dipt. Brun. (1964) 28, f. 6; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 244.

Differs from *ssp. conformis* as follows: *Leaves* 9–12 by 5–7 cm, nerves 15–18 pairs, *petiole* 17–25 mm long; *wings of calyx tube* to 3 mm wide.

Distr. *Malesia*: Borneo (N.E. Sarawak, Brunei, S.W. Sabah).

Ecol. Rare, Hill Dipterocarp forests, clay rich soils, below 800 m.

Vern. *Këruing beludu kuning*.

43. *Dipterocarpus acutangulus* VESQUE, C. R. Ac. Sc. Paris 78 (1874) 626; J. Bot. 12 (1874) 150; DYER, J. Bot. 12 (1874) 152; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 321; Reinwardtia 5 (1961) 457; SYM. Mal. For. Rec. 16 (1943) 166, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 107; ASHTON, Gard. Bull. Sing. 20 (1963) 240; Man. Dipt. Brun. (1964) 22, f. 6, 7; *ibid.* Suppl. (1968) 11; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 235, pl. 27 (habit). — *D. appendiculatus* (non SCHEFF.) DYER, J. Bot. 12 (1874) 152; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 200, p.p.; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 34, p.p.; MERR. En. Born. (1921) 397, p.p. — *D. tawaensis* SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 313, f. 6. — *D. heliopteryx* SLOOT, Bull. Jard. Bot. Btzg III, 16 (1940) 441, f. 4; BROWNE, For. Trees Sarawak & Brunei (1955) 109. — Fig. 17C.

Twig, bud, stipule (outside only), petiole and leaf beneath at first densely buff pubescent; persistent on leaf bud and stipule, \pm caducous elsewhere. *Twig* c. 3 mm \varnothing apically, becoming glabrous, terete, with swollen amplexicaul stipule scars. *Bud* 3–12 by 2.5–5 mm, ovoid, broad and short, subacute; occasionally glabrous. *Stipule* c. 5 by 0.8 cm, linear, obtuse. *Leaves* 7–10 by 3–6 cm, elliptic to ovate; base obtuse or cuneate, apex with narrow c. 1 cm long acumens, margin sinuate; nerves 7–12 pairs, at c. 30°–45°; tertiary nerves dense, scalariform; *petiole* 1.5–2.5 cm long, to 1 mm \varnothing . *Flowers* unknown. *Raceme* to 4 cm long, axillary, slender, glabrous. *Fruit calyx* glabrous; tube to 2.5 cm broad and long, globose or ellipsoid, becoming slightly impressed at the pedicel, constricted to c. 1 cm \varnothing neck; with 5 rounded or angular woody ribs, 3–4 mm thick and c. 3 mm wide (often less pronounced), initiating from the impressed base and terminating abruptly at the insertion of the calyx lobes; surface warty, glabrous, pruinose; 2 longer lobes c. 10 by 2.5 cm, oblong-spatulate, slightly twisted, to 5 mm broad at base, 3-nerved, the 2 laterals of variable length; 3 shorter wings c. 5 mm long and broad, deltoid, subacute, with revolute margins.

Distr. *Malesia*: Malaya (rare: Negri Sembilan), Borneo (Ulu Kapuas, W. Kalimantan; Sarawak, Brunei, S.W. and E. Sabah).

Ecol. Mixed Dipterocarp forest, sandy soils on coastal hills and inland ridges to 1000 m.

Vern. *Këruing mèrah, k. bêludu*.

Note. A polymorphic species (in this resembling *D. eurynchus* q.v.); collections from N.W. Borneo and Malaya bear distinctly larger more thickly coriaceous

leaves and are in this respect intermediate between this species and *D. globosus* VESQUE.

44. *Dipterocarpus sublamellatus* Foxw. Mal. For. Rec. 10 (1932) 92, pl. 8; SLOOT, Bull. Bot. Gard. Btzg III, 17 (1941) 108, f. 15; SYM. Mal. For. Rec. 16 (1943) 92, f. 85; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 269; ASHTON, Man. Dipt. Brun. Suppl. (1968) 17, f. 3.

Leaf bud and stipule outside (glabrous within) densely long pale fulvous hirsute, rarely glabrous, leaf nervation beneath sparsely caducously so, otherwise glabrous. *Twig* to 3 mm \varnothing towards the apex, much branched, slender, dark, lustrous, smooth; stipule scars pale, prominent. *Bud* to 12 by 8 mm, ellipsoid-ovoid, subacute. *Stipule* to 40 by 8 mm, lorate, acute. *Leaves* 5–15 by 3.5–8 cm, ovate to elliptic (immature), coriaceous persistently prominently plicate; base broadly cuneate; acumens short, slender, to 1 cm long in young trees; nerves 8–12 pairs, prominent beneath, ascending at 35°–55°; tertiary nerves very slender, densely scalariform; *petiole* c. 1.5(–3) cm long, slender, geniculate, drying black or pruinose. *Inflorescence* unknown. *Flower bud* to 3.5 by 1 cm. *Calyx* and *corolla* typical; calyx glabrous. *Stamens* c. 24, as long as style at anthesis; filaments lorate, slender, compressed, somewhat longer than anther; anther linear, tapering into the acicular appendage; appendage c. $\frac{1}{2}$ length of anther. *Ovary* ovoid, pubescent; style columnar, pubescent except in the apical $\frac{1}{3}$. *Fruit calyx tube* to 3 by 3 cm, globose, bearing 5, to 1.5 cm wide, incrassate undulate wings; wings tapering distally, auriculate at base; 2 longer calyx lobes to 12 by 3 cm, lorate, obtuse, c. 6 mm wide at the somewhat revolute base; 3 shorter calyx lobes to 5 by 7 mm, suborbicular, revolute.

Distr. *Malesia*: Malaya, Sumatra (Sibolga, Tapanuli, Indragiri), Borneo (Sarawak, west of the R. Suai in W.; Sebatik island and Nunukan in N.E.).

Ecol. Undulating land and low hills to 500 m, locally common, especially in moist places.

Vern. *Këruing kërut, k. padi, k. sugi* (Malaya), *lagan batu, 1. boeih, masibuk* (Sumatra).

Note. Collections from N.E. Borneo, and one from Central Sarawak (S 18428) have somewhat larger parts, especially fruit, and less undulate calyx tube wings.

Closely related to *D. insignis* THW. of Ceylon.

45. *Dipterocarpus concavus* Foxw. Mal. For. Rec. 10 (1932) 90, pl. 7; SLOOT, Bull. Bot. Gard. Btzg III, 17 (1941) 101, f. 12; SYM. Mal. For. Rec. 16 (1943) 171, f. 85. — *D. confertus* (non SLOOT.) SLOOT, Bull. Jard. Bot. Btzg III, 7 (1927) 324, *quoad spec.* Lingga.

Large buttressed tree. *Twig*, leaf bud, stipule outside, petiole, midrib above and inflorescence densely shortly yellow-brown tufted tomentose, leaf under-surface and nervation above more sparsely so, flower calyx and ovary densely yellow-brown puberulent, fruit calyx glabrescent. *Twig* c. 3 mm \varnothing apically, terete. *Buds* to 11 by 6 mm, narrowly ovoid, acute; expanded stipule unknown. *Leaves* 10–23 by 6–17 cm,

broadly elliptic, \pm chartaceous, \pm prominently concave beneath; base obtuse, apex \pm shortly prominently cuspidate, obtuse; nerves c. 12 pairs, prominently raised beneath as also the midrib; tertiary nerves remotely scalariform; *petiole* 3.5–6 cm long, c. 3 mm \varnothing , long. *Inflorescence* to 6 cm long, axillary, unbranched, bearing to 3 flowers. *Flower buds* to 3.5 by 1 cm, lanceolate. *Stamens* 25; mature flowers unknown. *Fruit* subsessile; *calyx tube* to 4.5 by 3.5 cm including the 5, to 1.5 cm wide, prominent continuous coriaceous wings, the tube itself c. 1.5 cm \varnothing , subglobose, the wings decurrent basally with the pedicel axis and apically with the base of the lobes; 2 longer lobes to 16 by 4 cm, broadly lorate, obtuse, hardly tapering but undulate at base; 3 shorter lobes to 1.5 by 1.2 cm, suborbicular, with narrowly revolute margin.

Distr. *Malesia*: Malaya (Pahang and Perak northwards), Sumatra (P. Singkep).

Ecol. Local, on well-drained flat land.

Vern. *Kéruing sendok*, *k. dadah*, *damar liat* (Malaya), *k. lakis*, *k. jantong* (Singkep).

Note. The Singkep specimens are sterile and might be *D. confertus*.

46. *Dipterocarpus stellatus* VESQUE, C. R. Ac. Sc. Paris 78 (March 1874) 626; J. Bot. 12 (1874) 150; DYER, J. Bot. 12 (1874) 153; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 202; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 38; BOERL. Cat. Hort. Bog. 2 (1901) 99; MERR. En. Born. (1921) 400; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 335; Reinwardtia 5 (1961) 465, f. 3; BROWNE, For. Trees Sarawak & Brunei (1955) 111; ASHTON, Gard. Bull. Sing. 20 (1963) 239; Man. Dipt. Brun. Suppl. (1968) 17. — *D. nobilis* DYER, J. Bot. 12 (Apr. 1874) 106; *ibid.* (May 1874) 153.

a. *ssp. stellatus*.

Young twig, raceme, leaf bud, stipule outside, midrib on both surfaces and petiole \pm densely persistently long rust-brown tomentose, sparsely so on leaf nervation beneath. *Twig* to 7 mm \varnothing , \pm angular, with an uneven cracked surface and large round petiole scars. *Leaf bud* 5–8 by 3–5 mm, spherical, obtuse. *Stipule* c. 2 by 0.8 cm, deltoid, acute. *Leaves* 20–25 by 12–16 cm, ovate, thinly coriaceous; base cordate; acumen to 14 mm long, nerves 12–16 pairs, well spaced, at c. 55°–60°; *petiole* 4–5 cm long. *Raceme* to 20 cm long, axillary, angular on drying, unbranched or singly branched. *Flower bud* to 6 by 2 cm, large. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* c. 30, subequal; filaments slender, compressed at base, tapering; anthers linear, \pm twice as long as filaments, expanded into small lateral knobs at base, tapering; appendage to connective filiform, as long as anther, reaching almost to style apex. *Ovary* small, ovoid; style c. 5 \times length of ovary, stoutly filiform, densely pubescent at base, sparsely so distally, glabrous in the apical $\frac{1}{4}$. *Fruit* sessile or on to 2 mm long stout pedicel. *Fruit calyx tube* to 5 by 2 cm, obconical, the nut enclosed in the distal half, the basal c. 1.4 cm a narrow central axis on which the wings are

fused; glabrous, smooth, c. 2.5 cm \varnothing at neck (including wings); wings c. 1.2 cm wide, thin, undulate, \pm bent over on one side at maturity, continuous from the base to the calyx lobes; concurrent with the margins of the lobes; 2 longer lobes c. 12 by 3 cm, oblong, obtuse, with undulate margin at the c. 1.7 cm wide base; with 3 parallel nerves, close to the centre, continuing to the apex; 3 shorter lobes c. 1 cm long and broad, deltoid, obtuse, with an undulate revolute margin.

Distr. *Malesia*: Borneo (Sarawak west of the Lupar).

Ecol. Hill forests, 500–800 m, local.

Note. Immature plants of the two subspecies can be indistinguishable.

b. *ssp. parvus* ASHTON, Gard. Bull. Sing. 20 (1963) 239; Man. Dipt. Brun. Suppl. (1968) 170. — *D. conformis sensu* ASHTON, Man. Dipt. Brun. (1964) 45; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 268.

Differs from *ssp. stellatus* as follows: *Twig* c. 2 mm \varnothing ; *leaves* 10–15 by 5–7 cm, base obtuse, acumen to 8 mm long, *petiole* c. 2 cm long; *racemes* to 10 cm long.

Distr. *Malesia*: Borneo (Rejang eastwards to E. Sabah, Tidung, and Belajan R.).

Ecol. Undulating land and hills to 700 m on leached clay rich soil, including acid volcanics.

Vern. *Kéruing bulu*, *k. daun nipis*.

Note. Closely allied to *D. concavus* of E. Malaya, which differs principally in the concave leaf.

47. *Dipterocarpus sarawakensis* [BROWNE, For. Trees Sarawak & Brunei (1955) 111, *nomen*] SLOOT. Reinwardtia 5 (1961) 465, f. 2; KOCHUMMEN, Mal. For. 25 (1962) 163; ASHTON, Man. Dipt. Brun. (1964) 43, f. 6; *ibid.* Suppl. (1968) 17, pl. 3 (bark).

Twig, leaf bud, raceme, stipule outside, midrib on both surfaces, and nerves below densely persistently tawny tomentose; nerves above and tertiary nerves beneath sparsely tomentose; leaf margin setose. *Twig* 3–4 mm \varnothing , terete. Bud 6–10 by 3 mm, ovoid, acute. *Stipule* c. 1.5 cm long, small, narrowly ovate, obtuse. *Leaves* 5.5–8 by 3.5–5 cm, broadly obovate, applanate, margin straight and revolute towards the cuneate base, becoming sinuate towards the obtuse or retuse apex; nerves 7–8 pairs, distant, ascending (30°–35°); *petiole* 0.7–1.0 cm long, stout. *Raceme* to 7 cm long, unbranched or singly branched, terete. *Flower bud* to 2.5 by 1 cm. *Calyx* and *corolla* typical, calyx glabrous. *Stamens* 15, shorter than the style; filaments short; anthers narrowly oblong, relatively short, stout; appendage to connective stout at base, tapering gradually, short, $\frac{2}{3}$ length of anther. *Ovary* globose, tomentose as also the narrowly cylindrical style and stylopodium. *Fruit* subsessile, glabrescent; *calyx tube* to 2.5 by 1.3 cm, fusiform, broadest towards the base, tapering to the pedicel and more gradually to the 6 mm \varnothing neck; 5-winged, wings thin and papery, striated, strongly undulate, to 8 mm broad towards the apex, tapering to the pedicel or terminating somewhat above it, tapering more rapidly apically and joining with the base of the lobes; 2 longer

calyx lobes to 9 by 2 cm, oblong, obtuse; bases constricted to c. 6 mm broad, with slightly revolute margins, with 2 lateral nerves running up half the length of the lobe and one median nerve dividing into three after the termination of the laterals; 3 short lobes 0.8–1.5 by 0.5 cm, ovate, completely revolute, narrowly acute.

Distr. *Malesia*: Malaya (river Kemaman, Trengganu, one record), S. Borneo (Barito), Sarawak and Brunei.

Ecol. Locally frequent on leached sandy soils on low coastal hills to 400 m.

Vern. *Këruing layang*.

48. *Dipterocarpus coriaceus* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 331, f. 11; SYM. Mal. For. Rec. 16 (1943) 171, f. 85; BROWNE, For. Trees Sarawak & Brunei (1955) 108; ANDERSON, Gard. Bull. Sing. 20 (1963) 157; ASHTON, Man. Dipt. Brun. Suppl. (1968) 12, f. 2. — *D. dyeri* (non PIERRE) FOXW. Mal. For. Rec. 10 (1932) 80, p.p.

Leaf beneath, petiole and twig shortly densely evenly pale pink-brown pubescent; leaf bud, stipule outside and midrib beneath, twig and petiole of young tree with to 2 mm long dense hairs; stipule glabrous within. *Twig* 8–13 mm \varnothing , stout, terete, with subhorizontal stipule scars; internodes 3–10 mm long, short. *Bud* 2.5–3 by 1.0–1.7 cm, ovoid-deltoid; *stipule* to 4 by 2 cm, narrowly ovate, subacute. *Leaves* 16–21 by 10–15 cm, broadly elliptic-ovate, thickly coriaceous, with obtuse or broadly cuneate base and obtuse to subacute apex; nerves 14–16 pairs, at 20°–60°, prominent beneath, depressed above, the midrib likewise; tertiary nerves obscure, scalariform; *petiole* 4.5–6 cm long, prominently geniculate. *Flower and inflorescence* unknown. *Fruit pedicel* to 7 mm long, prominent. *Fruit calyx* glabrous; tube to 3 by 2.2 cm, \pm broadly ovoid, with 5, to 5 mm wide, stout wings or ribs, tapering abruptly at the apex and gradually towards the base, absent in the basal $\frac{1}{4}$ of the tube; 2 longer lobes to 14 by 2.5 cm, spatulate, narrowly obtuse, to 5 mm broad above the tube; 3 shorter lobes to 14 by 2.5 cm, spatulate, narrowly obtuse, to 5 mm broad above the tube; 3 shorter calyx lobes to 12 by 6 mm, elliptic, obtuse, applanate to slightly revolute.

Distr. *Malesia*: Malaya (Lower Perak, Pahang), Sumatra (Indragiri), Borneo (Lower Kapuas, Sukadana, Lower Dayak, and Lundu to K. Balingian in Sarawak).

Ecol. Local, in Mixed Peat swamp forest.

Vern. *Këruing paya* (Sar.), *këdau*, *tampurau* (S.E. Borneo).

Note. Malayan collections have smaller fruit with narrower wings on the tube, and glabrescent leaf beneath in mature trees.

49. *Dipterocarpus cuspidatus* ASHTON, Gard. Bull. Sing. 23 (1967) 261, pl. 2; Man. Dipt. Brun. Suppl. (1968) 13, f. 2.

Leaf bud densely persistently long buff tomentose;

twig, petiole, midrib above and leaf nervation beneath sparsely long pale grey-brown subsistent tomentose. *Twig* c. 1 mm \varnothing apically, slender, terete, much branched; stipule scars slender, obscure. *Bud* to 7 by 3 mm, oblong; *stipule* unknown, caducous. *Leaves* 6–11 by 2–4 cm, narrowly elliptic-ovate, applanate with plicate folding almost disappearing when fully expanded; base obtuse to rarely cuneate; acumen to 2 cm long, prominent, slender, cuspidate; nerves 8–9 pairs, slender but prominent beneath, at 40°–50°; tertiary nerves densely scalariform; midrib slender, prominent beneath; *petiole* 12–18 mm long, slender, geniculate. *Flower* unknown. *Raceme* to 5 cm long, terminal or axillary, terete, slender, sparsely persistently long grey-brown tomentose, singly branched. *Fruit pedicel* to 5 mm long, prominent. *Calyx* glabrous; 2 longer lobes to 8 by 1.8 cm, spatulate, obtuse to subacute, c. 6 mm broad at the tube; 3 shorter lobes to 9 by 4 mm, oblong, obtuse, somewhat revolute; tube to 2 cm long, to 1.8 cm \varnothing , with 5 prominent wings; wings thin, somewhat undulate, tapering into the base but to 9 mm broad and subauriculate apically. *Nut* to 3 by 1.6 cm, ovoid, greatly exceeding the length of the calyx tube.

Distr. *Malesia*: Borneo (N.E. Sarawak).

Ecol. Rare: Mixed Dipterocarp forest on undulating land and low hills.

Vern. *Këruing runching*.

50. *Dipterocarpus eurynchus* MIQ. Sum. (1862) 485; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 613; WALP. Ann. 7 (1869) 377; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 203; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 40; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 273, 302; ASHTON, Gard. Bull. Sing. 20 (1963) 238; Man. Dipt. Brun. (1964) 30, f. 6; *ibid.* Suppl. (1968) 14; Gard. Bull. Sing. 31 (1978) 12. — *D. eurynchoides* SCHEFF. Nat. Tijd. N.I. 31 (1870) 346; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 203; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 40; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 273, 302. — *D. appendiculatus* SCHEFF. Nat. Tijd. N.I. 31 (1870) 347; *ibid.* 32 (1873) 407; DYER, J. Bot. 12 (1874) 104, p.p.; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 200, p.p.; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 34, p.p.; MERR. En. Born. (1921) 397, p.p.; HEYNE, Nutt. Pl. ed. 2 (1927) 1094; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 326; Reinwardt 5 (1961) 458; FOXW. Mal. For. Rec. 10 (1932) 83, *in obs.*; SYM. Mal. For. Rec. 16 (1943) 167, f. 85. — *D. basilanicus* FOXW. Philip. J. Sc. 13 (1918) Bot. 179; *ibid.* 67 (1938) 259; MERR. En. Philip. 3 (1923) 88.

Leaf bud densely persistently long buff tomentose; twig, petiole and leaf nervation beneath sparsely long pale grey-brown subsistent pubescent; stipule persistently so. *Twigs* to 2 mm \varnothing apically, terete, smooth or verrucose; stipule scars slender. *Bud* to 10 by 3 mm, conical, obtuse or subacute. *Stipule* to 3 by 0.8 cm, narrowly oblong, subacute. *Leaf* 4–6(–10) by 2–3.5(–4.5) cm, elliptic to obovate; base cuneate; apex subacute to shortly acuminate (caudate in young trees); nerves 8–9 pairs, at c. 40°; tertiary nerves

slender, dense; *petiole* 6–9 mm long, slender. *Flower* unknown. *Raceme* to 6 cm long, axillary, terete or ± compressed, glabrous, simple or singly branched. *Fruit calyx* glabrous; tube to 1.7 by 2 cm, 5 winged; wings c. 2.5 mm wide, thin, continuous from base to apex, straight, rigid, frequently becoming bent over to one side; 2 longer lobes to 8 by 2 cm, oblong, obtuse, tapering and revolute at base; 3 shorter lobes to 7 by 5 mm, ovate, obtuse, becoming revolute.

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

Ecol. Local, on undulating land in Mixed Dipterocarp forest on leached clay soils, and on ridge tops to 700 m.

Vern. Kēruing baran, k. padi (Mal.), *sēmanto minjak, kērukēh, ansang ansang, kēruing, kēruing senium* (Sum.).

Note. A polymorphic species. One distinctive and well collected segregate is recognised here as a separate species, *D. ochraceus*; others, presently ill understood, may eventually deserve taxonomic definition: The few Malayan and Sumatran collections have markedly larger leaves with longer petioles, and collections from Gunong Angsi, Negri Sembilan (including KEP 23788, quoted by SYMINGTON (1943) as a possible hybrid between *D. gracilis* and *D. costatus*) come close to *D. ochraceus*. This species is apparently derived from the widespread *D. costatus* of the seasonal zone, as may be the closely similar *D. glandulosus* THW. of Ceylon.

51. *Dipterocarpus ochraceus* MEIJER, Acta Bot. Neerl. 12 (1963) 351, pl. 14; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 26.

Large tree. Young parts densely ochereous velutinate, persistent on leaf buds, stipules outside, and twigs, becoming sparse yet partially persisting on petiole and nervation beneath, caducous on other known parts. *Twigs* c. 4 mm Ø apically, rather stout, terete, ± minutely fissured. *Buds* to 20 by 8 mm, large, ovoid-lanceolate, acute; mature *stipules* unknown. *Leaves* 10–19 by 4.5–9.5 cm, broadly elliptic-ovate, coriaceous, ± persistently plicate; base cuneate or rarely obtuse; acumen to 15 mm long, broad; nerves 11–15 pairs, slender but prominent beneath, ascending at 30°–60°; tertiary nerves densely subscalariform, slender but distinctly elevated beneath; midrib prominent beneath, ± appanate above; *petiole* 1.5–2.5 cm long, stout. *Inflorescences* and *flowers* unknown. *Fruit pedicel* to 3 by 2 mm, prominent. *Calyx tube* to 18 by 15 mm, broadly ellipsoid, with 5, to 2 mm broad, continuous straight coriaceous wings; 2 longer lobes to 8 by 1.8 cm, lorate-spatulate, narrowly obtuse, c. 6 mm broad at base; 3 shorter lobes to 6 by 6 mm, ovate, subacute, subrevolute.

Distr. Malesia: N.E. Borneo (Kinabalu area).

Ecol. Ultrabasic and basaltic mountains, 600–700 m.

Vern. Kēruing ranau.

Note. A species which has presumably segregated from the widespread *D. eurynchus*; see there.

52. *Dipterocarpus perakensis* ASHTON, Gard. Bull. Sing. 31 (1978) 13. — *D. alatus* (non ROXB.) FOXW. Mal. For. Rec. 10 (1932) 89, *p.p.*; SYM. Mal. For. Rec. 16 (1943) 166, f. 85.

Large tree. Parts glabrous but for the cream puberulent ovary apex. *Twigs* c. 2 mm Ø apically, much branched, blackish. *Buds* to 9 by 2 mm, lanceolate, drying blackish; *stipules* unknown. *Leaves* 4–7 by 8–13 cm, elliptic, coriaceous; base broadly cuneate to obtuse; apex shortly acuminate; nerves 9–12 pairs, ascending, prominent beneath; tertiary nerves densely scalariform, slightly elevated beneath; *petioles* 1.5–3.2 cm long, slender. *Flowers* and *inflorescences* unknown. *Fruit pedicel* to 2 by 2 mm; *calyx tube* to 2.2 cm Ø, subglobose, with 5 prominent continuous to 8 mm wide coriaceous wings; 2 longer lobes to 12 by 3 cm, oblong-lorate, obtuse, tapering abruptly to c. 8 mm wide at the revolute base; 3 shorter lobes to 5 by 5 mm, suborbicular, subrevolute, small.

Distr. Malesia: Malaya (Penang hill, Dindings, Pangkor I.).

Ecol. Very local, in Lowland Dipterocarp forest on coastal hills.

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

53. *Dipterocarpus philippinensis* FOXW. Philip. J. Sc. 6 (1911) Bot. 253; *ibid.* 13 (1918) Bot. 179; *ibid.* 67 (1938) 263; MERR. En. Philip. 3 (1923) 90.

Tall tree. Leaf buds, twigs, stipules, leaf nervation beneath, midrib above, petiole, inflorescence and ovary densely evenly shortly persistently pale ochereous pubescent, leaf surface sparsely so; fruit calyx glabrous. *Twigs* 3–4 mm Ø apically, ± terete, pale brown. *Leaf buds* to 15 by 6 mm, lanceolate; expanded *stipules* not seen. *Leaves* 9–17 by 3.5–8 cm, narrowly ovate, thinly coriaceous; base cuneate; apex acute or shortly indistinctly acuminate; nerves 11–18 pairs, slender but prominent beneath, ascending at 45°; tertiary nerves densely scalariform, sinuate, very slender but somewhat elevated beneath; *petioles* 2.5–4.5 cm long, slender. *Inflorescence* to 8 cm long, unbranched, bearing to 4 flowers. *Flowers* unknown. *Fruit pedicel* c. 1 mm long, short; *calyx tube* to 2.3 cm Ø, subglobose, with 5, to 8 mm broad, prominent continuous coriaceous wings; 2 longer lobes to 14 by 2.8 cm, lorate, obtuse, c. 1 cm broad at the subrevolute base; 3 shorter lobes to 12 by 14 mm, ovate, suborbicular, revolute.

Distr. Malesia: Philippines (Luzon; Bataan and Abra Prov.).

Ecol. Rare, in Mixed Dipterocarp forest in seasonal areas.

Vern. Ayamban (Ilok.).

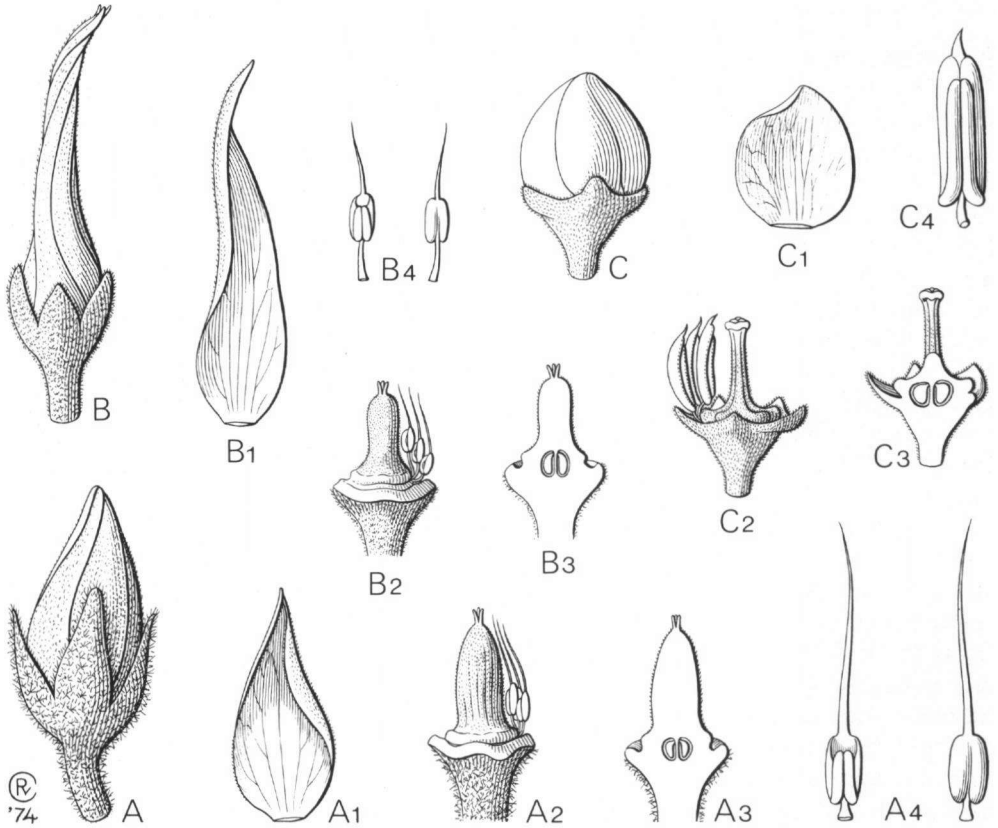


Fig. 27. *Anisoptera costata* KORTH. A. Bud, A1. petal, A2. stamens and pistil, A3. pistil in section, all $\times 5$, A4. stamens from inside (left) and outside, $\times 10$. — *A. thurifera* (BLCO) BL. B. bud, B1. petal, B2. stamens and pistil, B3. pistil in section, all $\times 5$, B4. stamens from inside (left) and outside, $\times 10$. — *A. laevis* RIDL. C. bud, C1. petal, C2. stamens and pistil, C3. pistil in section, all $\times 5$, C4. stamen from inside, $\times 10$ (A POILANE 830, B KOSTERMANS & SOEGENG 286, C S 24810).

Dubious

54. *Dipterocarpus orbicularis* FOXW. Philip. J. Sc. 13 (1918) Bot. 180; *ibid.* 67 (1938) 262; MERR. En. Philip. 3 (1923) 907.

Leaf buds, twigs, leaf nervation beneath and peduncle \pm sparsely fulvous hirsute, lamina beneath, midrib above and ovary sparsely puberulent; fruit calyx glabrous. Twigs c. 5 mm \varnothing apically, terete, pink-brown. Leaf buds to 12 by 6 mm, ovoid-lanceolate; stipules not seen. Leaves 9–13 by 6.5–10 cm, broadly elliptic, thinly coriaceous; base cuneate; apex mucronate; nerves 10–12 pairs, slender but prominent beneath, shallowly depressed above, ascending at 45°; tertiary nerves laxly subscalariform, elevated beneath; petioles 2.5–4.5 cm long, slender. Inflorescences to 12 cm long, unbranched, bearing to three flowers. Flowers and mature fruit unknown. Young fruit pedicel to 2 mm long; calyx tube with 5 prominent

chartaceous broad wings from base to apex; calyx lobes unequal, 2 aliform.

Distr. *Malesia*: Philippines (Camarines Prov., Luzon).

Ecol. Mixed Dipterocarp forest at low elevations. Notes. The type (FB 21719 from Camarines, Luzon) consists of a leafy twig and an immature fruit.

This little known species, which in the absence of ripe fruit cannot be placed in the key, resembles *D. grandiflorus* BLCO in its fruit and *D. gracilis* BL. in its indumentum. The leaf, almost orbicular and with few nerves, is distinctive. Sterile specimens from Sabah compared by FOXWORTHY with this species belong to the subsequently described *D. confertus* SLOOT., in which the leaves are much larger, the fruit calyx densely pubescent and with narrower wings. *D. orbicularis* would appear to be vicarious with *D. stellatus* VESQUE of Borneo and *D. concavus* FOXW. of the Malay Peninsula.

2. ANISOPTERA

KORTH. Kruidk. (1841) 65; WALP. Rep. 5 (1845) 125; Ann. 4 (1857) 335; BL. Ann. Mus. Lugd.-Bat. 2 (1852) 6; MIQ. Fl. Ind. Bat. 1, 2 (1859) 500; B. & H. Gen. Pl. 1 (1862) 500; DC. Prod. 16, 2 (1868) 615; DYER, Fl. Br. Ind. 1 (1874) 300; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 220; HEIM, Rech. Dipt. (1892) 30; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 40; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 258; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 359; SLOOT. Bull. Jard. Bot. Btzig III, 8 (1926) 3; HEYNE, Nutt. Pl. ed. 2 (1927) 1098; FOXW. Philip. J. Sc. 67 (1938) 263; SYM. Gard. Bull. S. S. 8 (1934) 1; Mal. For. Rec. 16 (1943) 199, f. 99 (map); WYATT-SMITH, Mal. For. 18 (1955) 70; ASHTON, Gard. Bull. Sing. 20 (1963) 230; Man. Dipt. Brun. (1964) 9; MEIJER & WOOD, Sabah For. Rec. 5 (1965) 292; SMITINAND, Thai For. Bull. (Bot.) 12 (1980) 18. — *Hopea* ROXB. Fl. Ind. ed. Carey 2 (1832) 611, *p.p.*, quoad *H. scaphula* ROXB. — *Mocanera* BLCO, Fl. Filip. ed. 1 (1837) 446, *p.p.*, quoad *M. thurifera* BLCO. — *Vatica* (non L.) DYER, Fl. Br. Ind. 1 (1874) 301, *p.p.*, quoad *V. scaphula*. — *Antherotriche* TURCZ. Bull. Soc. Nat. Mosc. 2 (1846) 505. — *Scaphula* PARKER in Fedde, Rep. 30 (1932) 326. — *Hopeoides* CRETZOIU, J. Jap. Bot. 17 (1941) 408. — Fig. 27–31.

Medium-sized to very large trees, often with prominent, thick, rounded, tall straight buttresses. *Crown* comparatively small, appearing irregularly hemispherical and oblong, rather diffuse, with a few large twisted branches ascending from the bole apex; branchlets not crowded towards the apices. *Bark surface* rather shallowly irregular-section fissured, the fissures separating \pm flat flaking ridges; dotted with warty lenticels. Young parts at first \pm densely lepidote with emarginate peltate hairs; lamina undersurface persistently so. *Twigs* ribbed. *Stipules* relatively large, narrow, fugaceous. *Leaves* oblong to obovate, base usually obtuse, apex shortly acuminate; nerves curving round and anastomosing at the apices, thus forming a looped intramarginal nerve (*cf. Cotylelobium*); tertiary nerves densely or remotely scalariform; *petiole* distinctly geniculate. *Inflorescence* long, lax, pendent, densely tomentose; bracteoles small, linear, caducous. *Flower bud* distinctly pedicellate, distichous. *Calyx* \pm imbricate, rarely calvate (*A. laevis*); with 2 obtuse outer lobes slightly more thickened than 3 inner acute lobes, united at base in an indistinct (in flower) tube round the partially inferior ovary. *Petals* oblong-linear, falling separately. *Stamens* 15–65 in 3 verticils or irregular, the outer somewhat shorter than the inner, glabrous; filaments rather short, slender, filiform, tapering, connate at base; anthers with 4 pollen sacs, the inner 2 shorter than the outer 2, latrorse; appendage to connective short or long. *Ovary* semi-inferior, with a distinct stylopodium; style long or short, obscurely trifold; stigma indistinct. *Fruit calyx* valvate with an ellipsoid basal tube almost entirely enclosing and adnate to the nut, with 2 long narrowly spatulate obtuse untwisted 3-nerved lobes, and 3 acuminate short lobes. *Nut* \pm globose, enclosed but for the apex in the valvate tube, with distinct stylopodium. Germination epigeal, pericarp splitting open irregularly apically; cotyledons unequal; first leaves paired, with interpetiolar stipules, or in a whorl of 4, without stipules; followed by spiral leaves as other genera.

Distr. 11 *spp.* from Chittagong and Indochina to New Guinea, in *Malasia*: 10 *spp.* Holocene fossils have been found in the Siwalik beds of N.W. India. Fig. 28.

Ecol. Lowland forests, rarely above 1000 m. Scattered in Mixed Dipterocarp, Mixed Swamp and Heath forests of the humid zone but becoming gregarious in N. Malaya, Indochina and parts of New Guinea.

Uses. The pale siliceous wood is not durable without preservatives and blunts saws but is an important source for veneers.

KEY TO THE SPECIES

- 1. Flower buds lanceolate. Stamens 25–60. Stylopodium in flower as broad as ovary, ovoid to oblong, tomentose. Style short, 3- or 6-furcate, stigma minute. *Spp. 1–8* 1. Sect. *Anisoptera*
 - 2. Stamens c. 25.
 - 3. Nerves at most 14 pairs; leaves fugaceous pubescent or epilose 1. *A. marginata*
 - 3. Nerves at least 15 pairs, petiole and nervation beneath ± persistently pubescent.
 - 4. Leaf undersurface brilliant gold lepidote, nerves depressed above 2. *A. curtisii*
 - 4. Leaf undersurface dull yellowish or greenish lepidote; nerves hardly or not depressed above 3. *A. costata*
 - 2. Stamens at least 30.
 - 5. Twigs and nerves and midrib beneath dark rufous scabrid tomentose; lamina golden yellow lepidote beneath; nerves and tertiary nerves ± prominently depressed above.
 - 6. Nerves 18–28 pairs; stamens c. 36 4. *A. grossivenia*
 - 6. Nerves 23–33 pairs; stamens c. 60 5. *A. megistocarpa*
 - 5. Twigs and nervation not as above.
 - 7. Nerves 9–14 pairs; twigs and leaves glabrescent 6. *A. reticulata*
 - 7. Nerves (10–)14–18(–20) pairs; twigs, petioles and nervation beneath pubescent.
 - 8. Stamens 37–57; leaves greyish to brown lepidote beneath 7. *A. thurifera*
 - 8. Stamens 35–38; leaves densely golden peltate beneath 8. *A. aurea*
 - 1. Flower buds subglobose. Stamens 15. Stylopodium broad and disc-like, glabrous. Style slender, columnar; stigma obscurely 3-lobed. *Spp. 9–10* 2. Sect. *Glabrae*
 - 9. Leaf 8–16 by 3.5–8 cm; undersurface pale grey-green lepidote; nerves 13–18 pairs 9. *A. scaphula*
 - 9. Leaf 7–11 by 3–4 cm; undersurface rust to golden lepidote; nerves 10–14 pairs 10. *A. laevis*

1. Section *Anisoptera*

ASHTON, Gard. Bull. Sing. 20 (1963) 231; Man. Dipt. Brun. (1964) 10. — *Antherotriche* TURCZ. l.c. — *Anisoptera* sect. *Pilosae* HEIM, Rech. Dipt. (1892) 33; SYM. Mal. For. Rec. 16 (1943) 199. — *Anisoptera* sect. *Antherotriche* HEIM, Rech. Dipt. (1892) 34.

Young parts and leaf below generally tomentose. Flower buds lanceolate; anther ellipsoid; appendage to connective many times longer than anthers, slender; stylopodium cylindrical to ovoid, conical, narrow; style short, stigma minute.

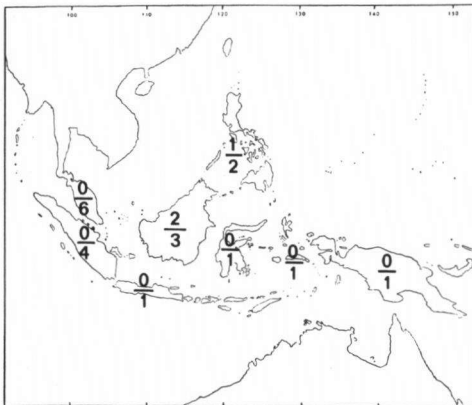


Fig. 28. Density map of *Anisoptera* KORTH. in Malesia; number of endemics above the hyphen, number of non-endemics below it.

1. *Anisoptera marginata* KORTH. Kruidk. (1841) 66, t. 6, 1a–13a; WALP. Rep. 5 (1845) 124; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 42; MIQ. Fl. Ind. Bat. 1, 2 (1859) 501; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 615; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 220; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 43; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 258; BOERL. Cat. Hort. Bog. 2 (1901) 100; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 275; ed. 2 (1927) 1099; MERR. En. Born. (1921) 401; RIDL. Fl. Mal. Pen. 1 (1922) 21; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1926) 5; FOXW. Mal. For. Rec. 10 (1932) 96; SYM. Gard. Bull. S. S. 8 (1934) 13, pl. 3C; Mal. For. Rec. 16 (1943) 206, f. 101, 103; BURK. Dict. (1935) 163; WYATT-SMITH, Mal. For. 18 (1955) 76; ANDERSON, Gard. Bull. Sing. 20 (1963) 157; ASHTON, Gard. Bull. Sing. 20 (1963) 232; Man. Dipt. Brun. (1964) 14, f. 5; *ibid.* Suppl. (1968) 5; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 298, f. 49B. — *A. grandiflora* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 43; MERR. En. Born. (1921) 401; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1926) 10. — *A. mindanensis* (non

FOXW.) WYATT-SMITH, Mal. For. 18 (1955) 77, p.p. — Fig. 29.

Young twig, leaf bud, stipule outside (glabrous within), midrib beneath and petiole shortly caducous pubescent; panicle persistently so. *Twig* terete, becoming angular on drying, smooth or with very fine striation. *Bud* 2.3–3.5 by 2 mm, ovoid, acute, compressed. *Stipule* c. 8 mm long, linear, obtuse. *Leaf* 7–10 by 3.5–4.5 mm, oblong to ± obovate, densely golden-brown lepidote beneath, bullate in young trees, otherwise applanate, with obtuse or broadly cuneate base; acumen to 6 mm long; nerves 10–14 pairs, slender, at c. 65–70° to the midrib; *petiole* 1.5–2 cm long, slender. *Panicle* to 14 cm long, terminal or axillary, lax, pendent, terete; irregularly doubly branched. *Flower bud* to 8 by 3.5 mm, lanceolate, acute. *Calyx* cupped at base; lobes subequal, narrowly deltoid, the 3 outer slightly narrower, acute, the 2 inner obtuse. *Corolla* pale yellow; petals broadly elliptic, fimbriate. *Stamens* c. 25; filaments short, slender; anther oblong; appendage to connective c. 2 times length of anther, reaching apex of stylopodium. *Stylopodium* cylindrical, shortly densely tomentose; style short, tapering, stout at base, the basal half tomentose, otherwise glabrous, trifurcate. *Fruit calyx* shortly pubescent; tube c. 1.3 cm \varnothing , globose, to 8 mm \varnothing at the neck; 2 longer calyx lobes to 12 by 2 cm, spatulate, obtuse; 3 shorter lobes 1.5–2 cm long, c. 3 mm broad at base, linear, acute; *apex of nut* almost flat, tapering abruptly to the c. 3 mm long, c. 1.5 mm \varnothing oblong stylopodium.

Distr. *Malesia*: Malaya (E. and W. coast, Perak and Pahang southwards), Banka, E. Sumatra (Asahan southwards to Lampung), Borneo.

Ecol. Widespread but rarely common, Mixed Peat Swamp forest; local, Heath forest on podsols, to 1200 m.

Vern. *Měrsawa paya* (Mal.), *pangiran kěrangas* (Sabah), *kětimpun*, *rěsak gunong* (S. Borneo), *těnam*, *mentanam*, *sěsawah*, *rěsak pantai*, *masěgar* (Sum.).

2. *Anisoptera curtisii* DYER *ex* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 100, *incl. var. latifolia* KING; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 263, t. 122, f. F; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 42; BURK. J. Str. Br. R. As. Soc. 81 (1920) 51, 63, fig.; MERR. En. Born. (1921) 400; RIDL. Fl. Mal. Pen. 1 (1922) 218; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 259; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1926) 11, p.p.; FOXW. Mal. For. Rec. 3 (1927) 79; *ibid.* 10 (1932) 99; Philip. J. Sc. 67 (1938) 271; SYM. Gard. Bull. S.S. 8 (1934) 15, pl. 4B; Mal. For. Rec. 16 (1943) 204, f. 100B, 101.

Large buttressed tree. *Twig* apices, stipules, leaf buds, nervation beneath, petiole, panicles and calyx ± densely gold-brown pubescent, caducous on twigs and calyx; leaf beneath brilliant gold lepidote. *Twig* c. 2 mm \varnothing apically, slender, becoming pale brown; stipule scars obscure. *Bud* to 6 by 4 mm, ovoid, acute; *stipules* to 7 by 2 mm, linear-lanceolate, acute, fugaceous. *Leaves* (4–)7–14 by (1.5–)2.5–6 cm, nar-

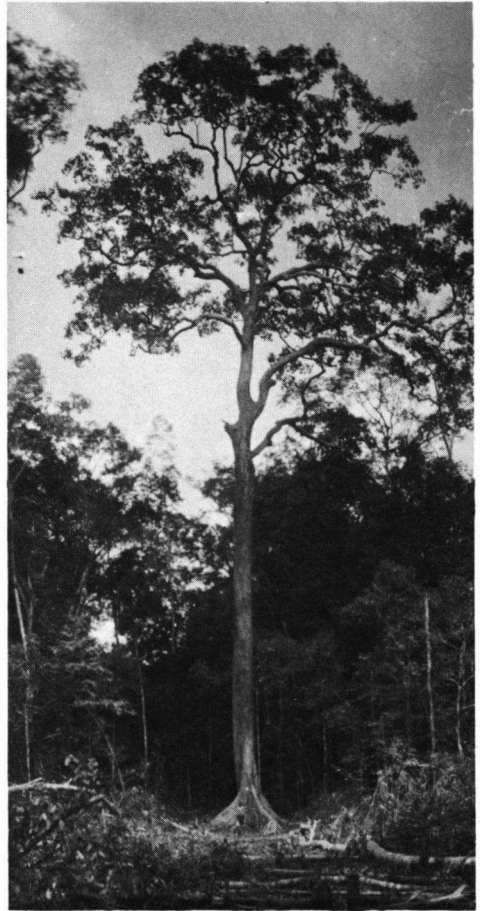


Fig. 29. Habit of *Anisoptera marginata* KORTH. Note the colossal size by the person standing in front of the flying buttresses. Palembang (Photogr. THORENAAR, 1925).

rowly elliptic to oblanceolate, coriaceous; base obtuse; acumen to 1 cm long, broad; nerves 15–25 pairs, spreading, with short secondary nerves, slender but prominent beneath, narrowly depressed above as also the midrib; tertiary nerves laxly subreticulate, ± elevated beneath; *petiole* 13–23 mm long, slender. *Panicle* to 18 cm long, terminal or axillary, lax, pendent, irregularly branched; branchlets to 2.5 cm long, bearing to 7 flowers. *Flower* white; *buds* to 5 by 2 mm, lanceolate; 2 longer *sepals* lanceolate, subacute; 3 shorter *sepals* broad at base, prominently slender acuminate; *stamens* 25, subequal; filaments somewhat shorter than anthers, filiform; anthers broadly oblong, somewhat tapering; appendage very slender, c. 3 times as long as anthers; *stylopodium* broadly

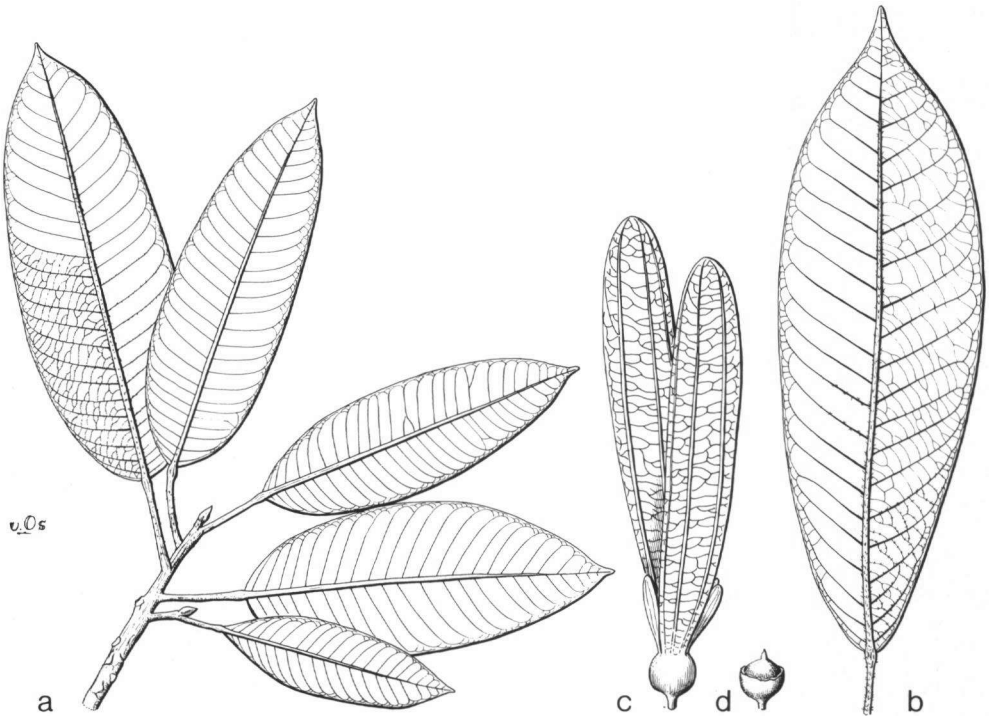


Fig. 30. *Anisoptera grossivenia* SLOOT. a. End of twig, b. single leaf, c. fruit, d. nut, all $\times \frac{1}{2}$ (a S 5819, b-d S 6514).

ellipsoid-cylindrical, densely gold puberulent, surmounted by the short but prominent trifid style. *Fruit pedicel* to 3 by 2 mm, expanding into calyx tube; calyx tube to 14 mm \varnothing , subglobose; 2 longer lobes to 10.5 by 1.8 cm, spatulate, obtuse, c. 5 mm broad at base; 3 shorter lobes to 20 by 3 mm, linear-lanceolate, acute.

Distr. Malesia: Malaya (commonest in north), Sumatra (P. Singkep).

Ecol. Mixed Dipterocarp forest on well drained periodically dry soils, especially coastal hills and inland ridges to 700 m.

Vern. *Měrsawa kuning, rengkong* (Malaya); *kěruing kutjing, měrsawa* (Singkep).

Note. Closely related to *A. costata*; some collections from N.W. Malaya suggest occasional hybridisation.

3. *Anisoptera costata* KORTH. Kruidd. (1841) 67, t. 6, f. 1-9; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 42; MIQ. Fl. Ind. Bat. 1, 2 (1859) 501; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 615; PIERRE in Lanessan, Pl. Util. Colon. Fr. (1886) 298; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 220; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 43; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 60; J. Str. Br. R. As. Soc. 54 (1910) 25, *p.p.*; Fl. Mal. Pen. 1 (1922) 218, *p.p.*; MERR. En. Born. (1921)

400; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1926) 7, f. 1; Reinwardtia 2 (1952) 8, f. 1, *p.p.*; THORENAAR, Med. Proefst. Boschw. 16 (1926) 106; HEYNE, Nutt. Pl. ed. 2 (1927) 1098; FOXW. Mal. For. Rec. 3 (1927) 79; *ibid.* 10 (1932) 97; SYM. Gard. Bull. S. S. 8 (1934) 9, pl. 3A; Mal. For. Rec. 16 (1943) 204, f. 100A, 101; WYATT-SMITH, Mal. For. 18 (1955) 74; BACKER & BAKH. f. Fl. Java 1 (1963) 330; ASHTON, Man. Dipt. Brun. (1964) 11, f. 5, pl. 4 (stem); Gard. Bull. Sing. 31 (1978) 13. — *Dryobalanops hallii* KORTH. msc. in BURCK, Ann. Jard. Bot. Btzg 6 (1887) 220, 243, *nomen in syn.* — *Dipterocarpus parallelus* KORTH. ex BURCK, Ann. Jard. Bot. Btzg 6 (1887) 220, 243. — *A. oblonga* DYER, Fl. Br. Ind. 1 (1874) 301; PIERRE, Fl. For. Coch. 3 (1889) t. 235, 236; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 42; Ind. Trees (1906) 67; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 369; GAMBLE, Man. Ind. Timb. (1922) 75; SYM. Gard. Bull. S. S. 8 (1934) 10, pl. 3B; Mal. For. Rec. 16 (1943) 208, f. 101; PARKINSON, Ind. For. Rec. 20 (1935) 7. — *Shorea nervosa* KURZ [Rep. Pegu App. A (1875) XVIII, *nomen*] Fl. Burma 1 (1877) 119. — *A. cochinchinensis* PIERRE in Lanessan, Pl. Util. Colon. Fr. (1886) 268; Fl. For. Coch. 3 (1889) t. 235A, 253; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 42; HEIM, Bot. Tidsskr. 25 (1902) 44; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 367; CRAIB, Fl. Siam. Enum. 1 (1925) 139; LECOMTE,

Bois Indochine (1926) 115. — *A. robusta* PIERRE, Fl. For. Coch. 3 (1889) t. 236; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 42; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 368; CRAIB, Fl. Siam. Enum. 1 (1925) 140; SYM. Gard. Bull. S. S. 8 (1934) 11. — *A. glabra* (non KURZ) PIERRE, Fl. For. Coch. 3 (1889) t. 235B; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 361 (fig.), 369. — *A. marginatoides* HEIM, Bot. Tidsskr. 25 (1902) 44; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 369; CRAIB, Fl. Siam. Enum. 1 (1925) 139. — *A. mindanensis* Foxw. Philip. J. Sc. 13 (1918) Bot. 181; *ibid.* 67 (1938) 266; MERR. En. Philip. 3 (1923) 92. — Fig. 27A-A4.

Twig of variable thickness, at first frequently angular, becoming minutely striated or smooth, terete. *Bud* 3-5 by 1.5-3 mm, ovoid, somewhat compressed, acute. *Stipule* c. 8 by 3 mm, hastate, acute, fugaceous. *Leaves* 6-18 by 7-11 cm, thinly coriaceous, frequently slightly bullate, oblong to obovate, undersurface grey-green lepidote to golden or chocolate; base obtuse or broadly cuneate; acumen to 5 mm long; margin not revolute or only slightly so; nerves 8-22 pairs, at 60°-70°; *petiole* 2-4 cm long. *Panicle* to 20 cm long, terminal or axillary, angular, pendent, doubly or trebly branched, branchlets bearing up to 5 flowers; *bracteoles* to 4 by 2 mm, hastate, acute, shortly densely pubescent. *Flower bud* to 12 by 6 mm, ovoid, acute. *Calyx* densely tomentose outside, shortly pubescent within; lobes deltoid, ± acute, acuminate, of varying lengths. *Corolla* cream; petals broadly hastate, acute, shortly puberulent on parts exposed in bud. *Stamens* c. 25 (to 35 outside Malesia), subequal; filaments short, compressed; anther oblong, tapering apically; appendage to connective about twice as long as anther, filiform, tapering, reaching almost to apex of stylopodium. *Stylopodium* cylindrical, somewhat tapering, densely pubescent; style short, trifid, pubescent at base, otherwise glabrous. *Fruit calyx* shortly pubescent, tube glabrescent; tube to 1 by 1.2 cm, globose, tapering gradually to the pedicel, narrowed to 8 mm \varnothing at the neck; 2 longer calyx lobes to 16 by 1.5-2 cm, spatulate, obtuse, c. 5 mm broad at base; 3 shorter lobes to 20 by 4 mm, variable, hastate, base slightly constricted. *Nut apex* broadly conical, crowned by a c. 2.5 by 1.5 mm oblong stylopodium, shortly pubescent.

Distr. Burma, Thailand, Cambodia, Cochinchina, and in *Malesia*: Malaya, Sumatra, W. Java (one record), Borneo (S.E. Kalimantan, Sabah, Brunei, N.E. Sarawak), Philippines (Mindanao, one record).

Ecol. Common, often gregarious, in Semi-evergreen Dipterocarp forest and evergreen forest in seasonal areas; rare but widespread in lowland forest in everwet areas, to 700 m.

Vern. *Měrsawa*, *m. kěsat*, *m. těrbak*, *těrbak*, *měr-anti těrbak*, *pokok pahit* (Malaya), *masėgar*, *tėnan*, *mėluwang tikus* (Sumatra), *kėtimpun*, *laripung*, *damar tingkis* (Kalimantan).

Notes. *A* very variable species; forms vary from epilose (*A. mindanensis* Foxw.) to densely pilose (*A. robusta* PIERRE), another has relatively small few-nerved leaves (*Anisoptera* sp. *A.* of Malayan literature).

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

There is a possibility of hybridisation with *A. curtisii* in N.W. Malaya, and with *A. megistocarpa* in Johore and Singapore (large-leaved golden tomentose forms).

VAN SLOOTEN (1952) recorded *A. costata* from Celebes and the Moluccas on the basis of sterile material. It is indistinguishable from *A. thurifera* (BLCO) BL. when sterile; for phytogeographical reasons I would prefer to tentatively associate these numbers with the latter species.

4. *Anisoptera grossivenia* SLOOT. Bull. Jard. Bot. Btzig III, 16 (1940) 431, f. 1; WYATT-SMITH, Mal. For. 18 (1955) 75; BROWNE, For. Trees Sarawak & Brunei (1955) 93; ASHTON, Gard. Bull. Sing. 20 (1963) 232; Man. Dipt. Brun. (1964) 12, f. 5, pl. 3 (habit); *ibid.* Suppl. (1968) 5; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 296, f. 50. — *A. curtisii* (non DYER ex KING) MERR. En. Born. (1921) 400, *p.p.*, *quoad spec. Born.*; SLOOT. Bull. Jard. Bot. Btzig III, 8 (1926) 11, *p.p.*, *quoad spec. Born.* — *Anisoptera* sp. 'B' WYATT-SMITH, Mal. For. 18 (1955) 79. — Fig. 30.

Leaf nervation beneath, petiole, stipule (outside, shortly pubescent within), leaf bud, panicle and twigs persistently rufous scabrid tomentose; lamina beneath densely rich golden-yellow lepidote. *Twig* to 2 mm \varnothing apically, terete or ± compressed, rugose when dry, becoming minutely striated. *Bud* 3-5 by 2.5 mm, ovoid, ± compressed. *Stipule* c. 8 by 2.5 mm, hastate, acute, fugaceous. *Leaves* 9-12 by 3-5 cm, oblong to narrowly obovate, slightly bullate; base cuneate; margin slightly recurved; acumen to 1 cm long, narrow; nerves 18-28 pairs, dense, arched, at 60°-70°; tertiary nerves conspicuous, semi-reticulate; looped intramarginal nerve c. 1 mm from margin; *petiole* 2-2.5 cm long, geniculate. *Panicle* to 20 cm long, terminal or axillary; slender, lax, pendent, angular; regularly doubly branched, branchlets lax, to 5 cm

long, bearing up to 8 flowers; *bracteoles* fugaceous. *Bud* to 5 by 2.5 mm, lanceolate, acute. *Calyx* densely rust-brown tomentose, cupped at the base; sepals imbricate, acuminate; 2 inner sepals slightly longer, broader, obtuse; 3 outer acute. *Corolla* magenta at first, becoming rich yellow on opening; petals lanceolate, acute, shortly pubescent on parts exposed in bud. *Stamens* c. 36; filaments slender, short; anthers subglobose; appendage to connective c. 3 × length of anther, reaching $\frac{3}{4}$ height of stylopodium, slender. *Ovary* half enclosed in calyx; stylopodium subcylindrical, tapering apically, densely shortly gold-brown tomentose; style short, glabrous; stigma minute. *Fruit calyx* sparsely puberulent; tube to 1.3 cm \varnothing , globose, hardly constricted at the neck; two longer calyx lobes to 20 by 2.5 cm, narrowly spatulate, obtuse, rarely acute, to 5 mm broad at base; 3 shorter lobes of varying length, occasionally to 6 by 0.4 cm, acute, linear. *Nut apex* obtuse, with c. 8 mm long, c. 15 mm \varnothing , acute oblong-ovoid stylopodium broadening into the nut at the base; shortly densely rufous pubescent.

Distr. *Malesia*: Borneo (S., S.E. & W. Kalimantan, Sarawak, Brunei, S.W. Sabah).

Ecol. Lowland Dipterocarp forest on sandy soil, on present or Pleistocene coastal hills.

Vern. *Měrsawa*, *m. durian* (Mal.), *běnchaloi* (Brun.), *pěngiran kěsar* (Sabah), *běrbakau*, *měrbani*, *pěnyau kěrabak*, *p. rěbong*, *p. batu*, *rěsak těmbaga*, *kělassih*, *kěpitun*, *ampereng*, *marlangat*, *chěngal padi*.

5. *Anisoptera megistocarpa* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1926) 12, f. 2; HOLTUM, Gard. Bull. S. S. 5 (1931) 184; FOXW. Mal. For. Rec. 10 (1932) 98; SYM. Gard. Bull. S. S. 8 (1934) 14, pl. 4A; Mal. For. Rec. 16 (1943) 207, f. 101; BURK. Dict. (1935) 164. — *A. costata* (non KORTH.) RIDL. J. Str. Br. R. As. Soc. 54 (1910) 25, *p.p.*; Fl. Mal. Pen. 1 (1922) 218, *p.p.*; BURK. J. Str. Br. R. As. Soc. 75 (1917) 43.

Tall buttressed tree. Twigs, leaf bud, stipule outside, petiole, nervation beneath, panicle, flower calyx and ovary densely persistently dark ferruginous scabrid pubescent; lamina beneath dark golden brown lepidote. *Twig* c. 5 by 3 mm \varnothing apically, stout, \pm compressed, rugose, becoming dark brown verrucose. *Buds* to 8 by 5 mm, ovoid; *stipules* to 12 by 6 mm, fugaceous. *Leaves* (5.5–)9–20 by (2.5–)3.5–8 cm, narrowly oblong-elliptic to oblanceolate, thickly coriaceous; margin subrevolute; base obtuse; acumen to 1 cm long, tapering, downcurved; nerves 23–33 pairs, dense, spreading, with short secondary nerves, slender but prominent beneath, distinctly depressed above as also the midrib and subreticulate tertiaries; *petiole* 2–2.8 cm long, to 3 mm \varnothing , stout. *Panicle* to 12 cm long, terminal or axillary, pendent, irregularly laterally branched; branchlets to 3.5 cm long, bearing to 5 flowers. *Flower* white; *buds* to 8 by 3 mm, lanceolate; 2 longer *sepals* lanceolate, subacuminate; 3 shorter sepals narrowly deltoid, subcaudate. *Stamens* c. 60, subequal; filaments shorter than anther, filiform; anthers oblong, attenuate; appendages filiform, twice length of anthers. *Stylopodium* stoutly ovoid, pubes-

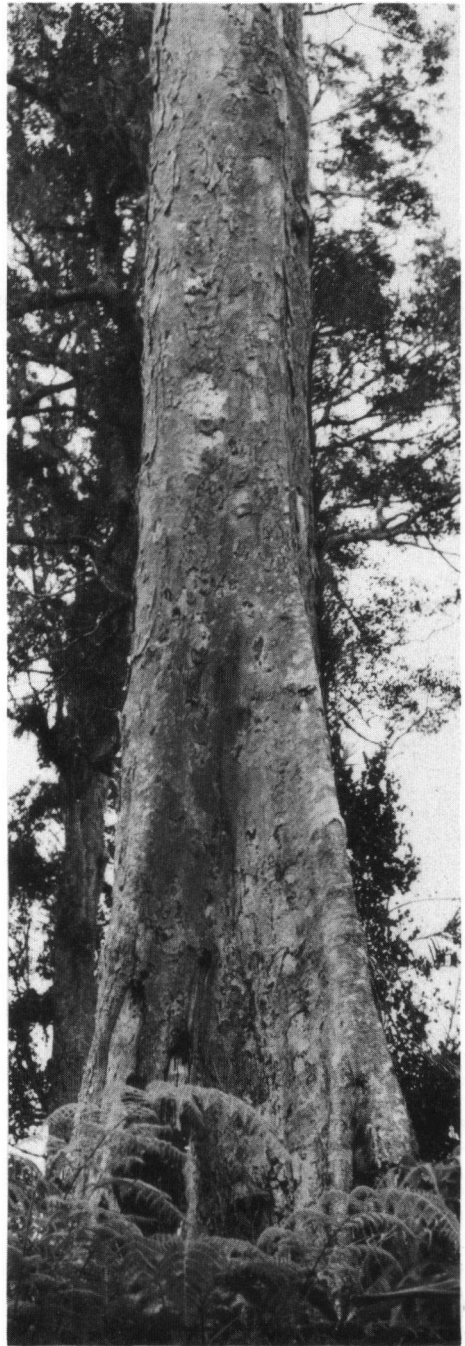


Fig. 31. Trunk-base of *Anisoptera thurifera* (BLCO) BL. Sogeri, Papua (Photogr. ASHTON, Aug. 1970).

cent, surmounted by a short but distinctly trifid style. *Fruit pedicel* to 3 by 2 mm. *Calyx tube* to 2 cm \emptyset , globose; 2 longer lobes to 22 by 3.8 cm, spatulate, obtuse, c. 6 mm wide at the base; 3 shorter lobes to 30 by 3 mm, linear.

Distr. Peninsular Thailand, and in *Malesia*: Malaya (south from Perak and Pahang), Sumatra (Langsa, Atjeh).

Ecol. Scattered in Mixed Dipterocarp forest on undulating land and low hills.

Vern. *Mèrsawa merah*, *m. api*, *sèpah petri* (Malaya); *beurmen* (Sumatra, Atjeh).

6. *Anisoptera reticulata* ASHTON, Gard. Bull. Sing. 22 (1967) 260, pl. 1; Man. Dipt. Brun. Suppl. (1968) 5, f. 1.

Leaf, buds, and twig fugaceous golden puberulent. *Twig* c. 2 mm \emptyset apically, terete, rugulose, dark chocolate-brown; internodes c. 1.5 cm long; stipule scar short, horizontal. *Leaf bud* 2 by 2 mm, ovoid, subacute. *Stipule* unknown. *Leaf* 4.5–13 by 2.2–5.5 cm, elliptic-obovate, coriaceous; base broadly cuneate; apex tapering abruptly to a c. 5 mm long, short acumen; nerves 9–14 pairs, prominent beneath, arched, at 50°–55°; tertiary nerves subreticulate; midrib applanate or somewhat depressed above, prominent beneath. *Petiole* 15–35 mm long, c. 2 mm \emptyset , terete, prominently geniculate and swollen distally, drying black. *Panicle* to 6 cm long, 2 mm \emptyset at base (in fruit); terminal or axillary, short, terete, \pm persistently golden pubescent, singly branched. *Bud* to 8 by 3 mm, fusiform. *Calyx* lobes narrowly deltoid, unequal, valvate. *Petals* cream, lorate, pubescent on parts exposed in bud. *Stamens* c. 35, subequal; filaments short, compressed; anthers oblong, attenuate; appendage to connective filiform. *Stylopodium* oblong, obtuse, pubescent. *Fruit pedicel* 4 mm long, c. 3 mm \emptyset , stout, prominent. *Calyx* sparsely caducous golden pubescent; tube to 2 cm \emptyset , subglobose; 2 longer calyx lobes to 13 by 3 cm, lorate-spatulate, obtuse, tapering to c. 9 mm broad above the tube; 3 shorter lobes to 20 by 3 mm, linear-lanceolate, acute. *Nut apex* densely persistently yellow-brown pubescent, crowned by a c. 4 mm long, 3 mm \emptyset , oblong obtuse pubescent stylopodium.

Distr. *Malesia*: Borneo (N.E. Sarawak, Brunei, S.W. Sabah).

Ecol. Rare, Mixed Dipterocarp forests on sandy soils.

7. *Anisoptera thurifera* (BLCO) BL. Mus. Bot. Lugd.-Bat. 2 (1852) 42; WALP. Ann. 4 (1857) 336; DC. Prod. 16, 2 (1868) 615; VIDAL, Sinopsis (1883) t. 14, f. E; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 44, t. 2, f. 28; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 258; MERR. & ROLFE, Philip. J. Sc. 3 (1908) Bot. 115; MERRITT, For. Bur. Bull. Philip. 8 (1908) 48; WHITFORD, Philip. J. Sc. 4 (1910) Bot. 703; For. Bur. Bull. Philip. 10 (1911) 78; FOXW. Philip. J. Sc. 6 (1911) Bot. 256; *ibid.* 13 (1918) Bot. 181; *ibid.* 67 (1938) 267; MERR. Sp. Blanc. (1918) 269; En. Philip. 3 (1923) 92; REYES, Philip. J. Sc. 22 (1923) 323; SLOOT. Bull. Jard.

Bot. Btzg III, 8 (1926) 4; SYM. Gard. Bull. S. S. 8 (1934) 6, pl. 4C; ASHTON, Gard. Bull. Sing. 31 (1978) 15. — *Mocanera thurifera* BLCO, Fl. Filip. ed. 1 (1837) 446. — *Dipterocarpus thurifer* BLCO, Fl. Filip. ed. 2 (1845) 310; *ibid.* ed. 3, 2 (1878) 212, t. 264; DC. Prod. 16, 2 (1868) 614. — **Fig. 27B–B4, 31.**

Notes. *A. thurifera* is now seen to be the eastern analogue of *A. costata*, with a distribution — if sterile collections from Celebes and the Moluccas are included — from northern Luzon throughout the Philippines to Celebes, the Moluccas and New Guinea. In the Philippines geographically defined variation occurs and a separate species has evolved within the aseasonal parts of its range. In New Guinea local variation is great and collections are presently inadequate to define geographical forms.

It is interesting that the species is known in both the Philippines and New Guinea to be the only dipterocarp which readily reinvasades cultivated land.

I recognize the Philippine and New Guinea populations as geographical subspecies.

KEY TO THE SUBSPECIES

1. Leaves oblanceolate to lanceolate, prominently acuminate. Stamens 35–47 . . . **a. ssp. thurifera**
1. Leaves obovate. Stamens 37–57 . . . **b. ssp. polyandra**

a. ssp. thurifera. — *Mocanera thurifera* BLCO, Fl. Filip. ed. 1 (1837) 446. — *Mocanera mayapis* BLCO, l.c. 449. — *Dipterocarpus thurifer* BLCO, Fl. Filip. ed. 2 (1845) 310. — *Dipterocarpus mayapis* BLCO, Fl. Filip. ed. 2 (1845) 313; DC. Prod. 16, 2 (1868) 610; DYER, J. Bot. 12 (1874) 108; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 40; MERR. Publ. Gov. Lab. Philip. 27 (1905) 21. — *Antherotriche lanceolata* TURCZ. Bull. Soc. Nat. Mosc. 2 (1846) 515; WALP. Ann. 1 (1848) 113. — *A. lanceolata* WALP. Ann. 1 (1848) 113; DC. Prod. 16, 2 (1868) 616; VIDAL, Phan. Cuming. (1885) 97; F.-VILL. Nov. App. (1880) 20; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 263, fig.; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 259, t. 112. — *Shorea mayapis* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 33; WALP. Ann. 4 (1857) 338; DC. Prod. 16, 2 (1868) 632. — *A. oblonga* (non DYER) F.-VILL. Nov. App. (1880) 20; VIDAL, Rev. Fl. Vasc. Filip. (1886) 60. — *Dipterocarpus turbinatus* (non GAERTN. f.) F.-VILL. Nov. App. (1880) 20. — *A. vidualiana* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 44; PERK. Fragm. Fl. Philip. (1904) 23; MERR. Philip. J. Sc. 1 (1906) Suppl. 97. — *A. tomentosa* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 45. — *A. calophylla* PERK. Fragm. Fl. Philip. (1904) 22. — *A. brunnea* FOXW. Philip. J. Sc. 6 (1911) Bot. 254, pl. 40; *ibid.* 13 (1918) Bot. 181; *ibid.* 67 (1938) 270; MERR. En. Philip. 3 (1923) 92.

Tall or medium-sized, buttressed tree. Twigs, leaf buds, stipules, petioles and leaves beneath \pm densely persistently grey-green or pale to chocolate-brown lepidote; panicles, flower calyx and ovary densely grey-brown puberulent; panicle and calyx becoming

sparse or glabrescent in fruit. *Twig* c. 3 mm \varnothing apically, terete, rugulose, pale brown. *Leaf bud* to 4 by 2 mm, lanceolate; *stipules* to 8 mm long, linear. *Leaves* 6–15 by 2.5–6.5 cm, thinly coriaceous, elliptic to lanceolate or obovate-oblongate, \pm coriaceous; base broadly cuneate or obtuse; acumen to 1.3 cm long, slender, down-curved and twisting over on pressing; nerves (12–)14–18(–20) pairs, slender but distinctly elevated beneath, less so above (as also the reticulate tertiary nerves), arched, at 55°–80°, with or without short secondary nerves; midrib prominent beneath, obscure, depressed, above; *petiole* 1.7–3.5 cm long, slender. *Panicles* to 20 cm long, terminal or subterminal axillary, lax, pendent; singly branched, branchlets bearing to 11 flowers. *Flower buds* to 9 by 3 mm, lanceolate. *Sepals* narrowly deltoid; 2 longer subacute, 3 shorter prominently acuminate. *Stamens* 45–47, subequal; filaments short, slender, filiform; anthers narrowly oblong, somewhat tapering; appendages very slender, \pm twice length of anthers. *Stylopodium* narrowly ellipsoid-cylindrical, puberulent distally, with prominent trifid style. *Fruit pedicel* to 3 mm long, short. *Calyx tube* to 17 mm \varnothing , globose; 2 longer lobes to 15 by 1.5 cm, spatulate, narrowly obtuse, c. 4 mm wide at base; 3 shorter lobes to 30 by 3 mm, linear. *Stylopodium* short, conical.

Distr. *Malesia*: Philippines.

Ecol. Evergreen and Semi-evergreen Dipterocarp forests below 750 m; common and often gregarious, regenerating in secondary forest.

Vern. *Mayapis*, *palosapis*, *palohapi*, *dagang*, *afu*.

b. ssp. polyandra (BL.) ASHTON, Gard. Bull. Sing. 31 (1978) 16. — *A. polyandra* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 42, t. 6; WALP. Ann. 4 (1857) 335; MIQ. Fl. Ind. Bat. 1, 2 (1859) 501; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 84; DC. Prod. 16, 2 (1868) 615; SCHEFF. Ann. Jard. Bot. Btzg 1 (1876) 9; F.v.M. Descr. Not. App. 6 (1887) 97; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 220; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 45; DIELS, Bot. Jahrb. 57 (1922) 461; LANE-POOLE, For. Res. (1925) 22, 33, 119, 167; SLOOT, Nova Guinea 14 (1926) 222; Bull. Jard. Bot. Btzg III, 8 (1926) 15; Reinwardtia 2 (1952) 11, f. 2; WHITE & FRANCIS, Proc. R. Soc. Queensl. 38 (1927) 247. — *Dipterocarpus parviflora* ZIPP. Flora 12 (1829) 281; Alg. Konst- & Letterbode 1, 19 (1829) 296; Bijdr. Natuurk. Wet. 5 (1837) 178; MIQ. Fl. Ind. Bat. 1, 2 (1859) 501, *nomen*. — *Dipterocarpus microcarpus* ZIPP. ex MIQ. Fl. Ind. Bat. 1, 2 (1859) 501, *nomen in syn.* — *Anisoptera* sp. DYER, J. Bot. 16 (1878) 99; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 221; BRANDIS, J. Linn. Soc. Bot. 3 (1895) 45; DIELS, Bot. Jahrb. 57 (1922) 461. — *A. forbesii* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 45; DIELS, Bot. Jahrb. 57 (1922) 491; BAKER f. J. Bot. 61, Suppl. (1923) 5. — *A. kostermansiana* DILMY, Reinwardtia 3 (1956) 347; *ibid.* 5 (1960) 267.

Differing as follows: *Leaves* 8.5–18 by 3.5–8.5 cm, elliptic to obovate, \pm coriaceous; base cuneate, obtuse or cordate; apex shortly acuminate; nerves (10–)12–14(–17) pairs, slender but distinctly elevated

on both surfaces. *Stamens* 37–57. *Fruit pedicel* to 4 by 2 mm, prominent; 2 longer calyx lobes to 7 by 0.6 cm; 2 shorter lobes to 7 by 0.6 cm.

Distr. *Malesia*: New Guinea, and possibly (sterile material) from Celebes and Moluccas (Morotai, Halmahera, Batjan, Obi and Aru Is.).

Ecol. Common, often gregarious, in lowland forest on undulating land and hills to 600 m, especially on sedimentary rocks and along ridges; regenerates profusely in secondary forest.

Vern. *Baotti*, *tolu* (Celebes), *bolam*, *kora*, *hate besi* (Morotai), *kara*, *hirus*, *kopodaka*, *owiru*, *kako* (Halmahera), *damar utan*, *d. hiru*, *asamban*, *gawi*, *wewe pérémpuan* (Batjan), *kora* (Obi), *jamar*, *doka* (Aru), *aran marei*, *wuku*, *taire*, *damar papan*, *taai*, *baurai*, *maniuri*, *armanuri*, *kansiopi*, *ansiopi*, *merait*, *landau*, *karalaka*, *garawa*, *karawa*, *warawa*, *balia*, *ordima*, *barida* (New Guinea).

Note. This species is extremely variable, paralleling *A. costata* (q.v.). The range of variation in tomentum is comparable in both species.

8. Anisoptera aurea FOXW. Philip. J. Sc. 67 (1938) 271, pl. 1–2. — *A. curtisii* (non DYER ex KING) FOXW. Philip. J. Sc. 6 (1911) Bot. 255, pl. 41; *ibid.* 13 (1918) Bot. 181; WHITFORD, Bull. Bur. For. Philip. 10 (1911) 78; MERR. En. Philip. 3 (1923) 92; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1926) 11; SYM. Gard. Bull. S. S. 8 (1934) 17.

Large tree with pale shaggy flaky bark. Leaf undersurface densely golden lepidote; nerves and midrib beneath, leaf buds, petiole, twigs and ovary densely persistently pale brown puberulent; panicles and fruit calyx sparsely so; parts of petals exposed in bud densely greyish puberulent. *Twigs* c. 3 mm \varnothing , becoming terete, pale brown, rugulose. *Leaf buds* to 4 by 2 mm, lanceolate, acute; *stipules* not seen. *Leaves* 7–11 by 2.5–5.5 cm, oblong or oblanceolate, thinly coriaceous; base cuneate or sometimes obtuse; acumen to 1 cm long, slender, prominent, down-curved and bending over on pressing; nerves (15–)18–20 pairs, slender but distinctly elevated beneath, less so but distinct above, at 65°–80°; secondary nerves obscure or absent; tertiary nerves densely reticulate, evident on both surfaces; midrib slender but prominent beneath, obscure, deeply depressed, above; petioles 15–27 mm long, slender, prominently geniculate. *Panicles* to 12 cm long, slender, lax, pendent, terminal or axillary, singly (if axillary) or doubly branched; branchlets to 15 mm long, bearing to 3 flowers. *Flower buds* to 6 by 3 mm. *Sepals* narrowly deltoid, 2 longer subacute, 3 shorter prominently acuminate; *stamens* 35–38, subequal; filaments \pm equal to the oblong somewhat tapering anthers, filiform; appendage very slender, c. $1\frac{1}{2}$ times as long as anthers; *stylopodium* broadly ellipsoid-cylindrical, densely golden stellate-puberulent, crowned by the prominently trifid acute style. *Fruit pedicel* to 4 mm long, slender; *calyx tube* to 7 mm \varnothing subglobose; 2 longer lobes to 10 by 1.5 cm, narrowly spatulate, narrowly obtuse, c. 3 mm wide at base; 3

shorter lobes to 12 by 2 mm, linear; *stylopodium* cylindrical, tapering, subacute.

Distr. *Malesia*: Philippines (Luzon: Quezon; Camarines: Polillo).

Ecol. Mixed Dipterocarp forest, especially on ridges to 200 m, in everwet zone.

Vern. *Dugong*, *manapo*, *malahapi*, *dagong* (Laguna).

2. Section *Glabrae*

HEIM, Rech. Dipt. (1892) 33; SYM. Gard. Bull. S. S. 8 (1934) 1; Mal. For. Rec. 16 (1943) 199; ASHTON, Gard. Bull. Sing. 20 (1963) 232; Man. Dipt. Brun. (1963) 10. — *Scaphula* PARKER in Fedde, Rep. 3 (1932) 326. — *Hopeoides* CRETZOIU, J. Jap. Bot. 17 (1941) 408.

Young leaves and twigs epilose. Flower buds globose; anthers linear; appendage to connective less than $\frac{1}{2}$ length of anther, stout; *stylopodium* a flattened discoid platform surmounting the ovary; style filiform, long, with distinct trifid stigma.

9. *Anisoptera scaphula* (ROXB.) KURZ, Fl. Burma 1 (1877) 547, 2 (1877) 586; PIERRE, Fl. For. Coch. 3 (1889) sub t. 235; SYM. Gard. Bull. S. S. 8 (1934) 2, 4, pl. 1; Mal. For. Rec. 16 (1943) 209, f. 101, 104. — *Hopea scaphula* ROXB. [Hort. Beng. (1814) 93, *nomen*] Fl. Ind. ed. Carey 2 (1932) 611; WALP. Rep. 5 (1845) 128; DC. Prod. 16, 2 (1868) 635; KURZ, Prelim. Rep. For. Pegu (1875) App. A, 19, App. B, 29; Fl. Burma 1 (1877) 121, 547. — *A. glabra* KURZ, J. R. As. Soc. Beng. Sc. 52, 2 (1873) 61; Prelim. Rep. For. Pegu (1875) App. A, 16, App. B, 29; Fl. Burma 1 (1877) 112; DYER, Fl. Br. Ind. 1 (1874) 301; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 41; Ind. Trees (1906) 67, t. 29; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 368. — *Vatica scaphula* DYER, Fl. Br. Ind. 1 (1874) 301; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 127; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 132; Ind. Trees (1906) 72; GAMBLE, Man. Ind. Timbers (1922) 84. — *A. thurifera* (non BL.) RIDL. Fl. Mal. Pen. 1 (1922) 219; FOXW. J. Mal. Br. R. As. Soc. 5 (1927) 341, p.p.; Mal. For. Rec. 3 (1927) 78, p.p.; *ibid.* 10 (1932) 100. — *Scaphula glabra* PARKER in Fedde, Rep. 30 (1932) 326; CRETZOIU, Act. Faun. Flor. Univ. Bot. 1, 9 (1933) 3; PARKINSON, Ind. For. Rec. 20, 15 (1935) 11. — *Hopeoides scaphula* CRETZOIU, J. Jap. Bot. 17 (1941) 408.

Very tall buttressed tree. Parts glabrous but for the greyish green lepidote leaf undersurface and young parts. *Twig* c. 2 mm \varnothing apically, slender, pale grey-brown, terete. *Buds* to 2 by 2 mm, small, acute; *stipules* to 20 by 3 mm, linear, acute. *Leaf* 8–16 by 3.5–8 cm, oblong-lanceolate to oblanceolate, somewhat chartaceous; base broadly cuneate to subcordate; acumen to 1 cm long, tapering; nerves 13–18 pairs, very slender, arched, ascending, elevated on both surfaces as also the very slender subreticulate tertiaries, with a few short secondary nerves; midrib slender but prominent, terete, beneath, channelled above; *petiole* 12–32 mm long, slender. *Panicle* to 9 cm long, terminal or axillary. *Flower* white; *buds* to 6 by 5 mm, broadly ovoid. 2 longer *sepals* lorate-lanceolate, subacute; 3 shorter *sepals* very short, deltoid, prominently slender acuminate. *Petals* broadly ovate, glabrous. *Stamens* 15; filaments lorate, tapering, c. $\frac{1}{2}$ length of the slightly

tapering lorate anthers; appendages very short, acicular. *Stylopodium* absent; style prominent, columnar, glabrous, with obscurely trifid apex. *Fruit pedicel* to 3 by 2 mm, prominent. *Calyx* tube to 1.5 mm \varnothing , subglobose; 2 longer lobes to 15 by 3 cm, spatulate, obtuse, c. 4 mm broad at base; 3 shorter lobes to 13 by 3 mm, linear-lanceolate.

Distr. Southern Indochina, Bangladesh (Chittagong), Burma, Peninsular Thailand, and in *Malesia*: Malaya (north of Negri Sembilan and Pahang).

Ecol. Semi-evergreen and Evergreen Dipterocarp forests on undulating land and the lower parts of valleys.

Vern. *Mérsawa gajah*, *sanai*, *těrbak*, *mědang sawa*, *kijal* (Malaya).

10. *Anisoptera laevis* RIDL. Fl. Mal. Pen. 1 (1922) 219; FOXW. Mal. For. Rec. 10 (1932) 101; SYM. Gard. Bull. S. S. 8 (1934) 7, pl. 2; Mal. For. Rec. 16 (1943) 205, f. 100C, 101, 102; ASHTON, Gard. Bull. Sing. 20 (1963) 233; Man. Dipt. Brun. (1964) 13, f. 5, pl. 5 (stem); *ibid.* Suppl. (1968) 5; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 298, f. 51. — *Anisoptera sp.* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 41 (sub *A. glabra*). — *A. glabra* (non KURZ) RIDL. Agr. Bull. Str. & F. M. S. 1 (1901) 60; J. Str. Br. R. As. Soc. 54 (1910) 25. — *A. thurifera* (non BL.) FOXW. Philip. J. Sc. 6 (1911) Bot. 257, p.p., *quoad sp. Mal.*; J. Mal. Br. R. As. Soc. 5 (1927) 341, p.p.; Mal. For. Rec. 3 (1927) 78, p.p. — *A. mindanensis* (non FOXW.) WYATT-SMITH, Mal. For. 18 (1955) 77, p.p. — Fig. 27C–C4.

Bud and twig apex \pm densely pale brown to rust lepidote at first, becoming glabrous. *Young twig* c. 1.5 mm \varnothing , slender, terete, becoming rugose on drying; later smooth or minutely striated. *Bud* 3–7 by 2 mm, compressed, hastate to ovate, acute. *Stipule* c. 10 by 3 mm, glabrous, hastate to linear. *Leaves* 7–11 by 3–4 cm, oblong to \pm obovate, not bullate, epilose, rust-brown lepidote beneath; base obtuse or broadly cuneate; acumen to 1 cm long; nerves 10–14 pairs, at 50°–60°, slender, curved; *petiole* 1.5–2 cm long. *Panicle* to 12 cm long, terminal or axillary, lax, pendent, angular, slender, densely shortly pale brown puber-



Fig. 32. *Upuna borneensis* SYM., *upun batu*, habit, about 40 m tall. Brunei, Labi Road (Photogr. ASHTON).

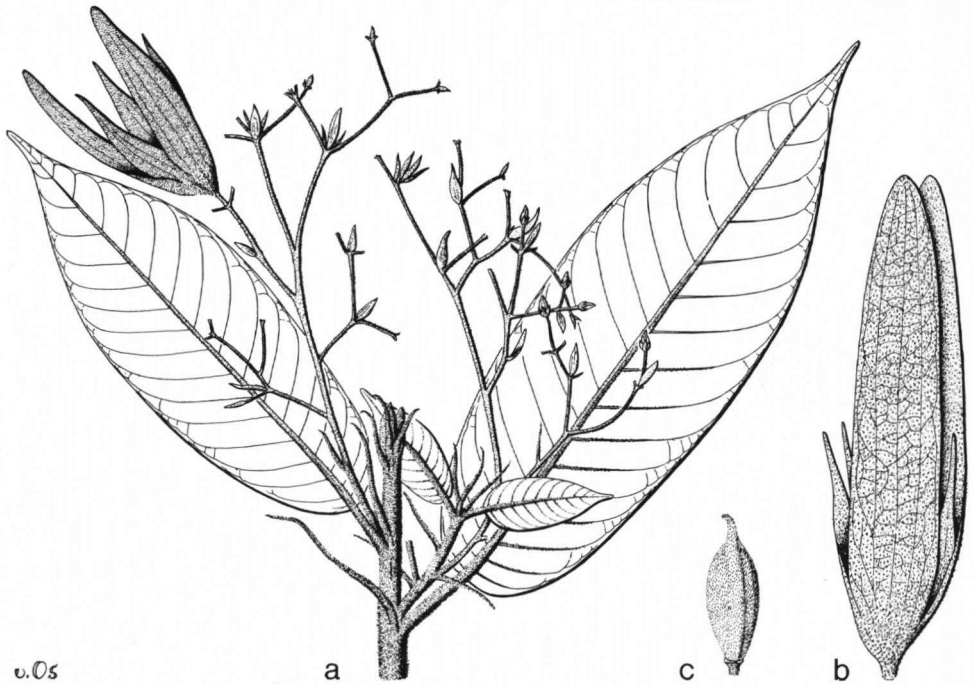


Fig. 33. *Upuna borneensis* SYM. a. Apex of flowering twig, b. fruit, c. nut, all $\times \frac{1}{2}$ (SAN 15184).

lent to glabrous; alternately doubly branched, branchlets short, bearing to 11 flowers; *bracteoles* to 2.5 mm long, lanceolate, shortly pubescent. *Bud* to 2 mm long, subglobose. *Calyx* cupped at base; sepals subequal, valvate, shortly grey-brown puberulent outside; 2 longer lobes slightly broader, obtuse, 3 shorter acute, acuminate. *Petals* small, elliptic-oblong, glabrous, pale yellow. *Stamens* 15, subequal, as long as or slightly longer than the style; filaments short, tapering to the anther; anther narrowly oblong, the inner cells smaller than the outer; appendage to connective short, erect. *Ovary* encased in the base of the calyx, covered by a discoid stylopodium, crowned by a filiform

glabrous style; stigma 3-lobed. *Fruit calyx* glabrous at maturity; tube 1.2–1.5 cm \varnothing , globose, to 8 mm \varnothing at the neck; 2 longer lobes to 15 by 1.5 cm, spatulate, obtuse, c. 5 mm broad at base; 3 short lobes to 1.5 cm long, c. 3 mm broad at base, hastate to linear, margin slightly revolute. *Nut apex* disc-like, shortly pubescent, flat; style remnant 5–8 mm long, filiform, very slender.

Distr. Malesia: Malaya, Borneo (Sarawak, Brunei, S.W. Sabah).

Ecol. Inland lowland and hill forests to 900 m; widespread and often common.

Vern. *Měrsawa durian*, *mědang sawa*, *madang loh* (Mal.), *pěngiran durian* (Sabah).

3. UPUNA

SYM. Bull. Jard. Bot. Btzig III, 17 (1941) 88, pl. I–II, f. I–II. — Fig. 32–36.

Large, flaky-barked trees. *Buttresses* low, broad, rounded, single or grouped in twos to fours round the base of the bole. Young parts caducous, inflorescence persistently multicellular glandular tomentose. *Stipule* subulate, subpersistent. *Inflorescence* cymose. *Flower sepals* subequal, imbricate, fused at the base to form a shallow cup free from the ovary. *Stamens* 25–30; filaments compressed, dilated at base, tapering and filiform below the anthers; anthers oblong to ovoid, latrorse; appendage to connective filiform, many times length of anthers. *Ovary* ovoid, without distinct stylopodium; style about twice as long as ovary, trifid towards

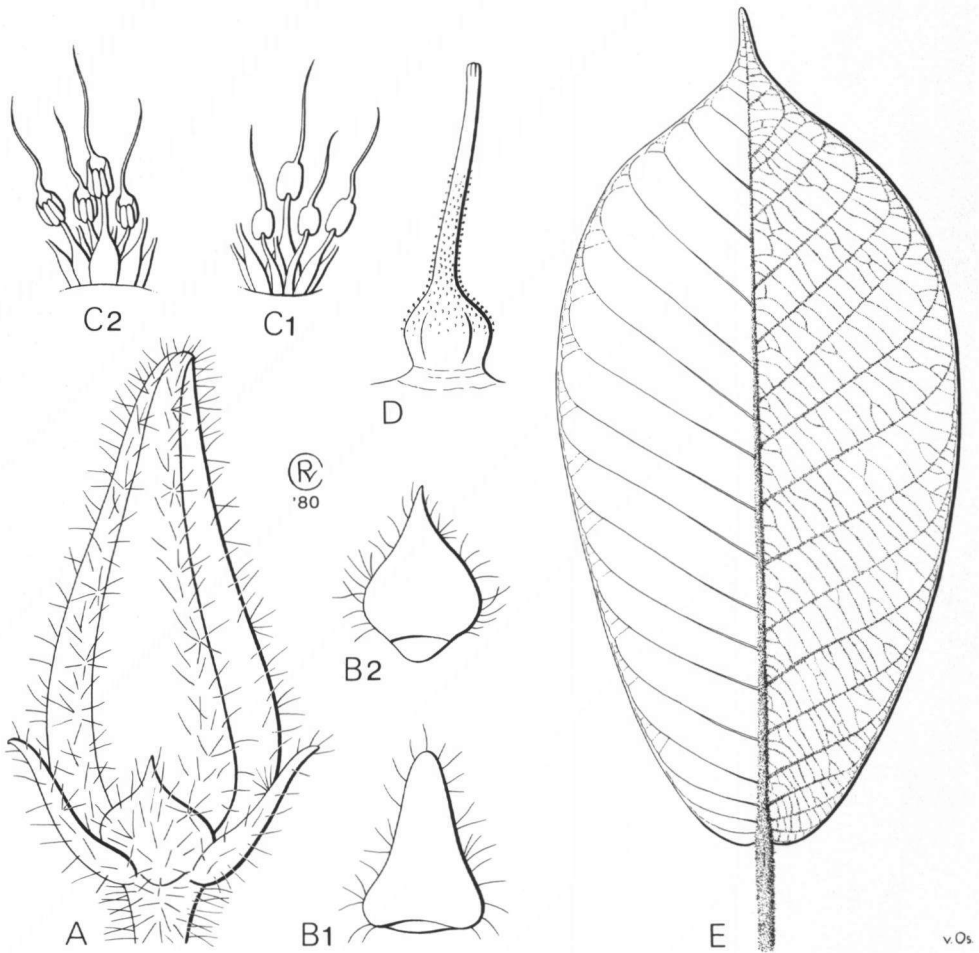


Fig. 34. *Upuna borneensis* SYM. — Flower details: *A*. bud, *B1*. outer sepal, *B2*. inner sepal, both from inside, *C1*. stamens from outside, *C2*. Stamens from inside, *D*. pistil, all $\times 10$. — *E*. Leaf from sterile twig, $\times \frac{1}{2}$ (*A–D* BRUN 3091, *E* SINCLAIR & KADIM 10292).

apex; stigma minute. *Fruit calyx* with a distinct basal cup enclosing but not fused with the nut; lobes valvate, chartaceous, 2 considerably longer than the other 3. *Nut* ellipsoid, 3-angled, splitting into 3 valves at germination, with short acute apical style remnant, tapering and narrow at base. *Seed* with distinct arillode. *Germination* epigeal; cotyledons subequal, cordate.

Distr. Malesia: Borneo. Monotypic.

Note. The only diptercarpoid genus not recorded from the present or past of S.E. Asia including Ceylon. An isolated and in many ways primitive taxon, with leaves and twigs superficially resembling *Monotes*, dehiscent pericarp and cymose inflorescence as in some *Vatica*, a rudimentary aril-like collar on the funicle resembling that in *Stemonoporus*, androecium somewhat as in *Anisoptera* and gynoecium somewhat as in *Cotylelobium*, though the gynoecium and androecium characters together are unique among those genera which share a valvate fruit calyx. The wood anatomy, notably the diffuse distribution of intercellular canals, supports its affinity with the last four genera.



Fig. 35. Trunk-base of *Upuna borneensis* SYM., same place as fig. 32 (Photogr. ASHTON).

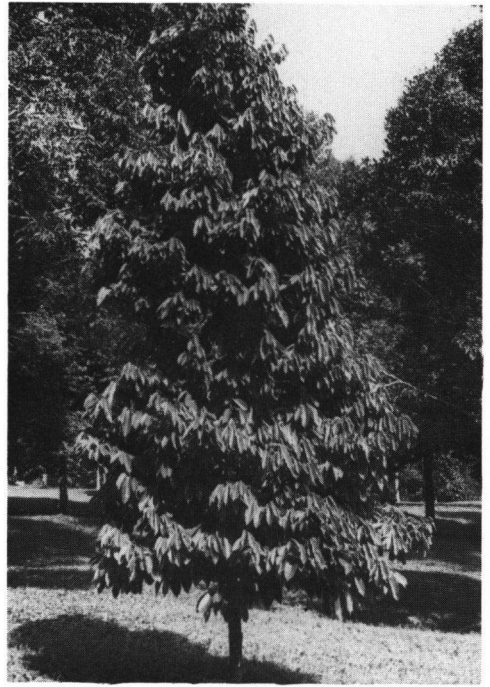


Fig. 36. Young, conical tree of *Upuna borneensis* SYM. Forest Research Institute, Kepong, cultivated (Photogr. HENDERSON).

1. *Upuna borneensis* SYM. Bull. Bot. Gard. Btsg III, 17 (1941) 88, pl. I-II, f. I-II; BROWNE, For. Trees Sarawak & Brunei (1955) 171; ASHTON, Man. Dipt. Brun. (1964) 7, f. 4, pl. 2 (habit); *ibid.* Suppl. (1968) 3; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 327. — Fig. 32–36.

Young parts caducous multicellular glandular tomentose; twig apices, cyme, leaf bud, stipule, petiole and leaf nervation beneath densely persistently pale chocolate-brown tomentose; lamina surface beneath white tomentose. Twig to 3.5 mm \varnothing apically, terete, becoming glabrous, smooth to rugulose, uneven; much branched; stipule scars small to obscure. Bud to

12 by 6 mm, ovoid to falcate, subacute. Stipules to 1.2 cm long, linear. Leaves 9–17 by 4–9.5 cm, oblong to obovate; base cordate, acuminate to 5 mm long, deltoid; margin revolute; nerves 16–20 pairs, well spaced, curved at the margin, raised beneath, at 60°–70° except at base, frequently with short secondary nerves; tertiary nerves well spaced, scalariform, distinct; midrib prominent, terete beneath, depressed above; petiole 1–2.5 cm long, geniculate. Cyme to 15 cm long, to 3-axillary, subterete, much branched; bracts to 10 by 3.5 mm, lanceolate, acute, sparsely tomentose, caducous. Flower bud to 5 by 2 mm, narrowly ovoid, conical, acute. Calyx lobes densely tomentose outside, glabrescent within, fused at base forming a cup free from the ovary, imbricate; subequal, 2 inner slightly more attenuate, obtuse, subacuminate; 3 outer acute, acuminate. Corolla deep purple, dark yellow at margins, fading to pale red on falling; petals broadly ovate, subacute, becoming reflexed apically, sparsely tomentose on parts exposed in bud. Stamens 25–30 in several verticils; filaments broad at base, tapering abruptly and filiform below the subglobose anthers; appendage to connective c. 3 times length of anther, slender, curved. Ovary ovoid, densely tomentose; style c. 3 times as long as ovary,

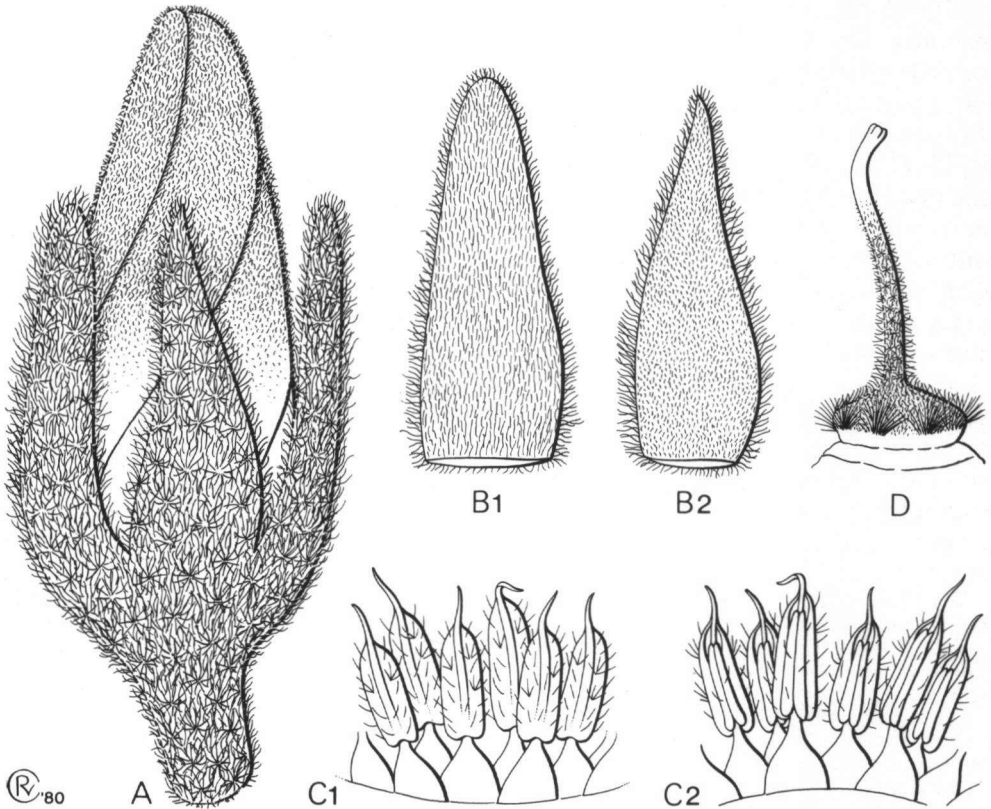


Fig. 37. Flower details in *Cotylelobium melanoxyton* (HOOK. f.) PIERRE. A. Bud, B1. outer sepal, B2. inner sepal, both from inside, C1. stamens from outside, C2. stamens from inside, D. pistil, all $\times 10$ (S 26853).

shortly pubescent in basal half, otherwise glabrous, sometimes trifurcate at apex. *Fruit calyx* sparsely ashen tomentose; base narrowly cuneate, the lobes united into a to 1 cm deep and wide cup; 2 longer lobes to 13 by 2.7 cm, lanceolate, tapering gradually to the subacute apex, constricted to 7 mm broad at base; 3 shorter lobes to 7.5 by 1.7 cm, similarly shaped, subequal. *Nut* to 3.2 by 1.5 cm, narrowly ovoid,

densely fulvous tomentose, tapering to a to 5 mm long slender style remnant, acute.

Distr. Malesia: Borneo (S. & W. Kalimantan, E. Kutei F. R.; Sarawak, Brunei, S.W. Sabah).

Ecol. Deep sandy soil in lowland Mixed Dipterocarp forests, subcoastal hills.

Uses. Heavy construction timber.

Vern. *Pënyau, upun batu.*

4. COTYLELOBIUM

PIERRE, *Fl. For. Coch.* 3 (1889) *sub t.* 235; HEIM, *Rech. Dipt.* (1892) 119; BRANDIS, *J. Linn. Soc. Bot.* 31 (1895) 114; SLOOT, *Bull. Jard. Bot. Btzg III*, 10 (1929) 393; *ibid.* III, 12 (1932) 43; SYM. *Mal. For. Rec.* 16 (1943) 232, f. 111 (map); ASHTON, *Man. Dipt. Brun.* (1964) 56; *ibid.* *Suppl.* (1968) 24; MEIJER & WOOD, *Sabah For. Rec.* 5 (1964) 323; ASHTON, *Blumea* 20 (1972) 358; SMITINAND, *Thai For. Bull. (Bot.)* 12 (1980) 23. — *Dyerella* HEIM, *Rech. Dipt.* (1892) 123. — Fig. 37–40.

Small, medium-sized or large trees; bole frequently twisted; buttresses low, rounded, similar to those of *Vatica*. *Crown* hemispherical, rather small. *Bark surface* greyish, at first smooth, hoop marked; becoming irregularly, frequently shaggy, flaky, leaving a distinct scroll-marked surface below. *Stipules* fugaceous. *Leaves* oblong to ovate-lanceolate, coriaceous, margin revolute, undersurface lepidote; nerves curved, unraised above, hardly so beneath, bifurcating towards the margin and anastomosing to form a looped intramarginal nerve, with shorter indistinct intermediate nerves similarly bifurcating; tertiary nerves reticulate, indistinct; midrib sunken above; *petiole* comparatively short, not geniculate. *Calyx lobes* imbricate in flower; 2 obtuse outer lobes somewhat larger than 3 acute inner lobes. *Petals* free, broad, elliptic-oblong, cream or pink. *Stamens* 15, subequal, in 3 whorls, hence pairs alternating with single stamens; filaments short, deltoid, connate at base; anthers narrowly oblong, latrorse, with 4 pollen sacs, the inner 2 shorter than the outer 2, setose along the lateral margins; appendage to connective short, slender. *Ovary* free from calyx, \pm globose; stylopodium indistinct; style filiform, slender, many times longer than ovary, shortly pubescent towards base; stigma small, trifid, slightly broader than style. *Fruit* as in *sect. Sunaptea* of *Vatica*; calyx free from nut, with distinct filiform style remnant.

Distr. 6 *spp.*, Ceylon, Peninsular Thailand; in *Malesia*: 3 *spp.*, in Malaya, E. Sumatra, Lingga, Anambas Is. and Borneo. Fig. 38.

Ecol. Main canopy trees of dry acid soils, especially on coastal hills, but also on rentzinas over limestone and mountain ridges inland to 1500 m; sometimes semi-gregarious.

Uses. A hard durable timber similar to that of *Vatica* is produced, but the trees are generally larger.

Note. The perianth and range of fruit variation strikingly resemble that of *Vatica*, and the wood anatomy underlines this affinity; but the androecium, gynoecium and leaf nervation are quite distinct from that genus. The Malesian species differ only in characters of the tomentum, and minor details of leaf shape and nervation; they are variable and at times difficult to identify with certainty; the possibility of occasional hybridisation cannot be ruled out.

KEY TO THE SPECIES

1. Leaf glabrescent, drying dull olive-brown 1. *C. melanoxyylon*
1. Leaf densely tomentose beneath.
2. Leaf 8-12 by 3-4.5 cm, oblong-lanceolate, drying dull olive-brown above, densely shortly even rich yellow-ochre tomentose beneath, with darker midrib and petiole; intramarginal nerve close to margin 2. *C. burckii*
2. Leaf 6-8 by 2.2-3 cm, ovate-lanceolate, drying dark grey-brown above, densely dark grey scabrid tomentose beneath with darker midrib and petiole; intramarginal nerve well within margin 3. *C. lanceolatum*

1. *Cotylelobium melanoxyylon* (HOOK. f.) PIERRE, Fl. For. Coch. 3 (1889) t. 235; HEIM, Rech. Dipt. (1892) 119, 120; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 268; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 115; MERR. En. Born. (1921) 408; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 78; *ibid.* 10 (1929) 403; *ibid.* 12 (1932) 44; SYM. Mal. For. Rec. 16 (1943) 236, f. 114; BROWNE, For. Trees Sarawak & Brunei (1955) 96; ASHTON, Man. Dipt. Brun. (1964) 59, f. 9; *ibid.* Suppl. (1968) 24, pl. 5 (bark); MEIJER & WOOD, Sabah For. Rec. 5 (1964) 324, f. 59. — *Anisoptera melanoxyylon* HOOK. f. Trans. Linn. Soc. 23 (1860) 160; DC. Prod. 16, 2 (1868) 616; WALP. Ann. 7 (1869) 378; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 221. — *Vatica melano-*

xyylon BENTH. & HOOK. f. ex MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 956, *incl. var. recta*. — *Vatica beccariana* HEIM, l.c. 955. — *Vatica harmandii* HEIM, l.c. 955. — *C. beccarii* PIERRE, Fl. For. Coch. 4 (1891) t. 258B; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 116; BECC. For. Born. (1902) 570, 591; MERR. En. Born. (1921) 408; BROWNE, For. Trees Sarawak & Brunei (1955) 95. — *C. harmandii* HEIM, Rech. Dipt. (1892) 122; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 115; MERR. En. Born. (1921) 408; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 78; *ibid.* 10 (1929) 405; BROWNE, For. Trees Sarawak & Brunei (1955) 95. — *C. beccarianum* HEIM, Rech. Dipt. (1892) 122; SLOOT. Bull. Jard. Bot. Btzg

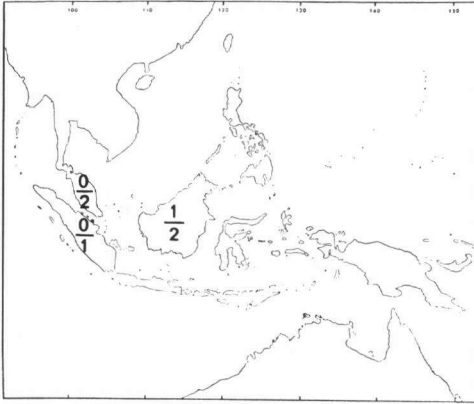


Fig. 38. Density map of *Cotylelobium* PIERRE in Malesia; number of endemics above the hyphen, number of non-endemics below it.

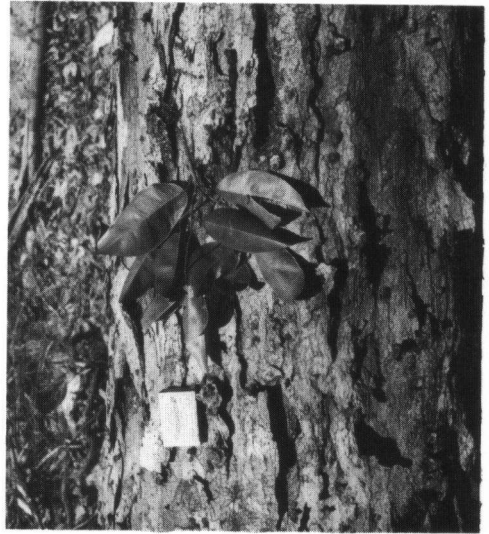


Fig. 39. Close-up of bark and leaves of *Cotylelobium melanoxyylon* (HOOK. f.) PIERRE. Brunei (Photogr. G. H. S. WOOD, SAN 17547).

III, 9 (1927) 78; *ibid.* 10 (1929) 405. — *C. leucocarpum* SLOOT. [Bull. Jard. Bot. Btzg III, 9 (1927) 78, *nomen*] *ibid.* III, 10 (1929) 399, f. 2. — *Vatica leucocarpa* FOXW. ex DEN BERGER & ENDERT, Med. Proefst. Boschw. 11 (1925) 130; ex HEYNE, Nutt. Pl. ed. 2 (1927) 1129. — Fig. 37, 39.

Young leaves, twig, stipules outside, bud and raceme densely shortly powdery grey tomentose, fugaceous on leaf and midrib, \pm so on twigs, persistent on racemes. *Twig* to 1 mm \varnothing apically, terete, slender, minutely striated with fine cracks; stipule scars obscure. *Bud* c. 1.5 by 1 mm, ovoid, acute. *Stipules* to 3 mm long, small, linear, caducous. *Leaves* 5–10 by 2–6 cm, ovate-lanceolate, oblong or obovate; base broadly cuneate or obtuse; acumens to 8 mm; margin \pm revolute; nerves 10–13 pairs, slender, hardly raised beneath, with more slender shorter parallel intermediates; intramarginal nerve strongly looped, c. 2 mm within the margin; *petiole* 9–12 mm long. *Panicle* to 8 mm long, axillary, slender, singly branched; *bracts* and *bracteoles* to 10 by 3 mm, lanceolate, acute, shortly pubescent outside, glabrescent within. *Flower bud* to 6 by 3 mm, ellipsoid, obtuse. *Calyx* densely pubescent outside, sparsely so within; lobes subequal, narrowly deltoid, acute. *Petals* narrowly ovate, obtuse, sparsely pubescent on parts exposed in bud. *Stamens* 15, subequal; filaments linear, tapering, c. 3 times as long as the anther, half as long as the style, sparsely ciliate along lateral margins; appendage to connective c. $\frac{1}{4}$ as long as the anther, short, slender. *Ovary* ovoid, densely pubescent; style filiform, slender, c. 3 times as long as the ovary, pubescent towards base, otherwise glabrous. *Fruit calyx* persistently pubescent towards base, glabrescent elsewhere; 2 longer lobes to 4.5 by 1.2 cm, oblong, obtuse, c. 2 mm broad at base; 3 shorter lobes 8–14 by 2–3 mm, hastate, acute, fimbriate; lobes united at base

into a shallow cup c. 8 mm \varnothing . *Nut* c. 6 mm long and broad, ovoid, with up to 5 mm long style remnant, shortly pale buff tomentose.

Distr. Coastal Peninsular Thailand; in *Malesia*: S. Malaya (N.E. Johore), Singapore, Sumatra (Singkep, Lingga; Central Sumatra: Siak, Indragiri; P. Musala), Borneo.

Ecol. Local, on dry, often sandy soils on coastal hills and terraces, sometimes in secondary forest.

Vern. *Resak*, *r. hitam* (Brunei), *r. tẽmpurong* (Sabah), *r. bukit*, *r. tẽmbaga* (Lingga), *r. batu*, *r. tẽmbaga*, *r. padi*, *r. kẽranji* (W. Borneo), *r. bunga* (E. Borneo).

Note. The species, especially *C. malayanum*, are somewhat variable and the possibility of hybridisation between *C. malayanum* and *C. melanoxyylon* cannot be excluded.

2. *Cotylelobium burckii* (HEIM) HEIM, Rech. Dipt. (1892) 122; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 78; ASHTON, Gard. Bull. Sing. 20 (1963) 243; Man. Dipt. Brun. (1964) 57, f. 9, pl. 20–21 (habit, stem); *ibid.* Suppl. (1968) 24. — *Vatica burckii* HEIM, Bull. Mens. Soc. Linn. Paris 2 (July 1891) t. 258A; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 115, t. 3, f. 22–24; BOERL. Cat. Hort. Bog. 2 (1901) 112; BECC. For. Born. (1902) 570; MERR. En. Born. (1921) 408; SLOOT. Bull. Jard. Bot. Btzg III, 12 (1932) 44; SYM. Gard. Bull. S. S. 8 (1934) 36; BROWNE, For. Trees Sarawak & Brunei (1955) 171; ANDERSON, Gard. Bull. Sing. 20 (1963)

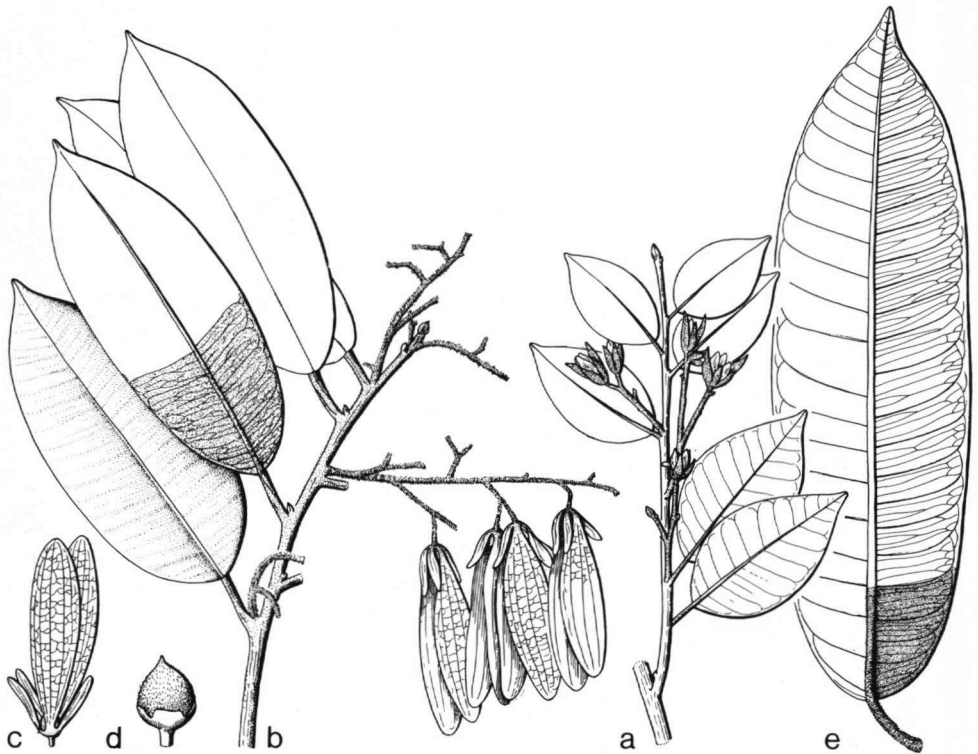


Fig. 40. *Cotylobium lanceolatum* CRAIB. **a.** Flowering twig, $\times 2/3$. — *C. burckii* (HEIM) HEIM. **b.** Fruiting twig, $\times 2/3$, **c.** fruit, **d.** nut, both $\times 2$, **e.** leaf from sterile twig, $\times 2/3$ (a S 28068, b S 12995, c-d KEP 32615, e bb. 15334).

157. — *C. asperum* SLOOT. Bull. Jard. Bot. Btzg III, 10 (1929) 401, f. 3; *ibid.* 12 (1932) 1. — Fig. 40b-e.

Twig, bud, petiole, stipules outside, midrib beneath and raceme densely shortly persistently buff tomentose, slightly scabrid; leaf evenly densely ocherous tomentose beneath. *Twig* $c.$ 1.5 mm \varnothing apically, slender, smooth. *Bud* 1.5–2 by 1.5 mm, small. *Stipules* to 8 mm long, narrowly deltoid, fugaceous. *Leaves* 8–12 by 3–4.5 cm, oblong-lanceolate; margin prominently revolute; base broadly cuneate or obtuse; acumen 2.5–7.5 mm long; nerves 10–12 pairs, indistinct, the intramarginal nerve comparatively straight and just within the margin; *petiole* 1.5–2 cm long. *Panicle* to 15 cm long; to 3-axillary, rarely terminal, terete or ribbed, irregularly doubly branched; *bracteoles* to 8 by 5 mm, elliptic, obtuse, shortly buff pubescent. *Flower bud* to 10 by 4 mm, ovoid-lanceolate, acute. *2 calyx lobes* long, linear, obtuse; 3 short, lanceolate, acute; densely buff tomentose outside, more sparsely within. *Corolla* cream; petals large, narrowly oblong, obtuse, glabrous. *Stamens* 15, the inner 5 slightly longer than the others; filaments short, broad at base, strongly tapering; anthers narrowly

oblong, reaching half length of style, with sparsely setose lateral margins; appendage to connective $\frac{1}{4}$ as long as anther, slender. *Ovary* subglobose, densely tomentose; style slender, 3–4 times as long as ovary, shortly pubescent but for the glabrous apical $\frac{1}{4}$. *Fruit calyx* as in *C. melanoxylon* but base more densely tomentose, longer lobes $c.$ 1.5 cm broad, persistently shortly sparsely tomentose; 3 shorter lobes to 1.2 cm long, linear, shortly sparsely tomentose on both surfaces. *Nut* as in other species.

Distr. Malesia: Borneo (W. Kutei, Lower Dayak, W. Borneo, Sarawak and Brunei N.E. to the Limbang).

Ecol. Locally common on giant podsols, on raised beaches, rare on sandstone cuestas, near present and Pleistocene coastlines.

Vern. Rêsak durian, r. babalok, r. gunong, r. baru.

3. *Cotylobium lanceolatum* CRAIB, Kew Bull. (1913) 113; Fl. Siam. Enum. 1 (1925) 142. — *C. malayanum* SLOOT. Bull. Jard. Bot. Btzg III, 12 (1932) 43; Foxw. Mal. For. Rec. 10 (1932) 247; BURK. Dict. (1935) 673; SYM. Gard. Bull. S. S. 9 (1938) 349; Mal. For. Rec. 16



Fig. 41. *Vatica umbonata* (HOOK. f.) BURCK. a. Habit, $\times \frac{1}{2}$, b-c. young fruits, $\times \frac{1}{2}$, d. ripe fruit, lateral view, e. ditto, apical view, both nat. size (a SAN 68373, flowers from SAN 15367, b A 4743, c FRI 12496, d-e BRUN 933).

(1943) 235, f. 113, 114; BROWNE, For. Trees Sarawak & Brunei (1955) 95; ASHTON, Man. Dipt. Brun. (1964) 11, f. 9; *ibid.* Suppl. (1968) 24, pl. 4 (bark); MEIJER, Sabah For. Rec. 5 (1964) 324. — *C. flavum* (non PIERRE) RIDL. J. Str. Br. R. As. Soc. 54 (1909) 25; Fl. Mal. Pen. 1 (1922) 239; SLOOT. Bull. Jard. Bot. Btzig III, 10 (1929) 396, f. 1, *specim.* BECCARI *excl.*; FOXW. Mal. For. Rec. 3 (1928) 71; *ibid.* 10 (1932) 247. — Fig. 40a.

Twig, bud, petiole, stipule outside, lamina beneath, and raceme persistently densely grey-brown to rufous scabrid tomentose; tomentum on lamina beneath dotted with scattered darker larger tufts. *Twig* c. 1 mm \varnothing apically, slender, terete. *Bud* c. 1.5 by 1 mm, small, conical. *Stipules* c. 3 mm long, narrowly deltoid, fugaceous. *Leaves* 6–8 by 2.5–3 cm, narrowly ovate-lanceolate; margin revolute; base broadly cuneate; acumen to 5 mm long; nerves 10–12 pairs, with a prominently looped intra-marginal nerve c. 2 mm from the margin; *petiole* 6–10 mm long, short, slender. *Panicle* to 6 cm long, terminal or axillary, short, terete, ribbed; irregularly singly or doubly branched; *bracteoles* to 4 by 3 mm, elliptic, obtuse, densely shortly

tomentose outside, sparsely so within. *Flower bud* to 8 by 3.5 mm, ovoid, obtuse. *Calyx* densely buff-tawny tomentose outside, sparsely so within, lobes subequal, deltoid, short; outer slightly narrower, more acute. *Corolla* cream; petals short, narrowly oblong, obtuse, glabrous. *Stamens* 15, the inner 5 slightly longer than the rest; filaments short, triangular; anthers narrowly oblong, with prominently setose margin; appendage to connective short, slender. *Ovary* small, subglobose, densely tomentose; style c. 3 times as long as ovary, filiform, pubescent towards base. *Fruit calyx* as in *C. burckii* but more scabrid tomentose; shorter lobes 1.2–2 by 0.4 cm, comparatively long, broadly hastate, constricted at base. *Nut* as in other species.

Distr. Eastern Peninsular Thailand, and *Malesia*: E. Malaya (from Trengganu southwards), Anambas Is., Borneo (W. Borneo, Sarawak, Brunei, S.W. & S.E. Sabah, Kutei, lower Mahakam), erroneously recorded from Sumatra by SYMINGTON (1938).

Ecol. Locally abundant, podsolised soils in Heath forest on terraces and sandstone ridges to 1500 m; on peaty soils over limestone in W. Sarawak.

Vern. *Resak*, *r. batu*, *r. bukit* (Mal.).

5. VATICA

LINNÉ, Mant. 2 (1771) 152; B. & H. Gen. Pl. 1 (1862) 192, *incl. sect. Isauxis* (ARN.) B. & H.; DC. Prod. 16, 2 (1868) 517; DYER, Fl. Br. Ind. 1 (1874) 301; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 223, *incl. sect. Sunaptea* (GRIFF.) BURCK *et sect. Pachynocarpus* (HOOK. f.) BURCK, *l.c.* 225; HEIM, Rech. Dipt. (1892) 99; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 268; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 116, *incl. subg. Synaptea* (GRIFF.) BRANDIS, *l.c.* 128, *subg. Retinodendron* (KORTH.) BRANDIS, *l.c.* 119, *subg. Isauxis* (ARN.) BRANDIS, *l.c.* 127; SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 67; FOXW. Philip. J. Sc. 67 (1938) 319; SYM. Mal. For. Rec. 16 (1943) 211, f. 105 (map); ASHTON, Gard. Bull. Sing. 20 (1963) 243; Man. Dipt. Brun. (1964) 61; *ibid.* Suppl. (1968) 25; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 301; SMITINAND, Thai For. Bull. (Bot.) 12 (1980) 81. — *Seidlia* KOSTEL. Allg. Med.-Pharm. Fl. 5 (1836) 1945. — *Vateria* ARN. Ann. Nat. Hist. 1, 3 (1839) 155, *pro sect. Isauxis* ARN. — *Retinodendron* KORTH. Kruidk. (1840) 55. — *Isauxis* (ARN.) REICHB. Nom. (1841) 210. — *Pteranthera* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 30. — *Sunaptea* GRIFF. Notul. 4 (1854) 516, corr. '*Synaptea*' KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 65. — *Pachynocarpus* HOOK. f. Trans. Linn. Soc. 23 (1860) 159; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 266. — *Elaeogene* MIQ. Sum. (1862) 460. — *Retinodendropsis* HEIM, C. R. Assoc. Fr. Pau 1892 (1893) 470. — *Perissandra* GAGN. Bull. Soc. Bot. Fr. 95 (1948) 27, *cf.* JACOBS, Blumea 15 (1967) 138. — *Brachypodandra* GAGN. *l.c.* 30. — Fig. 41–47.

Small to medium-sized, rarely large, trees; bole frequently sinuate, buttresses thick, rounded, concave, usually small. *Crown* irregular, oblong, sympodial, non-emergent. *Bark surface* usually grey mottled, smooth and hoop-marked, in large trees becoming patchily flaked, occasionally scroll-marked. Young parts usually \pm caducous powdery tomentose. *Leaves* variable; nerves curved, usually

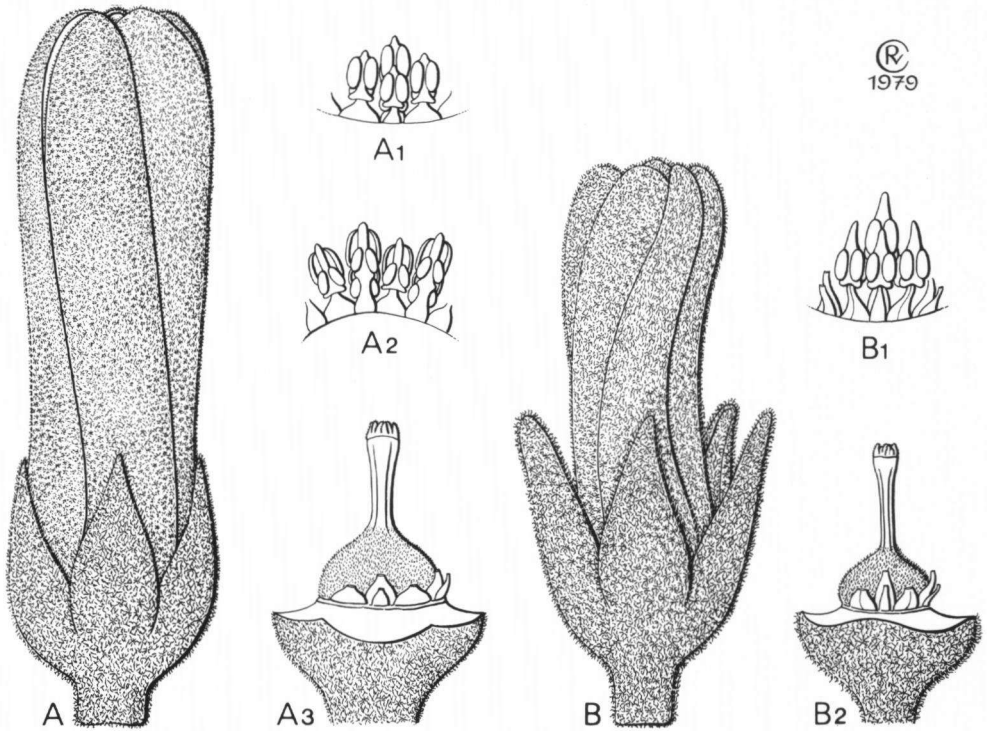


Fig. 42. *Vatica umbonata* (HOOK. f.) BURCK. A. Bud, A1. stamens from outside, A2. stamens from inside, A3. pistil, all x10. — *V. maingayi* DYER. B. Bud, B1. stamens from outside, B2. pistil, all x10 (A AMBULLAH 31457, B Neth. Ind. For. Serv. F 922).

somewhat oblique to the midrib; tertiary nerves \pm reticulate, never truly scalariform; *petioles* not geniculate. *Inflorescences* irregularly branched, racemose or sometimes partially cymose, short, rarely spreading. *Flower buds* ovoid to lanceolate, of variable size. *Calyx lobes* \pm valvate, subequal. *Petals* narrowly oblong, usually pale cream-white, not connate at base, falling separately. *Stamens* 15 in 3 verticils, single stamens alternating with pairs, short, the inner row slightly longer than the outer row; filaments short, dilated at base, \pm tapering and filiform below anthers; anthers broadly oblong, latrorse, the inner pollen sacs smaller than the outer; appendage to connective short, rarely as long as anthers, \pm deltoid, stout. *Ovary* \pm broadly ovoid, conical, superior or semi-inferior, shortly densely pubescent, without distinct stylopodium; style columnar, short, stout, glabrous, somewhat expanded at apex and with a prominent conical 3-lobed stigma. *Fruit calyx* variable. *Nut* of variable size, broadly ovoid or globose, with or without a distinct apical style remnant; pericarp splitting along 3 sutures at germination; *germination* epigeal (*sect. Sunaptea*; some *sect. Vatica*) or hypogean (some *sect. Vatica*) with the cotyledons remaining within the fruit; cotyledons, if free from fruit, magenta to pale yellow, usually non-photosynthe-

tic; first pair of leaves opposite with interpetiolar stipules, rarely alternate; the succeeding leaves spiral.

Distr. About 65 spp. in Ceylon and southern and eastern India, Burma, Thailand, Indochina, S. China (Hainan), and c. 55 spp. throughout *Malesia* excepting the Lesser Sunda Is. Fig. 43.

Ecol. Understorey trees, sometimes in main canopy, scattered in lowland forests and some species in hill forests to 1600 m; several species semi-gregarious on river-banks.

Uses. A hard semi-durable timber is obtained, but the trees are small; used locally for house posts and other minor construction.

Note. A genus clearly circumscribed by its extraordinary constancy of floral structure and also wood anatomy; its closest affinity is with *Cotylelobium* (*q.v.*). The two main forms of fruit calyx appear to have evolved only once and, judged by the wide geographical distribution of the two sections, would seem to mark an ancient dichotomy in the genus.

KEY TO THE SPECIES¹

1. Fruit calyx lobes equal. *Spp. 1-24. 1. Sect. Vatica*
2. Fruit calyx lobes corky, coalescing with each other and with the nut, forming a cup \pm enclosing it.
 3. Nut ovoid or globose, not exceeding 2.5 cm long. Petiole to 15 mm long 1. *V. umbonata*
 3. Nut to 4 cm long, narrowly ovoid-ellipsoid. Petiole exceeding 18 mm long 2. *V. stapfiana*
2. Calyx lobes not as above.
 4. Calyx lobes in fruit subcordate, somewhat revolute at base, not reflexed, \pm concealing nut.
 5. Nerves 8-15 pairs, without distinct secondary nerves 3. *V. venulosa*
 5. Nerves at least 16 pairs, with distinct secondary nerves.
 6. Twigs, panicles and petiole persistently fulvous \pm flocculent pubescent 4. *V. havilandii*
 6. Twigs and panicles caducous buff puberulent; petiole glabrous. 5. *V. chartacea*
 4. Calyx lobes not cordate; nut completely exposed.
 7. Nut ovoid, generally coming to exceed 2.3 cm long; pericarp thick, corky verrucose.
 8. Fruit sepals to 5 mm long, broadly ovate to suborbicular, adpressed to the base of the nut.
 9. Nut to 3 by 3 cm, ovoid 6. *V. pauciflora*
 9. Nut to 4.5 by 1.8 cm, fusiform 7. *V. ridleyana*
 8. Fruit sepals linear-lanceolate.
 10. Fruit sepals patent, becoming recurved and revolute resembling claws 8. *V. soepadmoi*
 10. Fruit sepals not as above.
 11. Nut prominently beaked 9. *V. bella*
 11. Nut not prominently beaked.
 12. Nut becoming asymmetrical; petiole exceeding 2 cm long 10. *V. rassak*
 12. Nut symmetrical; petiole shorter than 2 cm long.
 13. Leaves to 20 by 7 cm; nerves 10-12 pairs 11. *V. granulata*
 13. Leaves at least 22 by 7 cm; nerves 15-28 pairs. 12. *V. sarawakensis*
 7. Nut smooth.
 14. All parts entirely glabrous. 13. *V. albiramis*
 14. Young parts at least puberulent or pubescent.
 15. Tomentum vinous.
 16. Twigs compressed 14. *V. oblongifolia*
 16. Twigs terete.
 17. Calyx lobes thin, hardly revolute 15. *V. dulitensis*
 17. Calyx lobes, incrassate, becoming revolute.
 18. Nut 2.2 cm \varnothing 16. *V. pedicellata*
 18. Nut not exceeding 1 cm \varnothing .
 19. Nerves 9-11 pairs 17. *V. rotata*
 19. Nerves 12-20 pairs 18. *V. vinosa*
 15. Tomentum not vinous.
 20. Tomentum rufous.
 21. Leaves large, oblong, with obtuse or cordate base 19. *V. scortechinii*
 21. Leaves medium-sized, obovate, with narrowly cuneate base 20. *V. globosa*

(1) The following species are not inserted in the key: 52. *V. elliptica*, 53. *V. pentandra*, 54. *V. cauliflora*, 55. *V. glabrata*, and 56. *V. obtusa*.

22. Fruit sepals incrassate, adnate to nut 21. *V. lobata*
 22. Fruit sepals not incrassate, becoming \pm revolute or reflexed.
 23. Stipules large, elliptic, subsistent 22. *V. hullettii*
 23. Stipules minute, fugaceous.
 24. Leaves and nut glabrescent 23. *V. pallida*
 24. Leaves beneath and nut persistently pubescent 24. *V. flavida*
1. Fruit calyx lobes unequal. *Spp. 25-51. 2. Sect. Sunaptea*
 25. Fruit calyx lobes fused into a cup at base, adnate to the fruit.
 26. Nut exceeding 1 cm \varnothing ; fruit calyx lobes \pm patent, of varying lengths 25. *V. heteroptera*
 26. Nut at most 8 mm \varnothing ; calyx with ascending lobes, 2 of which greatly exceed the others.
 27. Tomentum cream to tawny; twigs \pm compressed at first.
 28. Nerves 8-11 pairs 26. *V. maritima*
 28. Nerves 13-17 pairs 27. *V. teysmanniana*
 27. Tomentum not as above; twigs terete.
 29. Twigs and petioles sparsely pale scurfy 28. *V. cinerea*
 29. Twigs and petioles densely persistently pubescent 29. *V. odorata*
25. Fruit calyx lobes free to base.
 30. Twigs compressed 30. *V. compressa*
 30. Twigs terete or ribbed.
 31. Leaf obovate, thickly coriaceous, normally obtuse or retuse, margin revolute.
 32. Inflorescence to 3 cm long, congested. Petiole exceeding 1.2 cm 31. *V. congesta*
 32. Inflorescence to 20 cm long, lax. Petiole less than 1 cm long 32. *V. coriacea*
31. Leaf not as above.
 33. Nerves at least 22 pairs, persistently pubescent beneath 33. *V. javanica*
 33. Nerves less than 22 pairs, or, if 22, then glabrous.
 34. Leaf nervation beneath pale brown or ocherous pubescent.
 35. Leaf undersurface persistently shortly buff scabrid pubescent; petiole 8-15 mm long
 34. *V. brunigii*
35. Leaf beneath (but not nerves) sparsely sericeous, glabrescent; petiole 15-30 mm long.
 36. Leaf base broadly cuneate. Nerves 10-11 pairs 35. *V. pachyphylla*
 36. Leaf base narrowly obtuse. Nerves 11-14 pairs 36. *V. obovata*
34. Leaf nervation glabrescent beneath.
 37. Nerves hardly more prominent beneath than above.
 38. Petiole at least 14 mm long.
 39. Nerves 7-9 pairs; tomentum pink-brown 37. *V. borneensis*
 39. Nerves 9-11 pairs; tomentum ocherous-buff 38. *V. bantamensis*
38. Petiole 1 cm long or shorter.
 40. Ripe nut broadly ovoid, obtuse, densely tomentose.
 41. Midrib raised above; base of leaf cuneate 39. *V. mangachapoi*
 41. Midrib flat or slightly sunken above; base of leaf obtuse 40. *V. parvifolia*
 40. Ripe nut narrowly ovoid, tapering, acute, glabrous 41. *V. rynchocarpa*
37. Nerves distinctly more prominently raised below than above.
 42. Inflorescence, petiole, nerves and midrib beneath persistently shortly pale brown scabrid tomentose. Leaf thin, obtuse.
 43. Petiole exceeding 15 mm long 42. *V. endertii*
 43. Petiole at most 11 mm long.
 44. Leaf elliptic to obovate, base narrowly cuneate 43. *V. brevipes*
 44. Leaf elliptic-oblong to lanceolate, base obtuse 44. *V. micrantha*
42. Tomentum not as above, nervation beneath glabrescent. Leaf base generally cuneate.
 45. Leaf drying yellowish olive, lustrous; tomentum ocherous buff 45. *V. flavovirens*
 45. Leaf drying grey-brown or red-brown; tomentum pink-brown or rufous.
 46. Tomentum very short, even.
 47. Petiole at least 2 cm long; longer calyx lobes to 8 by 2.5 cm 46. *V. badiifolia*
 47. Petiole shorter than 2 cm; longer calyx lobes to 6 by 1.8 cm 47. *V. perakensis*
46. Tomentum scabrid or flocculent.
 48. Major fruit calyx lobes coming to exceed 7 cm long.
 49. Major fruit calyx lobes somewhat broadened at base; leaf nerves 12-22 pairs 48. *V. nitens*
 49. Major fruit calyx lobes tapering at base; nerves at most 17 pairs.
 50. Petiole scabrid pubescent; nerves 10-17 pairs 49. *V. cuspidata*
 50. Petiole sparsely puberulent; nerves 9-11 pairs 50. *V. maingayi*
 48. Major fruit calyx lobes less than 6 cm long 51. *V. lowii*

1. Section *Vatica*

ASHTON, Gard. Bull. Sing. 20 (1963) 250, *incl. sect. Pachynocarpus* (HOOK. f.) BURCK. — *Seidlia* KOSTEL. — *Vateria sect. Isauxis* ARN. — *Retinodendron* KORTH. — *Isauxis* (ARN.) REICHB. — *Pachynocarpus* HOOK. f. — *Elaeogene* MIQ. — *Vatica sect. Isauxis* (ARN.) B. & H. — *Vatica sect. Retinodendron* (KORTH.) BURCK *et sect. Pachynocarpus* (HOOK. f.) BURCK, Ann. Jard. Bot. Btzig 6 (1887) 224. — *Vatica subg. Retinodendron* (KORTH.) BRANDIS *et subg. Isauxis* (ARN.) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 119, 127.

Calyx lobes equal.

1. *Vatica umbonata* (HOOK. f.) BURCK, Ann. Jard. Bot. Btzig 6 (1887) 232; SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 132, 133; ASHTON, Gard. Bull. Sing. 20 (1963) 250; Man. Dipt. Brun. (1964) 78, f. 10; *ibid.* Suppl. (1968) 36; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 320, f. 58, pl. 30A; ASHTON, Gard. Bull. Sing. 31 (1978) 17.

a. ssp. umbonata. — *Pachynocarpus umbonatus* HOOK. HOOK. f. Trans. Linn. Soc. 23 (1860) 159, t. 22; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 617; WALP. Ann. 7 (1868) 378; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 135, t. 3, f. 25; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270, fig.; MERR. En. Born. (1921) 409; RIDL. Fl. Mal. Pen. 1 (1922) 249, *p.p.*; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 265. — *V. verrucosa* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 232, t. 29, f. 5; SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 131; in Merr. Pl. Elm. Born. (1929) 205; BROWNE, For. Trees Sarawak & Brunei (1955) 102. — *Pachynocarpus verrucosus* HEIM, Rech. Dipt. (1892) 107; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 136; MERR. En. Born. (1921) 410; RIDL. Fl. Mal. Pen. 1 (1922) 249, *p.p.* — *V. blancoana* ELMER, Leaf. Philip. Bot. 4 (1912) 1473; FOXW. Philip. J. Sc. 13 (1918) Bot. 196; *ibid.* 67 (1938) 326; MERR. En. Philip. 3 (1923) 102. — *V. cupularis* SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 132, t. 13; in Merr. Pl. Elm. Born. (1929) 205, *p.p.*; HEYNE, Nutt. Pl. ed. 2 (1927) 1129; BROWNE, For. Trees Sarawak & Brunei (1955) 100. — *V. ramiflora* SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 118, *p.p.* — *V. stapfiana* (non SLOOT.) BROWNE, For. Trees Sarawak & Brunei (1955) 102. — Fig. 41, 42A–A3.

Young twig, raceme, leaf bud, stipule and petiole shortly sparsely pale grey-brown puberulent, persistent only on leaf bud and stipules. Twig to 3 mm \varnothing apically, stout, brittle, much branched, crooked, covered with small linear striations, cracks and sometimes flakes. Bud to 2 by 1.5 mm, ovoid, subacute. Stipules to 4 by 2 mm, hastate, subacute, early caducous. Leaves 8–16 by 3–6.5 cm, somewhat coriaceous, elliptic; base \pm broadly cuneate; apex obtuse or shortly acuminate; nerves 7–8 pairs, raised beneath, slightly curved, at 45°–55°; no distinct secondaries; midrib raised beneath, \pm appanate above. Petioles 7–15 mm long. Panicle to 12 cm long, singly, rarely doubly branched, axillary or terminal, rigid, brittle,

falling apart before maturity. Flower bud to 1 cm long; calyx shortly curved pubescent; flowers typical. Fruit pedicel 2–5 mm long. Nut to 3 cm long and \varnothing , pink-brown verrucose, compressed at base; calyx united into a tube adpressed to and fused to nut; differentiated into 5, to 2.6 by 1.8 cm, oblong-elliptic, up to 5 mm thick lobes by 5 deep longitudinal furrows; nut 3-sulcate, exposed only at apex.

Distr. *Malesia*: Malaya (Pahang, Trengganu), W. and N. Borneo, S. Philippines (Palawan).

Ecol. Locally abundant, alluvium river-banks; scattered on hillsides, locally frequent on acid soils in mountains at 900–1300 m.

Vern. *Resak ayer, r. gunong, r. labuan.*

Note. See also under 56. *V. obtusa* BURCK.

b. ssp. acrocarpa (SLOOT.) ASHTON, Gard. Bull. Sing. 31 (1978) 17. — *V. acrocarpa* SLOOT, Bull. Bot. Gard. Btzig III, 17 (1942) 241, f. 31; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 320.

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

Distr. *Malesia*: E. Borneo.

Ecol. Apparently always on or near river-banks.

Note. *V. umbonata* is frequently gregarious on river-banks and the continuous variation found in this habitat, especially in N.E. Borneo where the two subspecies occur in the same area and in E. Malaya where the closely related. *V. stapfiana* occurs in the same habitat, suggests panmixis and some local hybridisation. Some hybridisation appears to occur with *V. rassak* in E. Sabah.

2. *Vatica stapfiana* (KING) SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 129; *ibid.* III, 17 (1941) 137; FOXW. Mal. For. Rec. 10 (1932) 274; BURK. Dict. (1935) 2225; SYM. Mal. For. Rec. 16 (1943) 228, f. 107, 109. — *Pachynocarpus stapfianus* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 136; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 136; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 161, t. 194; BURK. & FOXW. J. Str. Br. R. As. Soc. 86 (1922) 279; RIDL. Fl. Mal. Pen. 1 (1922) 249; CRAIB, Fl. Siam. Enum. 1 (1925) 140. — *Pachynocarpus wallichii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 135, *p.p.*; RIDL. Fl. Mal. Pen. 1 (1922) 250, *p.p.* — *Pachynocarpus grandiflorus* RIDL. J. Fed. Mal. St. Mus. 10, 2 (1920) 127; CRAIB, Fl. Siam. Enum.

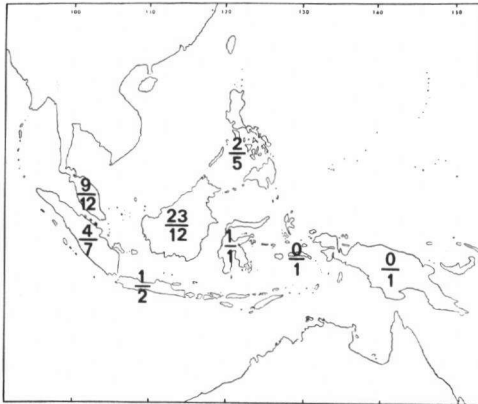


Fig. 43. Density map of *Vatica* L. in Malesia; number of endemics above the hyphen, number of non-endemics below it.

(1925) 140. — *Pachynocarpus umbonatus* (non HOOK. f.) RIDL. Fl. Mal. Pen. 1 (1922) 249, p.p. — *Pachynocarpus verrucosus* RIDL. Fl. Mal. Pen. 1 (1922) 249, p.p.

Medium-sized tree. Twigs, petioles, stipules, panicles, calyx outside and ovary \pm persistently densely scabrid ferruginous puberulent, leaf undersurface sparsely so or glabrescent, parts of petals exposed in bud pale brown puberulent. Twigs 3–4 mm \varnothing , stout, much branched, ribbed, becoming pale brown, rough. Buds to 3 by 2 mm, linear-lanceolate, acute, caducous. Leaves 12–25 by 5–12 cm, typically elliptic-obovate, \pm thickly coriaceous; base cuneate; margins \pm prominently revolute; acumen \pm abrupt, to 1.5 cm long, prominent; nerves 7–9(–15) pairs, ascending, arched, very stout and prominent beneath, evident above as also the midrib; tertiary nerves subreticulate, distinctly elevated beneath, hardly so above; petiole 1.7–3 cm long, 2–4 mm \varnothing , stout. Panicle to 10 cm long, terminal or axillary, somewhat congested and irregularly branched. Flower bud to 12 by 3 mm, fusiform; petals pale yellow with a purplish patch at base; staminal appendages c. $\frac{1}{2}$ length of outer anther cells, broadly deltoid; stigma short, hardly longer than ovary, stout, expanding distally into the conical style; flowers otherwise typical. Fruit subsessile or to 2 mm long pedicellate; calyx lobes equal, to 2.3 by 2.3 cm, ovate, acute, united except at the apex and fused with the to 4 by 2.5 cm ovoid apiculate protruding verrucose corky pericarp.

Distr. Peninsular Thailand and in Malesia: Malaya, Sumatra.

Ecol. Lowland dipterocarp forests, on hills, valleys and stream banks, to 500 m.

Vern. *Résak mempening*, *r. laru*.

Note. A variable species closely related to *V.*

umbonata, with which it appears to be undergoing local hybridisation.

3. *Vatica venulosa* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 32; WALP. Ann. 4 (1857) 337; MIQ. Fl. Ind. Bat. 1, 2 (1859) 502; DC. Prod. 16, 2 (1868) 623; BURCK, Ann. Jard. Bot. Btzg 6 (1878) 232; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 78; ASHTON, Man. Dipt. Brun. (1964) 79, f. 10; *ibid.* Suppl. (1968) 36; Gard. Bull. Sing. 31 (1978) 17.

a. ssp. *venulosa*. — *V. bancana* SCHEFF. Nat. Tijds. N. I. 31 (1870) 348; *ibid.* 32 (1873) 407; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 229, t. 27; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 128; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 269; K. & V. Bijdr. 5 (1900) 127; MOLL & JANSSONIUS, Mikrogr. Holz (1906) 360; KOORD. Exk. Fl. Java 2 (1912) 622; KOORD.-SCHUM. Syst. Verz. (1913) Dipteroc. 4; HALL. f. Med. Rijks-herb. 36 (1918) 4; MERR. En. Born. (1921) 408; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 264; HEYNE, Nutt. Pl. ed. 2 (1927) 1128; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 96; Foxw. Mal. For. Rec. 10 (1932) 263; SYM. Mal. For. Rec. 16 (1943) 217, f. 107; BROWNE, For. Trees Sarawak & Brunei (1955) 99; BACKER & BAKH. f. Fl. Java 1 (1963) 332; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 305, f. 53. — *V. schouteniana* SCHEFF. Nat. Tijds. N. I. 32 (1873) 408. — *Dryobalanops schefferi* HANCE, J. Bot. 14 (1876) 307. — *Retinodendron bancanum* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 129. — *Retinodendron kunstleri* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 129; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 157, t. 189B. — *V. kunstleri* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 127, t. 3, f. 10; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; RIDL. Fl. Mal. Pen. 1 (1922) 243. — *V. schefferi* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 128. — *V. lutea* RIDL. Kew Bull. (1926) 60.

Twig, raceme, leaf bud, stipule, midrib above and petiole \pm persistently densely shortly pale pink-brown puberulent; leaf beneath caducously so. Twigs to 1.5 mm \varnothing apically, thinly coriaceous, terete, becoming smooth, glabrous. Bud to 2.5 mm long, ovoid, acute. Stipules to 5 mm long, hastate, fugaceous. Leaves 4–12 by 1.5–5 cm, elliptic to ovate-lanceolate, thinly coriaceous; base cuneate, apex shortly acuminate; nerves 7–12 pairs, slender, hardly raised beneath, unraised above, curved at 60°–70°; without distinct secondaries; midrib slender, prominent beneath, slightly depressed above; petioles 5–9 mm long. Panicle to 3 cm long, terminal or 1-axillary, ribbed on drying, singly branched. Flower buds to 1.3 cm long; calyx pink-brown pubescent; flowers otherwise typical. Fruit pedicel to 2 mm long, hidden in the bases of the calyx. Calyx glabrous; lobes subequal, to 3 by 1.3 cm, ovate, acute, revolute, bases cordate. Nut to 1 cm \varnothing , globose, shortly sparsely pubescent, completely hidden by, but free from, calyx; style remnant to 1.5 cm long, acute.

Distr. Malesia: Malaya (Pahang, Perak), Sumatra (Palembang), Banka, Billiton, W. Java (Bantam), Borneo.

Ecol. Very local, on alluvium river banks and fresh water swamp.

Vern. *Resak letop* (Mal.), *r. banka*, *r. puteh*, *r. seluang*, *aboh*.

b. *ssp. simalurensis* (SLOOT.) ASHTON, Gard. Bull. Sing. 31 (1978) 18. — *V. simalurensis* SLOOT. Bull. Jard. Bot. Btżg III, 9 (1927) 100; HEYNE, Nutt. Pl. ed. 2 (1927) 1131.

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

Distr. *Malesia*: W. Sumatra (P. Simalur, Mentawai Is.).

Ecol. As the species.

4. *Vatica havilandii* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 133; MERR. EN. BORN. (1921) 409; SLOOT. Bull. Jard. Bot. Btżg III, 9 (1927) 95; SYM. J. Mal. Br. R. As. Soc. 19 (1941) 155; Mal. For. Rec. 16 (1943) 220, f. 107; BROWNE, For. Trees Sarawak & Brunei (1955) 100; ASHTON, Man. Dipt. Brun. (1964) 71, f. 10; *ibid.* Suppl. (1968) 33.

Young twig, raceme, leaf bud, stipule, and petiole densely persistently deep fulvous-brown flocculent tomentose; sparsely so, caducous, on leaf nervation beneath. *Twig* to 2.5 mm \varnothing apically, terete or slightly compressed, smooth or slightly flaked. *Bud* to 4 by 3 mm, conical, subacute. *Stipule* to 12 by 2.5 mm, linear, caducous. *Leaves* 8–17 by 2.5–5 cm, narrowly oblong to obovate; base cuneate; acumen to 1 cm long, narrow; nerves 15–20 pairs, slender, prominent beneath, curved towards the apices, at 60°–70°, with prominent short secondaries; midrib terete, prominently raised beneath, slender, flat to slightly raised above; *petiole* 1–1.2 cm long. *Panicle* to 8 cm long, terminal or axillary, terete, singly branched. *Flower bud* to 5 mm long, subglobose. *Calyx* densely rust-brown powdery tomentose; *appendage to connective* as long as anther, stout; flowers otherwise typical. *Fruit pedicel* 5 mm long, 2 mm \varnothing , pale rufous pubescent, hidden in the base of the calyx. *Calyx lobes* 2.5 by 1.5 cm, ovate, acute, revolute, bases subcordate. *Nut* 12 mm \varnothing globose, densely rufous pubescent, completely hidden in, but free from, the calyx.

Distr. *Malesia*: Malaya (Perak, Pahang, Trengganu), Borneo (Kapas valley, W. and Central Sarawak, Brunei, Sandakan area).

Ecol. Rare, in Mixed Dipterocarp forests on hills not far from the coast.

Vern. *Resak degong*.

Note. This and the following species share with *V. venulosa* a very distinctive calyx and thus form a well defined group within the genus.

5. *Vatica chartacea* ASHTON, Gard. Bull. Sing. 31 (1978) 18.

Medium-sized tree. Young twigs, stipules and panicles caducous buff puberulent; pedicel, ovary and parts of petals exposed in bud persistently so; parts otherwise glabrous. *Twig c.* 2 mm \varnothing apically, much

branched, pale. *Buds* to 3 by 2 mm \varnothing , ovoid, acute; *stipule* to 7 by 2 mm, lanceolate, caducous. *Leaves* 11–25 by 3–10 cm, oblong to obovate, thinly chartaceous and wrinkling on drying; base broadly cuneate or obtuse; acumen to 1 cm long, prominent; nerves 16–20 pairs, slender but prominent beneath, distinctly elevated above, arched, with short slender secondaries; tertiary nerves sinuately subscalariform, slender and elevated on both surfaces; midrib stout, terete and prominent beneath, distinctly elevated above; *petiole* 10–22 mm long, slender. *Panicle* to 5 cm long, to 3-axillary, stout. *Flower buds* to 6 by 2 mm, fusiform; *sepals* subequal, lanceolate, subacuminate; *anthers* small, broadly oblong, tapering to the equally long prominent stout appendages; *style* columnar, somewhat longer than ovary, slightly tapering, rimmed beneath the conical stigma; flowers otherwise typical. *Fruit pedicel* to 6 mm long, very slender. *Fruit sepals* to 6 by 1.5 cm, subequal, lanceolate, subacute, cordate at base, 5–7-nerved, ascending and hiding the to 13 by 11 mm ellipsoid nut.

Distr. *Malesia*: W. Borneo (Ulu Kapuas), N.E. Borneo (Bintulu, Sarawak; Beluran and Sandakan to Tawau).

Ecol. Moist low hillsides and banks of sluggish rivers, very local.

Vern. *Resak bunga*, *r. banka*.

6. *Vatica pauciflora* (KORTH.) BL. Mus. Bot. Lugd.-Bat. 2 (1852) 31, f. 7; DC. Prod. 16, 2 (1868) 618; MIQ. Sum. (1861) 191; BURCK, Ann. Jard. Bot. Btżg (1887) 226; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 124; ASHTON, Gard. Bull. Sing. 31 (1978) 19. — *Retinodendron pauciflorum* KORTH. Kruidk. (1841) 58. — *Vateria pauciflora* WALP. Rep. 5 (1845) 126; DC. Prod. 16, 2 (1868) 626. — *Elaeogene sumatrana* MIQ. Sum. (1861) 460, 183; M. A. in DC. Prod. 15, 1 (1866) 1257; HALL. f. Med. Rijks herb. 36 (1918) 14. — *V. zollingeriana* DC. Prod. 16, 2 (1868) 618; BURCK, Ann. Jard. Bot. Btżg 6 (1887) 227, t. 29–1; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 124; SLOOT. Bull. Jard. Bot. Btżg III, 9 (1927) 126. — *V. wallichii* DYER, J. Bot. 12 (1874) 154; BURK. & FOXW. J. Str. Br. R. As. Soc. 86 (1922) 273; CRAIB, Fl. Siam. Enum. 1 (1925) 141; HEYNE, Nutt. Pl. ed. 2 (1927) 1132; SLOOT. Bull. Jard. Bot. Btżg III, 9 (1927) 123, f. 12; FOXW. Mal. For. Rec. 10 (1932) 269; BURK. Dict. (1935) 2225; SYM. Mal. For. Rec. 16 (1943) 230, f. 106, 107, 110. — *V. lamponga* BURCK, Ann. Jard. Bot. Btżg 6 (1887) 227, t. 29, f. 3a–d; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 123; BRANDIS & GILG in E. & P. Pf. Fam. ed. 1, 3, 6 (1895) 269; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 313; *ibid.* ed. 2 (1927) 1131; GILG in E. & P. Pf. Fam. ed. 2, 21 (1925) 264. — *V. forbesiana* BURCK, Ann. Jard. Bot. Btżg 6 (1887) 228; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 124; HEYNE, Nutt. Pl. ed. 2 (1927) 1131. — *V. ruminata* BURCK, Ann. Jard. Bot. Btżg 6 (1887) 227, t. 29, f. 4; HEYNE, Nutt. Pl. ed. 2 (1927) 1132. — *Pachynocarpus wallichii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 135, p.p.; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 136; RIDL. Fl. Mal. Pen. 1 (1922) 250, p.p.; BURK. J. Str. Br. R. As.

Soc. 81 (1920) 75. — *Pachynocarpus ruminatus* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 136. — *V. ovalifolia* RIDL. J. Str. Br. R. As. Soc. 54 (1909) 26. — *V. kelsalli* RIDL. J. Str. Br. R. As. Soc. 54 (1909) 27; Fl. Mal. Pen. 1 (1922) 244. — *Pachynocarpus umbonata* (non HOOK. f.) RIDL. Fl. Mal. Pen. 1 (1922) 249, p.p. — *Pachynocarpus ridleyanus* (non ANDERS.) RIDL. Fl. Mal. Pen. 1 (1922) 250, p.p. — *V. sumatrana* SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 120, f. 11; HEYNE, Nutt. Pl. ed. 2 (1927) 1131; BACKER & BAKH. f. Fl. Java 1 (1963) 332.

Small or medium-sized tree. Outside of perianth ± persistently pale grey-brown cinereous; ovary, panicles, and twig apices caducously so; elsewhere glabrescent. *Twig* c. 3 mm \varnothing apically, much branched, pale grey-brown, usually minutely rugulose. *Buds* small, ovoid; *stipules* to 8 mm long, linear, becoming reflexed. *Leaves* 6.5–20 by 2.2–8 cm, variable in size, elliptic-lanceolate, thinly coriaceous; base cuneate; acumen to 1.5 cm long, prominent; nerves 6–9 pairs, arched, ascending, slender and hardly more elevated beneath than above; *petiole* 10–18 mm long, smooth, drying black. *Panicle* to 9 cm long, terminal or subterminal axillary, many-flowered, irregularly branching. *Flower bud* to 10 by 3 mm, fusiform; *appendages* minute, hardly exceeding anthers; *style* columnar, longer than ovary, expanding somewhat distally below the small conical style; flowers otherwise typical. *Fruit pedicel* to 7 by 3 mm, prominent; *calyx lobes* to 5 mm \varnothing , hemispherical, incrassate, ± adnate round the impressed base of the nut; *nut* to 3 by 3 cm, ovoid, subacute, with 3 distinct loculicidal furrows; pericarp thick, corky, verrucose.

Distr. Peninsular Thailand, and in *Malesia*: Malaya, Sumatra (Palembang, Lampong), Banka.

Ecol. Banks of sluggish rivers, fresh water swamps; common.

Vern. *Resak laru*, *r. paya*, *r. ayer*, *r. pasir*, *damar mata kuching* (Malaya), *r. padang*, *r. rawang* (Sumatra).

Notes. Occupying the same habitat as *V. umbonata* and indistinguishable from it when sterile; it is by the fruit calyx nevertheless consistently distinguishable. Though *V. pauciflora* is confirmed only as far north as Songkhla, *V. thorelii* PIERRE of Cochinchina, based on THOREL & HARMAND's herb. Pierre 1586, is known only in flower and is indistinguishable in that condition from it; moreover I have seen undoubted fruit of *V. pauciflora* washed up on the beach at Kompong Som, S.E. Cambodia.

See also 56. *V. obtusa* BURCK.

A specimen from Sikundur For. Res., W.N.W. of Medan (N.E. Sumatra) (DE WILDE & DE WILDE-DUYFJES 19537) bears fruit which differs in having greatly enlarged adnate sepals, in this resembling *V. umbonata*, so far unknown from Sumatra. This may represent a hybrid between the two species, nevertheless.

7. *Vatica ridleyana* BRANDIS in Hook. f. Ic. Pl. 25 (1895) t. 2401; J. Linn. Soc. Bot. 31 (1895) 122, t. 3, f.

5; BURK. & FOXW. J. Str. Br. R. As. Soc. 86 (1922) 277; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 49, 73, f. 1d; FOXW. Mal. For. Rec. 10 (1932) 268; BURK. Dict. (1935) 224; SYM. Mal. For. Rec. 6 (1943) 227, f. 107. — *Pachynocarpus ridleyanus* ANDERSON, Index Bot. Gard. Sing. (1912) 9; BURK. & FOXW. J. Str. Br. R. As. Soc. 86 (1922) 272; RIDL. Fl. Mal. Pen. 1 (1922) 250, p.p.

Medium-sized tree. Twigs, petioles, panicles, ovaries and parts of perianth exposed in bud ± persistently ochereous cinereous, parts elsewhere glabrescent. *Twig* c. 2–3 mm \varnothing apically, much branched, brown rugulose. *Buds* to 3 by 2 mm, ovoid. *Leaves* 6–14 by 3–7 cm, elliptic to narrowly ovate or obovate, coriaceous, dull beneath; base cuneate; apex subacute or shortly broadly acuminate; margin narrowly subrevolute; nerves 5–7 pairs, ascending, slender but prominent beneath, evident above as also the midrib and reticulate tertiary nerves; *petiole* 8–15 mm long, 2–3 mm \varnothing , stout. *Panicle* to 15 cm long but usually shorter, terminal or axillary, irregularly branched. *Flower bud* 7 by 2 cm, fusiform; *appendage* short, deltoid; *style* somewhat longer than ovary, columnar, expanding into the prominent conical stigma; flowers otherwise typical. *Fruit pedicel* short, stout; *calyx lobes* to 3 by 3 mm, short, deltoid, incrassate, relaxed, adnate to the base of the 4.5 by 1.8 cm fusiform beaked coarsely verrucose nut.

Distr. *Malesia*: Sumatra (Palembang), Singapore.

Ecol. Mixed Dipterocarp forest at low altitudes; rare.

Vern. *Resak buah cana*.

8. *Vatica soepadmoi* ASHTON, Gard. Bull. Sing. 31 (1978) 19.

Small tree. Twigs, leaf buds, petioles, midrib above, and panicles densely persistently pale brown scabrid puberulent, nuts evenly so; nervation beneath sparsely so. *Twigs* c. 2 mm \varnothing , ribbed at first, becoming terete. *Leaf buds* to 8 by 4 mm, lanceolate, acute. *Leaves* 7.5–12 by 3–5.5 cm, elliptic, oblong to narrowly ovate, coriaceous, somewhat bullate between the nerves; margin subrevolute; base obtuse; acumen to 1.5 cm long, slender, prominent; nerves c. 11 pairs, arched, tending to branch within the margin and form a ± indistinct looped intramarginal nerve, prominent beneath, shallowly depressed above, with short slender secondary nerves; tertiary nerves subreticulate, evident beneath, ± obscure above; midrib stoutly prominent beneath, evident but ± channelled above; *petiole* 10–15 mm long, slender. *Panicle* to 6.5 cm long, axillary, hardly branched. *Flowers* unknown. *Fruit pedicel* to 6 mm long, prominent; *calyx lobes* equal, to 18 by 10 mm, lanceolate, acute, recurved inwards and ± revolute thus resembling claws; *nut* ovoid, not known at maturity.

Distr. *Malesia*: E. Sumatra (Upper Riouw: Pekanbaru, Singkep).

Ecol. Low hills.

9. *Vatica bella* SLOOT. Bull. Jard. Bot. Btzg III, 9

(1927) 102, f. 6; Foxw. Mal. For. Rec. 10 (1932) 265; BURK. Dict. (1935) 2223; Sym. Mal. For. Rec. 16 (1943) 218, f. 107.

Medium-sized tree to 50 m tall. Twigs, leaf buds, petioles, midrib above and panicle densely persistently rufous cinereous, calyx and ovary caducously so, leaf undersurface sparsely caducously so. *Twig* c. 2 mm \varnothing apically, slender, terete, much branched, pale brown. *Bud* to 3 by 2 mm, small, ovoid; *stipules* fugaceous, not seen. *Leaves* 5–14 by 2.6 cm, elliptic-ovate, coriaceous; base cuneate; acumen to 1 cm long or short; margin frequently subrevolute; nerves 11–12 pairs, arched, ascending, slender but distinctly elevated beneath, evident above as also the midrib; tertiary nerves densely subreticulate, hardly elevated on either surface; *petiole* 5–15 mm long, short, relatively slender. *Panicle* to 2 cm long, axillary, congested, irregularly branched. *Flower buds* to 8 by 3 mm, lanceolate; appendage to connective as long as anther cells, deltoid, prominent; style slender, twice as long as ovary; stigma shortly conical; flowers otherwise typical. *Fruit pedicel* to 3 by 2 mm; *calyx lobes* to 30 by 13 mm, lanceolate, acute, c. 6 mm wide at the revolute base, becoming reflexed; *nut* to 2.5 by 2.5 cm, turbinate, verrucose, with to 1 cm long persistent tapering style remnant.

Distr. *Malesia*: Malaya (south from Perak and Pahang).

Ecol. Locally common in Mixed Dipterocarp forest, undulating land beneath 250 m.

Vern. *Resak kĕluang, r. laru, damar kĕluang*.

10. *Vatica rassak* (KORTH.) BL. Mus. Bot. Lugd.-Bat. 2 (1852) 31, *incl. var. subcordata* BL.; WALP. Ann. 4 (1857) 337; Miq. Fl. Ind. Bat. 1, 2 (1859) 502; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 619; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 225; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 125; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; GRESH. Ind. Mercuur 23 (1900) n. 37, tab.; Schets. Nutt. Ind. Pl. (1900) t. 50; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 313; *ibid.* ed. 2 (1927) 1130; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 73, 104, f. 1c; *ibid.* III, 17 (1942) 223, f. 22–24; ASHTON, Gard. Bull. Sing. 31 (1978) 20. — *Retinodendron rassak* KORTH. Kruidk. (1841) 56, t. 8. — *Vateria rassak* WALP. Rep. 5 (1845) 126. — *V. papuana* DYER, J. Bot. 16 (1878) 100; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 229; K.SCH. & HOLLR. Fl. Kais.-Wilh. Land (1889) 52; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 127; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; DIELS, Bot. Jahrb. 57 (1922) 463; LANE-POOLE, For. Res. Papua (1925) 120; SLOOT. Nova Guinea 14 (1926) 226; Bull. Jard. Bot. Btzg III, 9 (1927) 73, 112, f. 1b; MERR. Philip. J. Sc. 30 (1926) 411; WHITE & FRANCIS, Proc. R. Soc. Qsl. 38 (1927) 247; HEYNE, Nutt. Pl. (1927) 1129; FOXW. Philip. J. Sc. 67 (1938) 328; SLOOT. Bull. Jard. Bot. Btzg III, 17 (1942) 233, f. 27; *apud* Holth. & Lam, Blumea 5 (1942) 214; Reinwardtia 2 (1952) 63, f. 21; MEIJER & WOOD. Sabah For. Rec. 5 (1964) 314, f. 56; ASHTON, Man. Dipt. Brun. Suppl. (1968) 35, f.

5. — *Vateria papuana* DYER ex HEMSL. Bot. Chall. 1, 4 (1884–85) 123, 287, 296, t. 64B; K.SCH. & HOLLR. Fl. Kais. Wilh. Land (1889) 52; HEYNE, Nutt. Pl. ed. 2 (1927) 1129. — *V. moluccana* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 226, t. 26; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 124; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 313; *ibid.* ed. 2 (1927) 1129. — *Retinodendron moluccanum* HEIM, Rech. Dipt. (1892) 104. — *V. schumanniana* GILG, Bot. Jahrb. 18 (1894) Beibl. 45: 38; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 127; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 269, fig.; K.SCH. & LAUT. Fl. Schutzgeb. (1901) 451; DIELS, Bot. Jahrb. 57 (1922) 463; (in Index Kewensis *erron. under Shorea*). — *V. celebensis* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 126, t. 3, f. 6; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 77; *ibid.* III, 17 (1942) 254; Reinwardtia 2 (1952) 65. — *V. subcordata* (BL.) HALL. f. Med. Rijksherb. 36 (1918) 4; SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 228, f. 25–26. — *V. celebica* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 237, f. 28–29. — Fig. 44.

Twig, petioles, buds, and stipules outside (glabrous within) very shortly evenly persistently pale buff pubescent, leaf nervation beneath sparsely so. *Twig* c. 3 mm \varnothing , stout, crooked, ribbed, becoming rugose, flaky, pale grey-brown; stipule scars prominent, horizontal; internodes 1–3 cm long. *Bud* to 4 by 4 mm, ovoid-conical, subacute. *Stipules* to 14 by 4 mm, lorate, subacute, subsistent. *Leaves* 13–32 by 5–11 cm, oblong to narrowly elliptic, thickly coriaceous; base broadly cuneate to subcordate; acumen to 1.5 cm long; nerves (10–)16–20 pairs, prominent beneath, slightly elevated above, arched at 50°–60°, with short hardly elevated secondary nerves; tertiary nerves reticulate; midrib prominent beneath, applanate above; *petiole* 2–2.5 cm long, stout, not geniculate, drying pale buff pubescent. *Panicle* to 14 cm long, terminal or axillary, ribbed, at first shortly evenly buff pubescent, becoming pale brown flaky; irregularly branched, with many branches near base, appearing fasciated. *Flower bud* to 14 by 3 mm, fusiform; *calyx* densely shortly pale buff pubescent; flowers otherwise typical. *Fruit* glabrous. *Pedicel* to 3 mm long, stout. *Calyx lobes* to 12 by 7 mm, deltoid, acute, incrassate, reflexed, recurved. *Nut* to 5 by 3.5 cm, oblong, symmetrical and obtuse to ovoid, more or less prominently attenuate-acute and asymmetrically twisted, sometimes irregularly pitted, furrowed at the sutures, minutely verrucose and rugulose; pericarp thick, corky.

Distr. *Malesia*: Borneo (E. of Rejang valley and Sampit, commonest on E. coast), S. Philippines (Sulu Is.: Tawi Tawi), Celebes, Moluccas (Sula Is.: Mangoli; Morotai, Halmahera, Batjan, Obi Is., Aru Is.), New Guinea, Sudest I.

Ecol. River-banks in Borneo, elsewhere also on hills to 400 m, locally abundant.

Vern. *Resak irian, r. damau, r. ayĕr, r. tĕbong* (Sabah), *damar dĕrĕh, d. putĕh, nunuh, singkodoh putĕh* (Celebes), *kokolaka, bou-ura, por, damar hiru, manauri, laintoti, wakaju, imoimo, asuk, baia, guimbur, lagima, mutani, owi, simbiau* (New Guinea),

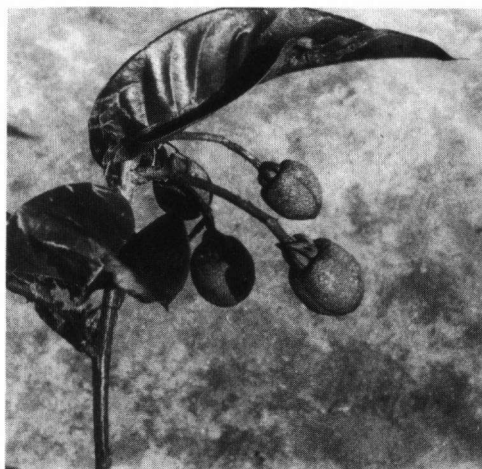


Fig. 44. Fruiting twig of *Vatica rassak* (KORTH.) BL. near Sarmi, c. 200 km west of Hollandia, Irian Jaya (Photogr. KARSTEL, Dec. 1957).

doyong (Sula Is.), *damar hiru*, *salo hiru*, *damar atung*, *geru* (Moluccas).

Notes. Another variable semi-gregarious chiefly riparian species (see e.g. *V. umbonata*).

The above description defines my interpretation of this variable species. The large, oblong-elliptic, coriaceous leaves with long petiole, and the large, corky nut, are characteristic though the nut shape is very variable (in part owing to the degree of maturity on herbarium specimens). Its distribution into seasonal areas and its semi-gregarious ecology parallel that of other polymorphic species such as *Anisoptera costata* KORTH., *A. thurifera* (BLCO) BL., and *Vatica umbonata* (HOOK. f.) BURCK. The variation is locally too great to clearly distinguish geographical subspecies.

Some hybridisation appears to occur with *V. umbonata* in East Sabah.

11. *Vatica granulata* SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 112, f. 10; *ibid.* III, 17 (1941) 136, f. 20; ASHTON, Man. Dipt. Brun. (1964) 70, f. 10; *ibid.* Suppl. (1968) 32; Gard. Bull. Sing. 31 (1978) 21.

a. ssp. granulata.

Young twig, leaf bud, stipule, petiole and nervation beneath densely shortly yellow scabrid tomentose at first, glabrescent or sparsely pubescent on nervation. Twig to 3 mm \varnothing apically, stout, angular, persistently papery flaky. Bud to 4 by 3 mm, conical, subacute. Stipule to 6 by 4 mm, hastate, subacute, caducous. Leaves 10–20 by 2.7–7 cm, coriaceous, narrowly obovate; base narrowly obtuse; acumen to 6 mm long; nerves 12–14 pairs, prominent beneath, well spaced,

slightly sunken above. Petiole 1.2–2 cm long, stout. Flowers unknown. Inflorescence unknown. Fruit pedicel to 1 mm long, fruit subsessile. Calyx lobes to 7 by 4 mm, chartaceous, deltoid, brittle, reflexed, glabrous. Nut to 3.5 by 4 cm, ovoid, obtuse or subacute, coarsely granulate, dehiscent along 3 distinctly furrowed sutures at germination.

Distr. *Malesia*: Borneo.

Ecol. Widespread, locally abundant, on high ridges at 500–1200 m.

Vern. *Rèsak ranting bersisek*.

b. ssp. sabaensis ASHTON, Gard. Bull. Sing. 31 (1978) 21.

Differing as follows: Leaf by 6–10 cm, petiole 12–20 mm long. Stipules to 3 by 2 cm, oblong to lanceolate, acute, obtuse to subcordate, subpersistent. Fruit sepals to 20 by 12 mm, elliptic, revolute, reflexed.

Distr. *Malesia*: Borneo (Crocker range, S.W. Sabah to Kelabit Highlands, N.E. Sarawak).

Ecol. As type subspecies, to 1700 m.

Vern. *Rèsak pengasoh*.

12. *Vatica sarawakensis* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 970; Rech. Dipt. (1892) 109; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 124; SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 106, f. 7; BROWNE, For. Trees Sarawak & Brunei (1955) 101; ASHTON, Gard. Bull. Sing. 20 (1963) 252; Man. Dipt. Brun. (1964) 77, f. 10; *ibid.* Suppl. (1968) 36; Gard. Bull. Sing. 22 (1967) 262; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 319, f. 57. — *Retinodendropsis aspera* HEIM, C. R. Assoc. Fr. Pau 1892 (1893) 470; cf. ASHTON, Gard. Bull. Sing. 22 (1967) 262. — *V. ramiflora* SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 118, p.p.; in Merr. Pl. Elm. Born. (1929) 205; Bull. Bot. Gard. Btzig III, 17 (1942) 240, f. 30; Reinwardtia 5 (1961) 479; BROWNE, For. Trees Sarawak & Brunei (1955) 101.

Twig, raceme, leaf bud, stipule and petiole densely pale brown to fulvous scabrid tomentose, sparsely so on leaf nervation beneath. Twig to 5 mm \varnothing apically, stout, becoming ribbed, smooth or finely cracked. Bud to 8 by 5 mm, conical, subacute. Stipule to 15 by 5 mm, narrowly hastate, acute. Leaves 22–35 by 7–15 cm, thinly coriaceous, oblong to obovate; base obtuse; acumen to 1.4 cm long, deltoid; nerves 15–28 pairs, prominent beneath, flat or slightly raised above; petiole 1–2 cm long, to 4 mm \varnothing , stout. Panicle to 12 cm long, axillary to ramiflorous (rarely terminal), to 3-axillary, terete or angled; much branched, the branchlets cymose; bracts to 8 by 4 mm, narrowly deltoid, subacute, densely rufous tomentose, subpersistent. Flower bud to 8 mm long; calyx shortly red-brown pubescent; appendage to connective over $\frac{2}{3}$ length of anther, prominent; flower otherwise typical. Fruit glabrous; pedicel to 2 mm long. Calyx lobes subequal, to 16 by 7 mm, oblong-hastate, obtuse, becoming reflexed, somewhat revolute. Nut to 2.5 by 2.5 cm, subglobose to ovoid, verrucose-lenticellate, with 3 distinct sutures uniting at the apex; style remnant short but prominent.

Distr. *Malesia*: Borneo (Sarawak to Sabah; S.E. Borneo to P. Laut and Balikpapan).

Ecol. Scattered in Mixed Dipterocarp forest on clay rich soils on undulating land and hills below 1000 m.

Vern. *Resak daun bésar*, *r. sarawak*, *damar tingkis*.

Note. The fruit sepals of *E. Borneo* specimens (*V. ramiflora* SLOOT.) are foliose and rather broad, these on Sarawak specimens narrow and incrassate. Further collections may justify distinction of two subspecies in *V. oblongifolia*.

13. *Vatica albiramis* SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 101, f. 5; in Merr. Pl. Elm. Born. (1929) 205; ASHTON, Man. Dipt. Brun. (1964) 66, f. 10; *ibid.* Suppl. (1968) 30; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 305, f. 52.

Parts glabrous but for the shortly sparsely caducous pubescent calyx and shortly fulvous caducous pubescent ovary. Twig to 1 mm \varnothing apically, slender, smooth to rugulose. Bud to 2 by 1 mm, conical, acute. Stipule to 16 by 3.5 mm, hastate, subacute, caducous. Leaves 8–20 by 3–7 cm, thinly coriaceous, elliptic to lanceolate; base \pm narrowly cuneate; acumen to 1.5 cm long, narrow; nerves 4–6 pairs, rather broad, slightly raised on both surfaces, more prominently so beneath, curved, continuing almost parallel to the margin before terminating, at 45°–50°(–70°); midrib broad, rounded, slightly raised on both surfaces; tertiary nerves subscalariform; petiole 1–1.3 cm long. Panicle to 28 cm long, terminal or axillary, lax, spreading, glabrous, terete; doubly or trebly branched. Flower bud to 1.5 cm long, slender; calyx shortly sparsely pubescent; corolla rich lemon-yellow; appendage to connective rudimentary; flowers otherwise typical. Calyx lobes subequal, to 12 by 4 mm, ovate, obtuse, tapering to 3.5 mm broad at base, coriaceous, glabrous, becoming reflexed. Nut to 1.2 by 1.2 cm, globose, without style remnant, shortly fulvous pubescent.

Distr. *Malesia*: Borneo (Rejang valley to Kinabalu; E. Sabah).

Ecol. Clay rich soils, low hills and ridges; to 1400 m in Kinabalu area.

Vern. *Resak ranting puteh*, *r. puteh*.

Note. Differing from the closely related *V. hullettii* of Malaya in the narrow fugaceous hastate stipules and totally glabrous young parts and petiole.

14. *Vatica oblongifolia* HOOK. f. Trans. Linn. Soc. 23 (1862) 160; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 619; WALP. Ann. 7 (1868) 378; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 229; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 126, t. 3, f. 11; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 109, f. 8; *ibid.* III, 17 (1941) 135; BROWNE, For. Trees Sarawak & Brunei (1955) 101; ASHTON, Man. Dipt. Brun. (1964) 75, f. 10, *p.p.*; *ibid.* Suppl. (1968) 34; Gard. Bull. Sing. 22 (1967) 264, pl. 3–7; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 314, f. 55, pl. 30b (stem). — Fig. 45.



Fig. 45. Stem-base of young tree of *Vatica oblongifolia* HOOK. f. *ssp. oblongifolia*, with flowering and fruiting twigs. Sibulu R., Mengalang For. Res., Beaufort Distr. (Photogr. G. H. S. WOOD, July 1954, KEP 80255).

Note. The taxa I here recognise as subspecies are rather constant and rarely difficult to identify. Though the full range of variation they together manifest is great, the distinctive characters of the depressed twig and short dense vinose indumentum unites them as a single entity.

KEY TO THE SUBSPECIES

1. Petiole at most 14 mm long; leaf elliptic
b. *ssp. elliptifolia*
1. Petiole at least 15 mm long.
2. Fruit calyx lobes more than 10 by 6 mm; nerves at least 26 pairs.
3. Leaf broadly oblong, base \pm cordate
c. *ssp. crassilobata*
3. Leaf narrowly obovate, base \pm cuneate
d. *ssp. multinervosa*

2. Fruit calyx lobes at most 4 by 3 mm; nerves at most 18 pairs.

4. Leaf narrowly elliptic, base cuneate, petiole 1.5–2.5 cm long . . . *e. ssp. selakoensis*

4. Leaf obovate to oblong, base obtuse, petiole 2.5–5 cm long . . . *a. ssp. oblongifolia*

a. ssp. oblongifolia. — ASHTON, Gard. Bull. Sing. 22 (1967) 264, pl. 3. — *V. furfuracea* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 228; BECC. For. Born. (1902) 570. — Fig. 45.

Young twig, raceme, calyx, leaf bud, stipule, petiole and leaf nervation densely shortly evenly persistently vinous cinereous. *Twig c.* 4 by 2 mm \varnothing apically, compressed; becoming terete, smooth to finely cracked and flaked. *Leaf bud* to 3 by 5 mm, conical, subacute, compressed. *Stipule* to 4.5 by 1.2 cm, oblong, obtuse. *Leaves* 10–31 by 4.5–10 cm, coriaceous, oblong to obovate; base obtuse; apex \pm abruptly tapering, with or without an up to 1 cm long acumen; nerves 10–18 pairs, prominent beneath, curved distally, at 50°–80°; with short \pm prominent secondary nerves; midrib prominent, terete beneath, depressed above; *petiole* 2.5–5 cm long, geniculate. *Panicle* to 8 cm long, compressed, singly or doubly branched, terminal or to 3-axillary. *Flower bud* to 1.5 cm long, slender; petals cream, purplish towards base at first; flowers typical. *Fruit pedicel* to 8 mm long. *Calyx lobes* to 3 by 2 cm, equal, thickly coriaceous, deltoid, acute, \pm reflexed. *Nut* to 2 cm long and \varnothing , globose, faintly 3-sulcate.

Distr. *Malesia*: Borneo (widespread).

Ecol. Leached shallow soils on low hills and on ridges to 700 m inland.

Vern. *Résak mambangan, r. daun panjang*.

b. ssp. elliptifolia ASHTON, Gard. Bull. Sing. 22 (1967) 265, pl. 7; Man. Dipt. Brun. Suppl. (1968) 34.

Twigs c. 3 by 2 mm \varnothing . *Leaves* 12–20 by 3.5–7 cm, elliptic or obovate; base broadly cuneate; acumen to 1 cm long, short, slender; nerves 14–16 pairs, slender, prominent beneath; *petiole* 10–14 mm long, short. *Fruit calyx lobes* to 8 by 4 mm, oblong, obtuse, revolute.

Distr. *Malesia*: Borneo (Central Sarawak, Brunei).

Ecol. Rare, deep sandy soils on subcoastal hills.

c. ssp. crassilobata ASHTON, Gard. Bull. Sing. 22 (1967) 265, pl. 5; Man. Dipt. Brun. Suppl. (1968) 34.

Twigs c. 4 by 2 mm \varnothing , stout. *Leaves* 11.5–21 by 4.5–10.5 cm, broadly oblong; base obtuse or cordate; acumen short, broad; nerves 16–23 pairs, prominent beneath; *petiole* 1.8–2.8 cm long. *Fruit calyx lobes* to 15 by 12 mm, obovate, obtuse to emarginate, subrotate.

Distr. *Malesia*: Borneo (Sarawak, Brunei).

Ecol. Local, Mixed Dipterocarp forests on deep leached sandy soils near Pleistocene coastlines.

d. ssp. multinervosa ASHTON, Gard. Bull. Sing. 22 (1967) 265, pl. 6; Man. Dipt. Brun. Suppl. (1968) 34.

Twig c. 4 by 2 mm, stout. *Leaves* 14–31 by 4–8.5 cm, narrowly obovate; base narrowly obtuse or cuneate; acumen to 1.5 cm, long, slender; nerves 18–27 pairs, very prominently elevated beneath, with prominent short secondaries and tertiaries; *petiole* 1.5–2.5 cm long. *Fruit calyx lobes* to 13 by 8 mm, oblong, obtuse, reflexed.

Distr. *Malesia*: Borneo (Sarawak, Sabah to Nunukan I.).

Ecol. Frequent on deep fertile clay-rich soils; especially on volcanic and basement rocks.

e. ssp. selakoensis ASHTON, Gard. Bull. Sing. 22 (1967) 264, pl. 4; Man. Dipt. Brun. Suppl. (1968) 34.

Twig c. 2 by 1 mm, slender. *Leaves* 6.5–22 by 2.5–6.5 cm, narrowly elliptic, base cuneate, acumen to 1.5 cm long, slender; nerves 11–18 pairs, slender, hardly raised beneath; *petiole* 1.5–2.5 cm long. *Fruit calyx lobes* to 4 by 3 mm, oblong, obtuse.

Distr. Borneo (W. Sarawak).

Ecol. Abundant in summit forests of granodiorite mountains, 600–1400 m.

15. *Vatica dulitensis* SYM. Gard. Bull. S.S. 8 (1934) 35, pl. 10; BROWNE, For. Trees Sarawak & Brunei (1955) 100; ASHTON, Man. Dipt. Brun. (1964) 69, f. 10, pl. 22 (bark); *ibid.* Suppl. (1968) 31; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 308.

Young twig, raceme, leaf bud, stipule (both surfaces), petiole, and leaf nervation beneath shortly densely dark vinous tomentose, caducous on nervation, persistent elsewhere. *Twig* to 1 mm \varnothing apically, slender, much branched, becoming smooth glabrous. *Bud* to 2 by 1.5 mm, broadly ovoid, obtuse. *Stipule* to 3 by 1 mm, narrowly hastate, acute, caducous. *Leaves* 4–11 by 0.8–3.2 cm, thinly coriaceous, narrowly obovate to elliptic-lanceolate, base cuneate; acumen to 1.5 cm long, caudate; nerves 10–12 pairs, slender, hardly raised beneath, curved, at 50°–60°, with short slender secondaries; midrib slender, prominent beneath, applanate above; *petiole* 6–10 mm long, slender. *Panicle* to 2.5 cm long, singly or doubly branched, terminal or axillary. *Flower bud* to 6 mm long, small. *Calyx* densely vinous cinereous; *corolla* cream; *appendage to connective* short, acute; flowers otherwise typical. *Fruit pedicel* to 3 mm long, slender. *Calyx lobes* equal, to 14 by 5 mm, oblong, obtuse, base to 5 mm broad, glabrous outside, vinous caducous puberulent within, becoming rotate to reflexed. *Nut* to 8 mm \varnothing , globose; style remnant to 1 mm long, linear, densely shortly vinous tomentose.

Distr. *Malesia*: Borneo (Sarawak to Sabah, Bulungan).

Ecol. Locally abundant on shale ridges, to 1350 m in Kinabalu area, occasional on undulating clay rich soils in lowlands.

Vern. *Résak tiang*.

16. *Vatica pedicellata* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 125, t. 3, f. 12–14; MERR. En. Born. (1921) 409; SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 111, f. 9;

BROWNE, For. Trees Sarawak & Brunei (1955) 101; ASHTON, Man. Dipt. Brun. Suppl. (1968) 35, f. 5.

Twig, bud, petiole and stipule persistently densely shortly vinous pubescent. *Twig* c. 2 mm \varnothing apically, slender, subterete to slightly compressed, lax; stipule scars short, horizontal. *Bud* to 4 by 2 mm, ovoid, compressed, acute. *Stipule* to 7 by 2 mm, lorate, subacute, caducous. *Leaves* 9–23 by 3.5–7.5 cm, medium-sized, elliptic to lanceolate, coriaceous, with somewhat revolute margin; base obtuse, rarely cuneate, acumen to 2 cm long, slender; nerves 9–15 pairs, slender, hardly raised on either surface but more prominent beneath, at 60°–80°, arched, tending to anastomose distally forming an indistinct looped intramarginal nerve; with many short slender secondaries; tertiary nerves reticulate; midrib prominent beneath, slender but elevated above yet set in a distinct trough; *petiole* 1–2.5 cm long, not geniculate, terete, drying rugulose, shortly evenly vinous pubescent. *Panicle* to 8 cm long, axillary, ribbed, compressed, slender, densely shortly evenly persistently vinous pubescent; singly or slightly doubly branched, branchlets bearing to 6 \pm secund flowers; *bracteoles* fugaceous. *Flower bud* to 6 by 2 mm, fusiform; *calyx* vinous puberulent; *petals* cream with a purplish suffusion outside; flowers otherwise typical. *Fruit* entirely shortly evenly vinous pubescent, caducous on calyx, otherwise persistent. *Pedicel* to 8 mm long, slender. *Calyx lobes* to 6 by 4 mm, oblong, obtuse, revolute, reflexed. *Nut* to 18 by 22 mm, becoming subglobose, subacute; sutures obscure.

Distr. *Malesia*: Borneo (Sarawak west of the Lupar).

Ecol. Locally frequent in Heath forest, usually on shallow rocky soils near coast.

Note. Clearly close to *V. oblongifolia* but lacking its distinctive compressed twig.

17. *Vatica rotata* ASHTON, Gard. Bull. Sing. 22 (1967) 270, pl. 13; Man. Dipt. Brun. Suppl. (1968) 36, f. 5.

Twigs, leaf bud, petiole, and midrib beneath persistently densely vinous sericeous. *Twig* c. 1 mm \varnothing , slender, much branched, terete, smooth. *Leaf bud* c. 2 by 1 mm, ovoid, subacute. *Stipule* unknown, fugaceous. *Leaves* 5.5–10 by 3–5 cm, broadly elliptic, ovate, coriaceous; base obtuse; acumen to 8 mm long; nerves 9–11 pairs, arched, at 65°–80°, hardly raised on either surface; tertiary nerves slender, densely reticulate; midrib prominent beneath, evident towards base above, otherwise obscure, depressed; *petiole* 8–12 mm long, slender, drying vinous to black. Flowers unknown. *Fruit* and *inflorescence* entirely persistently evenly vinous sericeous. *Panicle* to 1.5 cm long, terminal or axillary, slender, terete, singly branched. *Fruit pedicel* to 9 mm long, slender. *Calyx lobes* to 7 by 4 mm, equal, suborbicular, revolute, rotate. *Nut* (immature) c. 4 mm \varnothing , subglobose, obtuse, with 3 indistinct sutures.

Distr. *Malesia*: Borneo (Central Sarawak, Kapuas valley).

Ecol. Mixed Dipterocarp—Heath forest ecotone, deep sandy soil.

18. *Vatica vinosa* ASHTON, Gard. Bull. Sing. 19 (1962) 318, pl. 32; Man. Dipt. Brun. (1964) 79, f. 10; *ibid.* Suppl. (1968) 37.

Young twig, raceme, leaf bud, stipule, petiole and nervation beneath \pm persistently shortly evenly rich vinous pubescent, tending to rub off leaf undersurface. *Twig* to 1.5 mm \varnothing apically, slender, much branched, becoming pale grey and brown mottled, glabrous, frequently thinly cracked and flaked. *Bud* to 1.5 mm long and \varnothing , ovoid, obtuse. *Stipule* to 5 by 2.5 mm, oblong, subacute, caducous. *Leaves* 6–15 by 1.5–4.5 cm, elliptic to lanceolate; base narrow, obtuse to cuneate; acumen to 1.2 cm long, narrow; nerves 12–20 pairs, slender, \pm prominent beneath, curved, close set, at 50°–70° to the midrib, with short slender secondary nerves; midrib slender, prominent, terete below, flat above; *petiole* 6–13 mm long, slender. *Panicle* to 7 cm long, terminal or axillary, terete, singly or doubly branched; *flower bud* to 6 mm long, small; *calyx* sparsely vinous cinereous; *appendage* to *connective* short, obtuse; flowers otherwise typical. *Fruit calyx* densely shortly vinous puberulent on both surfaces; lobes to 9 by 8 mm, equal, obovate, \pm abruptly revolute, thickened, reflexed at base but curving outwards and \pm rotate apically; *nut* to 8 mm \varnothing , globose, densely vinous puberulent; style remnant short.

Distr. *Malesia*: Borneo (N.E. of Rejang valley to E. Sabah and Tarakan).

Ecol. Fertile clay-rich soils in Mixed Dipterocarp forest below 300 m.

Vern. *Resak tangkai ungu*.

19. *Vatica scortechinii* (KING) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 122, t. 3 f. 9, *p.p.*; RIDL, Fl. Mal. Pen. 1 (1922) 244; CRAIB, Fl. Siam. Enum. 1 (1925) 141, *p.p.*; SLOOT, Bull. Jard. Bot. Btzg III, 9 (1927) 73, 108, f. 1e, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 267, *p.p.*; BURK. Dict. (1935) 2224; SYM. J. Mal. Br. R. As. Soc. 19, 2 (1941) 155; Mal. For. Rec. 16 (1943) 227, f. 107; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 319. — *Retinodendron scortechinii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 128; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 157, t. 190.

Medium-sized tree. Young parts ferruginous cinereous, caducous except on twig apices and panicles. *Twig* 3–6 mm \varnothing apically, straight, terete or ribbed especially along the leaf traces, with conspicuous slightly downpointing stipule scars. *Buds* to 5 by 3 mm, ovoid-lanceolate, acute, hidden within to the 35 by 12 mm lanceolate subsistent stipules. *Leaves* 13–40 by 5–16 cm, oblong-lanceolate or oblanceolate, thinly coriaceous; base obtuse or occasionally cordate; margin \pm narrowly revolute; apex subacuminate to acute; nerves 14–25 pairs, arched, slender but prominent beneath, distinctly elevated above as also the midrib, with many short indistinct secondary nerves; tertiary nerves reticulate, distinctly elevated on both surfaces; *petiole* 13–25(–40) mm long, 3–5 mm \varnothing , stout, characteristically puckered on drying. *Panicle* to 9 cm long, axillary to ramiflorous; *flower buds* to

14 by 5 mm, fusiform; *anthers* oblong, tapering, relatively long; appendages very short; *style* somewhat longer than ovary, columnar, capitate; stigma conical, prominent; flowers otherwise typical. *Fruit pedicel* to 5 by 1 mm, slender, long; *calyx lobes* to 7 by 4 mm, lanceolate, subacute, reflexed at base, upcurved distally; *nut* to 15 mm \varnothing , subglobose, with 3 indistinct loculicidal grooves.

Distr. *Malesia*: Malaya (Perak, Selangor, Pahang, Trengganu).

Ecol. Local, on undulating land near coast and to 1800 m on inland ridges.

Vern. *Resak langgong*.

Note. Some sterile collections from the east coast closely resemble *V. sarawakensis*, so far not confirmed from Malaya.

20. *Vatica globosa* ASHTON, Gard. Bull. Sing. 22 (1967) 269, pl. 12; Man. Dipt. Brun. Suppl. (1968) 32, f. 5.

Twig, leaf bud and petiole persistently rufous-brown sericeous. *Twig* c. 2 mm \varnothing apically, terete, smooth, grey; stipule scar short, horizontal, obscure. *Bud* c. 2 by 2 mm, ovoid, acute. *Stipule* unknown. *Leaves* 7–18 by 3–6.5 cm, obovate, somewhat chartaceous; base narrowly cuneate; acumen to 2 cm long, slender, caudate; nerves 12–16 pairs, slender but prominent beneath with the lamina concave between them, distinctly elevated above, at 35°–60°, with many short secondary nerves; tertiary nerves reticulate; midrib prominent on both surfaces, more so beneath than above; *petiole* 7–15 mm long, terete with a distinct furrow above, drying rugulose. *Panicle* to 3 cm, terminal or axillary, frequently several in an axil, congested, ribbed or terete, persistently rufous sericeous; irregularly \pm singly branched; *bracteoles* fugaceous. *Flower bud* to 5 by 2 mm, lanceolate. *Calyx* densely vinous pubescent outside, glabrous within; corolla sparsely so, cream on opening; *appendage to connective* conical, c. $\frac{1}{2}$ length of anther; flowers otherwise typical. *Fruit* entirely persistently rufous sericeous. *Calyx lobes* to 4 by 3 mm, equal, oblong, obtuse, reflexed. *Nut* to 20 mm \varnothing , globose, obtuse, 3-sutured.

Distr. *Malesia*: Borneo (Mukah to Niah valleys, Central Sarawak), W. Borneo (Ulu Kapuas).

Ecol. Very local, Mixed Dipterocarp forest on low hills.

21. *Vatica lobata* FOXW. Mal. For. Rec. 10 (1932) 276, pl. 23; BURK. Dict. (1935) 2224; SYM. Mal. For. Rec. 16 (1943) 221, f. 107.

Small tree. Young parts, calyx and ovary \pm caducous buff cinereous; leaf buds, panicles and petals outside persistently so, otherwise glabrous. *Twig* c. 2 mm \varnothing , slender, pale brown, sometimes chartaceous flaky, terete. *Buds* small, ovoid; *stipules* fugaceous. *Leaves* 7–24 by 2–9.5 cm, elliptic-lanceolate, thinly coriaceous; base \pm narrowly cuneate, subdecurrent; acumen to 15 mm long, slender; nerves c. 5(–8) pairs, ascending, slender but distinctly elevated beneath, less

so above, as also the midrib; tertiary nerves laxly reticulate, hardly elevated on either surface; *petiole* 8–12 mm long, c. mm \varnothing , relatively short. *Panicle* to 5 cm long, terminal or axillary, shortly branched. *Flower buds* to 6 by 2 mm, fusiform; *appendages* very short, deltoid; *style* stoutly columnar, somewhat longer than ovary, expanding at base and at the prominent conical style; flowers otherwise typical. *Fruit pedicel* to 2 by 1 mm; *calyx lobes* to 10 by 8 mm, equal, elliptic, incassate, smooth, lustrous, adnate to the 17 by 15 cm ovoid smooth apiculate nut.

Distr. *Malesia*: Malaya (E. coast: Trengganu to Johore).

Ecol. Local, near streams.

Vern. *Resak paya, r. laru*.

22. *Vatica hullettii* (RIDL.) ASHTON, Gard. Bull. Sing. 31 (1978) 21. — *Capura hullettii* RIDL. J. Str. Br. R. As. Soc. 54 (1910) 36. — *Otophora hullettii* RIDL. Fl. Mal. Pen. 1 (1922) 494; RADLK. in E. & P. Pfl. R. Heft 98 (1932) 775, cf. LEENH. Blumea 17 (1969) 88. — *V. stipulata* RIDL. J. Str. Br. R. As. Soc. 82 (1920) 172, *nom. illeg.*; Fl. Mal. Pen. 1 (1922) 244; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 76; FOXW. Mal. For. Rec. 10 (1932) 253; SYM. Mal. For. Rec. 16 (1943) 229.

Small tree. Ovary, calyx and panicle caducous pale brown puberulent, petioles persistently so. *Twigs* c. 2 mm \varnothing apically, smooth, with prominent ribs decurrent from leaf traces; stipule scars obscure, horizontal. *Buds* hidden between to 33 by 22 mm large ovate to elliptic subacute coriaceous 3–5-nerved persistent stipules. *Leaves* 9–30 by 2–9 cm, narrowly elliptic, coriaceous, frequently somewhat bullate; base cuneate; acumen to 2 cm long; nerves 8–11 pairs, slender but distinctly raised beneath, elevated above as also the midrib, arched, ascending, with short secondary nerves; tertiary nerves reticulate, slightly elevated on both surfaces; *petiole* to 3 cm long, 1–3 mm \varnothing , drying characteristically pale cream brown rugulose. *Panicle* to 15 cm long, lax, irregularly branched, slender. *Flower buds* to 12 by 2 mm; *appendages* small, deltoid; *style* longer than ovary, slender, greatly expanding into the prominent conical stigma; flowers otherwise typical. *Fruit pedicel* to 4 by 1 mm, prominent; *calyx lobes* to 20 by 14 mm, ovate, subacute, loosely enclosing the base of the nut but the sides becoming completely revolute; *nut* to 2 cm \varnothing , subglobose, verruculose, with 3 indistinct loculicidal sutures.

Distr. *Malesia*: Malaya (Negri Sembilan, Malacca, Johore).

Ecol. Rare, lowland dipterocarp forest on hills.

Note. Related to *V. albiramis* (q.v.).

23. *Vatica pallida* DYER, Fl. Br. Ind. 1 (1874) 302; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 121; RIDL. Fl. Mal. Pen. 1 (1922) 244; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 73, 103, f. 1a; FOXW. Mal. For. Rec. 10 (1932) 266; BURK. Dict. (1935) 2224; SYM. Mal. For. Rec. 16 (1943) 225, f. 107. — *Retinodendron pallidum* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 128; BURK. J. Str. Br. R. As. Soc. 81 (1920) 51, 62, 63, fig.

Small, low-branched tree. Young parts pale brown caducous puberulent, persisting on into the young fruit on calyx and ovary. *Twig c.* 1 mm \varnothing apically, slender, straight, terete, smooth, pale grey-brown. *Buds* minute. *Leaves* 6–16 by 2–5.6 cm, narrowly elliptic, thinly coriaceous; base narrowly cuneate; acumen to 2 cm long, slender, subcaudate; nerves 9–11 pairs, arched, ascending, slender, hardly elevated on either surface as also the reticulate tertiary nerves and somewhat more prominent midrib; *petiole* 5–8 mm long, short, slender. *Panicle* to 4 cm long, terminal or subterminal axillary, few branched. *Fruit pedicel* to 4 by 1 mm, slender, long; *calyx lobes* to 8 by 3 mm, lanceolate, loosely clasping the *c.* 1 cm \varnothing subglobose smooth mucronate nut.

Distr. *Malesia*: Malaya (Penang).

Ecol. Common in the forests on the slopes of Penang hill, to 350 m.

Vern. *Résak kèchil*.

Note. Closely allied to *V. philastreana* PIERRE of southern Indo-China and also to *V. lanceaefolia* BL. of Assam.

24. *Vatica flavida* FOXW. Mal. For. Rec. 10 (1932) 272, pl. 22; BURK. Dict. (1935) 2223; SYM. Mal. For. Rec. 16 (1943) 220, f. 107.

Medium-sized tree. Twigs, petioles, leaf buds, midrib above, panicles and nut densely persistently tawny scabrid pubescent, leaf nervation beneath sparsely so,

calyx outside caducously so; outsides of petals densely evenly cream puberulent. *Twigs* 2–3 mm \varnothing apically, prominently ribbed at first, becoming pale brown, terete. *Buds* to 6 by 4 mm, ovoid-lanceolate, acute. *Leaves* 6–11 by 2.5–5 cm, elliptic to narrowly obovate, coriaceous; base broadly cuneate to obtuse; acumen to 1 cm long, slender, prominent; nerves 9–11 pairs, prominent beneath, distinctly depressed above with the leaf surface bullate between, arching within the margin; tertiary nerves subreticulate, distinctly elevated beneath, hardly so above; midrib stoutly prominent beneath, shallowly depressed though evident above; *petiole* 11–15 mm long. *Panicles* to 3.5 cm long, short, axillary, twice branched from the bases, many-flowered and appearing congested about the bases of the leaves. *Flower buds* to 8 by 3 mm, fusiform; *sepals* unequal, ovate-lanceolate; *corolla* pale yellow; *stamens* 15; anthers subglobose, appendages prominent, broadly deltoid; *style* columnar, slightly longer than ovary; stigma conical; flowers otherwise typical. *Fruit pedicel* to 4 mm long, prominent but hidden in the reflexed sepals; *calyx lobes* to 8 by 6 mm, equal, broadly lanceolate, becoming reflexed with the apices recurved upwards; *nut* to 10 by 10 mm, broadly ovoid to subglobose, with 3 distinct loculicidal furrows.

Distr. *Malesia*: Malaya (S. Perak).

Ecol. Rare, in forest on swampy land.

Vern. *Résak padi*.

2. Section Sunaptea

(GRIFF.) BURCK, Ann. Jard. Bot. Btzg 6 (1887) 223; ASHTON, Gard. Bull. Sing. 20 (1963) 250. — *Sunaptea* GRIFF., corr. '*Synaptea*' KURZ. — *Pteranthera* BL. — *Vatica* sect. *Euwatica* B. & H. Gen. Pl. 1 (1862) 192; DYER, Fl. Br. Ind. 1 (1874) 301; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 224; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 102. — *Vatica* subg. *Synaptea* (GRIFF.) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 128.

Fruit calyx lobes unequal, chartaceous, with 2 lobes longer than the other three, not becoming reflexed.

25. *Vatica heteroptera* SYM. J. Mal. Br. R. As. Soc. 19 (1941) 147, pl. 5B; Mal. For. Rec. 16 (1943) 221, f. 107.

Medium-sized tree. Young parts pale brown caducous cinereous, panicle and nut \pm persistently so. *Twig c.* 2 mm \varnothing apically, slender, rather straight, terete, smooth, pale brown. *Bud* to 2 by 2 mm, small, ovoid; *stipule* fugaceous. *Leaf* 9–20 by 3–8 cm, narrowly oblong-elliptic, thinly coriaceous; base narrowly obtuse to broadly cuneate; acumen to 2 cm long; nerves 11–14 pairs, slender but prominent beneath, evident above, arched, with or without short secondary nerves; midrib slender but prominent beneath, sharply elevated above; tertiary nerves densely subreticulate; *petiole* 11–18 mm long, *c.* 2 mm \varnothing , relatively short. *Panicles* to 12 cm long, terminal or axillary, rather straight; flowers unknown. *Fruit pedi-*

cel to 3 by 2 mm; *calyx lobes* to 2.5 by 1 cm, lanceolate, subacute, unequal but patent; *nut* to 15 mm \varnothing , to 12 mm long, depressed-globose; shortly mucronate.

Distr. *Malesia*: Malaya (Perak, Pahang).

Ecol. Locally frequent in Upper Dipterocarp forest on ridges, 1000–1300 m in the Malayan Main Range.

Vern. *Résak gunung*.

26. *Vatica maritima* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 245, f. 32; ASHTON, Man. Dipt. Brun. (1964) 72, f. 10; *ibid.* Suppl. (1968) 33; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 310.

Young twig, panicle, leaf bud and petiole densely shortly evenly \pm persistently cream pubescent. *Twig* to 8 mm \varnothing apically, ribbed or somewhat compressed, becoming terete, glabrous, smooth. *Bud* to 4 by 3 mm,

ovoid, subacute. *Stipule* unknown. *Leaves* 8–16 by 3–8 cm, broadly or narrowly ovate, coriaceous; base broadly cuneate to subcordate, acuminate to 1 cm long, short, broad; nerves 7–10 pairs, raised on both surfaces, more prominently so beneath, with short, slender secondary nerves; tertiary nerves reticulate; *petiole* 2–2.7 cm long, not geniculate. *Panicle* to 11 cm long, axillary, rarely terminal, lax, angular; branchlets to 1.5 cm long, short, with up to 12 close flowers; *bracteoles* to 3 by 2 mm, ovate, subacute, sparsely pubescent. *Flower bud* to 1.4 cm long; *calyx* densely pale brown, tomentose, flowers otherwise typical. *Fruit pedicel* to 4 mm long; *calyx* puberulent at base, otherwise glabrous; 2 longer lobes to 5 by 1 cm, oblong-spatulate, obtuse, base to 3 mm broad, fusing with shorter lobes forming an up to 5 mm \varnothing shallow cup adnate to the base of the fruit; 3 shorter lobes to 13 by 4 mm, lanceolate, acute. *Nut* to 7 by 7 mm, subglobose, sparsely cream pubescent; style remnant to 1 cm long, slender.

Distr. *Malesia*: Borneo (N.E. Kalimantan; Brunei; W. Sabah), also S. Philippines (Palawan).

Ecol. Very local, dry coastal hills in non-seasonal lowland forest.

Vern. *Résak laut*, r.l. *timor* (Borneo).

27. *Vatica teysmanniana* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 230; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 133; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 314; *ibid.* ed. 2 (1927) 1131; SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 90, f. 3. — *Synaptea teysmannii* HEIM, Rech. Dipt. (1892) 100.

Medium-sized to large tree. Twigs, leaf buds and petioles densely persistently pale fawn scabrid pubescent, midrib above and panicles \pm caducously so; parts of petals exposed in bud and ovary densely evenly persistent-puberulent, calyx and pedicel caducously so. *Twig* c. 4 by 2 mm \varnothing apically, compressed at first, becoming terete, \pm ribbed, blackish, with long \pm prominent pale horizontal somewhat descending stipule scars. *Buds* to 6 by 5 mm, ovoid, acute. *Leaves* 9.5–34 by 3–11 cm, variable in size, narrowly elliptic to lanceolate, lustrous, thickly coriaceous; margin narrowly subrevolute; base broadly cuneate to obtuse; apex shortly retuse, obtuse or to 1 cm long broadly acuminate; nerves 13–17 pairs, arched, slender but prominent beneath, less (but distinctly so) above as also the midrib, sometimes with a few short \pm obscure secondary nerves; tertiary nerves densely reticulate, distinctly elevated on both surfaces; *petiole* 13–25 mm long, c. 3 mm \varnothing , stout, not geniculate. *Panicles* to 15 cm long, terminal or axillary, lax, spreading, rather regularly singly or doubly branched; branchlets to 7 cm long, bearing to 7 flowers. *Flower buds* to 12 by 3 mm, large. *Fruit pedicel* to 6 mm long, slender, prominent; calyx lobes unequal; 2 longer lobes to 11 by 1.8 cm, loriate-spatulate, obtuse, c. 4 mm wide at base; 3 shorter lobes to 18 by 6 mm, lanceolate, acute; *nut* to 6 mm \varnothing , globose.

Distr. *Malesia*: Sumatra (E. Coast: Bengkulu), Banka.

Ecol. Mixed swamp forests.

Vern. *Résak ayèr*, r. *payar*, r. *badouw*, r. *siantèn*.

Note. The vegetative parts evoke *V. coriacea* of Borneo, but the fruit calyx, inflorescence and bracts at once distinguish the species.

28. *Vatica cinerea* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 104; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 131; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 150, t. 183A; RIDL, J. Str. Br. R. As. Soc. 61 (1912) 50; Fl. Mal. Pen. 1 (1922) 243; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 312; CRAIB, Fl. Siam. Enum. 1 (1925) 140; SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 80; FOXW. Mal. For. Rec. 10 (1932) 256; BURK, Dict. (1935) 2223; SYM. J. Mal. Br. R. As. Soc. 19 (1941) 157; Mal. For. Rec. 16 (1943) 218, f. 107. — *V. lankaviensis* RIDL, J. Str. Br. R. As. Soc. 54 (1909) 27; CRAIB, Fl. Siam. Enum. 1 (1925) 141. — *Synaptea cinerea* RIDL, Fl. Mal. Pen. 1 (1922) 243. — *Synaptea lankaviensis* RIDL, Fl. Mal. Pen. 1 (1922) 241.

Small or medium-sized tree. Twig, petiole and panicle sparsely pale pink-brown puberulent; outside of perianth and ovary densely so, caducous except on petals and ovary. *Twig* c. 1 mm \varnothing apically, slender, much branched, pale brown, terete, smooth. *Bud* small, ovoid; *stipules* fugaceous. *Leaf* 5.5–14 by 1.5–5 cm, elliptic-lanceolate, thinly coriaceous; base cuneate, apex acute to subacuminate; nerves 9–11 pairs, arched, ascending, slender and hardly more elevated beneath than above as also the midrib and densely reticulate tertiary nerves; *petiole* 5–11 mm long, slender. *Panicle* to 9 cm long, terminal or axillary, irregularly branched. *Flower bud* to 8 by 3 mm, lanceolate; *appendages* very short; *style* columnar, slender, somewhat longer than ovary, capitate; stigma large, conical; flowers otherwise typical. *Fruit pedicel* to 3 by 1 mm, slender, prominent; *calyx* united into an up to 7 mm \varnothing cup at base adnate to the basal $\frac{1}{2}$ of the ovary; 2 longer lobes to 7 by 1.8 cm, spatulate, obtuse, c. 3 mm wide at base; 3 shorter lobes to 15 by 5 mm, lanceolate, acute; *nut* to 7 mm \varnothing , subglobose, with filiform style remnant.

Distr. South Tenasserim, Peninsular Thailand, and in *Malesia*: Malaya (Kedah, Perlis, Langkawi).

Ecol. Dry ridges, headlands, limestone and other rocky places, in *Schima*-bamboo forests, to 600 m.

Vern. *Résak*, r. *laut*.

29. *Vatica odorata* (GRIFF.) SYM. J. Mal. Br. R. As. Soc. 19 (1941) 156; Mal. For. Rec. 16 (1943) 224, f. 107; ASHTON, Gard. Bull. Sing. 22 (1967) 263; *ibid.* 31 (1978) 23.

a. ssp. odorata. — *Hopea faginea* WALL. Cat. (1828) 963, *nomen*. — *Shorea pinangiana* WALL. Cat. (1828) 157, *nomen*; KURZ, J. R. As. Soc. Beng. Sc. 43, 2 (1874) 96, *nomen pro syn.*; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 105, *nomen pro syn. sub V. faginea*. — *Synaptea odorata* GRIFF. Notul. 4 (1854) 516; Ic. Pl. As. (1854) t. 585A, f. 5; HEIM, Rech. Dipt. (1892) 113. — *Hopea grandiflora* WALL. [Cat. (1828) 958, *nomen*] ex A. DC.

Prod. 16, 2 (1868) 634. — *Synaptea grandiflora* KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 65; PIERRE, For. Fl. Coch. 4 (1891) t. 240–242. — *Anisoptera odorata* KURZ, Flora 30 (1872) 191; J. R. As. Soc. Beng. Sc. 43, 2 (1874) 96; Fl. Burma 1 (1877) 112. — *V. grandiflora* DYER, Fl. Br. Ind. 1 (1874) 301; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 101; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 129; Ind. Trees (1906) 72; FOXW. Mal. For. Rec. 10 (1932) 260. — *V. faginea* DYER, Fl. Br. Ind. 1 (1874) 301; KURZ, J. R. As. Soc. Beng. Sc. 43, 2 (1874) 96; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 105; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 129; Ind. Trees (1906) 72; BRANDIS & GILG in E. & P. Pfl. Fam. 3, 6 (1895) 270; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 391; RIDL. Fl. Mal. Pen. 1 (1922) 242, *p.p.*; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 265; HEYNE, Nutt. Pl. ed. 2 (1927) 1129; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 81; FOXW. Mal. For. Rec. 10 (1932) 260. — *V. astrotricha* HANCE, J. Bot. 14 (1876) 241; LANESS. Pl. Util. Colon. Fr. 1 (1886) 299; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 130; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; FISCHER, Kew Bull. (1926) 457; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 80. — *V. dyeri* PIERRE ex LANESS. Pl. Util. Colon. Fr. 1 (1886) 299; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 106; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 128, t. 3, f. 15–17; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 387, 392, fig.; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 82; FOXW. Mal. For. Rec. 10 (1932) 258; BURK. Dict. (1935) 2223. — *Synaptea astrotricha* PIERRE, For. Fl. Coch. 4 (1891) t. 240; HEIM, Rech. Dipt. (1892) 118. — *Synaptea dyeri* PIERRE, For. Fl. Coch. 4 (1891) t. 241; RIDL. Fl. Mal. Pen. 1 (1922) 240. — *Synaptea faginea* PIERRE, For. Fl. Coch. 4 (1892) 242; RIDL. Fl. Mal. Pen. 1 (1922) 242. — *V. curtisii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 105; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 131; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 151, t. 183B; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 81; FOXW. Mal. For. Rec. 10 (1932) 257; BURK. Dict. (1935) 223. — *V. fleuryana* TARDIEU, Not. Syst. 10 (1942) 137; Fl. Gén. I.-C. Suppl. 1 (1943) 359, f. 39 (9–16). — *V. tonkinensis* [CHEVALIER, Bull. Ec. Indochine 20 (1918) 799, *nomen*] TARDIEU, Not. Syst. 10 (1942) 137; Fl. Gén. I.-C. Suppl. (1943) 357, f. 39 (1–8).

Young twig, raceme, leaf bud, stipule, and petiole ± densely persistently pale yellowish brown to fulvous tomentose. *Twig* 1.5 mm \varnothing apically, terete, glabrous, rugose, frequently finely flaked. *Bud* to 2 by 1.5 mm, ovoid, obtuse. *Stipule* to 8 by 2 mm, oblong, obtuse, caducous. *Leaves* 8–16 by 2.7–5.5 cm, narrowly elliptic to ovate, thinly coriaceous, base obtuse or cuneate; acumen to 8 mm long; nerves 11–15, prominent beneath; midrib prominent beneath, appanate above or slightly depressed; *petiole* 8–12 mm long. *Panicle* to 7 cm long; terminal or axillary singly branched. *Flower bud* to 8 mm long; *calyx* densely shortly pale grey-brown tomentose; *appendage to connective* short, obtuse; flowers otherwise typical. *Fruit pedicel* c. 3 mm long, slender. *Fruit calyx* at first powdery tomentose, glabrescent, united in an

up to 5 mm deep, to 8 mm \varnothing , cup at base and fused to nut; 2 longer lobes to 5.5 by 1.5 cm, thin, spatulate, obtuse, base to 2.5 mm broad, 3 shorter lobes to 14 by 4 mm, hastate, acute. *Nut* to 7 mm long and \varnothing , globose, shortly densely yellow-brown to fulvous tomentose, the basal half adnate with the calyx cup; style remnant to 2 mm long, linear.

Distr. Tenasserim, Thailand, Indochina, S. China (Kwangsi), and in *Malesia*: Malaya (Negri Sembilan & Pahang northwards), Borneo (Tawau, S.E. Borneo).

Ecol. Scattered on dry ridges in coastal forests in \pm seasonal areas.

Vern. *Résak runting kēsāt*.

b. ssp. mindanensis (Foxw.) ASHTON, Gard. Bull. Sing. 22 (1967) 263; Man. Dipt. Brun. (1964) 75 (as *V. odorata*; f. 10); *ibid.* Suppl. (1968) 34 (*ditto*); Gard. Bull. Sing. 31 (1978) 24. — *V. mindanensis* Foxw. in Elmer, Leaf. Philip. Bot. 6 (1913) 1957; Philip. J. Sc. 13 (1918) Bot. 196; *ibid.* 67 (1938) 327; MERR. En. Philip. 3 (1923) 102; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 71; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 313. — *V. sorsogonensis* Foxw. Philip J. Sc. 13 (1918) Bot. 196. — *V. aerea* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1941) 133, f. 19.

Differing from *ssp. odorata* in the 15–20 mm long geniculate petiole and leaf drying greyish rather than yellow-brown.

Distr. *Malesia*: Borneo (Kapuas hinterland; Sarawak to Crocker range; Tawau); Philippines (Luzon, Leyte, Mindanao).

Ecol. Common on ridges between 1000–1200 m, in non-seasonal areas.

Vern. *Résak biabas* (Borneo).

30. *Vatica compressa* ASHTON, Gard. Bull. Sing. 22 (1967) 267, pl. 10; Man. Dipt. Brun. Suppl. (1968) 30, f. 5.

Young parts (except stipule within) evenly pale pink-brown pubescent, caducous except on leaf bud and stipule outside. *Twig* c. 3 by 1 mm \varnothing , compressed, smooth; stipule scars c. 2 mm long at first, pale, horizontal, prominent. *Bud* c. 3 by 3 mm, ovoid, acute, compressed. *Leaves* 11–19 by 5–8.5 cm, ovate-elliptic, coriaceous; base obtuse; acumen to 1 cm long; nerves 10–15 pairs, slender, only slightly raised beneath, less so above, arched, at c. 50°, with short indistinct secondary nerves; tertiary nerves scalariform; midrib prominent beneath, appanate or raised above; *petiole* 15–23 mm long. *Panicle* to 7 cm long, somewhat compressed, sparsely pale pink-brown pubescent, irregularly singly or doubly branched. *Flower bud* to 9 by 4 mm, lanceolate; *calyx* densely pale fulvous pubescent; corolla densely pubescent on parts exposed in bud; flowers otherwise typical. *Fruit pedicel* to 8 mm long, slender, pubescent. *Calyx* puberulent to glabrescent; 2 longer lobes to 6.5 by 1 cm, loriate, \pm obtuse, c. 3 mm broad at base; 3 shorter lobes to 20 by 6 mm, deltoid, acute, revolute. *Nut* to 5 mm \varnothing , shortly ovoid, densely shortly buff pubescent; style remnant to 3 mm long glabrous.

Distr. *Malesia*: Borneo (Sarawak W. of Lupar valley).

Ecol. Local in Heath forest, often with impeded drainage.

31. *Vatica congesta* ASHTON, Gard. Bull. Sing. 22 (1967) 268, pl. 11; Man. Dipt. Brun. Suppl. (1968) 31, f. 5.

Young twigs, buds, stipules and petioles densely shortly pale ocherous-brown scabrid pubescent, leaf beneath and midrib above towards base sparsely so. *Twig* c. 3 mm \varnothing towards apex, stout, at first angular, rugose, becoming striated and chartaceous flaky. *Bud* to 4 by 3 mm, broadly ovoid-conical, acute. *Stipule* to 8 by 3 mm, narrowly deltoid, acute. *Leaves* 8–22 by 3.5–8 cm, oblong-elliptic to obovate, thickly coriaceous, subacuminate, obtuse or retuse; margin revolute; base obtuse; nerves 7–11 pairs, slightly raised above, stout and prominent beneath, at 40°–65°; tertiary nerves prominent beneath, less so above, reticulate; midrib hardly raised above, stout, prominent, striated, beneath; *petiole* 1.2–2.5 cm long, stout, rugulose. *Panicle* to 3 cm long, angular, densely shortly ocherous-brown scabrid tomentose, axillary to ramiflorous, fascicled, short, and congested; singly branched, branchlets to 1.8 cm long. *Flowers* distichous; *bud* to 8 by 3 mm; *calyx lobes* densely shortly ocherous-brown tomentose, deltoid, acute, somewhat spreading in bud; *petals* lorate, obtuse, densely pubescent on both surfaces; *appendage to connective* short, bifid; *style* short, sericeous; flowers otherwise typical. *Fruit pedicel* sparsely shortly ocherous-brown scabrid tomentose, fruit otherwise glabrous. *Pedicel* to 4 mm long, slender. 2 longer *calyx lobes* to 12 by 2.2 cm, lorate, obtuse, prominently recurved. *Nut* to 12 by 8 mm, ellipsoid, glabrous; style remnant to 6 mm long, slender.

Distr. *Malesia*: Borneo (W. and Central Sarawak; W. Kalimantan; Lower Kapuas).

Ecol. Rare, low hills, Mixed Dipterocarp forest.

32. *Vatica coriacea* ASHTON, Gard. Bull. Sing. 19 (1962) 314, pl. 30; Man. Dipt. Brun. (1964) 68, f. 10; *ibid.* Suppl. (1968) 31.

Young twig, panicle, leaf bud, stipule and petiole densely shortly ocherous pubescent, caducous on all but bud. *Twig* to 5 mm \varnothing apically, stout, ribbed, glabrous, smooth. *Bud* to 7 by 5 mm, ovoid, subacute. *Stipule* to 13 by 5 mm, hastate, subacute. *Leaves* 6.5–15 by 2.2–6 cm, thickly coriaceous, obovate, \pm strongly cupped towards margin; base narrow, obtuse or cuneate; apex obtuse to retuse; nerves 10–11 pairs, slightly raised on both surfaces, indistinct, curved, at 50°–60°, with short slender secondary nerves; midrib stout, prominent, terete beneath, slightly raised above; *petiole* 1–1.5 cm long. *Panicle* to 20 cm long, axillary or terminal, singly branched; limits of inflorescence ill-defined, often bearing leaf-like bracts. *Flowers* to 1.8 cm long; *calyx* densely shortly pale grey-brown pubescent; flowers typical. *Fruit pedicel* to 7 mm long, slender; *calyx* shortly persistently pubes-

cent outside, glabrescent within, free to base; 2 longer lobes to 7 by 2.3 cm, oblong, obtuse, to 3.5 mm broad at base; 3 shorter lobes to 2 by 6 mm, hastate, acute. *Nut* to 8 mm \varnothing , and globose, puberulent or glabrescent, rugulose, frequently crowned with an up to 2 mm long linear style remnant.

Distr. *Malesia*: Borneo (Sarawak, Brunei).

Ecol. Locally frequent, Heath forest on podsols on coastal raised beaches, and on rentzinas over limestone in the west.

Vern. *Resak daun tēbal*.

33. *Vatica javanica* SLOOT, Bull. Jard. Bot. Btzg III, 16 (1940) 451, f. 9; BACKER & BAKH. f. Fl. Java 1 (1963) 332; ASHTON, Gard. Bull. Sing. 31 (1978) 22.

a. *ssp. javanica*.

Medium-sized to large tree. Twigs, petioles, panicles, pedicels and base of calyx outside densely persistently tawny scabrid pubescent; leaf undersurface frequently more sparsely so; fruit calyx caducously so. *Twig* c. 3 mm \varnothing apically, stout, \pm compressed at first and ribbed, becoming terete, smooth. *Leaf bud* to 8 by 5 mm, ovoid, acute. *Leaves* 13–24 by 6–10 cm, elliptic-oblong or obovate, applanate, thinly coriaceous; base obtuse or subcordate; acumen to 1.5 cm long, \pm prominent; nerves 22–25 pairs, \pm straight, ascending, \pm distinctly branching and arching within the margin forming a looped intramarginal nerve, stoutly prominent beneath, elevated above as also the midrib, without distinct secondary nerves; tertiary nerves subscalariform, prominent beneath, evident above; *petiole* 2–3 cm long, c. 3 mm \varnothing , stout. *Panicles* to 12 cm long, terminal or axillary, rather straight, irregularly doubly branched. *Flower buds* to 11 by 4 mm, fusiform; *sepals* narrowly lanceolate, unequal; *anthers* subglobose; appendages very short; *style* c. 1½ times as long as ovary, expanding distally; stigma conical; flowers otherwise typical. *Fruit pedicel* to 8 mm long, slender; *calyx lobes* unequal, free to base; 2 longer lobes to 7.5 by 1.7 cm, spatulate, obtuse; 3 shorter lobes to 30 by 7 mm, lanceolate, slender; *nut* globose, unknown at maturity.

Distr. *Malesia*: W. Java (Priangan Regencies, once collected).

Ecol. Primary forest, 950 m.

b. *ssp. scaphifolia* (KOSTERM.) ASHTON, Gard. Bull. Sing. 31 (1978) 22. — *V. scaphifolia* KOSTERM. New & Crit. Mal. Pl. 3 (1955) 2, f. 1.

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

Distr. *Malesia*: S.E. Borneo (Samarinda, Balikpapan).

Ecol. Locally frequent in Lowland Dipterocarp forest on well drained undulating land.

34. *Vatica brunigii* ASHTON, Gard. Bull. Sing. 22

(1967) 267, pl. 9; Man. Dipt. Brun. Suppl. (1968) 30, f. 5.

Young twigs, buds, stipules, petioles, and leaf beneath persistently shortly yellowish buff scabrid pubescent; leaf above fugaceous flocculent tomentose. *Twig* c. 2 mm \varnothing towards apex, slender, terete. *Bud* to 3 by 2 mm, ovoid-conical, obtuse. *Stipule* to 5 by 2 mm, lorate, obtuse; acumen to 1 cm long; nerves 9–12 pairs, unraised above, slender but prominent beneath, at 65°–80°; midrib hardly raised above, prominent beneath; tertiary nerves scalariform, obscure above, slightly raised beneath; *petiole* 8–15 mm long. *Panicle* to 12 cm long, terete or angular, densely shortly persistently ocherous scabrid tomentose, terminal or axillary but confined to young twigs; singly (if axillary) or doubly (if terminal) branched, branchlets to 6 cm long; bracteoles to 3 by 1 mm, elliptic, sparsely pubescent. Flowers distichous; *flower buds* to 8 by 2 mm, ellipsoid; calyx densely shortly ocherous-grey pubescent; *petals* narrowly oblong, obtuse, sparsely pubescent outside, glabrescent within; appendage to connective short, erect, exceeding apex of anther; *style* columnar, longer than ovary; flowers otherwise typical. *Fruit pedicel* and *calyx* sparsely buff pubescent, nut densely scabridly so. *Pedicel* to 3 mm long, slender; 2 longer *calyx lobes* to 6.5 by 1.5 cm, lorate to spatulate, obtuse; 3 shorter lobes to 15 by 6 mm, ovate, acute, slightly recurved. *Nut* to 9 by 7 mm, ovoid, subacute.

Distr. *Malesia*: E. Sumatra (P. Musala, Lower Langkat, Riouw), Borneo (Pontianak, Sarawak, Brunei).

Ecol. Heath forest on shallow podsols, terraces, plateaux and cuestas, coastal areas and dry ridges to 700 m.

35. *Vatica pachyphylla* MERR. Philip. J. Sc. 13 (1918) Bot. 311; En. Philip. 3 (1923) 102; Foxw. Philip. J. Sc. 67 (1938) 325.

Twigs, petioles, panicle, parts of petals exposed in bud and ovary densely persistently pale tawny somewhat scurfy pubescent, leaf undersurface and midrib above \pm caducously so. *Twig* c. 3 mm \varnothing , stout, rugose, with prominent raised petiole scars. *Leaves* 7–15 by 2.8–7.5 cm, elliptic, coriaceous, dull beneath, lustrous above; base \pm broadly cuneate, acumen to 1 cm long, slender, prominent, nerves 10–11 pairs, ascending at c. 45°, rather straight, prominent beneath, somewhat less so above, as also the midrib; tertiary nerves densely reticulate, distinctly \pm equally elevated on both surfaces; *petiole* 17–23 mm long. *Panicle* to 7 cm long, axillary, stout, irregularly doubly branched. *Flower bud* to 9 by 3 mm; sepals narrowly deltoid, unequal; anthers narrowly oblong, tapering; appendages slender but prominent; *style* slightly longer than ovary, expanding distally, capitate; *stigma* conical; flower otherwise typical. *Fruit pedicel* to 4 mm long, slender; 2 longer *calyx lobes* to 7 by 1.3 cm, broadly spatulate, obtuse, c. 5 mm broad at base; 3 shorter lobes to 20 by 8 mm, narrowly elliptic-lanceolate, acute; *nut* to 8 mm \varnothing , broadly ovoid or subglobose, mucronate.

Distr. *Malesia*: Philippines (E. Luzon, Polillo).

Ecol. Scattered in non-seasonal evergreen dipterocarp forests below 80 m.

Vern. *Hagakhae na itim*, *dadiangao*, *tamahuan* (Camarines), *manapo* (Tayabas), *yacal* (Polillo), *banic* (Cagayan).

36. *Vatica obovata* SLOOT. [Med. Proefst. Boschw. 2 (1925) 132, *nomen*] Bull. Jard. Bot. Btzig III, 9 (1927) 89, f. 2.

Medium-sized tree. Twigs, petiole, leaf buds, stipules, nut, fruit pedicel and midrib and nerves beneath densely \pm persistently evenly pale brown puberulent, leaf undersurface and fruit calyx sparsely so. *Twig* c. 2 mm \varnothing apically, ribbed at first, becoming terete. *Leaf bud* to 5 by 4 mm, ovoid, acute; *stipule* to 8 by 3 mm, lanceolate, fugaceous. *Leaves* 8–15 by 9.5–7 cm, elliptic to obovate, thinly coriaceous; margin narrowly subrevolute; base narrowly obtuse; acumen to 1.5 cm long, downcurved and twisting over on pressing; nerves 11–14 pairs, arched, slender but prominent beneath, evident and slightly elevated above as also the midrib; tertiary nerves subscalariform, very slender but slightly elevated on both surfaces; *petiole* 15–20 mm long, slender, prominently geniculate. Flowers and inflorescences unknown. *Fruit pedicel* to 5 mm long; *calyx lobes* unequal, 2 longer lobes to 6.5 by 1.5 cm, spatulate, subacute, c. 5 mm broad at base; 3 shorter lobes to 1.5 by 6 mm, lanceolate-acuminate; *nut* to 6 mm \varnothing , subglobose.

Distr. *Malesia*: Sumatra (Palembang).

Vern. *Resak lingga*.

37. *Vatica borneensis* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 230; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 133; MERR. En. BORN. (1921) 408; SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 87; BROWNE, For. Trees Sarawak & Brunei (1955) 100; ASHTON, Gard. Bull. Sing. 20 (1963) 252; Man. Dipt. Brun. (1964) 68, f. 10; *ibid.* Suppl. (1968) 30. — *V. urbanii* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 956; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 133; MERR. En BORN. (1921) 409; SLOOT. Bull. Jard. Bot. Btzig III, 9 (1927) 77. — *Sunaptea borneensis* HEIM, Rech. Dipt. (1892) 116. — *Sunaptea urbanii* HEIM, Rech. Dipt. (1892) 115. — *V. beccarii* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 133, *nomen in syn.*

Young twig, panicle, leaf bud, midrib beneath and petiole \pm persistently densely evenly pink-brown puberulent. *Twig* to 1.5 mm \varnothing apically, slender, ribbed or terete, becoming smooth or rugulose. *Bud* to 2 by 1.5 mm, ovoid, acute. *Stipule* unknown. *Leaves* 6–10 by 2.5–5 cm, elliptic, coriaceous; base cuneate; acumen to 6 mm long; nerves 7–9 pairs, hardly raised on either surface, at 30°–35°, strongly curved, with short secondary nerves; midrib slender, prominent beneath, \pm applanate above; *petiole* 1.5–2.5 cm long, slender, not swollen distally. *Panicle* to 5 cm long, axillary, terete, densely pink-brown pubescent. *Flower bud* to 1 cm long; densely pink-brown pubescent; flowers otherwise typical. *Fruit pedicel* c. 5 mm long,



Fig. 46. Close-up of inflorescence of *Vatica bantamensis* (HASSK.) B. & H. ex MIQ. Cult. Hort. Bog. July 1955.

slender; calyx caducous rufous powdery tomentose; lobes free to base; 2 longer lobes to 5.5 by 1.5 cm, oblong-spatulate, to 4 mm broad at the non-revolute base; 3 shorter lobes to 1.8 by 7 mm, unequal, narrowly ovate, tapering, acute, slightly constricted at base, not revolute. Nut to 1 cm \varnothing , globose, puberulent to glabrous, crowned by a short acute style remnant.

Distr. *Malesia*: Borneo (Sarawak, Brunei).

Ecol. Leached sandy soils, coastal hills and inland ridges to 900 m; pole forest.

Vern. *Resak kĕmudi*.

38. *Vatica bantamensis* (HASSK.) B. & H. ex MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85, cf. B. & H. Gen. Pl. 1 (1862) 192; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 231, t. 28; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 132; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 270; K. & V. Bijdr. 5 (1900) 129; KOORD. Exk. Fl. Java 2 (1912) 622; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 265; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 87; BACKER & BAKH. f. Fl. Java 1 (1963) 332. — *Anisoptera bantamensis* HASSK. Retzia 1

(1855) 140; WALP. Ann. 4 (1857) 336; MIQ. Fl. Ind. Bat. 1, 2 (1859) 501; DC. Prod. 16, 2 (1868) 615. — *Synaptea bantamensis* KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 65; PIERRE, For. Fl. Coch. 4 (1892) t. 258; HEIM, Rech. Dipt. (1892) 113. — Fig. 46.

Medium-sized tree, to 30 m. Young parts densely evenly pale ochreous buff puberulent, persistently so on ovary, panicle, calyx, and parts of petals exposed in buds; becoming sparse or glabrous on fruit calyx. Twig c. 2 mm \varnothing apically, terete, \pm rugulose. Buds minute. Leaves (4.5–)7.5–18 by (1.8–)3.5–7.5 cm, elliptic or lanceolate, coriaceous, \pm lustrous; base cuneate; acumens to 1 cm long, slender; nerves 9–11 pairs, slender, arched, ascending, distinctly and almost equally elevated on both surfaces as also the short \pm obscure secondary and densely reticulate tertiary nerves; midrib prominent beneath, distinctly but less prominently elevated above; petiole (10–)14–22 mm long, slender, distinctly geniculate. Panicle to 7 cm long, terminal or axillary, irregularly doubly branched. Flower bud to 9 by 3 mm, fusiform; sepals unequal; anthers narrowly oblong, tapering; appendage very short, conical; style longer than ovary, columnar, expanding from base; stigma shortly conical; flowers otherwise typical. Fruit pedicel to 5 mm long, slender; calyx lobes unequal, united into a shallow, to 5 by 10 mm cup at base adnate to the nut; 2 longer lobes to 9 by 2.5 cm, broadly spatulate, obtuse, c. 6 mm broad at base; 3 shorter lobes to 2.5 by 9 mm, lanceolate, narrowly subacuminate; nut to 10 mm \varnothing , subglobose.

Distr. *Malesia*: W. Java (S.W. Bantam: Udjong Kulon).

Ecol. Rare, evergreen forests.

39. *Vatica mangachapoi* BLCO, Fl. Filip. ed. 1 (1837) 401; DC. Prod. 16, 2 (1868) 623; VIDAL, Sinopsis (1883) t. 15B, f. 1–6; Rev. Pl. Vasc. Philip. (1886) 61; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 134; MERR. Publ. Govt. Lab. Philip. 27 (1905) 22; Philip. J. Sc. 1 (1906) Suppl. 98; Sp. Blanc. (1918) 272; En Philip. 3 (1923) 101; WHITFORD, Philip. Bur. For. Bull. 10, 2 (1911) 76, t. 81; FOXW. Philip. J. Sc. 6 (1911) Bot. 282; *ibid.* 13 (1918) Bot. 196; *ibid.* 67 (1938) 321; REYES, Philip. J. Sc. 22 (1923) 320; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 94; in Merr. Pl. Elm. Born. (1929) 205; BROWNE, For. Trees Sarawak & Brunei (1955) 101; ANDERSON, Gard. Bull. Sing. 20 (1963) 159; ASHTON, *ibid.* 20 (1963) 253; Man. Dipt. Brun. (1964) 71, f. 10; *ibid.* Suppl. (1968) 33; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 310, f. 54; ASHTON, Gard. Bull. Sing. 31 (1978) 22.

a. ssp. mangachapoi. — *Mocanera mangachapoi* BLCO, Fl. Filip. ed. 1 (1837) 450. — *V. sinensis* (non GMEL.) BLCO, Fl. Filip. ed. 1 (1837) 401; *ibid.* ed. 2 (1845) 280; *ibid.* ed. 3, 2 (1878) 156, 'chinensis'; DC. Prod. 16, 2 (1868) 623. — *V. apterantha* BLCO, Fl. Filip. ed. 2 (1845) 281; *ibid.* ed. 3, 2 (1878) 156. — *Dipterocarpus mangachapoi* BLCO, Fl. Filip. ed. 2 (1845) 313; *ibid.* ed. 3, 2 (1878) 216; DC. Prod. 16, 2 (1868) 614. — *Shorea*

mangachapoi Bl. Mus. Bot. Lugd.-Bat. 2 (1852) 34; DC. Prod. 16, 2 (1868) 632; WALP. Ann. 4 (1857) 518; F.-VILL. Nov. App. (1880) 21. — *Pteranthera sinensis* Bl. Mus. Bot. Lugd.-Bat. 2 (1852) 30. — *Pteranthera mangachapoi* Bl. l.c. — *Anisoptera mangachapoi* DC. Prod. 16, 2 (1868) 616. — *V. scaphala* (non DYER) F.-VILL. Nov. App. (1880) 21. — *V. bureavi* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 955; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 133, t. 3, f. 20–21; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 76. — *Synaptea bureavi* HEIM, Rech. Dipt. (1892) 114. — *V. reticulata* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 106, non (THW.) A. DC. 1868; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 131; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 83; FOXW. Mal. For. Rec. 10 (1932) 259, p.p.; BURK. Dict. (1935) 2224. — *Cotylolebia philippinense* HEIM ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 134, nomen in syn. — *Synaptea reticulata* RIDL. Fl. Mal. Pen. 1 (1922) 243. — *V. whitfordii* FOXW. Philip. J. Sc. 67 (1938) 322, pl. 8. — *V. patula* SYM. J. Mal. Br. R. As. Soc. 19, 2 (1941) 148, pl. 5A; Mal. For. Rec. 16 (1943) 226, f. 107.

Young twig, panicle, petiole, leaf bud, and stipule shortly densely cream pubescent, \pm caducous on all but bud and panicle. *Twig* to 1.5 mm \varnothing apically, smooth. *Leaf bud* to 2 by 1.5 mm, ovoid, obtuse. *Stipule* to 5 by 2 mm, narrowly oblong, subacute. *Leaves* 6–11 by 2.7–5 cm, coriaceous, elliptic; base cuneate; acumen to 7 mm long; nerves 7–9 pairs, slender, hardly raised on either surface, slightly curved, at 45°–60°; no distinct secondary nerves; midrib rounded beneath, raised above; *petiole* 5–11 mm long, short. *Panicle* to 14 cm long, terete, singly or doubly branched, terminal or axillary. *Flower buds* to 1.2 cm long; calyx shortly densely cream-buff pubescent; *appendage to connective* sharply acute; flowers otherwise typical. *Fruit pedicel* to 4 mm long, slender. *Calyx* glabrous; 2 longer lobes to 5.5 by 1.5 cm, spatulate, obtuse; base to 3 mm broad, free to pedicel; 3 shorter lobes to 10 by 4 mm, lanceolate, acute. *Nut* to 4 by 6 mm, subglobose, glabrescent; style remnant, short, abrupt.

Distr. Peninsular Thailand, in *Malesia*: N. Malaya (N. Perak and Trengganu northwards), Borneo (Sarawak and Brunei; E. Sabah), Philippines.

Ecol. Common, becoming gregarious, especially on dry ridges to 800 m, in more seasonal parts of range; confirmed to Heath forest on podsols and shallow peats below 400 m near coast in W. and Central Borneo.

Vern. *Résak julong* (Malaya), *r. bajau* (Sabah), *narig, karig* (Philippines).

b. ssp. obtusifolia (ELMER) ASHTON, Gard. Bull. Sing. 31 (1978) 23. — *V. obtusifolia* ELMER, Leaf. Philip. Bot. 4 (1912) 1471; FOXW. Philip. J. Sc. 13 (1918) Bot. 196; *ibid.* 67 (1938) 323; MERR. En. Philip. 3 (1923) 102.

Leaf small, thickly coriaceous, obtuse to subacuminate. *Panicle* not exceeding 6 cm long.

Distr. *Malesia*: S.W. Philippines (Palawan), N. Borneo (E. Sabah).

Ecol. Rocky exposed ridges and plateaux, very local.

Note. A species with much local variation, especially in the Philippines. Forms approaching both *V. odorata* ssp. *mindanensis* and *V. pachyphylla* occur and suggest hybridisation.

40. *Vatica parvifolia* ASHTON, Gard. Bull. Sing. 19 (1962) 316, pl. 31; Man. Dipt. Brun. (1964) 76, f. 10; *ibid.* Suppl. (1968) 35.

Young twig, panicle, leaf bud, and petiole densely ferruginous powdery tomentose, stipule sparsely so. *Twig* to 1 mm \varnothing apically, much branched, becoming glabrous, smooth. *Bud* to 3 by 1.5 mm, ovoid, subacute. *Stipules* to 5 by 1 mm, linear, caducous. *Leaves* 2.8–6 by 1–2.3 cm, coriaceous, narrowly ovate to lanceolate; base obtuse; acumen to 1 cm long, caudate; nerves c. 8 pairs, indistinct, unraised, strongly curved, at 60°–75°; midrib slender, prominent beneath, appanate above; *petiole* 6–9 mm long. *Panicle* to 2 cm long, terminal or axillary, terete, singly branched. *Flower bud* to 6 mm long, small; *calyx* grey-brown pubescent; flowers otherwise typical. *Fruit pedicel* to 3 mm long, slender. *Fruit calyx* glabrescent but for the persistently puberulent base, lobes free to the pedicel; longer lobes to 6 by 0.7 cm, subequal, oblong, narrowly obtuse, revolute above the abruptly constricted base; 3 shorter lobes to 10 by 7 cm, subequal, broadly ovate, acute, cordate at base, prominently revolute. *Nut* to 5 by 3.5 mm, broadly ovoid, obtuse, shortly fulvous pubescent.

Distr. *Malesia*: Borneo (Sarawak and Brunei).

Ecol. Rare, Heath forest below 600 m.

Vern. *Résak kërangas padi*.

41. *Vatica rynchocarpa* ASHTON, Gard. Bull. Sing. 22 (1967) 270, pl. 14; Man. Dipt. Brun. Suppl. (1968) 36. — *V. sp.* ASHTON, Man. Dipt. Brun. (1964) 80.

Young twig, raceme, leaf bud, stipule, and petiole shortly sparsely grey puberulent, glabrescent. *Twig* to 1 mm \varnothing apically, slender, terete, becoming smooth. *Bud* to 1.5 by 1 mm, conical, subacute. *Stipule* to 2.5 mm long, narrowly hastate, acute, fugaceous. *Leaves* 5–8.5 by 1.3–2.5 cm, narrowly elliptic to lanceolate, thinly coriaceous; base obtuse; acumen to 1 cm long, narrow; nerves 10–14 pairs, slender, curved near the margin, hardly raised beneath, at 75°–85°, well spaced, with short obscure secondary nerves; midrib slender, raised beneath, slightly depressed, especially towards the base, above; *petiole* to 4 mm long, short, slender. *Flowers* unknown; *panicle* to 3 cm long, terminal or axillary, singly branched, pale brown puberulent. *Fruit pedicel* to 7 mm long, slender; *calyx* entirely glabrous, lobes free to base; 2 longer lobes to 6.2 by 1.4 cm, chartaceous, spatulate, narrowly obtuse, to 2.5 mm broad at base; 3 shorter lobes to 15 by 2.5 mm, hastate, acute. *Nut* to 18 by 8 mm, ovoid, glabrous, drying black; style remnant to 4 mm long, linear.

Distr. *Malesia*: Borneo (from Kapuas and Rejang valleys north-eastwards to S.E. Sabah).

Ecol. Locally frequent on clay alluvium river banks.

42. *Vatica endertii* SLOOT. Bull. Bot. Gard. Btzg III, 18 (1942) 248, f. 34; ASHTON, Man. Dipt. Brun. Suppl. (1968) 32, f. 5.

Young twig, bud, petiole and occasionally nervation beneath shortly pale grey-brown caducous puberulent. *Twig* c. 1 mm \varnothing apically, terete, much branched, at first striated, becoming smooth; stipule scars short, obscure. *Bud* to 2 by 2 mm, subglobose. *Stipule* fugaceous. *Leaves* 4.8–14 by 1.7–5.5 cm, narrowly oblong to obovate or rarely lanceolate, chartaceous; margin revolute; base cuneate; acumen to 1 cm long, slender; nerves 11–14 pairs, unraised above, prominent beneath, at 55°–60°, without secondary nerves; tertiary nerves scalariform, slender but elevated beneath; midrib hardly raised above, prominent beneath; *petiole* 8–20 mm long. *Flowers* unknown. *Panicle* to 3 cm long, singly branched, terete, striated, shortly evenly persistently grey-brown puberulent. *Fruit pedicel* to 8 mm long, slender. *Calyx* glabrescent; 2 longer lobes to 8 by 2 cm, oblong-spatulate, obtuse, c. 3 mm broad above the base; 3 shorter lobes to 20 by 6 mm, lanceolate, acute, to c. 3 mm broad at base, hardly recurved. *Nut* to 6 by 5 mm, subglobose, buff sericeous.

Distr. *Malesia*: Borneo (Central Sarawak, Tawau area, W. Kutei, Sangkulirang).

Ecol. Mixed Dipterocarp forest, especially on acid tuffaceous rocks, in lowlands but usually 700–1000 m.

43. *Vatica brevipes* ASHTON, Gard. Bull. Sing. 31 (1978) 24.

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

Distr. *Malesia*: Borneo (Sarawak: Ulu Rejang).

Ecol. Local, in Mixed Dipterocarp forest, to 700 m.

44. *Vatica micrantha* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 246, f. 33; ASHTON, Man. Dipt. Brun. (1964) 73, f. 10; *ibid.* Suppl. (1968) 33; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 312.

Young twig, panicle, leaf bud, stipule, and petiole densely \pm persistently pale brown scabrid tomentose, leaf nervation beneath and midrib above sparsely so. *Twig* to 2 mm \varnothing apically, terete, smooth or slightly striated. *Bud* to 3.5 by 2 mm, ovoid, acute. *Stipule* to 7 by 3 mm, hastate, acute. *Leaves* 4.5–16 by 1.5–6 cm, thinly coriaceous, elliptic-oblong to lanceolate; base obtuse; acumen to 1.5 cm long, narrow; nerves 8–11 pairs, slender, curved, at 55°–70°, raised beneath, the lamina frequently bullate between them; secondary nerves slender, short; midrib slender, prominent beneath, \pm applanate above; *petiole* 5–10 mm long. *Panicle* to 7.5 cm long, terete, terminal or axillary, singly branched; *flower bud* to 1.3 cm long; *calyx* shortly pubescent; *corolla* cream, suffused with violet towards base outside at first; flowers otherwise typical. *Fruit pedicel* to 2.5 mm long, short; *calyx* sparsely glabrescent, free to the impressed base; 2 longer lobes to 5.8 by 1.5 cm, chartaceous, oblong-spatulate, subacute, base to 3 mm broad, revolute; 3 shorter lobes to 25 by 6 mm, ovate, caudate-acuminate, similar at base. *Nut* to 14 by 8 mm, ellipsoid, obtuse, shortly pale yellow-brown pubescent; style remnant short or usually absent.

Distr. *Malesia*: Borneo.

Ecol. Widespread in Mixed Dipterocarp forest below 600 m, especially on sedimentary rocks.

Vern. *Resak hijau* (Brun.), *r. bulu* (Sabah).

45. *Vatica flavovirens* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 252, f. 36; Reinwardtia 2 (1952) 66.

Medium-sized tree. Young twig, petiole and calyx densely evenly \pm caducous pale ochreous buff pubescent; panicle, ovary, fruit pedicel and part of petals exposed in bud persistently so. *Twig* c. 2 mm \varnothing apically, terete, rugulose, drying dark brown. *Leaves* 8–21 by 2–7 cm, narrowly elliptic to lanceolate, coriaceous, \pm lustrous, margin subrevolute; base cuneate or occasionally obtuse; acumen to 1 cm long or short, tapering; nerves 12–14 pairs, arched, slender but \pm distinctly and equally elevated on both surfaces as also the midrib, short \pm obscure secondary nerves, and densely reticulate tertiary nerves; *petiole* 13–25 mm long, slender. *Panicle* to 14 cm long, terminal or axillary, \pm irregularly doubly branched. *Flower buds* to 10 by 3 mm; sepals narrowly lanceolate, unequal; *anthers* ellipsoid; appendage very small; style as long as ovary, short, capitate; stigma deltoid; flowers otherwise typical. *Fruit pedicel* to 4 mm long, slender; calyx lobes unequal, free to base; 2 longer lobes to 4.5 by 1.7 cm, spatulate, acute, c. 5 mm broad at base; 3 shorter lobes to 20 by 5 mm, lanceolate, subacuminate; nut to 7 mm \varnothing , subglobose.

Distr. *Malesia*: Celebes.

Ecol. Locally common on hill slopes below 400 m.

Vern. *Hulodiri puteh*, *h. motaha*, *kongieh*, *morularieh* (Tobela), *awalasa*, *bolampao*, *dama dama*, *tomborusu* (Bug.).

46. *Vatica badiifolia* ASHTON, Gard. Bull. Sing. 22 (1967) 266, pl. 8; Man. Dipt. Brun. Suppl. (1968) 30, pl. 7 (bark & slash). — *V. bantamensis* (non B. & H. ex MIQ.) ASHTON, Man. Dipt. Brun. (1964) 266, f. 10.

Young twig, panicle, leaf bud, stipule, and petiole ± densely evenly shortly caducous fulvous pubescent. Twig to 3 mm \varnothing apically, terete or ribbed, becoming smooth. Bud to 1.5 by 1 mm, ovoid, subacute. Stipule to 5 by 1.5 mm, hastate, acute. Leaves 7.5–15 by 3–6.5 cm, coriaceous, ± elliptic; base ± cuneate; acumen to 5 mm long, deltoid; nerves 9–12 pairs, curved, prominent, stout, terete beneath, slightly raised above; petiole 2–3.5 cm long, thickened in the distal half. Panicle to 8 cm long, terminal or axillary, singly or doubly branched. Flower buds to 1.3 cm long; calyx densely shortly cream pubescent; flower typical. Fruit pedicel to 5 mm long, slender. Calyx lobes caducous, pink-brown pubescent, free almost to the pedicel, fused into a flat plate at the base; 2 longer lobes to 8 by 2.5 cm, oblong-spatulate, chartaceous, constricted to 6 mm wide at the base; 3 shorter lobes to 30 by 8 mm, hastate, acute, constricted to 4 mm wide at base. Nut to 8 mm long and \varnothing , globose, shortly evenly fulvous pubescent, crowned by the up to 2 mm long abrupt linear style remnant.

Distr. *Malesia*: Borneo (Rejang valley to Brunei; W. Kalimantan: Kapuas valley).

Ecol. Deep soils on low coastals hills, Mixed Dipterocarp forest.

47. *Vatica perakensis* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 103, *p.p.*; *emend.* SYM. J. Mal. Br. R. As. Soc. 19, 2 (1941) 152; Mal. For. Rec. 16 (1943) 226; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 132, t. 3, f. 18–19, *p.p.*; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 149, t. 181, *p.p.*; SLOOT, Bull. Jard. Bot. Btzg III, 9 (1927) 86, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 262, *p.p.*; BURK, Dict. (1935) 2224; ASHTON, Gard. Bull. Sing. 31 (1978) 24. — *Synaptea perakensis* RIDL. Fl. Mal. Pen. 1 (1922) 242, *p.p.* — *V. songa* SLOOT, Bull. Jard. Bot. Btzg III, 9 (1927) 93, f. 4; HEYNE, Nutt. Pl. ed. 2 (1927) 1131.

Small to medium-sized tree. Twig endings, petiole, panicles, and parts of perianth exposed in bud persistently greyish pink or yellow-brown cinereous, leaf nervation beneath and nut glabrescent. Twig *c.* 1 mm \varnothing apically, slender, much branched, terete, pale brown. Leaf bud small, ovoid. Leaf 6–14 by 1.8–3.8 cm, lanceolate to oblanceolate; base cuneate, tapering; acumen to 2 cm long, slender, subcaudate; nerves 11–13 pairs, slender but prominent beneath, evident above as also the midrib, ascending; tertiary nerves densely subreticulate, evident on both surfaces; petiole 1–2 cm long, slender. Panicle to 5 cm long, singly ± irregularly branched; flowers typical. Fruit pedicel to 6 by 1 mm, long, slender; 2 longer calyx lobes to 6 by 1.8 cm, spatulate, obtuse, *c.* 5 mm broad at the subrevo-

lute base; 3 shorter lobes to 15 by 6 mm, lanceolate, acute; nut to 10 cm \varnothing , ovoid, apiculate.

Distr. *Malesia*: Malaya (S. Kedah, Perak), Central Sumatra (P. Musala, Tapanuli, Indragiri); one doubtful collection (SAN 41580) from Pulau Kelambu near the N.E. Borneo coast at Tawau.

Ecol. Common in coastal hills and on low ridges to 600 m.

Vern. *Résak puteh*.

48. *Vatica nitens* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 104; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 131; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 150, t. 182A; BURK, J. Str. Br. R. As. Soc. 81 (1920) 61; Dict. (1935) 2224; SLOOT, Bull. Jard. Bot. Btzg III, 9 (1927) 78; FOXW. Mal. For. Rec. 10 (1932) 254; SYM. Mal. For. Rec. 16 (1943) 223, f. 107, 108; ASHTON, Man. Dipt. Brun. (1964) 74, f. 10; *ibid.* Suppl. (1968) 34, f. 5. — *Synaptea nitens* RIDL. Fl. Mal. Pen. 1 (1922) 241; *ibid.* 5 (1925) 292. — *V. cuspidata* (non RIDL.) BROWNE, For. Trees Sarawak & Brunei (1955) 100.

Young vegetative parts densely powdery fulvous tomentose, fugaceous on leaf, subsistent only on panicle, leaf bud and stipule. Twig to 2 mm \varnothing apically, becoming smooth, glabrous. Bud to 3 by 3.5 mm, ovoid, acute. Stipule to 20 by 3.5 mm, narrowly oblong, subacute, caducous. Leaves 10–17 by 3.5–5.5 cm, coriaceous, narrowly oblong; base obtuse or cuneate; acumen to 1 cm long; nerves 12–22 pairs, raised beneath, curved, at 45°–70°, with short secondary nerves; midrib obtuse, raised beneath, appanate or slightly raised above; petiole 1–2 cm long, slightly geniculate. Panicle to 11 cm long, terminal, occasionally axillary, densely persistently fulvous tomentose, terete or angular; singly, rarely doubly, branched; bracteoles fugaceous. Flower bud to 7 by 3 mm, fusiform; calyx densely pubescent on both surfaces, lobes narrowly deltoid, acute; appendage to connective short, stout; style very short, not exceeding anthers; flowers otherwise typical. Fruit pedicel 3–5 mm long, calyx fulvous powdery tomentose, glabrescent, base impressed; 2 longer lobes to 13 by 2 cm, free to base, oblong, slightly recurved, hastate, acute; base to 7 mm broad, ± revolute. Nut to 3 cm \varnothing , globose, shortly densely persistently pale fulvous tomentose.

Distr. *Malesia*: Malaya (except seasonal areas), Borneo (Kapuas valley; Sarawak to S.W. Sabah).

Ecol. Scattered on low hills, and ridges to 600 m, in Mixed Dipterocarp forest.

Vern. *Résak daun panjang* (Mal.).

49. *Vatica cuspidata* (RIDL.) SYM. Mal. For. 3 (1934) 200; J. Mal. Br. R. As. Soc. 19 (1941) 149; Mal. For. Rec. 16 (1943) 219, f. 107. — *Synaptea cuspidata* RIDL. J. Str. Br. R. As. Soc. 82 (1920) 172; Fl. Mal. Pen. 1 (1922) 242. — *Synaptea maingayi* RIDL. Fl. Mal. Pen. 1 (1922) 240 *p.p.* — *V. maingayi* (non DYER) SLOOT, Bull. Jard. Bot. Btzg III, 9 (1927) 85, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 261, *p.p.*

Medium-sized to large tree. Young twigs, petioles

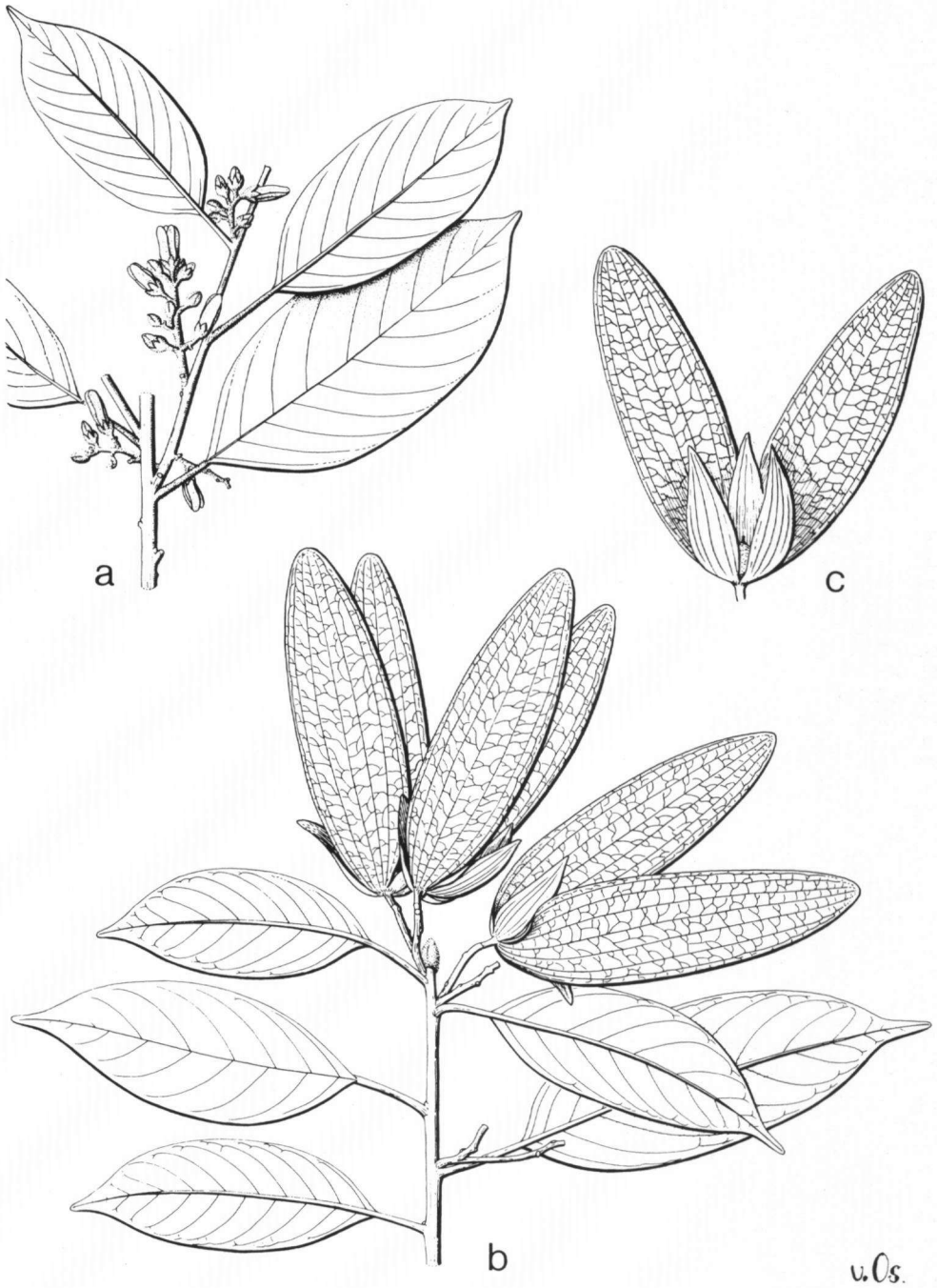


Fig. 47. *Vatica maingayi* DYER. a. Flowering twig, b. fruiting twig, c. fruit, all x2/3 (a SF 34959, b-c ANDERSON 9159).

and panicles persistently pale ferruginous scabrid pubescent, ovary and perianth outside densely puberulent, fruit calyx glabrescent. *Twig* c. 2 mm \varnothing apically, ribbed, pale brown. *Bud* to 3 by 2 mm, ovoid, acute; *stipule* fugaceous. *Leaf* 7–18 by 2.8–6 cm, elliptic to oblong-lanceolate, coriaceous; base broadly cuneate; acumen to 1 cm long, slender, prominent; nerves 10–17 pairs, arched, slender but distinctly elevated beneath, less elevated above as also midrib and the subscalariform tertiary nerves; *petiole* 2–4(–5) cm long, c. 2 mm \varnothing , slender. *Panicle* to 7 cm long, terminal or axillary, irregularly branched. *Flower bud* to 6 by 2 mm; *appendages* very short, hardly exceeding anthers; *style* columnar, slightly longer than ovary, broadening distally into the prominent long slender conical stigma; flowers otherwise typical. *Fruit pedicel* to 5 by 1 mm, slender, prominent; 2 longer *calyx lobes* to 7 by 1.5 cm, spatulate, obtuse, c. 4 mm wide at base; 3 shorter lobes to 25 by 7 mm, lanceolate, acute; *nut* to 8 by 8 mm, ovoid, apiculate.

Distr. *Malesia*: Malaya.

Ecol. Common, coastal hills and inland ridges.

Vern. *Résak daun runching*.

50. *Vatica maingayi* DYER, Fl. Br. Ind. 1 (1874) 302; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 104; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 131; SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 85, *p.p. quoad desc.*; FOXW. Mal. For. Rec. 10 (1932) 261, *p.p.*; BURK, Dict. (1935) 2224; SYM. J. Mal. Br. R. As. Soc. 19 (1941) 151; Mal. For. Rec. 16 (1943) 223, f. 107; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 309; ASHTON, Man. Dipt. Brun. Suppl. (1968) 33. — *V. lowii* (non KING *emend.* SYM.) KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 103, *p.p.*; SLOOT, Bull. Jard. Bot. Btzig III, 9 (1927) 83. — *Synaptea maingayi* RIDL, Fl. Mal. Pen. 1 (1922) 240, *p.p.* — *Synaptea lowii* RIDL, Fl. Mal. Pen. 1 (1922) 241, *p.p.* — *V. macroptera* SLOOT, *ex* THOR-ENAAR, Med. Proefst. Boschw. 16 (1926) 120, t. 21; Bull. Jard. Bot. Btzig III, 9 (1927) 83, *nomen in syn. sub V. lowii*. — *V. aperta* SLOOT, Bull. Bot. Gard. Btzig III, III, 17 (1942) 250. — Fig. 42B–B2, 47.

Twigs, petioles, buds and stipules outside shortly fulvous flocculent tomentose, patchily caducous except on buds. *Twigs* c. 2 mm \varnothing apically, smooth. *Bud* to 3 by 3 mm, ovoid, acute, prominent. *Stipules* to 10 by 3 mm, lorate, leaving conspicuous pale horizontal scars. *Leaves* 5.5–12.5 by 1.2–5 cm, elliptic, somewhat chartaceous; base cuneate; acumen to 1 cm long, deltoid; nerves 9–11 pairs, with few short secondary nerves, appanate above, slender but prominent beneath, arched at 35°–50°; midrib prominent on both surfaces; tertiary nerves slender, reticulate; *petiole* 1–2.5 cm long, prominently geniculate, ribbed. *Panicle* to 4 cm long, axillary, short, ribbed, shortly patchily caducous fulvous flocculent tomentose, irregularly singly branched; *bracteoles* c. 2 mm long, linear. *Flower buds* to 1 cm long, fusiform; calyx rufous flocculent tomentose; *corolla* bright red; flowers otherwise typical. *Fruit* shortly fulvous flocculent tomentose, subsistent on nut, patchily cadu-

cous elsewhere. *Pedicel* to 3 mm long; calyx lobes free to within 2 mm of the pedicel; 2 longer *calyx lobes* to 8 by 2.5 cm, lorate to narrowly ovate, obtuse, c. 7 mm wide and somewhat revolute at base; 3 shorter lobes to 2.5 by 1 cm, narrowly ovate, acute, 3 mm wide at base. *Nut* to 7 by 7 mm, globose, shortly mucronate.

Distr. *Malesia*: Malaya, Singapore, Sumatra (Palembang), Borneo (Sarawak W. of Lupar, S.W. Sabah).

Ecol. Locally frequent, on low lying land and hillsides below 500 m.

Vern. *Résak lidi*, *kéruing babi*, *jenuong* (Mal.), *résak daun merah* (Sabah).

51. *Vatica lowii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 103, *p.p.*; *emend.* SYM. J. Mal. Br. R. As. Soc. 19 (1941) 153; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 131, *p.p.*; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 150, t. 182B; SYM. Mal. For. Rec. 16 (1943) 222, f. 107. — *V. perakensis* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 103, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 262, *p.p.* — *Synaptea lowii* RIDL, Fl. Mal. Pen. 1 (1922) 241 *p.p.*

Small to medium-sized tree. Leaf bud, petiole and panicle persistently pale rufous scabrid somewhat flocculent puberulent; young twigs and calyx outside caducously so; young leaves fugaceously so; petals on parts exposed in bud and ovary prominently evenly pale rufous puberulent. *Twig* c. 2 mm \varnothing apically, slender, becoming dark brown, smooth, terete. *Buds* to 2 by 1 mm, small, ovoid. *Leaf* 5–14 by 2–5 cm, elliptic-lanceolate, coriaceous, somewhat lustrous; base broadly cuneate to obtuse; acumen to 1 cm long; nerves 11–14 pairs, slender, arched, distinctly elevated beneath, slightly so above as also the midrib; tertiary nerves densely subreticulate, evident and slightly elevated on both surfaces; *petiole* 6–16 mm long, slender. *Panicle* to 3.5 cm long, terminal or axillary, shortly irregularly branched. *Flower buds* to 5 by 2 mm; *appendages* c. $\frac{1}{2}$ length of anthers, small, deltoid; *style* shorter than ovary, columnar, expanding to the short conical style; flowers otherwise typical. *Fruit pedicel* to 3 by 0.5 mm, very slender, prominent; 2 longer calyx lobes to 6 by 1.4 cm, spatulate, obtuse, c. 3 mm wide at the sub-revolute base; 3 shorter lobes to 18 by 6 cm, lanceolate, acute; *nut* to 5 mm \varnothing , subglobose, mucronate.

Distr. *Malesia*: Malaya (Kelantan-Thailand border, Perak).

Ecol. Locally abundant, coastal hills and inland ridges below 750 m.

Vern. *Résak pipit*.

Not yet placed

Mature fruit of the following species are unknown

52. *Vatica elliptica* Foxw. Philip. J. Sc. 67 (1938) 329.

Twig endings, petioles, panicles, calyx outside, parts of petals exposed in bud and ovary \pm densely persistently ferruginous scabrous puberulent, elsewhere glabrous. *Twig* c. 1 mm \varnothing apically, slender, at first rugulose, becoming smooth, pale brown. *Leaves*

4–11 by 13–25 cm, narrowly elliptic, thinly coriaceous; tapering to a narrowly obtuse base and to a 1 cm long acumen; margin \pm narrowly revolute; nerves 12–14 pairs, arched, slender but prominent beneath, elevated above, with short less prominent secondary nerves; tertiary nerves subreticulate, distinctly elevated on both surfaces but more prominent beneath as also the midrib; *petiole* 4–9 mm long, short. *Panicle* to 5 cm long, slender, terminal or axillary, irregularly doubly branched. *Flower bud* to 5 by 3 mm, lanceolate, small; *sepals* subequal; *anthers* narrowly oblong; *appendages* prominent, deltoid; *style* columnar, expanding distally, slightly longer than ovary; stigma deltoid; flowers otherwise typical. *Mature fruit* unknown; very young fruit with subequal reflexed calyx lobes.

Distr. *Malesia*: Philippines (Zamboanga, Mindanao), twice collected.

53. *Vatica pentandra* ASHTON, Gard. Bull. Sing. 31 (1978) 24.

Twigs, petioles and panicles persistently shortly scabrid fulvous pubescent, calyx outside \pm caducously so, parts of petals exposed in bud and ovary persistently evenly buff puberulent. *Twigs* c. 2 mm \varnothing apically, ribbed, much branched, ascending. *Leaf buds* minute. *Leaves* 18–45 by 9–20 mm, elliptic, thinly coriaceous, with subrevolute margins, obtuse to broadly cuneate base and \pm deeply retuse apex; nerves 4–5 pairs, ascending, at c. 45°, slender, hardly elevated on either surface though more so below; *petiole* 4–11 mm long, slender, hardly geniculate. *Panicle* to 4 cm long, slender, singly branched; branchlets bearing to 3 flowers. *Flower buds* to 9 by 3 mm; *stamens* 5, in a single whorl; flowers otherwise typical. Fruit unknown.

Distr. *Malesia*: East Borneo (Central Kutei).

Ecol. Unknown, lowlands.

Note. The only *Vatica* with but 5 stamens; the leaves are among the smallest and most distinctive in the genus also.

54. *Vatica cauliflora* ASHTON, Gard. Bull. Sing. 31 (1978) 25.

Twigs, petioles and panicles persistently scabrid fulvous pubescent; midrib beneath caducously so; calyx outside, parts of petals exposed in bud and ovary persistently evenly buff puberulent. *Twigs* c. 3 mm \varnothing apically, stout, ribbed; *leaf buds* minute. *Leaves* 7–22 by 2.5–8 cm, oblanceolate, coriaceous, with subrevolute margins, obtuse to subcordate base and \pm prominent caudate acumen; nerves 14–16 pairs, ascending at 50°–60°, prominent beneath, evident but depressed above, as also the many secondaries; tertiaries reticulate, barely elevated though evident on both surfaces; midrib prominent beneath, less so above; *petiole* 10–18 mm long, c. 2 mm \varnothing , relatively slender. *Panicles* to 6 cm long, solitary, axillary, doubly branched, many-flowered. *Flower buds* to 7 by 2 mm, lanceolate, otherwise typical.

Distr. *Malesia*: Ulu Kapuas, W. Borneo.

Ecol. Locally frequent along river banks.

Note. This species is distinguished by the nerves which are depressed above, by the caudate acumen and slender petiole. Very young fruit indicate a possible affinity with *V. venulosa* BL.

55. *Vatica glabrata* ASHTON, sp. nov.

V. mangachapoi BLCO *simulans lamina nervis intrinsecus 9–11 ascendentibus petiolo longissimo partibus glabrescentibus ovarii excepto differt.*

Medium-sized tree, to 20 m tall, 1 m girth. Apical buds and ovary densely ocherous puberulent, young parts sparsely caducously so, otherwise glabrous. *Stipules* to 12 by 8 mm, elliptic, obtuse, not at first caducous, leaving a more or less prominent falcate scar. *Leaves* 6–15(–22) by (2–)2.5–7 cm, lanceolate, coriaceous, \pm concave, lustrous, with obtuse base and prominently attenuate to 15 cm long acumen; nerves 9–11 pairs, ascending, slender, elevated on both surfaces but more so below, with \pm short secondaries; tertiaries reticulate, elevated on both surfaces. *Petiole* 1.8–4 cm long, slender, very long. *Panicles* to 7 cm long, irregular, 1– ∞ axillary or terminal. *Flowers* white, as in other species. *Fruit* unknown.

Distr. *Malesia*: Borneo: Sarawak, S 34865, 36852 (holotype in K, in fl.), Dulit range, Ulu Tinjar, Baram; BRUN 2526, 2533, Ulu Medamat, Limbang.

Ecol. Local, scattered in submontane forest at 1200–1500 m on acid soils overlying sandstone immediately below the mossy forest zone.

Notes. I collected this species in April 1958 while on an expedition to the Pagon range. Fallen fruit, apparently from this species, were also collected but were lost in a river accident on the return: they were of the *Sunaptea* type, with two long and three short sepals free to the base. The new collections from Sarawak, and more particularly the type differ in their concave laminae and prominent subplexicaul subpersistent stipules. The unusually long slender petioles, 9–11 pairs of ascending nerves and glabrous young twigs and inflorescences distinguish the four collections from those of *V. mangachapoi* BLCO which it otherwise resembles and convince me that they represent but a single species.

Doubtful species

56. *Vatica obtusa* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 228; MERR. En. Born. (1921) 409; SLOOT. Bull. Jard. Bot. Btzg III, 9 (1927) 126, *nom. illeg., non* (WALL.) STEUD.

The type, TEYSMANN HB 11352, from Karimata, is in flower. It is indistinguishable in this state from *V. umbonata* (HOOK. f.) BURCK and *V. pauciflora* (KORTH.) BL.

Excluded

Vatica imbricata SLOOT. Bull. Jard. Bot. Btzg III, 16 (1940) 452, f. 10, is according to KOSTERMANS, Reinwardtia 7 (1969) 426 = *Mesua acuminatissima* (MERR.) KOSTERM. (*Guttiferae*).

6. DRYOBALANOPS

GAERTN. *f. Fruct.* 3 (1805) 49; DC. *Prod.* 16, 2 (1868) 606; DYER, *J. Bot.* 12 (1874) 98, t. 142; BURCK, *Ann. Jard. Bot. Btzig* 6 (1887) 242; HEIM, *Rech. Dipt.* (1892) 81; BRANDIS, *J. Linn. Soc. Bot.* 31 (1895) 46; BRANDIS & GILG in E. & P. *Pfl. Fam. ed.* 1, 3, 6 (1895) 258; SLOOT, *Bull. Jard. Bot. Btzig III*, 12 (1932) 1; SYM. *Mal. For. Rec.* 16 (1943) 191, f. 93 (map); BROWNE, *For. Trees Sarawak & Brunei* (1955) 111; WYATT-SMITH, *Mal. For.* 18 (1955) 145; ASHTON, *Man. Dipt. Brun.* (1964) 48; *ibid.* *Suppl.* (1968) 20; MEIJER & WOOD, *Sabah For. Rec.* 5 (1964) 278. — *Pterigium* CORREA, *Ann. Mus. Hist. Nat. Paris* 8 (1806) 397, *p.p.*, *quoad P. teres* CORREA. — *Baillonodendron* HEIM, *Bull. Mens. Soc. Linn. Paris* 2 (1890) 867. — **Fig. 48–53.**

Large or very large, occasionally medium-sized, trees; with tall, long, concave, rather thick, narrowly rounded plank buttresses, spreading over the surface apically as large sinuous roots; *crown* very large, hemispherical or dome-shaped, rather diffuse; 'cauliflower' shaped with a few large twisted branches ascending from the bole apex, the branchlets numerous, bunched towards the ends. *Bark surface* evenly or persistently shaggily flaked; *twigs* ribbed owing to the decurrent leaf trace, slender. *Stipules* linear, fugaceous. *Leaves* coriaceous, prominently acuminate, with slender dense hardly raised nervation; nerves very many, parallel, straight, rarely branched apically, linked at the margin by a \pm visible intramarginal nerve; secondary nerves, if present, indistinct; tertiary nerves subreticulate, generally obscure; midrib sunken above, prominent beneath; *petiole* distinctly channelled above, slender, not geniculate. *Inflorescences* paniculate, lax, diffuse, few flowered; *bracteoles* minute, fugaceous. *Flower buds* narrowly ovoid, obtuse. *Calyx lobes* equal, imbricate, glabrous, united at base into a \pm cuneate tube tapering into the pedicel. *Petals* broadly elliptic, subacute, glabrous, hardly contorted in bud, united at base and falling in a rosette, white. *Stamens* *c.* 30, glabrous, subequal, the innermost slightly longer than the outermost, epipetalous, yellow; filaments broad and compressed, connate at base, tapering in the distal half and filiform below the anther; anthers long, linear, latrorse; pollen sacs subequal, the outer somewhat larger than the inner; appendage to connective small, stout, hardly projecting above the anthers. *Ovary* \pm ovoid, glabrous, without distinct stylopodium; style *c.* 3 times length of ovary, glabrous; stigma minute. *Fruit calyx* with basal cup partially enclosing, but free from, base of nut; 5 lobes subequal, subvalvate, short and acute or long spatulate, obtuse, \pm rotate. *Nut* large, glabrous, with short apiculate style remnant. Pericarp splitting at *germination* into 3 valves; cotyledons reniform, epigeal, on long slender hypocotyl; first 2 pairs of leaves opposite, with a very short intermediate internode.

Distr. Malesia: 7 spp. in Malaya, Central Sumatra, Borneo and intervening islands.

Fossil wood records from S. India, Cambodia, S. Sumatra, W. Java and Amboyna in the Moluccas (SCHWEITZER, *Palaeontographica* 105B, 1959, 1–66). Fig. 49.

Ecol. Semigregarious or gregarious emergent canopy trees of lowland dipterocarp, Heath and Mixed Peat Swamp forests to 800 m; on account of their size playing an important structural role in the forests where they occur.

Uses. The timber is an important moderately heavy and durable construction timber. *D. aromatica* was once a major source of camphor, obtained as crystals in splits within the bole by felling.

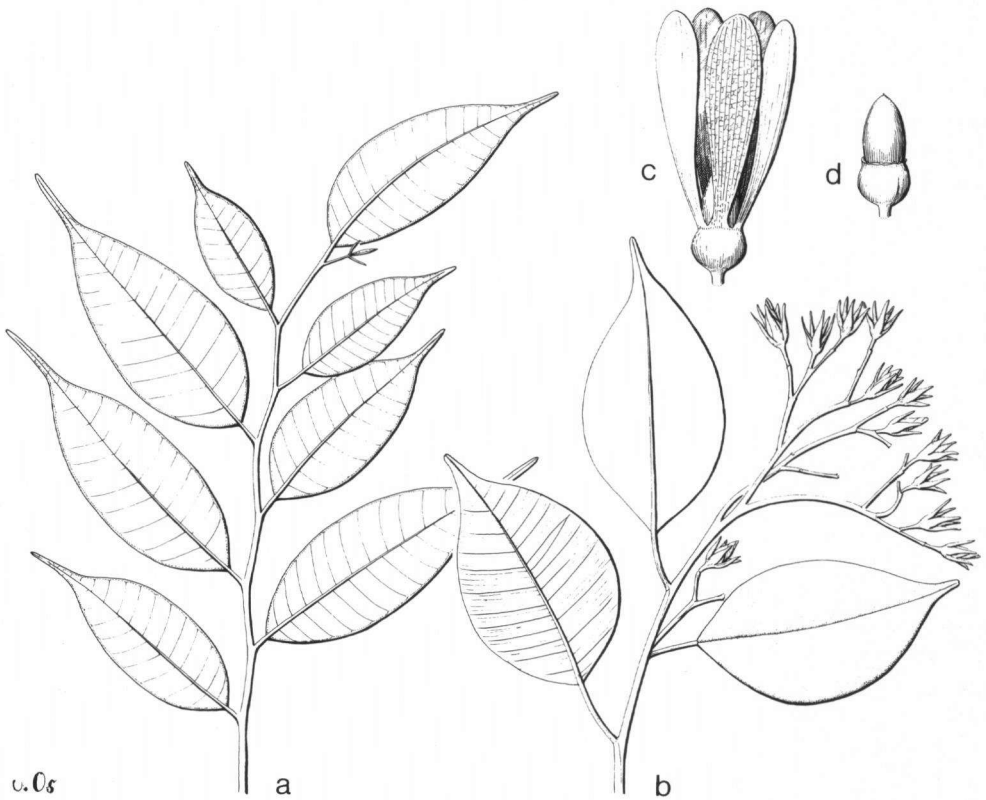


Fig. 48. *Dryobalanops aromatica* GAERTN. f. a. Sterile twig, b. flowering twig, c. fruit, d. nut, all $\times \frac{1}{2}$ (a, c-d SAN 15148, b KEP 72435).

KEY TO THE SPECIES

- | | |
|---|---------------------------|
| 1. Fruit calyx lobes shorter than nut | 1. <i>D. oblongifolia</i> |
| 1. Fruit calyx lobes longer than nut, aliform. | |
| 2. Leaves usually longer than 14 cm; nerves distinctly unequal, prominent beneath, depressed above | 2. <i>D. keithii</i> |
| 2. Leaves shorter than 12 cm; nerves hardly raised beneath, subequal, not depressed above. | |
| 3. Fruit calyx lobes 10–12 mm broad. Calyx fused into a to 15 mm \varnothing , over 5 mm deep, cup at base. | |
| 4. Leaf lanceolate, revolute at base | 3. <i>D. lanceolata</i> |
| 4. Leaf broadly ovate, not revolute at base | 4. <i>D. aromatica</i> |
| 3. Fruit calyx lobes to 8 mm broad, narrow. Calyx fused into a cup at base not broader than 8 mm, not deeper than 3 mm. | |
| 5. Leaf 5–8 by 1.7–3 cm, glabrous | 5. <i>D. beccarii</i> |
| 5. Leaf 6–11 by 2–4 cm, more or less tomentose beneath. | |
| 6. Tomentum persistent, even, dark gold | 6. <i>D. fusca</i> |
| 6. Tomentum \pm caducous, flocculent, rufous | 7. <i>D. rappa</i> |

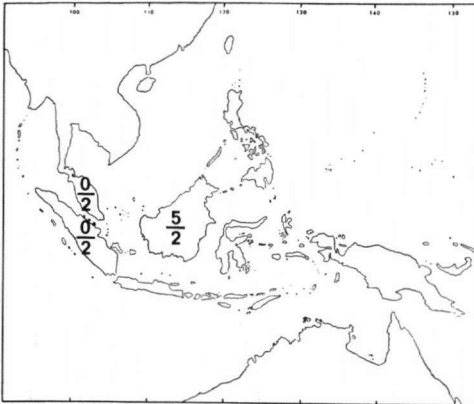


Fig. 49. Density map of *Dryobalanops* GAERTN. f. in Malesia; number of endemics above the hyphen, number of non-endemics below it.

1. *Dryobalanops oblongifolia* DYER, J. Bot. 12 (1874) 100, t. 142, f. 8–12; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 224; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 51; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 259; BECC. Nelle For. Born. (1902) 550, 572; MERR. En. Born. (1921) 401; BURK. J. Str. Br. R. As. Soc. 86 (1922) 291; DEN BERGER & ENDERT, Med. Proefst. Boschw. 11 (1925) 104; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 255; THORENAAR, Med. Proefst. Boschw. 16 (1926) 110; FOXW. J. Mal. Br. R. As. Soc. 5 (1927) 340; Mal. For. Rec. 1 (1921) 76; *ibid.* 3 (1927) 49; *ibid.* 8 (1930) 17; *ibid.* 10 (1932) 110; HEYNE, Nutt. Pl. ed. 2 (1927) 1105; SLOOT, Bull. Jard. Bot. Btzg III, 12 (1932) 22; BURK. Dict. (1935) 867; CORNER, Ways. Trees (1940) 212; SYM. Mal. For. Rec. 16 (1943) 196, f. 94B, 95, 98; WYATT-SMITH, Mal. For. 18 (1955) 153, p.p.; BROWNE, For. Trees Sarawak & Brunei (1955) 116; ASHTON, Man. Dipt. Born. Suppl. (1968) 23, f. 4; Gard. Bull. Sing. 31 (1978) 25.

a. *ssp. oblongifolia*. — *Baillonodendron malayanum* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 867; Rech. Dipt. (1892) 38. — *D. abnormis* SLOOT, Bull. Jard. Bot. Btzg III, 16 (1940) 449, f. 8; cf. ASHTON, Gard. Bull. Sing. 22 (1967) 262, 347 (photogr. fr.).

Young twigs caducously shortly evenly densely pale fulvous pubescent; vegetative parts otherwise glabrous. *Twig* c. 2 mm \varnothing at apex, terete, smooth, lustrous. *Bud* to 2 by 1 mm, small, conical, acute. *Stipule* to 3 by 1 mm, linear, fugaceous. *Leaf* 6–20 by 4.5–5(–6.5) cm, narrowly oblong, frequently undulate, base broadly cuneate to obtuse, apex cuspidate with 1.5 cm long slender acumen; nervation evident but not prominent beneath, obscure above; midrib depressed above, prominent beneath. *Petiole* 5–14 mm. *Panicle* to 14 cm long, terminal or axillary, angular or terete, densely shortly evenly rufous pubes-

cent; singly branched, branchlets to 3 cm long, bearing to 6 distichous flowers; *bracteoles* minute, fugaceous. *Flower buds* to 8 by 5 mm, ovoid, glabrous. *Sepals* subequal, ovate, acute, glabrous. *Petals* white, oblong, glabrous. *Stamens* c. 40, unequal, reaching to below the style apex; filaments connate at base, broadly lorate, tapering below the anther insertion, c. $\frac{1}{2}$ length of anther; anther linear; appendage to connective \pm erect, exceeding anther apex. *Ovary* ovoid, glabrous; style 2–3 times as long as ovary, filiform, glabrous. *Fruit* entirely glabrous. *Pedicele* short, merging with calyx. *Calyx lobes* to 5 by 7 mm, deltoid, acute, incrassate, frequently reflexed, bordering a to 1.5 cm deep, to 1.5 cm \varnothing massive incrassate cup. *Nut* to 3.5 by 2.7 cm, ellipsoid to obovoid, obtuse to mucronate, prominently lenticellate.

Distr. *Malesia*: Borneo (Kapuas hinterland, Sarawak W. of the Kemena, W. Kutei).

Ecol. Local on hillsides below 600 m.

Vern. *Empedu* (Sar.), *kélansau* (Iban).

b. *ssp. occidentalis* ASHTON, Gard. Bull. Sing. 31 (1978) 26. — *D. beccariana* RIDL, Fl. Mal. Pen. 1 (1922) 211. — *D. ovalifolia* I. H. BURKILL, Illustr. Guide Bot. Gard. Sing. (1927) 22, *nomen*.

Differing as follows: *Leaf* 6–11 by 2–4.5 cm; *fruit calyx tube* to 8 mm deep, funnel-shaped, with \pm obscurely 5-lobed undulate margin; *nut* broadly ellipsoid, striated but otherwise smooth.

Distr. *Malesia*: Malaya (E. coast, rare from Perak northwards in W.); E. Sumatra (Bengkalis, Riouw, Djambi, Palembang).

Ecol. By streams and in fresh water swamps, locally abundant; occasionally on hillsides.

Vern. *Kéladan*, *kapur paya*, *k. kuras* (Mal.), *k. guras*, *pétanang* (Sum.).

2. *Dryobalanops keithii* SYM. Gard. Bull. S. S. 10 (1939) 379, pl. 27; SLOOT, Bull. Jard. Bot. Btzg III, 16 (1940) 449; Reinwardtia 5 (1961) 475, f. 6; WYATT-SMITH, Mal. For. 18 (1955) 152; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 283, f. 3 d.

Medium-sized tree. Outside of calyx and panicle fugaceous puberulent, parts otherwise glabrous. *Twig* c. 2 mm \varnothing apically, ribbed at first, verrucose lenticellate, becoming smooth. *Leaves* 14–33 by 5–10 cm, lorate to narrowly lanceolate or oblanceolate, coriaceous; margin narrowly subrevolute; base obtuse or cordate; acumen to 1 cm long (longer in young trees), slender, prominent; nerves many but relatively distant, distinct and prominent, beneath, obscure but distinctly narrowly depressed above as also the midrib, arched just within the margin and then uniting with a \pm straight intramarginal nerve; with shorter less distinct parallel secondary nerves and \pm obscure reticulate tertiary nerves; *petiole* 7–12 mm long, short, stout. *Panicles* to 14 cm long, singly or doubly (if terminal) branched, terminal or subterminal axillary, lax; branchlets to 3.5 cm long, bearing to 4 flowers; *bracts* and *bracteoles* to 2 by 2 mm, suborbicular-deltoid, not at first caducous. *Flower bud* to 10 by 4 mm,

ellipsoid, acute; *sepals* narrowly deltoid, subacute; *petals* ovate, acute, glabrous; *stamens* subequal, slightly shorter than the style; filaments compressed, tapering distally, united at base, c. $\frac{1}{2}$ length of the linear tapering anthers; appendages acicular, short but distinctly exceeding anther apex; ovary narrowly ovoid, puberulent; *style* filiform, glabrous, c. $2\frac{1}{2}$ times length of ovary. *Fruit pedicel* to 4 by 2 mm; *calyx lobes* to 4 by 2 cm, broadly spatulate, obtuse, c. 8 mm broad above the to 6 by 10 mm basal cup; *nut* to 16 by 15 mm, depressed ovoid, apiculate.

Distr. *Malesia*: N.E. Borneo (Sandakan bay to Tawau and Tidung).

Ecol. Undulating land and hills to 250 m, never far from water and often on banks of streams; locally common.

Vern. *Kapur gumpait* (Kadazan, Kinabatangan), *k. daun bésar*.

3. *Dryobalanops lanceolata* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 244, t. 29, f. 6; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 244; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 51, t. 1, f. 1-6; BOERL. Cat. Hort. Bog. 2 (1901) 100; MERR. En. Born. (1921) 401; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 238; HEYNE, Nutt. Pl. ed. 2 (1927) 1106; SLOOT. Bull. Jard. Bot. Btzg III, 12 (1932) 28, f. 3; WYATT-SMITH, Mal. For. 18 (1955) 115; BROWNE, For. Trees Sarawak & Brunei (1955) 116; ASHTON, Man. Dipt. Brun. (1964) 52; *ibid.* Suppl. (1968) 22; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 285, pl. 21 (stem), f. 47, pl. 29 (habit). — *D. oblongifolia* DYER, J. Bot. 12 (1874) 100, *p.p.* — *D. kayanensis* BECC. Nelle For. Born. (1902) 551; MERR. En. Born. (1921) 401; HEYNE, Nutt. Pl. ed. 2 (1927) 1104.

Leaf bud and stipule sometimes shortly fugaceous tomentose, otherwise entirely glabrous. *Twigs* 1.5-2 mm \varnothing apically, slender, dotted with minute pale brown lenticels, smooth but for the prominent ribs above the lateral bundles of the petiole. *Bud* c. 4 by 1 mm, narrowly lanceolate. *Stipule* to 12 by 1 mm, narrowly lanceolate. *Leaves* 7-10 by 2-3.5 cm, lanceolate, thinly coriaceous, base cuneate, with revolute margin, acumen to 1 cm long, slender; margin frequently undulate; *petiole* c. 1 cm long, slender. *Panicle* to 6 cm long; terminal or axillary, ribbed and angular on drying, glabrous; simple or singly branched. *Flower bud* to 12 by 5 mm, fusiform, obtuse. *Calyx* glabrous; lobes subequal, lanceolate, obtuse. *Corolla* white; petals lanceolate, acute, glabrescent. *Stamens* c. 30, subequal, shorter than the style; filaments compressed, slender, tapering, united at base; anthers linear; appendage to connective short, hardly exceeding anther apex. *Ovary* small, ovoid, glabrous; style filiform, c. 3 times length of ovary, glabrous. *Fruit calyx* with to 2 cm \varnothing , to 5 mm deep, shallow cup at base, impressed at the pedicel; with a shallow tubercle at the base of each calyx lobe; lobes to 9 by 2 cm, spatulate, equal, obtuse, tapering gradually to a 3-5 mm broad base. *Nut* to 2 cm long and \varnothing , ovoid to globose, glabrous, subacute.

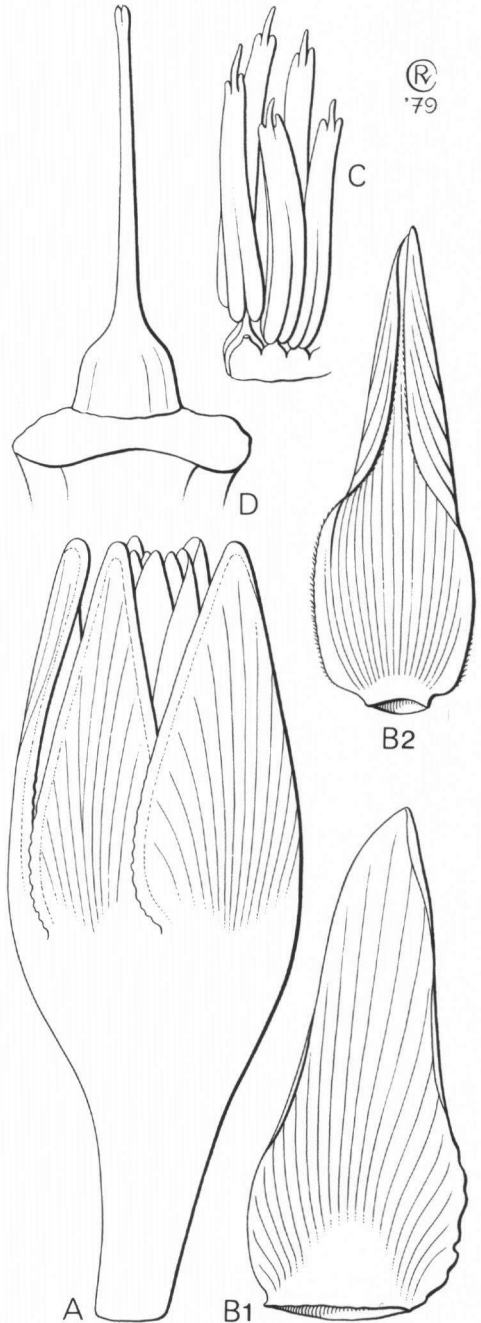


Fig. 50. *Dryobalanops aromatica* GAERTN. f. A. Bud, B1. outer sepal, B2. inner sepal, both from inside, C. stamens from outside, D. pistil, all $\times 10$ (Cult. Hort. Bog. XI-B-XVII-213).

Distr. *Malesia*: Borneo (N.E. of the Lupar to Sabah, and S.E. to W. Kutei and Sangkulirang).

Ecol. Widespread on fertile clay-rich soils, abundant on undulating land on basic volcanics and calcareous shale to 700 m.

Uses. The most valuable kapur source in N.E. Borneo; the timber floats.

Vern. *Paji*, *kapur paji* (M., Iban), *k. daram*, *k. bukit* (Brun.), *sesuan* (Murut), *ngeri* (Bassap), *adu* (Kwijau), *jalam* (Dus.).

4. *Dryobalanops aromatica* GAERTN. *f. Fruct.* 3 (1805) 49, t. 186, f. 2; *BL. Fl. Jav.* 2 (1828) Dipt. 6 in not.; *Mus. Bot. Lugd.-Bat.* 2 (1852) 38; *WALP. Ann.* 4 (1857) 336; *Hook. f. Trans. Linn. Soc.* 23 (1860) 160; *BAILLON, Hist. Pl.* 4 (1872) 202, f. 211-214; *DYER, J. Bot.* 12 (1874) 100, t. 142, f. 1-5; *BURCK, Ann. Jard. Bot. Btzg* 6 (1887) 243; *LAKE & KELSALL, J. Str. Br. R. As. Soc.* 26 (1894) 35; *Agr. Bull. Str. & F. M. S.* 1 (1901) 61; *Fl. Mal. Pen.* 1 (1922) 210; *BRANDIS, J. Linn. Soc. Bot.* 31 (1895) 50; *BRANDIS & GILG in E. & P. Pfl. Fam. ed.* 1, 3, 6 (1895) 259, fig; *BOERL. Cat. Hort. Bog.* 2 (1901) 100; *HEYNE, Nutt. Pl. ed.* 1, 3 (1917) 276; *BURK, J. Str. Br. R. As. Soc.* 81 (1920) 56, fig.; *ibid.* 86 (1922) 291; *MERR. En. Born.* (1921) 401; *Foxw. Mal. For. Rec.* 1 (1921) 74; *ibid.* 2 (1921) 68; *ibid.* 8 (1927) 45; *ibid.* 10 (1932) 105; *GILG in E. & P. Pfl. Fam. ed.* 2, 21 (1925) 255; *HENDERSON, Gard. Bull. S. S.* 4 (1928) 226; *WATSON, Mal. For. Rec.* 5 (1928) 59, 60, 184; *EDWARDS, Mal. For. Rec.* 9 (1930) 129; *SLOOT. Bull. Jard. Bot. Btzg III*, 12 (1932) 7, f. 1; *BURK. Dict.* (1935) 862; *CORNER, Ways. Trees* (1940) 211; *SYM. Mal. For. Rec.* 16 (1943) 194, f. 94A, 95, 96 (map), 97; *WYATT-SMITH, Mal. For.* 18 (1955) 148; *BROWNE, For. Trees Sarawak & Brunei* (1955) 114; *BACKER & BAKH. f. Fl. Java* 1 (1963) 330; *ASHTON, Gard. Bull. Sing.* 20 (1963) 241; *Man. Dipt. Brun.* (1964) 49, f. 8, pl. 15 (habit), pl. 18 (stem); *ibid. Suppl.* (1968) 22; *MEIJER & WOOD, Sabah For. Rec.* 5 (1964) 278, f. 45. — *Arbor camphorifera* RUMPH. *Herb. Amb. cap.* 82 (1755) 67. — *Pterigium teres* CORREA, *Ann. Mus. Hist. Nat. Paris* 10 (1807) 159, t. 8, f. 1. — *D. camphora* COLEBR. *As. Res.* 12 (1816) 535, t. 8; *JACK in Hook. Comp. Bot. Mag.* 1 (1835) 264; *Calc. J. Nat. Hist.* 5 (1843) 117; *KORTH. Kruidk.* (1841) 68; *WALP. Rep.* 5 (1845) 125; *LINDL. Veg. Kingd.* (1846) 393; *DE VRIESE in Miq. Pl. Jungh.* (1851) 80; *Ned. Kruidk. Arch.* 3 (1851) 1-89, *cum tab.*; *transl. in Hook. J. Bot. Kew Misc.* 4 (1852) 33, 68; *Hook. f. ibid.* 4 (1852) 200; *DE VRIESE, Tuinb. Fl.* (1856) 86; *Mém. sur le Camphrier* (1856) t. 1-2; *OUDEMANS, Ann. Sc. Nat.* IV, 5 (1856) 90, t. 4; *HAYNE, Arzneigew.* 12 (1856) 17, *cum tab.*; *MIQ. Fl. Ind. Bat.* 1, 2 (1856) 499; *Ann. Mus. Bot. Lugd.-Bat.* 3 (1867) 85; *DC. Prod.* 16, 2 (1868) 606; *WALP. Ann.* 7 (1868) 377; *DEN BERGER & ENDERT, Med. Proefst. Boschw.* 11 (1925) 104; *HEYNE, Nutt. Pl. ed.* 2 (1927) 1099. — *Shorea camphorifera* ROXB. *Fl. Ind. ed.* Carey 2 (1832) 616; *ibid.* ed. 4 (1873) 440; *DC. Prod.* 16, 2 (1868) 632. — *Dipterocarpus dryobalanops* STEUD. *Nomencl. Bot. ed.* 2, 1 (1840) 518; *DC. Prod.* 16, 2 (1868) 614; *WALP. Rep.* 5 (1845) 124. — *Diptero-*

carpus teres STEUD. *Nomencl. Bot. ed.* 2, 1 (1840) 518; *DC. Prod.* 16, 2 (1868) 614. — *D. junghuhnii* BECC. *Nelle For. Born.* (1902) 554. — *D. vriesii* BECC. *Nelle For. Born.* (1902) 554. — **Fig. 48, 50-52.**

Young twig, raceme, stipule, petiole and leaf beneath at first sparsely minutely lepidote, appearing yellowish, becoming glabrous. *Twig c.* 1 mm \varnothing apically, slender, smooth. *Bud* 2-5 by 1-1.5 mm, small, narrowly lanceolate, often compressed. *Stipule* 5-8 mm long, small, linear, fugaceous. *Leaves* 4-6 by 2-4 cm, \pm broadly ovate, coriaceous, sometimes (excluding acumen) broader than long, base cuneate or broadly obtuse, acumen to 1.5 cm long, prominent; nervation indistinct; midrib depressed above, prominent beneath; *petiole* 0.5-1 cm long, slender. *Panicle* to 7 cm long, terminal or axillary, ribbed and angular on drying, singly or doubly branched. *Flower bud* to 9 by 4 mm, fusiform. *Calyx* glabrous, lobes subequal, lanceolate, obtuse. *Corolla* white, petals glabrous, \pm oblong, acute. *Stamens c.* 30, subequal, shorter than the style; filaments slender, tapering, united at base; anthers linear; appendage to connective short, linear, somewhat exceeding anther apex. *Ovary* small, ovoid, glabrous; style filiform, *c.* 2 times length of ovary, glabrous. *Fruit calyx* base 6-8 mm deep, 8-15 mm \varnothing , cup-shaped, \pm constricted at the rim; lobes equal, 4-6 by 0.8-2 cm, spatulate, obtuse, to 3-5 mm broad at the base, entirely glabrous. *Nut* to 3 by 1.5 cm, ovoid, glabrous, constricted at the apex of the calyx cup, acute, with a short style remnant.

Distr. *Malesia*: Malaya (down E. coast from Trengganu southwards, rare in Selangor and Negri Sembilan), N.W. Sumatra (Angkola, Sibolga, Kelasan and Upper Singkil), E. Sumatra (Bengkalis, Siak), Musala, Lingga, Singkep, Borneo (N.E. of the Rejang to S.W. Sabah).

Ecol. Locally dominant, gregarious on dry sandy or gravelly soils over sandstone and granite, on subcoastal hills or (rarely) inland quartzite dikes to 400 m.

Uses. The most important source of camphor, and kapur timber, in the genus.

Vern. *Kapur* (Mal.), *k. barus* (Sum.), *k. bukit*, *k. përingii*, *k. анги* (Brun.), *këladan* (Iban), *tëlajin* (Belait).

5. *Dryobalanops beccarii* DYER, *J. Bot.* 12 (1874) 100, t. 142, f. 6-7; *BURCK, Ann. Jard. Bot. Btzg* 6 (1887) 243; *BRANDIS, J. Linn. Soc. Bot.* 31 (1895) 50; *BECC. Nelle For. Born.* (1902) 572; *MERR. En. Born.* (1921) 401; *SLOOT. Bull. Jard. Bot. Btzg III*, 12 (1932) 36; *WYATT-SMITH, Mal. For.* 17 (1955) 149; *BROWNE, For. Trees Sarawak & Brunei* (1955) 115; *ASHTON, Gard. Bull. Sing.* 20 (1963) 242; *Man. Dipt. Brun.* (1964) 51, f. 8, pl. 16 (stem); *ibid. Suppl.* (1968) 22; *MEIJER & WOOD, Sabah For. Rec.* 5 (1964) 280, pl. 28 (stem), f. 46. — *D. beccariana* RIDL. *Fl. Mal. Pen.* 1 (1922) 211, *p.p.* — *D. oiocarpa* SLOOT. *ex HEYNE, in Den Berger & Endert, Med. Proefst. Boschw.* 11 (1925) 107; *Nutt. Pl. ed.* 2 (1927) 1106; *ENDERT, M.-O. Born. Exp.* (1927) 239; *VAN DER LAAN, HARING & LIT,*

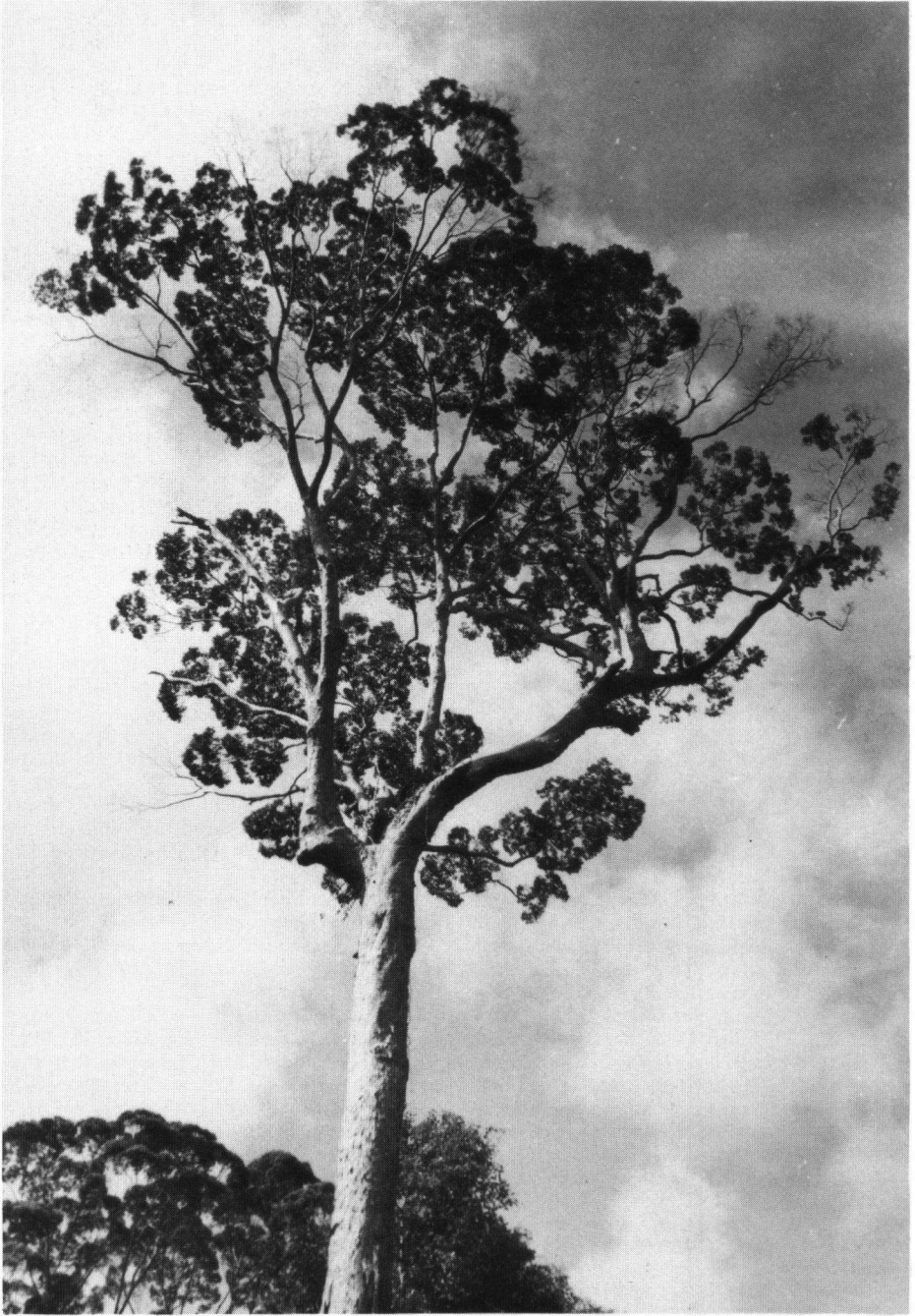


Fig. 51. Crown of *Dryobalanops aromatica* GAERTN. f. Brunei (Photogr. ASHTON).

Bijdr. boom. Z.O. Borneo (1928) 19, *nomen*. — *D. oocarpa* SLOOT. Bull. Jard. Bot. Btzg III, 12 (1932) 33, f. 4; WYATT-SMITH, Mal. For. 17 (1955) 149.

Young parts sometimes fugaceous puberulent, all parts otherwise entirely glabrous. *Twig* to 1 mm \varnothing apically, slender, smooth. *Bud* 3–4 by 2 mm, narrowly lanceolate, compressed. *Stipule* 5–8 mm long, linear, fugaceous. *Leaves* 5–8 by 1–3 cm, ovate to lanceolate, comparatively thin, base cuneate, acumen to 17 mm long, narrow, margin frequently undulate; *petiole* 0.7–1 cm long, very slender. *Panicle* to 10 cm long, terminal or axillary, terete, wrinkled on drying, irregularly doubly branched; *bracteoles* and *bracts* small, linear, fugaceous. *Flower bud* to 10 by 3.5 mm, fusiform, acute. *Sepals* glabrous, equal, narrowly deltoid, subacute. *Corolla* white; petals large, broadly elliptic, obtuse, glabrous. *Stamens* c. 30, subequal, almost $\frac{3}{4}$ length of style; filaments united in a tube around the base of the ovary, the tube almost half as long as the anthers; anther narrowly oblong, the cells tapering, acute; appendage to connective short, erect, slightly exceeding anther. *Ovary* ovoid, glabrous; style 2–3 times as long as ovary, filiform, glabrous. *Fruit calyx* glabrous; base with to 8 mm \varnothing , shallow or to 5 mm deep cup, uncontracted at the rim, tapering gradually and cuneate at the pedicel; lobes equal, to 6.5 by 0.8 cm, glabrous, oblong-spatulate, narrow, subacute, to 2 mm broad at the base, very thin and opaque between the reticulations of the nerves. *Nut* to 1.4 cm long and \varnothing , ovoid to globose, glabrous, with acute style remnant, resting on the considerably narrower calyx cup and pushing the lobes out to a wide angle.

Distr. *Malesia*: Borneo (excepting S. and S.W.).

Ecol. Locally abundant on leached sandy soils on coastal hills and inland ridges below 700 m.

Vern. *Kapur, k. merah, k. ranggi* (Mal.), *kĕladan* (Iban).

Note. Collections from S.E. Borneo tend to have longer narrower leaves, often less coriaceous, than those from elsewhere; the species generally occurs on deeper, more fertile soils there. Nevertheless there is no consistent way in which these plants may be distinguished in field or herbarium.

6. *Dryobalanops fusca* SLOOT. Bull. Jard. Bot. Btzg III, 12 (1932) 39, f. 5; WYATT-SMITH, Mal. For. 17 (1955) 149; ASHTON, Man. Dipt. Brun. Suppl. (1968) 22, f. 4.

Leaf undersurface shortly densely even persistently golden tomentose; midrib beneath, petiole, leaf bud and stipule outside (subglabrous within) more darkly so. *Twig* 1–2 mm \varnothing at the apex, slender, much branched. *Bud* to 4 by 2 mm, lanceolate, acute. *Stipule* to 3 by 1 mm, linear, fugaceous. *Leaves* 5–10 by 2–4 cm, broadly lanceolate, coriaceous, base obtuse or broadly cuneate; acumen to 1.5 cm long, slender, tapering, caudate; nerves obscured by tomentum; midrib depressed above, prominent beneath; *petiole* 5–10 mm long, short, drying pale rufous tomentose. *Panicle* to 5 cm long, terminal or axillary, terete,

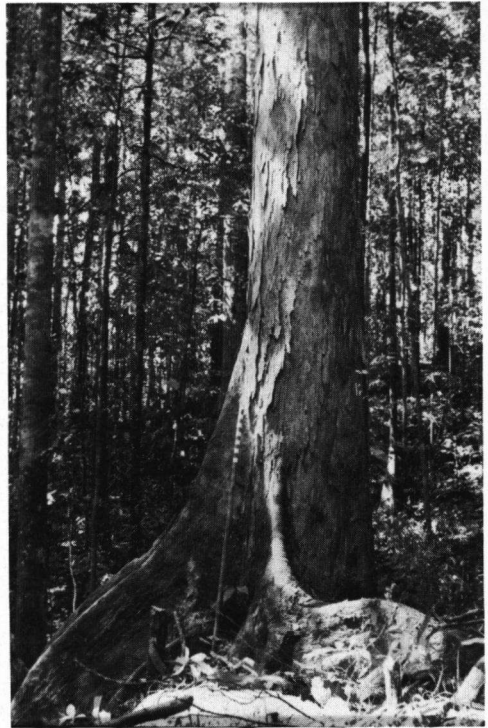


Fig. 52. Trunk-base of *Dryobalanops aromatica* GAERTN. f. Brunei (Photogr. ASHTON).

densely shortly evenly pale rufous tomentose; singly branched, branchlets to 2 cm long, bearing to 3 flowers. *Flower bud* to 12 by 3 mm, lanceolate, glabrous. *Sepals* equal, narrowly lorate-deltoid, obtuse, glabrous. *Petals* lanceolate, glabrous. *Stamens* c. 30, subequal, reaching to below style apex; filaments connate at base, tapering, c. $\frac{2}{3}$ length of anthers; anthers narrowly oblong, tapering; appendage to connective erect, extending somewhat above anther apex. *Ovary* ovoid, glabrous; style 3–4 times length of ovary, filiform, glabrous. *Fruit* entirely glabrous. *Pedicel* to 6 mm long, prominent. *Calyx lobes* to 6 by 1.3 cm, spatulate, obtuse, c. 4 mm wide above the to 3 mm deep, to 7 mm \varnothing , shallow thickened basal cup. *Nut* to 2 by 1.3 cm, ellipsoid-ovoid, apiculate.

Distr. *Malesia*: W. Borneo (N. of the Kapuas and W. of the Lupar).

Ecol. Locally dominant on podsols, low ridges and especially raised beaches, in Heath forest.

Vern. *Empedu, kapur ĕmpedu* (Mal.).

7. *Dryobalanops rappa* BECC. Nelle For. Born. (1920) 572; MERR. En. Born. (1912) 401; SLOOT. Bull. Jard. Bot. Btzg III, 12 (1932) 41; WYATT-SMITH, Mal. For.



Fig. 53. Trunk and crown of *Dryobalanops rappa* BECC., *kapur paya*. Note shaggy bark. Sarawak (Photogr. SMYTHIES).

18 (1955) 155; BROWNE, For. Trees Sarawak & Brunei (1955) 116; ANDERSON, Gard. Bull. Sing. 20 (1963) 157; ASHTON, Gard. Bull. Sing. 20 (1963) 242; Man. Dipt. Brun. (1964) 53, f. 8, pl. 19 (stem); *ibid.* Suppl. (1968) 23; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 289, f. 48; ASHTON, Gard. Bull. Sing. 31 (1978)

25. — *D. oblongifolia* (non DYER) WYATT-SMITH, Mal. For. 18 (1955) 155. — Fig. 53.

Young twig, raceme, stipule and bud, petiole, midrib and leaf beneath densely powdery caducous or persistent rufous tomentose. Twigs slender, becoming smooth but for minute, warty lenticels. Bud 3–6 by 2–3

mm, ovoid, subacute, slightly compressed. *Stipule* 5–8 mm long, linear. *Leaves* 6–11 by 2.5–4 cm, ovate-lanceolate, coriaceous, base obtuse; acumen to 1 cm long, narrow; midrib prominent, grooved, beneath; *petiole* 6–10 mm long, stout. *Panicle* to 8 cm long, terminal or axillary, ribbed apically on drying, otherwise terete; regularly alternately doubly branched, branchlets bearing up to 4 flowers; *bracteoles* linear, fugaceous. *Flower bud* to 10 by 5 mm, ellipsoid, acute. *Petals* cream, lanceolate, glabrous. *Sepals* equal, narrowly deltoid, obtuse, glabrous. *Stamens* c. 30, subequal, reaching to below style apex; filaments united in a tube round the ovary, tapering apically to the anthers, c. $\frac{3}{4}$ length of anthers; anthers narrowly oblong, tapering; appendage to connective erect, extending somewhat above anther apex. *Ovary* ovoid, glabrous; style twice as long as ovary, filiform, tapering, glabrous. Base of *fruit calyx* 5–8 mm \varnothing , 3 mm deep, shallowly cupped; lobes to 5 by 0.6 cm, linear to spatulate, subacute,

2.5–3.5 mm broad at the base. *Nut* to 10 by 6 mm, ovoid, glabrous, crowned by a c. 6 mm long slender persistent style remnant.

Distr. *Malesia*: Borneo (Lower Kapuas, Sarawak, Brunei, W. Sabah).

Ecol. Common, locally dominant and gregarious, in Mixed Peat Swamp forest overlying sand terraces, and on podsols below 200 m.

Uses. Considered of inferior quality, darker, harder and more liable to splitting than other species.

Vern. *Kapur paya* (Mal.), *k. rappa* (Sar.), *lu'an* (Dusan), *lesuan* (Murut), *kajatan* (West Borneo).

Note. SFN 32194, a flowering collection from swamps in S.E. Johore, differs from *D. oblongifolia* DYER in possessing more coriaceous leaf and rufous flocculent pubescent innovations and inflorescence, in this resembling this species which is otherwise unknown outside Borneo. Fruit are required to confirm this record.

7. PARASHOREA

KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 65; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 221; HEIM, Rech. Dipt. (1892) 54; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 103; SLOOT, Bull. Jard. Bot. Btzig III, 8 (1927) 370; FOXW. Philip. J. Sc. 67 (1938) 316; SYM. Mal. For. Rec. 16 (1943) 97, f. 58 (map), 59–62; ASHTON, Man. Dipt. Brun. (1964) 82; *ibid.* Suppl. (1968) 38; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 190; WANG HSIE, Acta Phytotax. Sin. 15, 2 (1977) 10, 22, fig.; ASHTON, Gard. Bull. Sing. 31 (1978) 26; SMITINAND, Thai For. Bull. (Bot.) 12 (1980) 54. — Fig. 54–59.

Large trees with large, rounded, slightly concave, hardly branched plank buttresses. *Crown* dense, becoming dome-shaped or hemispherical, even, the branchlets usually crowded towards the ends but not ‘cauliflower’ shaped; main branches several to many, radiating from the bole apex (except in *P. macrophylla*). *Bark surface* distinctly mauve-grey to purplish, with narrow shallow fissures, broad smooth or flaking flat ridges, and numerous conspicuous large pale corky lenticels. *Stipules* linear to hastate, fugaceous. *Leaves* broadly oblong-ovate, shortly acuminate; nerves scalariform, with subsistent plicate folding; no intermediate nerves; young leaves white beneath. *Inflorescence* racemose (except *P. macrophylla*). *Flower* and *fruit* as in *Shorea*, but *sepals* in bud \pm equal, very narrowly imbricate. *Petals* falling separately. *Stamens* 15, much longer than ovary in bud; filaments short, dilated and compressed at base, tapering abruptly and filiform below anthers; anthers narrowly oblong, with 4 pollen sacs, the inner 2 shorter than outer 2; appendage to connective hardly exceeding anther apex, not reflexed, stout. *Ovary* small, \pm ovoid, shortly pubescent, with or without a slender stylopodium; style as long as or longer than ovary, filiform, glabrous. *Fruit pedicel* short. *Fruit calyx lobes* either \pm spatulate, slender, thickened and saccate at the valvate base, frequently subequal, 3 somewhat larger than the other 2, or shorter than nut, equal; pushed apart by the ripening nut. *Nut* large, globose, pubescent, verrucose-lenticellate; style remnant short, indistinct. *Germination* as in *Shorea*, but with seedling leaves at first linear, quite unlike the peltate sapling leaves.

Distr. About 14 spp.: southern Burma, Thailand, Indochina and S. China (Yunnan, Kwangsi); in *Malesia*: 10 spp., in Malaya, Sumatra, Borneo, the Philippines and intervening islands. Fig. 55.

Ecol. Local, sometimes abundant, in lowland Mixed and Semi-evergreen Dipterocarp forests, and occasionally hills to 1400 m.

Uses. An important pale coloured light hardwood exported from the Philippines and N.W. Borneo.

KEY TO THE SPECIES

- 1. Fruit sepals shorter than nut, linear-lanceolate, subequal.
- 2. Leaves glabrescent, silvery stellate puberulent beneath; nerves to 9 pairs (saplings excluded) 1. *P. aptera*
- 2. Leaves not as above, generally pubescent at least on nervation; nerves at least 10 pairs.
- 3. Leaves 7-15 by 3-3.6 cm, sparsely pubescent or glabrous beneath; tertiary nerves evident but not prominent; petiole 9-12 mm long 2. *P. densiflora*
- 3. Leaves 12.5-18 by 6.5-9 cm, persistently scabrid pubescent beneath; tertiary nerves sharply prominent beneath; petiole 14-18 mm long 3. *P. globosa*
- 1. Fruit sepals aliform, much longer than the nut, spatulate, unequal.
- 4. Leaves 30-50 by 16-24 cm, very large, white beneath, with 28-36 pairs of close straight nerves 4. *P. macrophylla*
- 4. Leaves shorter than 20 cm, nerves less than 20 pairs.
- 5. Leaves (mature trees) glabrous, drying as dark beneath as above; plication obscure; nerves distant, arched, elevated but slender and not prominent beneath; petiole long, slender, geniculate.
- 6. Leaves 6-9 by 3-4.5 cm; tertiary nerves distant, elevated beneath 5. *P. parvifolia*
- 6. Leaves 6-16 by 2.3-8 cm; tertiary nerves dense, obscure 6. *P. stellata*
- 5. Leaves longer than 9 cm, silvery lepidote or puberulent, dull beneath; plication subpersistent; nerves dense, hardly arched, prominent beneath.
- 7. Stipule scars amplexicaul. Leaves broadly elliptic to ovate, base unequal.
- 8. Leaves glabrous beneath. Connectival appendage longer than anther. Fruit sepals to 15 cm long 7. *P. malaanonan*
- 8. Leaves ± persistently pubescent beneath. Connectival appendage shorter than the anther. Mature fruit sepals to 20 cm long 8. *P. tomentella*
- 7. Stipule scars short, descending. Leaves not as above.
- 9. Leaves 6-14 by 2.5-6 cm, glabrescent beneath as also the petiole; nerves to 12 pairs; petiole to 15 mm long 9. *P. lucida*
- 9. Leaves 10-18 by 4-7 cm; nervation beneath and petiole scabrid pubescent; nerves 14-18 pairs; petiole 15-22 mm long 10. *P. smythiesii*

1. *Parashorea aptera* SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 377, f. 3; Reinwardtia 5 (1961) 478.

Tall tree. Young twigs, buds, petiole, bracts outside, panicles, calyx parts of corolla exposed in bud and ovary densely evenly ± persistently buff pubescent; nerves beneath sparsely ± caducously so. *Twig* c. 2 mm ø apically, much branched, ± ribbed, becoming smooth, terete, blackish; stipule scars short, obscure. *Bud* to 6 by 4 mm, ovoid, acute; stipules fugaceous, not seen. *Leaves* 7-17 by 2.8-6 cm, ovate-lanceolate, coriaceous, ± distinctly persistently plicate, dull and ± silvery stellate puberulent beneath; base cuneate, apex to 1.5 cm long slender acuminate; nerves 6-9(-10) pairs, ascending, rather straight, slender but prominent and drying blackish beneath, applanate above; tertiary nerves very slender, hardly elevated, densely scalariform; midrib prominent beneath, shallowly furrowed above; *petiole* 9-18 mm long, geniculate. *Panicle* to 9 cm long, terminal or axillary, singly or doubly branched, branchlets with 3 prominently pedicellate flowers; *bracts* to 4 by 3 mm, elliptic. *Flower buds* to 6 by 4 mm, ovoid; calyx, petals and ovary densely hirsute. *Sepals* short, broadly ovate-deltoid. *Stamens* slightly exceeding style at

anthesis; filaments compressed, broad, short, attenuate; anthers lorate; appendages very short, hardly exceeding the anthers; *ovary* small, ovoid; style longer than ovary, slender. *Fruit pedicel* to 3 mm long, stout; sepals to 14 by 3 mm, subequal, linear-attenuate, appressed to nut, incrassate at base. *Nut* to 2.5 cm ø, subglobose, apiculate, densely verrucose.

Distr. *Malesia*: Sumatra (Labuan Batu, E. coast; Rawas, Palembang).

Ecol. Locally frequent below 70 m in lowland forest on sandy soils on hills.

Vern. *Mèranti horsik*, *ngèrawan batu*, *mèrakunyit lawang*.

Note. Some sterile Sumatran collections may represent the Malayan *P. densiflora*.

2. *Parashorea densiflora* SLOOT. & SYM. Gard. Bull. S. S. 10 (1939) 373, pl. 24; SYM. Mal. For. Rec. 16 (1943) 100, f. 59A, 60, 61. — *P. aptera* (non SLOOT.) FOXW. Mal. For. Rec. 10 (1932) 243; BURK. Dict. (1935) 1664.

Large tree. Young twigs, petioles and leaves below sparsely pubescent (West coastal Malaya) or glabrous (E. coast), panicle and parts of perianth exposed in

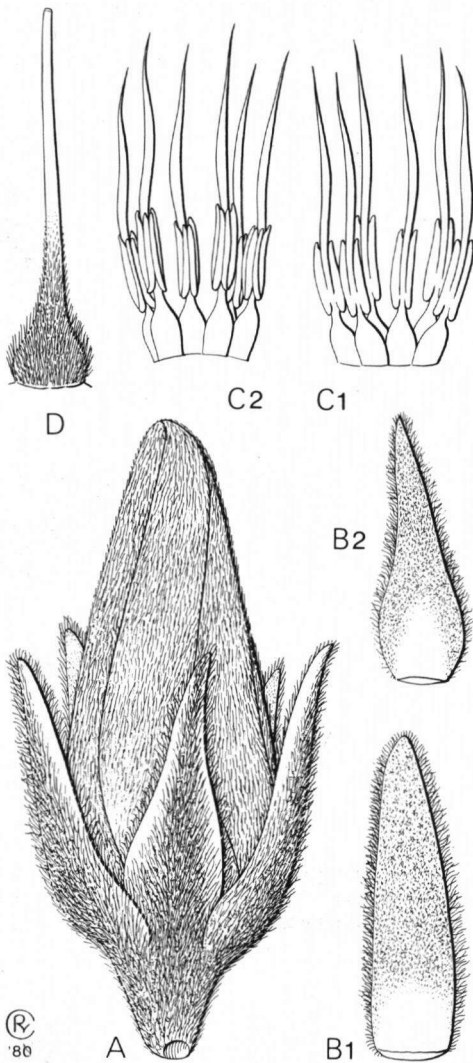


Fig. 54. Flower details in *Parashorea malaanonan* (BLCO) MERR. A, Bud, B1, outer sepal, B2, inner sepal, both from inside, C1, stamens from outside, C2, stamens from inside, D, pistil, all $\times 5$ (PUASA 4643).

bud densely persistently pale brown pubescent, ovary caducously so. *Twig* c. 3 mm \varnothing , ribbed, pale to dark brown; stipule scars pale, horizontal, persistent. *Bud* c. 4 by 3 mm, ovoid; *stipule* to 12 mm long, linear, fugaceous. *Leaves* 7–15 by 3–6.5 cm, elliptic to ovate, coriaceous, \pm densely pale purplish stellate lepidote beneath; base cuneate (if ∞ -nerved) or obtuse to subcordate (if few-nerved); acumen to 1 cm long,

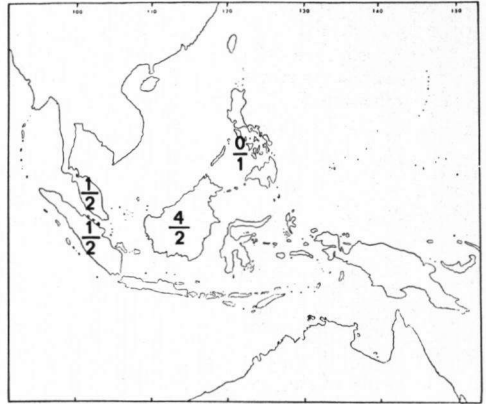


Fig. 55. Density map of *Parashorea* KURZ in Malasia; number of endemics above the hyphen, number of non-endemics below it.

tapering; nerves 10–20 pairs, stout and prominent beneath, evident above, ascending, the basal pair frequently branching laterally; tertiary nerves scalariform, sinuate, evident on both surfaces; midrib prominent beneath, obscure and depressed above; *petiole* 9–12 mm long, stout, terminal or axillary, short, congested. *Flower buds* to 6 by 4 mm, ovoid-lanceolate; *sepals* lanceolate, the 2 inner slightly the smaller, acuminate; *petals* yellow, tinged purplish at base; *stamens* in 3 unequal verticils; filaments short, compressed, tapering; anthers oblong, the outer loculi sparsely setose; appendage hardly exceeding anthers, stout; *style* filiform, \pm twice length of the ovoid ovary. *Fruit pedicel* to 7 mm long, to 3 mm \varnothing , expanding into the receptacle; calyx lobes to 12 by 3 mm, subequal, narrowly lorate, acute, becoming reflexed; nut to 3 cm \varnothing , subglobose.

Distr. Malasia: Malaya (southern half and in Pahang and Trengganu).

Ecol. Scattered in lowland dipterocarp forest below 500 m.

Vern. Mēranti pasir, tēngkawang jantong.

Note. Collections from the Malayan East coast are glabrescent, with somewhat smaller cordate fewer-nerved leaves; more fertile collections are needed to establish their status, as they are indistinguishable from *P. aptera* when sterile.

3. *Parashorea globosa* SYM. Gard. Bull. S. S. 10 (1939) 375; Mal. For. Rec. 16 (1943) 101, f. 60.

Large tree. *Twig* apices, leaf buds, stipules, petioles and leaf nervation beneath \pm densely ocherous to rufous scabrid puberulent. *Twig* c. 3 mm \varnothing , stout, becoming rugulose; stipule scars short, somewhat ascending, falcate. *Bud* c. 4 by 3 mm, ellipsoid, obtuse; *stipule* to 23 by 6 mm, lanceolate. *Leaf* 12.5–18 by 6.5–9 cm, ovate-oblong, thickly coriaceous, rufous

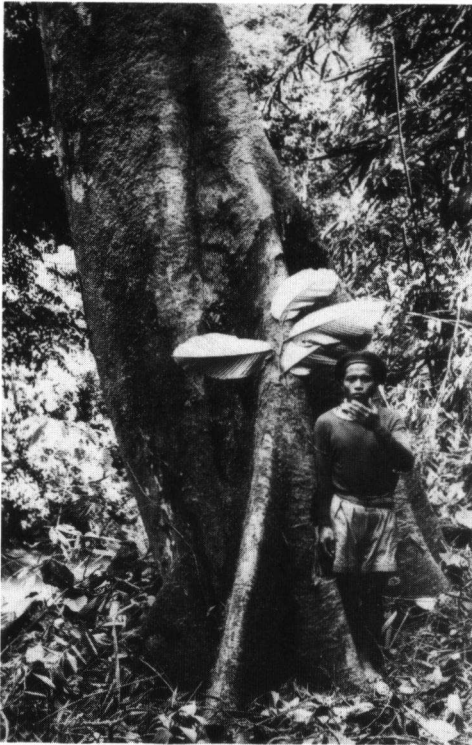


Fig. 56. Stem-base and leaves of *Parashorea macrophylla* WYATT-SMITH ex ASHTON. Kuala Belalong, Brunei (Photogr. G.H.S. WOOD, SAN 17377).

beneath (mature trees); base subcordate; apex acute to subacuminate; nerves *c.* 18 pairs, prominent beneath, evident above, spreading at leaf base, ascending towards apex; tertiary nerves slender but sharply prominent beneath, evident above; *petiole* 14–18 mm long, stout. *Panicles* and *flowers* unknown. *Fruit sepals* to 6 by 3 mm, lorate, obtuse; *nut* to 4 cm \varnothing , subglobose.

Distr. *Malesia*: Malaya (Perak), Sumatra (Labuan Batu, E. coast).

Ecol. Rare, lowland dipterocarp forest on low-lying land and up valleys at the margin of the plains.

Vern. *Mèranti pasir daun bèsar*.

4. *Parashorea macrophylla* WYATT-SMITH ex ASHTON, Gard. Bull. Sing. 19 (1962) 262, pl. 5; ASHTON, Man. Dipt. Brun. (1964) 83, f. 11; *ibid.* Suppl. (1968) 38, pl. 8–9 (habit, bark). — *Parashorea* sp. BROWNE, For. Trees Sarawak & Brunei (1955) 128 — Fig. 56.

Young twig, leaf bud, stipule (outside, glabrous within), petiole and inflorescence shortly densely evenly persistently pale ocherous tomentose. *Twig* to 12 by 5 mm \varnothing apically, compressed, becoming terete, smooth, amplexicaul; leaf scars large, elliptic, conspi-

cuous. *Bud* to 9 by 0.8 cm, linear, acute, pale cream-brown. *Stipule* to 15 by 2.5 cm, linear, subacute, caducous. *Leaves* alternate, 30–50 by 16–24 cm, subchartaceous, oblong-elliptic, silvery to white below, base subcordate, apex obtuse or shortly acuminate; nerves 28–36 pairs, dense, straight, curved towards the margin, not silvery, with semi-persistent interneural plicate folds; tertiary nerves slender, densely scalariform, diagonal to nerves; midrib stout, rounded beneath, slightly raised above; *petiole* 3–5 cm long, terete. *Panicle* to 16 cm long, terminal or axillary, doubly or trebly branched; branches alternate, branchlets cymose; *bracts* to 4 by 2.5 cm, ovate, acute, cupped, amplexicaul, caducous, densely shortly tomentose outside. *Petals* oblong, obtuse. *Stamens* subequal; filaments short, deltoid; anthers narrowly oblong, the inner pollen sacs somewhat the shorter; appendage prominent, tapering, *c.* $\frac{1}{2}$ length of anther. *Ovary* conical, shortly pubescent, tapering into a prominent narrowly cylindrical stylopodium. *Fruit* subsessile; *calyx* puberulent (more densely so at base), glabrescent; 3 longer lobes to 22 by 1.8 cm, spatulate, brittle, subacute, tapering to 6 mm broad above the to 16 by 8 mm elliptic shallowly saccate base; fused at the base to form an up to 8 mm deep, to 1 cm broad, cup at the pedicel; 3 shorter lobes to 12 by 0.7 cm, linear, unequal, tapering to 3 mm above the to 5 mm broad and long more prominently saccate base. *Nut* to 2.5 by 1.2 cm, ellipsoid, densely buff tomentose; style remnant to 6 mm long, linear.

Distr. *Malesia*: Borneo (Kapuas hinterland, Sarawak and Brunei).

Ecol. Moist clay rich soils in valleys and gulleys, on and near river banks in inland areas, locally abundant; to 600 m.

Vern. *Pèran* (Mal.), *bilat* (Ib.).

5. *Parashorea parvifolia* WYATT-SMITH ex ASHTON, Gard. Bull. Sing. 19 (1962) 264, pl. 6; ASHTON, Man. Dipt. Brun. (1964) 85, f. 11, pl. 24 (stem); *ibid.* Suppl. (1968) 38; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 195, f. 23.

Young twig, leaf bud, stipule, petiole and panicle sparsely shortly pale yellow-brown tomentose, caducous on twigs and petioles. *Twig* 1 mm \varnothing apically, terete, smooth, glabrous, dotted with minute pale round lentils; stipule scars short, slender. *Bud* to 3 by 1 mm, narrowly lanceolate, acute. *Stipule* to 3.5 mm long, narrowly hastate, acute, fugaceous. *Leaves* 6–9 by 3–4.5 cm, elliptic to ovate, glabrous; base broadly cuneate; acumen to 1.5 cm long, narrow to caudate; nerves 8–10 pairs, slender, raised beneath, curved, well spaced, at 50°–60°; tertiary nerves scalariform to subreticulate, widely spaced, *c.* 90° to nerves; midrib slender, prominent beneath, depressed above; *petiole* 1–1.8 cm long, geniculate, pale. *Panicle* to 14 cm long, terminal or axillary, singly branched, straight, pendant; *bracts* and *bracteoles* unknown. *Flower bud* to 4.5 by 3 mm, ellipsoid, obtuse. *Calyx* densely shortly grey-brown tomentose outside, glabrous within, lobes narrowly deltoid, subequal, sub-

acute, not adpressed to corolla in bud. *Petals* elliptic, obtuse, shortly tomentose on parts exposed in bud, pale cream. Inner 5 *stamens* slightly longer than the others, reaching $\frac{2}{3}$ length of style; filaments broad at base tapering; anther narrowly oblong; appendage to connective short, slightly extruding above anther. *Ovary* subglobose, densely tomentose; style c. 3 times length of ovary, filiform, shortly pubescent in the basal $\frac{1}{3}$, otherwise glabrous. *Fruit calyx* puberulent at base, glabrescent, becoming pushed apart by the ripening nut; 3 longer lobes to 8.5 by 1.7 cm, broadly spatulate, obtuse, to 3 mm broad above the to 7 mm long unexpanded slightly thickened base; 2 shorter lobes to 7.5 cm long, often only slightly smaller than longer lobes, subequal. *Nut* to 1.5 by 1.3 cm, ellipsoid, obtuse, verrucose with pale lenticels, buff tomentose; style remnant to 1 mm long, short.

Distr. *Malesia*: Borneo (N.E. of Rejang to Sabah, Bulungan and Tidung).

Ecol. Local, in Mixed Dipterocarp forests on clay rich soil, on ridges in mountains to 1350 m, rarely on river banks.

Vern. *Urat mata bukit* (Brun.), *urat mata daun kěchil* (Sabah), *lantang kuning* (Tidung).

6. *Parashorea stellata* KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 66; Fl. Burma 1 (1877) 117; PIERRE, For. Fl. Coch. 3 (1889) t. 224; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 267; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 104, t. 2, f. 11-12; Indian Trees (1906) 70, fig.; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 388, f. 38; RIDL. Agr. Bull. Str. F.M.S. 6 (1907) 170; Fl. Mal. Pen. 1 (1922) 234; TROUP, Silv. Ind. Trees 1 (1921) 134; FOXW. Mal. For. Rec. 1 (1921) 70; *ibid.* 3 (1927) 63; *ibid.* 10 (1932) 242; GAMBLE, Man. Ind. Timb. (1922) 83; BAKER f. J. Bot. 62, Suppl. (1924) 11; CRAIB, Fl. Siam. Enum. 1 (1925) 144; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 310; *ibid.* ed. 2 (1927) 1126; LECOMTE, Bois de l'Indochine (1926) 113; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 373, f. 2, p.p.; BURK. Dict. (1935) 1664; ASHTON, Gard. Bull. Sing. 31 (1978) 26. — *Shorea stellata* DYER, Fl. Br. Ind. 1 (1874) 304; KING, J. R. As. Soc. Beng. 62, 2 (1893) 120. — *Shorea cinerea* FISCHER, Kew Bull. (1926) 460. — *P. lucida* (non (MIQ.) KURZ) SLOOT. Kew Bull. (1927) 372, p.p.; SYM. Mal. For. Rec. 16 (1943) 102, f. 59B, 60, 62. — *P. poilanei* TARDIEU, Not. Syst. 10, 3 (1942) 136.

Medium-sized or large tree. Panicles, floral ovary and sepals outside densely greyish puberulent, ovary and sepals glabrescent in fruit; leaf undersurface \pm silvery lepidote; parts otherwise glabrous. *Twig* 1-2 mm \varnothing , slender, ribbed along the leaf traces, glabrescent; stipule scars short, pale, horizontal. *Buds* to 2 by 2 mm, small, ellipsoid, obtuse; *stipule* to 1.5 cm long, linear, fugaceous. *Leaf* 6-16 by 2.3-7 cm, lanceolate, thinly coriaceous; base cuneate; acumen to 1 cm long, tapering; nerves 8-12 pairs, very slender, elevated beneath, obscure above, steeply ascending, frequently sinuate and obscurely branching; tertiary nerves very slender, evident but hardly elevated, densely scalariform; midrib prominent beneath, shallowly depressed

and obscure above; *petiole* (10-)-12-30 mm long, slender, smooth. *Panicle* to 15 cm long, terminal or axillary, slender, lax, many-flowered, doubly branched; branchlets to 2 cm long, bearing to 7 second flowers. *Flower buds* to 2 by 2 mm, small, subglobose; *sepals* ovate, subequal, acute; *corolla* white; *stamens* subequal, yellow; filaments short, broad, compressed; anthers linear-oblong; appendages short, slightly exceeding anthers; ovary subglobose, densely pubescent; style columnar, c. $1\frac{1}{2}$ \times length of ovary. *Fruit pedicel* to 3 mm long, to 2 mm \varnothing , expanded into receptacle; calyx lobes to 11 by 1.8 cm, subequal, spatulate, obtuse, ascending, c. 3 mm broad above the narrow thickened base; *nut* to 2 by 1.5 cm, ellipsoid, crowned by an up to 4 mm long filiform tapering style remnant.

Distr. Southern Burma, Thailand, Indochina, and in *Malesia*: Malaya (Trengganu and Perak northwards).

Ecol. Frequent in lowland and hill evergreen dipterocarp forests in seasonal areas, especially in valleys, to 650 m.

Vern. *Gěrutu gěrutu*.

Note. Collections cited from Sumatra belong correctly to *P. lucida*.

7. *Parashorea malaanonan* (BLCO) MERR. Sp. Blanc. (1918) 271; En. Philip. 3 (1923) 100; REYES, Philip. J. Sc. 22 (1923) 330; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1927) 375; in Merr. Pl. Elm. Born. (1929) 202; SYM. Gard. Bull. S. S. 9 (1938) 334, pl. 21; BROWNE, For. Trees Sarawak & Brunei (1955) 128; ASHTON, Man. Dipt. Brun. (1964) 84, f. 11; *ibid.* Suppl. (1968) 38; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 192. — *Mocanera malaanonan* BLCO, Fl. Filip. (1837) 858. — *Dipterocarpus malaanonan* BLCO, Fl. Filip. ed. 2 (1845) 312; *ibid.* ed. 3, 2 (1878) 214; DC. Prod. 16, 2 (1868) 614. — *Shorea malaanonan* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 34; WALP. Ann. 4 (1857) 338; DC. Prod. 16, 2 (1868) 631; F.-VILL. Nov. App. (1880) 21; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 103; MERR. & ROLFE, Philip. J. Sc. 3 (1908) Bot. 115; WHITFORD, Bull. Bur. For. Philip. 10 (1911) 64; FOXW. Philip. J. Sc. 6 (1911) Bot. 270; *ibid.* 13 (1918) Bot. 189. — *P. plicata* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 104; MERR. & ROLFE, Philip. J. Sc. 3 (1908) Bot. 114; FOXW. Philip. J. Sc. 6 (1911) Bot. 280; *ibid.* 13 (1918) Bot. 194; *ibid.* 67 (1938) 317; WHITFORD, Philip. J. Sc. 6 (1911) Bot. 64. — Fig. 54, 57, 58.

Young twig, leaf bud, stipule, petiole and panicle shortly sparsely pale brown tomentose, glabrescent on petiole. *Twig* to 1.5 mm \varnothing apically, terete, becoming glabrous, dotted with minute pale round lenticels; stipule scars thin, pale, amplexicaul. *Bud* to 6 by 2 mm, lanceolate to subfalcate, acute. *Leaves* 9-15 by 3.5-7.5 cm, elliptic to ovate, greyish beneath, glabrous; base obtuse to broadly cuneate, subequal; acumen to 1 cm long, acute; margin undulate; nerves 9-14 pairs, straight, with \pm prominent interneural plicate folds, curved at the margin, prominent beneath; tertiary nerves slender, scalariform, sinuate, at 90°; midrib

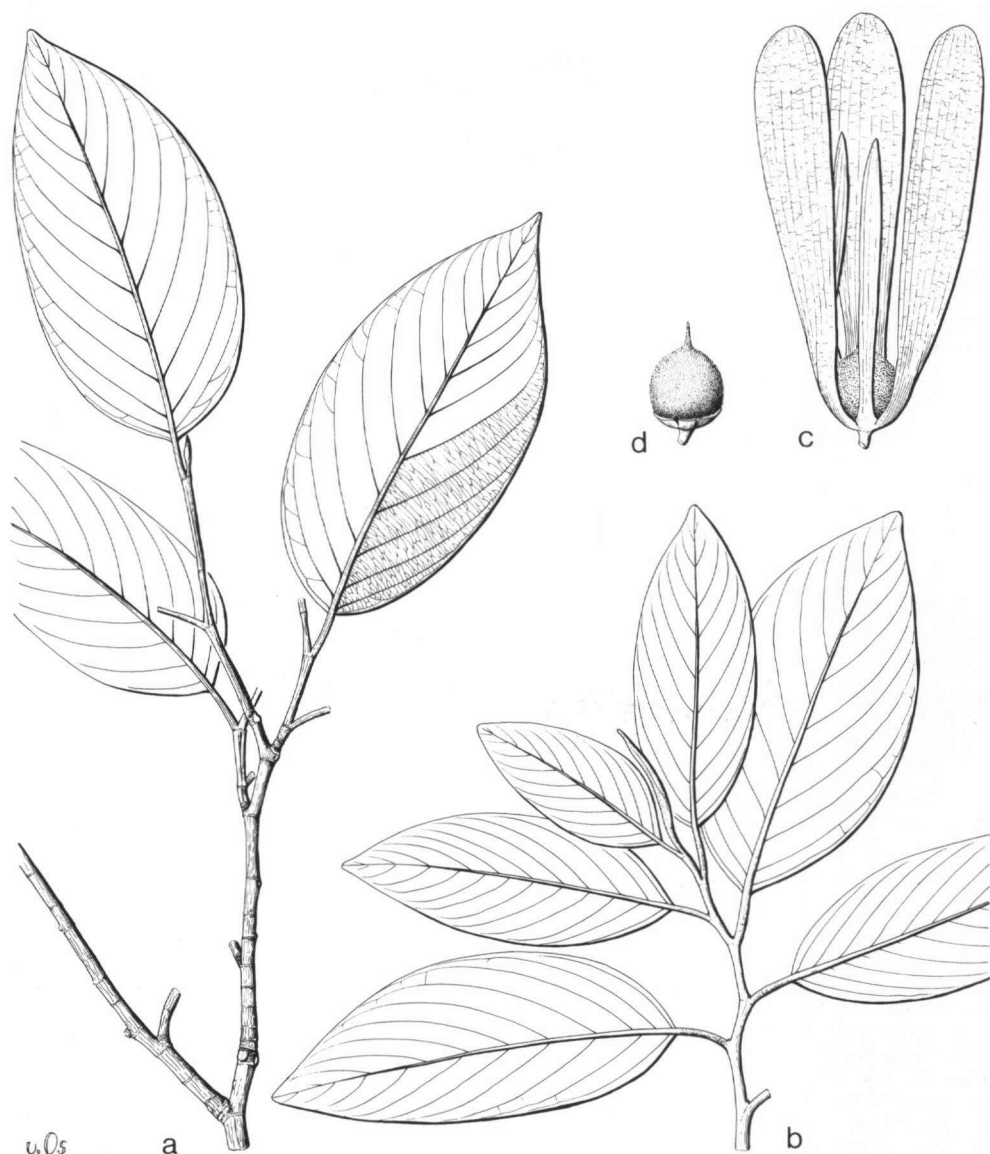


Fig. 57. *Parashorea malaanonan* (BLCO) MERR. *a.* Older sterile twig, *b.* younger sterile twig, *c.* fruit, *d.* nut, all $\times \frac{1}{2}$ (*a* A 281, *b* A 335, *c-d* A 3602).

prominent beneath, slightly raised above; *petiole* 1.2–2 cm long, slightly geniculate. *Panicle* to 18 cm long, terminal or axillary, terete; doubly branched, branchlets to 4 cm long, bearing to 3 flowers; *bracteoles* to 12 by 6 mm, oblong, obtuse, densely pubescent outside, glabrous within. *Bud* to 14 by 8

mm, large. *Flowers* cream. *Calyx* densely brown-buff pubescent outside, more sparsely so near the apex inside; 3 outer lobes narrowly deltoid acute, 2 inner lobes somewhat shorter, narrower. *Petals* hastate, acute, densely tomentose outside, glabrous within. *Stamens* subequal; filaments short, broad at base,

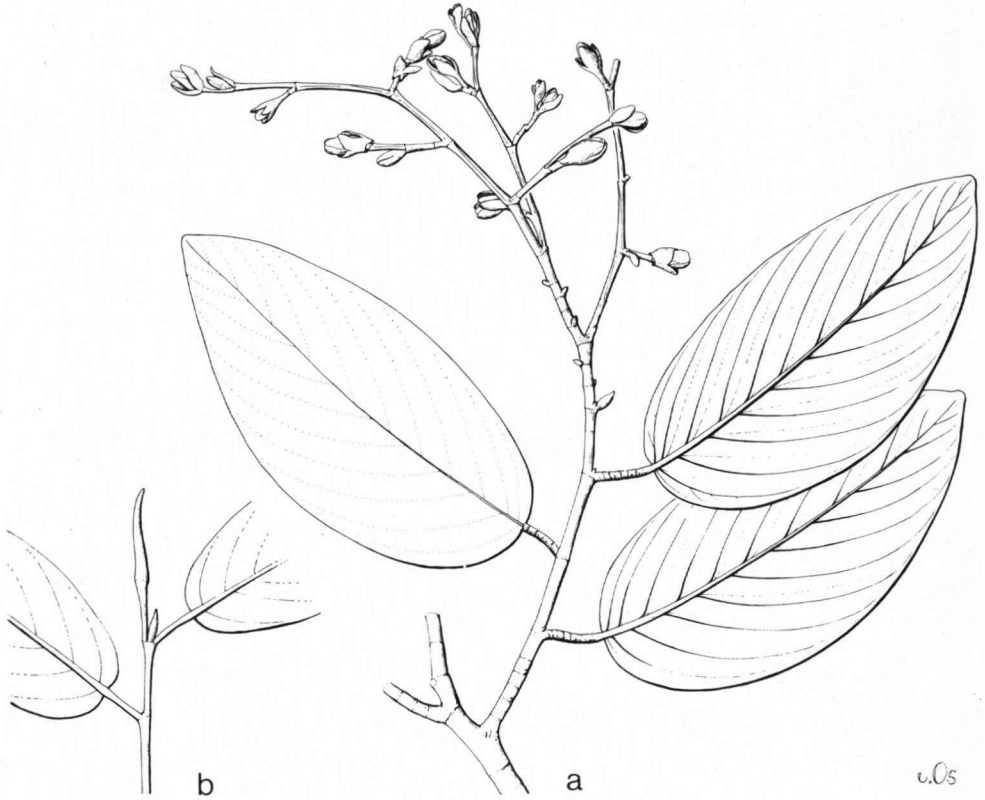


Fig. 58. *Parashorea malaanonan* (BLCO) MERR. a. Flowering twig, b. apex of twig with terminal bud, both $\times \frac{1}{2}$ (NOOTEBOOM 1135).

tapering; anthers linear, about twice length of filament; inner pollen sacs shorter, narrower, than outer; appendage to connective longer than anther, reaching to style apex, stout at base, tapering and slender in the apical half, erect. Ovary ovoid, shortly pubescent; stylopodium slender, tapering into style, shortly pubescent; style filiform, glabrous, c. 4 times length of ovary. Fruit pedicel to 4 mm long, broadening into base of fruit. Fruit calyx puberulent to glabrescent, more densely pubescent at base; 3 longer lobes to 16 by 1.7 cm, narrowly spatulate, subacute, to c. 3 mm broad above the to 5 by 4 mm deltoid shallowly saccate thickened base; shorter lobes to 10 by 0.7 cm, linear, similar at base or somewhat narrower. Nut to 1.7 by 1.4 cm, ellipsoid, obtuse, verrucose; style remnant to 6 mm long, linear, tomentose.

Distr. *Malesia*: Borneo (Brunei to Sabah, S. E. to Berau and Nunukan), Philippines.

Ecol. Abundant in lowlands of Philippines and E. Sabah, rare in W. Sabah, Brunei and N.E. Sarawak, recorded to 1300 m.

Uses. The most important plywood, decking and light construction timber exported from its region.

Vern. *Urat mata, urat mata daun lichin* (Borneo), *bagtican, lauan* (Philippines generally), *apnit* (Polillo, Tayabas, Catanduanes, Camarines, Albay, Sorsogon), *bayucan* (Nueva Ecija, Laguna), *binaliuan* (Bulacan), *danlig* (Tayabas, Masbate, Occidental Negros), *malaanonang* (Laguna), *mayatas* (Polillo), *tacuban* (Camarines).

8. *Parashorea tomentella* (SYM.) MEIJER, Acta Bot. Neerl. 12 (1963) 320; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 199, f. 25. — *P. malaanonan* var. *tomentella* SYM. Gard. Bull. S. S. 9 (1938) 338, pl. 22. — *P. sp.* THOMAS, Mal. For. 4 (1935) 131, p.p.; SYM. ex DESCH, Mal. For. Rec. 12 (1936) 33. — Fig. 59.

Large tree. Young twigs, buds, leaf undersurface, petioles, panicles, bracts outside, calyx parts of corolla exposed in bud and ovary densely evenly \pm persistently pale tawny pubescent. Twig c. 3 mm \varnothing apically, much branched, ribbed, becoming terete, smooth, dark brown; stipule scars slender, horizontal, amplexicaul. Bud to 10 by 4 mm, lanceolate, acute; stipule to 16 by 6 mm, narrowly lanceolate. Leaves



Fig. 59. Stem-base of *Parashorea tomentella* (SYM.) MEDER. Sabah, Tawau, Kalabakan; GANI behind buttress (Photogr. G.H.S. WOOD, Nov. 1955; SAN 17266).

10–20 by 5–10 cm, subcoriaceous, subsersistently plicate, dull but not silvery beneath; margin frequently narrowly subrevolute; base obtuse to subcordate, subequal (peltate in young trees and saplings); apex subacute or to 1 cm long, broadly acuminate; nerves 11–13 pairs, ascending, prominent beneath, somewhat arched; tertiaries densely scalariform, evident and slightly elevated beneath; midrib stout and prominent beneath, elevated above; *petiole* 15–25 mm long, c. 3 mm \varnothing , stout, hardly geniculate. *Panicle* to 13 cm long, singly or doubly branched, the branchlets bearing to 3 flowers; *bracts* to 10 by 4 mm, lanceolate. *Flower buds* to 15 by 10 mm, broadly lanceolate, flowers very large; *sepals* narrowly deltoid; *stamens*

somewhat shorter than style; filaments compressed, tapering; anthers oblong-linear; appendages somewhat longer than anthers, stoutly acicular; *ovary* small, ovoid; style columnar, c. 5 times length of ovary, stout, puberulent but for the apical $\frac{1}{3}$. *Fruit pedicel* c. 3 mm long; *sepals* aliform, 3 longer lobes to 20 by 2.3 cm, spatulate, obtuse; 2 shorter lobes to 10 by 0.8 cm, lorate, acute; *nut* to 2 cm \varnothing , subglobose, verrucose, apiculate.

Distr. *Malesia*: N. E. Borneo (Sangkulirang to Sandakan).

Ecol. Mixed Dipterocarp forest on flat and undulating land below 200 m. Common.

Vern. *Urat mata beludu*.

Note. Sterile and fruiting collections from the Philippines resembling this species were cited by FOXWORTHY under *P. warburgii* BRANDIS, regarded here as *species dubium*. Without flowering collection their identity remains obscure.

9. *Parashorea lucida* (MIQ.) KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 66; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 221; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 104; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 310; ed. 2 (1927) 1126; SLOOT, Bull. Jard. Bot. Btzig III, 8 (1927) 372, *p.p.*; ASHTON, Man. Dipt. Brun. Suppl. (1968) 38, *in nota sub P. smythiesii*; Gard. Bull. Sing. 31 (1978) 27. — *Shorea lucida* MIQ. Sum. (1862) 487, 191; DC. Prod. 16, 2 (1868) 631; WALP. Ann. 7 (1868) 379. — *Shorea subpeltata* MIQ. Sum. (1862) 488, 191; DC. Prod. 16, 2 (1868) 632; WALP. Ann. 7 (1868) 379; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 219; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 103. — *P. stellata* (non KURZ) SLOOT, Bull. Jard. Bot. Btzig III, 8 (1927) 373, *p.p.*

Large tree. Young twigs, buds, petioles, panicles, bracts outside, calyx, parts of corolla exposed in bud and ovary densely evenly ± persistently buff pubescent; nerves beneath sparsely ± caducously so. *Twig* c. 2 mm \varnothing apically, ± ribbed, becoming smooth, blackish, terete: stipule scars short, pale, horizontal. *Bud* to 4 by 2 mm, ovoid-apiculate; *stipules* to 5 by 3 mm, narrowly ovate, acute. *Leaves* 6–14 by 2.5–6.5 cm, ovate-lanceolate to elliptic, thinly coriaceous, ± distinctly persistently plicate, dull and ± silvery stellate beneath; base broadly cuneate to occasionally cordate, subequal; acumen to 1 cm long; nerves 9–12 pairs, slender but prominent beneath, rather straight, dense; tertiary nerves densely scalariform, very slender but distinct beneath; midrib prominent beneath, shallowly furrowed to elevated above; *petiole* 10–20 mm long, hardly geniculate. *Panicle* to 12 cm long, slender, terminal or axillary, singly branched, the branchlets bearing to 6 ± secund flowers; *bracts* to 4 by 3 mm, elliptic. *Flower bud* to 7 by 4 mm, lanceolate; *sepals* narrowly deltoid; stamens shorter than style; filaments broad, compressed, tapering, short; anthers loriate-oblong; appendages acicular, prominent and longer than anthers; *ovary* small, ovoid, surmounted by a distinct tapering somewhat longer stylopodium; style twice as long as ovary and stylopodium, filiform, somewhat expanding distally. *Fruit pedicel* to 3 mm long, broadening into receptacle; *sepals* aliform, unequal; 3 longer lobes to 8 by 1.7 cm, spatulate, obtuse; 2 shorter lobes to 7.5 by 0.8 cm, narrow; *nut* to 2.5 cm \varnothing , subglobose or ovoid, apiculate, densely verruculose.

Distr. *Malesia*: Sumatra (central E. & W. of Barisan range), Borneo (Central Kalimantan, Central and N. E. Sarawak).

Ecol. Mixed Dipterocarp forest on hills, to 700 m.

Vern. *Itjap, katoeka, damar laut, d. surantih, d. tyirik ayam, mēranti hitam* (Sumatra), *mēryun* (Iban).

10. *Parashorea smythiesii* WYATT-SMITH ex ASHTON,

Gard. Bull. Sing. 19 (1926) 266, pl. 7; ASHTON, Man. Dipt. Brun. (1964) 86, f. 11, pl. 23; *ibid.* Suppl. (1968) 38, *p.p.*; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 197, f. 24.

Young twig, leaf bud, stipule, petiole and panicle sparsely shortly pale yellow-brown tomentose, caducous on twigs and petioles. *Twig* 1 mm \varnothing apically, terete, smooth, glabrous, dotted with minute pale round lenticles; stipule scars short, slender. *Bud* to 3 by 1 mm, narrowly lanceolate, acute. *Stipule* to 3.5 mm long, narrowly hastate, acute, fugaceous. *Leaves* 6–9 by 3–4.5 cm, elliptic to ovate, glabrous; base broadly cuneate; acumen to 1.5 cm long, narrow to caudate; nerves 8–10 pairs, slender, raised beneath, curved, well spaced, at 50°–60°; tertiary nerves scalariform to subreticulate, widely spaced at c. 90° to nerves; midrib slender, prominent beneath, depressed above; *petiole* 1–1.8 cm long, geniculate, pale. *Panicle* to 14 cm long, terminal or axillary, singly branched, straight, pendent; bracts and bracteoles unknown. *Flower bud* to 4.5 by 3 mm, ellipsoid, obtuse. *Calyx* densely shortly grey-brown tomentose outside, glabrous within; lobes narrowly deltoid, subequal, subacute, not adpressed to corolla in bud. *Petals* elliptic, obtuse, shortly tomentose on parts exposed in bud, cream. *Inner 5 stamens* slightly longer than the others, reaching $\frac{1}{2}$ length of style; filaments broad at base, tapering; anther narrowly oblong; appendage to connective short, slightly protruding above anther; *ovary* subglobose, densely tomentose; style c. 3 times length of ovary, filiform, shortly pubescent in the basal $\frac{1}{3}$, otherwise glabrous. *Fruit calyx* glabrescent, puberulent at base, becoming pushed apart by the ripening nut; 3 longer lobes to 8.5 by 1.7 cm, broadly spatulate, obtuse, to 3 mm broad above the to 7 mm long unexpanded slightly thickened base; 2 shorter lobes to 7.5 cm long, often only slightly smaller than longer lobes, subequal. *Nut* to 1.5 by 1.3 cm, ellipsoid, obtuse, verrucose with pale lenticles, buff tomentose; style remnant to 1 mm long, short.

Distr. *Malesia*: Borneo (Rejang hinterland eastwards and northwards to Sabah and Tidung).

Ecol. Scattered in Mixed Dipterocarp forest on clay rich soils, on moist lower slopes, and hillsides to 1000 m.

Vern. *Mēryun* (Iban), *urat mata batu, urat mata daun puteh*.

Doubtful

Parashorea warburgii BRANDIS, J. Linn. Soc. Bot. 31 (1895) 105; FOXW. in Elmer, Leaf. Philip. Bot. 6 (1913) 1954; Philip. J. Sc. 13 (1918) Bot. 194; *ibid.* 67 (1938) 318; MERR. En. Philip. (1923) 100.

Described from a collection of WARBURG from Mindanao, Philippines, consisting of a single fruit undistinguishable from those of *P. malaanonan*. FOXWORTHY associated the name with pubescent-leaved forms from the Philippines otherwise resembling *P. malaanonan* though these may represent *P. tomentella* of Borneo (*q.v.*).



Fig. 60. *Neobalanocarpus heimii* (KING) ASHTON. *a.* Habit, *b.* immature fruits, both $\times \frac{1}{2}$ (*a* KEP 69424, *b* KEP 69415).

8. NEOBALANOCARPUS, *gen. nov.*

ASHTON, Gard. Bull. Sing. 31 (1978) 27. — *Balanocarpus* (*non* BEDD.) KING, *p.p.*, BRANDIS, *p.p.*, RIDL., *p.p.*, HEYNE, *p.p.*, FOXW., *p.p.*, SYM. (1934) 27, *p.p.*, (1943) 147. — Fig. 60, 61.

Calyx in fructu ut in Balanocarpus BEDD. (*Hopea* ROXB. *pro parte*), *floribus maximis antheris lineare-oblongis appendiculatis facile differt.*

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

Distr. Monotypic. Peninsular Thailand (Pattani) and *Malesia*: Malaya.

Note. The possession of short equal fruit sepals, in the presence of a unique androecium structure deprives this single species from the sole character by which it could be allotted to the genera *Shorea* or *Hopea*, underlining the close affinity between these genera. The general appearance of tree and foliage and especially the inflorescence, fruit embryo and mode of germination, suggests that this unsatisfactory genus bears very close affinity with *Hopea sect. subsect. Hopea*; the linear anthers are approached by those of *H. plagata* (BLCO) VIDAL, though there the appendage is acicular and prominent.

1. *Neobalanocarpus heimii* (KING) ASHTON, Gard. Bull. Sing. 31 (1978) 27. — *Balanocarpus heimii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 133; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 110; BURN-MURDOCH, Agr.

Bull. Str. & F.M.S. 7 (1908) 386; Trees and Timbers (1911) 3, fig.; BURK. J. Str. Br. R. As. Soc. 81 (1920) 3; J. Mal. Br. R. As. Soc. 1 (1923) 218; Dict. (1935) 204; RIDL. Fl. Mal. Pen. 1 (1922) 247; HEYNE, Nutt. Pl. ed.

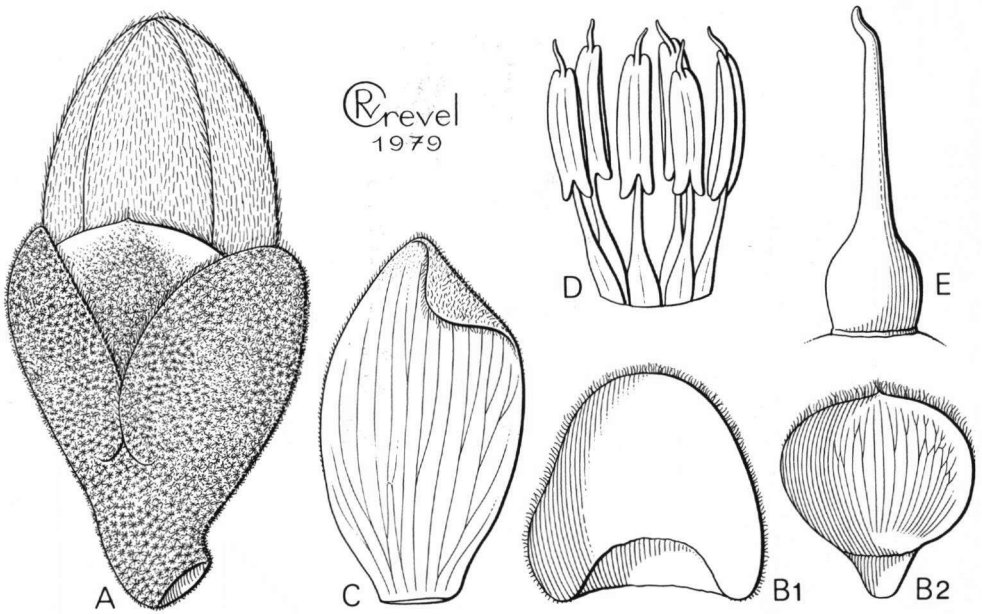


Fig. 61. *Neobalanocarpus heimii* (KING) ASHTON. A. Bud, B1. outer sepal, B2. inner sepal, C. petal, D. stamens from outside, E. pistil, all $\times 10$ (KEP 94605).

2 (1927) 1128; Foxw. Mal. For. Rec. 1 (1921) 64; *ibid.* 3 (1927) 53; *ibid.* 8 (1930) 10; *ibid.* 10 (1932) 149; J. Mal. Br. R. As. Soc. 5 (1927) 399; STRUGNELL, *ibid.* 9 (1931) 24; SYM. Gard. Bull. S. S. 8 (1934) 27; Mal. For. Rec. 16 (1943) 147, f. 80–82; CORNER, Ways. Trees (1940) 210; SMITINAND, Thai For. Bull. (Bot.) 12 (1980) 23. — *Balanocarpus wrayi* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 134. — *Balanocarpus acuminatus* (non BRANDIS) HEIM, Ass. Fr. Adv. Sc. Besançon 1893 (1894) 560, t. 4. — *Pierrea penangiana* HEIM ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 110, *nomen in syn.* — Fig. 60, 61.

Very large flaky barked buttressed tree. Twigs, midrib above, petioles and sepals outside caducous puberulent, leaf buds and panicles persistently so, parts of petals exposed in bud densely buff pubescent. *Twig* c. 2 mm \varnothing apically, ribbed, becoming smooth, dotted with minute pale lenticels; stipule scars linear, horizontal. *Buds* small, ovoid; *stipules* to 12 mm long, narrowly lorate, spreading, fugaceous. *Leaves* 7–17 by 2.3–5 cm, lanceolate-falcate, coriaceous; base unequal, cuneate to obtuse; acumen to 1.5 cm long, tapering; nerves 9–12 pairs, ascending, arched, prominent beneath, narrowly depressed above, the basal nerve on the broader (adaxial) side frequently with prominent lateral branchlets; tertiary nerves subreticulate, slender but prominently elevated beneath, obscure above; *petiole* 5–10 mm long, short. *Panicle* to

9 cm long, terminal or axillary, singly branched; branchlets to 2.5 cm long, bearing to 7 flowers. *Flower buds* to 4 by 3 mm, ovoid; *sepals* broadly ovate, acute, subequal, *corolla* pale greenish yellow; *stamens* 15, subequal; filaments tapering, long; anthers linear-oblong, appendages rudimentary; *ovary* ovoid, glabrous, surmounted by a filiform style twice its length. *Fruit pedicel* to 2 mm long, to 3 mm \varnothing , stout, inserted on a \pm impressed receptacle base; *calyx lobes* to 20 by 18 mm, subequal, ovate, thickened, saccate, adpressed to the base of the nut; *nut* to 5.5 by 2.5 cm, oblanceolate, cylindrical, shortly apiculate, lustrous.

Distr. Peninsular Thailand (Pattani) and in *Malaysia*: Malaya.

Ecol. Widespread in Mixed Dipterocarp forest below 1000 m, especially on undulating land on well drained friable soils.

Uses. The heavy durable timber used to be the best known in Malaya and the 'standard by which other timbers are judged' (SYMINGTON). Now largely replaced owing to the introduction of modern preservative techniques.

Vern. *Chèngal*, *chèngai*, *c. tèmbara*, *c. batu*, *c. bunga*, *c. dèdap*, *c. mas*, *c. kèmunting*, *c. labu*, *c. sabut*, *c. siput*, *c. tèmbara*, *c. tèmputrang*.

Note. The young leaves are bronze. Abnormal meiosis was observed by JONG & LETHBRIDGE (Notes R. Bot. Gard. Edinb. 27, 1967, 175).



Fig. 62. *Hopea beccariana* BURCK. a. Flowering branch, $\times 2/3$. — *H. dryobalanoides* MIQ. b. Fruiting branch, c. fruit, d. nut, all $\times 2/3$ (a SAN 30641, b-d BRUN 3179).

9. HOPEA

ROXB. Pl. Corom. 3 (1811) 7, *nom. gen. cons.*, non L. 1767; ENDL. Gen. Pl. (1840) 1014, 'Hoppea'; DC. Prod. 16, 2 (1868) 632; DYER, Fl. Br. Ind. 1 (1874) 308; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 235; HEIM, Rech. Dipt. (1892) 59, *incl. sect. Hancea* (PIERRE) HEIM, *l.c.* 62; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 53; FOXW. Philip. J. Sc. 67 (1938) 273; SYM. Mal. For. Rec. 16 (1943) 108, f. 67 (maps); ASHTON, Gard. Bull. Sing. 20 (1963) 254; Man. Dipt. Brun. (1964) 89; *ibid.* Suppl. (1968) 37; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 203; GUTIERREZ, Act. Manill. 4A, 2 (1968) 3; ASHTON, Blumea 20 (1972) 359; Gard. Bull. Sing. 31 (1978) 28; SMITINAND, Thai For. Bull. (Bot.) 12 (1980) 42. — *Neisandra* RAFIN. Sylv. Tellur. (1838) 163. — *Petalandra* HASSK. Cat. Hort. Bog. (1858) 104. — *Balano-carpus* BEDD. For. Man. Bot. (1873) 236 *bis*; HEIM, Rech. Dipt. (1892) 77, *pro sect. Sphaerocarpaceae* HEIM, *l.c.*; SYM. Mal. For. Rec. 16 (1943) 147, *p.p.* — *Hancea* PIERRE, For. Fl. Coch. 4 (1891) *sub t.* 244. — *Pierrea* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 958, *nom. gen. cons.*, non HANCE, 1877. — *Dioticarpus* DUNN, Kew Bull. (1920) 337. — *Pierreocarpus* RIDL. *ex SYM.* Gard. Bull. S. S. 8 (1934) 30, *nomen in syn.* — **Fig. 12–13, 62–76.**

Small or medium-sized, occasionally large, trees; bole usually tapering, frequently branching low; buttresses usually thin, sometimes thick; stilt roots and flying buttresses sometimes present; crown, in small species, persistently lanceolate, monopodial, the branches \pm horizontal and pendent; becoming densely evenly hemispherical in large trees, with many small straight branches radiating from the bole apex. Bark surface at first smooth, chocolate and grey mottled, hoop-marked; remaining so or becoming cracked and flaked, or fissured. Parts with or without indumentum of broad or narrow lobed hairs. *Twigs* slender, usually branching horizontally; stipule scars small, inconspicuous. *Stipules* linear, fugaceous (subpersistent in saplings). Leaves small or medium-sized, or narrowly oblong, large; nerves (see Fig. 64a) either scalariform, with scalariform tertiaries, or 'dryobalanoid' with \pm indistinct nerves, and with many equally prominent, but more or less shorter, secondaries, and indistinct reticulate tertiaries, superficially resembling those of *Dryobalanops*; or intermediate between these two types: 'subdryobalanoid', with more prominent reticulate or partially scalariform tertiaries, more prominent nerves, and fewer, shorter, intermediates. *Petiole* never geniculate. *Inflorescence* paniculate, slender, terminal or axillary. *Flower buds* small, ovoid or rarely globose. *Sepals* imbricate; 2 outer ovate, \pm obtuse, thickened; 3 inner suborbicular, frequently mucronate, thin at the margins. *Petals* oblong, connate at base and falling in a rosette. *Stamens* 10, 15 or up to 38 (*H. plagata*), in 1–3 verticils or irregular, falling with the petals; filaments broad and compressed at base, tapering medially and filiform below the anthers, anthers subglobose, tapering apically, latrorse; with 4 pollen sacs, the outer pair somewhat the larger; appendage to connective usually at least twice as long as anther, slender, glabrous or minutely glandular tuberculate. *Ovary* glabrous or tomentose, ovoid and with indistinct stylopodium marked by a ring of hairs at the apex of the ovary, or with a distinct stylopodium and hence pyriform, hour-glass-shaped, or cylindrical; style long or short,

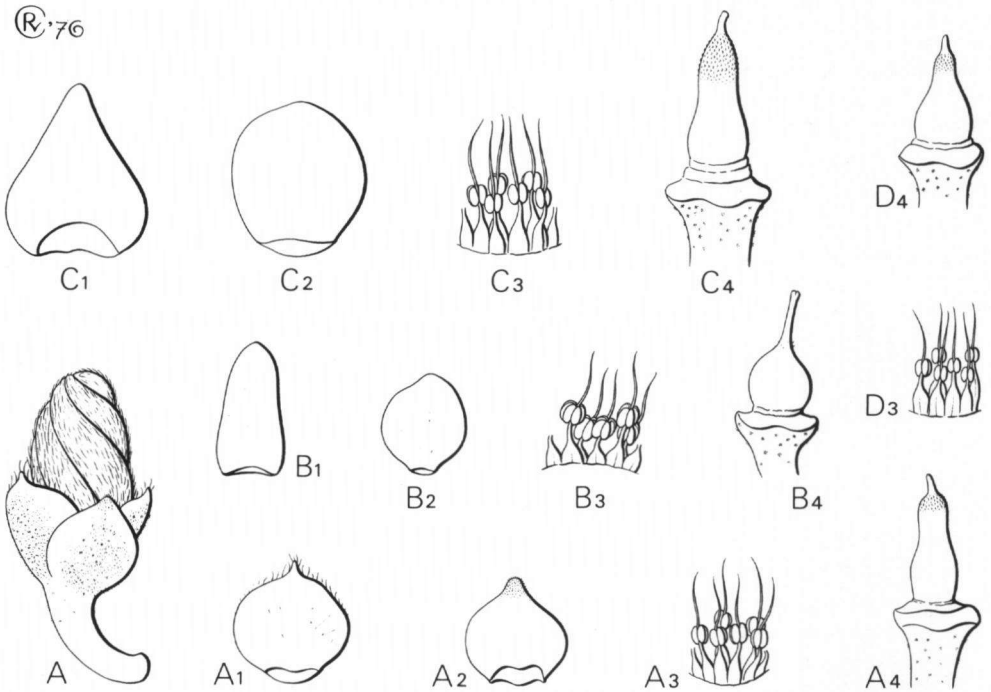


Fig. 63. Flower details in *Hopea* sect. *Dryobalanoides* MIQ. All $\times 10$. Sepals drawn from inside. — *H. myrtifolia* MIQ. A. Bud, A1. outer sepal, A2. inner sepal, A3. stamens from outside, A4. pistil. — *H. ferruginea* PARIJS. B1. Outer sepal, B2. inner sepal, B3. stamens from inside, B4. pistil. — *H. beccariana* BURCK. C1. Outer sepal, C2. inner sepal, C3. stamens from outside, C4. pistil. — *H. dyeri* HEIM. D3. Stamens from outside, D4. pistil (A KEP 99627, B A 4342, C KEP 76753, D BECCARI 2504).

glabrous; stigma minute (except *H. ferrea*). *Fruit* relatively small: 2 outer *fruit calyx lobes* prolonged, spatulate; 3 inner lobes short, or 5 short, subequal; lobes thickened and saccate at base. *Nut* ovoid, usually glabrous, with a distinct apical stylopodium if present in the flower. Pericarp splitting at *germination* into 3 valves (*H. pachycarpa*) or irregularly; cotyledons photosynthetic, subequal; first pair of leaves opposite, followed by spiral leaves or an initial whorl of 3; branching of sapling mainly at initiation of each period of growth by leader, hence appearing pagoda-like.

Distr. About 102 *spp.* in Ceylon, Andamans, South and East India, Burma, Thailand, Indochina, continental S. China (Yunnan, Kwangsi, S. Kwantung), Hainan, and 84 *spp.* throughout *Malesia* except the Lesser Sunda Islands. Fig. 65.

Ecol. Main canopy or understorey, rarely emergent, trees of lowland evergreen forests; and also semi-evergreen forests where there are more species, many of them local endemics, than any other dipterocarp genus. Several are semi-gregarious, several riparian.

Uses. Though some of the larger species provide a heavy durable construction timber few are common enough to be important economically. Several species in *sect. subsect. Dryobalanoides* produce a clear crystalline resin, *damar mata kuching*, that was formerly a valuable article of commerce.

Notes. Though apparently natural groupings whose typical members are at once recognisable, the

subsections and even sections of this genus are ill-defined in that several species share certain characters from more than one section, in marked contrast with the infrageneric groupings of the closely allied genus *Shorea*. See for a discussion about the subdivision of the genus accepted here ASHTON, Gard. Bull. Sing. 20 (1963) 254.

Pollination in those examined appear to be effected by thrips. Triploidy is known in both emergent (*H. odorata*), main canopy (*H. beccariana*) and understorey species (*H. subalata*). Either or both these factors may explain the high degree of local endemism in the understorey subsections *Sphaerocarpaceae* and *Pierrea*, and the curious local diversification in New Guinea.

SUBDIVISION OF HOPEA IN MALESIA

1. Leaf nervation truly dryobalanoid. *Spp. 1-26* *Sect. Dryobalanoides* *subsect. Dryobalanoides*
 1. Not so.
 2. Ovary and stylopodium not constricted between.
 3. Flowers remote on raceme; bracts subsistent. *Spp. 27-39*

Sect. Dryobalanoides *subsect. Sphaerocarpaceae*
 3. Flowers dense on raceme; bracts fugaceous. *Spp. 40-70* *Sect. Hopea* *subsect. Hopea*
2. Ovary and stylopodium hour-glass-shaped, distinctly constricted. *Spp. 71-84*

Sect. Hopea *subsect. Pierrea*

KEY TO THE SPECIES

1. Leaf nervation truly dryobalanoid. Fig. 67. *Spp. 1-26*.
 1. *Sect. Dryobalanoides* *1a. subsect. Dryobalanoides*
2. Ovary without distinct stylopodium.
 3. Midrib obscurely depressed above.
 4. Ovary glabrous.
 5. Twig pubescent 1. *H. pubescens*
 5. Twigs glabrous 2. *H. foxworthyi*
 4. Ovary pubescent 3. *H. quisumbingiana*
 3. Midrib evident, \pm elevated above.
 6. Shorter fruit sepals exceeding nut and \pm enclosing it.
 7. Leaf margin revolute.
 8. Leaf 5-9 by 2-7 cm, thinly coriaceous; stamens 15-18 4. *H. cernua*
 8. Leaf 11-16 by 6-10 cm, thickly coriaceous; stamens 15 5. *H. coriacea*
 7. Leaf margin applanate.
 9. Fruit pedicel to 7 mm long, calyx lobes tuberculate 6. *H. longirostrata*
 9. Fruit pedicel to 2 mm long; calyx lobes not as above.
 10. Main nerves with axillary domatia, the basal pair not longer than the rest; fruit pendent
 7. *H. sulcata*
 10. Main nerves without axillary domatia, the basal pair very long and continuing along 2/3 of the margin; fruit erect on panicle 8. *H. fluvialis*
 6. Shorter fruit sepals shorter than nut and not concealing it.
 11. Nerves very many, indistinct.
 12. Leaf base cuneate 9. *H. mengerawan*
 12. Leaf base obtuse 10. *H. micrantha*
 11. Nerves less than 13 pairs.
 13. Nerves c. 6 pairs, fruit calyx lobes short, subequal 11. *H. kerangasensis*
 13. Nerves more than 8 pairs, fruit calyx lobes unequal, 2 long and aliform.
 14. Nut to 15 mm long, cylindrical 12. *H. vesquei*
 14. Nut shorter than 11 mm, ovoid.
 15. Fruit sepals to 6.5 by 1.5 cm; midrib acutely elevated on both surfaces, drying black
 13. *H. dryobalanoides*
15. Fruit sepals to 4 by 0.8 cm; midrib not acute below, not drying black.
 16. Leaf base unequal; twig apices glabrescent.
 17. Flower bud to 6 by 3 mm, relatively large; panicle glabrous 14. *H. malibato*
 17. Flower bud less than 3 mm; panicle \pm puberulent.
 18. Leaves small, petiole less than 13 mm long; panicle less than 2 cm long 15. *H. johorensis*
 18. Leaves broadly ovate, petiole 12-17 mm long; panicle to 6 cm long 16. *H. latifolia*
 16. Leaf base equal; twig apices persistently pubescent 17. *H. ferruginea*

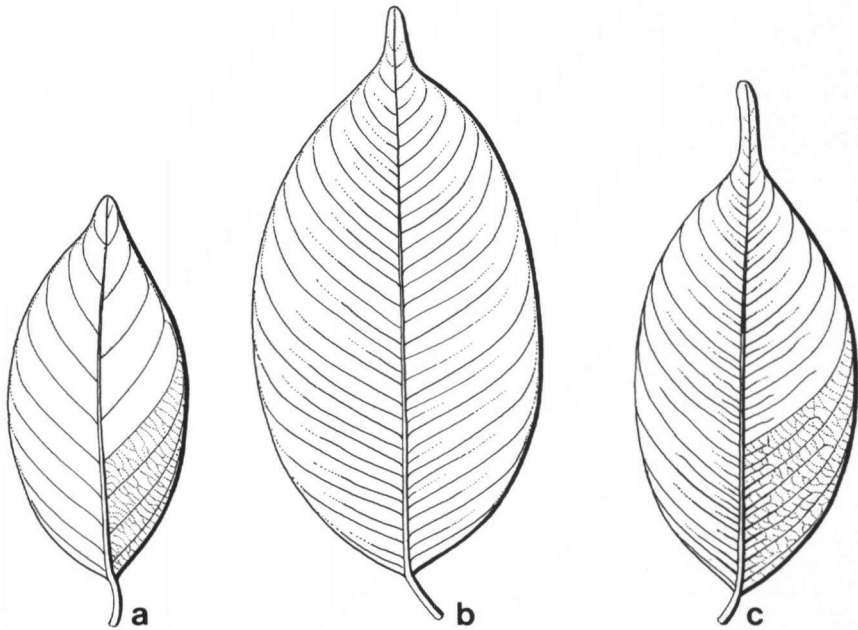


Fig. 64. Three venation types in *Hopea*. — a. Scalariform in *H. acuminata* MERR., b. dryobalanoid in *H. beccariana* BURCK, c. subdryobalanoid in *H. subalata* SYM.

- 2. Ovary with distinct stylopodium.
 - 19. Midrib above obscure, depressed.
 - 20. Main nerves very many, c. 18 pairs 18. *H. pierrei*
 - 20. Main nerves at most 10 pairs.
 - 21. Young parts sericeous 19. *H. inexpectata*
 - 21. Young parts glabrous 20. *H. griffithii*
 - 19. Midrib evident above.
 - 22. Stamens 10 21. *H. treubii*
 - 22. Stamens 15.
 - 23. Ovary and stylopodium pyriform; nerves at most 12 pairs.
 - 24. Petiole c. 15 mm long, leaf broadly ovate 22. *H. beccariana*
 - 24. Petiole shorter than 10 mm, leaf narrowly ovate-lanceolate 23. *H. dyeri*
 - 23. Ovary and stylopodium cylindrical; nerves at least 13 pairs, 13–16 pairs.
 - 25. Twigs and petioles pubescent 24. *H. myrtifolia*
 - 25. Twigs and petioles glabrous.
 - 26. Leaves applanate 25. *H. pedicellata*
 - 26. Leaves prominently revolute at least at base 26. *H. altocollina*
- 1. Leaf nervation not truly dryobalanoid. Compare fig. 64a & c.
 - 27. Ovary and stylopodium not constricted between.
 - 28. Flowers remote on raceme; bracts subpersistent, corolla dark coloured. *Spp.* 27–39.
 - 1. *Sect. Dryobalanoides* 1b. *subsect. Sphaerocarpace*
 - 29. Leaf nervation scalariform. Fig. 64a.
 - 30. Fruit calyx lobes short, subequal 27. *H. aequalis*
 - 30. Fruit calyx lobes unequal: 2 long, aliform.
 - 31. Nerves 11–13 pairs; leaves pale beneath 28. *H. rudiformis*
 - 31. Nerves (13–)16–19 pairs; leaves not pale beneath.
 - 32. Two longer fruit sepals to 12 cm long 29. *H. nervosa*
 - 32. Two longer fruit sepals not exceeding 8 cm 30. *H. sublancoolata*
 - 29. Leaf nervation subdryobalanoid. Fig. 64a.

- 33. Lamina base obtuse.
- 34. Fruit sepals unequal, 2 aliform 31. *H. nigra*
- 34. Fruit sepals short, subequal.
- 35. Petiole 3–6 mm long 32. *H. sphaerocarpa*
- 35. Petiole 7–10 mm long 33. *H. mesuoides*
- 33. Lamina base cuneate.
- 36. Fruit sepals unequal.
- 37. A single fruit sepal exceeding the nut, shortly lorate 34. *H. subalata*
- 37. Two fruit sepals aliform, spatulate.
- 38. Base of fruit sepals auriculate 35. *H. auriculata*
- 38. Base of fruit sepals not auriculate 36. *H. montana*
- 36. Fruit sepals all shorter than the nut, subequal.
- 39. Stamens 10 37. *H. vacciniifolia*
- 39. Stamens 15.
- 40. Ovary and stylopodium puberulent 38. *H. bracteata*
- 40. Ovary and stylopodium glabrous 39. *H. brachyptera*
- 28. Flowers dense on raceme; bracts fugaceous; corolla pale. *Spp.* 40–69.
- 2. *Sect. Hopea* 2a. *subsect. Hopea*
- 41. Nerves united into a prominent continuous intramarginal nerve midway between midrib and margin 40. *H. celtidifolia*
- 41. Nerves without intramarginal nerve.
- 42. Fruit sepals suborbicular; stamens 10 41. *H. dasyrrhachis*
- 42. Fruit sepals spatulate or, if suborbicular, then stamens 15.
- 43. Nerves on average at least 13 pairs.
- 44. Leaf base obtuse, \pm equal.
- 45. Leaf at least 10 by 3.5 cm; petiole at least 11 mm long; shorter fruit sepals shorter than nut 42. *H. similis*
- 45. Leaf at most 11 by 4 cm; petiole at most 8 mm long; 1 or the 3 shorter fruit sepals frequently lorate and exceeding nut 43. *H. forbesii*
- 44. Leaf base prominently unequal, generally cordate on one side; or subequal, subcordate on both sides.
- 46. Leaf glaucous beneath; stylopodium truncated, pubescent 44. *H. helferi*
- 46. Leaf not glaucous; stylopodium tapering, glabrous.
- 47. Fruit sepals short, subequal 45. *H. aptera*
- 47. Fruit sepals unequal, 2 aliform.
- 48. Base of leaf subequal, subcordate 46. *H. ultima*
- 48. Base of leaf prominently unequal.
- 49. Young parts evenly pubescent, leaf beneath glabrous, drying dull greyish 47. *H. novoguineensis*
- 49. Young parts scabrid pubescent; leaf nervation beneath \pm pubescent; leaf drying coppery brown to lustrous beneath.
- 50. Ripe nut to 8 by 6 mm; tertiary nerves beneath scabrous 48. *H. scabra*
- 50. Ripe nut to 16 by 9 mm, tertiary nerves beneath glabrescent 49. *H. papuana*
- 43. Nerves 12 pairs or less.
- 51. Stamens 10.
- 52. Leaf elliptic-lanceolate, nerves ascending.
- 53. Leaf drying coppery-brown; nerves 9–12 pairs, domatia small but distinct, puberulent 50. *H. acuminata*
- 53. Leaf drying pale grey-brown; nerves 6–8 pairs; domatia obscure or absent 51. *H. depressinerva*
- 52. Leaf ovate, drying dark grey-brown; nerves patent; domatia pubescent 52. *H. sangal*
- 51. Stamens 15 or more.
- 54. Connectival appendages shorter than anthers; sapling leaves peltate 53. *H. ferrea*
- 54. Connectival appendages at least as long as anthers; sapling leaves not peltate.
- 55. Ovary and stylopodium cylindrical or pyriform, the stylopodium stout, no longer than the ovary.
- 56. Style prominent, as long as ovary.
- 57. Nerves c. 11 pairs, very slender, distinct; midrib evident, applanate, above 54. *H. odorata*
- 57. Nerves 7–9 pairs, very slender, distinct; midrib evident, applanate, above 55. *H. centipeda*
- 56. Style very short.
- 58. Stamens 32–38 56. *H. plagata*
- 58. Stamens 15

59. Leaf base obtuse; domatia pore-like, prominently swollen.
60. Leaf thickly coriaceous, undersurface greyish lepidote 57. *H. nutans*
60. Leaf chartaceous, undersurface shagrened 58. *H. bancana*
59. Leaf base cuneate; domatia not as above.
61. Nerves c. 5 pairs 59. *H. pentanervia*
61. Nerves at least 6 pairs.
62. Leaf base distinctly unequal.
63. Midrib above and young twigs pubescent 60. *H. basilanica*
63. Midrib above and young twigs glabrous 61. *H. andersonii*
62. Leaf base \pm equal.
64. Panicle densely persistently buff pubescent.
65. Ovary and stylopodium ovoid 62. *H. ovoidea*
65. Ovary and stylopodium cylindrical, truncate 63. *H. semicuneata*
64. Panicle glabrous.
66. Panicles axillary. Ovary and stylopodium cylindrical-truncate. Leaf nerves to 7 pairs 64. *H. megacarpa*
66. Panicles ramiflorous. Ovary and stylopodium narrowly pyriform. Leaf nerves at least 9 pairs 65. *H. samarensis*
55. Gynoecium glabrous, narrow; stylopodium longer than ovary, slender, merging with the very short style.
67. Leaves equal at base, petiole (7-)10-16 mm long.
68. Nerves \pm depressed above, without domatia 66. *H. nodosa*
68. Nerves appanate to somewhat elevated above, with domatia towards leaf base 67. *H. celebica*
67. Leaves distinctly unequal at base, petiole 5-9(-10) mm long.
69. Leaves mostly with prominent pore-like glabrous axillary domatia 68. *H. iriana*
69. Leaves without distinct domatia.
70. Leaf undersurface glabrous; fruit sepals aliform 69. *H. glabrifolia*
70. Leaf undersurface stellate lepidote; fruit sepals short, becoming reflexed 70. *H. gregaria*
27. Ovary and stylopodium hour-glass-shaped, distinctly constricted medially; stylopodium tapering into the short style. *Spp. 70-83 2. Sect. Hopea 2b. subsect. Pierrea*
71. Leaves broad, base equal, cuneate on both sides; panicles solitary.
72. Fruit calyx lobes unequal, 2 aliform, spatulate 71. *H. glaucescens*
72. Fruit calyx lobes shorter than the nut, subequal 72. *H. wyatt-smithii*
71. Leaves narrow, base \pm unequal, obtuse to cordate at least on one side; panicles usually more than 1-axillary.
73. Tertiary nerves remotely subreticulate; petiole short, stout (flowers and fruit unknown) 73. *H. polyalthoides*
73. Tertiary nerves not as above or, if so, then petiole slender.
74. Fruit sepals short, subequal.
75. Nerves 9-12 pairs; panicles shorter than 5 cm.
76. Tertiary nerves densely scalariform 74. *H. cagayanensis*
76. Tertiary nerves remotely scalariform 75. *H. paucinervis*
75. Nerves at least 12 pairs; panicles exceeding 6 cm long.
77. Tertiary nerves subreticulate 76. *H. apiculata*
77. Tertiary nerves scalariform. Fig. 64a 77. *H. pachycarpa*
74. Fruit sepals unequal, aliform, spatulate.
78. Nerves 6-8 pairs, tertiary nerves remote 78. *H. bilitonensis*
78. Nerves at least 12 pairs
79. Leaves prominently bullate between the tertiary nerves 79. *H. bullatifolia*
79. Leaves not as above.
80. Base of fruit calyx lobes auriculate 80. *H. pterygota*
80. Base of fruit calyx lobes not auriculate.
81. Leaves with prominent pubescent axillary domatia.
82. Nerves at least 16 pairs.
83. Leaves at most 15 cm long; fruit sepals to 7.5 cm long 81. *H. philippinensis*
83. Leaves at least 15 cm long; fruit sepals exceeding 8 cm long 82. *H. mindanensis*
82. Nerves at most 12 pairs 65. *H. samarensis*
81. Leaves without prominent axillary domatia.
84. Leaves typically 13-22 by 4-7 cm; nerves 12-15 pairs 83. *H. tenuinervula*
84. Leaves typically 27-46 by 8-15 cm; nerves 16-30 pairs 84. *H. enicosanthoides*

1. Section Dryobalanoides

MIQ. Sum. (1861) 491, 192 as subgenus; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 239; HEIM, Rech. Dipt. (1892) 62; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 66; FOXW. Philip. J. Sc. 6 (1911) Bot. 265; Mal. For. Rec. 10 (1932) 132; SYM. Mal. For. Rec. 16 (1943) 108; ASHTON, Gard. Bull. Sing. 20 (1963) 258; Man. Dipt. Brun. (1964) 90; GUTIERREZ, Act. Manil. 4A, 2 (1968) 25. — Fig. 63, 70.

Nervation dryobalanoid or subdryobalanoid (*H. nervosa*, *H. sublanceolata* excepted). Bark surface smooth, fissured or cracked, not evenly flaky. Wood with numerous chambered parenchyma strands; rays not markedly heterogeneous.

1a. Subsection Dryobalanoides

Hancea PIERRE. — *Hopea* sect. *Hancea* (PIERRE) HEIM.

Nervation dryobalanoid. Bracts fugaceous. Corolla pale (*H. griffithii* excl.); panicles regularly branched, branchlets short; flowers many. Ovary and stylopodium ovoid or pyriform, rarely truncate.

Distr. Cochinchina, S.E. and Peninsular Thailand and Burma; in *Malesia*: Malaya, Sumatra, Borneo, Philippines, West New Guinea.

1. *Hopea pubescens* RIDL. Fl. Mal. Pen. 1 (1922) 239; Foxw. Mal. For. Rec. 10 (1932) 139; BURK. Dict. (1935) 1194; SYM. Mal. For. Rec. 16 (1943) 140, f. 69.

Medium-sized fissure-barked tree with small ± stilted buttresses. Twigs, petioles, midrib above and panicle densely persistently tawny puberulent, petals outside cream pubescent, otherwise glabrous. *Twig* c. 1 mm Ø apically, much branched, terete, becoming dark brown; internodes 5–12 mm long, short; stipule scars obscure. *Leaf bud* minute; *stipules* fugaceous. *Leaves* 2.5–6 by 1.3–2.8 cm, small, lanceolate, coriaceous; base broadly abruptly cuneate; acumen to 1 cm long, caudate; nervation dryobalanoid, main nerves c. 12 pairs with ± shorter secondaries, hardly evident beneath, obscure above; midrib sharply prominent beneath, obscure and depressed above; *petiole* 4–6 mm long, c. 1 mm Ø, slender. *Panicles* to 3 cm long, axillary or sometimes terminal, short, singly branched; branches to 8 mm long, bearing to 4 secund flowers. *Flower buds* to 3 by 1.5 mm, ellipsoid, small. *Sepals* ovate, acute, the outer 2 somewhat the longer and narrower. *Petals* cream. *Stamens* 15; filaments slender, tapering, compressed; appendages slender, somewhat papillose, c. 2 times length of the broadly oblong anthers. *Ovary* ovoid, glabrous, crowned by a somewhat longer columnar style. *Fruit pedicel* to 1.5 mm long, very slender. 2 longer calyx lobes to 30 by 6 mm, spatulate, obtuse, c. 1 mm broad above the to 3 by 1.5 mm narrowly elliptic saccate base; 3 shorter lobes to 3 by 2 mm, ovate, acuminate. *Nut* to 5 by 4 mm, ovoid, very shortly apiculate.

Distr. *Malesia*: Malaya (Kelantan, Pahang).

Ecol. Frequent, sometimes abundant, on well-drained flat land and low hills.

Vern. *Mĕrawan bunga*, *m. pipit*, *pĕngarawan*.

2. *Hopea foxworthyi* ELMER, Leaf. Philip. Bot. 4 (1912) 1469; Foxw. Philip J. Sc. 67 (1938) 282, *p.p.*; GUTIERREZ, Act. Manil. 4A, 2 (1968) 32, f. 6, pl. 2. — *H. pierrei* (non HANCE) FOXW. Philip. J. Sc. 6 (1911) Bot. 265, *p.p.*; *ibid.* 13 (1918) Bot. 184; WHITFORD, Bull. Bur. For. Philip. 10 (1911) 76; BROWN & MATTHEWS, Philip. J. Sc. 9 (1914) Bot. 439, 481; MERR. En. Philip. 3 (1923) 94; REYES, Philip. J. Sc. 22 (1923) 339. — *H. glutinosa* ELMER, Leaf. Philip. Bot. 4 (1912) 1470; Foxw. Philip. J. Sc. 13 (1918) Bot. 184.

Medium-sized smooth barked narrowly buttressed tree. Twig apices, leaf buds, petioles, base of peduncle, ovary and stylopodium fugaceous puberulent, otherwise glabrous. *Twigs* c. 1 mm Ø apically, slender, much branched, terete, rugulose, dark brown. *Leaves* 2.7–6.5 by 1–2.5 cm, lanceolate, thinly coriaceous, lustrous; margin subrevolute; base ± equal, cuneate, apex with to 1.5 cm long slender caudate acumen; nerves c. 10 pairs, very slender and ± obscure on both surfaces or slightly elevated beneath, slightly depressed above, ascending, arched, with a few shorter obscure secondary nerves; tertiary nerves reticulate, obscure; midrib sharply prominent beneath, obscure and depressed above; *petiole* 5–8 mm long, very slender. *Panicles* to 1.5 cm long, short, slender, axillary or terminal, singly branched; branchlets few, bearing to 5 flowers, *bracts* and *bracteoles* fugaceous. *Flower bud* to 5 by 3 mm, ellipsoid, rather large. 2 outer *sepals* ovate, acute; 3 inner suborbicular, subacute. *Stamens* 15; filaments compressed at base, tapering and filiform below the subglobose anthers;

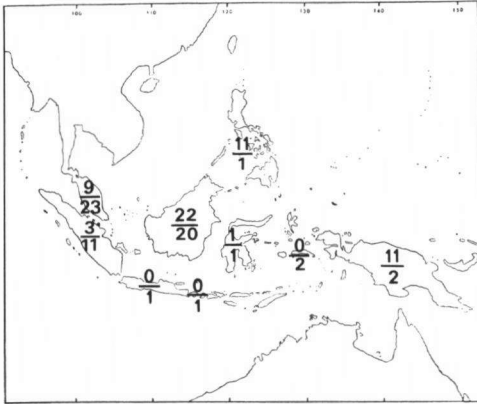


Fig. 65. Density map of *Hopea* ROXB. in Malesia; number of endemics above the hyphen, number of non-endemics below it.

appendage about twice as long as anther, slender. *Ovary* ovoid, glabrous, without stylopodium; style about twice as long as ovary, filiform, tapering. *Fruit pedicel* c. 1 mm long, short; 2 longer *calyx lobes* to 3.5 by 1 cm, broadly spatulate, obtuse, tapering to 2 mm broad above the to 5 by 4 mm ovate saccate thickened base; 3 shorter lobes to 5 by 5 mm, broadly ovate, acute; *nut* to 15 by 5 mm, narrowly ovoid, resinous, tapering to a prominent attenuate apiculus.

Distr. *Malesia*: Philippines (Sibuyan).

Ecol. Locally common on red sticky volcanic soil along ridges at 600–700 m, in seasonal semi-evergreen forest.

Vern. *Mangachapuy*.

Note. Collections cited by FOXWORTHY from islands other than Sibuyan belong to *H. malibato*.

3. *Hopea quisumbingiana* GUTIERREZ, Act. Manil. 4A, 2 (1968) 31, f. 5, pl. 1.

Twig apices caducous grey-brown puberulent, ovary and parts of petals exposed in bud persistently so. *Twig* c. 1 mm \varnothing apically, slender, much branched, becoming dark chocolate-brown; stipules minute. *Leaves* 5–7 by 2.5–3.2 cm, ovate-lanceolate, subcoriaceous; base broadly cuneate; acumen to 8 mm long, caudate; nervation dryobalanoid; nerves 9–13 pairs, very slender but evident beneath, sometimes with a few tomentose domatia, with shorter secondaries, tertiary nerves obscure; midrib slender but prominent beneath, obscure and depressed above; *petiole* 6–8 mm long, slender. *Panicles* to 3.5 cm long, terminal or to 2-axillary, singly branched, branchlets to 1 cm long, bearing to 5 secund flowers. *Flower buds* to 3 by 2 cm, ellipsoid. *Sepals* broadly ovate, subacute, subequal. *Stamens* 15, subequal; filaments broadly compressed at base, tapering and filiform distally; appendage aristate, c. twice length of subglobose anthers. *Ovary* ovoid, tapering into the equally long columnar taper-

ing style; ovary and basal $\frac{1}{2}$ of style pubescent. *Fruit* unknown.

Distr. *Malesia*: Philippines (Samar, once collected).

4. *Hopea cernua* T. & B. Nat. Tijds. N. I. 29 (1867) 252; MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 4, fig.; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 241; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 244; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 71, t. 2, f. 8–9; MERR. En. Born. (1921) 402; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 238; ASHTON, Man. Dipt. Brun. Suppl. (1968) 49, f. 6; Gard. Bull. Sing. 31 (1978) 28. — *H. microcarpa* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 954. — *Hancea cernua* PIERRE, For. Fl. Coch. 4 (1891) sub t. 244. — *H. argentea* MEIJER, Acta Bot. Neerl. 12 (1963) 348, pl. 13; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 207; ASHTON, Man. Dipt. Brun. Suppl. (1968) 47, f. 6.

Medium-sized buttressed tree with flying buttresses, bark becoming thickly flaky. Leaf bud, young twig and petiole caducous grey-brown pubescent. *Twig* c. 1 mm \varnothing , terete, smooth; stipule scars small, obscure. *Bud* to 3 by 2 mm, ellipsoid, obtuse. *Stipule* to 4 by 2 mm, lorate, elliptic, caducous. *Leaves* 5–15 by 2–5 cm, elliptic to ovate, subcoriaceous, \pm distinctly silvery lepidote beneath; base cuneate, equal, acumen to 6 mm long; nerves 10–12 pairs, slender but distinctly elevated and even prominent beneath, often with a few axillary pore-like pubescent domatia; with stout secondaries; midrib slender, slightly raised on both surfaces; *petiole* 7–9 mm long, slender. *Panicle* to 3 cm long, glabrous, terminal or axillary, terete; singly branched, branchlets bearing to 4 flowers; *bracteoles* c. 1 mm long, small, linear, glabrous, fugaceous. *Flower bud* to 5 by 4 mm, fusiform; *sepals* narrowly ovate, acute to subacuminate, subequal, glabrous, usually patent; *petals* lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15–18, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the subglobose anthers; appendage to connective slender, 2–3 times length of anther, minutely papillose towards base. *Ovary* ovoid, glabrous. *Style* c. $1\frac{1}{2}$ times length of ovary, sometimes slightly swollen in the villous basal $\frac{1}{3}$. *Fruit* glabrous; *pedicel* to 2 mm long; 2 longer *calyx lobes* to 6.5 by 12 cm, spatulate, obtuse, c. 4 mm broad above the to 5 by 5 mm ovate thickened saccate base; 3 shorter lobes to 1.5 cm long, lanceolate, acute, similar at base. *Nut* to 7 by 5 mm, ovoid, glabrous, apiculate.

Distr. *Malesia*: Banka, ? Sumatra, N. and E. Borneo.

Ecol. Local, in Mixed Dipterocarp forest on fertile soils especially on intermediate and basic igneous rocks including limestone, to 1650 m.

Vern. *Selangan urat* (Sabah), *luis timbul* (Sar.), *tëmang djankar*, *damar putih*, *d. puteh* (Indon. Borneo).

5. *Hopea coriacea* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 237; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64;

MERR. En. Born. (1921) 402; ASHTON, Gard. Bull. Sing. 31 (1978) 28. — *H. kelantanensis* SYM. J. Mal. Br. R. As. Soc. 19 (1941) 144, pl. 3; Mal. For. Rec. 16 (1943) 130, f. 69. — *H. garangbuaya* ASHTON, Gard. Bull. Sing. 19 (1962) 256, pl. 2; Man. Dipt. Brun. (1964) 101, f. 12; *ibid.* Suppl. (1968) 51.

Tall flaky or fissure-barked tree with \pm prominent buttresses. Glabrous but for petals. *Twig* to 2 mm \varnothing apically, stout, terete, smooth; *bud* ovoid, to 2 by 1 mm. *Stipule* to 4 mm long, linear, fugaceous. *Leaves* 11–16 by 6–10 cm, broadly ovate, thickly coriaceous, base obtuse; acumen to 1.2 cm long, narrow, margin slightly revolute; nerves 8–11 pairs, dryobalanoid but relatively prominent, strongly arched, at 60°–70° with short secondaries; tertiary nerves rather distinct, densely scalariform, at 90°; midrib broad, prominently rounded beneath, slightly raised above; *petiole* 2–2.5 cm long, stout. *Panicle* to 9 cm long, terminal or axillary, to 2-axillary, terete, glabrous; regularly singly branched, branchlets to 3 cm long, bearing to 6 second flowers; *bracts* and *bracteoles* unknown. *Flower bud* to 3 by 2.5 mm, ellipsoid, relatively large, distinctly pedicellate. *Calyx* glabrescent outside, firm-briate; 2 outer lobes ovate, acuminate, 3 inner lobes thin, suborbicular, terete. *Petals* to 1.3 cm long, narrowly lanceolate, acute, pubescent in parts exposed in bud, otherwise glabrous. *Stamens* 15, in 3 whorls, pairs alternating with single stamens; filaments slender, tapering; anthers oblong, the anterior cells slightly the larger; appendage to connective 2–3 times length of anther, prominently glandular tuberculate towards base. *Ovary* ovoid, glabrous at base, tapering gradually into style; apex of ovary and basal half of style densely setose; style filiform, tapering, as long as ovary; no distinct stylopodium. *Fruit calyx* glabrous, tapering into pedicel, lobes closely imbricate at base, hiding the nut, 2 longer to 7 by 1.5 cm, spatulate, somewhat tapering above the auriculate obtuse shallowly saccate unthickened base; 2 shorter to 2 by 1.2 cm, ovate, acute, similar at base. *Nut* to 18 by 9 mm, narrowly ovoid, with to 2 mm long apiculus; frequently exuding resin.

Distr. *Malesia*: Malaya (E. coast: Kelantan to Pahang); Borneo (Kapuas valley, Sarawak and Brunei).

Ecol. Local, on or near sandy river banks, rarely (in Brunei) on hills to 200 m.

Vern. *Giam hantu* (Mal.), *damar mēlapi* (Kapuas), *garang buaya*, *arang bayar* (Brun.).

6. *Hopea longirostrata* ASHTON, Gard. Bull. Sing. 22 (1967) 277, pl. 23; Man. Dipt. Brun. Suppl. (1968) 52, f. 7.

Smooth or patchily flaky-barked tree of medium size. All parts apparently glabrous. *Twig* c. 2 mm \varnothing apically, much branched, terete, smooth; stipule scar short, obscure. *Bud* to 2 by 2 mm, subglobose, obtuse. *Stipule* caducous, unknown. *Leaves* 7–9 by 3–5 cm, ovate-elliptic, coriaceous; base obtuse; acumen to 1.5 cm long, subcaudate; nervation dryobalanoid; main nerves c. 12 pairs, obscure, unraised, with subequal

long intermediates; midrib slender but prominent above, acute, elevated beneath. *Petiole* 7–10 mm long, geniculate, blackish. *Flower* unknown. Panicle and fruit glabrous. *Panicle* to 4 cm long, terminal or 3-axillary; singly branched, branchlets bearing to 5 flowers. *Pedicel* c. 5 mm long, uniquely long. 2 longer *calyx lobes* to 24 by 6 mm, spatulate, tapering to 3 mm and terminating abruptly in a small incrassate central tubercle; 3 shorter lobes to 15 mm long, linear to spatulate, acute or obtuse, similar at the base. *Nut* to 6 by 4 mm, ovoid; style remnant to 2 mm long.

Distr. *Malesia*: Borneo (Central Sarawak).

Ecol. Rare, lowland Mixed Dipterocarp forest.

7. *Hopea sulcata* SYM. Gard. Bull. S. S. 10 (1939) 358, pl. 20; Mal. For. Rec. 16 (1943) 145, f. 68G, 69, 79. — *H. micrantha* (non HOOK. f.) FOXW. Mal. For. Rec. 10 (1932) 135, p.p.

Medium-sized fissure-barked small-buttressed tree, at first with stilt roots. Twigs, petioles and panicles silvery lepidote, domatia and petioles outside cream pubescent, parts otherwise glabrous. *Twig* c. 1 mm \varnothing apically, slender, dark brown, \pm prominently ribbed; stipule scars obscure. *Leaf buds* minute, ovate, stipules minute, linear, fugaceous. *Leaves* 4–10 by 1.7–4 cm, ovate; lanceolate, falcate, relatively small; base cuneate, shortly decurrent, subequal; acumen to 2 cm long, slender, caudate; nervation dryobalanoid, main nerves c. 10 pairs with many shorter unequal secondaries, arched, \pm distinctly elevated beneath, \pm depressed or obscure above, the main nerves with \pm prominent axillary tomentose domatia; midrib elevated on both surfaces; *petiole* 5–11 mm long, slender. *Panicle* to 6 cm long, terminal or axillary, singly branched; branchlets to 16 mm long, bearing to 6 second pale yellow flowers. *Flower bud* to 2 by 1 mm, ovoid. *Sepals* ovate, acute, the outer 2 narrower, longer than inner 3. *Stamens* 15, filaments broadly compressed at base, tapering, appendage aristate, c. 3 \times length of subglobose anthers. *Ovary* ovoid, tapering into the equally long filiform style. *Fruit pedicel* c. 2 mm long, slender; base of fruit frequently impressed. 2 longer *calyx lobes* to 5.5 by 1.2 cm, spatulate, narrowly obtuse, c. 5 mm broad above the c. 7 mm broad subauriculate centrally saccate thickened base; 3 shorter lobes to 20 by 7 mm, similarly subauriculate, completely enclosing the nut. *Nut* to 10 by 7 mm, ovoid, acute.

Distr. *Malesia*: Malaya (Perak, Selangor, Trengganu, Johore).

Ecol. Locally abundant on ridges, at 100–400 m.

Vern. *Mērawan mēranti*, *pēngērawan bukit*.

8. *Hopea fluvialis* ASHTON, Gard. Bull. Sing. 19 (1962) 254, pl. 1; Man. Dipt. Brun. (1964) 100, f. 12; *ibid.* Suppl. (1968) 51. — Fig. 64c.

Medium sized, usually leaning, tree with smooth bark. Young parts shortly densely pale grey-brown tomentose, persistent on twig, leaf bud, stipule, panicle and petiole, fugaceous elsewhere. *Twig* to 1.5 mm \varnothing apically, terete, becoming smooth, glabrous.



Fig. 66. Habit of a 60 m high *Hopea mengerawan* MIQ., *ngarawan*. Palembang (Photogr. THORENAAR, 1923).

Bud to 1 mm long, ovoid, obtuse. *Stipule* to 2 mm long, linear, fugaceous. *Leaves* 7–12 by 2.8–4.8 cm, chartaceous to thinly coriaceous, lanceolate to ovate; base narrowly or broadly cuneate; acumen subequal, to 1.5 cm long, caudate; nerves many, *c.* 10 pairs with

long secondaries, slender, at 60°–80°, arched, the basal pair continuing as intramarginal nerves to $\frac{1}{4}$ up the margin; tertiaries \pm reticulate, indistinct; midrib flat or slightly raised beneath, prominently raised above; *petiole* 7–10 mm long. *Panicle* to 6 cm long, axillary, rarely terminal, borne singly or to 3-axillary, terete; regularly singly or doubly branched; branchlets to 1.5 cm long, bearing to 7 flowers; *bracteoles* to 2 mm long, ovate, acuminate, 3 inner lobes thinner, elliptic, mucronate. *Petals* narrowly lanceolate, densely pubescent outside, glabrous within. *Stamens* 15; filaments broad at base, tapering and filiform distally; anthers subglobose, the posterior cells somewhat smaller than the anterior cells; appendage to connective *c.* 2 times length of anther. *Ovary* ovoid, glabrous; style filiform, tapering, as long as ovary. *Fruit calyx* glabrous, tapering into 7 by 5.5 mm expanded, but unthickened and hardly saccate, base; 3 shorter lobes unequal, 1–2.5 cm long, acute, tapering, cupped and enveloping the nut. *Nut* to 11 by 6 mm, narrowly ovoid, tapering to a short acute style remnant.

Distr. *Malesia*: Borneo (S. E. Borneo, S. E. Sabah, North-East Sarawak and Brunei).

Ecol. Locally abundant on clay rich river banks.

Vern. *Mërawan ayër*.

9. *Hopea mengerawan* MIQ. Sum. (1860) 492, 192; DC. Prod. 16, 2 (1868) 635; WALP. Ann. 7. (1868) 379; SCHEFF. Nat. Tijd. N. I. 1 (1870) 351; HANCE, J. Bot. 14 (1876) 308; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 240, excl. syn. *H. cernua* T. & B.; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 125; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 70, *p.p.*; BURK. J. Str. Br. R. As. Soc. 81 (1920) 59, fig.; RIDL. Fl. Mal. Pen. 1 (1922) 238; THORENAAR, Med. Proefst. Boschw. 16 (1926) 112; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 1190; ed. 2 (1927) 1107, 1110; FOXW. Mal. For. Rec. 10 (1932) 137; BURK. Dict. (1935) 1190; SYM. Gard. Bull. S. S. 10 (1939) 361; Mal. For. Rec. 16 (1943) 132, f. 69, 73; ASHTON, Man. Dipt. Brun. Suppl. (1968) 53, f. 7. — *Hancea mengerawan* PIERRE, For. Fl. Coch. 3 (1891) *sub t.* 244. — Fig. 66.

Tall buttressed tree with dark fissured bark. Twigs, petiole and leaf beneath caducous lepidote, parts otherwise glabrous. *Twig c.* 2 mm \varnothing apically, slender; stipule scars short, pale. *Leaf bud* to 2 by 1 mm, ovoid. *Stipule* fugaceous. *Leaf* 6–12 by 2.5–5 cm, lanceolate, thickly coriaceous; base cuneate; acumen to 1.5 cm long, slender but evident beneath, with many short to subequal secondaries; midrib stout, prominent, on both surfaces; *petiole* 9–11 mm long, relatively short. *Panicle* to 3 cm long, terminal or axillary, terete, singly branched; branchlets bearing to 6 secund flowers; *bracteoles c.* 2 mm long, acicular, fugaceous. *Flower* pale yellow; *bud* to 3 by 2 mm, ovoid. *Calyx lobes* ovate, the 2 outer narrower, more coriaceous than the frequently suborbicular 3 inner. *Petals* sericeous on parts exposed in bud; *stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the subglobose anthers; appendage to connective slender, 2–3 times length of anther. *Ovary*

ovoid, glabrous; style *c.* 2 times length of ovary, villous in the basal $\frac{1}{4}$. *Fruit pedicel* to 2 mm long, slender. 2 longer *calyx lobes* to 7 by 1.2 cm, narrowly spatulate, narrowly obtuse, *c.* 3 mm broad above the to 7 by 4 mm narrowly ovate saccate thickened base; 3 shorter lobes to 6 by 5 mm, ovate, acute, saccate. *Nut* to 10 by 5 mm, narrowly ovoid; style remnant slender.

Distr. *Malesia*: Malaya (Negri Sembilan, Pahang southwards in east), Singapore, Billiton, Banka, Sumatra (Palembang, Lampong, Riouw, West Coast Res. at Tapanuli), Borneo (Central Sarawak, Melawi, Sampit N.E. to Nunukan).

Ecol. Local, on soils with impeded drainage on flat land and the base of hills.

Use. The resin was considered one of the best varieties in Sumatra and Malaya.

Vern. *Mĕrawan pĕnak*, *m. hitam*, *pĕngĕrawan*, *p. pĕnak* (Mal.), *mĕrawan banglai*, *chĕngal*, *c. bulu* (Sumatra), *nĕrakat*, *ĕmang*, *bangkirai tĕmbaga*, *b. telor* (S. E. Borneo).

10. *Hopea micrantha* HOOK. *f.* Trans. Linn. Soc. 23 (1860) 161; DC. Prod. 16, 2 (1868) 634; WALP. Ann. 7 (1868) 379; DYER, Fl. Br. Ind. 1 (1874) 310, *p.p.*, *quoad spec. Born.*; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 239; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 70, *p.p.*; MERR. En. Born. (1921) 402, *p.p.*; SYM. Gard. Bull. S. S. 9 (1938) 323–329; *ibid.* 10 (1939) 355, pl. 19; BROWNE, For. Trees Sarawak & Brunei (1955) 121, *p.p.*; ASHTON, Man. Dipt. Brun. (1964) 103, f. 12; *ibid.* Suppl. (1968) 54; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 213. — *Hancea micrantha* PIERRE, For. Fl. Coch. 4 (1891) t. 243.

Small to medium-sized smooth barked tree with small narrow buttresses and abundant stilt roots. Young twig, leaf bud, panicle, petiole, and stipule pale brown fugaceous pubescent. *Twig* to 1.5 mm \varnothing apically, slender, glabrous apart from the apices, terete, smooth. *Bud* to 2 by 1.5 mm, ovoid, obtuse. *Stipule* to 2 mm long, narrowly deltoid, acute, fugaceous. *Leaves* 6–8 by 2.5–3 cm, oblong-lanceolate, coriaceous; base obtuse or broadly cuneate, equal; acumen to 1.5 cm long, caudate; nerves 10–12 pairs, indistinct, curved, with short secondaries; midrib straight, slightly raised above, prominently so beneath; *petiole* 7–10 mm long, short. *Panicle* to 1 cm long, terminal or axillary, terete; singly branched, branchlets short, bearing up to 5 \pm secund flowers; *bracteoles* small, narrowly deltoid, glabrescent, fugaceous. *Bud* small, ovoid. *Calyx* puberulent outside, glabrous within; 2 outer lobes narrowly ovate, acuminate, 3 inner lobes thin, suborbicular, mucronate; *petals* linear, densely pubescent on parts exposed in bud. *Stamens* 15, of 3 lengths; filaments slender, tapering; anthers broadly oblong; appendage to connective *c.* $1\frac{1}{2}$ times length of anther. *Ovary* ovoid, glabrous, without distinct stylopodium; style *c.* $1\frac{1}{2}$ times length of ovary, filiform, glabrous. *Fruit calyx* glabrous; 2 longer lobes to 5 by 1.2 cm, spatulate, obtuse, to 2 mm wide above the to 4 by 3 mm saccate deltoid thickened base; 3 shorter lobes to 5 by 5 mm,

broadly ovate to suborbicular, subacute to obtuse, thin, saccate, shorter than the nut. *Nut* to 10 by 6 mm, ovoid; style remnant to 1.5 mm long, filiform.

Distr. *Malesia*: Borneo (northern coast between Limbang and Bintulu, including Labuan).

Ecol. Mostly on kerangas and white-sand terraces, or in heath forest, sometimes associated with *Agathis*, rarely on sandy clay soil, or on hillsides, at low altitude.

Vern. *Mĕrawan kĕrangas*.

11. *Hopea kerangasensis* ASHTON, Gard. Bull. Sing. 22 (1967) 277, pl. 22; Man. Dipt. Brun. Suppl. (1968) 52, f. 7.

Medium-sized smooth barked tree with thin flying buttresses. Twigs, petiole, buds, midrib above and domatia beneath shortly evenly persistently pale tawny pubescent, sometimes glabrescent. *Twig* *c.* 1 mm \varnothing apically, much branched, terete, becoming smooth. *Bud* to 1 mm, minute, globose. *Stipule* fugaceous. *Leaves* 1.5–4.5 by 1–3 cm, small, ovate, chartaceous, with broadly cuneate base; acumen to 1 cm long, caudate; nervation dryobalanoid, obscure, main nerves *c.* 6 pairs; midrib slightly depressed above, slender but prominent beneath, with to 6 pairs of prominent large pale fulvous pubescent domatia; *petiole* 3–5 mm long, slender. *Panicle* to 12 mm long, axillary, small, terete, sparsely buff puberulous; singly branched, branchlets to 4 mm long, bearing to 3 distichous flowers; *bracteoles* minute, linear, fugaceous. *Flower bud* *c.* 1.5 by 1 mm, ovoid. *Sepals* ovate, acuminate, glabrous; the inner 3 shorter, relatively narrower at apex, relatively broader medially, than the outer. *Petals* lanceolate, puberulent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the subglobose anthers; appendage to connective slender, 2–3 times length of anther, reaching almost to style apex at anthesis. *Ovary* ovoid, glabrous; style as long as ovary, columnar, tapering. *Fruit* glabrous. *Pedicel* to 1 mm long, short. *Calyx lobes* to 6 by 5 mm, subequal, ovate, acute, saccate, thickened, the 2 outer shorter, narrower and more incassate than the 3 inner. *Nut* to 8 by 5 mm, ovoid, subacute.

Distr. *Malesia*: Malaya (Pahang, Trengganu); Sumatra (Indragiri); Borneo (Sarawak west of the Lupar; Central Kalimantan: Upper Barito).

Ecol. Very local; there abundant, on leached soil in Mixed Dipterocarp and Heath forests on low hills.

Vern. *Sĕlangan kĕrangas* (Sar.).

12. *Hopea vesquei* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 971; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 68; MERR. En. Born. (1921) 403; BROWNE, For. Trees Sarawak & Brunei (1955) 122; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 226; ASHTON, Man. Dipt. Brun. Suppl. (1968) 57, f. 7.

Medium-sized tree with patchily cracked bark and thin buttresses. Young twigs, leaf bud, stipule and petiole \pm caducous grey-brown puberulent. *Twig* *c.* 1



Fig. 67. Stilt-rooted stem-base of *Hopea malibato* Foxw. Basilan, Philippines (Photogr. GUTIERREZ).

mm \varnothing apically, terete, much branched, straight, smooth; stipule scars short, obscure. *Bud* to 2 by 1 mm, ellipsoid, obtuse. *Stipule* to 3 mm long, linear, caducous. *Leaves* 3.5–6 by 1.5–3.5 cm, broadly ovate, coriaceous; base cuneate to obtuse; acumen to 1 cm long, slender; nervation dryobalanoid, main nerves c. 10–13 pairs, slender, hardly raised, with shorter secondaries; tertiary nerves obscure, reticulate; midrib somewhat raised on both surfaces; *petiole* 6–7 mm long, slender. *Panicle* to 3 cm long, \pm terete, ribbed, greyish tawny puberulent; singly branched, branchlets to 1 cm long, bearing to 5 flowers; *bracteoles* c. 1 mm long, short, linear, fugaceous. *Flower bud* to 3 by 2 mm, ellipsoid. *Sepals* ovate, pubescent on parts exposed in bud, 3 outer acute, 2 inner relatively broader, narrower at base, mucronate. *Petals* lanceolate, pubescent on parts exposed in bud; *stamens* 15, the inner 5 taller than the rest; filaments broad and compressed at base, tapering and filiform below the subglobose anthers; appendage to connective slender, slightly longer than anther. *Ovary* ovoid, glabrous; style c. $1\frac{1}{2}$ times length of ovary, columnar. *Fruit* glabrous. *Pedicle* 1–2 mm long, short, slender. *Calyx*

lobes sparsely setose in the basal half; 2 longer to 3.4 by 0.8 cm, spatulate, obtuse, c. 2 mm broad above the to 4 by 3 mm narrowly ovate somewhat thickened and saccate base; 3 shorter lobes to 4 by 4 mm, ovate, acute, saccate. *Nut* to 15 by 3 mm; cylindrical, style remnant c. 1 mm long, short.

Distr. *Malesia*: Borneo (W. and N. E. Sarawak).

Ecol. Locally abundant on leached yellow sandy soils in Mixed Dipterocarp forest on coastal hills.

Vern. *Luis tébal*.

13. *Hopea dryobalanoides* MIQ. Sum. (1860) 492; DC. Prod. 16, 2 (1868) 634; WALP. Ann. 7 (1868) 379; SCHEFF. Nat. Tijd. N. I. 31 (1870) 351; BURCK, Ann. Jard. Bot. Botz 6 (1887) 240; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 125, 126; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 69; BOERL. Cat. Hort. Bog. (1901) 104; HEYNE, Nutt. Pl. ed. 2 (1927) 1107; ENDERT, Tectona 28 (1935) 248; RAPPARD, Tectona 30 (1937) 897; SYM. Gard. Bull. S.S. 10 (1939) 345, pl. 15; Mal. For. Rec. 16 (1943) 123, f. 69; BROWNE, For. Trees Sarawak & Brunei (1955) 120; ASHTON, Gard. Bull. Sing. 20 (1963) 259; Man. Dipt. Brun. (1964) 50, f. 12, pl. 29

(seedlings); *ibid.* Suppl. (1968) 50; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 209. — *Hancea dryobalanoides* PIERRE, For. Fl. Coch. 4 (1891) *sub t.* 244. — *H. sarawakensis* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 971; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 69; MERR. En. Born. (1921) 403. — *H. borneensis* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 972; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 66, 69; MERR. En. Born. (1921) 402. — *H. micrantha* (*non* HOOK. *f.*) KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 126; FOXW. Mal. For. Rec. 10 (1932) 135; MERR. En. Born. (1921) 402, *p.p.* — Fig. 12, 13, 62b-d.

Tall tree with flaky bark and prominent thin buttresses and a few stilt roots. Young twig, leaf bud, petiole and leaf beneath shortly densely greyish brown fugaceous pubescent; domatia persistently so. *Twig* to 1 mm \varnothing apically, terete, slender, glabrous, smooth. *Leaf bud* to 1 mm long, minute. *Stipule* to 2 mm long, fugaceous. *Leaves* 5–12 by 1.5–4.5 cm, ovate-lanceolate, thinly coriaceous; base cuneate, equal or subequal; acumen to 2 cm long, narrow, caudate; nerves 8–12 pairs, slender but distinct beneath, curved, with or without scattered axillary domatia; with few short secondaries; midrib slender, raised and frequently sharp on both surfaces, more prominently so beneath; petiole 5–10 mm long, short, slender. *Panicle* to 5 cm long, terminal or axillary, 1–2-axillary, lax, terete, puberulent to glabrous; singly branched, branchlets bearing to 6 flowers; *bracteoles* small, linear. *Bud* small, broadly ovoid. *Calyx* puberulent outside, fimbriate; 2 outer lobes ovate, acuminate; 3 inner lobes suborbicular, shortly mucronate. *Petals* narrowly lanceolate, shortly tomentose on parts exposed in bud, pale yellow. *Stamens* 15, in 3 whorls; filaments slender, tapering; anthers subglobose; appendage to connective *c.* 2 times length of anther, sometimes sparsely glandular papillose. *Ovary* ovoid, glabrous, without distinct stylopodium; style as long as ovary, setose in the basal half, glabrous distally. *Fruit calyx* glabrous; 2 longer lobes to 6.5 by 1.5 cm, long, spatulate, subacute, pronouncedly twisted, tapering to 5 mm broad above the to 6 by 6 mm deltoid thickened saccate base; 3 shorter lobes to 8 by 6 mm, shorter than the nut, broadly ovate, obtuse or subacute, saccate but thinner than base of outer lobes. *Nut* to 10 by 8 mm, broadly ovoid, glabrous; style remnant to 1.5 mm long, filiform.

Distr. *Malaysia*: Malaya, Sumatra, Borneo.

Ecol. Widespread, locally frequent, clay-rich fertile soils on undulating or well drained flat land, or ridges below 600 m; common on basalt and intermediate igneous and volcanic rocks on slopes and ridges.

Uses. Formerly an important producer of damar mata kuching.

Vern. *Mata kuching hitam*, *mérawan mata kuching* (Mal.), *damar m.k.*, *bayang gunung*, *séluai hitam* (Sum.), *mang bësi*, (*emang*) *bërjangkar*, *mënsëga* (Indon. Borneo).

14. *Hopea malibato* Foxw. in Elmer, Leaf. Philip. Bot. 6 (1913) 1953; Philip. J. Sc. 13 (1918) Bot. 184;

ibid. 67 (1938) 281; MERR. En. Philip. 3 (1923) 93; GUTIERREZ, Act. Manil. 4A, 2 (1968) 39, f. 7, pl. 3; ASHTON, Gard. Bull. Sing. 31 (1978) 28. — *H. pierrei* (*non* HANCE) FOXW. Philip. J. Sc. 6 (1911) Bot. 265, *p.p.*; *ibid.* 13 (1918) Bot. 184, *p.p.* — *H. foxworthyi* (*non* ELMER) FOXW. Philip. J. Sc. 67 (1938) 282, *p.p.* — *H. woodiana* GUTIERREZ, Act. Manil. 4A, 2 (1968) 42, f. 8, pl. 4 — *H. dalingdingan* GUTIERREZ, Kalikasan 5 (1976) 92, f. 1. — Fig. 67, 68.

Medium-sized smooth barked tree. Domatia persistently greyish puberulent; young twigs, petioles and sepals fugaceous so, parts otherwise glabrous. *Twigs* *c.* 1 mm \varnothing apically, slender, terete, smooth, dark brown; *stipules* fugaceous. *Buds* minute. *Leaves* 5–9 by 1.5–4 cm, lanceolate-falcate; base cuneate, \pm shortly decurrent; acumen to 2 cm long, caudate, very slender; nervation dryobalanoid, main nerves *c.* 11 pairs, ascending, arched, with \pm shorter secondaries, very slender but evident and elevated beneath, \pm obscure above, with or without prominent pubescent axillary domatia; tertiary nerves densely reticulate, \pm obscure; midrib slender but distinctly and \pm equally elevated on both surfaces; *petiole* 8–16 mm long, slender. *Panicles* to 2.5 cm long, axillary, slender, singly branched; branchlets to 12 mm long, bearing to 5 flowers. *Flower buds* to 6 by 3 mm, ellipsoid. *Sepals* ovate, subacute, fimbriate apically, the inner 3 somewhat broader at base. *Petals* glabrous. *Stamens* 15; filaments lorate, tapering; appendages *c.* 1½ times as long as the subglobose anthers, shorter than style. *Ovary* ovoid, glabrous, without stylopodium, with columnar style 1½–2 times its length. *Fruit pedicel* to 2 mm long, short, slender; 2 longer calyx lobes to 35 by 9 mm, spatulate, obtuse, to 2 mm wide above the 4 by 3 mm ovate saccate thickened base; 3 shorter lobes to 4 by 4 mm, ovate, subacute, shorter than the to 7 by 4 mm apiculate nut.

Distr. *Malaysia*: Philippines.

Ecol. Widespread and locally common in evergreen non-seasonal dipterocarp forests.

Vern. *Malibato*, *barakbakau*, *danginginan* (Mbo.), *dadingdingan* (Tag.), *dala* (Neg.), *dalingdingan* (Bik., Tag., Dum.), *dalingdinganisak* (Tag., Bik.), *isak* (Tag.), *kaliot* (Pang.), *lito* (Ibn.), *malatagum* (Bik.), *manggachapuy* (Bik., Tag., Mbo., Pang.), *mululagum*, *pisak* (Bik.), *pisak* (Ibn.), *sarabsaban* (Mang.), *siyan*, *sugkad* (S.L. Bis.), *yakal-keliot* (official name).

Notes. This species is variable in tree size, leaf size and shape, and flower size and colour. On the basis of these differences GUTIERREZ has recognized two additional species for small-leaved collections formerly confused with *H. pierrei* HANCE and *H. foxworthyi* ELMER. These latter species conspicuously differ in their obscure depressed midribs on the leaf above as well as other characters. Though further study may prove him correct, I do not uphold these as the same level of variation occurs within some other dipterocarp species as here recognized, *e.g.* *H. dryobalanoides* and also in *Shorea ovata* and *S. curtisii*.

I define *H. malibato* by its dryobalanoid, unequal-based, ovate-lanceolate leaf with *c.* 11 pairs of slender



Fig. 68. Flowering twig of *Hopea malibato* FOXW
Basilan (Photogr. GUTIERREZ).

but elevated nerves with shorter secondaries, its evident and elevated midrib above, and by the absence of a floral stylopodium, small fruit and glabrous parts except for the petals and more or less caducous puberulent innovations. It differs therefore from *H. vesquei* HEIM in that the ripe nut does not exceed 11 mm length, from *H. dryobalanoides* MIQ. in that the fruit sepals do not exceed 4 cm length (as well as in characters of the leaf midrib and petiole), and from *H. johorensis* SYM., *H. latifolia* SYM. and *H. ferruginea* PARIJS notably in its glabrous panicle.

15. *Hopea johorensis* SYM. J. Mal. Br. R. As. Soc. 19, 2 (1941) 139, pl. 1B; Mal. For. Rec. 16 (1943) 130, f. 69.

Medium-sized trees with stilt roots and reddish powdery bark. Panicles and petals outside persistently greyish buff pubescent, twig apices, petioles and calyx outside caducously so. *Twig* c. 1 mm \varnothing , ribbed along the leaf traces, becoming blackish; stipule scars small, pale. *Leaf bud* minute; *stipule* fugaceous. *Leaves* 3–7 by 1.5–3.5 cm, ovate, coriaceous; base \pm abruptly cuneate, subequal; acumen to 12 mm long, prominent, slender, caudate; nerves many, main nerves c. 16 pairs with many subequal secondary nerves, very slender and hardly elevated beneath, obscure above; midrib slender but distinctly and equally elevated on both surfaces; *petiole* 7–13 mm long, slender. *Panicle* to 15 mm long, short, axillary, with short branchlets bearing to 3 flowers. *Mature flowers* unknown. *Stamens*

15. *Fruit pedicel* c. 2 mm long, very slender; 2 longer *calyx lobes* to 4 by 0.8 cm, spatulate, subacute, tapering to c. 1 mm wide above the to 3 by 3 mm ovate saccate thickened base; 3 shorter lobes to 3 by 3 mm, ovate, subacuminate. *Nut* to 8 by 4 mm, lanceolate, minutely apiculate.

Distr. *Malesia*: Malaya (E. Johore).

Ecol. Local, on hill ridges.

Vern. *Mata kuching pipit, mērawan*.

16. *Hopea latifolia* SYM. Gard. Bull. S. S. 10 (1939) 360; Mal. For. Rec. 16 (1943) 131, f. 69; ASHTON, Man. Dipt. Brun. (1964) 102, f. 12; *ibid.* Suppl. (1968) 52. — *H. intermedia* (non KING) FOXW. Mal. For. Rec. 10 (1932) 134, p.p. — *H. beccariana* (non BURCK) SYM. Gard. Bull. S. S. 9 (1938) 325, p.p.

Medium-sized smooth barked tree with small thin buttresses and stilt roots. *Twig*, leaf bud, stipule and leaf as *H. beccariana*. *Panicle* to 4 cm long axillary, rarely terminal, shortly grey-brown pubescent or glabrescent, terete, borne singly; singly or doubly branched, the branchlets bearing up to 5 distichous flowers. *Leaf bud* small, ovoid. *Calyx* shortly pubescent outside, glabrous within; 2 outer lobes ovate, acuminate, 3 inner lobes suborbicular, mucronate, thinner. *Petals* small, ovate, obtuse, pubescent on parts exposed in bud. *Stamens* 15, in 3 whorls; filaments broad at base, tapering somewhat abruptly distally; anthers subglobose; appendage to connective as long as anther, slender. *Ovary* ovoid, glabrous; style as long as ovary, without distinct stylopodium, filiform, \pm villous towards base. *Fruit calyx* glabrous; 2 longer lobes to 6 by 1.4 cm, spatulate, narrowly obtuse, tapering to 3 mm broad above the to 5 by 4 mm deeply saccate thickened base; 3 shorter lobes to 9 by 7 mm, ovate, acute, saccate, thickened, frequently hiding the nut. *Nut* to 8 by 7 mm, broadly ovoid, style remnant to 2 mm long, filiform.

Distr. *Malesia*: Malaya, Borneo (Sarawak, Brunei).

Ecol. Rare, low lying land in Mixed Dipterocarp forest; once from deep soil over limestone in Perlis.

Vern. *Mērawan daun bulat, m. jongkang, m. batu, chēngal mata kuching* (Mal.).

17. *Hopea ferruginea* PARIJS in Fedde, Rep. 33 (1933) 243; Bijdr. O-I. Damarhars (1933) 89; SYM. Gard. Bull. S. S. 10 (1939) 349, pl. 17; Mal. For. Rec. 16 (1943) 125; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 211, f. 27, pl. 23a (stem). — *H. micrantha* (non HOOK. f.) DYER, Fl. Br. Ind. 1 (1874) 310, p.p.; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 124, p.p.; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 70, p.p.; RIDL. Fl. Mal. Pen. 1 (1922) 237, p.p.; FOXW. Mal. For. Rec. 10 (1932) 136, f. 68D, 69; BUCKLEY, Mal. For. Rec. 11 (1932) 21. — *H. myrtifolia* (non MIQ.) HEYNE, Nutt. Pl. ed. 2 (1927) 1107; ENDERT, Tectona 28 (1935) 248. — *H. intermedia* (non KING) FOXW. Mal. For. Rec. 3 (1927) 74, p.p.; *ibid.* 10 (1932) 134, p.p. — *H. pierrei* (non HANCE) FOXW. Mal. For. Rec. 10 (1932) 133, p.p. — Fig. 63 B1–B4.

Medium-sized flaky barked tree with stilt roots and flying buttresses. Twig endings, petioles, midrib above and panicles densely \pm persistently greyish puberulent, petals outside densely cream pubescent. *Twig* c. 1 mm \varnothing apically, terete, becoming dark brown, smooth; internodes short; stipule scars obscure. *Leaf bud* minute; *stipules* minute, fugaceous. *Leaves* 4.5–7.5 by 1.5–4 cm, ovate to lanceolate, subcoriaceous; base cuneate, shortly decurrent; acumen to 1.5 cm long, slender, caudate; nervation dryobalanoid, main nerves c. 14 pairs with many subequal secondaries, distinct and frequently with \pm prominent axillary pubescent domatia especially in young trees; midrib slender but distinctly elevated on both surfaces; *petiole* 6–10 mm long, slender. *Panicles* to 2 cm long, axillary, slender, short, with to 8 mm long short branchlets bearing to 4 second pale yellow flowers. *Flower bud* to 3 by 2 mm, ellipsoid. *Sepals* ovate, the 3 outer somewhat longer, acute or subacuminate, the inner acute. *Stamens* 15, unequal; filaments broadly compressed at base, tapering and filiform distally; appendage very slender, c. twice length of the subglobose anthers. *Ovary* ovoid, style somewhat longer, columnar, tapering, villous towards base. *Fruit pedicel* to 2 cm long, very slender; 2 longer fruit *calyx lobes* to 3 by 0.5 cm, spatulate, narrowly obtuse, c. 1.5 cm broad above the to 4 by 2.5 mm ovate saccate thickened base; 3 shorter lobes to 8 by 4 mm, ovate-acuminate, closely enveloping nut. *Nut* to 7 by 4 mm, ovoid, apiculate.

Distr. *Malesia*: Malaya (Perak and Pahang southwards), Riouw Arch., E. and Central Sumatra (Tapanuli, Djambi), E. Borneo (Kudat to Pleihari and Martapura); wrongly recorded from Sarawak by BROWNE (Forest Trees of Sarawak and Brunei, 1955, 21).

Ecol. Deep fertile soils in Mixed Dipterocarp forest below 750 m; locally frequent.

Uses. A minor source of damar mata kucing.

Vern. *Mata kucing merah*, *mèrawan m.k.*, *mèrawan jangkang*, *m. merah*, *m. pasir* (Malaya), *gangsai* (Djambi), *mèranti emeh* (Tapanuli), *mèrawan puteh* (Kalimantan), *sèlangan mata kucing* (Sabah).

18. *Hopea pierrei* HANCE, J. Bot. 15 (1876) 308; *ibid.* 16 (1877) 329; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 263; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 67, *p.p.*; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 372; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 238; DAKKUS, Bull. Jard. Bot. Btzg III, Suppl. 1 (1930) 162; SYM. Gard. Bull. S. S. 9 (1938) 323, pl. 17; Mal. For. Rec. 16 (1943) 139, f. 69; SMITINAND, Thai For. Bull. 1 (1954) 19; ASHTON, Gard. Bull. Sing. 31 (1978) 29. — *H. micrantha* (non HOOK. f.) HANCE, J. Bot. 15 (1876) 242. — *Hancea pierrei* PIERRE, For. Fl. Coch. 4 (1891) t. 248. — *H. avellanea* HEIM, Bot. Tidsskr. 25 (1902) 46; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 375; CRAIB, Fl. Siam. Enum. 1 (1925) 147; SMITINAND, Thai For. Bull. 1 (1954) 10; Nat. Hist. Bull. Siam Soc. 19 (1958) 63.

Medium-sized smooth barked tree, with thin but-

trusses and sometimes stilt roots. Twig apex fugaceous puberulent, ovary caducously so, petals outside densely cream pubescent, parts otherwise glabrous. *Twig* c. 1 mm \varnothing apically, very slender, straight, terete, horizontal, dark brown; stipule scars obscure. *Leaf bud* minute; *stipules* minute, linear, fugaceous. *Leaves* 4–8 by 1.6–4 cm, lanceolate, subcoriaceous; base abruptly broadly cuneate; acumen to 12 mm long, slender, caudate; nervation dryobalanoid, main nerves c. 18 pairs with many \pm equal secondaries, very slender and hardly evident beneath, obscure above; midrib slender but prominent, terete beneath, obscurely depressed above; *petiole* 6–11 mm long, slender. *Panicle* to 2 cm long, slender, axillary or sometimes terminal, singly branched; branchlets to 8 mm long, bearing to 4 pale yellow flowers. *Buds* to 3 by 2 mm. *Sepals* broadly ovate, acute to subacuminate. *Stamens* 15, compressed at base, tapering; appendages very slender, c. 3 \times length of the subglobose anthers. *Ovary* and *stylopodium* hour-glass-shaped, equal, punctate beneath the short tapering style, with prominent median constriction. *Fruit pedicel* to 2 mm long, very slender. 2 longer *calyx lobes* to 27 by 7 mm, small, spatulate, obtuse, c. 1 mm broad above the to 3 by 2 mm ovate saccate thickened base; 3 shorter lobes to 3 by 2 mm, ovate. *Nut* to 6 by 5 mm, ovoid, shortly apiculate.

Distr. Vietnam, Cambodia, S.E. Thailand, and in *Malesia*: Malaya (Pahang, Selangor, Negri Sembilan).

Ecol. Ridges at 300–700 m in Malaya, sometimes locally gregarious (abundant in Heath forest in Cambodia, and widespread on sandy soils in evergreen forest in Indochina).

Vern. *Mèrawan palong*.

19. *Hopea inexpectata* ASHTON, Gard. Bull. Sing. 31 (1978) 29.

Medium-sized smooth barked tree. Young twigs, petioles and base of peduncle caducous tawny puberulent. *Twigs* c. 2 mm \varnothing apically, slender, much branched, somewhat ribbed, becoming blackish, smooth. *Leaves* 5–9 by 2.4–4.5 cm, ovate, coriaceous; margin subrevolute; base \pm equal, broadly cuneate; acumen to 15 mm long, slender; nervation dryobalanoid, main nerves 8–10 pairs, slender but distinct elevated beneath, arched, with 1 or a few shorter less distinct secondary nerves; tertiary nerves reticulate, evident beneath; midrib sharply prominent beneath, depressed and obscure above; *petiole* 6–7 mm long, short, slender. *Flowers* unknown. *Panicle* to 2.5 cm long, terminal or axillary to ramiflorous, slender, singly branched; *bracts* unknown, caducous. *Fruit pedicel* to 2 mm long, slender. 2 longer *calyx lobes* to 7 by 1.5 cm, spatulate, subacute, tapering to 2 mm broad above the 4 by 2 mm ovate saccate thickened base; 3 shorter lobes to 6 by 3 mm, ovate, acuminate, shorter than nut; *nut* to 8 by 4 mm, ovoid-acuminate, tapering to a short apiculus bearing the vestiges of a distinct stylopodium.

Distr. *Malesia*: West New Guinea (Keban valley).



Fig. 69. Trunk-base of *Hopea beccariana* BURCK. Brunei, Andaulu For. Res. (Photogr. G.H.S. WOOD, SAN 17534).

Ecol. Locally frequent in lowland forest.

Vern. *Bu-aan, arais*.

Notes. This unexpected record of the first member of sect. *Dryobalanoides* east of Wallace's Line suggests the possibility of polyphyletic origin, presumably from sect. *Hopea*, which is otherwise the only section occurring in New Guinea and already shows remarkable plasticity there, as in *H. celtidifolia*.

H. inexpectata shows a strong superficial resemblance to *H. griffithii* KURZ, but differs in its lustrous leaf undersurface, sericeous young parts and short petiole; flowers are required for critical comparison of androecium and gynoecium.

20. *Hopea griffithii* KURZ, J. R. As. Soc. Beng. Sc. 42, 2 (1873) 60; Fl. Burma 1 (1877) 122; DYER, Fl. Br. Ind. 1 (1874) 310; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 69 (*var. pedicellata* excl.); Indian Trees (1906) 68; HEYNE, Nutt. Pl. ed. 2 (1927) 1107; SYM. Gard. Bull. S. S. 9 (1938) 324, 329; *ibid.* 10 (1939) 343, pl. 14; Mal. For. Rec. 16 (1943) 127, f. 69; ASHTON, Man. Dipt. Brun. Suppl. (1968) 51, f. 7. — *Hancea griffithii* PIERRE, For. Fl. Coch. 4 (1891) *sub* t. 248. — *H. pierrei* (non HANCE) RIDL. Fl. Mal. Pen. 1 (1922) 238, *p.p.*

Medium sized smooth-barked tree with thin buttresses and a few stilt roots. Parts glabrous but for the

petals. *Twig* 1 mm \varnothing apically, terete, slender, much branched. *Bud* to 1 by 1 mm, small, conical. *Stipule* to 2 mm long, linear, fugaceous. *Leaves* 4–9 by 1.7–4.5 cm, ovate to lanceolate, coriaceous; base narrowly or broadly cuneate; acumen to 1.5 cm long, caudate; margin frequently subrevolute; nerves *c.* 9 pairs, dryobalanoid, hardly raised beneath; tertiary nerves reticulate; midrib depressed above, prominent beneath; *petiole* 8–15 mm long, slender. *Panicle* to 2.5 cm long, terminal or axillary, ribbed, glabrous, singly branched; branchlets short, bearing to 5 secund flowers; bracteoles to 2 mm long, linear, fugaceous. *Flower bud* to 2 mm long, ellipsoid. *Sepals* broadly ovate, subacuminate, fimbriate, otherwise glabrous, subequal; the inner 3 narrower at base, thinner at margin, than the outer 2. *Petals* lanceolate, arose, densely pubescent on parts exposed in bud, dark red. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the broadly ellipsoid anthers; appendage to connective *c.* 2 times length of anther, slender. *Ovary* and *stylopodium* stoutly pyriform, papillose towards apex, otherwise glabrous, tapering somewhat abruptly below the shortly columnar glabrous style. *Fruit* glabrous. *Pedicel* *c.* 1 mm long, slender. 2 longer *calyx lobes* to 3 by 0.5 cm, spatulate, obtuse, *c.* 2 mm wide above the to 4 by 3 mm deltoid thickened saccate base; 3 shorter lobes to 8 by 1 mm, linear, similarly expanded at base. *Nut* to 7 by 5 mm, ovoid, with to 1 mm long, slender apiculus.

Distr. Lower Burma, and in *Malesia*: Malaya (E. coast, W. Johore), Borneo (Sarawak W. of the Lupar, ? Rejang hinterland; W. & S. Kalimantan).

Ecol. Leached soils in Mixed Dipterocarp forest on low hills, locally common.

Vern. *Mérawan jantan, pérawan, pèngérawan bunga* (Mal.).

21. *Hopea treubii* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 955; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 68; MERR. EN. BORN. (1921) 403; ASHTON, Man. Dipt. Brun. (1964) 111, f. 12, pl. 30 (bark); *ibid.* Suppl. (1968) 57. — Fig. 70 B–B3.

Medium-sized, fissure-barked tree with low buttresses and flying buttresses. Glabrous but for petals and stylopodium. *Twig* to 1.5 mm \varnothing apically, slender, terete, smooth. *Bud* to 2 mm long. *Stipule* to 8 mm long, linear, fugaceous. *Leaves* 5–8 by 3–5.5 cm, broadly elliptic to obovate, coriaceous, base cuneate; acumen to 5 mm long, short, broad; margin subrevolute; nerves *c.* 7 pairs, strongly curved, dryobalanoid, at 60°–70° with secondaries running almost to margin; tertiary nerves reticulate, indistinct; midrib broad, rounded, slightly raised on both surfaces; *petiole* *c.* 1 cm long, short. *Panicle* to 8 cm long, terminal or axillary to ramiflorous, to 2-axillary, slender, rigid, strongly ascending, terete or \pm compressed, glabrous; regularly singly branched, branchlets to 2.5 cm long, straight, bearing to 7 secund flowers; bracteoles to 1 mm long, narrowly deltoid, glabrous, fugaceous. *Flower bud* to 2.5 mm long, ellipsoid, on to 2.5 mm

long pedicel. *Calyx* glabrous but for the fimbriate margin; outer lobes ovate-acuminate, inner lobes shorter, thinner, broadly ovate-mucronate. *Petals* narrowly lanceolate, acute, fimbriate, shortly pubescent on parts exposed in bud, lemon yellow. *Stamens* 10, subequal, in a single row; filaments slender, tapering from the base; anthers broadly oblong, subequal; appendage to connective about twice length of anther. *Ovary* and *stylopodium* cylindrical, glabrous but for the glandular papillose apex, subtruncate; style short, abrupt, glabrous. *Fruit pedicel* to 3 mm long, slender. *Calyx* glabrous; 2 longer lobes to 3.5 by 0.7 cm, spatulate, obtuse, to 2 mm broad at the narrow saccate unexpanded base; 3 shorter lobes to 8 by 2 mm, similar at base. Nut to 11 by 5 mm, narrowly ovoid, glabrous; style remnant short, acute.

Distr. *Malesia*: Borneo (Sarawak and Brunei).

Ecol. Local, on deep yellow sandy soils in Mixed Dipterocarp forest on coastal hills.

Vern. *Mĕrawan daun tĕbal*.

22. *Hopea beccariana* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 240; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 68; MERR. En. Born. (1921) 401; SYM. Gard. Bull. S. S. 8 (1934) 28, pl. 18; *ibid.* 9 (1938) 325, *p.p.*; Mal. For. Rec. 16 (1943) 122, f. 69, 71; SMITINAND, Thai For. Bull. 1 (1954) 19; BROWNE, For. Trees Sarawak & Brunei (1955) 120; ASHTON, Man. Dipt. Brun. (1964) 95, f. 12, pl. 26 (stem); *ibid.* Suppl. (1968) 48; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 207, f. 26, pl. 22. — *Hancea beccariana* PIERRE, For. Fl. Coch. 4 (1891) *sub* t. 244, in tab. also partly (by error) 'beccarii'. — *H. nicholsoni* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 973. — *H. intermedia* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 126, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 67, *p.p.*; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 156, t. 189, *p.p.*; HEYNE, Nutt. Pl. ed. 2 (1927) 1107; FOXW. Mal. For. Rec. 10 (1932) 134; DURANT, Rep. For. Brunei (1932) 40; BURK. Dict. (1935) 1190. — *Balanocarpus ovalifolius* RIDL. J. Fed. Mal. Str. Mus. 10 (1920) 130, *p.p.*; Fl. Mal. Pen. 1 (1922) 247, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 143, *p.p.* — *H. pierrei* (non HANCE) RIDL. Fl. Mal. Pen. 1 (1922) 238, *p.p.* — Fig. 62a, 63 C1–C4, 64b, 69.

Large, smooth or fissure-barked buttressed tree. Young twig, bud and petiole waxy glaucescent. *Twig* to 1 mm \varnothing apically, slender, terete, smooth. *Bud* to 2 by 1 mm, ovoid. *Stipule* to 2.5 mm long, linear, fugaceous. *Leaves* 5–8 by 2.2–4.5 cm, ovate, thinly coriaceous; base cuneate, frequently subequal; acumen to 1.5 cm long, caudate; margin not revolute; nerves c. 8 pairs, indistinct, dryobalanoid; main secondaries almost reaching margin; tertiary nerves reticulate, indistinct; midrib slender, slightly raised on both surfaces; *petiole* 1.2–1.7 cm long, slender. *Panicle* to 7 cm long, axillary (rarely terminal), terete, puberulent or glabrous; singly branched, branchlets bearing to 5 second cream flowers; *bracteoles* small, linear, fugaceous. *Flower bud* small, ellipsoid. *Calyx* shortly pubescent outside, glabrous within; 2 outer lobes

ovate-acuminate, 3 inner lobes ovate to suborbicular, obtuse or subacute. *Petals* linear, densely pubescent on parts exposed in bud. *Stamens* 15; filaments slender, tapering; anthers broadly oblong; appendage to connective about twice as long as anther, slender. *Ovary* and *stylopodium* hour-glass-shaped, puberulent towards the apex, tapering into the short glabrous style. *Fruit calyx* glabrous; 2 longer lobes to 3.5 by 1 cm, obtuse, to 2 mm broad above to 4 by 3.5 mm ovate saccate slightly thickened base, twisted; 3 shorter lobes to 7 mm long, acute, similar at base. *Nut* to 9 by 5 mm, broadly ovoid, glabrous; style remnant to 1 mm long.

Distr. Peninsular Thailand (Pattani) and in *Malesia*: Malaya, E. Sumatra (Karimun), Borneo.

Ecol. Widespread, on coastal hills and on deep soils on inland ridges (especially in Malaya), occasionally to 1200 m.

Vern. *Mĕrawan batu*, *m. jangkang*, *m. pĕnak* (Mal.), *sĕlangan pĕnak* (Sab.), *s. hijau*, *garang buaya daun kĕchil* (Brun.), *chĕngai pasir* (Iban), *tĕmang bĕsi*, *bangkirai*, *nuas njĕrakat hitam*, *bĕlang kĕmai* (S.E. Borneo).

23. *Hopea dyeri* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 972; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 68; MERR. En. Born. (1921) 402, *p.p.*; SYM. Gard. Bull. S. S. 8 (1932) 53; *ibid.* 9 (1938) 323, 324; *ibid.* 10 (1939) 353; Mal. For. Rec. 16 (1943) 124, f. 68F, 69; BROWNE, For. Trees Sarawak & Brunei (1955) 120; ASHTON, Man. Dipt. Brun. (1964) 99, f. 12, pl. 28 (stem-base); *ibid.* Suppl. (1968) 50; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 210. — *H. micrantha* (non HOOK. f.) BURCK, Ann. Jard. Bot. Btzg 6 (1887) 239, *p.p.*; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 124, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 70; BURK. J. Str. Br. R. As. Soc. 81 (1920) 58; HEYNE, Nutt. Pl. ed. 2 (1927) 1107; BURK. Dict. (1935) 1190. — *Hancea microptera* PIERRE, For. Fl. Coch. 4 (1891) *sub* t. 244, *nomen*. — *H. microptera* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 68, *nomen in syn.* — *H. intermedia* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 126, *p.p.*; Ann. R. Bot. Gard. Calc. 5, 2 (1896) 156, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 67, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 134, *p.p.* — *H. pierrei* (non HANCE) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 67, t. 2, f. 10, *p.p.*; MERR. En. Born. (1921) 403, *p.p.*; RIDL. Fl. Mal. Pen. 1 (1922) 238, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 133, *p.p.* — Fig. 63 D3–D4.

Medium-sized tree with flaking bark and thin low buttresses and stilt roots. Bud, stipule, panicle and domatia persistently grey-brown pubescent, twig and petiole caducously so. *Twig* to 1 mm \varnothing apically, slender, terete, much branched, becoming smooth. *Bud* minute, ovoid, obtuse. *Stipule* to 1.5 mm long, linear, caducous. *Leaves* 2.7–7 by 1.2–2.5 cm, ovate-lanceolate, somewhat coriaceous, frequently lepidote beneath; base cuneate, subequal; acumen to 1.5 cm long, narrow, caudate; margin frequently slightly revolute; nerves 8–12 pairs, slender, slightly raised, distinct beneath with many distinct secondaries fre-

quently subequal to them; midrib stout, raised on both surfaces, more prominently raised above than beneath; *petiole* 5–8 mm long, short, slender. *Panicle* to 3 cm long, terminal or axillary, borne singly, terete; singly or doubly irregularly branched, the branchlets short, bearing to 4 flowers; *bracteoles* minute, oblong, obtuse, pubescent, fugaceous. *Flower* cream; bud small, ovoid, *Calyx* puberulent to glabrous outside, glabrous within; 2 outer lobes narrowly ovate, subacuminate; 3 inner lobes thin, suborbicular, mucronate. *Petals* narrowly lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 whorls; filaments broad at base, tapering; anthers subglobose; appendage to connective about twice length of anther. *Ovary* and *stylopodium* pyriform, glabrous but for the puberulent apex, crowned by a short glabrous style. *Fruit calyx* glabrous; 2 longer lobes to 2.5 by 1 cm, small, spatulate, narrowly obtuse, to 2.5 mm broad above the to 5 by 3 cm narrowly deltoid slightly thickened saccate base; 2 shorter lobes to 7 by 4 mm, ovate, glabrous, acuminate, acute, thin. *Nut* to 9 by 4 mm, narrow, ovoid; style remnant short, acute.

Distr. *Malesia*: Malaya, Borneo (Sarawak, Sabah).

Ecol. Well drained soils on low hills and ridges to 1000 m; locally abundant.

Vern. *Mérawan palit*, *m. hitam*, *pəngawan pasir* (Mal.), *səlangan palit* (Sab.), *əməng besi* (Kapas).

24. *Hopea myrtifolia* MIQ. Sum. (1860) 49, 192; DC. Prod. 16, 2 (1868) 635; WALP. Ann. 7 (1868) 379; SCHEFF. Nat. Tijd. N. I. 31 (1870) 551; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 242; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 71, *p.p.*; MERR. En. Born. (1921) 403, *p.p.*; HEYNE, Nutt. Pl. ed. 2 (1927) 1107; SYM. Gard. Bull. S. S. 10 (1939) 347, pl. 16; Mal. For. Rec. 16 (1943) 134, f. 69, 74. — Fig. 63 A–A4.

Medium-sized, sometimes large, smooth barked tree with stilt roots and thin buttresses. Twigs, leaf buds, petioles, midrib above, and domatia densely ± persistently tawny puberulent, panicles sparsely so, petals outside densely golden pubescent. *Twig* c. 1 mm ø apically, slender, straight, ± horizontal, terete, becoming dark brown; stipule scars minute, pale. *Buds* minute; *stipules* small, linear, fugaceous. *Leaves* (4.5–)6–12 by (1.8–)2.2–5 cm, lanceolate, coriaceous; base broadly cuneate, subequal; acumen to 1.8 cm long, prominent; nervation dryobalanoid; main nerves c. 13 pairs, with many ± shorter secondaries, slender but evident beneath, distinctly narrowly depressed above, frequently with pubescent axillary domatia; tertiary nerves usually evident on both surfaces, minutely reticulate; midrib slender but distinctly elevated on both surfaces; *petiole* 6–12 mm long, slender. *Panicle* to 4 cm long, slender, axillary to ramiflorous, singly branched; branchlets to 1.5 cm long, bearing to 7 secund flowers. *Flower buds* c. 2.5 by 2 mm, ovoid. *Sepals* broadly ovate to suborbicular, mucronate or subacuminate. *Stamens* 15, filaments broadly compressed at base, tapering and filiform distally; appendages slender, c. twice as long as

subglobose anthers; *ovary* and *stylopodium* narrowly subcylindrical, equal in height but the ovary broader, without median constriction; style shorter than either, columnar, tapering. *Fruit pedicel* to 2 mm long, slender. 2 longer fruit *calyx lobes* to 5.5 by 1.2 cm, spatulate, narrowly obtuse, tapering to c. 2 mm broad above the to 7 by 3 mm ovate saccate thickened base; 3 shorter lobes to 4 by 3 mm, ovate, saccate, thickened. *Nut* to 9 by 7 mm, ovoid, bluntly apiculate.

Distr. *Malesia*: Malaya (S. Perak and Pahang southwards), Karimun, S. Sumatra (Lamongan), S.E. Borneo (Pulau Laut, Muara Teweh to Balikpapan and Tarakan), W. Borneo (Melawi).

Ecol. Well-drained undulating land with deep fertile soil.

Vern. *Mata kucing bəludu*, *mərawan jangkang* (Malaya), *mata kucing* (Sumatra), *njərakat jangkar* (Kutei), *bangkirai batu*, *lampəngwea* (Muaratewe).

25. *Hopea pedicellata* (BRANDIS) SYM. Gard. Bull. S. S. 9 (1938) 327, pl. 19; Mal. For. Rec. 16 (1943) 138, f. 68E, 69; SMITINAND, Thai For. Bull. 1 (1954) 10, 19; ASHTON, Man. Dipt. Brun. Suppl. (1968) 54, f. 7; Gard. Bull. Sing. 31 (1978) 30. — *H. micrantha* (non HOOK. f.) KING, J. R. As. Soc. Beng. Sec. 62, 2 (1893) 124, *p.p.*; RIDL. Fl. Mal. Pen. 1 (1922) 237, *p.p.* — *H. griffithii* var. *pedicellata* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 69, *p.p. quoad specim. Malay.*; RIDL. Fl. Mal. Pen. 1 (1922) 238. — *H. intermedia* (non KING) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 67, *p.p.* — *H. mengerawan* (non MIQ.) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 70, *p.p.* — *H. pierrei* (non HANCE) RIDL. Fl. Mal. Pen. 1 (1922) 238, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 133, *p.p.*; BURK. Dict. (1935) 1193, *p.p.* — *H. siamensis* HEIM, Bot. Tidsskr. 25 (1902) 46; WILLIAMS, Bull. Herb. Boiss. 2, 5 (1905) 147; SCHMIDT, Bot. Tidsskr. 7 (1907) 46; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 376; CRAIB, Fl. Siam. Enum. 1 (1925) 147; SMITINAND, Nat. Hist. Bull. Siam. Soc. 19 (1958) 63.

Medium-sized tree with flaky bark, thin buttresses and sometimes a few stilt roots. Young twig and domatia grey-brown puberulent, glabrescent; petiole, leaf bud and stipule persistently so. *Twig* c. 1 mm ø apically, slender, much branched, terete, smooth; stipule scars short, obscure. *Bud* to 1 by 1 mm, ellipsoid, obtuse, minute. *Stipule* small, linear, fugaceous. *Leaves* 4–9 by 1–3.5 cm, ovate-lanceolate, base cuneate; acumen to 1.5 cm long, subcaudate, slender; nervation dryobalanoid, main nerves c. 8–12 pairs, with subequal secondaries, indistinct, slender, hardly raised; midrib raised on both surfaces; *petiole* 6–8 mm long. *Panicle* to 2 cm long, terminal or axillary, terete, caducous puberulent; singly branched. *Calyx* glabrous, 2 outer lobes ovate, acute, 3 inner suborbicular, mucronate. *Petals* sericeous on parts exposed in bud, pale yellow. *Stamens* 15, unequal; filaments compressed at base, tapering abruptly medially and filiform below the oblong anthers; appendage to connective filiform, c. twice length of anthers. *Ovary* with *stylopodium*, cylindrical-conical, attenuate, truncate, punctate in the distal ½, surmounted by a short

style. Fruit glabrous. *Pedice* *c.* 2 mm long. 2 longer *calyx lobes* to 3 by 0.5 cm, spatulate, *c.* 2 mm broad above the *c.* 5 by 3 mm ovate saccate thickened base; 3 shorter lobes to 3 by 3 mm, ovate, saccate, adpressed to the nut. *Nut* to 6 by 4 mm, ovoid, abruptly acute.

Distr. Southern Indo-China, Peninsular Thailand and in *Malesia*: Malaya (Trengganu and Perak and northwards), Borneo (Sarawak, Sabah, Nunukan).

Ecol. Rare, in hill forests to 750 m.

Uses. A minor source of damar mata kucing.

Vern. *Mata kucing bukit* (Mal.).

26. *Hopea altocollina* ASHTON, Gard. Bull. Sing. 22 (1967) 271, pl. 16, 348 (phot. habit); Man. Dipt. Brun. Suppl. (1968) 46, f. 6, pl. 10 (stem-base).

Tall tree with prominent thin buttresses and pale thinly flaking bark. Sepals and petals sericeous outside; parts otherwise glabrous. *Twigs c.* 2 mm \varnothing apically, terete; stipule scars short, obscure. *Bud* to 1 by 1 mm, subglobose, small. *Stipule* unknown. *Leaves* 7–10 by 3–4.5 cm, lanceolate; base obtuse, appearing cuneate owing to the prominently revolute margin;

acumen to 1 cm long, caudate; nervation dryobalanoid, nerves *c.* 16 pairs, \pm obscure, with short secondaries; midrib slender, slightly elevated on both surfaces; *petiole* 10–13 mm long, somewhat thickened distally and geniculate, slender. *Panicle* to 8 cm long, terminal or axillary, frequently 2-axillary, terete, glabrous, singly branched. *Flower bud* to 4 by 3 mm. *Sepals* broadly ovate, acute, the inner 3 broader and thinner. *Stamens* 15; filaments rather slender, lorate at base, tapering medially; anthers ellipsoid; appendages *c.* 2 \times length of anthers, very slender. *Ovary* and *stylopodium* cylindrical, punctate at the rounded apex; style short. Fruit entirely glabrous. *Pedice* to 2 mm long. 2 longer *calyx lobes* to 4.5 by 0.8 cm, spatulate, obtuse, 2–3 mm broad above the 6 by 3 mm narrowly ovate thickened saccate base; 3 shorter lobes to 4 by 4 mm, suborbicular, obtuse, shorter than nut. *Nut* to 7 by 5 mm, ovoid; style remnant to 2 mm long, slender.

Distr. *Malesia*: Borneo (Rejang hinterland, Sarawak to Crocker range, S.W. Sabah).

Ecol. Locally frequent, clay rich soils, hillsides and spurs, 800–1000 m.

Ib. Subsection Sphaerocarpace

(HEIM) ASHTON, Gard. Bull. Sing. 20 (1963) 258; Man. Dipt. Brun. (1964) 90; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 26. — *Balanocarpus sect. Sphaerocarpace* HEIM, Rech. Dipt. (1892) 77. — *Hopea, Bracteata* group SYM. Gard. Bull. Sing. 10 (1939) 338; Mal. For. Rec. 10 (1943) 108.

Leaf nervation subdryobalanoid (except *spp.* 27–30 with scalariform venation); bracts subsistent; panicles irregularly branched, with long branchlets and few flowers (*H. nervosa*, *H. sublanceolata* excl.); corolla dark coloured; ovary and stylopodium truncate. Small or occasionally medium-sized trees; bark smooth or rarely irregularly cracked; buttresses thin small; usually with stilt roots.

Distr. *Malesia*: Malaya, Sumatra, Borneo, Mindanao.

27. *Hopea aequalis* ASHTON, Gard. Bull. Sing. 22 (1967) 271, pl. 15; Man. Dipt. Brun. Suppl. (1968) 46, f. 6. — *H. nov. spec. aff. H. pachycarpa* (non SYM.) MEIJER & WOOD, Sabah For. Rec. 5 (1964) 229.

Small to medium-sized tree. Apparently glabrous apart from the puberulent midrib above. *Twig c.* 2 mm \varnothing apically, terete, smooth; stipule scars short, horizontal, obscure. *Bud c.* 2 by 1 mm ellipsoid, obtuse. *Stipule* unknown. *Leaves* 13–25 by 5.5–8 cm, lanceolate, chartaceous; base obtuse; acumen to 1 cm long; nerves 16–20 pairs, slender, elevated beneath, at 65°–70°; tertiary nerves densely scalariform, very slender, diagonal to the nerves; midrib shallowly depressed above, prominent beneath, slender; *petiole* 15–18 mm long. *Flower* unknown. *Panicle* to 9 cm long, axillary, terete, glabrous, unbranched or singly branched. *Fruit* glabrous. *Calyx lobes* to 18 by 16 mm, subequal, ovate, subacute, saccate, incrassate. *Nut* to 23 by 15 mm, ovoid, acute, frequently coated with resin.

Distr. *Malesia*: Borneo (Central Sarawak, Sandakan Distr.).

Ecol. Rare, low hills in Mixed Dipterocarp forest.

28. *Hopea rudiformis* ASHTON, Gard. Bull. Sing. 31 (1978) 30.

Medium-sized tree. Twigs, leaf buds and parts of petals exposed in bud densely \pm persistently pale tawny puberulent; panicles sparsely so; calyx outside and nerves and midrib beneath sparsely caducously so. *Twigs c.* 2 mm \varnothing apically, rather straight, ribbed, becoming smooth, dark brown. *Bud* small, ovoid, acute; *stipules* fugaceous, unknown. *Leaves* 6.5–14 by 3.5–7.5 cm, ovate to broadly lanceolate, thinly coriaceous, minutely stellate lepidote and appearing pale and dull beneath; margin subrevolute; base broadly cuneate; acumen to 1.5 cm long, broad, tapering, down curved and twisted over on pressing; nerves 11–13 pairs, slender but prominent beneath, \pm obscurely depressed above, arched, at 55°–65°; second-

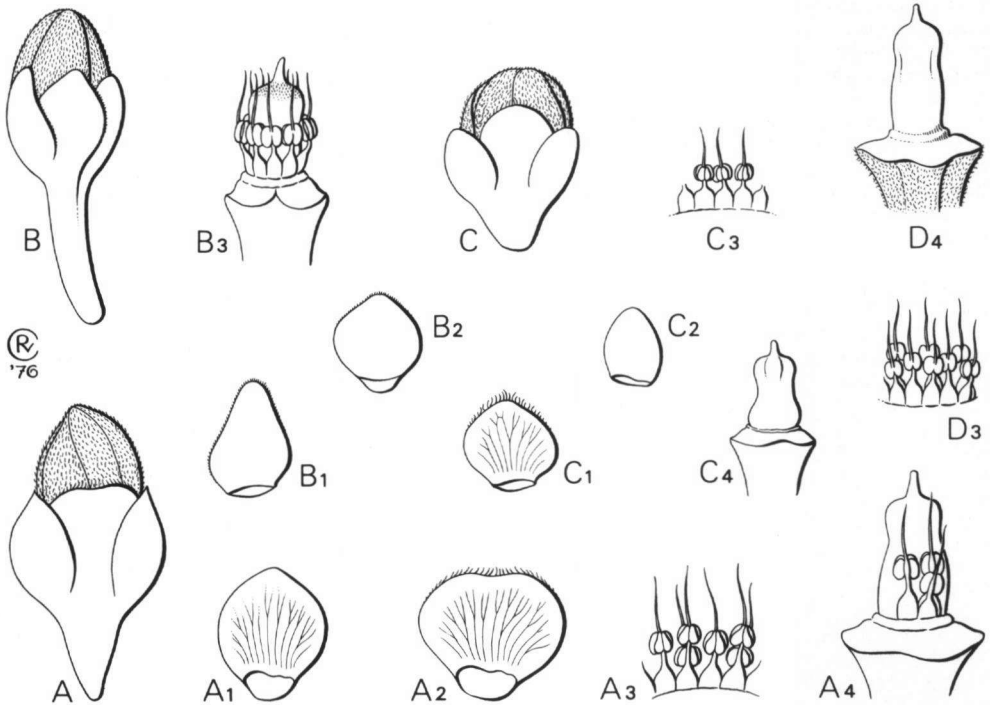


Fig. 70. Flower details in *Hopea* sect. *Dryobalanoides* MIQ. All $\times 10$. Sepals drawn from inside. — *H. bracteata* BURCK. A. Bud, A1. outer sepal, A2. inner sepal, A3. stamens from inside, A4. stamens and pistil. — *H. treubii* HEIM. B. Bud, B1. outer sepal, B2. inner sepal, B3. stamens and pistil. — *H. vacciniifolia* RIDL. ex ASHTON. C. Bud, C1. outer sepal, C2. inner sepal, C3. stamens from inside, C4. pistil. — *H. nervosa* KING. D3. Stamens from outside, D4. pistil (A HAVILAND 2225, B ANDERSON S 9482, C HOSE 583, D KOSTERMANS 13981).

ary nerves few, short, hardly elevated beneath; tertiary nerves densely scalariform, obscure; *petiole* 8–13 mm long. *Panicle* to 3.5 cm long, to 2-axillary; singly branched, branchlets bearing to 3 flowers; *bracts* unknown, fugaceous. *Flower bud* to 3 by 2 mm, ovoid, small. *Sepals* subequal, broadly ovate, subacuminate. *Stamens* 15, in 3 subequal verticels; filaments compressed at base, tapering medially and filiform below the shortly oblong anthers; appendages slightly longer than anthers, short, slender. *Ovary* ovoid, surmounted by an indistinct tapering ciliate stylopodium, and short columnar style c. $\frac{1}{4}$ length of ovary and stylopodium. *Fruit pedicel* to 2 mm long, short, base of ripe fruit \pm impressed. 2 longer *calyx lobes* to 9 by 2 cm, broadly spatulate, obtuse, c. 3 mm broad above the to 6 by 5 mm ovate deeply saccate thickened base; 3 shorter lobes to 8 by 8 mm, ovate, chartaceous at margin, subacute, reaching apex of nut and adpressed to it; *nut* to 8 by 8 mm, ovoid, terminating in the persistently truncate stylopodium.

Distr. Malesia: S.E. Borneo (Tawau to Pulau Laut); Ulu Kapuas, W. Borneo.

Ecol. Undulating land on deep well drained soil in lowlands; sometimes in freshwater swamps.

Vern. Səlangan jangkang, emang bahau, putang lēman, damar jangkar.

29. *Hopea nervosa* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 124; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 62; RIDL. Fl. Mal. Pen. 1 (1922) 236; FOXW. Mal. For. Rec. 10 (1932) 129, pl. 10 (hab.), p.p.; BURK. Dict. (1935) 1191; SYM. Mal. For. Rec. 16 (1943) 135, f. 69, 75; ASHTON, Man. Dipt. Brun. (1964) 104, f. 12; *ibid.* Suppl. (1968) 54; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 215, f. 28, pl. 23b (stem). — Fig. 70 D3–D4, 71.

Medium-sized tree. *Twig*, leaf bud, stipule, panicle, petiole and midrib on both surfaces puberulent, glabrescent. *Twig* to 1 mm \varnothing apically, slender, becoming smooth, glabrous. *Bud* to 2 by 1 mm, ovoid, acute. *Stipule* to 2 mm long, narrowly oblong, acute. *Leaves* 9–18 by 4–7 cm, thinly coriaceous, narrowly ovate to lanceolate; base broadly cuneate; acumen to 1.4 cm long, narrow; nervation scalariform, nerves

13–15 pairs, dense, slender, prominent beneath, slightly curved, at 40°–60°, with or without short slender secondaries; tertiary nerves dense, slender, scalariform, slightly sinuate, diagonal to nerves; midrib slender, prominent beneath, slightly depressed above; *petiole* 1–1.2 cm long. *Panicle* to 9 cm long, terminal or axillary, to 2-axillary, terete; singly branched, branchlets to 1.5 cm long, bearing to 5 flowers; *bracteoles* small, ovate, acute, puberulent outside, glabrous within. *Flower bud* to 3 mm long, subglobose. *Petals* narrowly oblong, densely tomentose on parts exposed in bud, purple with pale tips. *Stamens* 15; filaments of inner 2 rows broad at base, abruptly tapering, 5 outer filaments slender; anthers subglobose; appendage to connective slender, c. 2 times length of anther. *Ovary* and *stylopodium* broadly cylindrical, truncate, glabrous; style short. *Fruit* sessile. *Calyx* glabrous, impressed at base; 2 longer lobes to 12 by 1.8 cm, thinly coriaceous, spatulate, narrowly obtuse, to 2.5 mm broad above the to 13 by 8 mm broadly ovate saccate thickened base; 3 shorter lobes to 1.5 cm long, acute, similar at base, closely adpressed to nut. *Nut* to 1 cm long and \emptyset , ovoid, style remnant short.

Distr. *Malesia*: Malaya, Borneo (Sarawak to Sabah, S. E. Borneo to Balikpapan).

Ecol. Low lying flat land and hill slopes below 400 m on clay rich fertile soils; locally frequent.

Vern. *Mĕrawan jangkang*, *m. pĕnak*, *chĕngal rawan*, *c. pasir* (Mal.), *sĕlangan puteh*, *s. bĕrtunjang*, *damar jangkar* (S.E. Borneo).

30. *Hopea sublanceolata* SYM. Gard. Bull. S. S. 10 (1939) 341, pl. 13; Mal. For. Rec. 10 (1943) 144, f. 69. — *H. nervosa* (non KING) FOXW. Mal. For. Rec. 10 (1932) 129, p. p.

Medium-sized, sometimes large, tree with reddish flaky bark. Young twigs and petioles fugaceous puberulent, calyx outside caducously so, panicles sparsely persistently so; petals densely cream pubescent outside. *Twig* c. 2 mm \emptyset , dark brown, with a short rib following the leaf trace otherwise smooth, terete; internodes 1–2 cm long; stipule scars obscure. *Leaf bud* minute, ovoid; *stipule* fugaceous. *Leaves* 6.5–15 by 3.5–6.5 cm, elliptic-lanceolate, subcoriaceous; base cuneate, typically shortly decurrent; acumen to 1.5 cm long; nerves 13–18 pairs, arched, slender but prominent beneath, depressed above as also the midrib; occasionally with a few short secondary nerves; tertiary nerves densely scalariform, evident beneath, obscure above; *petiole* 7–20 mm long. *Panicle* to 5 cm long, terminal or axillary, ramiflorous, relatively short, singly branched; branchlets to 2.5 cm long, bearing to 8 flowers. *Flower buds* to 3 by 2 mm, ovoid. 2 outer *sepals* ovate, deltoid, acute; 3 inner broadly ovate, subacuminate. *Corolla* dark red. *Stamens* 15. *Ovary* and *stylopodium* cylindrical, truncate, with slight median constriction, the stylopodium the shorter and narrower; style short, stout. *Fruit pedicel* c. 1 mm long, short, stout, base of fruit shallowly depressed. 2 longer fruit *calyx lobes* to 11.5

by 2 cm, spatulate, obtuse, c. 4 mm broad above the to 8 by 8 mm ovate saccate thickened base; 3 shorter lobes to 17 by 12 mm, ovate-acuminate, appressed to nut and enclosing it except at apex. *Nut* to 2 by 1.3 cm, shortly apiculate.

Distr. *Malesia*: Malaya (S. Kedah, N. Perak, Kelantan, Pahang).

Ecol. Locally common on undulating land and low spurs.

Vern. *Mĕrawan jĕruai*, *chĕngal karang*, *mata puteh*, *panah*, *pau yang*, *pahi yang*.

31. *Hopea nigra* BURCK. Ann. Jard. Bot. Btzg 6 (1887) 238; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64; MERR. En. Born. (1921) 403.

Small tree. Twigs, leaf buds, stipules and parts of petals exposed in bud densely persistently tawny pubescent; panicles sparsely \pm caducously so. *Twigs* c. 2 mm \emptyset apically, rather straight, hardly branched, becoming smooth, terete. *Buds* minute, subglobose; *stipules* c. 2.5 mm long, linear, not at first caducous. *Leaves* 3–10 by 1–4 cm, broadly lanceolate, subcoriaceous; base obtuse; acumen to 1.5 cm long, slender; nerves 8–10 pairs, very slender, \pm elevated or obscure beneath, applanate or narrowly depressed above, arched, sometimes with small pubescent domatia; secondary nerves ∞ , short, obscure; tertiary nerves subscalariform, obscure; midrib sharply prominent beneath, \pm obscure and depressed above; *petiole* 3–6 mm long, short, slender. *Panicle* to 3 cm long, short, slender, axillary, usually solitary; singly branched, branchlets to 1 cm long, bearing c. 4 secund flowers; *bracts* and *bracteoles* to 2 mm long, linear, subsistent. *Flower bud* to 2 by 1 mm, small, ovoid. 2 outer *sepals* narrowly ovate-acuminate, 3 inner suborbicular, mucronate, sparsely fimbriate; *stamens* 15, in 3 subequal verticils, exceeding style; filaments broadly compressed at base, tapering and filiform below the small subglobose anthers; appendages 2–3 times length of anthers, very slender. *Ovary* and *stylopodium* cylindrical, truncate, punctate distally; style c. $\frac{1}{2}$ length of ovary and stylopodium, filiform. *Fruit pedicel* short. 2 longer calyx lobes to 5.5 by 1 cm, spatulate, \pm subacute, tapering to 2 mm broad above the to 6 by 4 mm ovate saccate somewhat thickened base; 3 shorter lobes to 4 by 5 mm, suborbicular, obtuse or mucronate. *Nut* to 8 by 6 mm, ovoid, retaining the prominently truncate stylopodium.

Distr. *Malesia*: E. Sumatra, Banka, Billiton.

Ecol. Lowland forests.

Vern. *Mĕdĕmut*, *sasak lingga* (Banka), *mang* (Billiton).

32. *Hopea sphaerocarpa* (HEIM) ASHTON. Gard. Bull. Sing. 20 (1963) 258; Man. Dipt. Brun. Suppl. (1968) 56, f. 8. — *Balanocarpus sphaerocarpus* HEIM, Rech. Dipt. (1892) 77; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 113; MERR. En. Born. (1921) 407.

Small tree. Twigs, petioles, buds and midrib on both surfaces \pm densely persistently evenly tawny pubescent, leaf nervation sometimes sparsely so. *Twig*



Fig. 71. Stilt-rooted *Hopea nervosa* KING. Sabah (Photogr. G.H.S. WOOD).

c. 1 mm \varnothing apically, terete, straight, lax, smooth. *Bud* c. 1 by 1 mm, small. *Stipule* c. 4 by 2 mm, oblong, obtuse, caducous. *Leaves* 3.5–10 by 1.4–4.5 cm, ovate to broadly lanceolate, chartaceous, undulate; base obtuse to subcordate; acumen to 1 cm long; nervation subdryobalanoid, main nerves 9–11 pairs, slender, elevated beneath, with obscure short secondaries; tertiary nerves densely scalariform, slender; midrib slender, elevated beneath, applanate above; *petiole* 3–6 mm long, short. *Panicle* to 10 cm long, axillary, sometimes terminal, lax, slender, glabrous; singly branched, branchlets zig-zag, bearing to 6 \pm distichous flowers; *bracteoles* c. 2 mm long, linear, glabrous, subsistent. *Flower bud* to 2 by 2 mm, subglobose. *Sepals* broadly ovate, subacute, sub-

equal, densely shortly pubescent on parts exposed in bud. *Petals* elliptic-oblong, subacute, puberulent on parts exposed in bud, dark crimson. *Stamens* 15, in 3 unequal rows; filaments broad and compressed at base, tapering abruptly and filiform beneath the subglobose anthers; appendage to connective 3–5 times as long as anther, slender. *Ovary* and *stylopodium* cylindrical, truncate, somewhat constricted medially, glabrous; style short, conical. *Fruit* glabrous. *Pedicel* to 4 mm long, very long. *Calyx lobes* to 8 by 7 mm, subequal, ovate, acute, saccate, thickened. *Nut* to 10 by 8 mm, ovoid; stylopodium to 2 mm tall, prominent, truncate.

Distr. *Malesia*: Borneo (W. and N. E. Sarawak; N.W. Kalimantan).

Ecol. Local; Mixed Dipterocarp forest on leached clay-rich soils on low hills.

33. *Hopea mesuoides* ASHTON, Gard. Bull. Sing. 22 (1967) 279, pl. 25; Man. Dipt. Brun. Suppl. (1968) 54. — *H. subalata* (non SYM.) ASHTON, Man. Dipt. Brun. (1964) 110, f. 12, pl. 27 (stem-base).

Medium-sized tree. Leaf bud and stipule shortly persistently pale yellow-brown pubescent, other parts glabrous. *Twig* to 1.5 mm \varnothing apically, slender, smooth, terete. *Bud* to 1 mm long, subglobose. *Stipule* to 2.5 by 1 mm, hastate, acute, fugaceous. *Leaves* 8–14 by 2.5–5 cm, thinly coriaceous, ovate; base obtuse; acumen 5–15 mm long, caudate; margin subrevolute; nerves *c.* 11 pairs, subdryobalanoid, distinct, slightly raised beneath, with shorter secondaries, at 55°–75°, strongly curved; tertiary nerves reticulate; midrib prominently raised beneath, narrow, depressed above, *petiole* 7–10 mm long, slender. *Panicle* to 4 cm long, axillary, short, terete, glabrous, singly branched; *bracteoles* to 1 mm long, deltoid, glabrous, subsistent. *Flower bud* small, ovoid to subglobose. *Calyx* sparsely pubescent outside, glabrous within; 2 outer lobes suborbicular, subacute or obtuse; 3 inner lobes suborbicular, \pm shortly mucronate. *Petals* oblong, obtuse, pubescent on parts exposed in bud. *Stamens* 15; filaments broad at base, tapering; anthers subglobose; appendage to connective 2–3 times length of anther, very slender. *Ovary* and *stylopodium* glabrous but for the puberulent apex, cylindrical, truncate, ovary slightly the broader; style short, glabrous. *Fruit pedicel c.* 1 mm long, short, impressed in the base of the calyx. *Calyx lobes* to 14 by 12 mm, subequal, ovate, chartaceous, \pm erose at the subacute apex, broadly imbricate, saccate, completely enclosing the nut and closely adpressed to it. *Nut* to 14 by 14 mm, subglobose, crowned by the persistent truncate stylopodium.

Distr. *Malesia*: Borneo (Sarawak N. E. of Balingian, Brunei).

Ecol. Mixed Dipterocarp and Heath forests, deep leached soil, lowlands.

34. *Hopea subalata* SYM. Gard. Bull. S. S. 10 (1939) 339, pl. 12; Mal. For. Rec. 16 (1943) 143, f. 68A, 69, 78. — *Balanocarpus ovalifolius* (non RIDL.) FOXW. Mal. For. Rec. 10 (1932) 143, *p.p.*

Small tree. Twigs and petioles sparsely fugaceous puberulent, petals outside cream pubescent, parts otherwise glabrous. *Twig c.* 1 mm \varnothing apically, slender, dark brown, at first ribbed along the leaf traces; internodes 1.5–2.5 cm long; stipule scars obscure. Leaf bud minute, ovoid; *stipule* to 5 mm long, linear, caducous. *Leaves* 4.5–10 by 2.3–5 cm, ovate-lanceolate, thinly coriaceous; base broadly cuneate; acumen to 1.5 cm long, subcuspidate; nervation subdryobalanoid; main nerves *c.* 12 pairs, arched, frequently with small pubescent axillary domatia, slender but distinctly elevated beneath, obscurely depressed above as also the many shorter secondaries; tertiary nerve subscalariform, obscure; midrib sharply promi-

nent beneath, narrowly depressed above; *petiole* 5–7 mm long, short. *Panicle* to 5 cm long, axillary at terminal, slender, lax, with to 2.5 cm long branchlets bearing to 5 flowers; *bracteoles* to 1 mm long, deltoid, apiculate, subsistent. *Flower buds* to 3 by 2 mm, ovoid; sepals suborbicular, obtuse or subacute, subequal; *petals* purple; *stamens* 15, filaments short, compressed, tapering immediately beneath the subglobose anthers; appendages very slender, 2–4 times length of anthers; *ovary* and *stylopodium* cylindrical, equal, subtruncate, punctate distally, with short stout tapering style. *Fruit pedicel* to 2 mm long and \varnothing . *Fruit calyx lobes* to 10 by 8 mm, ovate, subequal, saccate, thickened, enclosing the nut (the apex excepted), 1(–2) lobes generally with a to 10 by 3 mm aliform apical extension. *Nut* to 10 by 8 mm, ovoid, crowned by a truncate conical stylopodium with central terminal apiculus.

Distr. *Malesia*: Malaya (Selangor).

Ecol. Locally common in one locality, on low hills. Vern. *Mérawan kanching, m. jangkang.*

35. *Hopea auriculata* FOXW. Mal. For. Rec. 10 (1932) 125, pl. 9; BURK. Dict. (1935) 1189; SYM. Mal. For. Rec. 16 (1943) 121, f. 69.

Small tree. Young twigs and petioles caducous pale grey-tawny puberulent. *Twig c.* 2 mm \varnothing apically, slender, horizontal; stipule scars minute. *Leaf bud* minute; stipule acicular, fugaceous. *Leaf* 5–10 by 2–5 cm, ovate-lanceolate, thinly coriaceous; base cuneate; acumen to 1.5 cm long, caudate; nervation subdryobalanoid; nerves *c.* 9 pairs, arched, slender but distinctly elevated beneath, obscure above, with \pm prominently buff pubescent axillary domatia and short slender secondary nerves; tertiary nerves densely subscalariform, \pm obscure; midrib slender but prominent beneath, obscurely depressed above; *petiole* 5–11 mm long, slender. *Panicle* to 4 cm long, slender, hardly branched; *flowers* unknown. *Fruit pedicel* to 2 mm long; 2 longer *calyx lobes* to 7 by 1.5 cm, spatulate, obtuse, to 5 mm broad above the to 15 by 10 mm auriculate saccate thickened base; 3 shorter lobes to 2 cm long, ovate-auriculate, similarly thickened centrally; *nut* to 10 by 7 mm, ovoid, apiculate, completely enclosed in calyx.

Distr. *Malesia*: Malaya (N. E. Johore, E. Pahang). Ecol. Rare, between 250–700 m on ridges.

36. *Hopea montana* SYM. J. Mal. Br. R. As. Soc. 19, 2 (1941) 141, pl. 1A; Mal. For. Rec. 16 (1943) 133, f. 69; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 214.

Medium-sized tree. All known parts of mature tree glabrous. *Twig c.* 1 mm \varnothing apically, very slender, straight, blackish; stipule scars obscure. *Leaf bud* minute; *stipules* fugaceous. *Leaves* 6.5–9 by 2.2–4 cm, ovate-lanceolate, thinly coriaceous; base abruptly cuneate; acumen to 1 cm long, cuspidate; nervation subdryobalanoid; main nerves *c.* 14 pairs, arched, ascending, with many \pm shorter secondaries, elevated beneath, obscurely depressed above as also the midrib; tertiary nerves obscure; *petiole* 9–11 mm long, slender. *Flowers* unknown. *Panicle* to 2 cm long,

slender, hardly branched or unbranched. *Fruit pedicel* to 2 mm long, broadening into receptacle. 2 longer *calyx lobes* to 5 by 1.2 cm, spatulate, subacute, tapering to c. 2 mm broad above the to 5 by 3 mm elliptic saccate thickened base; 3 shorter lobes to 10 by 3 mm, ovate, frequently shortly winged apically. *Nut* to 7 by 5 mm, ovoid, the exposed apex surmounted by a truncate stylopodium and central apiculus.

Distr. *Malesia*: Malaya (Perak, Kelantan); Borneo (G. Kinabalu).

Ecol. Rare, hill slopes in upper dipterocarp forest, to 1200 m.

37. *Hopea vacciniifolia* RIDL. *ex* [BROWNE, For. Trees Sarawak & Brunei (1955) 122, *nomen*] ASHTON, Gard. Bull. Sing. 19 (1962) 258, pl. 3; Man. Dipt. Brun. (1964) 112, f. 12; *ibid.* Suppl. (1968) 57. — Fig. 70 C-C4.

Small tree. Young twig, leaf bud, stipule and petiole densely shortly pale grey-brown pubescent. *Twig* to 0.5 mm \varnothing apically, slender, much branched, horizontally, becoming smooth, glabrous. *Bud* minute. *Stipule* to 1.2 mm long, narrowly hastate, acute, fugaceous. *Leaves* 1–2.5 by 0.4–1.2 cm, chartaceous, elliptic to broadly ovate; base cuneate; apex obtuse or with to 1.5 mm long obtuse acumen in mature tree; nervation subdribaloid; main nerves c. 6 pairs, very indistinct with slender secondaries; tertiary nerves reticulate; midrib slender, applanate or slightly raised beneath, narrow and depressed above; *petiole* to 2 mm long, slender. *Panicle* to 1.3 cm long, to 2-axillary, short, terete, glabrous; irregularly singly branched, branchlets short, bearing to 3 flowers; *bracteoles* minute, deltoid, subsistent, glabrous. *Flower bud* small, ovoid, sessile. *Calyx* glabrous but for a fimbriate distal margin; 2 outer lobes ovate, acute; 2 inner lobes broadly suborbicular, obtuse, thinner. *Petals* oblong, obtuse, glabrous, strongly contorted, imbricate and forming a tube at base on opening, the distal half becoming abruptly rotate or recurved, dark wine-red. *Stamens* 10, subequal; filaments broad at base, abruptly narrowing and filiform distally; anthers subglobose, the interior cells somewhat the longer; appendage to connective slender, c. 2 times length of anther, reaching apex of stylopodium. *Ovary* and *stylopodium* cylindrical, truncate, glabrous but for the puberulent apical platform; style short, abrupt, glabrous. *Fruit calyx* glabrous; lobes subequal, to 4 by 3.5 mm, ovate, acute or obtuse, thickened, shallowly saccate. *Nut* to 8 by 6 mm, ovoid, glabrous; apex minutely truncate.

Distr. *Malesia*: Borneo (Brunei, N. E. Sarawak at Marudi).

Ecol. Locally abundant; Heath forest on giant podsols on raised beaches, and on sandstone cuestas.

Vern. *Mèrawan ribu*.

38. *Hopea bracteata* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 239; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 111; SYM. Gard. Bull. S. S. 10 (1939) 337; SLOOT. Reinwardtia 3 (1956) 317; ASHTON, Man. Dipt. Brun.

(1964) 97, f. 12; *ibid.* Suppl. (1968) 48; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 229; ASHTON, Gard. Bull. Sing. 31 (1978) 31. — *Balanocarpus curtisii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 131; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 158, t. 191; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 111; BURK. J. Str. Br. R. As. Soc. 81 (1920) 59, fig.; RIDL. Fl. Mal. Pen. 1 (1922) 246; SYM. Gard. Bull. S. S. 8 (1934) 27. — *Balanocarpus bracteatus* MERR. En. Born. (1921) 407; FOXW. Mal. For. Rec. 10 (1932) 142; BURK. Dict. (1935) 284. — *H. minima* SYM. Gard. Bull. S. S. 10 (1939) 337, pl. 11, *incl. var. penangiana* SYM. *et var. perakensis* SYM. l.c. 338; Mal. For. Rec. 16 (1943) 133, f. 69. — Fig. 70 A-A4.

Small, occasionally medium sized, tree. Twig, leaf bud, stipule and petiole shortly persistently grey-brown puberulent. *Twig* to 0.7 mm \varnothing apically, slender, terete, much branched, becoming smooth, glabrous. *Bud* to 2.5 mm long, lanceolate. *Stipule* to 3 mm long, linear, fugaceous. *Leaves* 2.5–6 by 0.7–2 cm, thin, narrowly ovate, base cuneate; acumen to 1.5 cm long; nerves c. 11 pairs, slender, hardly more distinct than secondaries, at 55°–65°, strongly curved; tertiary nerves slender, reticulate; midrib slender but raised beneath, narrow, depressed above; *petiole* 2–4 mm long, slender. *Panicle* to 9 cm long, terminal or axillary, very slender, lax, terete, glabrous; remotely irregularly singly or doubly branched, branchlets to 3 cm long, zigzag, bearing to 5 flowers; *bracteoles* to 1 mm long, deltoid, glabrous. *Bud* to 3 mm long, subglobose, distinctly pedicellate. *Calyx lobes* fimbriate, otherwise glabrous; outer lobes suborbicular, thin; inner lobes suborbicular, mucronate, thin. *Petals* oblong, acute, densely shortly tomentose on parts exposed in bud, dark red with pale tips. *Stamens* 15; filaments broad at base, tapering; anthers subglobose; appendage to connective c. 2 times length of anther, slender, joining abruptly with the distinctly broader connective and filament. *Ovary* and *stylopodium* glabrous, cylindrical, truncate, ovary only slightly the broader; style short, abrupt, glabrous. *Fruit* entirely glabrous. *Calyx lobes* to 5 by 5 mm, subequal, broadly ovate, obtuse, incrassate at base but for a chartaceous margin. *Nut* to 9 by 6 mm, ovoid; apex minutely truncate.

Distr. *Malesia*: Malaya (Penang, Perak), Borneo (Sarawak, Brunei, Sandakan, S.E. Borneo to Purukt-jau).

Ecol. Locally abundant on spurs and ridges below 650 m.

Vern. *Mèrawan ungu*, *damar mata kuching* (Mal.), *m. padi* (Brun.), *bangkirai* (S.E. Borneo).

Note. The rare *H. brachyptera* (FOXW.) SLOOT. of Zamboanga (Mindanao, Philippines) closely resembles *H. bracteata* though the leaf is somewhat larger. According to FOXWORTHY (Philip. J. Sc. 13, 1918, Bot. 195; *ibid.* 67, 1938, 285) the ovary differs in being densely pubescent. I have seen neither flowers nor fruit, which may all have been lost in the destruction of the Manila Herbarium in 1945.

39. *Hopea brachyptera* (FOXW.) SLOOT. Reinwardtia 3

(1956) 317. — *Balanocarpus brachypterus* FOXW. Philip. J. Sc. 13 (1918) Bot. 195; *ibid.* 67 (1938) 285; MERR. En. Philip. 3 (1923) 101; SYM. Gard. Bull. S.S. 8 (1934) 27, 28.

Medium-sized tree. Leaf buds, twigs and petiole, midrib above and outside of calyx sparsely \pm caducous puberulent; petals outside, ovary and domatia densely persistently pubescent. Twigs c. 1 mm \varnothing apically, terete, dark brown, \pm rugose. Leaves 3.5–7 by 2.3–3.5 cm, ovate-lanceolate, chartaceous; base unequal, cuneate; acumen to 12 mm long, slender, subcaudate; nerves 9–11 pairs, slender but prominent beneath, obscure and adpressed above, arched; secondary nerves many but very short; both \pm continuously furnished with pubescent domatia; tertiary nerves subscalariform, distinct but hardly elevated; petioles 3–5 mm long, very slender. Flowers to 3

mm long, dull, violet. Sepals ovate, acute. Stamens 15; filaments filiform, slightly expanded at base; appendages aristate, considerably longer than oblong anthers. Ovary and stylopodium cylindrical, truncate, with short style. Fruit calyx lobes short, subequal, ovate, adpressed to and hiding the 10 by 9 mm nut except at apex.

Distr. *Malesia*: Philippines (Zamboanga, Mindanao).

Ecol. Rare, lowland forests.

Vern. *Babase* (Sub.).

Note. The flower and fruit description are taken from FOXWORTHY; both material seems to have been completely destroyed during the burning of the Philippine herbarium. See the note under the preceding species *H. bracteata*.

2. Section Hopea

ASHTON, Gard. Bull. Sing. 20 (1963) 258; Man. Dipt. Brun. (1964) 91; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 25, 26. — *Hopea sect. Euhopea* MIQ. Sum. (1862) 192, as subgenus, 489, as section; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 237, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 3 (1895) 57; FOXW. Philip. J. Sc. 6 (1911) Bot. 260; Mal. For. Rec. 10 (1932) 118. — *Hopea, Euhopea* group SYM. Gard. Bull. S. S. 8 (1934) 72; Mal. For. Rec. 16 (1943) 108. — Fig. 72, 74.

Nervation scalariform; panicles irregularly branched, many flowered, flowers pale; bark surface smooth or evenly flaky. Wood with markedly heterogeneous rays; without chambered parenchyma strands (excepting *H. pachycarpa*).

2a. Subsection Hopea

Neisandra RAFIN. — *Petalandra* HASSK. — *Balanocarpus* BEDD. — *Dioticarpus* DUNN. — *Hopea sect. Petalandra* HEIM, Rech. Dipt. (1892) 63; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 65; FOXW. Philip. J. Sc. 6 (1911) Bot. 264; Mal. For. Rec. 10 (1932) 130. — *Balanocarpus sect. Pachynocarpoides* HEIM, Rech. Dipt. (1892) 75 *et sect. Microcarpae* HEIM, *l.c.* 76. — Fig. 72.

Panicles generally tomentose, rarely fascicled; ovary and stylopodium \pm ovoid, or, if elongate, without median constriction; style evident. Large, less often small, trees, usually with flaky bark and buttresses, but rarely stilt-rooted.

Distr. Throughout the range of the genus.

40. *Hopea celtidifolia* KOSTERM. Gard. Bull. Sing. 22 (1968) 443; ASHTON, Gard. Bull. Sing. 31 (1978) 32.

Medium-sized scaly barked buttressed tree. Young twigs, leaf buds and stipules densely \pm persistently tawny puberulent, petioles caducously so. Twig c. 1 mm \varnothing apically, much branched; internodes short. Buds small, ovoid, subacute; stipules small, fugaceous. Leaves 5–10 by 3–4.5 cm, elliptic to lanceolate, coriaceous, margin subrevolute; base obtuse to

broadly cuneate; acumen to 8 mm long, slender; nerves 4–5 pairs, frequently all arising from the proximal $\frac{1}{2}$ of the leaf, arched and coalescing midway to the margin forming an almost unlooped continuous prominent intramarginal nerve continuing to the acumen, the whole slender but prominent beneath, distinctly elevated above; intramarginal nerve with indistinct lateral branches to the margin; tertiary nerves scalariform, evident beneath; midrib stout,

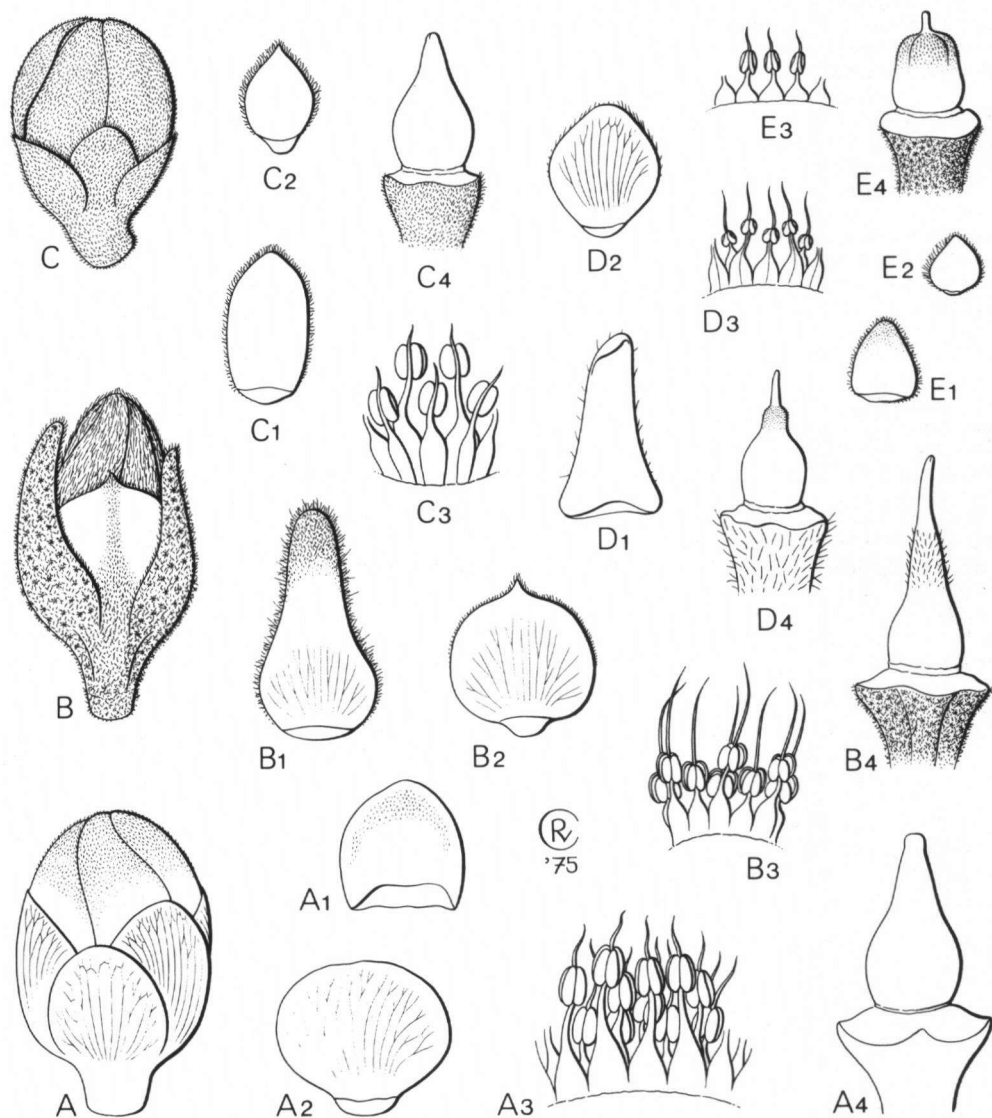


Fig. 72. Flower details in *Hopea* sect. *Hopea* subsect. *Hopea*. All $\times 10$. Sepals drawn from inside. — *H. plagata* (BLCO) VIDAL. A. Bud, A1. outer sepal, A2. inner sepal, A3. stamens from inside, A4. pistil. — *H. forbesii* (BRANDIS) SLOOT. B. Bud, B1. outer sepal, B2. inner sepal, B3. stamens from inside, B4. pistil. — *H. ferrea* LANESS. C. bud, C1. outer sepal, C2. inner sepal, C3. stamens from outside, C4. pistil. — *H. centipeda* ASHTON. D1. Outer sepal, D2. inner sepal, D3. stamens from inside, D4. pistil. — *H. sangal* KORTH. E1. Outer sepal, E2. inner sepal, E3. stamens from inside, E4. pistil (A PNH 78168, B CARR 12072, C1–C2 PHENG-NAREN, C, C3–C4 PUT 4307, D S 23342, E KEP 76619).

prominent beneath, elevated above; *petiole* 8–10 mm long, slender. *Panicle* unknown; *flowers* unknown. *Fruit* pedicel c. 2 mm long, stout; 2 longer *calyx lobes* to 5 by 1 cm, spatulate, obtuse, c. 2 mm broad above the to 6 by 3 mm narrowly ovate saccate thickened base; 3 shorter lobes to 5 by 4 mm, ovate, obtuse to acute, similarly saccate. *Nut* to 15 by 6 cm, narrowly ovoid, the stylopodium showing as a prominent medially thickened apiculus.

Distr. *Malesia*: W. New Guinea (R. Digoel, Muku Subdistr.); S. New Guinea; Strickland R., E. New Guinea.

Ecol. Local in lowland forest.

Vern. *Et, teh, keilmoen, katiaw, jeruieh.*

41. *Hopea dasyrrhachis* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1941) 130, f. 18; ASHTON, Gard. Bull. Sing. 31 (1978) 32. — *Isoptera dasyrrhachis* SLOOT. ex DEN BERGER & ENDERT, Med. Proefst. Boschw. 9 (1925) 117, *nomen*. — *Shorea dasyrrhachis* SLOOT. ex ENDERT, Tectona 28 (1935) 282, 295, *nomen*.

Large, dark flaky-barked tree. Twig apices, ovary apex and calyx caducous buff puberulent, panicles and parts of corolla exposed in bud persistently densely so. *Twig* c. 2 mm ϕ , terete; stipule scars short, obscure. *Bud* 1 by 1 mm, minute. *Stipule* fugaceous. *Leaves* 7–15 by 2.5–8 cm, ovate-falcate, somewhat coriaceous, base cuneate; acumen to 1.5 cm long; nerves 12–14 pairs, slender, arched, at 50°–60°; typically with prominent glabrous pore-like axillary domatia; tertiary nerves slender, scalariform; midrib raised on both surfaces; *petiole* 5–15 mm long. *Panicle* to 8.5 cm long, terete, singly branched, branchlets bearing to 10 secund flowers. *Flower bud* to 2 mm long, ovoid. 3 outer *calyx lobes* ovate, subacute, 2 inner suborbicular, villous on parts exposed in bud. *Petals* pubescent on parts exposed in bud, cream. *Stamens* 10, in a single verticil; filaments compressed at base, tapering abruptly medially, filiform at the base of the oblong anthers; appendage to connective filiform, as long as anther. *Ovary* and *stylopodium* subcylindrical, sericeous in the distal half, terminating in a short truncate style. *Fruit pedicel* to 3 mm long, slender. 2 longer fruit *calyx lobes* to 4 by 3.5 cm, suborbicular, chartaceous, frequently subauriculate with to 4 by 3 mm small thickened area at base; 3 shorter lobes to 6 by 7 mm, suborbicular, saccate. *Nut* to 15 by 15 mm, ovoid, shortly apiculate.

Distr. *Malesia*: Borneo (Kapuas valley, Lower Dyak, C. Dusun, Marabahan).

Ecol. On river banks in W. and S. Borneo.

Vern. *Damar puteh* (S. Borneo), *tékam, t. lampung, t. rayap, t. ayèr* (W. Borneo).

42. *Hopea similis* SLOOT. Reinwardtia 2 (1952) 30; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 41.

Medium-sized, buttressed tree with flaky bark. Leaf buds, twigs, petioles and panicles \pm persistently somewhat scabrid buff pubescent, parts of petals exposed in bud evenly so; calyx and leaf nervation

below caducously so, glabrescent. *Twig* c. 2 mm ϕ apically, stout, rugose, becoming ribbed; stipule scars distinct, short, \pm horizontal. *Bud* small, ovoid; *stipules* unknown, caducous. *Leaves* 10–22 by 3.5–8 cm, elliptic-oblong to lanceolate, coriaceous; margin revolute (less so in young trees); base obtuse to subcordate; acumen to 8 mm long, short, broad; nerves 12–16 pairs, prominent beneath, evident and elevated above; *petiole* 11–14 mm long, c. 2 mm ϕ , rather stout. *Panicle* to 6 cm long, axillary to ramiflorous, slender, to 2-axillary; singly branched, branchlets to 1.5 cm long, bearing up to 6 flowers. *Flower buds* to 4 by 2 mm, lanceolate; 2 outer *sepals* broadly lanceolate-acuminate, 3 inner suborbicular, obtuse, fimbriate. *Stamens* 15, in 3 subequal verticils; filaments broad and compressed at base, tapering and filiform beneath the subglobose anthers; appendages 2½–3 times length of anther, slender. *Ovary* and *stylopodium* narrowly pyriform, slightly constricted medially; stylopodium punctate distally, surmounted by a short columnar style. *Fruit pedicel* to 3 mm long, stout. 2 longer *calyx lobes* to 7.5 by 1.5 cm, obtuse, c. 2 mm wide above the to 8 by 4 mm narrowly ovate prominently saccate thickened base; 3 shorter lobes to 8 by 6 mm, ovate, mucronate or obtuse, similarly saccate; *nut* to 15 by 7 mm, narrowly ovoid, tapering, prominently slender-apiculate.

Distr. *Malesia*: *New Guinea* (Rouffaer river, W. Irian; Milne Bay Distr., Woitaki, Paiawa, and Northern Distr. Papua).

Ecol. Local, especially on ridges, in lowland (including *Anisoptera* and oak *Castanopsis*) forests; also recorded from freshwater swamp.

Vern. *Lomas* (Waigani), *koperitoma* (Upper Waria).

43. *Hopea forbesii* (BRANDIS) SLOOT. Reinwardtia 5 (1961) 477; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 34. — *Shorea forbesii* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 92; BAKER f. J. Bot. 61, Suppl. (1923) 5; SLOOT. Reinwardtia (1952) 61, f. 20. — Fig. 72 B-B4.

Tall, flaky-barked, hard-wooded tree. Young parts densely buff pubescent, leaf buds, stipules, twig apices, petioles, and parts of corolla expanded in bud persistently so, becoming sparse on leaf undersurface and calyx, caducous elsewhere. *Twig* c. 1 mm ϕ apically, becoming smooth, terete; internodes short, branchlets hence densely leaved. *Buds* minute, ovoid; *stipules* to 4 by 1 mm, linear-lanceolate, caducous. *Leaves* 5.5–11 (to 13 in young trees) by 1.8–4 cm, lanceolate, thinly coriaceous; margin subrevolute; base obtuse, \pm equal; acumen to 13 mm, slender; nerves (11–)13 to 15 pairs, dense, slender but prominent beneath, \pm obscure and depressed above as also the midrib, without domatia; tertiary nerves scalariform, \pm evident but unraised beneath; *petiole* 5–8 mm long. *Panicle* to 3.5 cm long, slender, to 2-axillary, singly branched; branchlets to 12 mm long, bearing to 5 secund flowers; *bracteoles* to 2 mm long, deltoid, not at first caducous. *Flower bud* to 3 by 2 mm, lanceolate.

2 outer *sepals* narrowly deltoid-acuminate, 3 inner suborbicular, mucronate. *Stamens* (15-)16-19, shorter than style; filaments long, compressed but slender, tapering to the oblong anthers; appendages c. 3 times length of anthers, slender. *Ovary* small, tapering into a somewhat longer stoutly columnar stylopodium tapering into short style. *Fruit pedicel* short, stout. 2 longer *calyx lobes* to 6.5 by 1.0 cm, spatulate, obtuse, c. 2 mm broad above the to 8 by 6 mm ovate saccate thickened base; 3 shorter lobes 12 by 8 mm, ovate, similarly saccate, mucronate, shorter than the nut; or one sometimes to 23 mm long, spatulate. *Nut* to 18 by 8 mm, narrowly ovoid, resinous, tapering, prominently apiculate.

Distr. *Malesia*: East New Guinea (Central and Milne Bay Distr.).

Ecol. Locally common in lowland seasonal semi-evergreen forest, sometimes dominant, especially on ridges, below 1000 m.

Vern. *Tatami, uwami, yala yala, emi sapu, walei*.

44. *Hopea helferi* (DYER) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 62; Ind. Trees (1906) 67; FISCHER, Kew Bull. (1927) 206; Sym. Gard. Bull. S. S. 8 (1934) 22; *ibid.* 8 (1935) 274; Mal. For. Rec. 16 (1943) 128, f. 69, 72, pl. 20; SMITINAND, Thai For. Bull. 1 (1954) 18. — *Vatica helferi* DYER, Fl. Br. Ind. 1 (1874) 302. — *Shorea helferi* KURZ, Fl. Burma 1 (1877) 119. — *H. dealbata* HANCE, J. Bot. 15 (1877) 329; LANESSAN, Pl. Util. Colon. Fr. 1 (1886) 300; PIERRE, For. Fl. Coch. 4 (1891) t. 246; HEIM, Rech. Dipt. (1892) 61; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 62; GUÉRIN, Fl. Gén. 1-C. 1 (1910) 374, fig.; LECOMTE, Bois Indochine (1926) 110; FOXW. Mal. For. Rec. 10 (1932) 128; BURK. Dict. (1935) 1189.

Large dark flaky-barked tree with hard wood. Twig apices, buds, petiole, leaf nervation beneath, stipules, panicles and perianth outside densely buff puberulent, ± caducous on twigs, leaf beneath, and calyx. *Twig* c. 3 mm \varnothing apically, blackish, becoming ribbed along the leaf traces; stipule scars obscure. *Bud* to 3 by 2 mm, ovoid, acute; *stipules* to 9 mm long, linear, caducous. *Leaves* (5-)10-24 by (2-)4.5-8 cm, oblong-lanceolate or occasionally oblanceolate, coriaceous, silvery lepidote beneath; base cuneate to occasionally cordate (especially sucker-shoots and young trees), subequal; apex shortly broadly acuminate or obtuse; nerves (12-)14-16 pairs, ascending, rather straight, slender but prominent beneath, obscure above; tertiary nerves densely scalariform, evident beneath; midrib prominent beneath, evident but shallowly channelled above; *petiole* (5-)7-11 mm, c. 3 mm \varnothing , stout. *Panicle* to 11 cm long, terminal or subterminal axillary, becoming lax; twice-branched, with to 2 cm long branchlets bearing to 10 \pm secund cream flowers. *Flower bud* to 3 by 2 mm, lanceolate. Outer 2 *sepals* lanceolate, subacute; inner 3 shorter, ovate, subacuminate. *Stamens* 15; filaments broadly compressed at base, tapering and filiform distally; appendages slender, c. $1\frac{1}{2}$ \times length of the narrowly ellipsoid anthers. *Ovary* and *stylopodium* cylindrical, subtruncate, equal in

height but the ovary the broader; style shorter than either, columnar. *Fruit pedicel* to 2 mm long, slender. 2 longer fruit *calyx lobes* to 6.5 by 1.8 cm, spatulate, obtuse, c. 4 mm wide above the c. 5 by 3 mm small elliptic saccate base; 3 shorter lobes to 5 by 3 mm, ovate (occasionally to 18 mm long and distally lorate). *Nut* to 10 by 7 mm, ovoid-apiculate.

Distr. Andamans, Burma, Thailand, Cambodia, and in *Malesia*: Malaya (Langkawi, S. Kedah, Upper Perak).

Ecol. Deep soils, especially on sedimentary rocks on hill slopes and undulating land in semi-evergreen forest.

Uses. A valuable construction timber.

Vern. *Lintah bukit* (Langkawi), *damar mata kuching, d. siput* (Perak).

45. *Hopea aptera* ASHTON, Gard. Bull. Sing. 31 (1978) 32.

Small, smooth, barked stilt-rooted tree. Twigs, petioles and panicles \pm persistently greyish sericeous, outside of calyx and leaf nervation below caducously so, parts of petals exposed in bud densely pubescent. *Twig* c. 2 mm \varnothing apically, becoming terete, \pm rugulose. *Buds* minute, ovoid; *stipules* fugaceous, not seen. *Leaves* 10.5-25 by 4-8 cm, oblong-lanceolate, coriaceous; margin subrevolute, base obtuse or shallowly cordate; acuminate to 3 cm long, prominent, slender; nerves 15-21 pairs, slender but prominent beneath, \pm obscurely depressed above, arched towards the margin, at 55°-70°, without secondaries; tertiary nerves scalariform, very slender but elevated beneath; midrib prominent beneath, elevated above; *petiole* 8-12 mm long. *Panicle* to 7 cm long, 1-axillary to ramiflorous, lax, slender; singly branched, branchlets to 1.5 cm long, bearing to 3 secund flowers. *Flower buds* to 5 by 3 mm, ellipsoid, rather long. *Sepals* subequal, suborbicular, pubescent, fimbriate, patent. *Stamens* 15, in 3 unequal verticils; filaments compressed and broad at base, tapering and filiform in the distal $\frac{1}{2}$; anthers small, subglobose; appendage c. $3\frac{1}{2}$ times length of anthers, very long and slender. *Ovary* and *stylopodium* narrowly hour-glass shaped, with short but distinct columnar style. *Fruit pedicel* very short. *Calyx lobes* to 8 by 6 mm, subequal, ovate, acute, saccate, \pm thinly incrassate. *Nut* to 10 by 6 mm, ovoid, crowned by a prominent medially swollen stylopodium.

Distr. *Malesia*: N.W. New Guinea (Vogelkop Peninsula).

Ecol. Locally common, primary and secondary forest below 300 m, clay soil including limestone.

Vern. *Gamur* (Maibrat).

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

46. *Hopea ultima* ASHTON, Gard. Bull. Sing. 31 (1978) 33.

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

Distr. *Malesia*: E. New Guinea (Milne Bay area, Normanby I.).

47. *Hopea novoguineensis* SLOOT. Nova Guinea 14 (1924) 224, t. 19; Reinwardtia 2 (1952) 31; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 38. — *H. celebica* (non BURCK) DIELS, Bot. Jahrb. 57 (1922) 462.

Medium-sized, flaky-barked tree with tall buttresses. Parts of petals exposed in bud, panicles, bracts and stipules densely persistently buff pubescent; calyx, twigs and petiole caducously so. *Twig* c. 2 mm \varnothing apically, becoming smooth, terete, blackish. Buds minute, ovoid; stipules to 4 by 2 mm, lanceolate, acute, caducous. *Leaves* 10–28 by 3.5–10 cm, variable in size and shape, chartaceous, undersurface pale and dull, margin \pm revolute; base \pm prominently unequal, cuneate abaxially, the adaxial side cuneate to deeply cordate; acumen to 1 cm long, slender; nerves (11)–14–16 pairs, slender but prominent beneath, narrowly elevated above, arched, at 50°–65°, usually with \pm prominent glabrous porous canaliculate domatia; tertiary nerves densely scalariform, slender, evident beneath; *petiole* 9–15 mm long. *Panicle* to 9 cm long, to 3-axillary or terminal, singly branched; branchlets to 2.5 cm long, bearing to 4 flowers; *bracteoles* to 2 by 2 mm, ovate, acute. *Flower buds* to 3 by 2 mm, ovoid. *Sepals* subequal, broadly ovate, acute. *Stamens* 15, shorter than style, in 3 subequal verticils; filaments compressed and broad at base, tapering to the subglobose anthers; appendages \pm equal to length of anthers, slender. *Ovary* small, tapering into a distinct equally long subcylindrical stylopodium and short style. *Fruit pedicel* to 3 mm long, stout. 2 longer *calyx lobes* to 8 by 2 cm, spatulate, obtuse, c. 5 mm broad above the to 5 by 4 mm ovate saccate thickened base; 3 shorter lobes to 7 by 4 mm, ovate, acuminate, shorter than nut. *Nut* to 17 by 8 mm, narrowly ovoid, tapering, prominently apiculate.

Distr. *Malesia*: New Guinea (Sorong Distr., and Munju Subdiv., South New Guinea, W. Irian; Western Distr. T.P.N.G.), Moluccas (Halmahera).

Ecol. Common in lowland forest.

Vern. *Puwokigih*, *woigik*, *wokidjih* (Mooi), *arid* (Mandobo), *kielmun* (Muju), *tanjung* (Halmahera).

Note. Very variable, especially in the depth of the cordate leaf base and in the lustrousness of the laminar surface; it is possible that further collections will show there to be more than one species.

48. *Hopea scabra* ASHTON, Gard. Bull. Sing. 31 (1978) 33, non BUCH.-HAM. Mem. Wern. Soc. 6 (1832) 300, *nom. inval.*, in *syn.*

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

Distr. *Malesia*: W. New Guinea (Hollandia Div., Madang).

Ecol. Clay soils on undulating land, locally frequent.

49. *Hopea papuana* DIELS, Bot. Jahrb. 57 (1922) 461; SLOOT. Reinwardtia 2 (1952) 33, f. 11; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 40.

Medium-sized tree with dark flaky bark. Twigs, petioles, leaf buds and stipules persistently rufous scabrid tomentose; nerves below and midrib on both surfaces thus at first, \pm glabrescent. *Twigs* c. 3 mm \varnothing apically, stout, \pm persistently ribbed, pale brown; stipule scars prominent, descending. *Buds* to 2 by 2 mm, ellipsoid, obtuse; *stipules* to 12 by 5 mm, lanceolate, subsistent. *Leaves* 11–28 by 4.2–10 cm, large, oblong, coriaceous; base \pm unequal, cordate; acumen to 2.5 cm long, tapering; nerves 16–24 pairs,

arched towards the margin, at 70°–80°, slender but prominent beneath, applanate above, without domatia or secondaries; tertiary nerves scalariform, barely evident beneath; midrib prominent beneath, elevated above; *petiole* 5–7 mm long, stout. *Complete panicle* unknown, short, 1-axillary, glabrous. *Flowers* unknown. *Fruit pedicel* short, stout. 2 longer *calyx lobes* to 5.5 by 1.8 cm, broadly spatulate, obtuse, *c.* 2 mm broad above the to 6 by 5 mm ovate saccate thickened base; 3 shorter lobes to 9 by 6 mm, ovate, subacute, similarly saccate. *Nut* to 16 by 9 mm, narrowly ovoid, tapering to a prominent stout apiculate stylopodium.

Distr. *Malesia*: New Guinea (Hollandia Div.; R. Digul, Muju, in S. New Guinea; Idenburg R.; Papua New Guinea: Central Distr., Amau hinterland, and Western Highlands).

Ecol. Locally abundant; alluvium, low hills, river banks (W. Irian); once on ridges with *Araucaria klinkii* in Papua New Guinea.

Vern. *Gointa* (Western Highlands), *riheu* (Nemo), *pasang kesereep* (Djair), *keilmun*, *ogerie* (Muju), *linak-iong* (Manikiong), *matre* (Berak).

50. *Hopea acuminata* MERR. Philip. Gov. Lab. Bur. Bull. 29 (1905) 30; Philip. J. Sc. 1 (1906) Suppl. 98; En. Philip. 3 (1923) 93; WHITFORD, Philip. J. Sc. 4 (1910) Bot. 703; Bull. Bur. For. Philip. 10 (1911) 75; FOXW. Philip. J. Sc. 2 (1907) Bot. 389; *ibid.* 4 (1909) Bot. 514; *ibid.* 6 (1911) Bot. 264; *ibid.* 13 (1918) Bot. 183; REYES, Philip. J. Sc. 22 (1923) 339; SYM. Gard. Bull. S. S. 8 (1934) 22; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 47, f. 9, pl. 5. — *H. maquilingsensis* FOXW. Philip. J. Sc. 13 (1918) Bot. 184. — Fig. 64a.

Medium-sized tree with flaky bark. Young parts fugaceous puberulent, panicle persistently so or glabrous, domatia and parts of petals exposed in bud persistently so. *Twig* *c.* 1 mm \varnothing apically, slender, much branched, terete, rugulose, dark brown. *Buds* minute; stipules fugaceous, not seen. *Leaves* 4.5–12 by 2–4.5 cm, elliptic-falcate to ovate-lanceolate, thinly coriaceous; base unequal, cuneate; acumen to 1 cm long, slender, tapering; nerves 9–11 pairs, slender but prominent beneath, \pm applanate above, arched, at 45°–65°, with (young trees) or without small axillary pubescent domatia; tertiary nerves densely scalariform, very slender, barely elevated beneath; *petiole* 6–8 mm long. *Panicle* to 3.5 cm long, slender, terminal or to 2-axillary, singly branched; branchlets bearing to 4 cream flowers; bracteoles fugaceous. *Flower buds* to 3 by 2 mm, ellipsoid. 2 outer *sepals* lanceolate-acuminate; 3 inner-*sepals* suborbicular, mucronate. *Stamens* 10, equal; filaments compressed, tapering, rather broad; appendages aristate, $1\frac{1}{2}$ times as long as the oblong anthers. *Ovary* and *stylopodium* broadly cylindrical, truncate, slightly tapering, densely puberulent; style shorter than ovary but prominent. *Fruit pedicel* *c.* 2 mm long, slender. 2 longer *calyx lobes* to 5.5 by 1 cm, spatulate, obtuse, *c.* 2 mm broad above the to 4 by 4 mm elliptic saccate thickened base; 3 shorter lobes to 3 by 2 mm, elliptic, similarly saccate.

Nut to 6 by 6 mm, broadly ovoid, with minute slender apical style remnant.

Distr. *Malesia*: Philippines.

Ecol. Widespread and common in semi-evergreen and evergreen forests, especially at 300–800 m but down to 100 m.

Vern. *Baniakau* (Ibn.), *barosingsing* (Ilk.), *daling-ding* (Tag.), *dalingdingan* (Tag., S.L.Bis.), *kalar* (Ilk.), *manggachapui* (official and general name), *mangga-chinoro* (Tag.), *siayu* (S.L.Bis.), *yakal* (Tag.).

Note. Allied to the widespread *H. sangal* which it replaces in the Philippines.

51. *Hopea depressinerva* ASHTON, Gard. Bull. Sing. 22 (1967) 275, pl. 20; Man. Dipt. Brun. Suppl. (1968) 50, f. 7.

Medium-sized tree with slightly cracked bark. Young parts glabrescent. *Twig* 1–2 mm \varnothing apically, terete, smooth; stipule scars short, obscure. *Bud* to 1 by 1 mm, minute. *Stipule* unknown. *Leaves* 5–13 by 2–5 cm, lanceolate to narrowly elliptic, coriaceous, base cuneate; acumen to 1.5 cm long, slender; nerves 6–8 pairs, slender but raised beneath, depressed above, at 40°–50°; tertiary nerves slender, densely scalariform; midrib prominently terete beneath, slender, somewhat depressed, above; *petiole* 11–13 mm long, terete. *Panicle* to 7 cm long, terete, terminal or axillary, densely persistently buff pubescent; singly branched, branchlets to 1.5 cm long, bearing to 5 second flowers; bracteoles fugaceous, unknown. *Flower bud* to 3 by 2 mm, ellipsoid. *Calyx* densely buff sericeous, lobes ovate, acute, the outer 2 somewhat longer, relatively narrower, than the inner 3. *Petals* elliptic, obtuse, densely pubescent on parts exposed in bud, pink outside, pale orange within. *Stamens* 10, equal, forming a ring round the ovary; filaments broad, compressed at base, tapering and filiform below the subglobose anthers; appendages to connectives *c.* 2 times length of anthers, filiform, slender. *Ovary* and *stylopodium* glabrous, cylindrical, truncate, surmounted by a short style. *Mature fruit* unknown; *calyx lobes* unequal, the 2 longer aliform, considerably larger than the other 3.

Distr. *Malesia*: Borneo (W. Sarawak).

Ecol. Rare, granodiorite hill slopes below 500 m.

52. *Hopea sangal* KORTH. Kruidk. (1841) 75; WALP. Rep. 5 (1845) 128; Ann. 4 (1857) 339; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 34; MIQ. Fl. Ind. Bat. 1, 2 (1859) 504; DC. Prod. 16, 2 (1868) 635; SLOOT. ex HEYNE, Nutt. Pl. ed. 2 (1927) 1111; SYM. Gard. Bull. S. S. 8 (1934) 18, pl. 5; Mal. For. Rec. 16 (1943) 141, f. 68C, 69, 77; BROWNE, For. Trees Sarawak & Brunei (1955) 121; BACKER & BAKH. f. Fl. Java 1 (1963) 331; ASHTON, Gard. Bull. Sing. 20 (1963) 260; Man. Dipt. Brun. (1964) 108, f. 12, pl. 25 (bark); *ibid.* Suppl. (1968) 56; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 56, pl. 21b (stem), f. 31. — *Dryobalanops sericea* KORTH. Kruidk. (1841) 72; DC. Prod. 16, 2 (1868) 606; WALP. Rep. 5 (1845) 125. — *H. sericea* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 35; WALP. Ann. 4 (1857) 339;

MIQ. Fl. Ind. Bat. 1, 2 (1859) 504; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 85; DC. Prod. 16, 2 (1868) 635; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 238; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64; MERR. En. Born. (1921) 403. — *Petalandra micrantha* HASSK. Hort. Bog. Desc. (1852) 105; MIQ. Fl. Ind. Bat. 1, 2 (1859) 505; DC. Prod. 16, 2 (1868) 636; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 126. — *H. fagifolia* MIQ. Sum. (1862) 490; DC. Prod. 16, 2 (1868) 635; WALP. Ann. 7 (1868) 379; SCHEFF. Nat. Tijd. N. I. 31 (1870) 351; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 65; BOERL. Cat. Hort. Bog. 2 (1899) 103; K. & V. Bijdr. 5 (1900) 124; MOLL & JANSSONIUS, Mikogr. Holz. (1906) 369; HEYNE, Nutt. Pl. 1, 3 (1917) 290; ed. 2 (1927) 1111; SYM. Gard. Bull. S. S. 7 (1933) 151, 154. — *H. diversifolia* (non MIQ.) SCHEFF. Nat. Tijd. N. I. 31 (1870) 351; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 239; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64; FOXW. Mal. For. Rec. 10 (1932) 123. — *H. odorata* (non ROXB.) HANCE, J. Bot. 5 (1876) 308, et auct. (1876–1927) *p.p. quoad syn. H. sangal.* — *Doona odorata* (ROXB.) BURCK, Ann. Jard. Bot. Btzg 6 (1887) 233, *p. min. p., quoad syn. H. sangal.* — *Doona micrantha* BURCK, l.c. 234. — *Doona javanica* BURCK, l.c. 235, t. 29, f. 7. — *Dryobalanops neglectus* KORTH. ex BURCK, l.c. 243, *nomen pro syn.* — *H. micrantha* [non (HASSK.) HOOK. f.] HEIM, Rech. Dipt. (1892) 64. — *H. hasskarliana* HEIM, l.c. 64. — *H. javanica* HEIM, l.c. 64; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64. — *H. curtisii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 124; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 65; BRÜHL & KING, Ann. Bot. Gard. Calc. 5, 2 (1896) 155, t. 187; BURK. J. Str. Br. R. As. Soc. 81 (1920) 66, fig.; RIDL. Fl. Mal. Pen. 1 (1922) 212, 236, fig.; FOXW. Mal. For. Rec. 10 (1932) 130; BURK. Dict. (1935) 1189. — *H. globosa* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 61; RIDL. J. Str. Br. R. As. Soc. 54 (1910) 26; Fl. Mal. Pen. 1 (1922) 236; HEYNE, Nutt. Pl. ed. 2 (1927) 1104; FOXW. Mal. For. Rec. 10 (1932) 121; BURK. Dict. (1935) 1190. — *H. lowii* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 63; RIDL. J. Str. Br. R. As. Soc. 73 (1916) 143; Fl. Mal. Pen. 1 (1922) 237; MERR. En. Born. (1921) 402; FOXW. Mal. For. Rec. 10 (1932) 123. — *H. minutiflora* C.E.C. FISCHER, Kew Bull. 1 (1927) 207; SMITINAND, Nat. Hist. Bull. Siam Soc. 19 (1958) 74. — *H. multiflora* (non BRANDIS) FOXW. Mal. For. Rec. 10 (1932) 110, *p.p.* — *H. albescens* (non RIDL.) FOXW. Mal. For. Rec. 10 (1932) 122. — Fig. 15, 72 E1-E4.

Medium-sized to large, dark flaky-barked, buttressed tree with prominent opaque white resin exudates on bole. Young twig, leaf bud, stipule, petiole, leaf undersurface, midrib above and panicle ± sparsely pale grey-brown pubescent, leaf sometimes glabrescent. *Twig* to 1 mm \varnothing apically, slender, much branched, smooth. *Bud* to 2 mm long, ovoid. *Stipule* to 3 mm long, linear, fugaceous. *Leaves* 5.5–10 by 3.5–5 cm, ovate, thin, base ± broadly cuneate; acumen to 1.2 cm long, caudate; nerves 10–12 pairs, slender, prominent beneath, slightly curved, at 50°–60°, with or without tomentose axillary domatia;

tertiary nerves very slender, scalariform, indistinct, oblique to nerves; midrib slender, prominent beneath, ± applanate above; *petiole* 0.5–1 cm long. *Panicle* to 7 cm long, terminal or axillary, lax, terete; singly or doubly branched, branchlets bearing to 8 second flowers; *bracteoles* to 1 mm long, small, deltoid, buff pubescent. *Flower buds* very small, ellipsoid-ovoid. *Calyx* densely pubescent on both surfaces; 2 outer lobes deltoid, subacute, 3 inner lobes suborbiculate, obtuse. *Petals* oblong-lanceolate, densely tomentose on parts exposed in bud, cream. *Stamens* 10; filaments slender, tapering; anthers oblong; appendage as long as anther, slender. *Ovary* and *stylopodium* short, broadly cylindrical, truncate, broader towards base, puberulent at apex; style $\frac{1}{2}$ length of ovary and stylopodium, filiform, glabrous. *Fruit calyx* glabrescent; 2 longer lobes to 7 by 1.5 cm, oblong-spatulate, obtuse, tapering to 4 mm broad above the 5 by 4 mm somewhat saccate thickened base; 3 shorter lobes to 7 by 4 mm, obtuse. *Nut* to 7 by 4 mm, ovoid, persistently subtruncate at the short style remnant, sparsely pubescent.

Distr. Peninsular Thailand, and in *Malesia*: Malaya, Sumatra, Banka, Billiton, W. Java (rare), Lesser Sunda Is. (Bali, rare), Borneo.

Ecol. Locally common on clay rich soils on river banks; scattered on fertile clay hillsides to 500 m.

Vern. *Mèrsiput, chengal pasir, c. mata kuching, damar siput, mèrawan hitam* (Mal.), *gagil* (Sabah), *m. tëlör, m. batu, tongon banwah, chêngal, c. hitam, c. bunga, damar bintang, d. gëndiran, timbalun* (Sumatra), *awang awang, d. lampung, d. item, d. puteh, d. kunyit, lampong gunung, lantang arong, tèkam, t. paya* (Borneo).

53. *Hopea ferrea* LANESS. Pl. Util. Colon. Fr. 1 (1886) 300; PIERRE, For. Fl. Coch. 4 (1891) t. 249; HEIM, Rech. Dipt. (1892) 62; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1894) 262; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 61; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 371, 377, fig.; FOXW. Mal. For. Rec. 10 (1932) 126; BURK. Dict. (1935) 1189; SYM. Mal. For. Rec. 16 (1943) 124, f. 68H, 69. — *Balanocarpus anomalus* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 132; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 109; RIDL. Fl. Mal. Pen. 1 (1922) 247. — *H. anomala* FOXW. J. Mal. Br. R. As. Soc. 5 (1927) 340; Mal. For. Rec. 10 (1932) 126. — Fig. 72 C-C4.

Small, occasionally stout and large, shaggy-barked trees, often twisted and gnarled. Panicle and outside of petals and sepals densely buff puberulent, otherwise glabrous. *Twig* c. 1 mm \varnothing , slender, slightly zig-zag, drying dark brown, minutely rugulose; stipule scars obscure. *Leaf bud* minute; *stipules* fugaceous. *Leaves* 4–10 by 2–5.5 cm, ovate; base ± broadly cuneate or rarely obtuse; acumen to 2 cm long, slender; nerves (6–)8(–9) pairs, arched, slender but distinctly raised beneath, evident above as also the midrib, frequently with minute glabrous axillary domatia; tertiary nerves densely scalariform, slender, evident beneath, obscure above; *petiole* 9–13 mm long, slender. *Panicle* to 8 cm



Fig. 73. *Hoepa odorata* ROXB. a. Flowering branch, with domatia on leaves visible, b. leaf with infructescence, c. fruit, d. nut, all $\times 2/3$ (a BKF 40492, the domatia from BKF 51769, b Cult. Hort. Bog. VIII-A-26, c Cult. Hort. Bog., sheet 902.146-395 in L).

long, slender, with to 3 cm long branchlets bearing many (to 12) secund cream flowers. *Flower bud* to 3 by 2 mm, small, ovoid. *Sepals* broadly ovate, subacuminate, subequal. *Stamens* 15, the filaments lorate but becoming filiform beneath the subglobose anthers; appendages somewhat shorter than anther. *Ovary* and *stylopodium* pyriform, glabrous; style short, obscure. *Fruit pedicel* to 2 by 1 mm, broadening into receptacle. 2 longer *calyx lobes* to 4 by 1 cm, broadly spatulate, obtuse, c. 2 mm broad above the to 3 by 1 mm minute thickened saccate base; 3 shorter lobes to 5 by 1 mm, lanceolate-acicular, thickened, saccate. *Nut* to 13 by 4 mm, cylindrical, tapering abruptly to a terminal apiculus.

Distr. Indochina, Thailand, and in *Malesia*: N. W. Malaya (Kedah, Perlis, Langkawi).

Ecol. Locally abundant on rocky ridges and slopes, especially on limestone.

Vern. *Malut* (Langkawi), *chēngal laki* (Kedah, Perlis).

54. *Hoepa odorata* ROXB. [Hort. Beng. (1814) 42, *nomen*] Pl. Corom. 3 (1819) 7, t. 210; Fl. Ind. ed. Carey 2 (1832) 609; WALP. Rep. 5 (1845) 128; DYER, Fl. Br. Ind. 1 (1874) 308; PIERRE, For. Fl. Coch. 4 (1891) t. 244; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 59; Ind. Trees (1906) 67; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 373; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 292; TROUP, Silv. Ind. Trees 1 (1921) 47; CRAIB, Fl. Siam. Enum. 1 (1925) 147; LECOMTE, Bois Indochine (1926) 11; FOXW. Mal. For. Rec. 2 (1927) 75; *ibid.* 10 (1932) 118; BURK. Dict. (1935) 1192; CORNER, Wayside Trees 1 (1940) 212;

SYM. Mal. For. Rec. 16 (1943) 137, f. 69; SMITINAND, Thai For. Bull. 1 (1954) 18. — *H. vasta* WALL. [Cat. (1828) 962, *nomen*] ex DC. Prod. 16, 2 (1868) 633. — *H. decandra* BUCH.-HAM. ex WIGHT, Ill. Ind. Bot. 1 (1840) 88. — Fig. 73.

Tall buttressed tree with dark brown flaky bark. Twig apices sparsely fugaceous pale buff puberulent; panicle, leaf buds, flower calyx and petals outside densely persistently so; fruit calyx lobes and frequently nut glabrescent. *Twig* c. 2 mm \varnothing apically, terete, dark brown, smooth to rugulose; stipule scars pale, minute. *Buds* minute, ovoid; *stipules* minute, fugaceous. *Leaves* 7–14 by 3–7 cm, ovate-lanceolate, falcate; base broadly cuneate, unequal; acumen to 1.5 cm long, broad; nerves 9–12 pairs, prominent beneath, narrowly depressed above, arched, with prominent porous saccate axillary domatia; tertiary nerves densely sinuate-scalariform, very slender but clearly evident on both surfaces; midrib prominent beneath, applanate to somewhat channelled above; petiole 10–16 mm long, slender. *Panicle* to 12 cm long, terminal or axillary, twice-branched, with many to 2.5 cm long branchlets bearing to 9 secund flowers. *Flower buds* to 3 by 2 mm, broadly ovoid. Outer 2 sepals lanceolate, obtuse or subacuminate; inner 3 broadly ovate, acute. *Petals* pale cream-yellow. *Stamens* 15; filaments slender, compressed at base, tapering; appendage slender, as long as narrowly ellipsoid anthers. *Ovary* ovoid, punctate or glabrous, surmounted by an equally tall columnar style. *Fruit pedicel* to 1 mm long, short, slender. 2 longer *calyx lobes* to 5.5 by 2 cm, \pm broadly spatulate, obtuse, c. 3 mm broad above the to 4 by 4 mm small elliptic saccate base; 3 shorter lobes to 4 by 4 mm, ovate, subacuminate. *Nut* to 6 by 5 mm, small, ovoid, subobtusate.

Distr. Andamans, Burma, Thailand, Indochina and in *Malesia*: Malaya (N. Perak & Trengganu northwards).

Ecol. Common, often gregarious, on river banks in Malaya.

Uses. Cultivated as a shade tree.

Vern. *Chèngal pasir*, *c. kampong*, *c. pulau*, *c. mas*.

Note. Allied to *H. parviflora* BEDD. of the Western Ghats, India.

55. *Hopea centipeda* ASHTON, Gard. Bull. Sing. 22 (1967) 274, pl. 19; Man. Dipt. Brun. Suppl. (1968) 48, pl. 11 (stem-base). — *H. acuminata* (non MERR.) ASHTON, Man. Dipt. Brun. (1964) 94. — Fig. 72 D1–D4.

Medium-sized, prominently stilt-rooted tree with smooth bark. Young twig, leaf bud, stipule (both surfaces), petiole, and nervation beneath densely shortly persistently brown pubescent. *Twig* to 1 mm \varnothing apically, branching horizontally, smooth, glabrous. *Bud* to 1.5 mm long, subglobose. *Stipule* to 3 mm long, linear. *Leaves* 5.5–9 by 1.5–3.5 cm, lanceolate; base unequal, cuneate; acumen to 1.5 cm long, caudate; nerves 7–9 pairs, prominent beneath, slightly curved, at 30°–40°, with prominent pilose axillary domatia; tertiary nerves slender, scalariform, with slight reticu-

lations, diagonal to nerves; midrib prominent, rounded beneath, narrow, depressed above; *petiole* 4–7 mm long, slender. *Panicle* to 2 cm long. *Flowers* cream; *bud* to 6 by 2 mm, lanceolate. *Calyx* sparsely pubescent; *sepals* ovate, acute, the outer 2 somewhat longer than the inner 3. *Stamens* 15, in unequal verticils; anthers subglobose; appendage to connective c. 3 times length of anthers, slender. *Ovary* and *stylopodium* pyriform, glabrous, surmounted by a prominent style equalling the stylopodium in length. *Fruit calyx* puberulent, glabrescent; 2 longer lobes to 2.8 by 0.6 cm, spatulate, obtuse, to 1.5 mm broad above the to 2.5 mm by 2 mm elliptic shallowly saccate thickened base; 3 shorter lobes to 4 mm long, obtuse, similar at base. *Nut* to 4 by 3 mm, ovoid, glabrous.

Distr. *Malesia*: Borneo (Rejang hinterland to Lawas, S. E. Sabah).

Ecol. Local, on banks of fast flowing inland rivers.

Vern. *Mèrawan daun bèrbulu*.

56. *Hopea plagata* (BLCO) VIDAL, Sinopsis (1883) t. 15A; Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64; MERR. Publ. Govt. Lab. Philip. 27 (1905) 22; MERRITT, Bull. Bur. For. Philip. 8 (1908) 48; WHITFORD, Philip. J. Sc. 4 (1910) 715; Bull. Bur. For. Philip. 10 (1911) 73; MERR. Sp. Blanc. (1918) 2691; En. Philip. 3 (1923) 94; REYES, Philip. J. Sc. 22 (1923) Bot. 447; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 55, f. 11, pl. 7; ASHTON, Gard. Bull. Sing. 31 (1978) 32. — *Mocanera plagata* BLCO, Fl. Filip. ed. 1 (1837) 447. — *Dipterocarpus plagatus* BLCO, Fl. Filip. ed. 2 (1845) 311; *ibid.* ed. 3, 2 (1878) 212; DC. Prod. 16, 2 (1868) 614. — *Anisoptera plagata* BL. Mus. Bot. Lugd.-Bat. 2 (1856) 42; WALP. Ann. 4 (1867) 336; DC. Prod. 16, 2 (1868) 616. — *Shorea reticulata* (non THW. ex DYER) F.-VILL. Nov. App. (1880) 21. — *H. odorata* (non ROXB.) FOXW. Philip. J. Sc. 13 (1918) Bot. 183. — *H. sp.* "Gyam" Foxw. Philip. J. Sc. 6 (1911) Bot. 263. — *H. dasyrrachis* (non SLOOT.) ASHTON, Man. Dipt. Brun. Suppl. (1968) 49, f. 7. — Fig. 72 A–A4.

Large flaky barked buttressed tree. Parts entirely glabrous or ovary pubescent. *Twig* c. 1 mm \varnothing apically, much branched, terete, becoming smooth, dark brown. *Bud* c. 2 by 1 mm, ovoid, stipules fugaceous, not seen. *Leaves* 6–12 by 2.5–7 cm, elliptic-lanceolate to ovate, \pm falcate, coriaceous; base cuneate to obtuse, \pm markedly unequal; acumen to 1.5 cm long, tapering; nerves 8–11(–12) pairs, slender, elevated beneath, \pm applanate above, ascending at 35°–65°, sometimes pale stellate lepidote beneath, usually with glabrous pore-like domatia; tertiary nerves densely scalariform, hardly elevated beneath; midrib \pm prominent on both surfaces; *petiole* 6–16 mm long. *Panicle* to 3 cm long, slender, 1-axillary or terminal, singly branched; branchlets to 2 cm long, bearing to 6 secund flowers; *bracteoles* fugaceous. *Flower bud* to 3 by 2 mm, ellipsoid, 2 outer sepals broadly ovate, subacute; 3 inner suborbicular, obtuse. *Stamens* c. 35, subequal, slightly shorter than style; filaments long, slender, narrowly compressed at base, tapering and

filiform in the distal $\frac{1}{2}$; anther elongate, tapering; appendages \pm equal in length to anthers; acicular. *Ovary* ovoid, with obscure stylopodium and short broad style. *Fruit pedicel* to 2 mm long; 2 longer *calyx lobes* to 45 by 20 mm, broadly oblong-spatulate, sometimes suborbicular; 3 shorter lobes to 7 by 4 mm ovate. *Nut* to 10 by 7 mm, narrowly ovoid, \pm pubescent or glabrous.

Distr. *Malesia*: Philippines (Luzon, Mindoro, Tablas, Basilan, Tawitawi; rare in Mindanao); N. E. Borneo.

Ecol. Widespread and common in semi-evergreen seasonal forests, more local in evergreen non-seasonal forests, on limestone in Sarawak.

Uses. The most widespread heavy construction timber in the Philippines.

Vern. *Banuan* (Gad.), *batik* (Ilk.), *gisok gisok* (Bik.), *haras* (P. Bis.), *nutik* (Buk.), *paina* (Tag.), *panggian* (Ilk.), *saplingan*, *siakal* (Tag.), *siggai*, *s. na nalabaga*, *s. mulata*, *s. apuran* (Ilk.), *tagai* (Ilk. Neg.), *yakal* (Ilk., Pang., Sbl., Tag., Sul.), *yakal saplingan* (official name).

Note. Two flowering collections, LOHER 12914 and 14901 from Luzon, differ in possessing flowers with pubescent ovary and 15 stamens. They could, when more material is available, merit separation as a separate taxon, and serve to underline the close affinity of this species to *H. dasyrrhachis* SLOOT. (*q.v.*) whose distinct suborbicular fruit sepals occur sometimes in the present species; indeed sterile and fruiting collections from Sarawak attributed here to *H. dasyrrhachis* may in fact belong to *H. plagata*.

57. *Hopea nutans* RIDL. Fl. Mal. Pen. 1 (1922) 235; FOXW. Mal. For. Rec. 10 (1932) 123; BURK. Dict. (1935) 1191; SYM. Mal. For. Rec. 16 (1943) 136, f. 69, 76; BROWNE, For. Trees Sarawak & Brunei (1955) 125; ASHTON, Man. Dipt. Brun. (1964) 104, f. 12; *ibid.* Suppl. (1968) 54; MELER & WOOD, Sabah For. Rec. 5 (1964) 217, f. 29. — *H. lowii* (non DYER) FOXW. Mal. For. Rec. 1 (1922) 67.

Medium-sized to large flaky-barked buttressed tree. Young twig, leaf bud, stipule, panicle and petiole very shortly sparsely pale brown pubescent. *Twig* to 2 mm \varnothing apically, much branched, smooth, becoming glabrous. *Bud* to 1.5 mm long, ovoid. *Stipule* to 2.5 mm long, linear, fugaceous. *Leaves* 8–13 by 4.5–8.5 cm, broadly ovate, coriaceous, greyish lepidote below in mature tree; base obtuse; acumen to 1 cm long; margin frequently slightly revolute; nerves 7–10 pairs, distinct, hardly raised beneath, curved, at 50°–60°, usually with large glabrous swollen pore-like domatia; tertiary nerves slender but distinct, scalariform with slight reticulations, diagonal to nerves; midrib broad, slightly raised on both surfaces; *petiole* 1–1.5 cm long. *Panicle* to 7 cm long, terminal or axillary, terete or angular; singly branched, branchlets to 1.5 cm long, bearing to 5 second pale yellow flowers; *bracteoles* to 3 mm long, hastate, subacute. *Flower bud* to 4 by 2.5 mm, broadly ellipsoid, obtuse. *Calyx* densely pubescent outside, glabrous within; 2 outer lobes hastate,

subacute; 3 inner lobes broadly ovate, thinner, tapering at base. *Petals* linear, puberulent on parts exposed in bud. *Stamens* 15, in 3 subequal whorls; filaments broad at base, tapering and filiform below anthers; anthers subglobose, tapering apically; appendage to connective *c.* 2 times length of anther, slender, scabrous towards apex. *Ovary* and *stylopodium* subcylindrical, glabrescent; style short, glabrous. *Fruit calyx* sparsely pale brown pubescent or glabrescent; 2 longer lobes to 8 by 1.5 cm, oblong, thinly coriaceous, broad, obtuse, tapering to the 2.5 by 3 mm ovate saccate thickened base; 3 shorter lobes to 10 mm long, acute, similar at base. *Nut* to 15 by 8 mm, ovoid, glabrous; style remnant, short, acute.

Distr. *Malesia*: Malaya (E. coast from Trengganu southwards), Borneo (Sarawak, Sabah, Nunukan).

Ecol. Sandy soils, often periodically swampy, near and on coastal hills.

Vern. *Giam*, *chēngal*, *c. batu*, *c. kēras*, *c. pēlandok*, *tēngkawang* (Mal.), *garang buaya daun kēchil* (Brun.).

58. *Hopea bancana* (BOERL.) SLOOT. Reinwardtia 3 (1956) 317. — *Balanocarpus bancanus* BOERL. Cat. Hort. Bog. (1901) 111.

Medium-sized flaky-barked hard-wooded tree. Twigs, petiole, midrib above and calyx outside caducous buff pubescent, persistent in young trees and on parts of petals exposed in bud and leaf buds. *Twig c.* 2 mm \varnothing apically, terete, rugulose, blackish. *Bud* minute; *stipules* not seen. *Leaves* 8–15 by 3.5–7.5 cm, ovate-falcate, thinly coriaceous, lustrous; base \pm broadly cuneate to obtuse, frequently shortly decurrent; unequal; acumen to 1.5 cm long, tapering; nerves 6–8 pairs, slender but distinctly elevated on both surfaces (more so below) as also the midrib, arched, at 45°–60°, with prominent glabrous porous canaliculate domatia (absent in immature trees); tertiary nerves densely scalariform, very slender, \pm elevated on both surfaces; *petiole* 11–14 mm long (shorter in young trees), slender. *Panicle* to 8 cm long, slender, pendant, to 2-axillary or terminal, singly branched; branchlets to 2 cm long, bearing to 5 flowers; *bracts* fugaceous. *Flower bud* to 3 by 2 mm, ellipsoid. 2 outer *sepals* ovate, acute, 3 inner ovate, acuminate. *Stamens* 15, in 3 unequal verticils; filaments compressed but rather narrow at base, tapering to the narrowly ellipsoid subacute anthers; appendage as long as anthers, relatively stout. *Ovary* and *stylopodium* stoutly pyriform, subtruncate, with short columnar style. *Fruit pedicel c.* 2 mm long, stout. 2 longer *calyx lobes* to 9 by 2.5 cm, lorate, obtuse, *c.* 5 mm broad and subrevolute above the *c.* 5 by 5 mm broadly ovate saccate thickened base; 3 shorter lobes to 6 by 6 mm, ovate, acute, similarly saccate. *Nut* to 9 by 6 mm, ovoid, shortly apiculate, resinous.

Distr. *Malesia*: Central W. Sumatra (P. Musala).

Ecol. Very rare, low hills.

Note. Most collections come from a tree in Kebun Raya Indonesia, the provenance of which was said to be Banka, though no collections exist from that island.

59. *Hopea pentanervia* SYM. ex WOOD, Gard. Bull. Sing. 17 (1960) 495; BROWNE, For. Trees Sarawak & Brunei (1955) 126; ANDERSON, Gard. Bull. Sing. 20 (1963) 157; ASHTON, Man. Dipt. Brun. (1964) 106, f. 12, pl. 31 (bark); *ibid.* Suppl. (1968) 55; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 219, f. 30.

Medium-sized, flaky-barked buttressed tree. Young parts puberulent, glabrescent. *Twig* to 1.5 mm \varnothing apically, terete, much branched, smooth. *Bud* to 1.5 mm long, small. *Stipule* to 2 mm long, linear, fugaceous. *Leaves* 5–10 by 3.2–5 cm ovate, coriaceous; base obtuse or broadly cuneate; acumen tapering, to 1.5 cm long, narrow, margin slightly revolute; nerves c. 5 pairs, prominent beneath, slender, at 45°–55° but strongly curved, with small glabrous pore-like domatia; tertiary nerves slender, distinct, densely scalariform, at 90° to midrib; midrib slender, raised beneath, \pm applanate above; *petiole* 6–11 mm long. *Panicle* to 8 cm long, terminal or to 2-axillary, terete, lax; regularly singly or doubly branched, branchlets to 1.5 cm long, bearing to 6 second flowers; *bracteoles* small, narrowly deltoid, glabrous, caducous. *Flower bud* small, ellipsoid, on c. 1.5 mm long pedicel. *Calyx* glabrous but for fimbriate margin; 2 outer lobes oblong, acute; 3 inner lobes short, ovate, acuminate. *Petals* narrowly lanceolate, shortly pubescent on parts exposed in bud. *Stamens* 15, small, well spaced round the ovary; filaments broad at base, tapering abruptly and filiform distally; anthers subglobose; appendage to connective c. 3 times length of anthers, very slender. *Ovary* and *stylopodium* cylindrical, truncate, glabrous; style short, abrupt, slender. *Fruit calyx* glabrous; 2 longer lobes to 5 by 1.2 cm, spatulate, chartaceous, obtuse, to 3 mm broad above the to 3 by 3 mm small ovate saccate somewhat thickened base; 3 shorter lobes to 4 by 3 mm, ovate, acute, saccate. *Nut* to 4 by 3.5 mm, ovate, glabrous; style remnant short.

Distr. *Malesia*: Borneo (Sarawak to W. Sabah, Sandakan).

Ecol. Mixed peat swamp forest over sand, podsols on cuestas, plateaux and terraces, near present or Pleistocene coastlines; on ultrabasic rocks in E. Sabah.

Vern. *Sĕlangan lima urat* (Sabah), *mang, m. bĕsi* (Sar.), *chĕngai paya* (Iban).

60. *Hopea basilanica* FOXW. Philip J. Sc. 6 (1911) Bot. 260, pl. 42; *ibid.* 13 (1918) 183; MERR. En. Philip. 3 (1923) 93; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 53, f. 10, pl. 6.

Tall, flaky-barked, hard-wooded tree. Young twig, petiole, midrib above, panicle, calyx and corolla outside and ovary greyish cinereous, persisting only on corolla outside. *Twig* 1–2 mm \varnothing apically, terete, much branched, dark brown. *Leaves* (7.5–)10–14 by (2.5–)3.5–5 cm, oblanceolate or elliptic, thickly coriaceous; base cuneate, unequal; acumen to 15 mm long, prominent, slender; nerves (9–)10–13 pairs, slender but prominent beneath, applanate above, with prominent glabrous pore-like domatia in the axils of the

basal 2–3 pairs; tertiary nerves scalariform, evident but hardly elevated on either surface; *petiole* 6–10 mm long, short. *Panicles* to 7 cm long, to 3 axillary or ramiflorous, slender, singly branched; branchlets to 17 mm long, bearing to 7 second flowers. *Flower bud* to 3 by 2 mm, very small. *Sepals* ovate, the outer 2 subacute, the inner 3 shortly slender-acuminate. *Stamens* 15, in 3 unequal verticils; filaments compressed, broad at base, tapering in the distal $\frac{1}{2}$ and filiform beneath the subglobose anthers; appendage slender, filiform, c. 2 $\frac{1}{2}$ times length of anthers. *Ovary* and *stylopodium* equal in length, together broadly hour-glass shaped with a distinct median constriction; style as long as ovary, columnar, slightly tapering. *Fruit pedicel* c. 1 mm long, short, slender. 2 longer calyx lobes to 4.5 by 1.5 cm, broadly spatulate, obtuse, chartaceous, c. 4 mm broad above the 2–6 by 5 mm elliptic saccate base; 3 shorter lobes to 7 by 5 mm, ovate, acute. *Nut* to 6 by 5 mm, small, ovoid, shortly apiculate.

Distr. *Malesia*: Philippines (Basilan, Mindanao).

Ecol. Undulating land and hills below 70 m.

Uses. Locally used for construction.

61. *Hopea andersonii* ASHTON, Gard. Bull. Sing. 22 (1967) 272, pl. 17; Man. Dipt. Brun. Suppl. (1968) 46, f. 6.

a. *ssp. andersonii*.

Medium-sized tree to 40 m tall, with chocolate-brown thickly flaky bark. Vegetative parts glabrous. *Twigs* c. 1 mm \varnothing apically, terete, smooth; stipule scars short, obscure. *Bud* to 1 by 1 mm, subglobose. *Stipule* unknown. *Leaves* 5–14 by 2–6 cm, lanceolate-falcate to elliptic, coriaceous, drying tawny with the nervation beneath dark red-brown; base obtuse on adaxial side, cuneate on the other, unequal; acumen to 2 cm long, slender, frequently falcate; nerves 9–12 pairs, slender, not prominently raised, arched, at 65°–75°, some with prominent axillary pustular pored domatia; tertiary nerves scalariform; midrib evident but unraised or hardly so above, prominent beneath; *petiole* 5–10 mm long. *Panicle* to 12 cm long, terminal or axillary, terete, frequently fascicled, densely evenly \pm persistently pale grey puberulent; singly branched, branchlets bearing to 9 second flowers; *bracteoles* to 2 mm long, linear, puberulent, fugaceous. *Flower bud* to 3 by 2 mm, ellipsoid. *Sepals* ovate, acute, subequal, densely pubescent outside, more sparsely so within. *Petals* lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the broadly ellipsoid anthers; appendage to connective slender, 2–2 $\frac{1}{2}$ times as long as anther. *Ovary* and *stylopodium* cylindrical, very slightly constricted medially, the stylopodium slightly narrower than the ovary, both densely papillose and puberulent; style short, columnar. *Fruit pedicel* to 3 mm long, slender. 2 longer calyx lobes to 6 by 2 cm, oblong, obtuse, puberulent at base but otherwise glabrous, to c. 3 mm broad above the to 4 by 3 mm elliptic somewhat

thickened saccate base; 3 shorter lobes to 4 by 3 mm, ovate, obtuse, saccate. *Nut* to 8 by 5 mm, ovoid, glabrous, with a small apical truncate stylopodium and c. 1 mm long mucronate style remnant.

Distr. *Malesia*: Borneo (W. and N.E. Sarawak).

Ecol. Common on the lower slopes of limestone hills, to 400 m.

Vern. *Luis somit*.

b. ssp. basalticola ASHTON, Gard. Bull. Sing. 22 (1967) 272.

Bark surface coppery-brown, thinly flaked. Leaf drying pale grey-brown.

Distr. *Malesia*: Borneo (Central and N.E. Sarawak, E. Sabah, S.E. Borneo to Pleihari, Ulu Kapuas).

Ecol. Mixed Dipterocarp forest on clay rich soils, especially on basic volcanic rocks; to 400 m.

62. *Hopea ovoidea* ASHTON, Gard. Bull. Sing. 31 (1978) 34. — *H. plagata* [non (BLCO) VIDAL] FOXW. Philip. J. Sc. 3 (1907) Bot. 396, *p.p.*; *ibid.* 4 (1909) Bot. 515; *ibid.* 6 (1911) Bot. 262, 285; *ibid.* 13 (1918) Bot. 183; *ibid.* 67 (1938) 278, *p.p.*

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

Distr. *Malesia*: N.E. Borneo (Sandakan to Tawau).

Ecol. Low hills near coast. Rare.

Notes. LOHER 12914 & 14901, from Luzon, confused by FOXWORTHY with *H. plagata* VIDAL, appear to belong to this species, though the leaves are narrower and the nerves less prominent beneath.

H. ovoidea closely resembles *H. semicuneata* SYM. when sterile, but can nevertheless be distinguished by its brown, rather than grey-brown, drying leaves and small, canaliculate rather than pustular domatia which are at times absent; the pubescent ovoid ovary

and rather stout connectival appendages (slender and thrice as long as the anthers in *H. semicuneata*) define this species.

63. *Hopea semicuneata* SYM. Gard. Bull. S. S. 8 (1934) 24, pl. 6; Mal. For. Rec. 16 (1943) 143, f. 69; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 224, f. 32; ASHTON, Man. Dipt. Brun. Suppl. (1968) 56, f. 8. — *H. sp.* SLOOT. ex MERR. Pl. Elm. Born. (1929) 202. — *H. diversifolia* MIQ. Sum. (1860) 491, *p.p.*; DC. Prod. 16, 2 (1868) 635; WALP. Ann. 7 (1868) 379. — '*Samarupa chengal*' FOXW. Mal. For. Rec. 10 (1932) 71, *p.p.* — *H. multiflora* (non BRANDIS) FOXW. Mal. For. Rec. 10 (1932) 119, *p.p.* — *H. plagata* (non VIDAL) SYM. Gard. Bull. S. S. 7 (1933) 154.

Tall flaky-barked and buttressed tree. Young twigs and petioles fugaceous puberulent, vegetative parts otherwise glabrous. *Twig* c. 1 mm \varnothing apically, terete, becoming striated. *Bud* to 2 by 1 mm, conical. *Stipule* to 2 mm long, linear, fugaceous. *Leaves* 6.5–14 by 2–7 cm, elliptic to ovate-lanceolate, chartaceous, frequently undulate; base narrowly or broadly cuneate; acumen to 2.5 cm long, slender, tapering; nerves 6–9 pairs, scalariform, depressed above, slender but prominent beneath, set obliquely at 45°–65°, frequently with prominent, pustular domatia; tertiary nerves densely scalariform, at 90° to the midrib; midrib slightly raised to slightly depressed above, \pm prominent beneath; *petiole* 6–12 mm long, slender. *Panicle* to 7 cm long, terminal or axillary, terete, densely shortly evenly persistently pale cream-buff pubescent; singly branched, the branchlets bearing to 7 cream flowers; *bracteoles* to 1 mm, short, deltoid, fugaceous. *Flower bud* to 2 by 1 mm, ellipsoid. *Sepals* broadly ovate, acute, subequal, glabrous or pubescent. *Petals* lanceolate, puberulent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering filiform below the ellipsoid anthers; appendage to connective slender, c. 3 times length of anther, reaching almost to style apex. *Ovary* and *stylopodium* cylindrical, truncate, sometimes constricted medially, glabrous but for the papillose apical platform; style shortly columnar, glabrous. *Fruit calyx* at first pale buff puberulent, caducous except at base. *Pedicel* to 2 mm long. 2 longer *calyx lobes* to 9.5 by 2.2 mm, broadly lorate, obtuse, c. 4 mm wide above the 8 by 6 mm elliptic thickened saccate base; 3 shorter lobes to 4 by 6 mm, broadly ovate, subacute, saccate. *Nut* to 6 by 5 mm, subglobose, shortly apiculate.

Distr. *Malesia*: Malaya, Sumatra (Atjeh, Lampong), Borneo.

Ecol. Local, clay rich alluvium, undulating land, and hillsides below 500 m.

Vern. *Samarupa chëngal*, *chëngal*, *c. batu*, *c. mas*, *pënak*, *p. batu* (Mal.), *giam kulit mëräh* (Sabah).

64. *Hopea megacarpa* ASHTON, Gard. Bull. Sing. 22 (1967) 278, pl. 24; Man. Dipt. Brun. Suppl. (1968) 53, f. 7.

Small or medium-sized smooth-barked tree. Young

twig, petiole and leaf nervation beneath sparsely caducous puberulent, leaf bud persistently so. *Twig* c. 1 mm \varnothing apically, slender, terete, smooth; stipule scars small, obscure. *Bud* to 1 by 1 mm, minute. *Stipule* to 2 mm long, linear-falcate, caducous. *Leaf* 6–12 by 1.5–5 cm, \pm narrowly elliptic, thinly coriaceous, undulate, with cuneate base and to 2 cm long prominent caudate acumen; nerves 6–7 pairs, slender, raised beneath, at 25°–40°; tertiary nerves slender, densely scalariform; midrib prominent, terete beneath, applanate to slightly raised, slender, above; *petiole* c. 6 mm long, short, grooved on upper side. *Panicle* to 3 cm long, axillary, terete, glabrous, lax; singly branched, branchlets bearing to 3 flowers; *bracts* and *bracteoles* to 2 mm long, linear. *Flower bud* 4 by 3 mm, subglobose. *Calyx lobes* fimbriate; 2 outer lobes ovate, acute; 3 inner lobes suborbicular, submucronate. *Petals* elliptic-oblong, obtuse, sparsely puberulent on parts exposed in bud, pale pink. *Stamens* 15; filaments broad at base, tapering and filiform distally; anthers oblong; appendage to connective c. 3 times length of anthers, slender, filiform. *Ovary* and *stylopodium* cylindrical, subtruncate, glabrous, surmounted by a short style. *Fruit* entirely glabrous. *Pedicel* to 3 mm long, broadening into fruit. 2 longer *calyx lobes* to 10 by 1.3 cm, narrowly spatulate, subacute, c. 5 mm wide above the to 9 by 15 mm subauriculate saccate base; 3 shorter lobes to 20 by 9 mm, ovate, similarly subauriculate, enclosing and obscuring the nut. *Nut* to 12 by 10 mm, ovoid, with minutely truncate mucronate apex.

Distr. *Malesia*: N.W. Borneo (Central Sarawak; W. and S.E. Kalimantan).

Ecol. Locally frequent in Mixed Dipterocarp forests below 600 m in the Rejang hinterland.

65. *Hopea samarensis* GUTIERREZ, Kalikasan 4 (1975) 236, f. 1.

Small smooth-barked tree. Parts glabrous but for the pubescent domatia and parts of petals exposed in bud, and glabrescent sepals. *Twigs* c. 2 mm \varnothing apically, slender. *Leaves* (4–)8–15 by (1.5–)3–5.5 cm, oblong-elliptic, thinly coriaceous; acumen to 1 cm long, subcaudate; base subequal, cuneate; nerves 9–12(–13) pairs, slender but prominent beneath, evident above, with small axillary domatia; tertiaries densely scalariform, very slender, evident beneath; petiole 8–12 mm long, slender. *Panicles* to 4 cm long, singly branched, to 3-ramiflorous; branchlets to 2 cm long, bearing to 4 second flowers; bracteoles minute, deltoid, fugaceous. *Flower bud* to 8 by 4 mm, ovoid; sepals broadly ovate, the inner 3 acute, the outer 1 acuminate, becoming rotate before anthesis; *petals* lorate; stamens 15 in 3 unequal verticils; filaments broad at base, tapering and filiform beneath the broadly ellipsoid anthers; appendage aristate, c. 2–3 times length of anthers; *ovary* ovoid, surmounted by a slightly shorter slender cylindrical tapering stylopodium with short terminal style c. $\frac{1}{2}$ its length. *Fruit* unknown.

Distr. *Malesia*: Philippines (Samar I.).

Ecol. Locally common in moist lowland valleys in Mixed Dipterocarp forest.

66. *Hopea nodosa* SLOOT. Reinwardtia 2 (1952) 25, f. 8; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 38.

Medium-sized tree with flaky bark and steep buttresses. Parts glabrous but for the persistently pubescent parts of the petals exposed in bud. *Twigs* 2–3 mm \varnothing , rather stout, terete; *buds* and *stipules* not seen. *Leaves* (6–)8–20 by (2.5–)3.8–7 cm, elliptic, coriaceous, lustrous, minutely punctate above; margin narrowly revolute; base broadly cuneate; acumen to 1 cm long, tapering; nerves 8–11 pairs, prominent beneath, elevated but frequently set in a groove above, arched, ascending at 50°–70°; domatia minute, porous, or absent; without secondaries; tertiary nerves scalariform, obscure; midrib prominent beneath, distinctly elevated above; *petiole* 7–15 mm long, rather stout. *Panicle* to 4 cm long, slender, terminal or to 2-axillary or ramiflorous; singly branched, branchlets to 12 mm long, bearing to 6 flowers; bracteoles fugaceous, not seen. *Flower buds* to 3 by 2 mm, ellipsoid. *Sepals* subequal, broadly ovate-deltoid, obtuse. *Stamens* 15, shorter than style, in 3 unequal verticils; filaments broad and compressed at base, tapering and filiform in the distal $\frac{1}{2}$; anthers subglobose; appendages c. twice as long as anthers, slender. *Ovary* and *stylopodium* narrowly pyriform with distinct medial constriction, tapering to the short but distinct columnar style. *Fruit* subsessile; *calyx lobes* to 7 by 8 mm, subequal, shorter than nut, broadly ovate, subacute, saccate, thickened. *Nut* to 10 by 6 mm, ovoid, shortly apiculate.

Distr. *Malesia*: N.W. New Guinea (Beriati, Teminabuan; Sorong).

Ecol. Locally common in secondary and primary lowland forest.

Vern. *Megun gun* (Telid).

67. *Hopea celebica* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 237; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64; HEYNE, Nutt. Pl. ed. 2 (1927) 1110; SLOOT. Reinwardtia 2 (1952) 15, f. 5; BACKER & BAKH, f. Fl. Java 1 (1963) 331; ASHTON, Gard. Bull. Sing. 31 (1978) 35. — *H. dolosa* SLOOT. Reinwardtia 2 (1952) 18, f. 6.

Medium-sized, hard-wooded, scaly-barked tree. Twig apices, petiole, panicle and calyx outside \pm caducous sometimes pubescent, parts of petals exposed in bud and sometimes panicle persistently so. *Twigs* c. 2 mm \varnothing much branched, terete, smooth. *Buds* small, ovoid; *stipules* not seen. *Leaves* (5.5–)8–22 by (2.2–)2.5–8 cm, ovate-lanceolate, coriaceous, \pm lustrous; margin \pm revolute; base subequal, obtuse or sometimes broadly cuneate; acumen to 1.5 cm long, usually short, tapering; nerves 8–11 pairs, slender but prominent beneath, slightly elevated above, arched, at 45°–55° except at base, often with prominent axillary porous canaliculate domatia; tertiary nerves subscalariform, evident on both surfaces though more distinct beneath; midrib prominent beneath, distinctly elevated above; *petiole* 10–16 cm long. *Panicle* to 9 cm long, terminal, to 3-axillary or ramiflorous, slender, pendant, singly branched; branchlets to 13 mm long,

short, bearing to 4 flowers; *bracteoles* minute, deltoid, fugaceous. *Flower buds* to 2 mm long, ellipsoid. 2 outer *sepals* long, narrowly deltoid-lanceolate; 3 inner broadly ovate, \pm distinctly acuminate. *Stamens* 15, in 3 subequal verticils, short; filaments broad and compressed at base, tapering and filiform beneath the oblong anthers; appendages *c.* $1\frac{1}{2}$ times length of anther, slender. *Ovary* and *stylopodium* stoutly pyriform, *stylopodium* punctate; style short but distinct, columnar. *Mature fruit* unknown; *pedicel* at least 3 mm long; *sepals* unequal, 2 aliform, spatulate, obtuse; 3 shorter lobes exceeded by the ovoid apiculate nut.

Distr. *Malesia*: Celebes (S.W. Peninsula: Maros; Central: Malili).

Ecol. Locally common in semi-evergreen forest below 500 m.

Uses. Construction.

Vern. *Hulo dereh, kērih* (Maros), *hulodere, damar derehitēm, d.d. lotang, bisik bisik, rinni rinni, sarēh parēh, torinih* (Malili).

68. *Hopea iriana* SLOOT. *Reinwardtia* 2 (1952) 28, f. 10; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 35; ASHTON, Gard. Bull. Sing. 31 (1978) 35. — *H. nabirensis* SLOOT. *Reinwardtia* 2 (1952) 27, f. 9; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 38.

Tall, hard-wooded tree with blackish flaky bark and flying buttresses. Young parts buff puberulent, becoming sparse but \pm persistent on calyx, persistent on panicle and parts of petals exposed in bud. *Twig c.* 2 mm \varnothing apically, much branched, terete, becoming smooth, blackish. *Leaf bud* minute, ovoid; *stipules* fugaceous, not seen. *Leaves* 5–13 by 2–4.5 cm, lanceolate-falcate, coriaceous, dull greyish minutely stellate beneath; margin frequently subrevolute; base unequal, cuneate; acumen to 1.5 cm long, slender, tapering; nerves 7–11 pairs, slender but distinctly elevated beneath, slightly elevated above, usually with prominent porous glabrous canaliculate domatia; tertiary nerves scalariform, evident on both surfaces, \pm distinctly elevated beneath; *petiole* 7–9 mm long, slender. *Panicle* to 6 cm long, slender, terminal or 1-axillary; singly branched, branchlets to 1.5 cm long, bearing to 5 dense secund flowers; *bracteoles* fugaceous, not seen. *Flower buds* to 3 by 2 mm, ellipsoid. 2 outer *sepals* narrowly lanceolate, subacute; 3 inner suborbicular, mucronate. *Stamens* 15, shorter than style, in 3 subequal verticils; filaments broad and compressed at base, tapering and filiform in the distal $\frac{1}{2}$; anthers broadly oblong; appendage *c.* 3 times length of anthers, long, slender. *Ovary* and *stylopodium* conical-cylindric, sericeous, tapering somewhat abruptly beneath the short but distinct columnar style. *Fruit pedicel* to 2 mm long. 2 longer *calyx lobes* to 7 by 1.8 cm, broadly spatulate, obtuse, *c.* 4 mm broad above the 6 by 4 mm ovate saccate thickened base; 3 shorter lobes to 6 by 4 mm, ovate, acute, similarly saccate. *Nut* to 13 by 7 mm, ovoid, with tapering apiculus.

Distr. *Malesia*: New Guinea (West: Manokwari

area, Hollandia; Papua New Guinea: Morobe Distr.), Japen I.; Aru Is. (sterile collections only).

Ecol. Evergreen forests; widespread hills below 600 m, especially on ridges.

Vern. *Sian, saindorih* (Japen), *lipiga* (Manikiong).

Notes. A variable species which, as *H. novoguineensis*, appears to possess regional diversification; collections from western New Guinea have notably larger more lustrous leaves.

69. *Hopea glabrifolia* C.T. WHITE, Proc. R. Soc. Queensl. 43 (1932) 49; SLOOT. *Reinwardtia* 2 (1952) 35, f. 13; v. ROYEN, Man. Forest Trees Papua New Guinea 8 (1965) 35.

Tall, buttressed tree with hard wood and flaky bark. Young parts and panicle greyish puberulent, glabrescent; petals persistently puberulent on parts exposed in bud. *Twig c.* 2 mm \varnothing apically, ribbed, much branched, becoming terete, rugose, dark brown. *Leaf buds* minute, ellipsoid; *stipules* not seen, fugaceous. *Leaves* 18–19 by 2–5.5 cm, lanceolate, falcate, coriaceous, lustrous; margin narrowly subrevolute; base prominently unequal, cuneate abaxially, cordate adaxially; acumen to 1.5 cm long, broad, tapering; nerves 9–12 pairs, slender but prominent beneath, \pm narrowly depressed above, arched, ascending at 45°–50° except at base; without secondaries; tertiaries densely scalariform, very slender but distinctly elevated beneath; midrib prominent beneath, slender but prominent above; *petiole* 5–8 mm long, short. *Panicles* to 5 cm long, terminal or to 3-axillary, slender; singly branched, branchlets to 1.5 cm long, bearing to 5 flowers. *Flower buds* to 3 by 2 mm, ellipsoid. *Sepals* ovate to suborbicular, subacute. *Stamens* 15; appendage *c.* 4 times the length of the anther cells. *Gynoecium* glabrous; ovary ovoid, surmounted by a cylindrical *stylopodium* twice its length and very short style. *Fruit pedicel c.* 1 mm long, short. 2 longer *calyx lobes* to 7 by 1.3 cm, spatulate, obtuse, *c.* 3 mm broad above the 7 to 8 by 6 mm ovate saccate thickened base; 3 shorter lobes to 9 by 7 mm, ovate, acute. *Nut* to 14 by 8 mm, ovoid, stoutly apiculate.

Distr. *Malesia*: Papua New Guinea (Milne Bay area) and Louisiades (Sudest I., Misima I.).

Ecol. Locally abundant in semi-evergreen seasonal forest below 350 m.

Vern. *Kapilatana, matapo, malabia*.

70. *Hopea gregaria* SLOOT. *Reinwardtia* 2 (1952) 21, f. 7; ASHTON, Gard. Bull. Sing. 31 (1978) 32.

Medium-sized or large flaky-barked tree with hard wood. Young parts buff puberulent, becoming sparse but \pm persistent on calyx, persistent on panicle and parts of petals exposed in bud. *Twig* 1–2 mm \varnothing apically, much branched, terete, becoming smooth, blackish. *Leaf bud* minute, ovoid; *stipules* fugaceous, not observed. *Leaf* 6–13 by 2.5–6.5 cm, lanceolate-falcate to ovate, thinly coriaceous, with dull minutely stellate undersurface; base cuneate, unequal; acumen to 1.5 cm long, slender, tapering; nerves 7–10 pairs, slender but distinctly elevated beneath, \pm applanate

above, rarely with glabrous porous canaliculate axillary domatia; tertiary nerves scalariform, \pm evident on both surfaces; midrib slender but prominent beneath, evident and \pm elevated above; *petiole* 6–10 mm long, slender. *Panicle* to 6 mm long, slender, terminal or 1-axillary, singly branched, branchlets to 12 mm long, bearing to 4 flowers. *Flower buds* to 3 by 2 mm, ellipsoid. *Sepals* subequal, ovate, acute. *Stamens* 15, shorter than style, in 3 subequal verticils; filaments broad, compressed, tapering and becoming filiform below the broadly oblong anthers; appendages c. $1\frac{1}{2}$

times length of anthers. *Ovary* and *stylopodium* broadly pyriform, punctate distally, somewhat abruptly tapering to the short columnar style. *Mature fruit* unknown. *Pedicels* c. 3 mm long; *sepals* unequal but the 2 longer relatively short, broad, becoming reflexed; nut ovoid, shortly apiculate.

Distr. *Malesia*: S.E. Celebes (Kendari), S.E. Moluccas (Aru Is. ?) and Japen I. (sterile collections)?

Vern. *Pooti* (Celebes), *koereh*, *mandonor* (Biak), *kamoera* (Aru).

2b. Subsection *Pierrea*

(HEIM) ASHTON, Gard. Bull. Sing. 20 (1963) 259; Man. Dipt. Brun. (1964) 91; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 25, 26. — *Pierrea* HEIM, non HANCE. — *Pierreocarpus* RIDL. ex SYM. in syn. — *Hopea*, *Pierrea* group SYM. Gard. Bull. S. S. 9 (1934) 32; Mal. For. Rec. 16 (1943) 108. — Fig. 74.

Panicles glabrescent, fascicled; ovary and stylopodium hour-glass-shaped, elongate; style short, obscure; bark surface generally smooth, or shallowly papery flaked, usually stilt-rooted.

Distr. *Malesia*: Malaya, Borneo, Philippines.

Note. The least well defined of the four subsections. The New Guinea species, with their elongate stylopodia and in several cases large leaves with unequal bases are almost intermediate between subsections *Hopea* and *Pierrea*, as also to a large extent are some Indochinese species in the type subsection (e.g. *H. oblongifolia* DYER, *H. reticulata* TARDIEU, *H. hongayanensis* TARDIEU), while *H. glaucescens* and *H. wyatt-smithii* share the flower colour and leaf-shape of the *H. nervosa* group within subsect. *Sphaerocarpaceae*.

71. *Hopea glaucescens* SYM. J. Mal. Br. R. As. Soc. 19 (1941) 142, pl. 2; Mal. For. Rec. 16 (1943) 126, f. 69. — *Hopea* sp. nov. SYM. J. Mal. Br. R. As. Soc. 14 (1936) 348.

Medium-sized, smooth-barked tree, often stilt-rooted. Panicles sparsely persistently puberulent, twigs and petioles fugaceous so, petals outside persistently densely gold pubescent. *Twig* 2–3 mm \varnothing apically, becoming dark brown, terete; with prominent ribs along the leaf traces; stipule scars minute. *Bud* to 2 by 2 mm, ovoid; *stipules* fugaceous. *Leaves* 9–18 by 3.5–9 cm, \pm elliptic, coriaceous, glaucescent beneath in mature trees; base cuneate; acumen to 1 cm long, slender, prominent; nerves 12–15 pairs, slender but relatively prominent beneath, obscure above, with many distinct short secondary nerves; tertiary nerves slender, subscalariform, evident to obscure in mature trees; midrib distinctly elevated on both surfaces; *petioles* 10–15 mm long. *Panicle* to 4 cm long, terminal or axillary to ramiflorous, with to 2 cm long branchlets bearing to 8 congested secund flowers. *Flower bud* to 4 by 3 mm, ovoid. *Sepals* subequal, broadly ovate, the outer 2 subacuminate, the inner 3 mucronate. *Stamens* 15; filaments broadly compressed at base, tapering and filiform distally; appendages aristate, c. $3 \times$ length of the small subglobose anthers; *style* and *stylopodium* hour-glass-shaped, equal in height but the ovary the broader; style short, tapering. *Fruit pedicel* to 1 mm long, slender. 2 longer *calyx lobes* to 7 by 1.5 cm, spatulate, obtuse, c. 5 mm broad above the

to 8 by 5 mm ovate saccate thickened base; 3 shorter lobes to 20 by 5 mm, linear-lorate, similar at base, completely enclosing nut. *Nut* to 9 by 7 mm, ovoid, apiculate.

Distr. *Malesia*: Malaya.

Ecol. Rare, below 500 m, in Mixed Dipterocarp forest.

Vern. *Mĕrawan kĕlabu*, *m. galor*, *m. jangkang*, *m. tĕngkok biawak*.

72. *Hopea wyatt-smithii* WOOD ex ASHTON, Gard. Bull. Sing. 19 (1962) 260, pl. 4; Man. Dipt. Brun. (1964) 113, f. 12; *ibid.* Suppl. (1968) 58; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 227, f. 33. — Fig. 74B–B4.

Small to medium-sized smooth-barked prominently stilt-rooted tree. All parts glabrous but for petals and ovary. *Twig* c. 1 mm \varnothing apically, smooth. *Bud* to 1.5 mm long, ovoid. *Stipule* to 2 mm long, linear, fugaceous. *Leaves* 9–14 by 5.5–9 cm, broadly ovate to elliptic, undersurface sparsely greyish lepidote; base broadly cuneate, occasionally obtuse; acumen caudate to 2 cm long; nerves 4–8 pairs, well spaced, irregularly disposed owing to frequent presence of short but prominent secondaries; slender, slightly raised beneath, basal 2–3 pairs straight, at first decurrent with midrib, distal pairs curved at 40°–50°; tertiary nerves well spaced, scalariform, at 90° or ascending; midrib slender, applanate beneath acute above; *petiole* 1.2–1.7 cm long. *Panicle* to 6 cm long,

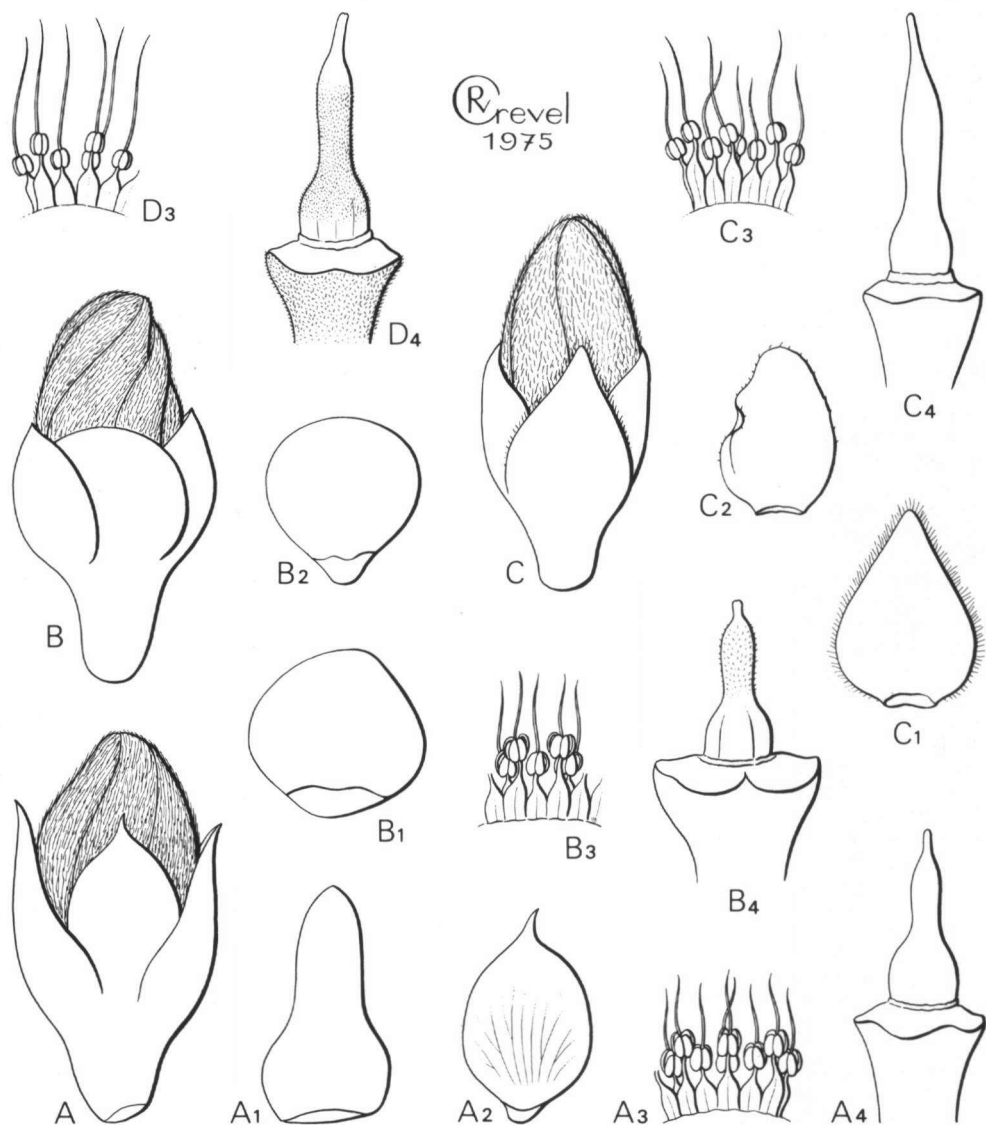


Fig. 74. Flower details in *Hopea* sect. *Hopea* subsect. *Pierrea* (HEIM) ASHTON. All $\times 10$. Sepals drawn from inside. — *Hopea philippinensis* DYER. A. Bud, A1. outer sepal, A2. inner sepal, A3. stamens from inside, A4. pistil. — *H. wyatt-smithii* WOOD ex ASHTON. B. Bud, B1. outer sepal, B2. inner sepal, B3. stamens from inside, B4. pistil. — *H. bilitonensis* ASHTON. C. Bud, C1. outer sepal, C2. inner sepal, C3. stamens from inside, C4. pistil. — *H. apiculata* SYM. D3. Stamens from inside, D4. pistil (A RAMOS & EDAÑO BS 31296, B WOOD 15061, C bb. 23087, D KEP 98175).

terminal or to 2-axillary, glabrous, terete or \pm compressed; singly branched, branchlets to 1.5 cm long, bearing to 6 secund flowers; *bracteoles* small, deltoid, glabrous. *Flower bud* to 3 mm long, subglobose. *Calyx* glabrescent, with a shortly fimbriate margin, spreading; lobes subequal, broadly ovate to suborbicular, obtuse. *Petals* dark red, oblong-lanceolate, obtuse, densely pubescent on parts exposed in bud. *Stamens* 15; filaments broad at base, tapering abruptly; anther broadly oblong, cells subequal; appendage to connective about twice length of anther, slender. *Ovary* and *stylopodium* narrowly hour-glass shaped; ovary glabrous, *stylopodium* somewhat longer than ovary, puberulent, crowned by a short glabrous style. *Fruit calyx* entirely glabrous; 5 lobes equal, to 10 by 8 mm, ovate, subacute, shallowly saccate, thickened, closely imbricate and adpressed to the nut. *Nut* to 1.2 cm long and \emptyset , ovoid, acute, enclosed by calyx but for an up to 3 mm \emptyset apical gap.

Distr. *Malesia*: Borneo (Sarawak N.E. of the Lupar, S.W. and S.E. Sabah).

Ecol. Local, on clay rich soils in Mixed Dipterocarp forest on low hills.

Vern. *Mĕrawan puteh* (Brun.), *sĕlangan daun bulat* (Sabah).

73. *Hopea polyalthioides* SYM. J. Mal. Br. R. As. Soc. 19, 2 (1941) 146, pl. 4; Mal. For. Rec. 16 (1943) 140, f. 69.

Small monopodial smooth-barked tree. Twig and petiole densely persistently fulvous tawny pubescent, leaf undersurface and midrib above sparsely so; panicle glabrous. *Twig* c. 3 mm \emptyset apically, stout, terete, becoming dark brown, with a prominent short rib at first following the leaf trace; internodes 1–5 cm long; stipule scars obscure; *stipules* unknown. *Leaves* (8–)14–27 by (2.5–)4–6 cm, narrowly oblong-lanceolate, coriaceous; base subcordate; acumen short, broad; nerves 10–13 pairs, arched and becoming wavy at the margin, prominent beneath, \pm obscure above, sometimes with a few short indistinct secondary nerves; midrib stout and prominent beneath, slender, elevated to shallowly channelled, above; *petiole* 5–8 mm long, c. 3 mm \emptyset , short, stout. *Panicles* to 11 cm long, very slender, laxly shortly branched; flowers and fruit unknown.

Distr. *Malesia*: Malaya (S. Johore).

Ecol. Rare, in well-drained forest.

Vern. *Giam rambai*, *rĕsak*, *r. rambai*, *sĕlubar*.

74. *Hopea cagayanensis* (FOXW.) SLOOT. Reinwardtia 3 (1956) 318. — *Balanocarpus cagayanensis* FOXW. Philip. Journ. Sc. 13 (1918) Bot. 194, pl. 2; *ibid.* 67 (1938) 285, pl. 3; MERR. En. Philip. 3 (1923) 101; REYES, Philip. J. Sc. 22 (1923) 335; SYM. Gard. Bull. S. S. 8 (1934) 17, 32.

Large, flaky-barked tree. Twigs, leaf bud, stipules, petioles, domatia and parts of petals exposed in bud densely persistently tawny pubescent; nerves and midrib above caducously so; panicle and nerves and midrib beneath sparsely caducously so. *Twigs* c. 1 mm

\emptyset apically, slender, much branched, becoming smooth, terete. *Buds* c. 2 by 1 mm, small, ovoid; *stipules* to 4 mm long, linear, not at first caducous. *Leaves* 8–10 by 2.5–4 cm, lanceolate, thinly coriaceous; base unequal, broadly cuneate or obtuse on the adaxial side, subcordate on the abaxial; acumen to 1.5 cm long, slender, subcaudate; nerves 9–12 (to 14 in young trees) pairs, slender but prominent beneath, applanate above, arched, at 55°–65°, with domatia; secondary nerves short, obscure; tertiary nerves densely scalariform, evident and \pm elevated beneath; midrib slender but evident and distinctly elevated on both surfaces; *petiole* 5–7 mm long, short. *Panicle* to 5 cm long, to 2-axillary, slender; singly branched, branchlets bearing to 3 flowers; *bracts* and *bracteoles* to 1 mm long, minute, deltoid, not at first caducous. *Flower bud* to 2.5 by 1.5 mm, ellipsoid. *Sepals* subequal, broadly ovate, shortly acuminate. *Stamens* 15, shorter than style, in 3 \pm unequal verticils; filaments broad and compressed at base, tapering and filiform in the distal $\frac{1}{2}$; anthers broadly oblong; appendages c. twice length of anther, slender. *Ovary* small, ovoid, tapering into an equally long somewhat narrower cylindrical punctate *stylopodium* and shorter columnar style. *Fruit* subsessile; *sepals* short, subequal; adpressed to the nut; outer 2 to 9 by 7 mm, ovate-acuminate, incrassate; inner 3 to 10 by 10 mm, broadly ovate, obtuse, thin. *Nut* to 15 by 10 mm, ovoid, apiculate, \pm thinly resin-coated.

Distr. *Malesia*: Philippines (N.E. Luzon: Cagayan Prov.).

Ecol. Locally frequent, semi-evergreen forests.

Uses. House posts.

Vern. *Narek*.

75. *Hopea paucinervis* PARUS in Fedde, Rep. 33 (1933) 243.

Medium-sized tree. Young parts fugaceous buff puberulent. *Twigs* slender. *Stipules* fugaceous, unknown. *Leaf* 4.5–8 by 2.5–4.5 cm, ovate-lanceolate, coriaceous; base subequal, obtuse or broadly cuneate; apex shortly acuminate; nerves 7–10 pairs, ascending, curved, prominent beneath; tertiary nerves subscalariform, elevated beneath. *Petiole* 8–12 mm long. *Panicle* to 4 cm long, to 2-axillary, axillary to ramiflorous. Buds and opened flowers and fruit are unknown. *Sepals* of old flowers unequal, ovate-lanceolate. *Stamens* 15, in 3 \pm unequal verticils; filaments lorate, tapering in distal $\frac{1}{2}$; anthers oblong; appendages equal to anther, short. *Ovary* and *stylopodium* equal, overall pyriform with prominent intermediate construction.

Distr. *Malesia*: S.E. Sumatra (Djambi).

76. *Hopea apiculata* SYM. Gard. Bull. S. S. 8 (1935) 277, pl. 21; Mal. For. Rec. 16 (1943) 120, f. 69, 70. — Fig. 74 D3–D4.

Small smooth-barked tree with sharp, often stilted buttresses. Twigs caducous tawny puberulent, petioles and outside of petals densely persistently pubescent, otherwise glabrous. *Twigs* c. 2 mm \emptyset apically, straight, infrequently branched, pendant,

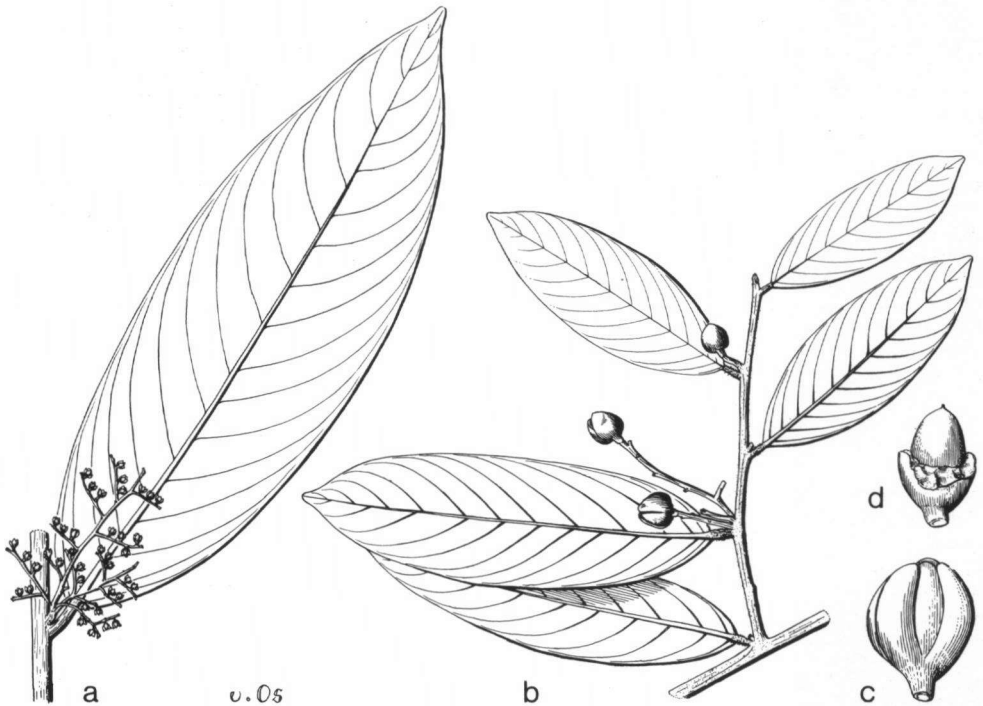


Fig. 75. *Hopea pachycarpa* (HEIM) SYM. *a*, Node with leaf and inflorescence, *b*, branch with young fruits, *c*, ripe fruit, *d*, ditto with sepals removed, all $\times \frac{1}{2}$ (*a* S 22406, with flowers of ANDERSON S 15408, *c-d* bb. 35260).

terete, pale brown; stipule scars minute, horizontal; leaves distant. *Buds* minute; *stipule* small, linear, caducous. *Leaves* alternate, 12–26 by 4–8 cm, narrowly oblong-lanceolate, subcoriaceous; base cordate, equal; acumen short; nerves 12–15 pairs, the first 2–3 arising from the base, slender but prominent beneath, shallowly depressed above, arched; midrib prominent beneath, obscure and depressed or sometimes evident and elevated above; tertiary nerves densely subreticulate, evident beneath, obscure above; *petiole* 6–12 mm long, *c*. 3 mm \varnothing , stout. *Panicles* to 20 cm long, terminal or ramiflorous, borne densely along the twigs, slender, laxly branched; branchlets to 2 cm long, unbranched, bearing to 6 secund flowers. *Flower bud* to 5 by 3 mm, ovoid; sepals ovate-lanceolate, fimbriate, acuminate, the outer 2 somewhat larger, sometimes obtuse; *petals* pale yellow. *Stamens* 15, filaments dilated at base, tapering; appendages very slender, 4–5 times as long as subglobose anthers. *Ovary* and *stylopodium* hour-glass-shaped, the latter somewhat the larger, with intervening frequently puberulent constriction; style columnar, shorter than ovary. Fruit pedicel to 1 mm long, short. *Sepals* to 2.5 by 0.5 cm but usually shorter than

nut (variable, even on one tree), unequal to subequal, spatulate to ovate-acuminate, thickened and saccate at base; *nut* to 20 by 12 mm, ovoid, prominently apiculate.

Distr. Malesia: Malaya (Perak). SMITINAND (Thai For. Bull., Bot. 12, 1980, 45) records this also from Peninsular Thailand and S. Burma (Kemas); I have not seen this material.

Ecol. Very local, common in two valleys east of the Keledong Saiong range.

Vern. *Mëlukut, resak mëlukut.*

77. *Hopea pachycarpa* (HEIM) SYM. Gard. Bull. S. S. 8 (1934) 30, pl. 8; BROWNE, For. Trees Sarawak & Brunei (1955) 125; ASHTON, Man. Dipt. Brun. (1964) 105, f. 12; *ibid.* Suppl. (1968) 54; Gard. Bull. Sing. 22 (1967) 271; *ibid.* 31 (1978) 35. — *Pierrea pachycarpa* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 958; Rech. Dipt. (1892) 78, pl. 7; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 268; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 113; MERR. En. Born. (1921) 408; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 263. — *Balanocarpus pubescens* RIDL. Fl. Mal. Pen. 1 (1922) 247; Foxw. Mal. For. Rec. 10 (1932) 147; SYM. Gard. Bull. S. S. 8

(1934) 28, 32; BURK. Dict. (1935) 288. — *Pierreocarpus pachycarpa* RIDL. ex SYM. Gard. Bull. S. S. 8 (1934) 30, *nomen in syn.* — *H. laxa* SYM. Gard. Bull. S. S. 8 (1934) 33, pl. 9; BROWNE, For. Trees Sarawak & Brunei (1955) 125; cf. ASHTON, Gard. Bull. Sing. 22 (1967) 271; ASHTON, Man. Dipt. Brun. Suppl. (1968) 54. — *H. resinosa* SYM. Gard. Bull. S. S. 8 (1935) 278, pl. 23; Mal. For. Rec. 16 (1943) 141, f. 68B, 69. — Fig. 75, 76.

Young twig, leaf bud, stipule outside (glabrous within) and petiole shortly persistently pale fawn tomentose; leaf glabrous. *Twig* to 2 mm \varnothing apically, terete, becoming smooth. *Bud* to 2.5 by 2 mm, ovoid to globose. *Stipule* to 4 mm long, linear, fugaceous. *Leaves* 13–22 by 4–7 cm, thinly coriaceous, elliptic to lanceolate, with or without silvery lepidote undersurface; base subequal, cuneate on one side, obtuse on the other; acumen to 1 cm long, narrow; nerves (10–)13–17 pairs, slender but distinctly raised beneath, at 45°–55° but curving round to run parallel to the margin before terminating at it, with small tomentose domatia; tertiary nerves slender, densely scalariform, sinuate, diagonal to nerves; midrib rounded, raised on both surfaces; *petiole* 7–10 mm long, short, stout. *Panicle* to 8 cm long, axillary to ramiflorous, terete, puberulent or glabrescent, to 2-axillary, rarely branched; *bracteoles* to 2 mm long, linear, not at first caducous. *Flower bud* to 4 by 2.5 mm, broadly ellipsoid. *Calyx* glabrous but for the fimbriate margin; 2 outer lobes broadly ovate, subacute; 3 inner lobes broader, slightly shorter, subacuminate. *Petals* broadly oblong, glabrescent, strongly contorted in bud. *Stamens* 15, in 3 unequal verticils, the 5 inner anther's length longer than the 10 outer; filaments broad at base, tapering, filiform distally; anthers subglobose; appendage to connective slender, 2–3 times length of anther, glabrous. *Ovary* small, ovoid, glabrous; style and stylopodium spindle-shaped, glandular-papillose towards apex, tapering into short glabrous style. *Fruit* entirely glabrous. 5 *calyx lobes* subequal, to 2 by 1.5 cm, ovate, subacute, thickened, deeply saccate, closely adpressed to nut; apex of nut visible only at 5 mm \varnothing apical gap. *Nut* to 1.5 cm \varnothing , subglobose; style remnant short, abrupt, acute.

Distr. *Malesia*: Malaya (Pahang, E. Johore), Central Sumatra, Ankola in W. Sumatra, Borneo (Ulu Kapuas, Sarawak, Brunei, Berau).

Ecol. Locally abundant on moist soils on lower hillsides and alluvium in Mixed Dipterocarp forest.

Vern. *Bayan*, *mĕrawan mata kuching* (Mal.), *mĕlapi bĕrjangkang* (Kapuas), *mĕrkoyong* (Sar.).

78. *Hopea bilitonensis* ASHTON, Gard. Bull. Sing. 31 (1978) 35. — Fig. 74 C–C4.

Small smooth-barked tree with stilt roots. Leaf buds and parts of petals exposed in bud densely tawny pubescent, young twigs and panicles fugaceous so, otherwise glabrous. *Twigs* c. 1 mm \varnothing apically, slender, much branched, red-brown, terete, smooth. *Leaf buds* c. 1 by 1 mm, ovoid, acute; *stipules* unknown,

fugaceous. *Leaves* 7.5–16 by 3.5–6 cm, ovate-lanceolate, \pm chartaceous, lustrous; base obtuse to subcordate, subequal; acumen to 2 cm long, attenuate; nerves 6–8 pairs, slender but prominent beneath, applanate above, arched, at 50°–60°; secondaries absent; tertiary nerves remotely subscalariform, evident and distinctly elevated beneath; *petiole* 6–8 mm long, short. *Panicle* to 18 cm long, slender, axillary, solitary, lax, pendant; twice branched, branchlets to 4 cm long, bearing to 6 flowers; *bracts* and *bracteoles* minute, deltoid, caducous. *Flower bud* to 3 by 2 mm, lanceolate. *Sepals* fimbriate; 2 outer deltoid, subacute; 3 inner ovate, subacute. *Stamens* 15, in 3 unequal verticils, shorter than style at anthesis; filaments somewhat slender, compressed at base, tapering distally and filiform beneath the small subglobose anthers; appendages c. 3½ times as long as anthers, very long and slender, \pm crisped. *Ovary* small, ovoid, with somewhat longer oblancoolate stylopodium and short terminal style. *Fruit pedicel* to 2 mm long, stout. 2 longer *calyx lobes* to 5 by 1.2 cm, broadly spatulate, obtuse, c. 7 mm broad above the to 7 by 4 mm subauriculate centrally thickened base; 3 shorter lobes to 9 by 6 mm, ovate, acuminate, shorter than nut. *Nut* to 10 by 6 mm, ovoid, prominently slender apiculate.

Distr. *Malesia*: E. Sumatra (Banka and Billiton); Malaya (Perak, once).

Ecol. Locally common in lowland forest, once recorded from limestone in N.W. Malaya.

Vern. *Pĕlepak*.

Notes. An interesting species, locally common on the sandy islands of Banka and Billiton and now recorded from limestone in a distinctly disjunct position in relatively seasonal N.W. Malaya, a range that has apparently become disjunct since the Pleistocene.

Though an isolated species on account of its leaves, solitary axillary inflorescences and small fruit, the leaves nonetheless recall those of the anomalous *H. polyalthioides* SYM. of East Johore, still unknown in flower or fruit, though they differ in size and shape.

79. *Hopea bullatifolia* ASHTON, Gard. Bull. Sing. 22 (1967) 274, pl. 18; Man. Dipt. Brun. Suppl. (1968) 48, f. 6.

Small smooth-barked stilt-rooted tree. Leaf bud, stipule outside (glabrous within), petiole and midrib beneath densely persistently evenly tawny pubescent, nervation and lamina beneath and midrib above sparsely so. *Twig* c. 2 mm \varnothing , terete, becoming smooth. *Bud* to 1 by 1 mm, small, subglobose. *Stipule* to 4 mm long, linear, caducous. *Leaves* 16–34 by 4.5–9 cm, oblong, prominently bullate between the tertiary nerves; base cordate, subequal; acumen to 1 cm long, slender; nerves 17–26 pairs, slender but prominent beneath, depressed above, at 35°–45°, frequently linked to form a looped intramarginal nerve distally; tertiary nerves scalariform, prominent beneath, depressed above; midrib prominent on both surfaces; *petiole* 3–6 mm long, short, stout. *Flowers* unknown.

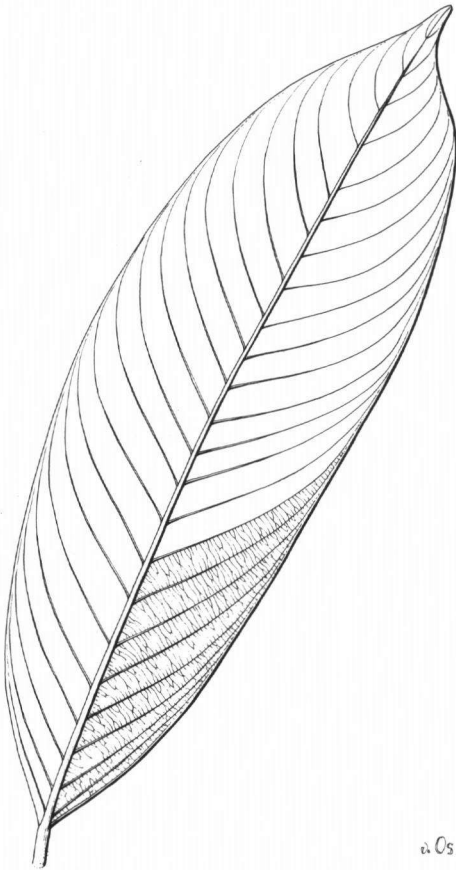


Fig. 76. *Heopea pachycarpa* (HEIM) SYM. Leaf from sterile branch, $\times \frac{1}{2}$ (S 22035).

Inflorescences unknown. *Fruit* entirely glabrous; 2 longer *calyx lobes* to 8 by 1.5 cm, spatulate, obtuse, c. 4 mm broad above the to 8 by 3 mm ovate thickened saccate base; 3 shorter lobes to 15 mm long, lanceolate, acute, slender, similar at base, enclosing the nut. *Nut* c. 10 by 7 mm, ovoid, apiculate, enclosed in the sepals.

Distr. Malesia: Borneo (Central Sarawak; S.E. Kalimantan, Pulau Laut).

Ecol. Rare, in Mixed Dipterocarp forest on shale knolls.

80. *Heopea pterygota* ASHTON, Gard. Bull. Sing. 22 (1967) 280, pl. 26; Man. Dipt. Brun. Suppl. (1968) 55, f. 8.

Small tree. Vegetative parts at first densely pale tawny pubescent, caducous first on lamina, nervation beneath, petiole and then twig, persistent on buds and

stipules. *Twig* c. 2 mm \varnothing apically, becoming smooth, glabrous. *Bud* to 2 by 1 mm, ovoid, acute. *Stipule* to 4 mm long, linear, caducous. *Leaves* 12–28 by 5–9 cm, oblong-lanceolate to oblanceolate; base obtuse to subcordate, unequal, the larger side adjacent to the twig; acumen to 2 cm long, subcaudate; margin somewhat revolute; nerves 12–21 pairs, slender, scalariform, diagonal to midrib and nerves; midrib prominent on both surfaces, more so beneath than above; *petiole* 3–8 mm long, short, stout. *Panicle* to 8 cm long, terete, glabrous, slender, frequently fasciculate, frequently borne up the branches behind the leafy twigs; singly branched, branchlets bearing to 8 second flowers. *Flower bud* to 3 by 2 mm, ellipsoid. *Calyx* glabrous, 2 outer sepals lanceolate, acuminate, 3 inner suborbicular, somewhat shorter, shortly mucronate. *Petals* linear, pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the subglobose anthers; appendage to connective slender, 3–4 times as long as anthers. *Ovary* narrowly ovoid, glabrous, surmounted by a spindle-shaped glabrous stylopodium and style somewhat shorter than the ovary in length. *Fruit* glabrous. *Pedice*l to 1 mm long, short. 2 longer *calyx lobes* to 10 by 1.5 cm, spatulate, chartaceous, c. 4 mm broad above the to 2 cm long, to 7 mm wide paired basal auricles, with a to 5 by 4 mm central basal ovate saccate thickened area; 3 shorter lobes to 3 cm long, with up to 12 by 4 mm tapering subacute lobe above a similar base. *Nut* to 7 by 5 mm, ovoid, acute, entirely concealed by auricles.

Distr. Malesia: Borneo (Sarawak, Brunei).

Ecol. Locally common in Heath forest and ridge tops; podsols and skeletal soils, to 1000 m.

Note. This species is variable in leaf size; some collections of *H. bullatifolia* from Kalimantan approach it, and the two species may eventually prove conspecific.

81. *Heopea philippinensis* DYER, J. Bot. 16 (1878) 100; VIDAL, Phan. Cuming. (1885) 97; Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 64; EVERETT & WHITFORD, Bull. Bur. For. Philip. 5 (1906) 16, 28, 53; WHITFORD, Bull. Bur. For. Philip. 10, 2 (1911) 75; FOXW. Philip J. Sc. 4 (1909) Bot. 515; *ibid.* 6 (1911) Bot. 261; *ibid.* 13 (1918) Bot. 183; *ibid.* 67 (1938) 276; MERR. En. Philip. 3 (1923) 94; REYES, Philip. J. Sc. 22 (1923) 338; SYM. Gard. Bull. S. S. 8 (1934) 32; *ibid.* 8 (1935) 279; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 65, f. 13, pl. 9. — *H. odorata* (non ROXB.) VIDAL, Sinopsis (1883) t. 15, f. A. — Fig. 74 A–A4.

Small, smooth-barked buttressed tree. Twigs, petioles, domatia, leaf bud, stipules and parts of petals exposed in bud densely persistently pale tawny pubescent; midrib above (densely puberulent in young trees) and panicle glabrescent. *Twig* c. 2 mm \varnothing apically, ribbed, becoming terete, red-brown. *Buds* small, ovoid; *stipules* to 5 mm long, linear, fugaceous. *Leaves* (7–)12–25 by (2.5–)4–7 cm, narrowly elliptic-oblong to lanceolate, thinly coriaceous; base unequal, cuneate abaxially, cordate adaxially; acumen to 2 cm

long, slender, subcaudate; nerves 17–22 pairs, slender but prominent beneath, obscurely depressed above, arched, at 50°–60°, with axillary tomentose domatia, without secondaries; tertiary nerves densely scalariform, very slender but evident and distinctly elevated beneath; midrib slender but prominent beneath, elevated above; *petiole* 5–7 mm long, short. *Panicle* to 5 cm long, 1-axillary to ramiflorous, slender, rather lax, singly branched; branchlets to 1.5 cm long, bearing to 4 flowers; *bracteoles* minute, deltoid, fugaceous. *Flower bud* to 3 by 2 mm, ellipsoid. 2 outer *sepals* lanceolate-acuminate; 3 inner broadly ovate, shortly acuminate. *Stamens* 15, slightly shorter than style at anthesis; filaments compressed at base, tapering and filiform in the distal $\frac{1}{3}$; anthers subglobose; appendages c. 2½ times length of anthers, slender. *Ovary* and *stylopodium* hour-glass shaped, the ovary slightly the broader; style short but distinct. *Fruit pedicel* short, base of fruit impressed. 2 longer *calyx lobes* to 12 by 3 cm, spatulate, obtuse, c. 3 mm broad above the to 9 by 8 mm ovate deeply saccate thickened base; 3 shorter lobes to 7 by 8 mm, broadly ovate, mucronate, shorter than nut. *Nut* to 11 by 8 mm, broadly ovoid, shortly apiculate.

Distr. *Malesia*: Philippines.

Ecol. Widespread and common in evergreen non-seasonal forest on hills to 500 m.

Vern. *Bagitarim* (Tag.), *baguatsan*, *bagupsan* (Bik.), *bantaya* (S. L. Bis.), *gisok* (P. Bis., Mbo., Lan., C. Bis.), *gisok gisok* (P. Bis., Sul., Sh. Bis.), *gisok nga-salngan* (S. L. Bis.), *kuli lisian*, *maka tayring* (Tag.), *malatamban* (Bik.), *malibato* (Mbo.), *mang-laum* (Tag.), *malalamba*, *malatagum*, *pagak son* (Bik.), *paina* (Tag.), *pongo*, *subigan* (S. L. Bis.).

82. *Hopea mindanensis* FOXW. Philip. J. Sc. 6 (1911) Bot. 261, pl. 43; *ibid.* 13 (1918) Bot. 183; *ibid.* 67 (1938) 277; MERR. En. Philip. 3 (1923) 93; REYES, Philip. J. Sc. 22 (1923) 334; SYM. Gard. Bull. S. S. 8 (1934) 32; GUTIERREZ, Act. Manil. 4, A, 2 (1968) 63, f. 12, pl. 8.

Medium-sized hard-wooded tree, with blackish flaky bark. Twigs, petioles, leaf buds and domatia ± persistently pale tawny pubescent, parts elsewhere glabrescent. *Twig* c. 5 mm \varnothing apically, stout, becoming terete, pale brown. *Leaves* 30–60 by 9.5–18 cm, large, narrowly oblong, thinly coriaceous; base unequal, cordate; acumen to 3 cm long, prominent; nerves 22–28 pairs, prominent beneath, ± shallowly depressed above ascending at 50°–60°, straight but arched at the margin and running along parallel to it before terminating; with small pubescent pore-like axillary domatia; tertiary nerves ± densely scalariform, very slender but distinctly elevated beneath; *petiole* 15–18 mm long, c. 5 mm \varnothing , short, relatively stout, *panicle* to 6 cm long, short, to 2-axillary or ramiflorous, singly branched. *Flower buds* to 3 by 2 mm, ovoid-lanceolate. 2 outer *sepals* ovate, acuminate; 2 inner suborbicular, acute. *Stamens* 15, subequal; filaments compressed, rather broad, tapering; appendages very slender, c. 1½ as the ellipsoid anthers. *Ovary* ovoid, surmounted by a prominent

spindle shaped stylopodium of equal length, with a prominent intervening constriction; style shorter than stylopodium but prominent, tapering. *Fruit pedicel* short; 2 longer *calyx lobes* to 11 by 15 cm, narrowly spatulate, obtuse, c. 3 mm broad above the to 9 by 7 mm ovate saccate thickened base; 3 shorter lobes to 12 by 8 mm, ovate, thin, saccate, appressed to nut; *nut* to 12 by 8 mm, ovoid, prominently apiculate, resinous.

Distr. *Malesia*: Philippines (Mindanao).

Ecol. Frequent in lowland evergreen forest.

Vern. *Bagasusu* (Zamboanga), *magasusu* (Sulu), *ganon* (Sub.), *yakal magasusu* (official name).

83. *Hopea tenuinervula* ASHTON, Gard. Bull. Sing. 22 (1967) 281, pl. 27, 349 (phot. habit); Man. Dipt. Brun. Suppl. (1968) 57. — *H. philippinensis* (non DYER) ASHTON, Man. Dipt. Brun. (1964) 107, f. 12.

Small to medium-sized stilt-rooted tree with papery flaky bark. Young vegetative parts densely pale tawny tomentose, persistent on buds and stipules, ± persistent on nervation beneath and midrib above; elsewhere caducous. *Twig* to 2 mm \varnothing apically, becoming smooth, glabrous. *Bud* to 3 by 1.5 mm, lanceolate. *Stipule* to 5 mm long, linear, subsistent. *Leaves* alternate, 10–27 by 3–5.5 cm, narrowly ovate to lanceolate; base obtuse, pronouncedly unequal, the larger side adjacent to the twig, acumen to 1 cm long, narrow; margin revolute; nerves 12–21 pairs, slender, prominent beneath, at 50°–60°; curving and running parallel to margin before terminating at it; tertiary nerves slender, densely scalariform, at 90°; midrib rounded, raised on both surfaces; *petiole* 3–7 mm long, short, stout. *Panicle* to 8 cm long, to 2-axillary, rarely terminal, terete, lax, glabrous; singly branched, branchlets to 3 cm long, bearing to 4 second pale yellow flowers; *bracteoles* to 1 mm long, deltoid, glabrous, subsistent. *Bud* to 4 mm long, ellipsoid, subsessile. *Calyx* glabrous but for fimbriate margin; 2 outer lobes narrowly ovate, prominently acuminate; 3 inner lobes suborbicular to broadly ovate, mucronate. *Petals* oblong, lanceolate, acute, densely pubescent on parts exposed in bud, otherwise glabrous. *Stamens* 15; filaments broad at base, tapering; anthers oblong-ellipsoid; appendage to connective slender, about twice length of anther. *Ovary* ovoid, glabrous; stylopodium as long as ovary, spindle-shaped, glabrous, indistinct from style. *Fruit* entirely glabrous; 2 longer *calyx lobes* to 10 by 1.7 cm, spatulate, narrowly obtuse, to 2 mm broad above the to 6 by 4 mm narrowly ovate prominently saccate thickened base; 3 shorter lobes to 3 cm long, subequal, acute, slightly auriculate at the to 7 mm broad base but otherwise similar. *Nut* to 12 by 8 mm, ovoid, almost completely enveloped by shorter calyx lobes; style remnant short, acute.

Distr. *Malesia*: Borneo (Sarawak, Brunei, S.E. Borneo).

Ecol. Locally abundant on leached sandy soils in Mixed Dipterocarp forest on low hills near Pleistocene coastlines.

Vern. *Mérawan daun serong*.

84. *Hopea enicosanthoides* ASHTON, Gard. Bull. Sing. 22 (1967) 276, pl. 21; Man. Dipt. Brun. Suppl. (1968) 50, f. 6.

Small smooth-barked stilt-rooted tree. Young twigs, buds, stipules, petioles and base of midrib above caducous pale tawny pubescent or glabrous. *Twig* c. 3 mm \varnothing , terete to somewhat compressed, smooth, prominently ribbed below the petiole insertion; stipule scars short, obscure. *Bud* to 2 by 1 mm, conical, acute. *Stipule* to 8 mm long, linear, subsistent. *Leaf* (16-)27-46 by (5-)8-15 cm, very large, oblong, coriaceous, prominently convex between the depressed nerves on the upper face; base cordate, unequal; acumen to 2.5 cm, long, slender; nerves 16-30 pairs, slender but prominent beneath; tertiary nerves densely scalariform, slender but evident beneath; *petioles* 5-8 mm long, short, stout. *Flowers* unknown. *Panicle* and *fruit* entirely glabrous. *Panicle* to 12 cm long, axillary to ramiflorous, frequently to 2-axillary, terete, lax, singly branched; branchlets to 3 cm long, ascending, bearing to 5 flowers; *bracteoles* c. 2 mm long, linear, subsistent. *Pedicele* c. 1 mm long, short. 2 longer calyx lobes to 13 by 3 cm, \pm broadly spatulate, obtuse, c. 6 mm broad above the c. 12 by 10 mm ovate thickened saccate base; 3 shorter lobes to 20 mm long, lanceolate, acute, similarly saccate but hardly thickened at base, enfolding the nut. *Nut* to 10 by 6 mm, ovoid; style remnant to 2 mm long, filiform.

Distr. *Malesia*: Borneo (Sarawak, from the Rejang R. to Miri).

Ecol. On low, damp hillsides and, most frequently, banks of sluggish or tidal, but not brackish rivers, but

apparently intolerant of prolonged root immersion. Locally frequent.

Dubious

Hopea parvifolia (WARB.) SLOOT. Reinwardtia 2 (1952) 37. — *Anisoptera parvifolia* WARB. Bot. Jahrb. 13 (1891) 382; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 45; DIELS, Bot. Jahrb. 57 (1922) 461; SLOOT. Bull. Jard. Bot. Btzg III, 8 (1926) 5 (misspelt *A. parviflora*); Nova Guinea 14 (1926) 225.

Nothing is known of this species apart from the inadequate original description; the type (WARBURG 20034) has not been found by myself and was not seen by BRANDIS or VAN SLOOTEN either. It was apparently in fruit, though it is not even possible from the description to be certain of the genus.

Excluded

Hopea gracilis MIQ. Sum. (1860) 490; DC. Prod. 16, 2 (1868) 635. BURCK (Ann. Jard. Bot. Btzg 6, 1887, 237) correctly excluded this species, based on a sterile TEYSMANN collection from Padang, Sumatra at Utrecht, from the family. Its correct identity remains obscure.

Hopea siranda MIQ. Sum. (1860) 489 = *Annonaceae*.

Hopea sumatrana KING ex GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 249, *nomen*. Quoted as producing resin of high quality. There is no other record of this name, which was certainly never published by KING.

10. SHOREA

ROXB. ex GAERTN. f. Fruct. 3 (1805) 48; ROXB. Pl. Corom. 3 (1815) t. 212; B. & H. Gen. Pl. 1 (1862) 193; DC. Prod. 16, 2 (1868) 628; DYER, Fl. Br. Ind. 1 (1874) 303; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 204; HEIM, Rech. Dipt. (1892) 36, *incl. sect. Anthoshorea* HEIM, l.c. 41, *sect. Hopeoides* HEIM, l.c. 43, *sect. Pachycarpae* HEIM, l.c. 44, *sect. Richetioides* HEIM, l.c. 48; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 73, *incl. sect. Pinanga* BRANDIS, l.c. 90, *sect. Mutica* BRANDIS, l.c. 100; FOXW. Philip. J. Sc. 67 (1938) 290, *incl. sect. Isoptera* (SCHEFF. ex BURCK) FOXW. l.c. 291, 301; SYM. Mal. For. Rec. 16 (1943) 1; MEIJER, Act. Bot. Neerl. 12 (1963) 322, *incl. subg. Richetia* (HEIM) MEIJER, *nom. inval.*, *subg. Rubroshorea* MEIJER, l.c. 322; ASHTON, Gard. Bull. Sing. 20 (1963) 261, *incl. sect. Neohopea* ASHTON, l.c. 266, *sect. Rubella* ASHTON, l.c. 267, *sect. Ovalis* ASHTON, l.c. 268; Man. Dipt. Brun. (1964) 115; *ibid.* Suppl. (1968) 60; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 48; ASHTON, Blumea 20 (1972) 360; Gard. Bull. Sing. 31 (1978) 36, *incl. sect. Pentacme* (A. DC.) ASHTON, l.c. 38; SMITINAND, Thai For. Bull. (Bot.) 12 (1980) 57. — *Saul* ROXB. ex W. & A. Prod. (1834) 84, *nomen*. — *Doona* THW. in Hook. Kew J. 3 (1851) t. 12; *ibid.* 4 (1852) 7; DYER, Fl. Br. Ind. 1 (1874) 311; *cf.* ASHTON, Blumea 20 (1972) 361. — *Pentacme* A. DC. Prod. 16, 2 (1868) 626; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 72; SYM. Mal. For. Rec. 16 (1943) 104, f. 63 (map). — *Isoptera* SCHEFF. ex BURCK, Med. Lands Pl. Tuin 3 (1886) 27; BRANDIS,

J. Linn. Soc. Bot. 31 (1895) 105. — *Ridleyinda* O. K. Rev. Gen. Pl. 1 (1891) 65. — *Richetia* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 975. — *Anthoshorea* PIERRE ex HEIM, Rech. Dipt. (1892) 41, *nomen in syn.* — *Parahoepa* HEIM, l.c. 66. — *Pachychlamys* (DYER ex KING) DYER ex RIDL. Fl. Mal. Pen. 1 (1922) 233. — Fig. 77–118.

Medium-sized or large buttressed trees without stilt-roots; mature crown large, hemispherical or dome-shaped, sympodial. *Inflorescence* paniculate. *Calyx lobes* free to receptacle; 3 outer lobes thicker, somewhat longer, narrower, than 2 inner lobes in flower. *Petals* usually connate at base on falling, sometimes free. *Stamens* 10–∞; filaments variable, lorate to filiform; anthers subglobose to narrowly oblong; appendage to connective vestigial or prominent. *Ovary* tomentose, rarely glabrous; style with or without a distinct stylopodium. 3 outer fruit *calyx lobes* usually much longer than 2 inner lobes, thin, spatulate; or all lobes subequal; base of lobes ± thickened, expanded, saccate. *Nut* free from calyx, pericarp splitting irregularly at germination. Unicellular scales, if present, broad-lobed.

Distr. About 194 spp. in Ceylon, India, Burma, Thailand, Indochina, and 163 spp. in *Malesia*: Malaya, Sumatra, Borneo and intervening islands, Java, Philippines and Moluccas. Fig. 79.

Fossil wood has been identified as *Shoreoxylon* from Timor in the Lesser Sunda Islands by SCHWEITZER (Palaeontographica 105B, 1959, 1–66) in which islands *Shorea* does not occur at present.

Ecol. The dominant emergent tree genus of the lowland forests of West Malesia; others occur and often are gregarious on river banks, on podsols and peat swamps; a few are montane, to 1750 m; some do not emerge from the main canopy.

Uses. The most important timber genus in the Asian humid tropics. *Sections Shorea, Pentacme* (Asian species only) and *Neohoepa* yield a hard heavy timber suitable for construction and decking (*balau*, Malaya, *sélangan batu*, Borneo, *yakal*, Philippines); *sect. Richetioides* a yellowish brown light hardwood (*yellow mēranti*, Malaya, *yellow sēraya*, Sabah, *lun*, Sarawak); *sect. Anthoshorea* a white siliceous timber veneers (*white mēranti*, Malaya, *raruk*, Sarawak, *mélapi*, Sabah), and the remaining sections pink, red or occasionally white or brown light medium or sometimes heavy hardwoods favoured for furniture as well as light construction (*red mēranti*, Malaya, *lup, pèrawan*, Sarawak, *red sēraya*, Sabah, *red lauan*, Philippines).

Note. The subdivision of the genus accepted here has been more fully discussed by me in my paper of 1963.

SUBDIVISION OF SHOREA IN MALESIA

1. Appendage to connective barbate, stout, anthers 4-locular, with apices of anterior loculi barbate. Fig. 78, 82
 1. *Sect. Shorea*
2. Flower buds elongate, petals narrow falling separately; appendage to connective sparsely ciliate. Fig. 78. *Spp. 1–28*. 1a. *Subsect. Shorea*
2. Flower buds globose before anthesis; petals short, oblong, connate at base on falling; appendages to connective and apices of anther cells densely barbate. Fig. 82. *Spp. 29–35* 1b. *Subsect. Barbata*
1. Appendages, if barbate surmounting a 2-locular anther, otherwise scabrous or glabrous; anthers glabrous.
3. Anthers linear, prolonged apically into prominent horn-like processes. Fig. 84. *Spp. 36–37*
 2. *Sect. Pentacme*
3. Anthers not as above.
 4. Appendage to connective not exceeding anther-apex, stout; stamens 15; anthers subglobose. Fruit calyx lobes subequal, elongated, much longer than the nut. Fig. 85. *Sp. 38* 3. *Sect. Neohoepa*
 4. Appendage exceeding anther apex or, of short, either slender, recurved or with more than 30 stamens. Fruit calyx lobes subequal but shorter than nut, or unequal, 3 prolonged and spatulate.
 5. Anthers with 2 pollen sacs. Fig. 87, 89 4. *Sect. Richetioides*
 6. Stamens more than 100; anthers lorate. Fig. 87. *Sp. 39*. 4a. *Subsect. Polyandreae*
 6. Stamens at most 17; anthers subglobose or oblong. Fig. 89. *Spp. 40–71* 4b. *Subsect. Richetioides*
 5. Anthers with 4 pollen sacs.
 7. Anthers linear to oblong; filaments lorate or tapering gradually (not abruptly medially); ovary without distinct stylopodium; style at least as long as ovary.
 8. Appendage to connective at least as long as anther, frequently scabrous. Wood yellow or white, with reticulate vessel arrangement in TS. Female silica present. Fig. 91B–C, 92. *Spp. 72–92*
 5. *Sect. Anthoshorea*



Fig. 77. *Shorea falciferoides* Foxw. *a.* Habit, *b.* leaf of seedling 1.2 m high, *c.* fruit, *d.* nut, all $\times \frac{1}{2}$ (*a* SAN 37512, *b* S 5718, *c-d* S 2125).

8. Appendage to connective less than $\frac{1}{4}$ the length of the anther; short, glabrous. Wood pink, with loose oblique vessel-arrangement in TS. Silica absent. Fig. 94, 95. *Spp.* 93–97. 6. *Sect. Rubella*
7. Anthers broadly oblong to subglobose; appendage to connective vestigial, or shorter than the anther and reflexed, or, if long and unreflexed filaments tapering \pm medially or united in a tube round the ovary; stylopodium usually distinct. Wood pink, without silica; pore arrangement oblique, clustered or solitary, variable though never reticulate.
9. Stamens less than 30; filaments compressed and broad at base.
10. Appendage to connective filiform, slender, at least twice as long as the anther, not reflexed; filaments broad at base, tapering abruptly and filiform below the anthers.
11. Filaments broad at base, tapering abruptly medially, filiform, not fixed into a distinct tube round the ovary though frequently connate at base; ovary either with a distinct stylopodium and \pm pyriform, or without and small and ovoid; style filiform. Fig. 91D, 98–100
7. *Sect. Brachypterae*
12. Stamens 24–28. Fig. 98. *Sp.* 98 7a. *Subsect. Smithiana*
12. Stamens 15. Fig. 91D, 99–100. *Spp.* 99–122 7b. *Subsect. Brachypterae*

11. Filaments united into a tube around the base of the ovary, tapering abruptly near apex; stylopodium merging into the style; style and stylopodium spindle-shaped, narrow and tapering at base and apex; or stylopodium indistinct, style at least twice as long as ovary, filiform. Fig. 103, 104. *Spp.* 123–132 8. *Sect. Pachycarpae*
10. Appendage to connective shorter than or as long as the anther, becoming reflexed; filaments tapering gradually from base to anther. Fig. 106, 107 9. *Sect. Mutica*
13. Fruit calyx lobes auriculate at base. Fig. 107. *Spp.* 133–138. 9a. *Subsect. Auriculatae*
13. Fruit calyx lobes not auriculate. Fig. 106. *Spp.* 139–159. 9b. *Subsect. Mutica*
9. Stamens 50–70, appendage to connective vestigial; filaments filiform. Fig. 115. *Sp.* 160 10. *Sect. Ovalis*

KEY TO THE SPECIES*

1. Appendage to connective barbate, stout, anthers 4-locular with apices of anterior loculi barbate. Fig. 78, 82. *Spp.* 1–35. 1. *Sect. Shorea*
2. Flower buds elongate, petals narrow, falling separately; appendage to connective sparsely ciliate. Fig. 78. *Spp.* 1–28. 1a. *Subsect. Shorea*
3. Appendage to connective typically with 1–4 (a few appendages with up to 8) bristles, stamens otherwise glabrous.
4. Stamens more than 50; fruit calyx lobes vestigial though aliform and slightly exceeding ripe nut 1. *S. collina*
4. Stamens at most 30; fruit calyx not as above.
5. Leaf undersurface persistently scabrid pubescent 2. *S. ochrophloia*
5. Leaf undersurface glabrescent.
6. Nerves at least 15 pairs 3. *S. guiso*
6. Nerves at most 14 pairs.
7. Fruit calyx lobes short, subequal 4. *S. havilandii*
7. Fruit calyx lobes unequal, 3 aliform.
8. Stamens at least 40 5. *S. brunnescens*
8. Stamens less than 35.
9. Appendage mostly with a single apical bristle 6. *S. scrobiculata*
9. Appendage with 2–4 bristles.
10. Petiole up to 14 mm long; stamens c. 30 7. *S. leptoderma*
10. Petiole at least 15 mm long; stamens less than 28.
11. Stamens c. 26; leaf lanceolate 8. *S. ciliata*
11. Stamens 20; leaf ovate 9. *S. submontana*
3. Appendage to connective with at least 5 bristles, or shoulder of filaments and usually anther apices setose.
12. Fruit calyx lobes subequal, shorter than nut.
13. Stamens c. 55, nut in fruit up to 5 by 5 cm 10. *S. geniculata*
13. Stamens 25–40, nut in fruit c. 1 by 1 cm.
14. Stamens 30–40 11. *S. seminis*
14. Stamens 25 12. *S. sumatrana*
12. Fruit calyx lobes unequal, 3 longer lobes greatly exceeding nut.
15. Filaments distinctly barbate along the distal lateral margins.
16. Leaf of mature tree not cream or white lepidote beneath 13. *S. foxworthyi*
16. Leaf of mature tree distinctly white or cream lepidote beneath.
17. Stamens at most 24 14. *S. lumutensis*
17. Stamens at least 25.
18. Young twigs compressed.
19. Tomentum on twig and petiole yellow-brown, scabrid; petiole less than 1.5 cm long 15. *S. exelliptica*
19. Tomentum on twig and petiole buff, even; petiole 1.5–2.6 cm long 16. *S. inappendiculata*
18. Twigs entirely terete.
20. Leaf falcate, base subequal, nerves beneath slender.
21. Stamens 33–44 17. *S. falcifera*
21. Stamens 25–32 18. *S. materialis*

* Flowers are unknown from the *spp.* 161–163 which can, for that reason, also not be placed in a section, and are omitted from the key.

20. Leaf subequal, base equal, nerves beneath stout.
22. Stamens 25–33 19. *S. atrinervosa*
22. Stamens 35–46.
23. Petiole 3.5–5 cm long 20. *S. crassa*
23. Petiole 1.2–2 cm long 21. *S. obscura*
15. Filaments glabrous.
24. Stamens more than 40.
25. Leaf subequal, not lepidote beneath; nerves 11–15 pairs, stout beneath . . . 22. *S. lunduensis*
25. Leaf falcate, cream lepidote beneath; nerves less than 12 pairs, slender beneath . . . 23. *S. falciferoides*
24. Stamens 37 or less.
26. Nerves of leaf 16–24 pairs, pilose beneath 24. *S. superba*
26. Nerves of leaf less than 16 pairs, epilose beneath.
27. Nerves 11–16 pairs; domatia if present very small.
28. Stamens *c.* 33; nerves appanate above 25. *S. hypoleuca*
28. Stamens 35–37; nerves narrowly depressed above 26. *S. malibato*
27. Nerves at most 12 pairs, with prominent pore-like axillary domatia.
29. Ovary with prominent stylopodium; stamens *c.* 32 27. *S. astylosa*
29. Ovary without stylopodium; stamens 25–30 28. *S. domatiosa*
2. Flower buds globose before anthesis; petals short, oblong, connate at base on falling; appendages to connective and apices of anther cells densely barbate. Fig. 82. *Spp.* 29–35. 1b. *Subsect. Barbata*
30. Stamens at least 45.
31. Leaf 6–15 by 2.3–9 cm; nerves 7–10 pairs 29. *S. glauca*
31. Leaf 6.5–10 by 2.5–4 cm; nerves 11–14 pairs 30. *S. laevis*
30. Stamens at most 35.
32. Nerves 6–7 pairs, not sunken above; leaf less than 8 cm long.
33. Fruit calyx lobes subequal, shorter than nut 31. *S. asahii*
33. Fruit calyx lobes unequal: 3 spatulate, thin, much longer than nut 32. *S. micans*
32. Nerves more than 8 pairs, depressed above or, if not depressed, leaf exceeding 10 cm long.
34. Fruit calyx lobes subequal, shorter than nut.
35. Leaf coriaceous, nerves 5–6 pairs, not depressed above 33. *S. ladiana*
35. Leaf thin, nerves more than 8 pairs, depressed above 34. *S. biawak*
34. Fruit calyx lobes unequal, 3 spatulate, thin, much longer than nut 35. *S. maxwelliana*
1. Appendages, if barbate, surmounting a 2-locular anther, otherwise scabrous or glabrous; anthers glabrous.
36. Anthers linear, prolonged apically into prominent horn-like processes. Fig. 84. *Spp.* 36–37.
2. *Sect. Pentacme*
37. Deciduous hard-wooded trees; leaf base equal, nerves 13–16 pairs 36. *S. siamensis*
37. Evergreen soft-wooded trees; leaf base unequal, nerves 7–9 pairs 37. *S. contorta*
36. Anthers not as above.
38. Appendage to connective not exceeding anther apex, stout; stamens 15; anthers subglobose. Fruit calyx lobes subequal, elongated, much longer than the nut. Fig. 85. *Sp.* 38. 3. *Sect. Neohopea*
38. *S. isoptera*
38. Appendage exceeding anther apex or, if short, either slender, recurved or with more than 30 stamens. Fruit calyx lobes subequal but shorter than nut or unequal, 3 prolonged and spatulate.
39. Anthers with 2 pollen sacs. Fig. 87, 89. *Spp.* 39–71. 4. *Sect. Richetioides*
40. Stamens more than 100; anthers lorate. Fig. 87. *Sp.* 39. 4a. *Subsect. Polyandrae*
39. *S. polyandra*
40. Stamens at most 17; anthers subglobose or oblong. Fig. 89. *Spp.* 40–71. 4b. *Subsect. Richetioides*
41. Fruit calyx shorter than nut.
42. Fruit calyx lobes unequal, spatulate 40. *S. kuantanensis*
42. Fruit calyx lobes subequal, \pm ovate.
43. Nut glabrous.
44. Petiole 1–1.2 cm long; floral ovary glabrous; stamens 15 41. *S. longiflora*
44. Petiole 1.8–3.8 cm long; floral ovary pubescent; stamens 10 42. *S. macrobalanos*
43. Nut pubescent.
45. Leaf of mature tree peltate 43. *S. peltata*
45. Mature tree leaf not peltate.
46. Leaf less than twice as long as broad.
47. Stamens 16–17 44. *S. richetia*
47. Stamens 10–15.
48. Leaf nervation persistently cream pubescent beneath 45. *S. laxa*

48. Leaf entirely glabrous.
49. Leaf 7–12 cm long, nerves 5–7 pairs; nut to 3 by 1.3 cm, drying mauve tomentose 46. *S. balanocarpoides*
49. Leaf less than 8 cm long, nerves 7 or more pairs; nut to 2 by 1.2 cm, cream-buff tomentose or glabrous.
50. Nerves 8–10 pairs, hardly raised beneath; leaf base cuneate but not decurrent at petiole insertion; petiole drying rugulose, black; style without distinct stylopodium 47. *S. multiflora*
50. Nerves 7–9 pairs, slender but distinctly raised beneath; leaf base cuneate, somewhat decurrent; petiole drying smooth, black; style with distinct stylopodium 48. *S. patoiensis*
46. Leaf at least twice as long as broad.
51. Leaf grey-brown scabrid tomentose beneath; base cordate 49. *S. induplicata*
51. Leaf not as above.
52. Nerves and midrib sunken in shallow furrows above 50. *S. subcylindrica*
52. Leaf nervation not as above.
53. Leaf nervation pubescent beneath.
54. Leaf base equal; midrib prominently depressed, obscure, above 51. *S. obovoidea*
54. Leaf base unequal, midrib not as above 52. *S. chaiana*
53. Leaf nervation glabrous beneath.
55. Petiole persistently pale cream puberulent throughout.
56. Petiole exceeding 19 mm long, leaf undersurface matte, lepidote; stamens 10; fruit calyx \pm patent 53. *S. collaris*
56. Petiole to 15 mm long; leaf undersurface and fruit calyx not as above.
57. Petiole 6–8 mm long; flower buds to 2.5 mm long; stamens 15; panicle to 10 cm long 54. *S. angustifolia*
57. Petiole exceeding 10 mm long; flower buds exceeding 12 mm long; stamens 10; panicles to 7 mm long 55. *S. maxima*
55. Petiole epilose, exceeding 8 mm long.
58. Leaf undersurface matte, distal end of petiole cream 56. *S. tenuiramulosa*
58. Leaf undersurface lustrous; petiole drying entirely black.
59. Nerves at most 6 pairs 57. *S. conica*
59. Nerves at least 9 pairs.
60. Leaf coriaceous, midrib appanate above 58. *S. bakoensis*
60. Leaf thin, midrib elevated above 59. *S. xanthophylla*
41. Fruit calyx lobes unequal, 3 prolonged, thin, spatulate, greatly exceeding the nut.
61. Leaf large, thickly coriaceous, with 14–16 pairs of slender nerves and tertiary nerves equally elevated on each surface 60. *S. blumutensis*
61. Leaf not as above.
62. Petiole at least 19 mm long, nerves at least 10 pairs.
63. Petiole 3–4 mm \varnothing , stout; leaf thickly coriaceous 61. *S. iliasii*
63. Petiole to 2 mm \varnothing , slender; leaf chartaceous 62. *S. faguetioides*
62. Petiole less than 18 mm long or, if longer, than nerves less than 9 pairs.
64. Nerves 14–19 pairs 63. *S. alutacea*
64. Nerves at most 12 pairs.
65. Leaf nervation beneath persistently tomentose.
66. Leaf undersurface densely pale grey-green pubescent 64. *S. longisperma*
66. Leaf undersurface glabrous but for nervation.
67. Leaf margin revolute, nerves 9–12 pairs, tomentum scabrid 65. *S. acuminatissima*
67. Leaf margin not revolute, nerves 7–9 pairs, tomentum even 66. *S. gibbosa*
65. Leaf nervation beneath fugaceous puberulent or glabrous.
68. Leaf nerves very slender, hardly raised beneath, with distinct secondaries; midrib drying reddish or blackish, frequently with a pair of glabrous domatia at base 67. *S. hopeifolia*
68. Leaf not as above.
69. Petiole 17–22 mm long, nerves 7–9 pairs 68. *S. kudatensis*
69. Petiole at most 16 mm long.
70. Nerves 5–7 pairs 69. *S. cuspidata*
70. Nerves 8 or more pairs.
71. Nerves c. 8 pairs, prominently raised beneath 70. *S. mujongensis*
71. Nerves 9–12 pairs, hardly raised beneath 71. *S. fagueticiana*
39. Anthers with 4 pollen sacs.

72. Anthers linear to oblong; filaments lorate or tapering gradually (not tapering abruptly medially); ovary without distinct stylopodium; style at least as long as ovary.
73. Appendage to connective at least as long as anther, frequently scabrous; wood yellow or white, with reticulate vessel arrangement in TS; silica present. Fig. 91B–C, 92. *Spp.* 72–92.
5. *Sect. Anthoshorea*
74. Stamens at least 17.
75. Stamens 17; nerves 20–24 pairs; leaf undersurface pale pink lepidote. 72. *S. dealbata*
75. Stamens at least 20.
76. Stamens less than 40.
77. Leaves elliptic-oblong; petiole 2–3 cm long; semi-deciduous tree 73. *S. farinosa*
77. Leaves elliptic lanceolate or broadly elliptic-ovate; petiole less than 2 cm long; evergreen trees.
78. Nerves at most 14 pairs; leaves broadly elliptic-ovate.
79. Stamens 21–25; tertiary nerves scalariform 74. *S. polita*
79. Stamens 25; tertiary nerves subreticulate 75. *S. gratissima*
78. Nerves 17–20 pairs; leaves elliptic-lanceolate 76. *S. henryana*
76. Stamens more than 45 77. *S. montigena*
74. Stamens 15.
80. Stipules ovate, auriculate, not at first caducous; leaves not usually exceeding 9 by 4.5 cm (in mature trees), with at least 13 pairs of nerves 78. *S. assamica*
80. Stipules not as above, caducous; leaves at least 10 cm long or with less than 13 pairs of nerves.
81. Leaf nervation beneath persistently tomentose.
82. Twigs, petioles, and nerves and midrib beneath red-brown to cream-brown pubescent; leaf undersurface bright yellow lepidote 79. *S. ochracea*
82. Tomentum dull grey to tawny brown, leaf undersurface dull grey.
83. Leaves typically obovate, with at most 17 pairs of nerves; twigs prominently compressed 80. *S. virescens*
83. Leaves typically ovate-oblong; nerves 17–26 pairs; twigs terete.
84. Tomentum short, even; anther thrice as long as broad 81. *S. javanica*
84. Tomentum uneven, scabrid; anther twice as long as broad 82. *S. lamellata*
81. Leaf nervation beneath early glabrescent.
85. Midrib evident, applanate above; deciduous tree. 83. *S. roxburghii*
85. Midrib obscure, depressed above; evergreen trees.
86. Fruit calyx lobes vestigial, about twice length of nut 84. *S. bentongensis*
86. Fruit calyx lobes at least thrice as long as nut.
87. Nerves at least 15 pairs; twig apices compressed.
88. Petiole at least 2 cm long; leaf undersurface cream lepidote in mature trees 85. *S. hypochra*
88. Petiole less than 2 cm long; leaf undersurface not cream lepidote
89. Fruit pedicel c. 1 cm long, c. 5 mm \varnothing , very stout and prominent; 3 longer fruit calyx lobes to 18 cm long 86. *S. symingtonii*
89. Fruit pedicel at most 2 mm long, not prominent; fruit calyx lobes not exceeding 13 cm long.
90. Leaf to 12 by 4.8 cm, narrowly elliptic to lanceolate; base obtuse or broadly cuneate; undersurface coppery lepidote 87. *S. retinodes*
90. Leaf at least 8 by 5.5 cm, oblong to obovate; base cordate; undersurface not lepidote 88. *S. cordata*
87. Nerves at most 15 pairs or, if more, then twigs terete.
91. Twig apices \pm compressed; leaf subchartaceous, drying chocolate brown 89. *S. bracteolata*
91. Twigs terete; leaf coriaceous, drying tawny to pale yellow-brown.
92. Leaf base cuneate 90. *S. resinosa*
92. Leaf base obtuse to cordate.
93. Base of fruit impressed; flower bud to 5 by 2.5 mm. 91. *S. agamii*
93. Base of fruit tapering; flower bud to 9 by 5 mm 92. *S. confusa*
73. Appendage to connective less than $\frac{1}{2}$ length of anther, short, glabrous. Wood pink, with loose oblique vessel arrangement (in TS); silica absent. Fig. 94, 95. *Spp.* 93–97. 6. *Sect. Rubella*
94. Midrib obscure above; twigs compressed; stamens 20–24 93. *S. albida*
94. Midrib evident above; twigs terete.
95. Stamens at most 20.
96. Stamens 15 94. *S. rubella*
96. Stamens 19–20 95. *S. elliptica*
95. Stamens at least 25.

97. Stamens *c.* 25 96. *S. dispar*
 97. Stamens *c.* 48 97. *S. negrosensis*
72. Anthers broadly oblong to subglobose; appendage to connective vestigial, or shorter than anther and reflexed, or, if long and unreflexed, filaments abruptly tapering \pm medially or united in a tube round the ovary; stylopodium usually distinct. Wood pink, without silica; pore arrangement oblique, clustered or solitary, variable though never reticulate.
98. Stamens less than 30; filaments compressed and broad at base.
99. Appendage to connective filiform, slender, at least twice as long as anther, not reflexed; filaments broad at base, tapering abruptly and filiform below the anthers.
100. Filaments broad at base, tapering abruptly medially, filiform, not fixed into a distinct tube round the ovary though frequently connate at base; ovary either with a distinct stylopodium and \pm pyriform, or without and small and ovoid; style filiform. Fig. 91D, 98–100. *Spp.* 98–122.
7. *Sect. Brachypterae*
101. Stamens 24–28. Fig. 98. *Sp.* 98. 7a. *Subsect. Smithiana*
 Only species. 98. *S. smithiana*
101. Stamens 15. Fig. 91D, 99–100. *Spp.* 99–122. 7b. *Subsect. Brachypterae*
102. Ovary ovoid, stylopodium indistinct or absent; style as long as ovary and stylopodium or longer, frequently \pm pubescent in the basal half.
103. Leaf base distinctly unequal, midrib curved to one side.
104. Leaf broadly ovate; nerves at most 13 pairs 99. *S. inaequalateralis*
 104. Leaf oblong-ovate; nerves at least 19 pairs 100. *S. selanica*
103. Leaf base equal.
105. Leaf undersurface, petiole and twig scabrid tomentose.
106. Leaf coriaceous, margin revolute, cream lepidote beneath; longer fruit calyx lobes to 6.5 by 1.5 cm 101. *S. flemmichii*
106. Leaf \pm chartaceous, not lepidote beneath; margin not revolute; longer fruit calyx lobes exceeding 10 by 2 cm.
107. Leaf concave 102. *S. almon*
 107. Leaf applanate 103. *S. parvistipulata*
105. Leaf undersurface, petiole, and twig densely shortly evenly pubescent to glabrous.
108. Nerves at least 13 pairs, very slender, hardly elevated beneath; tertiary nerves densely scalariform beneath, unraised.
109. Leaf beneath prominently cream lepidote 104. *S. balangeran*
 109. Leaf entirely glabrous.
110. Leaf 10–15 by 5–8 cm; base subpeltate, discernible as a rib over the base of the midrib in mature trees; stipule scars cuneate 105. *S. coriacea*
 110. Leaf 6–10 by 3–5 cm; base not subpeltate; stipule scars amplexicaul 106. *S. venulosa*
108. Nerves, if more than 13 pairs, prominent beneath and tertiary nerves not as above.
111. Nerves at least 16 pairs, leaf pinkish cream lepidote beneath 107. *S. waltoni*
 111. Nerves most 16 pairs and then leaf not pale lepidote beneath.
112. Petiole 4–6 cm long 108. *S. pachyphylla*
 112. Petiole at most 3.5 cm long.
113. Appendage to connective setose 109. *S. pauciflora*
 113. Appendage glabrous.
114. Leaves with to 3 pairs of white scale-like domatia at base; style glabrous except at base 110. *S. johorensis*
 114. Leaves without white scale-like domatia.
115. Fruit calyx lobes short, subequal 111. *S. palembanica*
 115. Fruit calyx lobes long, aliform, unequal.
116. Leaf undersurface cream lepidote (mature trees); corolla mauve; nut to 14 by 7 mm 112. *S. andulensis*
 116. Leaf undersurface glabrous; corolla cream; nut to 18 by 14 mm 113. *S. polysperma*
102. Ovary and stylopodium distinctly pyriform, the stylopodium distinct from the style; style not longer than ovary and stylopodium, glabrous.
117. Twigs compressed, nerves hardly raised beneath; midrib sharply acute beneath 114. *S. platyclados*
 117. Twigs terete, nerves distinctly raised beneath; midrib prominent beneath but not sharp.
118. Fruit calyx lobes relatively short, less than twice as long as ripe nut.
119. Style and stylopodium densely pubescent but for the apex, hardly distinguishable from one another, filiform at the apex, stouter beneath, frequently further swollen in the basal half; ripe nut to 5 by 2.5 cm 115. *S. scaberrima*

119. Style and stylopodium well defined; ovary and stylopodium ovoid, crowned by an equally long filiform glabrous style; ripe nut to 3.5 by 1.5 cm 116. *S. fallax*
118. Fruit calyx lobes more than 3 times as long as nut.
120. Style and stylopodium densely pubescent but for the apex 117. *S. pubistyla*
120. Ovary and stylopodium crowned by an equally long filiform glabrous style.
121. Stipules large, subpersistent, leaving amplexicaul scars 118. *S. palosapis*
121. Stipules fugaceous, small, leaving short scars.
122. Appendages exceeding style at anthesis, very slender, crisped; leaf bullate between tertiary nerves; nervation beneath, petiole and twig scabrid tomentose 119. *S. bullata*
122. Appendages not exceeding style apex, awn-like; leaf applanate, evenly pubescent or glabrous.
123. Style c. $\frac{1}{2}$ length of ovary and stylopodium; ovary and stylopodium glabrescent; anthers large, fused, strongly tapering towards apex 120. *S. flaviflora*
123. Style \pm equal in length to ovary and stylopodium; ovary and stylopodium shortly pubescent; anthers not large, not fused, hardly tapering.
124. Nerves 13–16 pairs; leaf undersurface gold lepidote, without domatia 121. *S. monticola*
124. Nerves 6–8 pairs; leaf glabrous, with pore-like domatia 122. *S. kunstleri*
100. Filaments united in a tube around the base of the ovary, tapering abruptly near apex; stylopodium merging into style; style and stylopodium spindle-shaped, narrow and tapering at base and apex; or stylopodium indistinct, style at least twice as long as ovary, filiform. Fig. 103, 104. *Spp. 123–132*.
8. *Sect. Pachycarpae*
125. Stipule scars amplexicaul.
126. Leaf densely gold-brown tomentose beneath 123. *S. pilosa*
126. Leaf shortly sparsely tomentose beneath or glabrous.
127. Stipule with cordate subequal base 124. *S. splendida*
127. Stipule not cordate.
128. Nerves 11–20 pairs; nut to 6 by 4 cm, relatively large; fruit calyx lobes to 11 cm long; relatively short.
129. Panicles to 35 cm long, axillary on modified parts of twigs with short internodes, the subtending leaves mainly abortive; stipules to 2 cm long, subrevolute 125. *S. stenoptera*
129. Panicles to 20 cm long, borne in axils of normal leaves on normal twig; stipule to 5 cm long, applanate 126. *S. macrophylla*
128. Nerves 9–12 pairs; nut to 3.7 by 2.5 cm, relatively small; fruit calyx lobes exceeding 15 cm long, relatively long.
130. Leaf 25–35 cm long 127. *S. praestans*
130. Leaf 11–21 cm long.
131. Leaf broadly ovate to suborbicular, 10–13 cm wide 128. *S. rotundifolia*
131. Leaf elliptic, 5–8 cm wide 129. *S. amplexicaulis*
125. Stipule scars not amplexicaul.
132. Leaf base cordate, undersurface densely persistently golden pubescent; nerves 16–20 pairs 130. *S. mecistopteryx*
132. Leaf base not cordate; tomentum not as above or leaf glabrous.
133. Stipule scars short, \pm straight or slightly up-pointing; nerves 11–14 pairs 131. *S. beccariana*
133. Stipule scars falcate, down-curved; nerves normally 14–19 pairs 132. *S. pinanga*
99. Appendage to connective shorter than, or as long as, anther, becoming reflexed; filaments tapering gradually from base to anther. Fig. 106, 107. *Spp. 133–159*. 9. *Sect. Mutica*
134. Fruit calyx lobes auriculate at base. Fig. 107. *Spp. 133–138*. 9a. *Subsect. Auriculatae*
135. Leaf narrowly oblong; nerves 19–37 pairs.
136. Leaf concave, nerves depressed above 133. *S. slootenii*
136. Leaf applanate.
137. Nerves 24–28 pairs; leaf beneath sparsely tufted tomentose or glabrescent 134. *S. myrionerva*
137. Nerves 19–25 pairs; leaf beneath densely shortly persistently pink-brown scabrid tomentose 135. *S. sagittata*
135. Leaf elliptic-ovate to lanceolate; nerves 10–15 pairs.
138. Leaf 7–16 by 2.2–6 cm.
139. Leaf undersurface lustrous, nerves prominent 136. *S. macroptera*
139. Leaf undersurface matte, nerves hardly raised 137. *S. ferruginea*
138. Leaf 14–26 by 6.5–12 cm, thickly coriaceous 138. *S. acuta*

134. Fruit calyx lobes not auriculate. Fig. 106. *Spp. 139–159. 9b. Subsect. Mutica*
140. Stipules exceeding 20 mm long, broad, boat-shaped, coriaceous, lustrous, not at first caducous; leaves unequal, ovate, glabrescent beneath.
141. Nerves 4–5 pairs 139. *S. quadrinervis*
141. Nerves 7–10 pairs 140. *S. acuminata*
140. Stipules less than 20 mm long, thin, \pm applanate.
142. Flower buds at least 14 mm long, large.
143. Petiole to 6 mm long; leaf base cordate, unequal 141. *S. macrantha*
143. Petiole 6–12 mm long; leaf base obtuse, equal 142. *S. hemsleyana*
142. Flower buds at most 10 mm long.
144. Fruit calyx lobes less than twice as long as nut 143. *S. singkawang*
144. Longer fruit calyx lobes more than three times as long as nut.
145. Leaf undersurface entirely glabrous.
146. Leaf apex retuse 144. *S. retusa*
146. Leaf apex acuminate.
147. Nerves 14–16 pairs; stipule to 20 mm long, subsistent 145. *S. lepidota*
147. Nerves at most 12 pairs; stipules to 8 mm long, fugaceous.
148. Nerves 8–9 pairs, with prominent axillary pore-like domatia 146. *S. foraminifera*
148. Nerves 11–12 pairs, with only a few pairs of small domatia at the base of the midrib 147. *S. teysmanniana*
145. Leaf undersurface sparsely or densely tomentose, or cream lepidote.
149. Leaf with at least 14 pairs of nerves or, if 12–13, with cream pubescent undersurface or with pale scale-like domatia up either side of the midrib.
150. Leaf evenly pinkish velutinate beneath; nerves 20–25 pairs, with prominent secondaries 148. *S. argentifolia*
150. Leaf tomentum not as above; nerves 14–21 pairs, without secondaries.
151. Leaf beneath, petiole and twigs densely fulvous scabrid tufted tomentose.
152. Leaf prominently concave, chartaceous; petiole 22–32 mm long 149. *S. uliginosa*
152. Leaf applanate, coriaceous; petiole 13–23 mm long 150. *S. rugosa*
151. Tomentum not as above, young tree leaf with prominent pale domatia up each side of the midrib.
153. Mature tree leaf cream pubescent beneath; nerves 12–15 pairs 151. *S. leprosula*
153. Mature tree leaf sparsely scabrid beneath; nerves 16–20 pairs 152. *S. platycarpa*
149. Leaf with at most 13 pairs of nerves; domatia and indumentum not as above.
154. Leaf narrowly ovate to lanceolate, \pm cream to pink lepidote beneath; nerves slender, hardly raised beneath; midrib acute beneath 153. *S. curtisii*
154. Leaf elliptic or broadly ovate, undersurface not as above; nerves prominent beneath.
155. Leaf lustrous beneath.
156. Leaf 5–9 by 3–5 cm, elliptic, frequently retuse; margin hardly or not revolute 154. *S. scabrida*
156. Leaf 10–15 by 5.5–10 cm, broadly ovate, acuminate, with revolute margin 155. *S. revoluta*
155. Leaf not lustrous beneath.
157. Leaf broadly ovate; nerves 8–10 pairs 156. *S. ovata*
157. Leaf ovate to elliptic; nerves *c.* 11 pairs.
158. Leaf beneath, petiole and twigs densely evenly vinous tomentose 157. *S. rubra*
158. Leaf beneath, petiole and twigs sparsely pale brown pubescent 159. *S. parvifolia*
98. Stamens 50–70, appendage to connective vestigial, filaments filiform. Fig. 115. *Sp. 160.*
10. *Sect. Ovalis, 160. S. ovalis*

1. Section Shorea

ASHTON, Gard. Bull. Sing. 20 (1963) 265; Man. Dipt. Brun. (1964) 116. — *Shorea sect. Eushorea* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 79. — *Shorea, Balau* group SYM. Mal. For. Rec. 16 (1943) 14. — Fig. 78, 82.

Flowers cream, often pink at base. *Stamens* 20–60, in several verticils; filaments broad at base, gradually tapering; anthers with 4 pollen sacs, \pm broadly oblong,

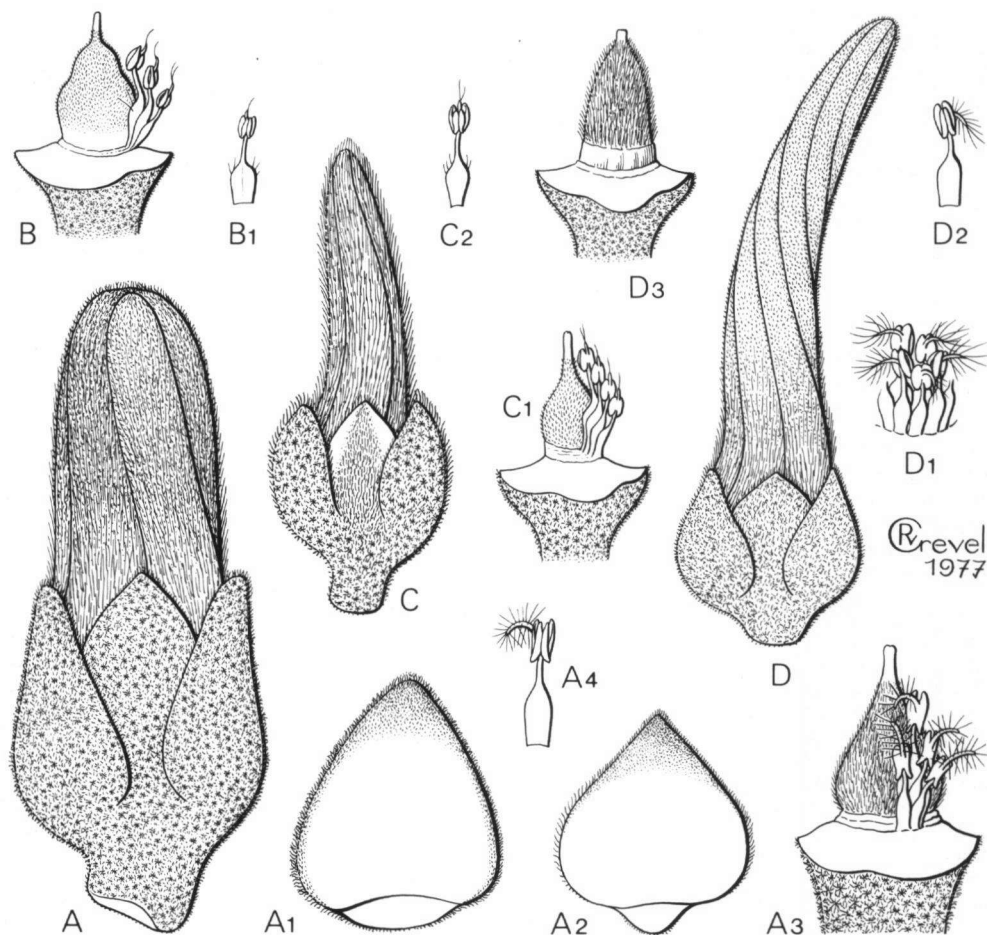


Fig. 78. Flower details in *Shorea* sect. *Shorea* subsect. *Shorea*. All $\times 10$. — *S. atrinervosa* SYM. A. Bud, A1. outer sepal, A2. inner sepal, both from inside, A3. stamens and pistil. — *S. brunnescens* ASHTON. B. Stamens and pistil, B1. stamen from inside. — *S. scrobiculata* BURCK. C. Bud, C1. stamens and pistil, C2. stamen from inside. — *S. hypoleuca* MEIJER. D. Bud, D1. stamens from outside, D2. stamen from inside, D3. pistil (A SAN 27274, B SMYTHIES 15218, C BRUN 740, D BAKAR 36229).

cells attenuate at base and apex; appendages shorter than anthers, with 1– ∞ bristles. Ovary tomentose, with stylopodium. Stipules and bracts fugaceous, small. Leaf with scalariform tertiary nerves; midrib raised or depressed above, always evident. Trees with narrow prominent buttresses. Bark surface flaky or dipped (*S. biawak* excepted); radially oblique stone-cell fingers often present; phelloderm pale, thick, conspicuous; expansion tissue in short fingers, more numerous towards outer surface.

Vern. *Balau* (Mal., Sum.), *sélangan batu* (Borneo, Mal.), *tékam* (Dayak), *yakal* (Philippines).

Note. The species are, with adequate material well defined and most vary little geographically.

1a. Subsection *Shorea*

Saul ROXB. ex W. & A. Prod. (1834) 84, *nomen*. — *Isoptera* SCHEFF. ex BURCK. — *Ridleyinda* O. K. — *Shorea* sect. *Isoptera* (SCHEFF. ex BURCK) FOXW. Philip. J. Sc. 67 (1938) 291, 301; SLOOT. Bull. Bot. Gard. Btzig 17 (1941) 116. — *Shorea ciliata* subgroup SYM. Mal. For. Rec. 16 (1943) 5. — **Fig. 78.**

Flower buds elongate. Petals linear, falling separately. Appendage to connective with few bristles.

Distr. Southern India and Ceylon to Indochina and through *Malesia* to the Moluccas.

Ecol. Evergreen, semi-evergreen and savanna (*S. robusta* of India, *S. obtusa* of S.E. Asia) forests, especially below 1000 m and always below 1500 m. Only *S. robusta*, the *sal*, can be strictly gregarious, most being scattered on well drained soil and river banks.

Note. *S. sumatrana* has been observed to be thrips pollinated and this is likely to be so with other species.

1. *Shorea collina* RIDL. Agr. Bull. Str. & F.M.S. 9 (1910) 182; Fl. Mal. Pen. 1 (1922) 231; BURN-MURDOCH, Trees and Timbers Mal. Pen. 1 (1911) 13; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 299; *ibid.* ed. 2 (1927) 1116; FOXW. Mal. For. Rec. 3 (1927) 63, *p.p.*; *ibid.* 10 (1932) 173, *p.p.*; SYM. Gard. Bull. S. S. 9 (1935) 270, pl. 18; Mal. For. Rec. 16 (1943) 12, f. 6, 7. — *S. angustiloba* FOXW. Mal. For. Rec. 10 (1932) 168, pl. 11; SYM. *apud* DESCH, Mal. For. 3 (1934) 195; SYM. Mal. For. 4 (1935) 26.

Medium-sized or large tree. Stipules outside, leaf bud, parts of petals exposed in bud, ovary and panicles persistently densely shortly evenly buff pubescent, twig and sepals caducously so, panicle sparsely caducously so. *Twigs* c. 3 mm \varnothing apically, stout, ribbed at first, becoming terete, smooth, blackish; stipule scars obscure, falcate, downcurved. *Buds* to 3 by 2 mm, ovoid, acute. *Stipules* to 10 by 5 mm, lanceolate, acute, caducous. *Leaves* 9–21 by 5–13 cm, broadly elliptic-oblong, coriaceous; base obtuse to cordate; apex obtuse, acute or with short broad acumen; nerves 11–15 pairs, slender but prominent beneath, arched, at to 90° at the base, down to 30° near the apex; tertiary nerves very slender, densely scalariform; midrib appanate above, prominent and terete beneath; *petiole* 2–4 cm long, stout. *Panicle* to 4 cm long, terminal or axillary, slender; singly branched, branchlets to 1 cm long, bearing to 3 secund flowers. *Flower buds* to 8 by 4 mm, fusiform; sepals broadly ovate, subequal, submucronate; *stamens* c. 55, subequal; filaments broadly dilated and connate at base, tapering; anthers narrowly oblong, glabrous; appendages somewhat exceeding anthers, with 2–5 prominent apical bristles; *ovary* broadly ovoid; style short, columnar. *Fruit pedicel* by 2 by 3 mm, stout; *calyx lobes* vestigial; 3 longer lobes to 5 by 1.3 cm, obtuse, spatulate, c. 6 mm wide above the to 1.7 by 1.4 cm ovate somewhat thickened saccate base; 2 shorter lobes to 2.5 by 0.5 cm apically, otherwise similar; *nut* to 3.5 by 2.5 cm, large, crowned by a to 8 mm long tapering style remnant.

Distr. *Malesia*: Malaya (E. coast from Trengganu southwards).

Ecol. Low lying land; local.

Vern. *Balau merah*, *b. bukit*, *b. tiong*, *sělímbar*, *těrbak*, *těngkawang batu*.

2. *Shorea ochrophloia* [SYM. *apud* DESCH, Mal. For. Rec. 4 (1935) 28, *nomen*] STRUGNELL ex SYM. Gard. Bull. S. S. 8 (1935) 268, pl. 17; Mal. For. Rec. 16 (1943) 23, f. 15.

Large buttressed tree. Twigs, buds, stipules, petioles, panicles, sepals, part of petals exposed in bud, ovary, midrib above and leaves beneath persistently densely shortly dark golden-brown scabrid pubescent. *Twig*. c. 2 mm \varnothing apically, terete, becoming blackish, rugulose to smooth. *Bud* to 4 by 3 mm, ellipsoid, subacute. *Stipules* to 10 by 5 mm, oblong-elliptic, obtuse, early caducous. *Leaves* (4)–6–12 by 3.5–6.5 cm, ovate to elliptic-oblong, coriaceous; margin frequently revolute; base obtuse to subcordate; apex obtuse, acute or with a short broad acumen; nerves 13–18 pairs, prominent beneath, \pm depressed above, set at 80° at the base but down to 25° near the apex; tertiary nerves slender, scalariform; midrib prominent and terete beneath, somewhat depressed above; *petiole* 7–17 mm long, short, geniculate. *Panicle* to 6 cm long, terminal or axillary, short, terete; singly branched, branchlets bearing to 6 flowers; *bracteoles* fugaceous, unknown. *Flower buds* to 7 by 2 mm, fusiform. *Sepals* ovate, the 3 outer subacute, the 2 inner subacuminate. *Petals* cream with a deep pink patch at the base within. *Stamens* 30, subequal, filaments tapering, compressed; anthers oblong, glabrous; appendage exceeding anther apex, with to 5 \pm prominent bristles; *ovary* with distinct stylopodium, both pubescent; style short but prominent. *Fruit pedicel* to 2 by 2 mm. 3 longer *calyx lobes* to 7 by 1.5 cm, spatulate, obtuse, c. 5 mm broad above the to 7 by 5 mm ovate saccate thickened base; 2 shorter lobes to 6 by 0.7 cm, otherwise similar. *Nut* to 2 by 1 cm, narrowly ovoid, tapering to an up to 3 mm long columnar style.

Distr. *Malesia*: Malaya, W. Sumatra (Painan).

Ecol. Scattered, local, on well drained undulating land and old alluvium below 350 m.

Vern. *Sěraya batu*.

Note. A local segregate of *S. guiso*, with which it now nevertheless grows in mixture without apparent hybridisation.

3. *Shorea guiso* (BLCO) BL. Mus. Bot. Lugd.-Bat. 2 (1852) 34; WALP. Ann. 4 (1857) 338; DC. Prod. 16, 2

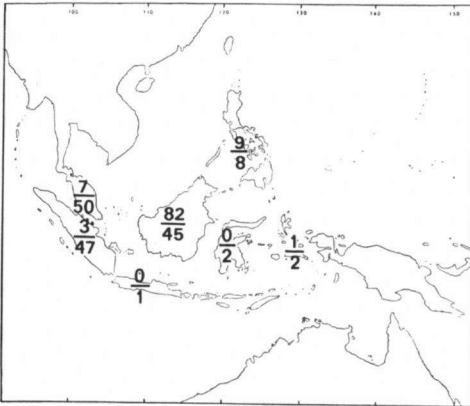


Fig. 79. Density map of *Shorea* ROXB. ex GAERTN. f. in Malasia; number of endemics above the hyphen, number of non-endemics below it.

(1868) 632; VIDAL, Sinopsis (1883) t. 15C; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 89; PERK. Fragm. Fl. Philip. (1904) 23; MERR. Philip. J. Sc. 1 (1906) Suppl. 98; Sp. Blanc. (1918) 270; En. Philip. 3 (1923) 97; FOXW. Philip. J. Sc. 2 (1907) Bot. 384; *ibid.* 4 (1909) Bot. 509; *ibid.* 6 (1911) Bot. 272; *ibid.* 13 (1918) Bot. 191; Mal. For. Rec. 10 (1932) 175; Philip. J. Sc. 67 (1938) 292; EVERETT & WHITFORD, Bull. Bur. For. Philip. 5 (1906) 16; MERRITT & WHITFORD, *ibid.* 5 (1906) 36; MERRITT, *ibid.* 8 (1908) 48; WHITFORD, Philip. J. Sc. 4 (1910) Bot. 703; Bull. Bur. For. Philip. 10 (1911) 71; REYES, Philip. J. Sc. 22 (1923) 337; SLOOT, in Merr. Pl. Elm. Born. (1929) 203; DESCH, Mal. For. 4 (1935) 29; Mal. For. Rec. 12 (1936) 20; SYM. Gard. Bull. S. S. 8 (1935) 266, pl. 16; Mal. For. Rec. 16 (1943) 16, f. 11; BROWNE, For. Trees Sarawak & Brunei (1955) 153; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 171, f. 18; ASHTON, Man. Dipt. Brun. Suppl. (1968) 71. — *Euphoria malaanonan* BLCO, Fl. Filip. ed. 1 (1837) 286. — *Mocanera guiso* BLCO, Fl. Filip. ed. 1 (1837) 449. — *Dipterocarpus guiso* BLCO, Fl. Filip. ed. 2 (1845) 313; DC. Prod. 16, 2 (1868) 614; BLCO, Fl. Filip. ed. 3, 2 (1878) 215. — *Euphoria vel Nephelium* BLCO, Fl. Filip. ed. 2 (1845) 200; *ibid.* ed. 3, 2 (1878) 9. — *Anisoptera guiso* DC. Prod. 16, 2 (1868) 616. — *S. pierrei* HANCE, J. Bot. 16 (1878) 302; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 81, t. 2, f. 15–16; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 264, 265, fig.; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 300; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 261. — *S. vidaliana* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 83. — *Isoptera burckii* BOERL. Cat. Hort. Bog. 2 (1901) 111; SLOOT, Bull. Bot. Gard. Btzg III, 17 (1941) 117. — *S. obtusa* var. *kohchangensis* HEIM, Bot.

Tidsskr. (1902) 263. — *S. robusta* var. *schmidtii* HEIM, l.c. 263. — *S. warburgii* (non GILG) PERK. Fragm. Fl. Philip. (1904) 23. — *S. longipetala* FOXW. Mal. For. Rec. 10 (1932) 174, t. 13. — *S. scrobiculata* (non BURCK) FOXW. Mal. For. Rec. 10 (1932) 174; SYM. *apud* DESCH, Gard. Bull. S. S. 8 (1935) 28, 29.

Large buttressed tree. Young parts at first greyish buff pubescent, early caducous except on inflorescence, calyx, corolla outside, ovary and nut; twig apices and stipule outside densely so at first, becoming sparse as parts expand, remaining dense on inflorescence and nut. *Twig*. c. 1 mm \varnothing apically, slender, smooth, with minute inconspicuous stipule scars. *Bud* to 5 by 3 mm, compressed, ovate-falcate. *Stipule* to 7 by 5 mm, oblong, subacute, caducous. *Leaves* 5.5–14 by 2.5–6 cm, oblong-lanceolate, thinly coriaceous, glabrescent; base obtuse to broadly cuneate, acuminate to 1 cm long, prominent, broad; nerves (11–)15–19 pairs, slender, at 45°–55° to the midrib but up to 90° at the base; tertiary nerves very slender, densely scalariform, frequently obscure; midrib slender, raised beneath, evident but somewhat depressed above; *petiole* 1–1.8 cm long, slender. *Panicle* to 10 cm long, slender, lax, pendent, the branchlets bearing to 5 second flowers; *bracts* and *bracteoles* minute, linear, fugaceous. *Flower bud* to 1 cm long, slender. *Sepals* broadly ovate; outer 3 acute, inner 2 acuminate, with thin margins. *Petals* bright yellow-red at base within, narrowly lanceolate, densely pubescent on parts exposed in bud. *Stamens* 20–28; filaments lorate, tapering, glabrous; anthers narrowly oblong, glabrous, the two outer cells somewhat the larger; appendage c. $\frac{1}{2}$ as long as anther, with 1–4(–8) long bristles. *Ovary* ovoid-conical, densely pubescent, surmounted by a columnar glabrous style c. $\frac{1}{2}$ its length. 3 longer *fruit calyx lobes* to 5.5 by 1 cm, spatulate, obtuse, c. 3 mm broad above the to 8 by 5 mm saccate thickened base; 2 shorter lobes to 3 cm long, linear but similar at base. *Nut* to 8 by 5 mm, ovoid, apiculate, hidden by base of calyx lobes.

Distr. Cochinchina, S.E. and Peninsular Thailand; *Malesia*: Malaya, Sumatra (Atjeh, Tapanuli, Palembang), Borneo (mainly in east), Philippines.

Ecol. Scattered in lowland forest on red soils, most common in slightly seasonal climates; rare and confined to limestone hills in W. and Central Borneo.

Uses. The hard red timber is valuable for light construction in the Philippines.

Vern. *Membatu*, *mêrbatu*, *lemesa*, *l. kulor*, *l. nerang*, *chêngal pasir*, *mêranti bulu*, *m. pahang*, *rêsak samak*, *sêlimbar* (Mal.), *bêraja*, *damar kênuar batu*, *mêranti hitam* (Sumatra), *sêlangan batu mêmrah* (Sabah), *pêlapak*, *lawan*, *raru*, *pakuin batu*, *keping burong*, *mênkabang*, *amban*, *bêrukan baju* (S.E. Borneo), *guijo* (Philippines).

4. *Shorea havilandii* BRANDIS, J. Linn. Soc. Bot. 3 (1895) 82; MERR. En. Born. (1921) 405; BROWNE, For. Trees Sarawak & Brunei (1955) 168; ASHTON, Man. Dipt. Brun. (1964) 136, f. 13, pl. 34 (stem); *ibid.* Suppl. (1968) 72, f. 9; MEIJER & WOOD, Sabah For. Rec. 5

(1964) 173. — *Hopea ovalifolia* BOERL. Cat. Hort Bog. 2 (1901) 102.

Small or medium-sized tree. Twig, petiole, midrib above, buds and stipule on both surfaces ± persistently shortly evenly greyish tawny pubescent. *Twig c.* 1 mm \varnothing apically, terete, slender; stipule scars *c.* 1 mm long, short, cuneate, horizontal or slightly descending. *Bud c.* 2 by 1.5 mm, ovoid, obtuse. *Stipule c.* 6 by 2.5 mm, oblong, subacute, fugaceous. *Leaves* 8–16 by 3.5–6 cm, thinly coriaceous, ovate-elliptic; base obtuse or broadly cuneate; acumen *c.* 0.7 cm long, narrow; nerves 9–12 pairs, dense, parallel, slender but prominent beneath, at *c.* 30°–45° along the lamina, to 80° at the base; with small tomentose domatia; tertiary nerves slender, densely scalariform; midrib grooved; petiole 8–12 mm long. *Panicle* to 12 cm long, terminal or axillary, straight, terete or slightly compressed, shortly sparsely persistently pale brown pubescent; singly branched, the branchlets to 1.5 cm long, short, bearing to 7 second flowers; *bracteoles* to 4 mm long, elliptic, subacute, shortly pubescent, fugaceous. *Flower bud* to 8 by 2.5 mm, lanceolate. *Calyx* shortly pubescent outside, glabrous within; lobes ovate, subacute, the inner 2 somewhat smaller, relatively broader and thinner than the outer 3. *Petals* cream pink at base. *Stamens* 30–50; filaments broad at base, tapering abruptly and filiform distally, glabrous; anthers oblong, the cells tapering, outer cells longer than inner cells; appendages to connective short, glabrous but for a single long apical bristle. *Ovary* broadly ovoid, pubescent. *Fruit calyx* to 10 by 8 mm; lobes subequal, shortly buff-pubescent on both surfaces, thin, ovate, prominently narrowly acuminate, shallowly saccate. *Nut* to 1.5 by 1 cm, globose, obtuse; style remnant *c.* 2 mm long, slender.

Distr. *Malaysia*: Borneo (Sarawak, E. Sabah).

Ecol. Locally abundant in Heath forest and fresh water swamp forest on white and yellow sand, and on peat overlying limestone.

Vern. *Sélangan batu pinang*.

5. *Shorea brunnescens* ASHTON, Gard. Bull. Sing. 22 (1967) 283, pl. 28; Man. Dipt. Brun. Suppl. (1968) 68, f. 9. — Fig. 78 B–B1.

Medium-sized tree. Leaf bud densely shortly persistently buff pubescent, young twigs and petiole sparsely caducously so; lamina glabrous. *Twig c.* 1 mm \varnothing towards apex, terete, smooth; stipule scars short, horizontal, obscure. *Bud* to 2.5 by 2 mm, small, ovoid, acute. *Stipules* unknown. *Leaves* 6–12 by 2.5–6 cm, broadly ovate to lanceolate, coriaceous; base broadly cuneate; acumen to 1 cm long, narrow; nerves 9–11 pairs, very slender, hardly raised beneath, curved, at 45°–60°; tertiary nerves dense, subreticulate, evident but hardly raised on either surface; midrib obscure, depressed above, prominent, furrowed, beneath; *petiole* 1–1.5 cm long. *Panicle* to 9 cm long, terminal or axillary, angular, sparsely shortly buff pubescent; singly branched, branchlets to 1.5 cm long; *bracteoles* unknown. *Flowers* secund; *buds* to 4 by 2 mm, narrowly ellipsoid. *Calyx* densely pubescent outside,

glabrous within; lobes ovate, acute, the inner two somewhat shorter and relatively broader than the outer 3. *Petals* lanceolate, shortly pubescent on parts exposed in bud. *Stamens* 40–62; filaments glabrous, compressed at base, tapering abruptly and filiform distally, anthers elliptic-oblong, glabrous, the inner 2 sacs somewhat smaller than the outer 2; appendage to connective shorter than anther, glabrous but for up to 2 long apical setae. *Ovary* and *stylopodium* pyriform, densely pubescent, crowned by a short columnar glabrous style. *Mature fruit* unknown: *Fruit calyx* at first greyish pubescent; calyx lobes aliform, unequal, 3 much longer than the other 2.

Distr. *Malaysia*: Borneo (W. Sarawak eastwards to Kinabalu, S.E. Borneo northwards to Belajan R.).

Ecol. Locally frequent on skeletal soils on high ridges to 1500 m, also sometimes on leached clay soil on undulating land.

Vern. *Sélangan batu tinteng*.

6. *Shorea scrobiculata* BURCK, Med. Lands Pl. Tuin 3 (1886) 223; Ann. Jard. Bot. Btzg 6 (1887) 207; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 83; MERR. EN. Born. (1921) 406; BROWNE, For. Trees Sarawak & Brunei (1955) 169; ASHTON, Gard. Bull. Sing. 20 (1963) 272; Man. Dipt. Brun. (1964) 144, f. 13; *ibid.* Suppl. (1968) 74. — *S. pierreana* HEIM, Rech. Dipt. (1892) 48. — *S. sp. nov.* SYM. ex DESCH, Mal. For. Rec. 12 (1936) 9. — *S. meadiana* SYM. Gard. Bull. S.S. 10 (1939) 366, pl. 23; Mal. For. Rec. 16 (1943) 22, f. 6; cf. ASHTON, Gard. Bull. Sing. 22 (1967) 282. — Fig. 78 C–C2.

Medium-sized tree. Twig, panicle, leaf bud, stipule and petiole densely shortly buff pubescent; midrib on both surfaces and nerves beneath sparsely dotted with minute hair tufts. *Twig c.* 1.5 mm \varnothing apically, terete, much branched, slender, smooth, becoming finely rugulose; stipule scars short, pale, horizontal. *Bud* 2–3 by 1–2 mm, ovoid, frequently slightly compressed. *Stipule c.* 7 by 3 mm, hastate, acute, fugaceous. *Leaves* 5.5–11 by 2.5–4 cm, narrowly ovate to oblong-lanceolate; base broadly cuneate; acumen to 1 cm long, narrow; nerves 10–12 pairs, dense, prominent, straight, at *c.* 35°–55°; midrib slightly depressed above; tertiary nerves densely scalariform, at 90° to the nerves; *petiole c.* 8 mm long. *Panicle* to 7 cm long, terminal or axillary, terete; singly branched, branchlets to 1.5 cm long, short, bearing to 9 second flowers; *bracteoles* to 3 mm long, elliptic, subacute, shortly pubescent. *Flower bud* to 6 by 2 mm, narrowly lanceolate. *Calyx* shortly tomentose outside, glabrous within; lobes ovate, subacute; inner 2 somewhat smaller, relatively broader, thinner, than outer 3. *Petals* pink, cream at margin, linear, pubescent on both surfaces, strongly contorted in bud. *Stamens* 20–30; filaments broad at base, tapering abruptly and filiform distally, glabrous; anthers oblong, glabrous, tapering, the outer cells larger than the inner cells; appendage to connective short, glabrous but for a single (–2) apical bristle. *Ovary* broadly ovoid, pubescent; *stylopodium* narrowly cylindrical, shorter than

the ovary, pubescent; style as long as stylopodium, tapering, glabrous. *Fruit calyx* shortly buff pubescent; 3 longer lobes to 5 by 1.2 cm, spatulate, chartaceous, obtuse, c. 2.5 mm broad above the c. 5 by 4 mm saccate thickened base; 2 shorter lobes to 3.5 by 4 mm, subequal, spatulate, similar at base. *Nut* to 10 by 7 mm, ovoid, densely shortly buff tomentose; style remnant c. 1.5 mm long.

Distr. *Malesia*: Malaya (Perak, Trengganu, Pahang), Borneo (Ulu Kapuas, Sarawak, E. Sabah, W. Kutei, Muaratewe).

Ecol. Undulating land and hills to 700 m, Mixed Dipterocarp forest.

Vern. *Sėlangan batu zang* (Sar.), *palepek gunong* (S.E. Borneo), *balau sengkawang*, *damar laut kuning* (Mal.).

7. *Shorea leptoderma* MEIJER, Act. Bot. Neerl. 12 (1963) 331, pl. 5; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 180, pl. 14b (stem).

Small to medium-sized tree. Young twigs, leaf buds, parts of petals exposed in bud, ovary, panicles, petioles, stipules outside (sparsely so within) and nervation above (glabrescent beneath) densely evenly shortly persistently pale ochreous pubescent; sepals thus at first, becoming sparse in fruit. *Twig* c. 2 mm \varnothing apically, ribbed at first, becoming terete, chocolate-brown, minutely pale lenticellate. *Buds* to 3 by 2 mm, ellipsoid, subacute. *Stipules* to 8 by 5 mm, elliptic, obtuse, fugaceous. *Leaves* 4–18 by 1.5–6.5 cm, elliptic, chartaceous; base cuneate; apex acute or with to 1 cm long slender acumen; nerves 7–12 pairs, slender but prominent beneath, arched, at 35°–45°; tertiary nerves slender, scalariform; midrib applanate above, prominent beneath; *petiole* 8–10 mm long. *Panicle* to 10 cm long, ribbed; singly branched, branchlets short, bearing to 8 congested secund flowers; *bracteoles* unknown. *Flower buds* to 5 by 2 mm, lanceolate; sepals broadly ovate, subequal, the outer 3 acute, the inner 2 subacuminate; *stamens* c. 30; filaments compressed, tapering; anthers ellipsoid, glabrous; appendages hardly exceeding anthers, with to 5 long bristles; *ovary* ovoid, with short columnar style. *Fruit pedicel* to 2 mm long, slender; 3 longer *calyx lobes* to 8 by 1.5 cm, spatulate, obtuse, c. 4 mm wide above the to 5 by 5 mm saccate thickened base; 2 shorter lobes to 4.5 by 0.4 mm, linear, acute, otherwise similar. *Nut* to 12 by 6 mm, ovoid, tapering to the 2 mm columnar style remnant.

Distr. *Malesia*: Borneo (N.E. Borneo, Sandakan Distr. and Tawau).

Ecol. Lowland forests.

Vern. *Sėlangan batu biabas*, s. b. *jambu*.

Note. Closely allied to *S. scrobiculata* from which it is doubtfully distinct.

8. *Shorea ciliata* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 118; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 82; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 154, t. 187; RIDL, Fl. Mal. Pen. 1 (1922) 229; FOXW. Mal. For. Rec. 10 (1932) 171; SYM. Mal. For. Rec. 16 (1943) 10, f. 6.

Medium-sized tree. Sepals, ovary and parts of petals exposed in bud densely shortly evenly buff pubescent; young innovations fugaceous cream lepidote, leaf undersurface sometimes sparsely persistently so, otherwise glabrous. *Twigs* c. 2 mm \varnothing apically, slender, much branched, terete, dark brown, smooth. *Buds* to 3 by 2 mm, ellipsoid, subacute. *Stipules* to 6 mm long, linear, fugaceous. *Leaves* (4–)5–13(–17) by (1.5–)2.5–5(–8) cm, ovate-lanceolate, coriaceous; base cuneate; acumen to 1 cm long, slender; nerves 9–11 pairs, slender, hardly elevated beneath, arched, at 25°–65°; tertiary nerves slender, subreticulate; midrib elevated on both surfaces though more prominent below than above, terete; *petiole* 1.5–2.5 cm long, slender, geniculate. *Panicle* to 10 cm long, terminal or axillary, terete; singly or doubly (if terminal) branched, branchlets to 3 cm long, bearing to 6 flowers; *bracteoles* unknown, fugaceous. *Flower bud* to 8 by 3 mm, lanceolate. *Petals* cream. *Sepals* ovate, subacute, unequal. *Stamens* c. 26–28, subequal; filaments compressed, tapering; anthers oblong, glabrous; appendages short, with to 5 prominent bristles; *ovary* with distinct stylopodium; style short but prominent, glabrous. *Fruit pedicel* to 1 mm, short. 3 longer *fruit calyx lobes* to 6 by 1.5 cm, spatulate, obtuse, to 5 mm wide above the to 8 by 5 mm ovate saccate thickened base; 2 shorter lobes to 3 by 0.4 cm, lorate, obtuse, otherwise similar. *Nut* to 12 by 8 mm, ovoid, tapering to a c. 3 mm long style remnant.

Distr. *Malesia*: Malaya.

Ecol. Widespread in Upper Dipterocarp Forests on ridges of the main range, at 800–1200 m, and down to 300 m on Penang Hill.

Vern. *Balau gunong*.

9. *Shorea submontana* SYM. Gard. Bull. S. S. 10 (1939) 368; Mal. For. Rec. 16 (1943) 24, f. 6. — *S. costata* (non (CORREA) PRESL) KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 119; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 81; BURK. J. Str. Br. R. As. Soc. 81 (1920) 67, 86, fig.; *ibid.* 86 (1922) 281; RIDL, Fl. Mal. Pen. 1 (1922) 231, p.p.; FOXW. Mal. For. Rec. 3 (1927) 67; *ibid.* 10 (1932) 176, p.p.; DESCH, Mal. For. Rec. 12 (1936) 9.

Large buttressed tree. Buds, stipules outside, panicles, parts of petals exposed in bud and ovary shortly densely evenly persistently buff pubescent; sepals thus at first, becoming sparsely so; twigs, petioles, midribs above and nervation beneath caducously so. *Twigs* c. 3 mm \varnothing apically, ribbed, becoming terete, smooth, blackish. *Buds* to 5 by 3 mm, ellipsoid, obtuse. *Stipules* to 14 by 6 mm, oblong, obtuse, caducous. *Leaves* 7–20 by 4–10 cm, ovate to obovate, thinly coriaceous; base broadly cuneate to cordate; apex acute or with up to 1 cm long, slender acumen; nerves 9–14 pairs, slender but prominent beneath, at 90° at the base, down to 45° towards the apex; tertiary nerves densely scalariform, slender, obscure; midrib prominent, terete, beneath, evident but \pm applanate above; *petiole* 15–33 mm long, geniculate. *Panicle* to 5 cm long, terete, terminal or axillary, singly branched; *bracts* and *bracteoles* and

mature flowers unknown. *Sepals* broadly ovate, subequal; *stamens* c. 20; filaments compressed, tapering; anthers oblong; appendages exceeding anthers, setose; *ovary* narrowly ovoid; style short, glabrous. *Fruit pedicel* to 1 by 1 mm, short. 3 longer fruit calyx lobes to 9 by 1.8 cm, spatulate, obtuse, c. 6 mm wide above the to 13 by 10 mm ovate saccate thickened base; 2 shorter lobes to 6 by 0.4 mm, lorate, obtuse, otherwise similar. *Nut* to 1.8 by 1.4 cm, ovoid, crowned by an up to 3 mm tapering style remnant.

Distr. *Malesia*: Malaya (Selangor and W. Pahang to Penang and Trengganu).

Ecol. Locally very common on high hills of the main range, usually 800–1000 m, but down to 350 m near coast.

Vern. *Balau gajah*.

10. *Shorea geniculata* SYM. ex [BROWNE, For. Trees Sarawak & Brunei (1955) 167, *nomen*] ASHTON, Gard. Bull. Sing. 19 (1962) 291, pl. 19; Man. Dipt. Brun. (1964) 133, f. 13, pl. 32 (habit, stem); *ibid.* Suppl. (1968) 71.

Large tree with stout buttresses. All vegetative parts glabrous. *Twig* c. 3 mm \varnothing apically, stout, much branched, terete, smooth; nodes prominent, with raised round petiole scar and c. 2–3 mm long straight pale linear ascending stipule scars (only visible on young twigs). *Bud* 4–7 by 1–1.5 mm, linear to falcate. *Stipule* to 10 by 3 mm, narrowly oblong, acute, caducous. *Leaves* 11–17 by 7–13 cm, broadly ovate to suborbicular, cream lepidote beneath, coriaceous; base obtuse or subcordate; acumen to 8 mm long; nerves 9–11 pairs, distant, arched, at c. 40°–50°; tertiary nerves sinuate, densely scalariform, slender; *petiole* 4–6 cm long. *Panicle* to 12 cm long, terminal or axillary, \pm terete, densely shortly persistently pale buff pubescent, glabrescent; regularly singly branched, branchlets to 1.5 cm, short, bearing to 4 second flowers; *bracteoles* to 4 mm long, oblong, puberulent, fugaceous. *Flower buds* to 20 by 4 mm, large, narrowly lanceolate, acute. *Calyx* shortly pubescent outside, glabrous within; lobes ovate, acute, the outer 3 slightly longer and narrower than inner 2. *Petals* cream, to 2.5 cm long, linear, pubescent on both surfaces. *Stamens* c. 55; filaments broad at base, tapering and filiform distally; anthers oblong, glabrous, the posterior lobes slightly smaller; appendage to connective somewhat shorter than anther but prominent, stout and setose. *Ovary* broadly ovoid, densely tomentose but for the glabrous base, abruptly tapering to a short broad trifurcate glabrous style; stigma minute. *Fruit calyx lobes* c. 1.5 cm long and broad, equal, deltoid, subacute, incrassate, sparsely pale grey-buff pubescent, the apices adpressed to the base of the nut. *Nut* to 5 by 5 cm, globose, very large, densely shortly grey-buff tomentose, ridged longitudinally and transversely rugose when dry, shortly mucronate.

Distr. *Malesia*: Borneo (Sarawak and Brunei).

Ecol. Very local, on deep leached yellow soils in Mixed Dipterocarp Forest on subcoastal hills.

Vern. *Upun pēnyau* (Brun.).

11. *Shorea seminis* (DE VRIESE) SLOOT. in Merr. Pl. Elm. Born. (1929) 204; Bull. Bot. Gard. Btzg III, 17 (1941) 117; DAKKUS, Bull. Jard. Bot. Btzg III, Suppl. 1 (1930) 268; FOXW. Mal. For. Rec. 10 (1932) 237; Philip. J. Sc. 67 (1938) 301; BAL, Landbouw 9 (1934) 275; BURK. Kew Bull. (1935) 317; ROWAAN, Landbouw 13 (1937) 310; Bericht n. 13 Afd. Handelsmus. Kol. Inst. (1937) 5; BROWNE, For. Trees Sarawak & Brunei (1955) 170; ASHTON, Gard. Bull. Sing. 20 (1963) 272; Man. Dipt. Brun. (1964) 145, f. 13; *ibid.* Suppl. (1968) 75; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 185, f. 2d, pl. 17 (habit). — *Hopea seminis* DE VRIESE, Minyak Tengkawang (1861) 32; T. & B. Cat. Hort. Bog. (1866) 202. — *Hopea lanceolata* DE VRIESE, Minyak Tengkawang (1861) 32. — *S. schefferiana* HANCE, J. Bot. 16 (1878) 303; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 82; MERR. En. Born. (1921) 406. — *Isoptera borneensis* SCHEFF. ex BURCK, Med. Lands Pl. Tuin 3 (1886) 27; Ann. Jard. Bot. Btzg 6 (1887) 222, t. 25; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 106, *p.p.*; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 263; BOERL. Cat. Hort. Bog. 2 (1901) 110; BECC. For. Born. (1902) 155, 192, 571; Wand. (1904) 92, 124, 390; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 310; FOXW. Philip. J. Sc. 13 (1918) Bot. 194, pl. 1; MERR. En. Born. (1921) 407; En. Philip. 3 (1923) 101; REYES, Philip. J. Sc. 22 (1923) 301; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 259; DEN BERGER & ENDERT, Med. Proefst. Boschw. 11 (1925) 117; ENDERT, M.O. Born. Exp. (1927) 204, 289, 311; HEYNE, Nutt. Pl. ed. 2 (1927) 1113, 1114, 1127; WATSON, Mal. For. Rec. 5 (1928) 45, 205, *p.p.*; SLOOT. Bull. Bot. Gard. Btzg III, 17 (1941) 117. — *S. borneensis* PIERRE, For. Fl. Coch. 3 (1889) t. 234. — *Ridleyinda borneensis* O. K. Rev. Gen. Pl. 1 (1891) 65. — *Hopea ovalifolia* (non BOERL.) FOXW. Philip. J. Sc. 6 (1911) Bot. 263; *ibid.* 13 (1918) Bot. 183. — *Isoptera seminis* BURK. Kew Bull. (1935) 317; Dict. (1935) 1254; BACKER & BAKH. f. Fl. Java 1 (1963) 332.

Medium-sized to large tree. *Twig*, *panicle*, *leaf bud*, *stipule*, *petiole*, *midrib* on both surfaces and nerves beneath shortly evenly pale grey-brown pubescent. *Twig* c. 1.5 mm \varnothing apically, straight, slender, frequently ribbed when young; stipule scars to 1 mm long, short, descending. *Bud* 1.5–2.5 by 1–2 mm, slightly compressed, ovoid to falcate, acute. *Stipule* to 7 by 3.5 mm, oblong, obtuse, caducous. *Leaves* variable in size, 9–18 by 2.5–8 cm, oblong-ovate to lanceolate, glabrous or greyish lepidote beneath, thinly coriaceous; base obtuse or cuneate; acumen 0.8–2 cm long, narrow; nerves 9–15 pairs, slender, rather straight, prominent beneath, at c. 40°–55°; tertiary nerves slender, densely scalariform, sinuate; *petiole* 1–1.5 cm long. *Panicle* to 10 cm long, terminal or axillary to ramiflorous, terete, drying angular; regularly singly branched, branchlets to 1.7 cm long, bearing to 5 second flowers; *bracteoles* linear, shortly pubescent, fugaceous. *Flower bud* to 8 by 2 mm, narrowly lanceolate. *Calyx* shortly pubescent outside,



Fig. 80. *Shorea sumatrana* (SLOOT. ex THORENAAR) SYM. ex DESCH; tree c. 30 m high. Palembang (Photogr. THORENAAR, 1924).

glabrous within; lobes subequal, ovate, obtuse, the inner 2 somewhat narrower and thinner than the outer 3. *Petals* cream, pink towards base, linear, hardly contorted, shortly tomentose outside, glabrous within; *stamens* 30–40; filaments compressed at base, tapering, with a few long bristles; anthers oblong, glabrous, the outer cells larger than the inner cells; appendage to connective short, setose. *Ovary* and *stylopodium* conical to hour-glass shaped, densely pubescent; style short, glabrous. *Fruit calyx* shortly sparsely greyish buff pubescent, lobes subequal, to 2 by 1.8 cm (usually c. 1.5 by 1.4 cm), incressate, orbicular, rotate. *Nut* c. 1 cm long and \varnothing , ovoid or globose; style remnant to 12 mm long, stout.

Distr. *Malesia*: Borneo, Philippines.

Ecol. Alluvium banks of sluggish river, often gregarious.

Uses. The fruit are prepared in Borneo as a source of illipe butter, but are too small to be valued for export.

Vern. *Engkabang chengai*, *e. tēgelam*, *e. tērdak*, *e. mayoh*, *e. pēlèpak*, *tēkam tēgelam* (Sar.), *sangkawang* (Brun.), *tēngkawang ayer*, *t. batu*, *t. pēlèpak* (*kēlèpak*), *t. tanggoi*, *t. tērdak*, *t. chēpak* (Indon. Borneo).

12. *Shorea sumatrana* (SLOOT. ex THORENAAR) SYM. ex DESCH, Mal. For. 3 (1934) 195; *ibid.* 12 (1936) 9; J. Str. Br. R. As. Soc. 19 (1941) 161; Mal. For. Rec. 16 (1943) 25, f. 6, 16; SLOOT. Bull. Bot. Gard. Btzg III, 17 (1941) 124, f. 17. — *Isoptera borneensis* (non SCHEFF. ex BURCK) KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 129, *p.p.*; RIDL. Trans. Linn. Soc. 3 (1893) 284; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 106, *p.p.*; MERR. En. Born. (1921) 407, *p.p.*; FOXW. Mal. For. Rec. 1 (1921) 71; *ibid.* 2 (1922) 170; *ibid.* 3 (1927) 70; BURK. J. Str. Br. R. As. Soc. 86 (1922) 281, 287; Bot. Gard. Sing. Guide (1925) 22; RIDL. Fl. Mal. Pen. 1 (1922) 245; MERR. En. Philip. 3 (1923) 101, *p.p.*; WATSON, Mal. For. Rec. 8 (1930) 30; BUNTING & MILSUM, Guide Govt. Exp. Plant. Serdang (1931) 122. — *Isoptera sumatrana* SLOOT. ex [ENDERT, Tectona 18 (1925) 73, 78, 135; DEN BERGER & ENDERT, Med. Proefst. Boschw. 11 (1925) 117, t. 15, f. 58, *nomen*] THORENAAR, Med. Proefst. Boschw. 16 (1926) 115, f. 19; HEYNE, Nutt. Pl. ed. 2 (1927) 1127; FOXW. Mal. For. Rec. 10 (1932) 238; BURK. Dict. (1935) 1257. — Fig. 80, 81.

Description as in *S. seminis*, but stamens 25.

Distr. Pattani in S.E. Peninsular Thailand and in *Malesia*: Malaya (mainly East Coast Res.), Sumatra.

Ecol. Alluvium banks of sluggish but not brackish rivers, sometimes semi-gregarious.

Vern. *Sēngkawang* (Mal., Sum.), *kēdawang*, *sēngkawang bēsak* (Palembang), *tēngkawang*, *t. ijok*, *t. batu* (Mal.).

Note. Of the characters by which VAN SLOOTEN distinguished this taxon from *S. seminis* only the number of stamens is consistently reliable, and this species is hence of dubious specific status.

13. *Shorea foxworthyi* SYM. Gard. Bull. S. S. 8 (1935) 272, pl. 19; Mal. For. Rec. 16 (1943) 14, f. 6, 9; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 169; ASHTON, Man. Dipt. Brun. Suppl. (1968) 70, f. 9. — *S. collina* (non RIDL.) FOXW. Mal. For. Rec. 3 (1927) 63; *ibid.* 10 (1932) 173; SYM. *apud* DESCH, Mal. For. 3 (1934) 195.

Tall buttressed tree. Twigs, petioles, buds and stipules outside (sparsely within) densely shortly evenly persistently golden-tawny pubescent, leaf-nerve beneath sparsely caducously so. *Twig* c. 2 by 3 mm \varnothing apically, somewhat compressed, rugose when dry, becoming smooth, terete; stipule scars short, dark, slender, horizontal. *Bud* to 3 by 2 mm, ellipsoid, obtuse. *Stipule* to 15 by 4 mm, narrowly elliptic to falcate, subacute, caducous. *Leaves* 8–13 by 3–6.5 cm, elliptic, coriaceous; base broadly cuneate; acumen to 1 cm long, broad; nerves 10–14 pairs, very prominent beneath, applanate or depressed above with the lamina bullate between them, at 85° at the base, 40°–55° towards the apex; tertiary nerves slender, densely scalariform; midrib prominent beneath, somewhat depressed above; *petiole* 11–20 mm long, drying rugose. *Panicle* to 5 cm long, terminal or axillary, short, rugose when dry, persistently evenly shortly golden-tawny pubescent, branchlets bearing to 3 flowers; *bracteoles* fugaceous. *Flower bud* to 10 by 3 mm, fusiform. *Calyx* shortly densely pubescent on parts exposed in bud, the inner 2 lobes fimbriate distally; lobes ovate, acute, the inner 2 somewhat smaller than the outer 3. *Petals* cream, pale carmine at base, linear, shortly densely pubescent outside, sparsely sericeous within. *Stamens* 32–41; filaments comparatively densely setose, compressed at base, tapering distally; anthers narrowly oblong, sparsely setose on the distal margin, the 2 outer cells somewhat the larger; appendage to connective hardly exceeding anther apex, densely setose. *Ovary* ovoid, densely pubescent, surmounted by a similarly tomentose narrowly conical stylopodium and glabrous filiform style; style as long as ovary and stylopodium. *Fruit pedicel* and base of calyx lobes outside sparsely pubescent, nut densely evenly shortly persistently buff pubescent, fruit otherwise glabrous. 3 longer *calyx lobes* to 10 by 2.5 cm, broadly spatulate, obtuse, to 7 mm broad above the to 15 by 12 mm ovate thickened saccate base; 2 shorter lobes to 1.4 by 1 cm, linear, acute, similar at base. *Nut* to 2.5 by 1.4 cm ovoid; stylopodium to 6 mm long, prominent.

Distr. *Malesia*: Peninsular Thailand, in Malaya (W. coast from Kedah to Selangor; E. coast), Sumatra (N.E. at Langkat), Borneo (Central & N.E. Sarawak, E. Sabah, S.E. Borneo to Puruktjau).

Ecol. Scattered, sometimes common, undulating land or hills below 700 m; sandy clay soils.

Vern. *Balau bukit*, *damar laut kuning* (Mal.), *sēlangan batu kuning*, *s. b. bērsisek*, *tēkam* (Borneo).

14. *Shorea lumutensis* SYM. Gard. Bull. S. S. 10 (1939) 364, pl. 22; Mal. For. Rec. 16 (1943) 19, f. 6. — *S. ? inappendiculata* (non BURCK) SYM. ex DESCH, Mal.

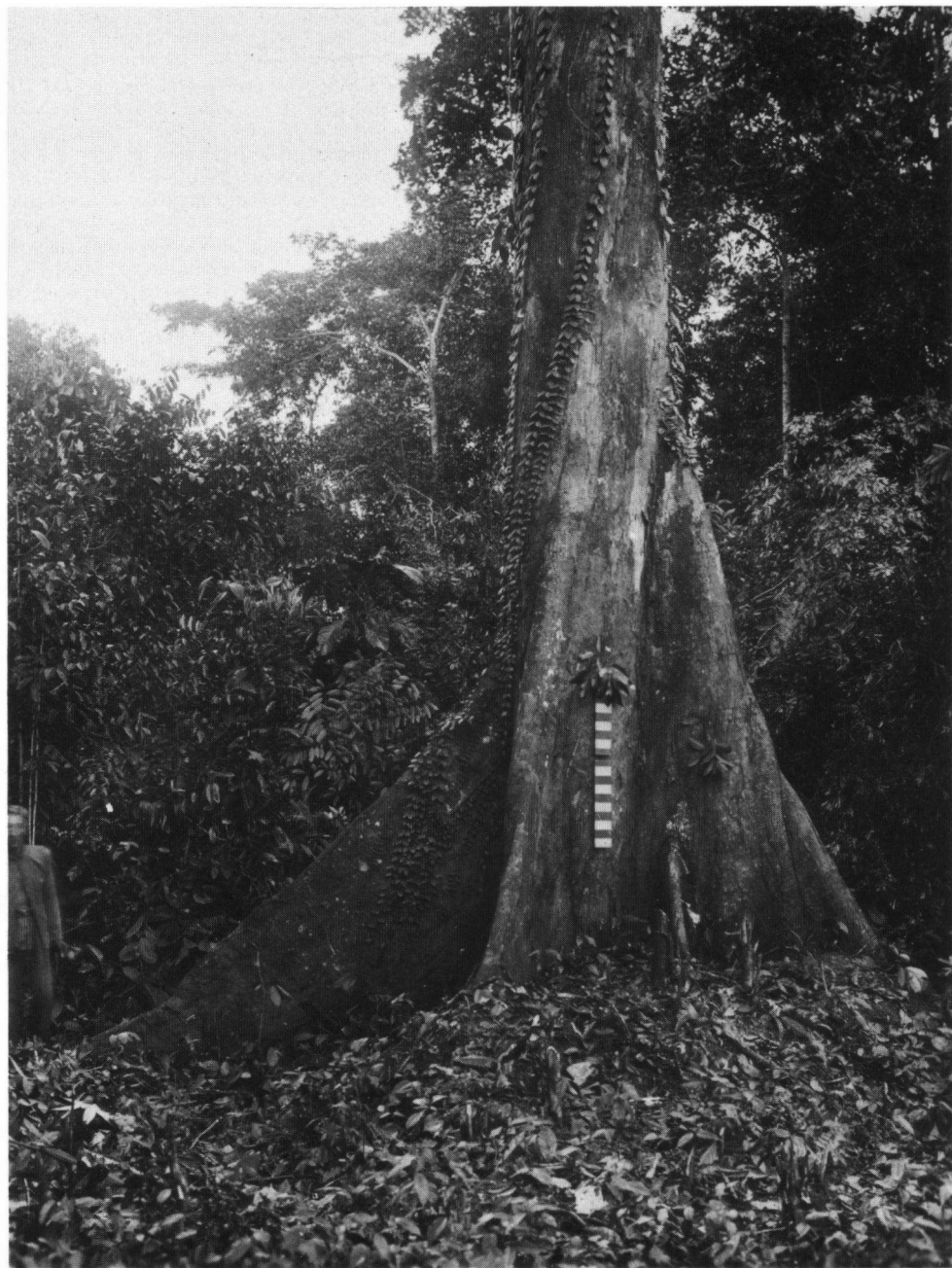


Fig. 81. Trunk-base of *Shorea sumatrana* (SLOOT. ex THORENAAR) SYM. ex DESCH with some root-climbers ascending, the soil in front carpeted with seedlings. Measuring staff 2 m; same tree as in fig. 80. Palembang (Photogr. THORENAAR, 1924).

For. Rec. 12 (1936) 9, p.p.; Govt. Gaz. F. M. S. 29, 26 notice n. 5884 (1937), p.p.

Medium-sized to large tree. Young twigs and fruit calyx caducous cream puberulent, panicles, parts of perianth exposed in bud, ovary and base of style persistently grey-brown, rough pubescent. *Twigs* c. 3 mm \varnothing apically, terete, drying black. *Stipules* not seen. *Leaves* 7–29 by 2.5–7 cm, oblong or elliptic, coriaceous, persistently cream lepidote beneath, fugaciously so above; margin \pm sinuate; base cuneate or obtuse; acumen short, broad; nerves 12–16 pairs, obscure above, prominent and drying black beneath; tertiary nerves densely scalariform, sinuate, evident beneath; midrib prominent beneath, evident but \pm appanate above; *petiole* 2–3.5 cm long, geniculate, \pm persistently cream lepidote. *Panicle* to 10 cm long, terminal or axillary; singly or (if terminal) doubly branched, branchlets to 1.5 cm long, bearing to 5 second flowers. *Flower buds* c. 9 mm long at anthesis; 3 outer sepals ovate-deltoid, obtuse; 2 inner ovate, acute or acuminate; *stamens* 20–24, of several heights; filaments rather short, broad at base, tapering and filiform beneath the ellipsoid anthers; outer anther cells \pm sparsely barbate at apices; appendages short, with 1–2 terminal bristles; *ovary* and *stylopodium* ovoid-conical, tapering into the short stout style. *Fruit* \pm sessile; 3 longer *calyx lobes* to 7 by 1.5 cm, spatulate, obtuse, tapering to c. 5 mm above the to 10 by 8 mm elliptic saccate thickened base; 3 shorter lobes to 4.0 by 0.4 mm, \pm linear, similar at base; *nut* to 20 by 12 mm, ovoid, prominently beaked.

Distr. *Malesia*: W. coastal Malaya (Dindings).

Ecol. Local but common on coastal hills above 100 m.

Vern. *Balau puteh*, *b. bukit*, *damar laut* (Mal.).

Note. Without flowers this species is indistinguishable from the Bornean *S. inappendiculata* BURCK. Sterile specimens from N.W. Johore, Sumatra's E. coast, Karimun and Lingga could belong to either species.

15. *Shorea exelliptica* MEIJER, Act. Bot. Neerl. 12 (1963) 323, pl. 1; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 167; ASHTON, Man. Dipt. Brun. (1964) 132, f. 13; *ibid.* Suppl. (1968) 69. — *S. ?elliptica* (non BURCK) SYM. Mal. For. Rec. 16 (1943) 13, f. 6, 8. — *Shorea* sp. BROWNE, For. Trees Sarawak & Brunei (1955) 170.

Tall buttressed tree. Twig, panicle, leaf bud, stipule (short on inner, long on outer surfaces), petiole, midrib on both surfaces and nerves on undersurface densely persistently purplish brown to gold-brown scabrid tomentose; sometimes glabrous on midrib upper surface in mature trees. *Twigs* c. 2 mm \varnothing apically, ridged at first, becoming terete or somewhat compressed, smooth, with c. 2 mm long pale linear descending stipule scars. *Bud* to 3.5 by 3 mm, ovoid, \pm compressed. *Stipule* to 8 by 4 mm, not at first caducous, broadly ovate, acute. *Leaves* 9–15 by 3.5–7 cm, coriaceous, oblong to broadly ovate, golden to silver lepidote beneath; base broadly cuneate; acumen to 1 cm long; nerves 12–18 pairs, prominent beneath,

at c. 50°–60°; tertiary nerves slender, sinuate, scalariform; *petiole* 1.2–1.7 cm long, rugose. *Panicle* to 12 cm long, terminal or axillary, ribbed and slightly compressed; singly branched, branchlets to 2.5 cm long, bearing to 8 second flowers; *bracteoles* to 4 mm long, elliptic, acute, shortly pubescent, fugaceous. *Flower* to 10 by 3 mm, narrowly lanceolate. *Calyx* densely pubescent outside, puberulent within; lobes deltoid, subequal. *Petals* cream, pink at base, linear, densely tomentose outside, shortly pubescent within. *Stamens* 30–40; filaments compressed at base, slender, tapering, slightly hispid; anthers oblong, the outer cells somewhat larger than the inner cells; appendage to connective as long as anther, stout, setose. *Ovary* and *stylopodium* shortly ovoid, densely tomentose except at the base; style as long as ovary and stylopodium, slender, glabrous. *Fruit calyx* puberulent to glabrous; 3 longer lobes to 8 by 2.4 cm, spatulate, obtuse, to 4 mm broad above the to 12 by 7 mm ovate thickened saccate base; 2 shorter lobes to 4.5 by 1.7 cm, otherwise similar. *Nut* to 1.5 by 1 cm, ovoid, densely pale grey-buff pubescent; style remnant to 3 mm long.

Distr. *Malesia*: Malaya (Kedah, Perak, E. coast), Borneo.

Ecol. Widespread, leached clay soils on undulating land, ridges and plateaux to 600 m.

Vern. *Balau tembaga* (Mal.), *sélangan batu tembaga* (N. Borneo).

16. *Shorea inappendiculata* BURCK, Ann. Jard. Bot. Btzg 6 (1877) 206; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 102, t. 2, f. 21, 30; MERR. En. Born. (1921) 405; BROWNE, For. Trees Sarawak & Brunei (1955) 171; ASHTON, Man. Dipt. Brun. Suppl. (1968) 73.

Large buttressed tree with flaky bark. Twigs, buds, stipules, petioles, midrib above and panicles densely persistently scabrid rufous pubescent, leaf nervation beneath sparsely so (denser, longer in young trees); leaf undersurface frequently \pm densely silvery lepidote. *Twig* 2–4 mm \varnothing apically, blackish, prominently ribbed or compressed at first; stipule scars pale, horizontal. *Bud* to 6 by 4 mm, ovoid, conical; *stipules* to 10 by 4 mm, broadly lanceolate, acute. *Leaves* (7–)10–16 by (2–)3–8 cm (to 30 by 15 cm in young trees), oblong-elliptic, coriaceous; base \pm unequal, obtuse or cordate; apex shortly acuminate to obtuse; nerves 13–24 pairs, prominent beneath, \pm distinctly depressed above with the lamina bullate between; tertiary nerves densely scalariform, slightly elevated beneath; midrib prominent beneath, depressed above; *petiole* 15–30 mm long, \pm stout. *Panicle* to 10 cm long, axillary, ribbed when dry, rather unevenly persistently buff pubescent; singly branched, branchlets to 2 cm long, bearing to 7 second flowers; *bracteoles* to 3 by 2 mm, elliptic, obtuse, shortly evenly pubescent, fugaceous. *Flower bud* to 7 by 3 mm, fusiform. *Calyx lobes* ovate, densely pubescent on parts exposed in buds, inner sepals fimbriate; 3 outer sepals subacute, larger than the 2 acuminate inner sepals. *Petals* linear, densely pubescent on parts exposed in bud. *Stamens* 28–34; filaments setose

distally abaxially, compressed, tapering; anthers narrowly oblong-elliptic, sparsely setose distally, the 2 outer sacs larger than the 2 inner; appendage to connective as long as anthers on outer stamens, shorter on inner, with a few terminal setae. *Ovary* and *stylopodium* ovoid, densely pubescent, tapering into the short glabrous style. *Fruit pedicel* to 4 by 3 mm, broadening into the receptacle; fruit calyx glabrescent; 3 longer lobes to 13 by 3 cm, broadly spatulate, obtuse, c. 8 mm broad above to 15 by 12 mm ovate saccate thickened base; 2 shorter lobes to 10 by 0.9 cm, lorate, subacute, similar at base; nut to 33 by 16 mm, ovoid, prominently apiculate.

Distr. *Malesia*: Malaya (N.W. Johore), Sumatra (Langkat), ?Lingga, northern Borneo (Sarawak to E. Sabah and south to Tiding and Muara Tewe).

Ecol. Lowland Mixed Dipterocarp forest on coastal hills and immediately behind the peat swamps; rather rare.

Vern. *Pelepak*, *p. gunong*, *damar pangin*.

Note. See under *S. lumutensis*, with which it is vicarious.

17. *Shorea falcifera* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 86; BECC. For. Born. (1902) 571; MERR. En. Born. (1921) 571; ASHTON, Gard. Bull. Sing. 31 (1978) 36. — *Hopea linggensis* BOERL. Cat. Hort. Bog. 2 (1901) 103. — *S. glauca* (non KING) BROWNE, For. Trees Sarawak & Brunei (1955) 168, *p.p.* — *S. flava* MEIJER, Act. Bot. Neerl. 12 (1963) 325, pl. 2; ASHTON, Man. Dipt. Brun. Suppl. (1968) 69, f. 9. — Fig. 10.

Medium-sized tree. Twig, bud, stipule (sparsely so within), nervation and lamina beneath densely persistently pale yellow lepidote. *Twig* c. 1 mm \varnothing apically, slender, terete, smooth; stipule scars short, horizontal, obscure. *Bud* to 2 by 1 mm, small, ellipsoid, subacute. *Stipule* to 6 by 4 mm, elliptic, obtuse, fugaceous. *Leaf* 6.5–12 by 2.5–5 cm, narrowly ovate to lanceolate, coriaceous; base broadly cuneate, subequal; acumen to 2 cm long, slender; nerves c. 10 pairs, slender, somewhat elevated beneath, applanate above, at 40°–60°; tertiary nerves obscure, scalariform; midrib slender, prominent beneath, shallowly depressed above; *petiole* 11–18 mm long, somewhat geniculate. *Panicle* to 11 cm long, terminal or axillary, terete or ribbed, shortly evenly persistently buff pubescent; singly branched, branchlets to 3 cm long, short, bearing to 5 distichous flowers. *Flower buds* to 8 by 2 mm, fusiform. *Calyx* pubescent on parts exposed in bud; lobes ovate, the two inner subacuminate, somewhat narrower than the outer 3; outer 3 subacute. *Petals* cream, linear, densely pubescent on parts exposed in bud, sparsely so elsewhere. *Stamens* 33–34; filaments setose, compressed at base, tapering and filiform distally; anthers oblong, the two outer cells slightly the larger, sparsely setose on the distal margin; appendage to connective shorter than anther, shortly setose. *Ovary* and *stylopodium* pyriform, densely sericeous, tapering into the short glabrous style. *Fruit pedicel*, base of calyx and nut shortly densely evenly cream pubescent, calyx elsewhere sparsely so. 3 longer

calyx lobes to 9.5–1.8 cm, broadly spatulate, obtuse, to 7 mm broad above the to 2 by 1.3 cm ovate thickened saccate base; 2 shorter lobes to 7 by 0.8 cm, narrowly spatulate, obtuse, similar at base. *Nut* to 2.5 by 1.5 cm, ovoid; *stylopodium* to 7 mm, prominent, filiform.

Distr. *Malesia*: Malaya (E. coast: Trengganu, Pahang), N.E. Sumatra (Idi in Atjeh; Langkat; Lingga), Borneo (Sarawak west of K. Lupar).

Ecol. Locally abundant on dry hillslopes near coast.

Vern. *Sĕlangan batu kĕring* (Sar.).

18. *Shorea materialis* RIDL. Agr. Bull. Str. & F. M. S. 9 (1910) 183; Fl. Mal. Pen. 1 (1922) 227; BURN-MURDOCH, Tr. Timb. Mal. Pen. 1 (1911) 11; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 306; *ibid.* ed. 2 (1927) 1123; BURK. J. Str. Br. R. As. Soc. 81 (1920) 68; FOXW. Mal. For. Rec. 1 (1921) 69; *ibid.* 3 (1927) 62; *ibid.* 10 (1932) 172; SYM. Mal. For. Rec. 16 (1943) 29, f. 6, 13; ASHTON, Man. Dipt. Brun. (1964) 140, f. 13; *ibid.* Suppl. (1968) 74. — *S. glauca* (non KING) BROWNE, For. Trees Sarawak & Brunei (1955) 168, *p.p.*

Medium-sized tree. Young twig, panicle, leaf bud and petiole caducous cream lepidote. *Twig* 1.5 mm \varnothing apically, terete, smooth, dark chocolate-brown; stipule scars c. 1 mm long, pale, falcate. *Leaf bud* to 3 by 1 mm, linear, acute. *Stipule* to 12 mm long, linear, fugaceous. *Leaf* 8–15 by 3.5–8.5 cm, broadly ovate, glabrous above, cream lepidote beneath; base cuneate to subcordate, unequal; apex with to 1.5 cm long slender acumen; nerves 9–12 pairs, slender but prominent beneath, set at 30°–45° to the midrib at base, glabrous; tertiary nerves slender, densely scalariform. *Petiole* 1.2–2 cm long, to 2 mm \varnothing , cream lepidote. *Panicle* to 15 cm long, terminal or axillary, terete or ribbed; singly branched, branchlets to 12 mm long, bearing to 11 secund flowers; *bracteoles* to 2 mm long, ovate, acute, lepidote. *Flower bud* to 10 by 4 mm, lanceolate. *Calyx* sparsely evenly tomentose outside, glabrous within; lobes ovate, subacute, subequal. *Corolla* cream; petals linear, acute, shortly pubescent on parts exposed in bud. *Stamens* c. 30; filaments glabrous, flat at base, tapering and filiform below the anther; anthers ellipsoid, the 2 outer cells somewhat the larger; appendage to connective short, setose. *Ovary* and *stylopodium* ovoid-conical, densely evenly cream pubescent, tapering into a short glabrous style. *Fruit pedicel* 2 mm long, short. *Fruit calyx* sparsely pubescent towards base; outer lobes to 9 by 3 cm, spatulate, obtuse, tapering to 8 mm broad above the c. 8 by 8 mm saccate thickened base; 2 shorter lobes to 6 by 0.8 cm, linear, subacute, similar at base. *Nut* to 12 by 12 mm, broadly ovoid, densely shortly cream tomentose, tapering to the 4 mm acute style remnant.

Distr. *Malesia*: Malaya (E. coast: S. Trengganu, Pahang, Johore), N.W. Borneo (Brunei, N.E. Sarawak), E. coast Sumatra (sterile collections)?

Ecol. Heath forest on white sand giant podsols of Quaternary marine and estuarine terraces, and sandstone cuestas to 800 m. Locally semi-gregarious.

Vern. *Balau pasir*, *b. laut*, *b. betul* (Mal.).

19. *Shorea atrinervosa* SYM. Gard. Bull. S. S. 10 (1939) 363, pl. 21; Mal. For. Rec. 16 (1943) 9, f. 5A, 6; BROWNE, For. Trees Sarawak & Brunei (1955) 167; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 163, f. 17, pl. 12b; ASHTON, Man. Dipt. Brun. Suppl. (1968) 68, f. 9. — *S. collina* (non RIDL.) FOXW. Mal. For. Rec. 10 (1932) 173, p.p. — *S. ? inappendiculata* (non BURCK) SYM. ex DESCH, Mal. For. Rec. 12 (1936) 9, p.p.; Govt. Gaz. F.M.S. 29, 26, notice n. 5994 (1937) 2, p.p. — Fig. 78 A-A3.

Large tree. Bud, twig and petiole at first caducous buff pubescent, outside of stipule persistently sparsely so, vegetative parts otherwise glabrous. *Twig* c. 2 mm \varnothing apically, terete, drying ribbed; stipule scars short, pale horizontal. *Bud* to 4 by 2 mm, narrowly ovoid, acute. *Stipule* to 8 by 3 mm, lanceolate, acute, caducous. *Leaves* 8–16 by 3.5–9 cm, elliptic to ovate, frequently irregular in shape, coriaceous, undulate, \pm persistently white lepidote beneath; base broadly cuneate to subcordate; acumen to 1 cm long; nerves 10–12 pairs, prominent beneath, glabrous, frequently somewhat sinuous, at 45°–55° except at base, sometimes with small glabrous axillary domatia; tertiary nerves sinuous, slender, scalariform; midrib raised above, prominently so beneath; *petiole* 12–22 mm long, terete. *Panicle* to 11 cm long, terminal or axillary, straight, terete, densely somewhat unevenly shortly pale grey pubescent; singly branched, branchlets to 2 cm long, bearing to 6 second flowers; *bracteoles* to 3 by 2 mm, elliptic, acute, sparsely pubescent, caducous. *Flower bud* to 8 by 3 mm, fusiform. *Calyx* shortly pubescent on parts exposed in bud; lobes ovate, acute, the inner 2 somewhat shorter, thinner, than the outer 3; *petals* crimson at centre, cream at margins, linear, sericeous on both surfaces. *Stamens* 25–33; filaments compressed at base, tapering, sparsely setose; anthers oblong-elliptic, glabrous, the inner pair of pollen sacs shorter, setose. *Ovary* and *stylopodium* ovoid, pubescent, surmounted by a short glabrous style. *Fruit pedicel* to 4 by 2 mm, broadening into calyx. *Fruit calyx* sparsely pubescent, tomentum caducous except at base; 3 longer lobes to 11 by 2.5 cm, spatulate, obtuse, c. 1 mm broad above the to 10 by 8 mm ovate thickened prominently saccate base; 2 shorter lobes to 8.5 by 0.9 cm, lorate, acute, similar at base. *Nut* to 2 by 1.3 cm, ovoid, densely shortly evenly buff pubescent; *stylopodium* to 2 mm long, short, conical.

Distr. *Malesia*: Malaya (E. coast: Trengganu to Johore), Sumatra (Atjeh, West coast south to Bangkahulu, Tapanuli; Riouw Distr. and Langkat in E.), northern Borneo (Ulu Kapuas, Sarawak, Sabah, Bulungan to W. Kutei).

Ecol. Undulating land in valleys, and on hillsides on clay rich soil, in Mixed Dipterocarp forest; locally common.

Vern. *Balau hitam* (Mal.), *résak bamban*, *résak bunga*, *laru bétina*, *mēranti hursik*, *rihir minyak kuyung* (Sumatra), *lēmباسung* (Tarakan), *mēlapi bukit* (Kapuas), *sēlangan batu hitam* (Sabah).

20. *Shorea crassa* ASHTON, Gard. Bull. Sing. 20 (1963) 271; Man. Dipt. Brun. (1964) 130, f. 13; *ibid.* Suppl. (1968) 69, pl. 13 (bark).

Medium-sized to large tree. Twig, panicle, bud, stipule (outside only; glabrescent within) and petiole densely shortly tomentose, with minute adpressed persistent hair tufts; leaf nervation beneath sparsely so. *Twig* to 5 by 2.5 mm \varnothing apically, compressed, becoming terete and glabrous, sometimes narrowly evenly cracked; stipule scars c. 2 mm long, cuneate, pale, ascending. *Bud* to 6 mm long and broad, ovoid, compressed, subacute. *Stipule* to 8 by 4 mm, ovate, cupped, subacute, fugaceous. *Leaves* 10–18 by 5–10 cm, elliptic to ovate, pale cream to golden lepidote beneath; base equal or subequal, cuneate or narrowly obtuse, occasionally subcordate; acumen to 1 cm long; nerves 7–11 pairs, prominent, well spaced, at c. 40°–55°; tertiary nerves slender, sinuate, densely scalariform; midrib appanate at base, depressed towards apex, above; *petiole* 3.5–5 cm long, stout. *Panicle* to 13 cm long, terminal or axillary, terete or somewhat compressed, ribbed on drying, stout; regularly singly branched, branchlets to 4.5 cm long, bearing to 12 distichous flowers; *bracteoles* to 3 mm long, suborbicular, shortly pubescent, caducous. *Flower bud* to 15 by 3.5 mm, narrowly lanceolate. *Calyx* pubescent outside, glabrescent within; lobes broadly ovate, subacute; outer lobes slightly longer, more obtuse than inner. *Petals* cream, pink at base, linear, shortly pubescent, glabrescent within. *Stamens* 38–46; filaments broad at base; tapering, hispid; anthers narrowly oblong, cells tapering, sacs subequal or the outer slightly larger; appendage to connective prominent but always shorter than the anther, setose. *Ovary* ovoid, glabrous at base, otherwise tomentose; *stylopodium* longer than ovary, cylindrical, tomentose; style very short, glabrous. *Fruit calyx* sparsely puberulent towards apex, more densely so towards base; 3 longer lobes to 9 by 2.5 cm, broadly spatulate, coriaceous, obtuse, c. 8 mm broad above the c. 1.5 by 1.3 cm elliptic shallowly saccate thickened base; 2 shorter lobes to 7 by 0.7 cm, narrowly oblong, similar at base. *Nut* to 2.5 by 2 cm, ellipsoid, densely shortly cream tomentose; style remnant stout, tapering, to 8 mm.

Distr. *Malesia*: Borneo (Sarawak, Brunei, Ulu Kapuas, ? Puruktjau, sterile collections).

Ecol. Common on deep leached yellow sandy and sometimes clay soils, on low hills, terraces and occasionally dry sandstone ridges to 1000 m; mainly near the coast.

Vern. *Sēlangan batu daun tēbal* (Brun.).

21. *Shorea obscura* MEIJER, Act. Bot. Neerl. 12 (1963) 333, pl. 6; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 184, pl. 16 (bark); ASHTON, Man. Dipt. Brun. (1964) 142, f. 13; *ibid.* Suppl. (1968) 74.

Large tree. Leaf nervation beneath, petiole, twig, panicle, bud and stipule shortly evenly pale brown pubescent, almost entirely caducous except on panicle, bud and stipule. *Twig* c. 1.5–2 mm \varnothing apically, terete, slender, becoming glabrous; stipule scars short,

pale, obscure. *Bud* 2–4 by 1.5–2.5 mm, ovoid to falcate. *Stipule* to 7 by 2.5 mm, oblong, acute, caducous. *Leaves* 7–12 by 2.5–5 cm, ovate-lanceolate, coriaceous, cream lepidote beneath in mature trees, base cuneate; acumen to 1 cm long, narrow; with or without small pore-like axillary domatia; nerves 7–9 pairs, curved, rather prominent, at 30°–45°, tertiary nerves slender, scalariform at 90°; midrib applanate or slightly raised above; *petiole* 1.2–2 cm long, slender. *Panicle* to 12 cm long, terminal or axillary, ± terete; singly branched, branchlets to 1.5 cm long bearing to 5 second flowers; *bracteoles* to 3 mm long, ovate-elliptic, acute, puberulent, fugaceous. *Flower bud* to 6 by 2 mm, lanceolate. *Calyx* shortly pubescent outside, glabrous within; lobes ovate, acute, the inner 2 somewhat thinner than the outer 3. *Petals* bright pink, cream at margin, linear, pubescent outside, puberulent within. *Stamens* 35–45; filaments compressed at base, tapering, glabrous; anthers oblong-elliptic, the inner sacs shorter than the outer; appendage to connective almost as long as anther, stout, setose. *Ovary* and *stylopodium* ovoid, pubescent but for the glabrous base, tapering into the short glabrous style. *Fruit calyx* shortly sparsely caducously cream pubescent; 3 longer lobes to 10 by 2 cm, spatulate, obtuse, to 5 mm broad above the c. 7 mm broad saccate base; 2 shorter lobes to 5 by 0.5 cm, subacute, narrowly oblong, similar at base. *Nut* to 12 by 9 mm, globose to ellipsoid, shortly buff pubescent, abruptly apiculate.

Distr. *Malesia*: Borneo (Sarawak N.E. of Rejang valley, Sabah, S.E. Borneo to Sampit).

Ecol. Local, skeletal shale soils on ridges and steep hillsides, typically at 600–800 m, but rarely below and to 1400 m.

Vern. *Mēlapi bukit* (Kapuas), *buntok*, *bēnuas* (S.E. Borneo), *sēlangan batu tandok* (Sabah), *s.b. padi* (Brun.).

22. *Shorea lunduensis* ASHTON, Gard. Bull. Sing. 22 (1967) 284, pl. 29; Man. Dipt. Brun. Suppl. (1968) 73.

Large tree. Twigs and buds shortly evenly fugaceous buff pubescent; leaves glabrous. *Twig* c. 3 by 2 mm \varnothing apically, at first compressed, somewhat lustrous; stipule scars c. 3 mm long, pale, prominent, ascending. *Bud* to 5 by 3 mm, ovoid, acute. *Stipules* unknown. *Leaves* 14–24 by 6–15 cm, large, ± broadly ovate to elliptic; base broadly cuneate to subcordate; acumen to 1 cm long; nerves 11–15 pairs, obscure above, prominent beneath, at 40°–55° to the midrib; tertiary nerves sinuate, densely scalariform; midrib hardly elevated above, prominent beneath; *petiole* 2–3.5 cm long, stout. *Panicle* to 12 cm long, terminal or axillary, subterete, densely shortly tufted buff pubescent, singly or doubly branched, branchlets to 3 cm long; *bracteoles* to 4 by 2 mm, ovate, densely shortly pubescent, fugaceous. *Flowers* secund; *bud* to 10 by 3 mm, narrowly ovoid, with the calyx somewhat spreading. *Calyx* sericeous in parts exposed in bud; sepals narrowly ovate, subacute, the inner 2 smaller, relatively broader, than the outer 3. *Petals* cream, linear, densely pubescent on parts exposed in bud.

Stamens 47–52; filaments compressed, tapering, glabrous; anthers oblong, tapering distally, glabrous; appendage to connective exceeding length of anther, densely setose. *Ovary* and *stylopodium* pyriform, densely pubescent, crowned by a glabrous columnar style. *Mature fruit* unknown; sparsely shortly pubescent at first. *Calyx lobes* unequal, 3 long and two short, spatulate, subacute. *Nut* crowned by a short, c. 1 mm long, apiculus.

Distr. *Malesia*: Borneo (W. Sarawak).

Ecol. Local, lower slopes of granodiorite mountains to 650 m, and along porphyry dikes in sedimentary areas.

Note. Possibly vicarious with *S. collina* of E. coastal Malaya.

23. *Shorea falciferoides* FOXW. Philip. J. Sc. 13 (1918) Bot. 189; *ibid.* 67 (1938) 296; ASHTON, Gard. Bull. Sing. 31 (1978) 37, incl. *ssp. glaucescens* (MEIJER) ASHTON. — *S. balangeran* (non BURCK) VIDAL, Phan. Cuming. (1885) 97; Rev. Pl. Vasc. Filip. (1886) 61; BRANDIS, J. Linn. Soc. Bot. 31 (1885) 86; FOXW. Philip. J. Sc. 4 (1909) Bot. 508, 516; *ibid.* 6 (1911) Bot. 269; WHITFORD, Bull. For. Bur. Philip. 10 (1911) 73; FOXW. Philip. J. Sc. 13 (1918) Bot. 187; MERR. En. Philip. 3 (1923) 96; REYES, Philip. J. Sc. 22 (1923) 336; SYM. Gard. Bull. S. S. 8 (1935) 273; ASHTON, Gard. Bull. Sing. 31 (1978) 36. — *S. gisok* FOXW. Philip. J. Sc. 67 (1938) 294, pl. 4 — Fig. 77.

a. ssp. falciferoides.

Large tree. Young twig, panicle, petiole, leaf bud and stipule shortly densely evenly cream pubescent. *Twig* c. 2–3.5 mm \varnothing apically, terete or ± compressed and ribbed, stout, smooth; stipule scars c. 1.5 mm long, pale, cuneate, horizontal. *Bud* to 5 by 3.5 mm, globose to ovoid, subacute, slightly compressed. *Stipules* c. 10 by 4 mm, obtuse, fugaceous. *Leaves* 10–18 by 4.5–8 cm, broadly ovate, chartaceous, pale cream-brown lepidote beneath; base obtuse to cuneate, subequal; acumen to c. 8 mm long; nerves 8–11 pairs, slender, well spaced, raised but not prominent beneath, at c. 40°–50°; tertiary nerves slender, densely scalariform, at c. 90° to the nerves; *petiole* 1.5–2 cm long, stout. *Panicle* to 4 cm long, terminal or axillary, ribbed and somewhat compressed; singly branched, branchlets to 1.2 cm long, bearing to 6 close second flowers; *bracteoles* to 3 mm long, elliptic, shortly pubescent, fugaceous. *Flower bud* to 5 by 2.5 mm, small, lanceolate. *Calyx* densely pubescent outside, glabrous within; lobes suborbicular, obtuse, subequal. *Petals* cream, narrowly elliptic, acute, shortly pubescent on both surfaces. *Stamens* c. 45; filaments glabrous, applanate at base, tapering and filiform distally, somewhat gibbous; anthers subglobose, the 2 outer cells slightly larger; appendage to connective very short on inner anthers, ± $\frac{1}{2}$ length of anthers on outer anthers, sparsely shortly setose but for a single long apical bristle. *Ovary* and *stylopodium* ovoid, densely pubescent, tapering into the short glabrous style. *Fruit calyx* sparsely puberulent.

lent, more densely so at the base; 3 longer lobes to 9.5 by 2.2 cm, broadly spatulate, obtuse, with c. 8 by 8 mm thickened saccate base closely adpressed to the base of the nut; 2 shorter lobes to 7 by 1 cm, subequal, broad, tapering to 5 mm broad above the saccate base. *Nut* c. 15 by 15 mm, broadly ovoid, shortly densely cream-buff tomentose; style remnant c. 4 mm long, tapering.

Distr. *Malesia*: throughout the Philippine islands to Prov. Zambales and Bulacan (Central Luzon) in the moderately seasonal northwest.

Ecol. In Mixed Dipterocarp forest to 1000 m, more or less confined to ridge tops in the everwet areas.

Note. Specimens from the more seasonal N.E. Luzon (*S. falciferoides*) have more or less smaller leaves than other Philippine collections (formerly named *S. gisok*).

b. ssp. glaucescens (MEIJER) ASHTON, Gard. Bull. Sing. 31 (1978) 37. — *S. glaucescens* MEIJER, Act. Bot. Neerl. 12 (1963) 327, pl. 3; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 170; ASHTON, Man. Dipt. Brun. (1964) 134, f. 13; *ibid.* Suppl. (1968) 71.

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

Distr. *Malesia*: Borneo, except the west and southwest.

Ecol. Clay rich soils in Mixed Dipterocarp forest to 600 m.

Vern. *Sĕlangan batu daun nipis* (Brun.), *s. b. laut* (Sabah).

Note. Differs from the type subspecies only in the leaf characters.

24. Shorea superba SYM. Gard. Bull. Sing. 17 (1960) 491; ASHTON, Man. Dipt. Brun. (1964) 146, f. 13; *ibid.* Suppl. (1968) 146; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 187, f. 22, pl. 18–19 (habit). — Fig. 9.

Vast, prominently buttressed tree. Twig, panicle, leaf bud, stipule, petiole and nerves beneath densely shortly evenly pink-brown pubescent. *Twig* c. 2.5 by 1 mm \varnothing apically, compressed and ridged at first, becoming terete, much branched; stipule scars c. 1.5 mm long, pale, linear, horizontal. *Leaf bud* to 4 by 3 mm, ovoid, compressed, slightly asymmetrical, subacute. *Stipule* to 12 by 5 mm, ovate-lanceolate, fugaceous. *Leaves* 7–12 by 4–7 cm, oblong, thinly coriaceous, silver to cream lepidote beneath; base broadly cuneate; acumen 5–10 mm long, broad; nerves 16–24 pairs, dense, straight, at 50°–60°; midrib slender, prominent beneath, depressed above; tertiary nerves densely scalariform, slender, \pm obscure; *petioles* 1–1.5 cm long, slender. *Panicle* to 8 cm long, terminal or axillary, somewhat compressed and ribbed; regularly singly branched, branchlets to 2 cm long, bearing to 8 close secund flowers; *bracteoles* to 5 mm long, lanceolate, acute, caducous. *Flower bud* to 7 by 2 mm, lanceolate. *Calyx* shortly pubescent outside, glabrous within; 3 outer lobes deltoid-ovate, acute; 2 inner lobes smaller, ovate, acuminate, thinner. *Petals* cream, linear, shortly tomentose outside, glabrous

within, hardly contorted. *Stamens* c. 30, subequal; filaments compressed and broad at base, tapering; anthers oblong, the outer sacs larger than the inner, glabrous; appendage to connective short, setose. *Ovary* and *stylopodium* cylindrical to conical, tomentose; style short, glabrous. *Fruit calyx* puberulent; 3 longer lobes to 6 by 1.2 cm, spatulate, acute or obtuse, tapering to a c. 8 by 8 mm elliptic saccate thinly incrassate base; 2 shorter lobes to 30 by 4 mm linear, acute, similar at base. *Nut* to 12 by 7 mm, ovoid, shortly pubescent; style remnant short.

Distr. *Malesia*: Borneo (Sarawak N.E. of Bintulu, Sabah, Tidung, Berau, Sampit; sterile coll.).

Ecol. Fertile clay soils at low altitudes in Mixed Dipterocarp forest to 600 m.

Vern. *Sĕlangan batu daun halus* (Sabah), *s.b. tulang ikan* (Brun.).

25. Shorea hypoleuca MEIJER, Act. Bot. Neerl. 12 (1963) 329, pl. 4; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 174, pl. 13; ASHTON, Man. Dipt. Brun. Suppl. (1968) 72, f. 9. — Fig. 78 D–D3.

Large tree. Midrib above, bud and stipule outside shortly evenly persistently ocherous pubescent, twig caducously so; twig, midrib above, petiole and leaf beneath yellowish lepidote. *Twig* 1.5–2 mm \varnothing apically, ribbed, becoming terete, smooth; stipule scars short, falcate, descending. *Stipule* to 7 by 4 mm, oblong-ovate, subacute, fugaceous. *Leaves* 8.5–17 by 3.5–8 cm, ovate to narrowly elliptic, coriaceous, yellowish lepidote beneath; margin undulate distally; base cuneate to obtuse; acumen to 1.5 cm long, slender; nerves 11–16 pairs, prominent beneath, straight, oblique at 30°–50°, with small subglabrous axillary domatia; tertiary nerves slender, scalariform; midrib depressed above, prominent beneath; *petiole* 10–16 mm long, rather short, terete. *Panicle* to 14 cm long, terminal or axillary, ribbed, shortly sparsely puberulent; singly branched, branchlets to 2.5 cm long, bearing to 5 secund flowers; *bracteoles* fugaceous. *Flower buds* to 10 by 2 mm, fusiform. *Calyx* pubescent on parts exposed in bud; lobes ovate; inner 2 subacuminate, smaller than outer 3; outer 3 subacute. *Petals* pale yellow, linear, pubescent on parts exposed in bud. *Stamens* c. 33; filaments glabrous, broad and compressed at base, tapering abruptly and filiform distally; anthers elliptic-oblong, glabrous; appendage to connective as long as anther, setose, the apical bristles longer and exceeding length of anther; *ovary* and *stylopodium* pyriform, densely pubescent, crowned by a short glabrous filiform style. *Fruit calyx lobes* sparsely puberulent basally, glabrous distally; 3 longer lobes to 8.5 by 1.7 cm, narrowly spatulate, obtuse, to c. 3 mm broad above the to 10 by 6 mm narrowly elliptic thickened saccate base; 2 shorter lobes to 6 by 0.4 cm, subacute, similar at base. *Nut* to 15 by 10 mm, ovoid, densely evenly pale buff pubescent; *stylopodium* to 3 mm long, slender.

Distr. *Malesia*: Northern Borneo (Sarawak, Sabah, Tidung).

Ecol. Alluvium, undulating land, hillsides below

300 m, on fertile deep soils in Mixed Dipterocarp forest.

Vern. *Sēlangan batu kēlabu*.

26. *Shorea malibato* FOXW. in Elmer, Leaf. Philip. Bot. 6 (1913) 1955; Philip. J. Sc. 13 (1918) Bot. 189, pl. 6; *ibid.* 67 (1938) 298; MERR. En. Philip. 3 (1923) 97; SLOOT. in Merr. Pl. Elm. Born. (1929) 203.

Large buttressed tree. Buds, twigs and parts of perianth exposed in bud caducously pale cream puberulent, petioles more persistently so; panicles and ovary persistently so. *Twigs* c. 1 mm \varnothing apically, much branched, terete, becoming smooth to rugulose, blackish. *Buds* to 4 by 2 mm, lanceolate-falcate, acute. *Stipules* fugaceous, not seen. *Leaves* 7–12 by 2–5 cm, elliptic to lanceolate, \pm thinly coriaceous; base broadly cuneate; acumen to 1.5 cm long, tapering, slender; nerves 11–14 pairs, slender but distinctly elevated beneath, distinctly depressed above except in young trees, at 35°–50°; tertiary nerves densely scalariform, obscure; midrib prominent beneath, obscure and depressed above; *petiole* 9–20 mm long, very slender. *Panicles* to 8 cm long, slender, terminal or axillary, pendant, singly or doubly branched. *Flower bud* to 5 by 3 mm; sepals broadly ovate, acute. *Stamens* 35–37; filaments glabrous; anthers ellipsoid; appendages prominent, with 1–3 long terminal, and 2–3 shorter lateral setae. *Ovary* ovoid-conical, style short. *Mature fruit* unknown. *Fruit* subsessile; *calyx lobes* unequal, 3 longer lobes c. 5 by 1.3 cm, spatulate, obtuse, c. 3 mm broad above the c. 5 by 4 mm elliptic saccate thickened base; 2 shorter lobes c. 25 by 3 mm, linear, similar at base; *nut* small, ovoid, apiculate.

Distr. *Malesia*: Philippines (Mindanao, Leyte and Luzon).

Ecol. Local in non-seasonal evergreen forests of lowlands.

Vern. *Malibato*, *yakal* (Tayabas, Zamboanga), *guisok*, *g. amarillo* (Camarines), *g. madlao* (Leyte).

Note. Replacing *S. hypoleuca* in the Philippines, from which it differs notably in the number of stamens and the smaller, less coriaceous leaf with narrowly channelled nerves above.

27. *Shorea astylosa* FOXW. Philip. J. Sc. 13 (1918) Bot. 188, pl. 5; *ibid.* 67 (1938) 297; MERR. En. Philip. 3 (1923) 96; ASHTON, Gard. Bull. Sing. 31 (1978) 37. — *S. ciliata* (non KING) FOXW. Philip. J. Sc. 13 (1918) Bot. 188; *ibid.* 67 (1938) 300.

Large tree. Young twigs and petioles caducous buff puberulent, panicles and buds persistently so, calyx thus at first, becoming sparsely so, parts of petals exposed in bud and ovary densely persistently cream pubescent. *Twigs* c. 1 mm \varnothing apically, slender, much branched, terete, smooth. *Buds* small, ovoid; *stipules* fugaceous, not seen. *Leaves* 6.5–12 by 2.5–6.5 cm, ovate, thinly coriaceous, \pm lustrous above, glabrous or \pm densely cream lepidote beneath the nerves excepted; base cuneate to obtuse, subequal; acumen to 1.5 cm long, slender, tapering; nerves 8–9 pairs, slender, somewhat elevated beneath, evident but \pm

applanate above as also the midrib, arched and somewhat sinuate, set at 45°–75°, with \pm prominent glabrous pore-like domatia; tertiary nerves densely scalariform, obscure; *petiole* 11–25 mm long, long, slender, geniculate. *Panicle* to 9 cm long, terminal or axillary, singly branched; branchlets short, few-flowered. *Flower buds* to 5 by 3 mm, fusiform; *sepals* broadly ovate, acute, subequal; *stamens* 32, subequal; filaments compressed, tapering; anthers oblong, glabrous, the outer cells tuberculate at base; appendages exceeding anther apex, densely setose; *ovary* ovoid, tapering into a prominent stylopodium; style short, glabrous. *Fruit* (? immature): *Pedicel* c. 2 mm long, slender; 3 longer *calyx lobes* to 6 by 1.5 cm, spatulate, obtuse, c. 3 mm wide above the 7 by 4 mm ovate elliptic saccate thickened base; 2 shorter lobes to 25 by 2 mm, linear, similar at base; *nut* to 15 by 8 mm, ovoid, tapering into a long slender stylopodium.

Distr. *Malesia*: Philippines (Luzon, Biliran, Samar, Negros, Mindanao).

Ecol. Local, in Lowland Evergreen Dipterocarp forest.

Vern. *Yacal*.

Notes. This and the following species differ principally in the number of stamens as in the pair *S. seminis* and *S. sumatrana*, and like them occupy geographically separate ranges.

FOXWORTHY maintained that BS 18575 from Biliran I. and FB 22788 from Quezon Prov., Luzon represented a different taxon from the type of *S. astylosa* (FB 13271, from Zamboanga, Mindanao); he compared them with *S. ciliata* KING of Malaya. MERRILL was in disagreement and I concur with MERRILL that they belong to *S. astylosa*.

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

28. *Shorea domatiosa* ASHTON, Gard. Bull. Sing. 19 (1962) 285, pl. 16; Man. Dipt. Brun. (1964) 131, f. 13; *ibid.* Suppl. (1968) 69; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 166.

Large tree. Panicle, flowers and stipule outside pale cream pubescent, domatia fimbriate, parts otherwise \pm glabrous. *Twig* c. 1.5 mm \varnothing , much branched slender, terete, frequently wrinkled or compressed when dried, smooth; stipule scars short, pale, horizontal, obscure. *Bud* c. 4 by 2 mm, ovoid, acute. *Stipules* c. 6 by 2.5 mm, ovoid, narrowly obtuse, caducous. *Leaves* 6.5–10 by 3–7 cm, broadly ovate to obovate, \pm chartaceous, cream lepidote on undersurface only in fully mature and old tree; base obtuse or subcordate; acumen to 8 mm long; nerves 8–12 pairs, slender, curved, set at 45°–65°, with prominent axillary pore-like fimbriate domatia; tertiary nerves slender, densely scalariform, sinuate; midrib prominent beneath; *petiole* 1.5–2.5 cm long, slender, long, geniculate with the distal half swollen. *Panicle*, *bracts* and *bracteoles* unknown. *Bud* to 1.3 by 4 mm, fusiform. *Calyx* shortly pubescent outside, glabrous within; 3 outer

lobes broadly ovate, subacute, 2 inner lobes narrowly ovate, acute. *Petals* linear, obtuse, hardly contorted in bud, sparsely pubescent on parts exposed in bud, elsewhere glabrous. *Stamens* c. 25–30; filaments appanate towards base, tapering; anthers broadly oblong, the inner 2 pollen sacs shorter than the outer 2, with sparsely setose apices; appendage $\frac{1}{4}$ as long as anther, stout, densely setose. *Ovary* ovoid, densely tomentose except at base; stylopodium $1\frac{1}{2}$ times as long as ovary, very long, pubescent towards base, elsewhere glabrous. *Fruit calyx* glabrous; 3 longer

lobes to 13 by 3 cm, broadly spatulate, obtuse, to 8 mm broad above the to 1.8 by 1.6 cm elliptic saccate thickened base; 2 shorter lobes to 7 by 1.2 cm, narrowly spatulate, with similar base. *Nut* 8.5 by 2.5 cm, ovoid, densely shortly pale cream pubescent; style remnant to 1 cm long, filiform.

Distr. *Malesia*: N.E. Borneo (Rejang valley north-eastwards to S.W. and S.E. Sabah and Nunukan).

Ecol. Scattered on clay soils in Mixed Dipterocarp forest below 600 m.

Vern. *Sĕlangan batu lobang idong*.

1b. Subsection *Barbata*

SYM. ex ASHTON, Gard. Bull. Sing. 20 (1963) 266; Man. Dipt. Brun. (1964) 166. — *Barbata* group SYM. J. Mal. Br. R. As. Soc. 79 (1941) 162. — Fig. 82.

Flower buds subglobose. Petals cream, short, elliptic-oblong, obtuse, connate at base on falling. Appendages and apices of outer anther cells densely setose.

Distr. Peninsular Burma and Thailand to *Malesia*: Sumatra, Borneo.

Ecol. Scattered in lowland forests below 1500 m.

29. *Shorea glauca* KING, J. R. As. Soc. Beng. 62, 2 (1893) 117; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 102; RIDL. Fl. Mal. Pen. 1 (1922) 223; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 300; *ibid.* ed. 2 (1927) 1118, 1121; FOXW. Mal. For. Rec. 3 (1927) 64; *ibid.* 10 (1932) 232; BURK. Dict. (1935) 2010; SYM. Mal. For. Rec. 16 (1943) 15, f. 6, 10.

Medium-sized or large tree. Parts of petals exposed in bud, ovary and panicles densely persistently evenly ocherous pubescent, sepals thus at first, becoming sparsely so in fruit; twigs, stipules outside, petiole, midrib above and leaves beneath persistently cream lepidote. *Twig* c. 1 mm \varnothing apically, terete, becoming smooth, pale brown. *Leaves* 6–15 by 2.3–9 cm, ovate to lanceolate, thin; margin undulate; base cuneate; acumen to 2 cm long, slender, tapering, nerves 7–10 pairs, slender, hardly raised beneath, arched, at 50°–70° to the midrib; secondary nerves slender, scalariform, obscure; midrib appanate above, slightly elevated beneath; *petiole* 10–20 mm long, slender, terete. *Panicles* to 7 cm long, slender, lax, terminal or axillary, terete or compressed; singly or doubly branched, branchlets bearing to 8 second flowers; *bracteoles* short, linear, fugaceous. *Flower bud* to 3 by 3 mm, globose; *sepals* broadly ovate, the 3 outer somewhat larger, acute, the inner 2 subacuminate; *stamens* c. 60, subequal; filaments broadly compressed at base, tapering; anthers lorate-oblong, barbate at base and apex, appendages not exceeding anthers, very short, villous; *ovary* ovoid, style short, broadly cylindrical. *Fruit pedicel* to 1 by 1 mm. 3 outer calyx lobes to 7 by 1.8 cm, spatulate, obtuse, c. 5 mm wide above the to 6 by 5 mm ovate, saccate thickened base; 2 shorter lobes to 5 by 1 cm, otherwise similar. *Nut* to 1.5 by 1.5 cm, broadly ovoid, shortly apiculate.

Distr. Peninsular Thailand, and in *Malesia*: Malaya, west coast Sumatra (from Painan to Atjeh), Simalur I.

Ecol. Local, but often semi-gregarious, on hills, especially rocky slopes and ridges, generally near the coast, to 600 m.

Vern. *Damar laut daun bĕsar, rĕsak, r. rĕmenia, terbak, sĕlimbar, damar laut kuning, tĕngkawang*.

Note. Flowering specimens, without which the species cannot always be distinguished with certainty from *S. materialis* and *S. falcifera* in *subsect. Shorea*, are unknown from east coastal Malaya, east coastal Sumatra and Riouw, and it seems unlikely that it occurs there in spite of earlier reports (e.g. SYMINGTON).

30. *Shorea laevis* RIDL. Fl. Mal. Pen. 1 (1922) 232; HEYNE, Nutt. Pl. ed. 2 (1927) 1121; FOXW. Mal. For. Rec. 10 (1932) 179; SYM. Mal. For. Rec. 16 (1943) 18, f. 6, 12; BROWNE, For. Trees Sarawak & Brunei (1955) 169; ASHTON, Man. Dipt. Brun. (1964) 139, f. 13, pl. 33 (habit), 35 (stem-base); *ibid.* Suppl. (1968) 73, f. 9; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 178, pl. 12a (habit), pl. 14a (stem), f. 20; ASHTON, Gard. Bull. Sing. 31 (1978) 38. — *S. ciliata* (non KING) RIDL. Agr. Bull. Str. & F.M.S. 4 (1905) 63; FOXW. Mal. For. Rec. 1 (1921) 69; *ibid.* 3 (1927) 66; *ibid.* 8 (1930) 19; EDWARDS, Mal. For. Rec. 9 (1931) 142. — *Hopea laevifolia* PARIJS in Fedde, Rep. 33 (1933) 244. — *S. laevifolia* ENDERT, Tectona 28 (1935) 292; BROWNE, For. Trees Sarawak & Brunei (1955) 171. — *S. rogersiana* RAIZADA & SMITINAND, Thai For. Bull. Bot. 1 (1954) 7.

Vast, prominently buttressed tree. All vegetative parts epilose. *Twig* c. 1 mm \varnothing apically, much branched, slender, terete, smooth; stipule scars small, obscure. *Bud* c. 3.5 by 1.5 mm, narrowly ovoid. *Stipule* to 8 by 2 mm, narrowly lanceolate, acute, fugaceous. *Leaves* 6.5–10 by 2.5–4 cm, narrowly ovate-lanceolate; falcate, thinly coriaceous, cream lepidote beneath in mature trees; base subequal, broadly

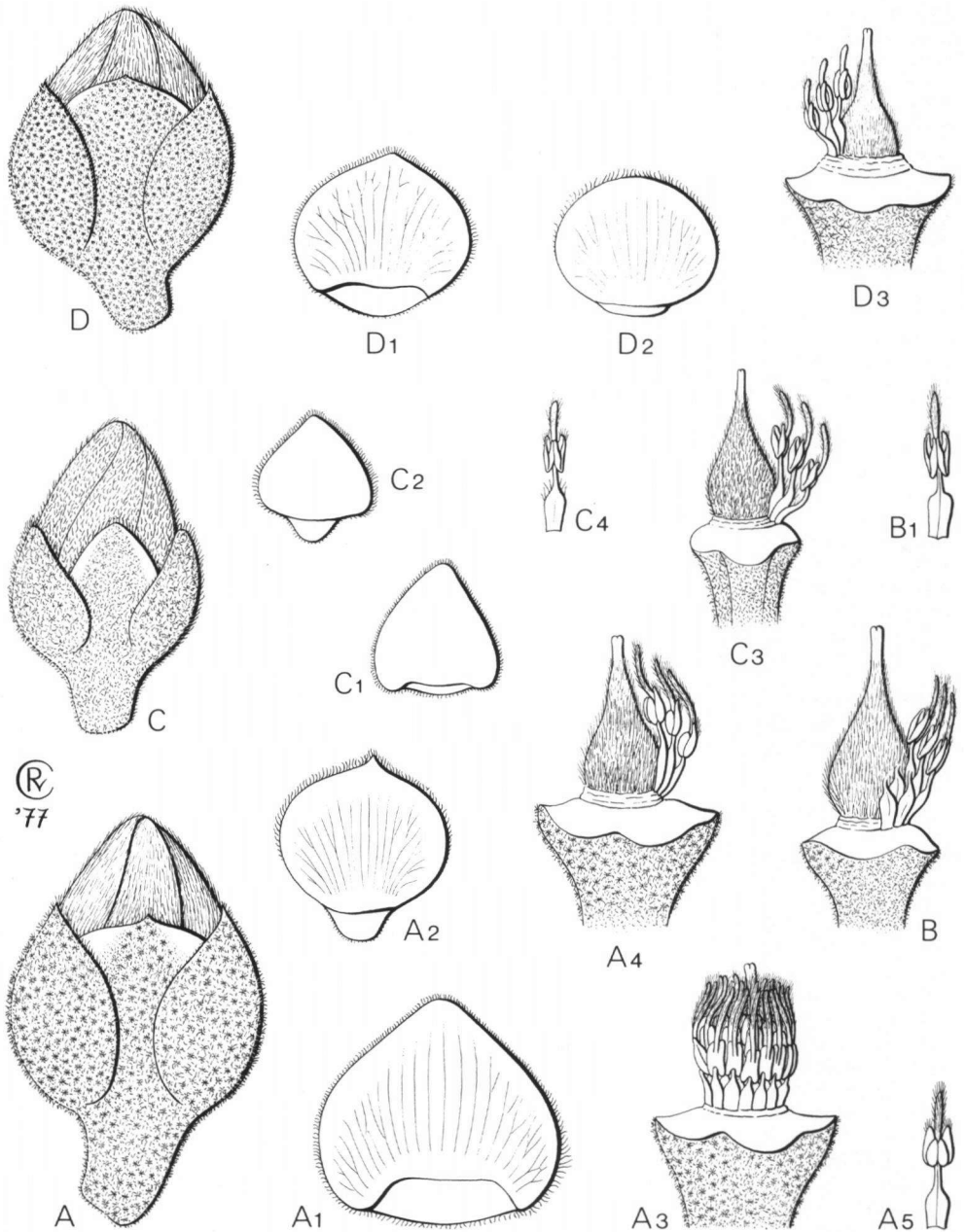


Fig. 82. Flower details in *Shorea* sect. *Shorea* subsect. *Barbata* SYM. ex ASHTON. All $\times 10$. Sepals drawn from inside. — *S. ladiana* ASHTON. A. Bud, A1. outer sepal, A2. inner sepal, A3. androecium, A4. three stamens and pistil, A5. stamen from inside. — *S. asahii* ASHTON. B. Stamens and pistil, B1. stamen from inside. — *S. maxwelliana* KING. C. Bud, C1. outer sepal, C2. inner sepal, C3. stamens and pistil, C4. stamen from inside. — *S. biawak* ASHTON. D. Bud, D1. outer sepal, D2. inner sepal, D3. stamens and pistil (A ROSLI 15025, B bb. 35219, C KEP 69917, D S 28778)

cuneate; acumen to 2 cm long, slender; nerves 11–14 pairs, slender, coriaceous, dense, curved, at c. 50°–60°, unraised on either surface as also the midrib; tertiary nerves slender, densely scalariform, diagonal to nerves; *petiole* 1–1.5 cm long, slender, geniculate. *Panicle* to 12 cm long, terminal or axillary, slender, terete, shortly persistently pale cream grey pubescent, ± glabrescent; singly or doubly branched, branchlets to 3 cm long, bearing to 9 distichous flowers; *bracteoles* to 2 mm long, linear, pubescent, fugaceous. *Flower bud* to 2 mm long, globose. *Calyx* shortly pale cream-brown tomentose outside, glabrous within; 3 outer lobes ovate-deltoid, subacute; 2 inner lobes smaller, suborbicular. *Petals* small, oblong, shortly pubescent on parts exposed in bud. *Stamens* c. 50; filaments slender, tapering, sparsely barbate towards the apex; anther oblong, the longer, outer, sacs barbate at base and apex; appendage to connective small, barbate. *Ovary* and *stylopodium* small, conical, densely buff tomentose, crowned by a short glabrous style. *Fruit calyx* shortly buff pubescent on both surface; 3 longer lobes to 6.5 by 1 cm, oblong, chartaceous, slightly broader at the obtuse apex, untapering but saccate and adpressed to the nut at the base; 2 shorter lobes to 4 by 0.5 cm, subacute, otherwise similar. *Nut* to 1.5 by 0.9 cm, ovoid, shortly densely evenly buff pubescent; style remnant to 4 mm long, tapering, frequently bent over.

Distr. Peninsular Burma and Thailand (Pattani); in *Malesia*: Malaya, N. Sumatra (Atjeh), Borneo.

Ecol. Widespread, often common and even gregarious on skeletal or dry soils on ridges in Hill Dipterocarp forest, typically at 200–1000 m, but sometimes lower.

Vern. *Kumas*, *k. mèrah*, *k. hitam*, *sèlimbar*, *damar laut kuning* (Mal.), *mikai* (Sar.), *sèlangan batu kumus* (Sabah), *pényau* (W. Borneo), *bangkirai tanduk*, *b. lampong*, *mèrenting*, *tènggelan mènpelem*, *gèlam* (S.E. Borneo), *bènuas*, *b. layang* (S. Borneo).

31. *Shorea asahii* ASHTON, Gard. Bull. Sing. 19 (1962) 279, pl. 13; Man. Dipt. Brun. (1964) 128, f. 13; *ibid.* Suppl. (1968) 68; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 163. — Fig. 82 B–B1.

Medium-sized tree. Young parts at first shortly pubescent, otherwise glabrous but for panicles and flowers. *Twig* c. 0.7 mm \varnothing apically, slender, terete; stipule scars small, horizontal, obscure. *Bud* c. 1.5 by 1.0 mm, falcate, small. *Stipule* to 5 mm long, narrowly deltoid, fugaceous. *Leaves* 6–10 by 3–5 cm, ovate, coriaceous, lustrous; base broadly cuneate, subequal; acumen c. 1 cm long, narrow; nerves 6–7 pairs, arched, slender, at c. 60°; midrib unraised on either surface, indistinct; tertiary nerves scalariform, dense, very slender and obscure, at 90° to midrib or slightly ascending though at 90° to the nerves nearer the margin; *petiole* c. 1 cm long, slender. *Panicle* to 2 cm long, terminal or axillary, slender, terete, straight, densely shortly cream tomentose; singly branched, branchlets to 7 mm long, short, zig-zag, bearing to 4 close secund flowers; *bracteoles* to 2 mm long,

elliptic, acute, puberulent, fugaceous. *Flower bud* to 2 mm long, globose. *Calyx* shortly pubescent outside, glabrous within; 3 outer lobes ovate-deltoid, subacute; 2 inner lobes smaller, relatively broader, ovate, less acute. *Petals* elliptic-oblong, acute, shortly pubescent outside, puberulent within. *Stamens* c. 30; filaments broad at base, abruptly tapering, filiform and sparsely barbate distally; anther narrowly oblong, 2 outer sacs larger, sparsely barbate apically; appendage to connective up to 2 times length of anther, stout, barbate towards apex. *Ovary* and *stylopodium* ovoid, densely pubescent, tapering into the short slender glabrous style. *Fruit calyx lobes* to 4 by 4 mm, subequal, ovate, subacute, sparsely buff pubescent, adpressed to nut. *Nut* to 11 by 6 mm, oblong-ovoid, acute, densely buff pubescent.

Distr. *Malesia*: N.W. Borneo (Kapuas valley; Rejang valley to Brunei).

Ecol. Local, on shale spurs below 850 m in Mixed Dipterocarp forest.

Vern. *Tèkam padi* (Iban), *kumus bukit* (Mal.).

32. *Shorea micans* ASHTON, Gard. Bull. Sing. 31 (1978) 38.

Medium-sized tree. Panicles and nut densely greyish puberulent, fruit calyx sparsely so, other known parts glabrous. *Twig* c. 1 mm \varnothing apically, slender, much branched, smooth, terete. *Buds* minute; *stipules* not seen. *Leaves* 5–10 by 1.8–4.7 cm, ovate-lanceolate, thinly coriaceous, lustrous on both surfaces; margin narrowly subrevolute; base broadly cuneate, ± unequal; apex to 1.3 cm caudate; nerves 7–8 pairs, very slender, slightly elevated beneath, ± appanate above, at 50°–55°; tertiary nerves obscure, scalariform; midrib slender, evident and slightly elevated on both surfaces; *petiole* 7–12 mm long, rather short, very slender. *Panicle* to 7 cm long, terminal or subterminal axillary, slender, shortly branched. *Flowers* unknown. *Fruit pedicel* c. 1 mm long, slender; 3 longer *calyx lobes* to 5 by 1.5 cm, spatulate, obtuse, c. 4 mm broad above the to 8 by 7 mm elliptic saccate thickened base; 2 shorter lobes to 2.5 by 4 mm, narrowly spatulate, acute, similar at base; *nut* to 19 by 7 mm including the prominent slender apiculus, ovoid.

Distr. *Malesia*: N.E. Borneo (once collected north of Sandakan).

Ecol. On ultrabasic rock in lowlands.

Note. Differing (in the absence of flowering collection) from *S. asahii* only in the fruit sepals.

33. *Shorea ladiana* ASHTON, Gard. Bull. Sing. 19 (1962) 295, pl. 21; Man. Dipt. Brun. (1964) 138, f. 13; *ibid.* Suppl. (1968) 73. — Fig. 82 A–A5.

Small to medium-sized tree. Young twig and petioles shortly puberulent, bud and panicle grey tomentose, vegetative parts otherwise glabrous. *Twig* 1.5–2 mm \varnothing apically, terete, much branched, smooth to rugulose; stipule scars small, slightly descending, obscure. *Bud* c. 1 by 0.5 mm, small, conical. *Stipule* unknown. *Leaves* 10–14 by 4.5–7.5 cm, coriaceous,



Fig. 83. *Shorea maxwelliana* KING. *a*. Habit, *b*. fruit, both $\times \frac{1}{2}$, *c*. venation, enlarged (*a* S 29235, *b*-*c* SAN 16988).

lustrous, ovate; base subequal to equal, obtuse or broadly cuneate; acumen 1-1.5 cm long; nerves 5-6 pairs, prominent beneath, well spaced, arched, set at *c.* 40°-50°; tertiary nerves slender, indistinct, densely scalariform, at 90°; margin usually narrowly revolute; *petiole* 1-2.2 cm long. *Panicle* to 15 cm long, terminal or to 2-axillary, somewhat compressed, straight, lax, shortly persistently pale cream-grey pubescent; singly or doubly branched; branchlets to 8 mm long, short, zigzag, bearing to 9 close secund flowers; *bracteoles* to 4.5 mm long, ovate-deltoid, acute, shortly pubescent, fugaceous. *Flower bud* to 1.5 mm \varnothing , globose (only young bud known). *Calyx* densely puberulent outside, glabrous within; *sepals* ovate, subequal. *Petals* broadly elliptic. *Stamens* 30-35; filaments short, tapering; anthers oblong, the outer sacs the larger, shortly barbate apically; appendage to connective longer than anther, long barbate. *Ovary* and *stylopodium* ovoid, densely pubescent, with short glabrous style. *Fruit pedicel* to 3 mm long, slender, puberulent. *Calyx* shorter than nut, the 5 equal lobes *c.* 8 mm long and broad, broadly ovate, puberulent, subacute, thickened, shallowly saccate, closely adpressed to the nut. *Nut* to 1.7 by 1.4 cm, obovoid-globose, densely

shortly buff pubescent, abruptly tapering to the *c.* 1 mm long narrow acute style remnant.

Distr. *Malesia*: Borneo (Sarawak, Brunei).

Ecol. Local, deep yellow sandy soils in Mixed Dipterocarp forest on low hills to 300 m.

Vern. *Sĕlangan batu kilat*.

34. *Shorea biawak* ASHTON, Gard. Bull. Sing. 19 (1962) 281, pl. 14; Man. Dipt. Brun. (1964) 129, f. 13, pl. 37 (bark); *ibid.* Suppl. (1968) 68; MEIJER, & WOOD, Sabah For. Rec. 5 (1964) 165. — Fig. 82 D-D3.

Small tree. Young twig, panicle, leaf bud and *petiole* shortly pale buff pubescent, persistent on panicle and leaf bud. *Twig* to 1 mm \varnothing apically, slender, terete, much branched, smooth or striated. *Bud* to 1 mm long, small. *Stipule* unknown. *Leaves* 6-10 by 2.5-4.5 cm, obovate, thinly coriaceous; base obtuse or broadly cuneate; acumen to 1.5 cm long, narrow to caudate; nerves 5-6 pairs, slender, slightly raised beneath, slightly depressed above, arched, at 50°-60°, with small puberulent axillary domatia; tertiary nerves obscure, scalariform at *c.* 90°; midribs slightly raised beneath, slightly raised or appanate above; *petiole* 7-10 mm long, slender. *Panicle* to 14 cm

long, terminal or 1-axillary, terete; singly branched, branchlets to 6 mm long, short, \pm secund, bearing to 6 close secund flowers; *bracteoles* to 2 mm long, ovate, acute, puberulent, fugaceous. *Flower bud* to 1.5 mm long, globose. *Calyx* shortly puberulent outside, glabrous within; lobes broadly ovate, acute, subequal, the inner 2 slightly shorter and relatively wider, thinner. *Petals* elliptic, obtuse, puberulent outside, glabrous within. *Stamens* c. 35; filaments slender, tapering, glabrous; anthers narrowly oblong, sparsely barbate apically, tapering, the 2 outer sacs the larger; appendage to connective somewhat shorter than anther, densely barbate. *Ovary* and *stylopodium* ovoid to pyriform, densely pubescent, crowned by a short glabrous style. *Fruit calyx lobes* to 7 by 9 mm, subequal, shorter than nut, suborbicular, obtuse, thin, closely adpressed to nut, shortly persistently buff puberulent. *Nut* to 1.3 by 1 cm, subglobose, obtuse, densely pale buff pubescent; style remnant to 1.5 mm long.

Distr. *Malesia*: Borneo (Rejang valley to S Sabah).

Ecol. Local, clay ridges below 600 m, in Mixed Dipterocarp forest.

Vern. *Résak biawak* (Brun.), *səlangan batu buaya* (Mal.).

Note. Forming, with *S. maxwelliana*, a pair similar to *S. asahii* and *S. micans*, and differing from the following species principally in the fruit, though also in the androecium.

35. *Shorea maxwelliana* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 114; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 86; RIDL, Fl. Mal. Pen. 1 (1922) 227; FOXW. Mal. For. Rec. 3 (1927) 35; *ibid.* 10 (1932) 194; SYM. Gard. Bull. S. S. 7 (1933) 146, pl. 44; *ibid.* 8 (1934) 28; *ibid.* 9 (1938) 325, 326; Mal. For. Rec. 16 (1943) 21, f. 5B, 6, 14; BROWNE, For. Trees Sarawak & Brunei (1955) 169; ASHTON, Man. Dipt. Brun. (1964) 141, f. 13, pl. 36 (bark); *ibid.* Suppl. (1968) 74; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 182, t. 15, f. 21. — *S. utilis* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 119; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 81; RIDL, Agr. Bull. Str. & F.M.S. 1 (1901) 58; Fl. Mal. Pen. 1 (1922) 230; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 310; *ibid.* ed. 2 (1927) 1126; FOXW. Mal. For. Rec. 3 (1927) 65; *ibid.* 10 (1932) 177; BURK. J. Str. Br. R. As. Soc. 81 (1920) 69, fig.; *ibid.* 86 (1922) 281. — *S. barbata* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 81; RIDL, Agr. Bull. Str. & F.M.S. 1 (1901) 59; J. Str. Br. As. Soc. 54 (1909) 23; Fl. Mal. Pen. 1 (1922) 230; FOXW. Mal. For. Rec. 1 (1921)

68; *ibid.* 3 (1927) 68; *ibid.* 10 (1932) 178. — *S. ciliata* (non KING) RIDL, Agr. Bull. Str. & F.M.S. 4 (1905) 63. — *S. alba* RIDL, J. Str. Br. R. As. Soc. 82 (1920) 171; Fl. Mal. Pen. 1 (1922) 230. — *Balanocarpus ovalifolius* RIDL, J. F.M.S. Mus. 10 (1920) 130, p.p.; Fl. Mal. Pen. 1 (1922) 247, p.p. — Fig. 82 C-C4, 83.

Tall, prominently buttressed tree. Vegetative parts glabrous but for the shortly pubescent to glabrescent buds and stipules. *Twig* c. 0.7 mm \varnothing apically, slender, much branched, smooth; stipule scars minute, short, obscure. *Bud* c. 1 mm long and broad, minute, globose to conical. *Stipule* to 4 mm long, puberulent on both surfaces, linear, fugaceous. *Leaves* 6-10 by 2.5-4 cm, coriaceous, ovate-lanceolate, sometimes sparsely cream lepidote beneath; base obtuse or broadly cuneate; apex to 2 cm long caudate; nerves 8-10 pairs, slender; midrib elevated beneath, depressed above, at c. 40°-50°, well spaced, curved, with or without minute axillary domatia; tertiary nerves very slender, scalariform, at 90°; *petiole* 0.7-1 cm long, slender. *Panicle* to 5 cm long, terminal or to 3-axillary, terete, straight, shortly evenly buff pubescent; singly branched, branchlets to 1.3 cm long, short, bearing to 6 close secund flowers; *bracteoles* to 1.5 mm long, elliptic, puberulent, fugaceous. *Flower bud* to 2.5 mm long, globose. *Calyx* shortly pubescent outside, glabrous within. *Stamens* c. 30; filaments broad at base, tapering gradually to anther, glabrous; anther narrowly oblong, outer cells larger, barbate apically; appendage to connective as long as anther, barbate at apex. *Ovary* and *stylopodium* ovoid to pyriform, densely pubescent; style glabrous, short. *Fruit calyx* \pm puberulent, more densely so towards base; 3 longer lobes to 10 by 1.5 cm, spatulate, obtuse, to 4 mm broad above the to 1.5 by 1 cm elliptic somewhat thickened prominently saccate base; 3 shorter lobes to 6 by 0.6 cm, otherwise similar. *Nut* to 2 by 1.5 cm, ovoid, tapering, apiculate, densely buff pubescent.

Distr. *Malesia*: Malaya (Penang and Trengganu southwards), Sumatra (Atjeh, West Coast, Lampong), Borneo.

Ecol. Widespread, sometimes common, in Mixed Dipterocarp forest in low hills on well drained clay-rich soils to 700 m.

Vern. *Damar laut daun kēchil*, *kumus hitam*, *chēnderas*, *chēngal batu*, *rēsak*, *r. hitam*, *balau*, *sēngkawang*, *damar laut kuning* (Mal.), *səlangan batu asam* (Sabah), *pakit* (W. Borneo), *tēkam tēgelam* (Iban, Tidung), *rikir*, *r. minyak*, *r. sēga*, *damar bintang*, *rēsak tanduk* (Sumatra).

2. Section Pentacme

(DC.) ASHTON, Gard. Bull. Sing. 31 (1978) 38. — *Pentacme* A. DC. Prod. 16, 2 (1868) 626; KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 151; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 72; FOXW. Mal. For. Rec. 10 (1932) 154; SYM. Mal. For. Rec. 16 (1943) 104, f. 63 (map), 64-66. — Fig. 84.

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

Distr. One species in seasonal S.E. Asia and *Malesia*: Malaya, and one in the Philippines.

Ecol. See under the species.

Note. *S. siamensis* differs from the Philippine species in having a hard heavy durable wood anatomically similar to that in *sect. Shorea*; in the Philippine species the wood is soft, light and unsuitable for exterior work.

36. *Shorea siamensis* MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 214; DC. Prod. 16, 2 (1868) 631; WALP. Ann. 7 (1868) 379; DYER, Fl. Br. Ind. 1 (1874) 304; RYAN & KERR, J. Siam Soc. 8 (1911) 7, 15, 35, t. 1-4; ASHTON, Gard. Bull. Sing. 31 (1978) 39. — *Hopea suava* WALL. [Cat. (1828) n. 959, *nomen*] ex A. DC. Prod. 16, 2 (1868) 635. — *Pentacme suavis* A. DC. Prod. 16, 2 (1868) 626; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 72; Indian Trees (1906) 68; GAMBLE, Man. Ind. Timb. (1922) 77; TROUP, Silv. Ind. Trees 1 (1921) 145; CRAIB, Fl. Siam. Enum. 1 (1925) 145; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 259; SMITINAND, Thai For. Bull. 1 (1954) 9, 10, 24. — *Pentacme siamensis* (MIQ.) KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 66; Fl. Burma 1 (1877) 119; PIERRE, For. Fl. Coch. 3 (1889) t. 225-227, *incl. var. laevis* PIERRE *et var. suavis* (DC.) PIERRE; HEIM, Rech. Dipt. (1892) 56; Bot. Tidsskr. 25 (1902) 46; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 263, fig.; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 379, 385, fig.; CRAIB, Fl. Siam. Enum. 1 (1925) 145; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 238; FOXW. Mal. For. Rec. 8 (1930) 15, 35; *ibid.* 10 (1932) 155, pl. 2 (seedlings); BURK. Dict. (1935) 1690; SYM. Mal. For. Rec. 16 (1943) 105, f. 64-66. — *S. bracteata* PIERRE ex LANESSAN, Pl. Util. Colon. Fr. (1886) 301. — *S. mekongensis* PIERRE ex LANESSAN, l.c. — *S. suavis* PIERRE ex LANESSAN, l.c. — *S. tomentosa* (non MIQ.) PIERRE, For. Fl. Coch. 3 (1889) sub t. 225 *in syn.* — *Pentacme malayana* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 107; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 151, t. 184; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 62; Fl. Mal. Pen. 1 (1922) 220; CRAIB, Fl. Siam. Enum. 1 (1925) 145. — *Pentacme tomentosa* CRAIB, Kew Bull. (1915) 423; Fl. Siam. Enum. 1 (1925) 145.

Small gnarled, \pm shortly deciduous tree (in *Malesia*). Young calyx, twigs and panicle caducous puberulent, otherwise glabrous (in Mal.). *Twigs* 3-5 mm \varnothing apically, terete, smooth; stipule scars short, pale. *Bud* small, ovoid, acute; stipule to 18 by 7 mm, ovate-falcate, fugaceous. *Leaves* 9-12 by 6-13 cm (smaller if subtending panicles), broadly ovate-oblong, chartaceous; base deeply cordate to cuneate (if subtending panicles); acumen to 1 cm long, short, broad; nerves 13-16 pairs, slender but prominent beneath, barely elevated above as also the midrib, arched, the basal

pair with prominent lateral branchlets; tertiary nerves remotely scalariform, sinuate, slender but typically prominently elevated beneath; *petiole* 3-5 mm long, c. 2 mm \varnothing , straight. *Panicle* to 14 mm long, terminal or axillary, lax, peduncle stout at base; irregularly branched, branchlets to 7 cm long, bearing a few \pm secund flowers. Anthesis directly following leaf fall; *bud* to 15 by 6 mm, large, ellipsoid; *sepals* narrowly ovate, prominently slender, acuminate, subequal; *petals* broadly elliptic, glabrous (in Mal.); *stamens* 15, subequal; filaments lorate, slightly tapering; anther cells linear, extended apically beyond the connective into prominent tapering horns c. $\frac{1}{2}$ their length; appendages acicular, glabrous, c. $\frac{1}{2}$ length of anthers; *ovary* narrowly ovoid, tapering into a stoutly columnar style c. twice its length and exceeding the stamens at anthesis. *Fruit pedicel* to 5 by 3 mm, broadening into the receptacle; 3 longer *calyx lobes* to 12 by 1.3 cm, narrowly spatulate, narrowly obtuse, c. 4 mm broad above the to 8 by 7 mm elliptic saccate thickened base; 2 shorter lobes to 7 by 0.5 cm, lorate, subacute, similar at base. *Nut* to 20 by 12 mm, ovoid, tapering into an up to 8 mm long prominent acicular style remnant.

Distr. Burma, Indochina and Thailand south to *Malesia*: N.W. Malaya (Langkawi and once in Perlis).

Ecol. A tree of Dry Dipterocarp forests, especially on skeletal soils and overlying granite; occurring scattered on rocky headlands in Malaya.

Vern. *Tĕmak batu*, *tĕmak*, *mĕranti tĕmak*.

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

37. *Shorea contorta* VIDAL, Sinopsis (1883) 15, t. 15E; Rev. Pl. Vasc. Filip. (1886) 61; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 88; MERR. Philip. J. Sc. 1 (1906) Suppl. 98; ASHTON, Gard. Bull. Sing. 31 (1978) 40. — *Pentacme contorta* (VIDAL) MERR. & ROLFE, Philip. J. Sc.

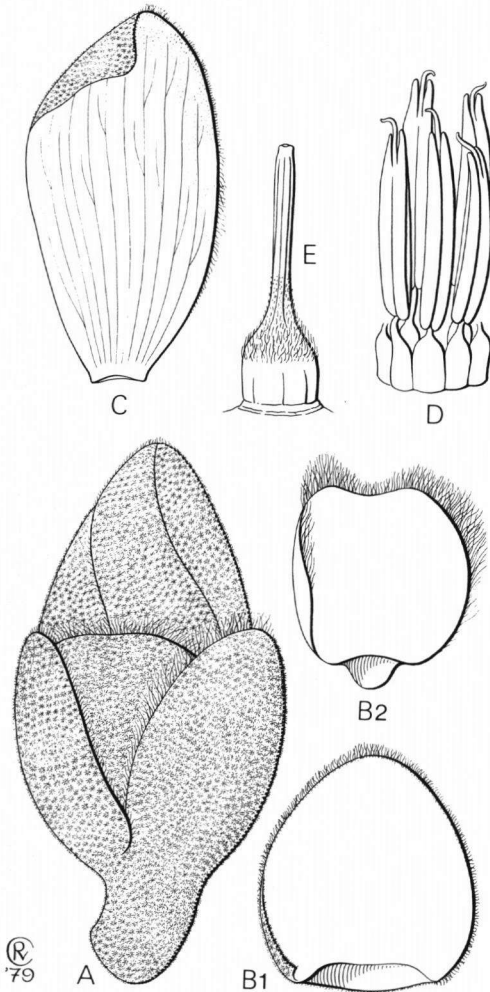


Fig. 84. Flower details in *Shorea* sect. *Pentacme* (DC.) ASHTON. — *S. contorta* VIDAL. A. Bud, B1. outer sepal, B2. inner sepal, both from inside, C. petal, D. stamens from outside, E. pistil, all $\times 10$ (FB 10721).

3 (1908) Bot. 115; MERRITT, Bull. Bur. For. Philip. 8 (1908) 48; WHITFORD, Philip. J. Sc. 4 (1910) Bot. 703; Bull. Bur. For. Philip. 10 (1911) 61; Foxw. Philip. J. Sc. 4 (1910) Bot. 511; *ibid.* 6 (1911) Bot. 266; *ibid.* 13 (1918) Bot. 186; *ibid.* 67 (1938) 287; MERR. En. Philip. 3 (1923) 95; REYES, Philip. J. Sc. 22 (1923) 332. — *Pentacme paucinervis* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 73. — *Pentacme mindanensis* FOXW. Philip. J. Sc. 13 (1918) Bot. 185; *ibid.* 67 (1938) 289; MERR. En. Philip. 3 (1923) 95; REYES, Philip. J. Sc. 22 (1923) 332. — Fig. 84.

Medium-sized, sometimes large evergreen V-fisured buttressed tree. Panicle, parts of petals exposed in bud, ovary and leaf buds densely persistently pale brown puberulent, twigs, petioles and calyx outside caducously so. *Twig* c. 2 mm \varnothing apically, terete or \pm ribbed; stipule scars short, descending. *Leaf buds* to 6 by 3 mm, lanceolate; *stipules* fugaceous. *Leaves* 9–29 by 5.5–11 cm, ovate to lanceolate, thinly coriaceous; base subequal, obtuse or rarely cordate (subpeltate in young trees); apex broadly to 1 cm long acuminate; nerves 5–8(–9) pairs, slender but prominent beneath, distant, arched, \pm applanate above as also the midrib, set at 45° – 70° ; tertiary nerves densely scalariform, slender, hardly elevated on either surface; *petioles* 20–33 mm long, slender. *Panicles* to 22 cm long (if terminal), to 14 cm long (if axillary), singly or doubly branched; branchlets to 4 cm long. *Flower buds* to 8 by 4 mm, ovoid, lanceolate; *sepals* ovate, obtuse, the outer 3 somewhat the larger; *petals* broadly oblong-elliptic, acute; *stamens* 15, subequal; filaments short, broad, applanate; anther cells linear, subequal, prolonged into prominent distal horns c. $\frac{1}{2}$ their length and as long as the stout appendage; *style* columnar, c. thrice length of ovary. *Fruit* shortly pedicellate; 3 longer *calyx lobes* to 12 by 3 cm, spatulate, obtuse, tapering to c. 8 mm wide at the incrassate saccate base; 2 shorter lobes to 9 by 1.5 cm, otherwise similar; *nut* to 35 by 15 mm, narrowly ovoid, apiculate.

Distr. *Malesia*: throughout the Philippines.

Ecol. Common, often semi-gregarious in more or less seasonal Semi-evergreen Dipterocarp forests in the lowlands, uncommon in everwet areas.

Vern. *Malaanonan*, *lauan*.

Note. Leaves of Mindanao and some other specimens in the non-seasonal areas are usually longer leaved, and formerly named *Pentacme mindanensis* (cf. *S. falciferoides*, *S. polysperma*).

3. Section Neohopea

ASHTON, Gard. Bull. Sing. 20 (1963) 266; Man. Dipt. Brun. (1964) 116. — Fig. 85.

Flower small, cream, bud globose. *Petals* broadly elliptic, falling separately. *Stamens* 15, in 3 verticils; filaments stout, short, compressed, hardly tapering; anthers with 4 pollen sacs, subglobose; appendage to connective hardly exceeding anther apex, short, stout, glabrous. *Ovary* and *stylopodium* conical, both puberulent; style very short. *Stipules* and *bracts* minute, fugaceous. *Leaf* with

scalariform tertiary nerves; midrib broad, evident above. Bark and wood as in *sect. Shorea*.

Distr. & Ecol. See under the species.

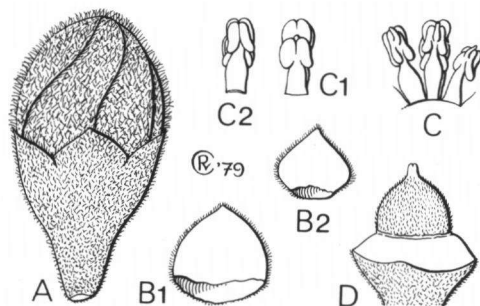


Fig. 85. Flower details in *Shorea* sect. *Neohopea* ASHTON. — *S. isoptera* ASHTON. A. Bud, B1. outer sepal, B2. inner sepal, both from inside, C. stamens abaxial view, C1. outside view on staminal group, C2. inside view on staminal group, D. pistil, all $\times 10$ (BRUN 3018).

38. *Shorea isoptera* ASHTON, Gard. Bull. Sing. 19 (1962) 293, pl. 20; Man. Dipt. Brun. (1964) 137, f. 13; *ibid.* Suppl. (1968) 73; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 189, f. 19. — Fig. 85, 86.

Tall, stoutly buttressed tree. All vegetative parts glabrous. Twig to 1.5 mm \varnothing apically, slender, smooth, terete; stipule scars short, obscure. Bud to 1.5 mm long, small, globose. Stipule caducous, unknown. Leaves 9–16 by 5.8–8 cm, ovate; base broadly cuneate to obtuse, decurrent to 2 mm down petiole (peltate in saplings); acumen to 1.5 cm long, narrow; margin undulate; nerves 9–11 pairs, curved, slightly raised beneath, depressed above, at 45°–65°; tertiary nerves scalariform, sinuate, slender; midrib terete, slightly

elevated, beneath, \pm applanate above; petiole 1.3–2 cm long. Panicle to 11 cm long, terminal or to 3-axillary, terete or somewhat compressed, lax, shortly persistently greyish puberulent; regularly alternately doubly branched, branches to 5 cm long, branchlets to 1 cm long, short, bearing to 6 close secund flowers; bracts unknown; bracteoles to 1 mm long, linear, pubescent, fugaceous. Flower bud to 1.5 mm long, globose. Calyx shortly pubescent outside, glabrous within; lobes subequal, imbricate, acute; 3 outer lobes ovate, 2 inner lobes deltoid. Petals densely pubescent outside, shortly sparsely pubescent within, oblong, obtuse, strongly contorted. Stamens 15, in 3 verticils, double alternating with single stamens; filaments broad, compressed, hardly tapering, glabrous; anthers oblong-globose, pollen sacs subequal or the outer somewhat larger; appendage to connective short, stout, glabrous, not exceeding the anther apex. Ovary and stylopodium ovoid-conical, glabrous at base, puberulent near apex, crowned abruptly by a short glabrous style; stigma minute. Fruit calyx glabrescent to puberulent at base; lobes to 5.5 by 1.5 cm, subequal, spatulate, obtuse, to 5 mm broad above the slightly broader saccate base, rotate when ripe, narrowly imbricate at base. Nut to 9 by 10 mm, ovoid, broader than long, shortly pale grey-brown pubescent, on an up to 8 mm \varnothing broad shallow receptacle; style remnant to 4 mm long, tapering.

Distr. *Malesia*: Northern Borneo (Sarawak, S.W. Sabah and Sandakan Distr.).

Ecol. Locally frequent on clay rich \pm calcareous soils, and on limestone scarps, on low hills below 600 m.

Vern. *Selangang batu gëlombang*, s.b. *main bulu ayam*.

Note. An isolated species whose fruit, with broad shallow receptacle and subequal sepals, and androecium are unique.

4. Section *Richetioides*

HEIM, Rech. Dipt. (1892) 48; ASHTON, Gard. Bull. Sing. 20 (1963) 267; Man. Dipt. Brun. (1964) 116; Gard. Bull. Sing. 22 (1967) 288. — *Richetia* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 975. — *Shorea*, *Richetia* group SYM. Gard. Bull. S. S. 9 (1938) 330; Mal. For. Rec. 16 (1943) 44, f. 27 (map). — *Shorea*, *Meranti Damar Hitam* group SYM. Gard. Bull. S. S. 9 (1938) 330; Mal. For. Rec. 16 (1943) 2, 44. — *Shorea* subg. *Richetia* (HEIM) MEIJER, Act. Bot. Neerl. 12 (1963) 322, *nom. inval.* — Fig. 87, 89.

Flowers usually small, usually bright lemon yellow or pale yellow; petals narrow, strongly twisted and forming a sharply defined though small cup at base enclosing anthers at anthesis, falling as a rosette. Leaf with \pm reticulate pellucid



Fig. 86. *Shorea isoptera* ASHTON. a. Flowering twig, b. fruit, c. nut, all $\times \frac{1}{2}$ (a S 17978, b-c SAN 15222).

tertiary nerves; midrib elevated or depressed above, evident. Young leaves often deep violet or magenta. Large or small trees, the larger with stout prominent buttresses. *Bark* usually appearing scaly; phelloderm thin, inconspicuous; expansion tissue in long fingers, becoming wider outwards.

Distr. & Ecol. See under the species.

Vern. *Damar hitam* (Mal.), *lun* (Sarawak), *mèrakunyat* (Sum., Dayak), *sèraya kuning* (Sabah).

4a. Subsection *Polyandrae*

ASHTON, Gard. Bull. Sing. 22 (1967) 288. — Fig. 87.

Bud large, broadly ovoid. *Stamens* ∞ ; filaments compressed at base, tapering; anthers narrowly oblong; appendages to connectives somewhat shorter than anther apices, densely setose. *Ovary* ovoid, without stylopodium, pubescent; style short, broad, prominently trifurcate.

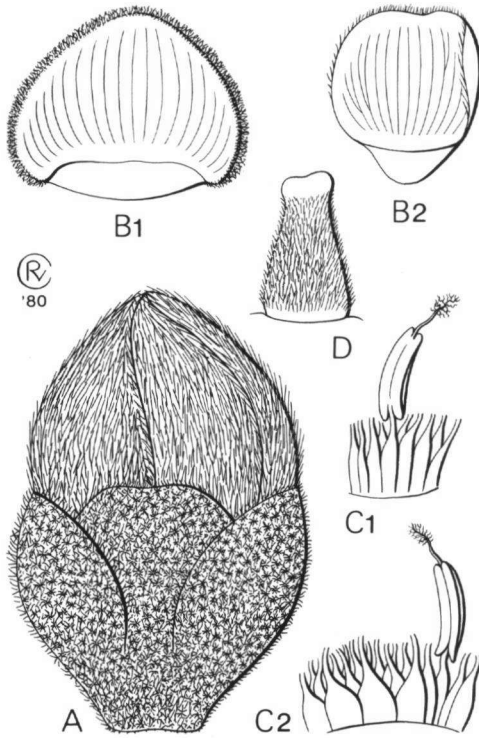


Fig. 87. Flower details in *Shorea* sect. *Richetioides* HEIM subsect. *Polyandrae* ASHTON. — *S. polyandra* ASHTON. A. Bud, B1. outer sepal, B2. inner sepal, both from inside, C1. staminal group from outside, C2. staminal group from inside, D. pistil, all $\times 10$ (KOSTERMANS 13302).

39. *Shorea polyandra* ASHTON, Gard. Bull. Sing. 22 (1967) 286, pl. 32; Man. Dipt. Brun. Suppl. (1968), f. 11. — Fig. 87, 88.

4b. Subsection *Richetioides*

ASHTON, Gard. Bull. Sing. 22 (1967) 288. — Fig. 89.

Flowers usually small, buds fusiform. *Stamens* (10–)15, in (2–)3 verticils; filaments broad at base, frequently gibbous, tapering \pm abruptly medially, filiform distally; anthers broadly oblong to subglobose; appendages to connectives longer than anthers, \pm scabrous towards apex. *Ovary* with stylopodium, shortly tomentose, with a slender columnar style.

Distr. Non-seasonal western *Malesia* including the Philippines.

Ecol. Lowland forests below 1500 m.

Notes. *S. multiflora* has been observed to be thrip-pollinated; in view of the uniformity of flower structure other species are likely to be also. Sympatric species flower sequentially. The short-sepalled species do not form a

Very large, buttressed tree. Twig, petiole and leaf beneath persistently purplish rufous lepidote, fading to grey; bud and stipule persistently shortly purplish rufous puberulent. *Twig* c. 1 mm \varnothing apically, slender, terete, smooth or minutely striated; stipule scars short, horizontal, obscure. *Bud* to 2 by 1 mm, small, ellipsoid, subacute. *Stipule* to 5 by 2 mm, lanceolate, subacute, fugaceous. *Leaves* 8–13 by 3–5 cm, lanceolate, chartaceous, undulate; base cuneate; acumen to 2 cm long, slender; nerves 11–14 pairs, slender, elevated beneath, at 40°–60°; tertiary nerves scalariform, slender, at 90° to the midrib; midrib slender, evident, appanate above, prominent beneath; *petiole* 14–20 mm long, slender. *Panicle* to 6 cm long, terminal or axillary, terete, densely dark rufous pubescent; singly branched, branchlets to 1 cm long, bearing to 3 more or less distichous flowers; *bracteoles* to 4 by 3 mm, elliptic, subacute, rufous pubescent, caducous. *Flower bud* to 5 by 4 mm, broadly ovoid. *Calyx* sericeous on parts exposed in bud; lobes suborbicular, subequal. *Petals* oblong, obtuse, densely pubescent on parts exposed in bud. *Stamens* 102–107, very many, subequal; filament compressed at base, tapering, c. $\frac{1}{2}$ length of anther, anther narrowly oblong, c. 4 times as long as broad; appendage to connective filiform, tapering, somewhat shorter than length of anther, densely pubescent. *Ovary* ovoid, densely pubescent, tapering into a short broadly columnar trifid style; style pubescent except at apex. *Fruit pedicel* to 1 mm long, short. *Calyx* sparsely purplish rufous pubescent towards the base, elsewhere glabrescent; 3 longer lobes to 8 by 1.4 cm, spatulate, obtuse or subacute, tapering to 8 mm broad above the to 10 by 8 mm tuberculate saccate thickened base; 2 shorter lobes to 5 by 0.5 cm, linear, acute, similar at base. *Nut* to 30 by 13 mm, narrowly ovoid, acute, densely rufous pubescent.

Distr. *Malesia*: Borneo (Ulu Kapuas, Sarawak, S. E. Sabah, S. E. Borneo to Pulau Laut and Meratus mountains).

Ecol. Locally abundant on fertile clay rich soils on calcareous shales, igneous and volcanic rocks below 600 m.

Vern. *Putang lénit*, *p. bési*, *mèrakunyit*, *damar hirang*, *d. këtuyang*, *d. kuning*, *d. jangkar*, *kèlapih pahit*, *loda*, *duku mintola*.



Fig. 88. *Shorea polyandra* ASHTON. a. Sterile twig, b. flowering twig, c. fruit, d. nut, all $\times 2/3$ (a bb. 31167, b KOSTERMANS 13302, c-d bb. 12375).

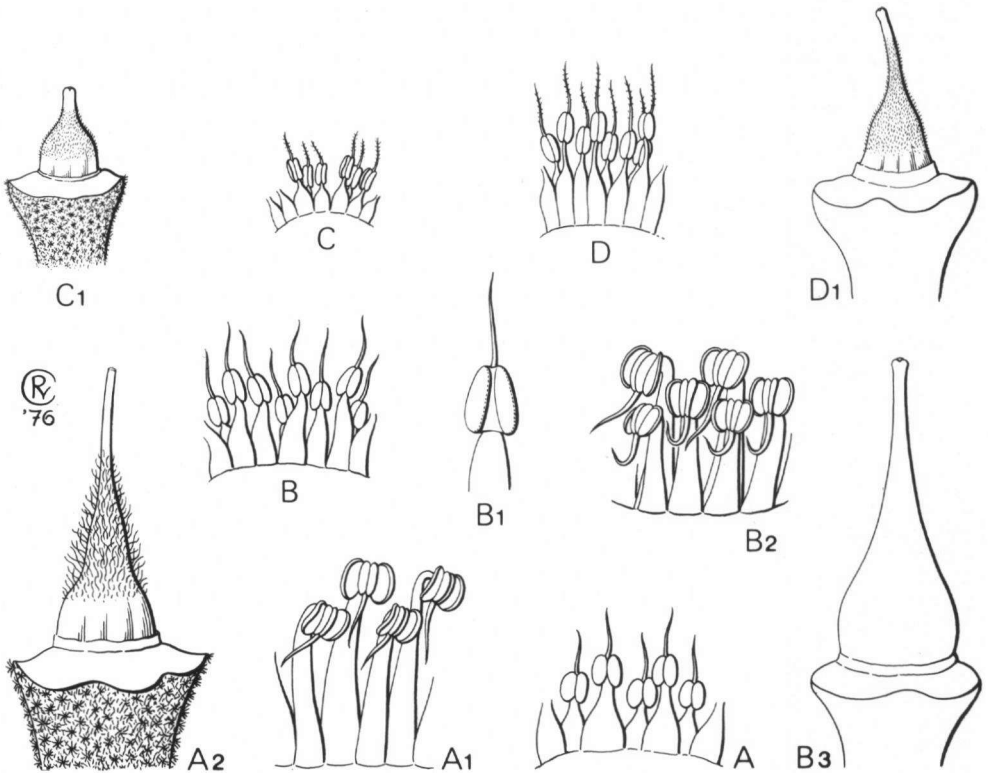


Fig. 89. Flower details in *Shorea* sect. *Richetioides* HEIM subsect. *Richetioides*. All $\times 10$, except *B1*. — *S. maxima* (KING) SYM. *A*. Young stamens from inside, *A1*. mature stamens from outside, *A2*. pistil. — *S. longiflora* (BRANDIS) SYM. *B*. Young stamens from inside, *B1*. anther of young stamen, $\times 20$, *B2*. mature stamens from outside, *B3*. pistil. — *S. angustifolia* ASHTON. *C*. Stamens from inside, *C1*. pistil. — *S. richetia* SYM. *D*. Stamens from inside, *D1*. pistil (*A* KEP 80222, *B* S 19425, *C* BRUN 778, *D* ROSLI s.n., tree 121).

natural group and some form species pairs with long-sepalled species, as in *S. multiflora* and *S. hopeifolia*. Species with long fruit sepals are invariably emergent, whereas most with short sepalled are of the main canopy and understorey. Endemism is heavily predominant among short sepalled species, while several of the widespread species, e.g., *S. gibbosa*, *S. faguetiana*, and *S. hopeifolia* (long-sepalled) and *S. multiflora* (short-sepalled) show complex geographical variation, some of which I recognize as local sibling species (*S. mujongensis*, *S. cuspidata*, *S. alutacea* of *S. gibbosa*; *S. iliasii*, *S. kuantanensis*, *S. kudatensis* of *S. faguetiana*; *S. richetia* of *S. multiflora*). Such patterns recall those of *S. macroptera* and its allies in sect. *Mutica* subsect. *Auriculatae* where apomixis through adventive embryony is known to occur.

40. *Shorea kuantanensis* ASHTON, Gard. Bull. Sing. 31 (1978) 41.

Medium-sized tree. Twig apices and leaf buds sparsely buff puberulent, ovary densely so. Twig c. 2 mm \varnothing apically, terete, striated. Leaves 7.5–12 by 2.7–5 cm, lanceolate, thinly coriaceous; base cuneate, subequal; acuminate to 1 cm long, slender; margin subrevolute; nerves 8–9 pairs, slender but elevated beneath, obscurely depressed above; tertiary nerves reticulate;

midrib prominent beneath, hardly elevated above; petiole 15–18 mm long, slender. Panicles and flowers unknown. Fruit pedicel to 4 mm long, expanding into the fruit base; calyx lobes \pm subequal, to 22 by 4 mm, linear except at the expanded incrassate saccate base; nut to 25 by 11 mm, narrowly ellipsoid, acute, exceeding fruit sepals.

Distr. *Malesia*: Malaya (Bukit Goh forest, Kuantan).

Ecol. Apparently once, frequent on the basalt soils in this one locality, now converted to plantation.

Vern. *Damar hitam*.

41. *Shorea longiflora* (BRANDIS) SYM. Gard. Bull. S. S. 9 (1938) 330; SLOOT. Reinwardtia 3 (1956) 318; BROWNE, For. Trees Sarawak & Brunei (1955) 163; ANDERSON, Gard. Bull. Sing. 20 (1963) 158; ASHTON, Man. Dipt. Brun. (1964) 156, f. 14; *ibid.* Suppl. (1968) 86. — *Hopea longiflora* BRANDIS, J. Linn. Soc. Bot. 31 (1885) 63. — *Hopea longifolia* (non DYER) MERR. En. Born. (1921) 402. — *Balanocarpus longiflorus* FOXW. ex SYM. Gard. Bull. S. S. 8 (1934) 29, pl. 7. — *Balanocarpus grandifolius* RIDL. ex SYM. Gard. Bull. S. S. 8 (1934) 29, *nomen in syn.* — Fig. 89 B–B3, 90.

Small, frequently crooked, tree, Young twig, panicle, bud and stipule fulvous powdery pubescent, caducous on twig and petiole. *Twig* to 2.5 mm \varnothing apically, terete, stout, becoming striated and papery flaked. *Bud* to 3 by 2 mm, slightly compressed, globose to ellipsoid. *Stipule* to 10 by 6 mm, oblong-elliptic, obtuse, cupped. *Leaves* 10–24 by 4–6 cm, narrowly ovate to lanceolate, coriaceous; base obtuse; acumen narrowly acute, 1–2 cm long; margin prominently revolute; nerves 12–15 pairs, distant, prominent beneath, at 60°–70°; tertiary nerves broadly scalariform; *petiole* 1–1.2 cm long, short. *Panicle* to 11 cm long, terminal or axillary, terete; unbranched or singly branched; bracteoles minute, fugaceous. *Flower bud* to 8 by 3.5 mm, lanceolate, relatively large. *Calyx* glabrous but for the shortly fimbriate margin; lobes broadly ovate, thickened, the inner 2 somewhat smaller, thinner, more constricted basally, shortly acuminate, the outer 3 obtuse. *Petals* brownish purple to dark yellow, linear, strongly contorted, inner margin shortly setose, puberulent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments stout, gradually tapering; anther oblong, becoming \pm reflexed at anthesis; appendage to connective as long as anther, sparsely ciliate towards apex. *Ovary* small, ovoid, glabrous; stylopodium glabrous, slender, tapering; style glabrous; stylopodium and style about twice length of ovary. *Fruit* subsessile; *calyx* glabrous, lobes subequal, c. 7 mm long and broad, broadly deltoid to ovate, rather thin, striated, not adpressed to the base of the nut but somewhat spreading with the apices turned slightly inwards. *Nut* to 4.5 by 1.7 cm, lustrous, glabrous, finely striated, ellipsoid to sub-ovoid or obovoid, often bent over to one side; style remnant short, acute.

Distr. *Malesia*: Borneo (Sarawak, Brunei, Sangkulirang and Lower Mahakam region in south-east).

Ecol. Shallow peat swamps and rarely yellow sandy soils, on low hills and plateaux to 1000 m.

Vern. *Damar hitam paya* (Brun.), *lun paya* (Sar.).

42. *Shorea macrobalanos* ASHTON, Gard. Bull. Sing. 22 (1967) 202, pl. 37; Man. Dipt. Brun. Suppl. (1968) 86, f. 11.

Tall buttressed tree. Leaf bud and stipule persistently buff pubescent, otherwise glabrous. *Twig* c. 4

mm \varnothing apically, terete, becoming prominently verrucose; stipule scars c. 3 mm long, obscure, ascending. *Leaf bud* to 2 by 2 mm, ovoid, acute. *Stipule* unknown. *Leaves* 19–37 by 9–15 cm, oblong, coriaceous; margin revolute; base cordate; apex shortly broadly acuminate or obtuse; nerves 12–16 pairs, prominent beneath, set obliquely at 45°–65°; tertiary nerves slender, remotely subreticulate; midrib appanate above, prominent beneath; *petiole* 1.8–3.8 cm long, stout. *Panicle* to 32 cm long, terminal or axillary, terete to somewhat compressed, glabrous, pale brown, becoming rugose, singly or doubly branched. *Flower* to 9 by 3.5 mm, lanceolate, large. *Calyx* glabrous; lobes broadly ovate, thickened; inner 2 somewhat smaller than outer 3. *Petals* linear, inner margin shortly setose, puberulent on parts exposed in bud. *Stamens* 10, in a single verticil; filaments slender, tapering; anthers broadly oblong; appendages to connective as long as anther. *Ovary* narrowly ovoid, tapering, densely yellow-brown pubescent; style glabrous. *Fruit* sessile, entirely glabrous; *calyx lobes* to 8 by 8 mm, ovate, acute, \pm undulate and subrotate, not closely adpressed to the nut, mounted on a to 1 cm \varnothing , to 8 mm deep, receptacle. *Nut* to 5 by 2.5 cm, large, oblong, shortly apiculate.

Distr. *Malesia*: Borneo (W. and Central Sarawak; E. Kalimantan: W. Kutei).

Ecol. Rare, clay rich soils on undulating land and ridges to 900 m.

Vern. *Engkabang low* (Sar.).

43. *Shorea peltata* SYM. J. Mal. Br. R. As. Soc. 19 (1941) 158, pl. 6; Mal. For. Rec. 16 (1943) 56, f. 29; DESCH, Mal. For. Rec. 14 (1941) 27; SLOOT. Reinwardtia 3 (1956) 337, f. 8.

Small tree. Panicles, petals outside and nut persistently densely buff puberulent, calyx outside caducously so, parts of petals exposed in bud puberulent; other parts glabrous. *Twig* c. 2 mm \varnothing apically, terete, smooth. *Buds* minute, ovoid, acute. *Stipules* unknown. *Leaves* 8–16 by 4–7.5 cm, oblong, chartaceous, prominently peltate; acumen to 1 cm long, cuspidate; nerves 8–9 pairs the first 3 of which arise from the petiole insertion, arched, slender but distinctly raised beneath, elevated above as also the subreticulate tertiaries and terete midrib; *petiole* 1.8–3 cm long, slender. *Panicle* to 14 cm long, terminal or subterminal axillary, with to 1 cm long branchlets bearing to 5 secund flowers. *Flower buds* to 6 mm long, lanceolate; *sepals* ovate, acute, subequal; *petals* yellow; *stamens* 15, in 3 unequal verticils; filaments broad at base, tapering and filiform beneath the broadly ellipsoid anthers; appendages c. 1½ times length of anther, scarious towards the apex, slender; *ovary* ovoid, sericeous distally, crowned by a glabrous columnar style equal in length. *Fruit* subsessile; *calyx lobes* to 8 by 5 mm, short, subequal, ovate, acute, incrassate, tuberculate; *nut* to 30 by 9 mm, fusiform, tapering, acute.

Distr. *Malesia*: S. E. Malaya (N. E. Johore), E Sumatra (Indragiri Uplands), West Borneo.



Fig. 90. *Shorea longiflora* (BRANDIS) SYM. with narrow, thick leaves. Brunei (Photogr. G.H.S. WOOD, SAN 17535).

Ecol. Locally common or even gregarious, on well-drained flat land or low hills in Mixed Dipterocarp forest.

Vern. *Mēranti telepok, sama rupa mēranti* (Malaya), *manga* (Sumatra).

44. *Shorea richetia* SYM. Gard. Bull. S. S. 9 (1938) 330; SLOOT. Reinwardtia 3 (1956) 335, f. 6; ASHTON, Man. Dipt. Brun. Suppl. (1968) 89, f. 11, pl. 15 (slash). — *Richetia coriacea* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 975. — *Balanocarpus coriaceus* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 112; SYM. Gard. Bull. S. S. 8 (1934) 27; MERR. En. Born. (1921) 407. — Fig. 89 D-D1.

Medium-sized tree. Apices of twigs, buds and stipules puberulent, other vegetative parts glabrous. Twig 1–2 mm \varnothing apically, terete, smooth, pale grey-brown; stipule scars short, horizontal, obscure. Bud to 2 by 2 mm, ovoid, subacute. Stipule to 5 by 2 mm, lanceolate, acute. Leaves 5–11 by 3–6.5 cm, broadly elliptic, thickly coriaceous; base broadly cuneate; acumen to 1 cm long; nerves 5–7 pairs, comparatively stout and prominent beneath, arched, at 45°–65°; tertiary nerves subscalariform; midrib appanate to slightly depressed above, prominent beneath; petiole 6–10 mm long, stout. Panicle to 8 cm long, terminal or axillary, compressed or terete, lax, buff puberulent or

glabrous; singly branched, branchlets bearing to 5 \pm distichous flowers. Buds to 7 by 2 mm, fusiform. Sepals broadly ovate, fimbriate but otherwise glabrous; outer 3 acute, inner 2 relatively broader, thinner at margin. Petals lime-yellow, lanceolate, densely pubescent on parts exposed in bud, imbricate at base after opening forming a cup, spreading and contorted apically. Stamens 16–17 in 3 unequal verticils; filaments compressed at base, tapering and filiform below the broadly ellipsoid anthers; appendage to connective slender, c. 1½ times length of anther, pubescent in the distal ½. Ovary ovoid, densely pubescent; style columnar, tapering, 2–3 times as long as ovary, pubescent in the basal ½. Fruit pedicel to 2 mm long, stout. Calyx glabrous; lobes to 1.7 by 1 cm, subequal, narrowly ovate, acute, incrassate, saccate and tuberculate at base. Nut to 2.5 by 1.5 cm, obovoid, acute, densely shortly persistently buff pubescent.

Distr. Malesia: N. W. Borneo (W. Sarawak and lower Kapuas valley).

Ecol. Local, on leached soils on undulating land in Mixed Dipterocarp and Heath forest.

Vern. *Lun mēlapi*.

45. *Shorea laxa* SLOOT. Reinwardtia 3 (1956) 345; ASHTON, Man. Dipt. Brun. (1964) 155, f. 14, pl. 38 (habit, saplings); *ibid.* Suppl. (1968) 86, pl. 16 (bark); MEIJER & WOOD, Sabah For. Rec. 5 (1964) 75. — *S. peltata* (non SYM.) BROWNE, For. Trees Sarawak & Brunei (1955) 164.

Medium-sized to large tree. Bud, stipule outside, twig, panicle, petiole and the basal half of the midrib beneath persistently shortly \pm sparsely pale cream-brown pubescent. Twig 2 mm \varnothing apically, smooth. Bud c. 3 by 2 mm, globose to ovoid, subacute. Stipule to 5 by 2 mm, fugaceous, lanceolate, acute. Leaves 7–14 by 4–9 cm, ovate to elliptic, coriaceous; base obtuse or broadly cuneate; acumen c. 1–1.5 cm long, narrow; margin slightly revolute; nerves 8–10 pairs, prominent beneath, at 50°–85° towards the base and 30°–40° at the apex, curved and following the margin for a short distance distally; tertiary nerves well spaced, scalariform; petiole 1.5–2.2 cm long. Panicle to 18 cm long, terminal or axillary, terete, slender, lax; irregularly doubly branched, branchlets to 3 cm long bearing to 7 \pm distichous flowers; bracteoles to 1.5 mm long, minute, fugaceous. Flower bud to 8 by 2 mm, relatively large, lanceolate, acute. Calyx shortly cream pubescent outside, glabrous within; lobes ovate, acute, shortly acuminate, the inner 2 slightly smaller, thinner, basally constricted, with a pronouncedly setose margin. Petals cream, linear, pubescent on parts exposed in bud, imbricate at base and forming a small cup on opening, spreading distally but hardly twisted. Stamens 15, in 3 unequal verticils; filaments slender, tapering, hardly gibbous; anthers subglobose; appendage to connective twice length of anther, slender, reaching base of style, shortly ciliate towards apex. Ovary and stylopodium ovoid-conical, densely shortly pubescent, tapering distally; style short, densely setose in basal half, otherwise glabrous. Fruit calyx glabrous,

lobes subequal, c. 1 cm long and broad, broadly ovate, thickened at the base, tuberculate, closely adpressed to the base of the nut, the obtuse thin apices recurved. *Nut* c. 3.5 by 2.5 cm, large, broadly obovoid, shortly buff pubescent, splitting open at germination unevenly to reveal brilliant red cotyledons.

Distr. *Malesia*: N. E. Borneo (N. E. Sarawak, Brunei, S. E. Sabah).

Ecol. Local, deep yellow sandy soils, Mixed Dipterocarp forest on hills near coast; on ultrabasics in Sabah.

Vern. *Damar hitam timbul* (Brun.).

46. *Shorea balanocarpoides* SYM. Gard. Bull. S. S. 9 (1938) 330; Mal. For. Rec. 16 (1943) 47, f. 29, 30; DESCH, Mal. For. Rec. 14 (1941) 27, 28; *ibid.* 15 (1941) 127; SLOOT. Reinwardtia 3 (1956) 340, f. 9. — *Balanocarpus pahangensis* FOXW. Mal. For. Rec. 10 (1932) 145; BURK. Dict. (1935) 287; DESCH, Mal. For. Rec. 12 (1936) 37, 38. — *S. dolichocarpa* SLOOT. Reinwardtia 3 (1956) 342; ASHTON, Man. Dipt. Brun. (1964) 151, f. 14; *ibid.* Suppl. (1968) 83.

Small to medium-sized tree. Young twig, leaf bud, stipule outside, panicle and buds shortly sparsely grey puberulent, otherwise glabrous. *Twig* c. 1.5 mm \varnothing apically, terete, much branched. *Bud* to 2 by 1.5 mm, small, globose to ovoid, obtuse. *Stipule* to 4 mm long, linear, fugaceous. *Leaves* 6–12 by 2–7 cm, coriaceous, \pm ovate; base obtuse or broadly cuneate, usually unequal, decurrent to 1.5 mm along the petiole; acumen to 1 cm long, narrow; nerves 5–7 pairs, strongly curved, widely spaced, at 60°–70°, running parallel to the margin for a short distance distally; tertiary nerves distant, scalariform at the margin, reticulate near the midrib; *petiole* 1.2–2 cm long. *Panicle* to 8 cm long, terminal or axillary, slender, terete; somewhat irregularly doubly branched, branchlets to 1.5 cm long, short, frequently zigzag, bearing to 8 distichous flowers; *bracteoles* minute, fugaceous. *Flower bud* to 4.5 by 1.2 mm, lanceolate, acute. *Calyx* shortly pubescent outside, glabrous within; 3 outer lobes deltoid, acute; 2 inner lobes subequal to them, suborbicular, mucronate, thin. *Petals* yellow-brown with bright yellow margin, linear, puberulent on parts exposed in bud, imbricate in basal half, spreading and twisted distally when opened. *Stamens* 15, in 3 slightly unequal verticils; filaments broad and slightly gibbous at base, tapering and filiform distally; anther broadly oblong to subglobose; appendage to connective somewhat longer than anther, shortly ciliate towards apex. *Ovary* and *stylopodium* conical, glabrescent, tapering; style short, stout, glabrous. *Fruit* subsessile; *calyx lobes* c. 5 mm long and broad, equal, short, deltoid, subacute, glabrous, saccate and closely adpressed to the nut, margin slightly revolute. *Nut* to 3 by 1.3 cm, ellipsoid to obovoid, densely evenly pubescent, appearing distinctly purplish; style remnant short, acute.

Distr. *Malesia*: Malaya (Kedah, Perak, E. coast), Sumatra (Atjeh; Langkat), Borneo (Sarawak N.E. of Rejang valley and Brunei).

Ecol. Common in Mixed Dipterocarp forest on undulating ground and on ridges to 700 m.

Vern. *Damar katup, mērawan, m. hijau, kala daun bēsar, damar hitam d.b.* (Malaya), *damar hitam gondol* (Brun.).

47. *Shorea multiflora* (BURCK) SYM. Gard. Bull. S. S. 9 (1938) 330; Mal. For. Rec. 16 (1943) 54, f. 28, 29, 33, 34; DESCH, Mal. For. Rec. 14 (1941) 27, 28; *ibid.* 15 (1941) 127; SLOOT. Reinwardtia 3 (1956) 320, f. 1; BROWNE, For. Trees Sarawak & Brunei (1955) 63; ASHTON, Man. Dipt. Brun. (1964) 157, f. 14, pl. 39 (bark); *ibid.* Suppl. (1968) 87; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 76, f. 1b. — *Doona multiflora* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 234. — *Richettia latifolia* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 976. — *Richettia acuminata* HEIM, l.c. 979. — *Richettia oblongifolia* HEIM, l.c. 979. — *Richettia penangiana* HEIM, l.c. 980; BRANDIS & GILG in E. & P. Pf. Fam. ed. 1, 3, 6 (1895) 268. — *Balanocarpus penangianus* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 131; BRANDIS & GILG in E. & P. Pf. Fam. ed. 1, 3, 6 (1895) 268; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 109; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 158, t. 191; BURK. J. Str. Br. R. As. Soc. 81 (1920) 65, fig.; Dict. (1935) 287; RIDL. Fl. Mal. Pen. 1 (1922) 246; FOXW. Mal. For. Rec. 1 (1921) 66; *ib.* 3 (1927) 58; *ib.* 8 (1930) 11; *ibid.* 10 (1932) 143; RIDL. Fl. Mal. Pen. 1 (1922) 246. — *Hopea multiflora* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 60; BOERL. Cat. Hort. Bog. 2 (1901) 102, *incl. var. venosa* BOERL.; RIDL. Fl. Mal. Pen. 1 (1922) 237; FOXW. Mal. For. Rec. 10 (1932) 110; BURK. Dict. (1935) 1191. — *Balanocarpus latifolius* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 112; MERR. En. Born. (1921) 407; FOXW. Mal. For. Rec. 10 (1932) 145; BURK. Dict. (1935) 286. — *Balanocarpus acuminatus* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 113; MERR. En. Born. (1921) 407. — *Balanocarpus sibogae* BOERL. Cat. Hort. Bog. 2 (1901) 112. — *Balanocarpus* sp. SLOOT. ex MERR. Pl. Elm. Born. (1929) 200. — *Balanocarpus multiflorus* SYM. Gard. Bull. S. S. 7 (1933) 153, pl. 47; DESCH, Mal. For. Rec. 12 (1936) 37, 38. — Fig. 5.

Small to medium-sized, occasionally large tree. Young twig, petiole, stipule outside and bud shortly grey tomentose, caducous on twig and petiole. *Twig* c. 1 mm \varnothing apically, slender, terete, smooth, much branched. *Bud* 1–2 by 1.5–2 mm, small, ovoid, obtuse or acute. *Stipule* to 6 by 2 mm, narrowly lanceolate, acute, fugaceous. *Leaves* 4.5–7.5 by 2–3.5 cm, small, ovate-lanceolate; base cuneate, equal or subequal, with or without paired domatia; acumen to 1.5 cm long, narrow; nerves 8–10 pairs, very slender and barely elevated beneath, distant, at 50°–60°; tertiary nerves scalariform to reticulate; *petiole* 7–10 mm long, slender. *Panicle* to 16 cm long, terminal or axillary, terete, lax, shortly sparsely or densely evenly persistently pale cream-buff pubescent; regularly doubly, rarely trebly, branched, branchlets to 1 cm long, zigzag, bearing to 9 distichous flowers; *bracteoles* minute, fugaceous. *Flower bud* to 2.5 mm long, small, lanceolate. *Calyx* shortly cream pubescent outside,

glabrous within; lobes ovate, acute, the inner 2 slightly thinner, more constricted at the base. *Petals* pale yellow, linear, pubescent on parts exposed in bud, the basal $\frac{1}{2}$ imbricate forming a cup, twisted and spreading distally. *Stamens* (10–)15, in (1–)3 slightly unequal verticils; filaments short, broad at base, tapering, filiform distally; anther subglobose; appendage to connective $1\frac{1}{2}$ –2 times length of anther, reaching base of style, shortly ciliate distally. *Ovary* ovoid, tapering, shortly pubescent; stylopodium pubescent, tapering; style short, glabrous; the 2 latter as long as ovary. *Fruit calyx* puberulent to glabrous but for fimbriate margin; lobes to 5 by 4 mm, equal, deltoid, thickened, saccate, subacute. *Nut* to 2 by 1.2 cm, obovoid, finely striated longitudinally, glabrous and lustrous or shortly grey pubescent; style remnant mucronate.

Distr. *Malesia*: Malaya, Sumatra (Karimun, Asahan S.E. to Langsa, Tapanuli, and Palembang, S.W. to Sibolga, Pariaman, Painan), Borneo.

Ecol. Widespread and common, on low hills near coast and inland ridges to 700 m, in Heath and Mixed Dipterocarp forest.

Vern. *Damar hitam*, *d. katup*, *sénggai* (Mal.), *d. tanduk*, *d. hitam*, *d. siput*, *riung*, *méranti kèpala rusa*, *mandirawan*, *kèpala tupai*, *d. rèsak hitam manis* (Sumatra), *tismantok* (Murut), *banjutan* (Dusun), *loan sane barit*, *bunbun puteh*, *bambèring*, *mandjin bukit*, *kèpala pipit*, *puting dèlatit* (Indon. Borneo).

48. *Shorea patoiensis* ASHTON, Gard. Bull. Sing. 19 (1962) 302, pl. 24; Man. Dipt. Brun. (1964) 159, f. 14; *ibid.* Suppl. (1968) 88; MELJER & WOOD, Sabah For. Rec. 5 (1964) 78.

Medium-sized tree. Vegetative parts glabrous but for the fimbriate stipule and bud scales and frequently a white waxy powder on young buds and twigs in mature trees. *Twig c.* 1 mm \varnothing apically, slender, much branched in mature trees, terete, smooth or rugulose. *Leaf bud c.* 3 by 1 mm (to 4 by 2 mm in young trees), narrowly ovoid, obtuse with the bud scales conspicuously patent. *Stipule c.* 8 by 2 mm, glabrous but for margin, oblong, acute. *Leaves* 5–8 by 2–3.5 cm, ovate, chartaceous, frequently subfalcate; base \pm broadly cuneate, decurrent for up to 1 mm at the petiole insertion; acumen c. 1 cm long, narrow; nerves 7–9 pairs, curved, set obliquely (35°–45°), slightly elevated above, slender but prominent beneath; tertiary nerves densely scalariform; *petiole* 7–10 mm long. *Panicle* to 9 cm long, terminal or axillary, rather short and compact, slender, terete, shortly persistently pale greyish brown pubescent; singly or doubly branched, branchlets to 1 cm long, bearing to 6 flowers; *bracteoles* minute, fugaceous. *Flower bud* to 3.5 by 1.5 mm, lanceolate, acute. *Calyx* densely reddish brown pubescent; lobes very small, suborbicular, obtuse, the inner 2 somewhat thinner, constricted at the base. *Petals* bright lemon-yellow, linear, imbricate and forming a cup at the base, twisted and spreading apically. *Stamens* 15, in unequal verticils; filaments rather short, broad at base, abruptly tapering and filiform distally; anther subglobose; appendage to

connective as long as anther, shortly ciliate towards the apex, reaching almost to the style apex. *Ovary* ovoid, shortly pubescent; stylopodium cylindrical, pubescent; style short, glabrous. *Fruit calyx* shorter than nut, caducous yellowish buff pubescent, margin persistently fimbriate; lobes 3–5 mm long and broad, subequal, broadly ovate, \pm adpressed to the base of the nut and united at the base to form a c. 5 mm \varnothing cup. *Nut* to 15 by 8 mm, small, oblong-ellipsoid, striated, glabrescent at maturity, with a minute style remnant.

Distr. *Malesia*: Northern Borneo (Central and N.E. Sarawak, S.E. Sabah, Tidung, E. Kutei).

Ecol. Local, on fertile clay rich soils on calcareous shales and volcanic rocks, hills below 500 m.

Vern. *Damar hitam padi* (Brun.), *sèraya kuning pinang* (Sabah), *njèrakat* (Berau).

49. *Shorea induplicata* SLOOT, Reinwardtia 3 (1956) 327, f. 2; ASHTON, Man. Dipt. Brun. Suppl. (1968) 85, f. 10.

Medium-sized tree. Innovations pale rufous scabrid tomentose, turning dark grey-brown and persisting on twig, buds, stipule, petiole and leaf beneath. *Twig c.* 2 mm \varnothing apically, terete, becoming verruculose; stipule scars short, horizontal, obscure. *Bud* to 3 by 2 mm, ellipsoid, obtuse. *Stipule c.* 5 by 2 mm, linear, not at first caducous. *Leaves* 8–17 by 2–5 cm, lanceolate, coriaceous, margin revolute; base cordate; acumen to 2 cm long, slender; nerves 12–16 pairs, prominent beneath, at 45°–55° except at base; tertiary nerves subscalariform; midrib depressed above, prominent beneath; *petiole* 6–13 mm long, rather short. *Flowers* unknown. *Fruit pedicel* to 2 mm long. *Calyx* glabrescent; *lobes* to 8 by 6 mm, subequal, ovate, acute, the apices becoming subpatent, thickly incrasate. *Nut* to 2.5 by 2.0 cm, broadly ellipsoid, obovoid, subacute, densely shortly evenly fulvous pubescent.

Distr. *Malesia*: Borneo (North-west of the Kapuas and Lupar).

Ecol. Local on podsols on sandstone hills; Mixed Dipterocarp forest — Heath forest ecotone.

Vern. *Lun puteh* (Sar.), *tènkuyung* (Sanggau).

50. *Shorea subcylindrica* SLOOT, Reinwardtia 3 (1956) 331, f. 4; ASHTON, Man. Dipt. Brun. Suppl. (1968) 90, f. 11.

Small to medium-sized tree. Young twigs, bud, stipules outside (subglabrous within) and petiole pale brown frequently somewhat flocculent caducous pubescent. *Twig c.* 2 mm \varnothing apically, terete or occasionally compressed, straight, minutely fissured; stipule scars short, horizontal. *Bud c.* 3 by 2 mm, ovoid, obtuse. *Stipule* to 10 by 4 mm, lanceolate, subacute, fugaceous. *Leaves* 9–24 by 4–12 cm, relatively large, narrowly elliptic or ovate to lanceolate, coriaceous, lustrous; base cuneate, rarely obtuse; acumen to 1.5 cm long, slender to caudate; nerves 8–11 pairs, prominent beneath, evident above and sunken in shallow furrows as also the midrib, oblique, at 35°–50°; midrib prominent on both surfaces; tertiary nerves subreticulate, the scalariform elements

set at 90° to the midrib; *petiole* 9–18 mm long. *Panicle* to 12 cm long, terminal or axillary, terete, lax, ± densely somewhat flocculent buff pubescent, partially caducous; doubly or trebly branched, branchlets bearing to 5 ± secund flowers; *bracteoles* c. 1 mm long, minute, deltoid, acute, fugaceous. *Flower bud* to 3 by 1 mm, small, fusiform. *Sepals* ovate, pubescent on parts exposed in bud; 3 outer acute, 2 inner acuminate, thinner towards margin than outer 3. *Petals* cream, narrowly lanceolate, sparsely pubescent on parts exposed in bud, imbricate at base after opening and thus forming a cup, spreading and contorted apically. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the subglobose anthers; appendage to connective as long as or somewhat longer than anther, slender, glabrous, exceeding style apex. *Ovary* ovoid, sericeous; style columnar, stout, somewhat shorter than ovary, sericeous in the basal $\frac{1}{2}$. *Fruit pedicel* c. 1 mm long, short. *Calyx* glabrescent; lobes to 12 by 9 mm, subequal, ovate, acute, relatively thin, hardly saccate. *Nut* to 23 by 16 mm, ellipsoid, acute, densely shortly pale buff pubescent.

Distr. *Malesia*: N.W. Borneo (Sarawak west of the Lupar).

Ecol. Local, on leached clay soils on undulating land in Mixed Dipterocarp forest.

51. *Shorea obovoidea* SLOOT. Reinwardtia 3 (1956) 332, f. 5; ASHTON, Man. Dipt. Brun. Suppl. (1968) 88, f. 11.

Small to medium-sized tree. Leaf bud, twig and petiole densely ± unevenly shortly golden-brown pubescent, nervation beneath sparsely so. *Twig* c. 2 mm \varnothing , terete, becoming pale red-brown, slightly rough; stipule scars short, pale, cuneate, horizontal. *Bud* to 2 by 1 mm, ovoid, acute. *Stipule* unknown. *Leaves* 5–13 by 1.7–4.5 cm, elliptic, coriaceous; base cuneate; acumen to 12 mm long, slender or caudate; nerves 8–10 pairs, slender but prominent beneath, arched, at 45°–55°; tertiary nerves subreticulate; midrib depressed above, prominent beneath; *petiole* 5–8 mm long, slender. *Panicle* to 7 cm long, terminal or axillary, terete, densely ± unevenly shortly golden-brown pubescent; singly branched, branchlets bearing to 5 distichous flowers. *Bud* to 3 by 2 mm, small. *Calyx lobes* ovate, obtuse, pubescent on parts exposed in bud, the outer 3 somewhat longer than the inner 2. *Petals* pale yellow, pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering medially and filiform below the oblong anthers; appendage to connective slightly longer than anther, filiform, villous in the distal $\frac{1}{2}$. *Ovary* narrowly ovoid, sericeous near the apex, slender; style glabrous. *Fruit pedicel* c. 1 mm long, c. 2 mm \varnothing , short. *Calyx* densely evenly persistently yellow-brown pubescent; lobes to 7 by 4 mm, subequal, short, ovate, acute. *Nut* to 2.5 by 1.7 cm, obovoid to ellipsoid, acute, densely evenly shortly buff pubescent.

Distr. *Malesia*: N.W. Borneo (W. and Central

Sarawak; Kalimantan: Kapuas Valley; Upper Barito).

Ecol. Rare, Mixed Dipterocarp forest on shale hills and undulating land to 500 m.

52. *Shorea chaimana* ASHTON, Gard. Bull. Sing. 31 (1978) 42.

Large buttressed tree. Petioles, panicles, perianth outside and ovary persistently ± densely cream-buff puberulent; sepals, twigs and leaf nervation below sparsely ± caducously so; other parts glabrous. *Twigs* c. 1 mm \varnothing apically, much branched, terete, becoming smooth, dark brown. *Buds* minute. *Leaves* 6–11 by 2–4 cm, elliptic-lanceolate, ± distinctly falcate, subcoriaceous, margin subrevolute; base cuneate or obtuse, subequal; acumen to 15 mm long, slender, caudate; nerves 8–11 pairs, slender but prominent beneath, evident above, arched; tertiary nerves reticulate, distinctly elevated beneath; midrib prominent and terete beneath, evident but appanate to shallowly depressed above; *petiole* 5–8 mm long, short, slender. *Panicle* to 6.5 cm long, terminal or axillary, slender, singly branched; branchlets to 2 cm long. *Flower buds* to 5 by 2 mm, lanceolate. *Sepals* broadly ovate, subacuminate, subequal. *Stamens* 15; filaments expanded and gibbous in the basal half, filiform distally; appendages acicular, c. 2½ times as long as the narrowly ellipsoid 2-locular anthers. *Ovary* ovoid-conical, surmounted by an equally tall columnar puberulent stylopodium and shorter glabrous style. *Mature fruit* unknown; sepals ovate, subequal; ovary ovoid.

Distr. *Malesia*: Northern Borneo (Central and N.E. Sarawak).

Ecol. Local, in Mixed Dipterocarp forest below 1000 m.

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

53. *Shorea collaris* SLOOT. Reinwardtia 3 (1956) 329; f. 3; ASHTON, Man. Dipt. Brun. Suppl. (1968) 82, f. 10.

Large buttressed tree. Petiole and bud persistently greyish buff sericeous, young twigs and midrib above caducously so. *Twig* c. 2 mm \varnothing apically, terete, smooth; stipule scars short, horizontal, obscure. *Bud* to 2 by 2 mm, ovoid, subacute. *Stipule* unknown. *Leaves* 13–23 by 4.3–8.5 cm, oblong-lanceolate, somewhat chartaceous; margin frequently somewhat revolute; base obtuse; acumen to 1 cm long, broad; nerves 13 pairs, slender but elevated beneath, at 45°–60°; tertiary nerves slender, hardly raised, scalariform; midrib appanate above, slender but prominent beneath; *petiole* 19–30 mm long. *Panicle* to 9 cm long, terminal or axillary, terete, densely pale greyish buff pubescent or glabrous; doubly branched, branchlets bearing to 8 ± secund flowers; *bracteoles* fugaceous. *Flower bud* to 5 by 3 mm, ellipsoid. *Sepals* ovate,

subacute, densely pubescent on parts exposed in bud; 2 inner sepals narrower at base, thinner at margins, than outer 3. *Petals* lanceolate, densely pubescent on parts exposed in bud or glabrous, strongly contorted. *Stamens* 10, subequal; filaments compressed at base, tapering and filiform below the narrowly ellipsoid anthers; appendage to connective c. $2\frac{1}{2}$ times length of anther, the inner 5 reaching to the style apex, slender, sparsely pubescent in the distal $\frac{1}{4}$. *Ovary* and *stylopodium* pyriform, densely pubescent or glabrous, crowned by a short glabrous trifid style. *Fruit pedicel* to 3 mm long, stout. *Calyx* glabrescent; lobes to 10 by 9 mm, subequal, ovate, acute, incrassate, becoming \pm reflexed distally. *Nut* to 3 by 2 cm, broadly obovoid-ellipsoid, large, apiculate, persistently pale fulvous sericeous.

Distr. *Malesia*: Central Borneo (Central Sarawak, Ulu Mahakam, Ulu Kapuas).

Ecol. Locally common, clay rich soils, often near streams, in Mixed Dipterocarp forest on hills below 500 m.

Vern. *Lun kēlabu* (Sar.), *tēlingan* (Kapuas), *tēglam* (Mahakam).

54. *Shorea angustifolia* ASHTON, Gard. Bull. Sing. 19 (1962) 277, pl. 12; Man. Dipt. Brun. (1964) 150, f. 14; *ibid.* Suppl. (1968) 81; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 67. — Fig. 89 C–C1.

Small to medium-sized tree. Young twig and stipule sparsely shortly caducous pale brown pubescent; bud, panicle and petiole persistently so. *Twig* to 2 mm \varnothing apically, straight, terete, superficially cracked, rugose and coming away in small papery flakes. *Leaf bud* 0.5 by 1 mm, small, ovoid, obtuse. *Stipule* to 3 mm long, linear, fugaceous. *Leaves* 8–14 by 2.5–4 cm, deep violet when opening, ovate to lanceolate, coriaceous; base cuneate; acumen to 1.5 cm long; nerves 8–10 pairs, hardly raised beneath, curved, well spaced, at c. 50°–60°; midrib beneath hardly elevated; tertiary nerves densely scalariform; *petiole* 6–8 mm long, finely cracked and drying distinct pale brown to cream-grey. *Panicle* to 10 cm long, terminal or axillary, slender, lax, terete; regularly singly or doubly branched, branchlets to 2 cm long, bearing to 8 distichous flowers; *bracteoles* small, fugaceous. *Flower bud* to 2.5 by 1.5 mm, lanceolate, acute. *Calyx* shortly pubescent outside, glabrous within; lobes ovate, acute, the 2 inner lobes thinner, more constricted at base than 3 outer. *Petals* cream, linear, shortly pubescent on parts exposed in bud, imbricate and cupped at base on opening, twisted and spreading distally. *Stamens* 15, in 3 unequal verticils; filaments broad at base, tapering and filiform distally; anthers oblong; appendage to connective 1–2 times length of anther, ciliate towards apex, as long as style. *Ovary* ovoid, shortly pubescent except at base; stylopodium conical; style short, glabrous; style and stylopodium as long as ovary. *Fruit calyx lobes* to 5 by 5 mm, subequal, broadly ovate, incrassate, obtuse. *Nut* to 8 by 9 mm, obovoid, acute, shortly buff pubescent.

Distr. *Malesia*: Borneo (Sarawak N.E. of Rejang

valley, S.W. Sabah, Tidung, Upper Dyak in S. Borneo).

Ecol. Local, on shale ridges at 500–1200 m (rarely lower).

Vern. *Damar hitam bukit* (Brun.), *sēraya kuning bukit* (Sabah).

55. *Shorea maxima* (KING) SYM. Gard. Bull. S. S. 9 (1938) 330; Mal. For. Rec. 16 (1943) 53, f. 29, 32. — *Balanocarpus maximus* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 133; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 110; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5 (1896) 159, t. 192; RIDL, Fl. Mal. Pen. 1 (1922) 248; BURK. J. Mal. Br. R. As. Soc. 1 (1923) 218; HEYNE, Nutt. Pl. ed. 2 (1927) 1128; FOXW. Mal. For. Rec. 3 (1927) 56; *ibid.* 10 (1932) 148; BURK. Dict. (1935) 287. — Fig. 89 A–A2.

Small to medium-sized, often crooked tree. Petiole, stipule, ovary and parts of petals exposed in bud persistently buff puberulent, panicle and calyx outside caducously so. *Leaf bud* to 3 by 2 mm, ovoid, subacute. *Stipule* to 1 cm long, acicular, fugaceous. *Twig* c. 3 mm \varnothing , pale red-brown, \pm prominently ribbed and conspicuously papery flaky. *Leaves* 8.5–19 by 3.5–7 cm, dark violet when opening, elliptic to lanceolate or rarely oblanceolate, coriaceous; base broadly cuneate to obtuse; apex tapering into an up to 1 cm long short broad acumen; nerves 7–10 pairs, \pm ascending, slender but distinctly elevated beneath, obscure above; *petiole* 1–1.5 cm long, c. 3 mm \varnothing , relatively short and stout. *Panicle* to 7 cm long, short, axillary to ramiflorous or occasionally terminal, with a few short branchlets bearing up to 4 second flowers. *Flower buds* to 15 by 4 mm, large, lanceolate. *Sepals* broadly ovate, subequal; outer 3 acute, inner 2 shortly acuminate. *Corolla* pale yellow; *stamens* 10, equal; filaments long, lorate, slender, tapering; anthers subglobose, becoming reflexed; appendages as long as anthers, relatively short. *Ovary* narrowly ovoid, tapering into the prominent glabrous style. *Fruit* sessile; sepals to 15 by 10 mm, subequal, ovate, acute, united at the thickened tuberculate base. *Nut* to 6.5 by 2 cm, very large, fusiform to narrowly obovoid, apiculate.

Distr. *Malesia*: Malaya (Perak and Pahang southwards).

Ecol. Local, on undulating land and hills to 1300 m.

Vern. *Mēranti sēngkawang puteh*, *m. bahru*, *sēngkawang puteh*, *m. kērbau*, *rēsak*, *damar katup*, *sēraya*.

56. *Shorea tenuiramulosa* ASHTON, Gard. Bull. Sing. 31 (1978) 42.

Small to medium-sized tree. Panicles caducous greyish puberulent; bracts persistently so, parts of petals exposed in bud and ovary persistently densely so. *Twig* 1–2 mm \varnothing apically, terete, pale greyish brown, rugulose. *Buds* and *stipules* not seen. *Leaves* 9–24 by 4–11 cm, elliptic to lanceolate, thinly coriaceous drying pale greyish brown; margin undulate, somewhat revolute; base broadly cuneate to obtuse; apex shortly broadly acuminate; nerves 8–9(–11) pairs, arched, at 55°–60°, very slender but distinctly

elevated beneath, slightly so above, as also the laxly reticulate tertiary nerves; midrib prominent on both surfaces; *petioles* 11–20 mm long, drying cream-brown at the ends, otherwise blackish. *Panicles* to 18 cm long, terminal or to 3-axillary or ramiflorous, slender, many flowered; doubly branched, branchlets to 2 cm long; *bracts* to 2 mm long, elliptic, fugaceous. *Flower buds* to 5 by 2 mm. *Sepals* ovate-deltoid, incrassate, subacute, glabrous, subequal. *Stamens* 15, in 3 unequal verticils; filaments dilated at base, tapering and filiform distally; appendages slender, villous distally, c. $1\frac{1}{2}$ times as long as the narrowly ellipsoid anthers. *Ovary* ovoid, tapering into the somewhat shorter stout columnar style; style villous in the basal $\frac{1}{2}$. *Fruit pedicel* to 2 by 2 mm; *sepals* to 6 by 5 mm, equal, ovate, subacuminate, thickened; *nut* to 25 by 8 mm, fusiform-lanceolate.

Distr. *Malesia*: N.E. Borneo (E. Sabah, Sakar I.).

Ecol. Locally frequent on dry rocky ultrabasic ridges near coast.

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

57. *Shorea conica* SLOOT. *Reinwardtia* 3 (1956) 336, f. 7.

Medium-sized tree. Young parts glabrescent; panicles, parts of petals exposed in bud, calyx and ovary densely persistently pale rufous puberulent. *Twigs* c. 1 mm \varnothing apically, much branched, terete, smooth, blackish. *Buds* small, ovoid; *stipule* to 2 by 1 mm, ovate, acute, fugaceous. *Leaves* 6–10 by 2–4.5 cm, narrowly ovate, coriaceous; margin subrevolute; base cuneate, subequal; acumen to 2 cm long, slender, prominent; nerves 4–6 pairs, slender but prominent beneath, hardly elevated above as also the midrib, arched, ascending at 45°–50°; tertiary nerves densely subreticulate, barely elevated beneath; *petiole* 8–12 mm long, slender. *Panicles* to 8 cm long, terminal or axillary, slender; singly branched, branchlets to 2 cm long; *bracteoles* and *flowers* unknown. *Fruit pedicel* to 3 mm long, stout; *calyx lobes* to 10 by 8 mm, short, subequal, subacuminate, saccate, thickened, appressed to the base of the nut. *Nut* to 32 by 10 mm, narrowly ovoid-lanceolate, tapering, acute.

Distr. *Malesia*: E. Sumatra (Labuan Batu, Indragiri).

Ecol. Local, undulating land near coast.

Vern. *Mēranti pugil*, *m. kunyit*, *m. tēmpalo*, *m. rambai*, *samarupa chēngal*.

58. *Shorea bakoensis* ASHTON, *Gard. Bull. Sing.* 22 (1967) 289, pl. 34; *Man. Dipt. Brun. Suppl.* (1968) 81, f. 10.

Small tree. All vegetative parts apparently glabrous. *Twig* c. 2 mm \varnothing apically, smooth; stipule scars short, horizontal. *Bud* and *stipule* unknown. *Leaves* 13–18 by 5–6 cm, narrowly oblong to lanceolate,

coriaceous; base obtuse; acumen to 1 cm long, slender; nerves 9–10 pairs, prominent beneath, at 55°–65°; tertiary nerves slender, hardly raised beneath, subscalariform; midrib appanate above, prominent beneath; *petiole* 10–12 mm long, stout. *Flower* and *inflorescence* unknown. *Fruit pedicel* short, obscure. *Calyx lobes* to 4 by 3 mm, subequal, oblong, obtuse, incrassate, saccate, patent, sparsely persistently buff sericeous on the outer surface. *Nut* to 25 by 14 mm, ellipsoid-cylindric, densely evenly persistently buff pubescent; style remnant to 1 mm long.

Distr. *Malesia*: Borneo (W. Sarawak).

Ecol. Rare (one collection); skeletal podsols near coast.

59. *Shorea xanthophylla* SYM. *Gard. Bull. S. S.* 9 (1938) 342, pl. 24; BROWNE, *For. Trees Sarawak & Brunei* (1955) 164; SLOOT, *Reinwardtia* 3 (1956) 344; ASHTON, *Man. Dipt. Brun.* (1964) 160, f. 14; *ibid. Suppl.* (1968) 91; MEIJER & WOOD, *Sabah For. Rec.* 5 (1964) 78.

Small tree. Young twig and petiole shortly buff caducous pubescent; panicle, stipule (outside only), and leaf bud persistently shortly evenly cream pubescent. *Twig* 2–3 mm \varnothing apically, straight, stout, terete; petiole scars large, orbicular, swollen; stipule scars short, indistinct. *Bud* to 3 by 1.5 mm, conical. *Stipule* c. 8 by 3 mm, fugaceous, narrowly deltoid, cupped, subacute. *Leaves* 12–25 by 4–7 cm, bright red at first, oblong-lanceolate, thinly coriaceous, slightly bullate; base obtuse or broadly cuneate; acumen to 1 cm long, deltoid; margin sometimes slightly revolute; nerves 9–13 pairs, prominent beneath, at 40°–50°, curving and continuing parallel with the margin distally, sometimes anastomosing to form an indistinct intramarginal nerve; tertiary nerves remotely scalariform; *petiole* 8–15 mm long, c. 1.5 mm \varnothing , short. *Panicle* to 10 cm long, terminal or 2-axillary to ramiflorous, angular; somewhat irregularly doubly branched, branchlets to 1.5 cm long, zigzag, bearing to 9 flowers; *bracteoles* minute, fugaceous. *Flower bud* to 4.5 by 1.5 mm, lanceolate, acute. *Calyx* shortly puberulent outside, glabrous within; lobes ovate, the inner 2 lobes thinner, more constricted at the base. *Petals* cream-yellow, linear, shortly pubescent on parts exposed in bud, imbricate and cupped at the base, spreading and twisted distally. *Stamens* 15, in 3 unequal verticils; filaments broad at base, tapering and filiform distally; anthers oblong; appendage to connective 1–2 times length of anther, ciliate towards the apex, reaching the base of the style. *Ovary* ovoid-conical, glabrous at base, shortly pubescent apically, tapering into the stylopodium; style short, glabrous. *Fruit calyx lobes* c. 7 mm long and broad, subequal, broadly ovate, thickened, shortly pale fulvous caducous pubescent outside, glabrous within, not appressed to the nut but prominently saccate. *Nut* c. 2.0 by 1.3 cm, obovoid, subacute, slightly striated longitudinally, densely shortly persistently pale fulvous pubescent.

Distr. *Malesia*: N.E. Borneo (Sabah, Brunei, Sarawak N.E. of Rejang valley).

Ecol. Mixed Dipterocarp forest below 1000 m, on clay soil.

Vern. *Sĕraya kuning baru*n (Sabah), *mĕrabubok* (Iban).

60. *Shorea blumutensis* Foxw. Mal. For. Rec. 10 (1932) 236, pl. 20; SYM. Mal. For. Rec. 16 (1943) 49, f. 29.

Large tree. Leaf bud, twigs, petioles, midrib below, stipules, panicles, bracteoles, calyx and parts of petals exposed in bud densely tawny puberulent, caducous except on bud, twig apices, petiole, panicle and petals; ovary and nut densely pale buff puberulent. *Leaf bud* 4 by 2 mm, ovoid, subacute. *Stipules* short, acicular, fugaceous. *Twig* c. 2 mm \varnothing apically, smooth, terete. *Leaves* 8–17 by 2.8–6.5 cm; elliptic-lanceolate, coriaceous, lustrous beneath, dull above; base cuneate; margin narrowly revolute; acumen to 1 cm long, tapering; nerves 14–16 pairs, very slender, slightly elevated on both surfaces as also the subreticulate tertiary nerves, ascending at c. 50°; midrib prominent beneath, evident and elevated above; *petiole* 1.2–2.2 cm long, c. 2 mm \varnothing . *Panicle* to 16 cm long, terminal or axillary, lax, singly branched; branchlets to 1 cm long, short, bearing c. 4 secund flowers. *Flower bud* to 6 by 3 mm, fusiform; *sepals* ovate, subequal, the 2 inner somewhat the narrower; *stamens* 15, in 3 subequal verticils; filaments compressed, broad at base, tapering and filiform beneath the subglobose anthers; appendages slender, scabrous in the distal $\frac{1}{2}$, c. 1 $\frac{1}{2}$ times length of anthers; *ovary* ovoid, with prominent narrow stylopodium, both densely puberulent; style short, obscurely trifid, glabrous. *Fruit* subsessile; 3 longer *calyx lobes* to 9 by 1.8 cm, spatulate, obtuse, c. 7 mm broad above the to 8 by 10 mm ovate saccate thickened tuberculate base; 2 shorter lobes to 6.5 by 0.7 cm, lorate, similar at base. *Nut* to 3 by 1.3 cm, obovoid, apiculate.

Distr. *Malesia*: Malaya (Johore), N.E. Sumatra (Karimun).

Ecol. Rare, in Lowland Dipterocarp forest below 500 m.

Vern. *Mĕranti kelim*.

61. *Shorea iliasii* ASHTON, Gard. Bull. Sing. 22 (1967) 291, pl. 36; Man. Dipt. Brun. Suppl. (1968) 85, f. 10.

Medium-sized tree. Young parts greyish sericeous, caducous. *Twig* c. 2 mm \varnothing apically, terete, sometimes patchily chartaceous flaky; stipule scars short, horizontal. *Bud* c. 2 by 2 mm, conical, subacute. *Leaf* 19–25 by 9–12 cm, oblong-ovate, obtuse but shortly decurrent and subequal at base; acumen to 8 mm long, broad, short; nerves 12–14 pairs, prominent beneath, arched, at 50°–75°; tertiary nerves remotely subscalariform; midrib applanate or slightly elevated above, prominent beneath; *petiole* 22–30 mm long, stout, terete. *Panicle* to 10 cm long, terminal or axillary, terete or somewhat compressed, caducous grey-buff sericeous; singly or doubly branched; bracts and bracteoles unknown. *Buds* to 4 by 2 mm, small, fusiform. *Calyx* densely puberulent on parts exposed

in bud; 3 outer lobes ovate, acute; 2 inner lobes somewhat smaller, narrower at base, shortly fimbriate. *Petals* cream, linear, obtuse, strongly contorted, pubescent on parts exposed in bud. *Stamens* 15, in 2 unequal verticils, the inner 5 somewhat longer than the outer 10; filaments broad at base, tapering and filiform below the subglobose anthers; appendage to connective c. 1 $\frac{1}{2}$ times length of anther, sericeous in the apical $\frac{1}{4}$. *Ovary* narrowly ovoid, pubescent, tapering into the short glabrous style. *Fruit calyx* sparsely greyish sericeous towards the base; 3 longer lobes to 8 by 2.2 cm, spatulate, obtuse to subacute, c. 4 mm broad above the 6 by 5 mm thickened saccate prominently tuberculate base; 2 shorter lobes to 5.5 by 1.2 cm, otherwise as longer lobes. *Nut* to 10 by 8 mm, ovoid, acute, densely persistently greyish sericeous.

Distr. *Malesia*: Borneo (Central Sarawak).

Ecol. Local, clay soils on undulating land and hills below 400 m.

Vern. *Lun siput daun bĕsar*.

62. *Shorea faguetioides* ASHTON, Gard. Bull. Sing. 19 (1962) 287, pl. 17; Man. Dipt. Brun. (1964) 154, f. 14; *ibid.* Suppl. (1968) 83; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 80.

Large buttressed tree. Young twig sometimes shortly buff caducous pubescent; other vegetative parts entirely glabrous. *Twig* 3 mm \varnothing apically, slightly compressed at first, becoming terete, minutely striated or rugulose. *Bud* 3–4 by 2.5 mm, ovoid, obtuse, compressed. *Stipule* to 18 by 6 mm, narrowly deltoid, saccate, obtuse, less caducous than in most species of *sect. Richetioides*. *Leaves* 12–18 by 5–7 cm, brilliant magenta when opening, narrowly ovate, chartaceous; base broadly cuneate to subcordate, subequal; acumen prominent, c. 2 cm long; nerves 10–15 pairs, slender but prominent, at 60°–70°; tertiary nerves scalariform, slightly oblique to the nerves; *petioles* 2.2–3 cm long, very long, slender. *Panicle* to 15 cm long, terminal or axillary, terete, rugose when dry, lax, sparsely persistently pale greyish brown pubescent; regularly alternately doubly, rarely trebly, branched, branchlets to 2 cm long, bearing to 7 flowers; *bracteoles* small, fugaceous. *Flower bud* to 2.5 by 1.5 mm, small, elliptic, obtuse. *Calyx* densely shortly pubescent outside, glabrous within; lobes ovate, acute, the 2 inner slightly the smaller, thinner, more constricted at base. *Petals* cream, linear, pubescent on parts exposed in bud, imbricate in the basal half forming a broad shallow cup, distally spreading and twisted. *Stamens* 15, in 3 unequal verticils; filaments slender, tapering, basally compressed and slightly gibbous, distally filiform; anthers subglobose; appendage to connective slender, 3 times length of anther, the longest 5 exceeding the style apex, slightly ciliate towards the apex. *Ovary* ovoid, sparsely pubescent; stylopodium shorter than ovary, cylindrical, more densely pubescent; style short, glabrous. *Fruit calyx* puberulent at the base, otherwise glabrescent; 3 longer lobes to 7 by 1.5 cm, chartaceous, broadly spatulate, obtuse, tapering to 4 mm above the to 5 mm broad

prominently tuberculate saccate thickened base; 3 shorter lobes to 5 by 0.7 cm, spatulate, similar at base. *Nut* c. 20 by 6 mm, ellipsoid to obovoid, pale buff pubescent; style remnant c. 3 mm long, slender.

Distr. *Malesia*: Northern Borneo (Ulu Kapuas and Sarawak to S.W. Sabah and W. Kutei).

Ecol. Local, on clay rich soils on hillsides below 700 m.

Vern. *Damar hitam daun nipis* (Brun.), *bēpisang* (Kapuas), *pēnuar* (W. Kutei).

Note. One collection (bb 35287, Ng. Njaban, Ulu Kapuas, W. Borneo) possesses fruit with short subequal sepals; without further collections it is not possible to assess whether it represents more than a single aberrant tree.

63. *Shorea alutacea* ASHTON, Gard. Bull. Sing. 22 (1967) 288, pl. 33; Man. Dipt. Brun. Suppl. (1968) 81, f. 10.

Medium-sized tree. Twigs, stipules, leaf buds, petioles and midrib shortly densely persistently buff pubescent, leaf nervation and surface beneath sparsely so. *Twigs* c. 2 mm \varnothing near the apices, terete; stipule scars c. 1.5 mm long, horizontal, evident. *Bud* c. 2 by 1.5 mm, ovoid, acute, small. *Stipule* to 8 by 3 mm, narrowly deltoid, acute, relatively large. *Leaves* 15–22 by 6–8 cm, ovate to lanceolate, undulate, chartaceous, with cordate base; acumen to 1 cm long, narrow; nerves 14–19 pairs, slender, narrowly depressed above, slender and prominent beneath, at up to 100° at base, 60°–70° distally; tertiary nerves subscalariform, slender, indistinct; midrib depressed above, prominent, terete beneath; *petiole* 6–10 mm long, drying rugose. *Panicle* to 15 cm long, terete, straight, densely shortly pale buff pubescent; singly or doubly branched, branchlets to 2.5 cm long; *bracteoles* to 4 by 3 mm, ovate, acute, densely shortly buff fugaceous pubescent. *Flowers* secund; *buds* to 6 by 3 mm, ellipsoid, relatively large. *Calyx* densely pubescent on parts exposed in bud; sepals broadly ovate, subequal, the inner 2 shortly acuminate, thinner towards the margin and narrower at the base than the acute outer 3. *Petals* lanceolate, pale yellow, pubescent on parts exposed in bud; imbricate at base after opening forming a cup; spreading and twisted distally. *Stamens* 15, in 3 unequal verticils the appendages of the inner 5 exceeding the style apex; filaments broad and compressed at base, tapering and filiform distally; anthers broadly oblong; appendage to connective slender, 3–4 times as long as anther, glabrous. *Ovary* and *stylopodium* pyriform, densely pubescent, tapering into a glabrous columnar style equal in length to the stylopodium. *Fruit pedicel* and *calyx* shortly sparsely caducous pubescent. *Pedicel* c. 1 mm long, short. 3 longer calyx lobes to 8 by 1.8 cm, spatulate, c. 4 mm broad above the to 7 by 7 mm ovate saccate thickened base; 2 shorter lobes to 6 by 1.2 cm, otherwise similar to longer lobes. *Nut* to 2.2 by 1 cm, narrowly ovoid, shortly apiculate, densely shortly evenly buff pubescent.

Distr. *Malesia*: Borneo (W. Sarawak).

Ecol. Rare, lower slopes of granodiorite mountains.

64. *Shorea longisperma* ROXB. [Hort. Beng. (1814) 93, *nomen*] Fl. Ind. ed. Carey 2 (1832) 618; DC. Prod. 16, 2 (1868) 632; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 103; RIDL, Fl. Mal. Pen. 1 (1922) 143; ASHTON, Gard. Bull. Sing. 31 (1978) 43. — *Parashorea longisperma* KURZ, J. R. As. Soc. Beng. Sc. 39, 2 (1870) 66; DYER, Fl. Br. Ind. 1 (1874) 441; SLOOT, Bull. Jard. Bot. Btzg III, 8 (1927) 571; FOXW. Mal. For. Rec. 10 (1932) 226. — *S. resina-negra* FOXW. Mal. For. Rec. 10 (1932) 205, pl. 16; BURK. Dict. (1935) 2021; SYM. Mal. For. Rec. 16 (1943) 56, f. 29, 35; ASHTON, Man. Dipt. Brun. Suppl. (1968) 89, f. 11, pl. 18 (habit, bole, damar).

Very large, prominently buttressed tree. Leaf bud and stipule persistently unevenly shortly fulvous pubescent, twig caducously so. Leaf beneath and petiole persistently shortly subscabrid pale grey-green pubescent. *Twig* 1–2 mm \varnothing apically, slender, terete, becoming smooth; stipule scar small, horizontal to descending, frequently obscure. *Bud* to 3 by 2 mm, ovoid, acute. *Stipule* to 5 by 2 mm, ovate to lorate, acute, caducous. *Leaves* 7–12 by 2.3–6 cm, elliptic to ovate, somewhat chartaceous, pale mauve when fresh; base cuneate to obtuse, acumen to 1.5 cm, long, slender; nerves 10–13 pairs, at 45°–55°, slender, raised beneath; tertiary nerves subscalariform; midrib applanate to slightly depressed above, prominent beneath; *petiole* 10–15 mm long. *Panicle* to 7 cm long, terete or ribbed, slender, densely persistently pale fulvous scabrid pubescent; shortly singly branched, branchlets ascending, bearing to 4 flowers. *Buds* to 9 by 3 mm, lanceolate. *Sepals* broadly ovate, acute, densely sericeous on parts exposed in bud, the inner 2 fimbriate, somewhat shorter than the outer 3. *Petals* pale yellow, narrowly lanceolate, strongly contorted, sericeous on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments broad and compressed at base, tapering to the large broadly ellipsoid anthers; appendage to connective slender, c. 2 times length of anther at anthesis. *Ovary* and *stylopodium* pyriform, shortly densely pubescent; style slender, columnar, glabrous, as long as ovary and stylopodium. *Fruit* sessile. *Calyx* sparsely pubescent; 3 longer lobes to 9 by 1.5 cm, spatulate, obtuse, c. 3 mm broad above the to 6 by 4 mm elliptic saccate tuberculate thickened base; 2 shorter lobes to 7 by 0.4 cm, linear, obtuse, similar at base. *Nut* to 2.3 by 1.2 cm, ellipsoid, acute, shortly evenly densely buff pubescent.

Distr. *Malesia*: Malaya (except seasonal areas), E. Sumatra (Labuhan Batu), Borneo (Central and N. Sarawak, S.E. and S. Borneo).

Ecol. Scattered on fertile clay rich soils in Mixed Dipterocarp forest, especially on igneous and volcanic rocks on undulating land and sheltered inland mountain slopes to 1400 m.

Vern. *Mēranti damar hitam, kala, katup, mērawan, sēnggai* (Mal.), *lun mēranti* (Sar.), *mērsiput, mērak-unyit, kērambukuh, mēmukuh, awang sih* (S.E. Borneo).

65. *Shorea acuminatissima* SYM. Gard. Bull. S. S. 9 (1938) 340, pl. 23; BROWNE, For. Trees Sarawak & Brunei (1955) 162; ASHTON, Man. Dipt. Brun. (1964) 149, f. 14; *ibid.* Suppl. (1968) 81; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 65, pl. 2 (habit), f. 8.

Very tall buttressed tree with dark brown square-section fissured bark. Twig, panicle, petiole, bud, stipule and nervation beneath \pm persistently scabrid rust pubescent. *Twig* c. 1.5 mm \varnothing apically, slender, much branched, terete, becoming smooth. *Bud* to 1.2 by 1 mm, globose to ellipsoid, small. *Stipule* c. 6 by 3.5 mm, oblong-falcate, base obtuse or subcordate; caducous, more persistent in young trees. *Leaves* 7–10 by 3–4 cm, ovate, sometimes cream to brown lepidote beneath; base obtuse; acumen c. 7 mm long; short, acute; margin revolute; nerves 9–12 pairs, prominent beneath, at c. 40°–50°; tertiary nerves dense, scalariform, distinct; midrib prominent beneath, depressed above; *petiole* 1–1.5 cm long, slender. *Panicle* to 8 cm long, terminal or axillary, terete, singly branched; branchlets to 2 cm long, bearing to 6 secund flowers; *bracteoles* to 2 by 2 mm, broadly oblong, obtuse, puberulent. *Flower bud* to 5 by 3 mm, ellipsoid, subacute. *Calyx* densely pubescent outside, glabrous within; lobes broadly ovate, subequal, obtuse; inner 2 lobes thinner towards margin, narrower at base, than outer 3. *Petals* shortly pubescent on parts exposed in bud, imbricate at base after opening forming a cup, spreading and contorted distally. *Stamens* 15, of 2 lengths the longest 5 exceeding the ovary; filaments broad, compressed, tapering, somewhat gibbous; anthers broadly oblong; appendage to connective longer than anthers, slender, puberulent towards apex. *Ovary* and *stylopodium* narrowly ovoid, with a band of short hairs towards the apex; style as long as ovary and *stylopodium*, slender, glabrous. *Fruit* sessile, with prominent obconical receptacle; *calyx* puberulent or glabrescent; 3 longer lobes to 6 by 1.3 cm, spatulate, obtuse, to 3 mm broad above the to 4 by 4 mm somewhat tuberculate thickened base; 2 shorter lobes to 4.5 by 0.8 cm, otherwise similar. *Nut* to 2 by 0.7 cm, narrowly ovoid, densely pale rufous pubescent.

Distr. *Malesia*: N.E. Borneo (from Baram valley N.E. to Sabah).

Ecol. Local, Mixed Dipterocarp forest on sandy clay soils on hills below 500 m, usually near the coast.

Vern. *Sĕraya kuning runching* (Sabah), *damar hitam runching* (Brun.), *barun runching* (Sar.).

66. *Shorea gibbosa* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 99; RIDL, J. Str. Br. R. As. Soc. 54 (1909) 23; BURK. *ibid.* 76 (1917) 165, fig.; RIDL, Fl. Mal. Pen. 1 (1922) 289; FOXW. Mal. For. Rec. 10 (1932) 208; SYM. Gard. Bull. S. S. 7 (1933) 143, pl. 42; Mal. For. Rec. 16 (1943) 51, f. 29; BROWNE, For. Trees Sarawak & Brunei (1955) 162; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 71, pl. 4a, f. 9; ASHTON, Man. Dipt. Brun. Suppl. (1968) 83, f. 10. — *Hopea grisea* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 63; MERR. En. Born. (1921) 404.

Very tall, buttressed tree. Twig, bud, petiole and stipule persistently shortly evenly pale rufous pubescent, leaf nervation beneath sparsely so, glabrescent. *Twig* c. 1 mm \varnothing apically, slender, much branched, at first frequently rugulose. *Stipules* to 3 by 1 mm, narrowly elliptic, acute, fugaceous. *Leaves* pink when opening, 5–13 by 2–6 cm, ovate, chartaceous, undulate; base broadly cuneate to obtuse; acumen to 1.5 cm long; nerves 7–9 pairs, slender but prominent beneath, at 50°–65°; tertiary nerves subreticulate; midrib somewhat depressed above, prominent beneath; *petiole* 8–12(–16) mm long, short. *Panicle* to 10 cm long, terminal or axillary, terete, densely persistently buff to pale rufous pubescent; singly branched, branchlets to 2 cm long, bearing to 6 \pm distichous flowers; *bracteoles* to 2 by 1 mm, oblong, obtuse, shortly pubescent, fugaceous. *Bud* to 5 by 3 mm, lanceolate. *Sepals* ovate, shortly densely pubescent on parts exposed in bud; outer 3 acute, inner 2 shortly acuminate, relatively broader, shorter, thinner at the margin. *Petals* cream with a pink base, narrowly oblong, strongly contorted, sericeous on parts exposed in bud. *Stamens* 15, in 3 unequal verticils, the longest reaching the style apex; filaments compressed and gibbous at base, tapering and filiform below the small broadly ellipsoid anthers; appendage to connective somewhat longer than anther, slender, glabrous. *Ovary* ovoid, densely pubescent; style columnar, pubescent in the basal $\frac{1}{2}$, otherwise glabrous. *Fruit pedicel* to 2 mm long, slender. *Calyx* shortly sparsely pubescent; 3 longer lobes to 9 by 2 cm, spatulate, obtuse, c. 4 mm broad above the to 10 by 6 mm ovate saccate thickened tuberculate base; 2 shorter lobes to 6 by 0.5 cm, narrowly spatulate, acute, similar at base. *Nut* to 1.8 by 1.2 cm, narrowly ellipsoid, densely buff pubescent, acute.

Distr. *Malesia*: Malaya (Johore), Singapore, S.E. Sumatra (Palembang, Lampong), Borneo.

Ecol. Locally common on deep fertile clay-rich soils, on undulating land and low hills below 650 m.

Vern. *Damar hitam gajah* (Mal.), *lun gajah* (Sar.), *sĕraya kuning gajah* (Sab.), *madilan*, *mĕrakunyit*, *damar tĕnkuyung*, *d. kĕtuyung*, *awang pakit*, *kelepeh*, *kĕnuar*, *mĕranti kuning*, *dahu mentola*, *bangkirai*, *lampong kuning* (Indon. Borneo), *damar buah*, *d. b. kuning* (Sumatra).

Note. A variable species distinguished by the sparsely pubescent leaf nervation and leaves crinkling on drying. Collections from East Borneo typically bear lanceolate leaves drying pale grey-green beneath, and a denser fulvous tomentum on perianth and panicle.

67. *Shorea hopeifolia* (HEIM) SYM. Gard. Bull. S. S. 8 (1933) 150, pl. 46; *ibid.* 8 (1934) 36; Mal. For. Rec. 16 (1943) 52, f. 29; BROWNE, For. Trees Sarawak & Brunei (1955) 163; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 72; ASHTON, Man. Dipt. Brun. Suppl. (1968) 84, f. 10; Gard. Bull. Sing. 31 (1978) 43. — *Cotylelobium hopeifolium* HEIM, Bull. Mens. Soc. Linn. Paris 1 (1891) 971; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 95;

BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 153. — *S. ridleyana* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 115, *p.p.*; RIDL, Fl. Mal. Pen. 1 (1922) 226, *p.p.*; FOXW. Mal. For. Rec. 2 (1927) 353; *ibid.* 10 (1932) 209, *p.p.*; SLOOT, ex MERR. Pl. Elm. Born. (1929) 204. — *Hopea heimiana* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 63; MERR. En. Born. (1921) 402. — *Hopea albescens* RIDL, J. Str. Br. R. As. Soc. 73 (1916) 142; Fl. Mal. Pen. 1 (1922) 236. — *S. kalunti* MERR. Philip. J. Sc. 26 (1925) 475; DESCH, Mal. For. Rec. 12 (1936) 35, 39; FOXW. Philip. J. Sc. 67 (1938) 307. — *Hopea hopeifolia* SLOOT, Bull. Jard. Bot. Btzg III, 10 (1929) 396.

Very tall buttressed tree. Vegetative parts glabrous. *Twigs* *c.* 1 mm \varnothing apically, terete, slender, much branched, minutely rugulose; stipule scars short, horizontal, obscure. *Bud* *c.* 1 by 1 mm, small, ovoid, acute, glabrous. *Stipule* to 5 by 2 mm, lanceolate, acute, fugaceous. *Leaves* 3.5–8 by 2–4 cm, small, ovate, somewhat chartaceous and undulate; base broadly cuneate, usually with prominent pore-like glabrous domatia on either side of the base of the midrib; acumen to 1 cm long, prominent; nerves 9–11 pairs, slender, hardly raised beneath, arched, at 55°–65°, with distinct secondary nerves; tertiary nerves reticulate; midrib appanate above, prominent beneath, drying dark red or black; *petiole* 8–10 mm long, slender, geniculate. *Panicle* to 5 cm long, terminal or axillary, terete, densely persistently pale buff pubescent; singly branched, branchlets bearing to 9 distichous flowers; *bracteoles* to 2 by 2 mm, elliptic, obtuse, puberulent outside, glabrous within, caducous. *Bud* to 5 by 2 mm, small, lanceolate. *Sepals* pubescent on parts exposed in bud, ovate, acute; the inner 2 relatively broader and thinner at the margins than the outer 3. *Petals* pale yellow, narrowly lanceolate, densely pubescent on parts exposed in bud, strongly contorted. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the ellipsoid anthers; appendage to connective slightly shorter than anther, glabrous. *Ovary* ovoid, pubescent, surmounted by a columnar tapering style equal in length and pubescent in the basal $\frac{1}{2}$. *Fruit* *pedicel* and base of calyx sparsely buff pubescent, calyx elsewhere glabrescent. *Pedicel* *c.* 3 mm long. 3 longer *calyx lobes* to 7 by 1.5 cm, spatulate, obtuse, *c.* 4 mm broad above the to 5 by 5 mm deltoid thickened saccate tuberculate base; 2 shorter lobes to 4 by 0.7 cm, spatulate, acute, similar at base. *Nut* to 2.7 by 1.2 cm, ellipsoid, shortly apiculate, densely shortly evenly buff pubescent.

Distr. *Malesia*: Malaya (seasonal area excepted), Sumatra (Palembang, Lampong, and E. Coast Res.: Tapanuli to Pariaman in west), Borneo, Philippines (Mindanao).

Ecol. Scattered on fertile clay rich soil on undulating land and hills below 600 m, often in moist places.

Vern. *Damar siput jantan*, *sĕraya*, *s. labu* (Mal.), *suranti limau manis*, *aruĕng*, *mĕranti kuning*, *damar buah* (Sumatra), *sĕraya kuning jantan* (Sabah), *lun siput jantan* (Sar.), *tali makas* (Dus.), *sĕlangan kacha*,

mĕrakunyit, *bĕrĕmbuku*, *lampong bĕmbĕring*, *damar b.*, *utuhatup* (Indon. Borneo).

Note. Some specimens from S.E. Sabah and N.E. Kalimantan suggest that hybridization with *S. gibbosa* may sometimes occur there.

68. *Shorea kudatensis* WOOD ex MEIJER, Act. Bot. Neerl. 12 (1963) 346, pl. 12; Sabah For. Rec. 5 (1964) 74, pl. 5 (bark).

Medium-sized buttressed tree. Panicle, parts of petals exposed in bud and ovary persistently cream puberulent; calyx at first densely so, becoming sparse; twig caducously so. *Twigs* *c.* 3 mm \varnothing , rather stout, terete, \pm rugulose. *Bud* small, ovoid, obtuse; *stipules* fugaceous, not seen. *Leaves* 8–15 by 5–9 cm, ovate, coriaceous, lustrous above; base \pm obtuse, subequal, shortly decurrent; apex shortly broadly acuminate; nerves 7–9 pairs, very slender but distinctly elevated on both surfaces as also the midrib, strongly arched, at 45°–55°; tertiary nerves subreticulate, distinctly elevated beneath, evident above; *petiole* 17–22 mm long, rather stout. *Panicle* to 14 cm long, terminal or axillary, many-flowered; doubly branched, branchlets to 3 cm long. *Flower buds* *c.* 3 by 2 mm, small, ellipsoid. *Sepals* broadly ovoid, the outer 3 subacuminate, the inner 2 acute. *Petals* cream. *Stamens* 15, unequal; filaments broadly compressed at base, tapering and filiform beneath the oblong anthers; appendages slender but short, \pm equal in length to anthers, scarios towards apices. *Ovary* ovoid, tapering into the short glabrous style. *Fruit* subsessile; 2 longer *calyx lobes* to 6 by 1 cm, spatulate, obtuse, *c.* 3 mm broad above the *c.* 4 by 3 mm narrowly ovate thickened saccate tuberculate base; 2 shorter lobes to 4.3 by 5 mm, subacute, otherwise similar. *Nut* to 20 by 8 mm, narrowly ovoid.

Distr. *Malesia*: N.E. Borneo (Kudat to Kiliias and Sandakan).

Ecol. Locally common on dry hills near coast.

Vern. *Sĕraya kuning kudat*.

69. *Shorea cuspidata* ASHTON, Gard. Bull. Sing. 22 (1967) 290, pl. 35, 350 (phot. habit); Man. Dipt. Brun. Suppl. (1968) 82, f. 10, pl. 14 (stem-base).

Medium-sized tree. Leaf bud and stipule shortly buff pubescent, young twigs caducously so; leaf glabrous. *Twig* *c.* 1 mm \varnothing towards apex, slender, terete, minutely striated. *Bud* *c.* 1 mm long, small, ovoid. *Leaves* 5–9 by 2–6 cm, small, broadly ovate, subcoriaceous, with broadly cuneate base; acumen to 1.5 cm long, subcaudate; nerves 5–7 pairs, slender, hardly raised beneath, at 40°–50°; tertiary nerves reticulate, obscure; midrib slender, appanate or slightly raised above, prominent beneath; *petiole* 7–11 mm long, slender. *Panicle* to 9 cm long, terminal or axillary, slender, terete, densely evenly shortly buff pubescent; singly branched, branchlets to 1.5 cm long. *Flowers* secund; *buds* to 3 by 2 mm, small, ellipsoid. *Calyx* pubescent on parts exposed in bud; sepals broadly ovate, small, subequal, acute, the inner 2 broader and thinner at the margin than the outer 3.

Petals pale lime-yellow, lanceolate, densely pubescent on parts exposed in bud, connate at base, strongly contorted. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering and filiform below the ellipsoid anther; appendage to connective c. 1½ times length of anther, slender, pubescent in the distal ½, almost reaching to style apex at anthesis. *Ovary* and *stylopodium* pyriform, sericeous, crowned with a short columnar glabrous style. *Fruit pedicel* and *calyx* shortly sparsely buff pubescent. *Pedicel* c. 1 mm long, short. 3 longer *calyx lobes* to 5 by 1.5 cm, broadly spatulate, obtuse, c. 3 mm broad above the to 5 mm broad saccate thickened base; 2 shorter lobes to 4 by 1 cm, otherwise as in longer lobes. *Nut* to 2.5 by 1.5 cm, obovoid, mucronate, densely shortly evenly buff pubescent.

Distr. *Malesia*: Borneo (Sarawak w. of the Lupar).

Ecol. Locally common on undulating land and low hills in Mixed Dipterocarp forest, to 500 m.

Vern. *Lun runching padi*.

70. *Shorea mujongensis* ASHTON, Gard. Bull. Sing. 22 (1967) 292, pl. 38, 351 (phot. habit); Man. Dipt. Brun. Suppl. (1968) 87, f. 11, pl. 17 (stem-base).

Tall buttressed tree. Young twig, bud and petiole shortly buff pubescent, glabrescent. *Twig* c. 2 mm Ø apically, terete, rugulose; *stipule* unknown. *Leaves* 6–14 by 2.5–5.5 cm, ovate or elliptic, margin ± revolute, base obtuse to cuneate; acumen to 8 mm long; nerves 8–13 pairs, slender but prominent beneath, curved, at c. 50°; tertiary nerves scalariform, unraised, narrowly channelled, beneath; midrib appanate above, prominently terete beneath; *petiole* 10–16 mm long, terete. *Flowers* unknown. *Panicle* to 6 cm long, singly branched, terete, rugulose, shortly evenly buff puberulent. *Flower bud* to 6 by 4 mm, fusiform. *Perianth* puberulent on parts exposed in bud; *sepals* ovate, subacute. *Stamens* 15, in 3 unequal verticils; filaments broad at base, tapering; anthers ellipsoid; appendages same length as anthers, slender, glabrous. *Ovary* and *stylopodium* pyriform, puberulent except at apex, surmounted by a short glabrous style. *Fruit pedicel* to 2 mm long, puberulent. *Fruit calyx* sparsely puberulent to glabrescent; 3 longer lobes to 7 by 1.5 cm, spatulate, obtuse, 4 mm wide above the 6 by 5 mm tuberculate incrassate base; 2 shorter lobes to 4.5 by 0.7 cm, otherwise similar. *Nut* to 2.2 by 0.7 cm, narrowly ovoid, densely shortly pale buff pubescent.

Distr. *Malesia*: Borneo (Central Sarawak, E. Sabah).

Ecol. Local, on fertile soils overlying or influenced by basic volcanic rocks, to 1100 m.

Note. Close to *S. gibbosa* but the minutely channelled, hardly or unraised tertiary nerves beneath (sapling excluded), and the glabrous subcoriaceous appanate leaves serve to distinguish it. Collections from Sarawak have larger more prominently revolute ovate leaves.

71. *Shorea faguettiana* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 975; BRANDIS, J. Linn. Soc. Bot. 31

(1895) 95, *p.p.*; MERR. En. Born. (1921) 414; SYM. Gard Bull. S. S. 7 (1933) 148, pl. 45; *ibid.* 10 (1939) 381; Mal. For. Rec. 16 (1943) 50, f. 29, 31; BROWNE, For. Trees Sarawak & Brunei (1955) 162; ASHTON, Man. Dipt. Brun. (1964) 152, f. 14; *ibid.* Suppl. (1968) 83; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 69, pl. 3, 4b. — *S. ridleyana* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 115, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 99, *p.p.*; BRÜHL & KING, Ann. R. Bot. Gard, Calc. 5, 2 (1896) 153, t. 185, *p.p.*; RIDL. Fl. Mal. Pen. 1 (1922) 226, *p.p.*; FOXW. Mal. For. Rec. 3 (1927) 38, *p.p.*; *ibid.* 10 (1932) 209, *p.p.*; BURK. Dict. (1935) 2021. — *S. dryobalanoides* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 95, *nomen in syn.*

Medium-sized or large buttressed tree. Bud, stipule outside, panicle and young twig pale greyish pubescent; fresh young leaves sparsely fugaceous pubescent beneath. *Twig* slender, dotted with large pale lenticels, with a minutely wrinkled striated papery flaked surface. *Bud* c. 2 by 1.5 mm, small, ovoid to conical. *Stipule* to 4 by 1.5 cm, hastate, pubescent. *Leaves* 7–12 by 3–5 cm, elliptic to oblong-lanceolate or ovate, coriaceous; base obtuse or cuneate, symmetrical or subequal; acumen to 1 cm long; margin generally slightly revolute; nerves 9–12 pairs, slender but distinctly elevated beneath, at c. 30°–50°; tertiary nerves scalariform, rather dense, oblique to the nerves; *petiole* 1–1.5 cm long, fairly stout. *Panicle* to 20 cm long, terminal or axillary, terete or angular, lax; regularly doubly or trebly branched, branchlets to 1 cm long, bearing to 8 flowers; *bracteoles* small, fugaceous. *Flower bud* to 3 mm long, small, elliptic to subglobose. *Calyx* shortly pubescent outside, glabrous within; lobes ovate, subequal, subacute, 2 inner lobes thinner towards margin, more constricted basally. *Petals* cream, linear, the basal half imbricate, forming a cup on opening, spreading and strongly twisted distally. *Stamens* 15, in 3 unequal verticils; filaments broad at base, tapering rapidly and filiform distally; anthers subglobose; appendage to connective as long as anthers and reaching almost to the style apex, sparsely ciliate towards the apex. *Ovary* subglobose, shortly pubescent; *stylopodium* as long as *ovary*, pubescent; style short, glabrous. *Fruit* sparsely pubescent; 3 longer *calyx lobes* to 6 by 1.2 cm, thinly coriaceous, spatulate, obtuse, 2.5 mm broad above the c. 3.5 mm broad thickened tuberculate base; 2 shorter lobes c. 4.5 cm long, narrower, with a narrower base. *Nut* to 15 by 5 mm, narrowly ellipsoid to subobovoid, shortly buff pubescent; style remnant short, acute.

Distr. Thailand (Pattani) and in *Malesia*: Malaya (non-seasonal parts), Borneo (Sarawak, Sabah, S.E. Borneo to Muara Tewe).

Ecol. Well drained clay soils on low hills and particularly ridge tops at 150–1000 m (mainly to 700 m).

Vern. *Damar siput*, *kala*, *k. jantan*, *sēraya*, *s. kitan*, *bam*, *rinchong*, (Mal.), *lun siput* (Sar.), *sēraya kuning siput* (Sabah), *katukan* (Kinababangan), *selangan kacha*, *sērangan kacha*, *pangkang puteh* (Tidung, Berau).

5. Section Anthoshorea

HEIM, Rech. Dipt. (1892) 41; BRANDIS, J. Linn. Soc. Bot. (1895) 84, *p.p.*; SYM. Mal. For. Rec. 16 (1943) 27, f. 17 (map); ASHTON, Gard. Bull. Sing. 20 (1963) 268; Man. Dipt. Brun. (1964) 116. — *Shorea sect. Hopeoides* HEIM, Rech. Dipt. (1892) 43. — *Anthoshorea* PIERRE *ex* HEIM, *l.c. in syn.* — *Parahopea* HEIM, *l.c.* 66. — *Shorea Meranti Pa'ang* group SYM. Mal. For. Rec. 16 (1943) 27. — *Shorea subg. Anthoshorea* (HEIM) MEIJER, Act. Bot. Neerl. 12 (1963) 322. — **Fig. 91B–C, 92.**

Flowers usually large. *Petals* white, sometimes with a median pink suffusion, broadly elliptic or ovate-lanceolate, contorted imbricate at base at anthesis forming a rather large broad goblet enclosing the anthers, loosely connate on falling. *Stamens* 15–30 in 3 verticils, or ∞ ; filaments broad at base, gradually tapering; anthers with 4 pollen sacs, narrowly oblong to linear; appendage to connective unreflexed, prominent, usually at least half as long as anther, stout or slender, scabrous or glabrous. *Ovary* pubescent or glabrous, without distinct stylopodium; style longer than ovary, \pm distinctly trifold distally. *Stipules* caducous, often large; *bracts* and *bracteoles* frequently large, somewhat persistent. *Leaf* with scalariform tertiary nerves; midrib obscure, depressed, above. Medium sized or more usually large stoutly buttressed trees. *Bark* surface with irregular section fissures, frequently short and anastomosing; inner edge of outer bark ill-defined; outer surface rotting off, rarely flaking regularly; periderms undulate, incomplete or absent; inner bark simply laminate. *Wood* cream or yellow, rarely red (*S. montigena*) with ray cells bearing silica deposits; vessels arranged in a reticulum as seen in transverse section, solitary or occasionally in pairs.

Distr. Ceylon and Peninsular India to Indochina and through *Malesia* to the Moluccas.

Ecol. Semi-evergreen and evergreen lowland forests. Several species (*S. roxburghii*, *S. hypochra*, *S. polita*, *S. assamica*, *S. retinodes*) can occur in gregarious stands, especially in seasonal forests.

Vern. *White méranti*, *méranti pa'ang* (Mal.), *raruk* (Iban), *mélapi* (Sabah).

Note. *S. bracteolata* appears to be pollinated by thrips (APPANAH) whereas *S. roxburghii* has been found to be visited by bees in Thailand (SMITINAND, pers. comm.). Most species are rather uniform and well defined, the notable exception being the widespread *S. assamica* and its siblings *S. agamii* of Borneo, which has two subspecies, one of which can be triploid, and *S. resinosa* in which abundant apoximis through adventive polyembryony is well known (FOXWORTHY, KAUR).

72. *Shorea dealbata* FOXW. Mal. For. Rec. 10 (1932) 192, pl. 14; BURK. Dict. (1935) 2010; SYM. Mal. For. Rec. 16 (1943) 35, f. 19; ASHTON, Man. Dipt. Brun. Suppl. (1968) 93, f. 12. — *S. aff. hypochra* (non HANCE) BROWNE, For. Trees Sarawak & Brunei (1955) 519.

Medium-sized, hardly buttressed tree. Young twigs, buds, stipules outside and petiole densely shortly evenly dark fulvous pubescent, nervation beneath fugaceously so; leaf beneath pale pink-brown lepidote. *Twig*. *c.* 4 by 2 mm \varnothing towards apex, compressed, smooth to finely rugulose; *stipule scars* *c.* 2 mm long on young twigs, subhorizontal, prominent with a prominent rib descending the twig from their ends. *Bud* to 6 by 4 mm, ovoid, conical, subacute. *Stipule* to 20 by 5 mm, elliptic-oblong, subacute. *Leaves* alternate, 8–16 by 4–7.5 cm, ovate to elliptic,

coriaceous; base obtuse, rarely cuneate; acumen to 1 cm long, narrow; nerves (11–)20–24 pairs, obscure and slightly depressed above, slender and hardly elevated beneath, at up to 75° towards the base, 40°–60° towards the apex; tertiary nerves dense, parallel, slender, obscure; midrib obscure, depressed above, prominent, subacute beneath; *petiole* 1.5–2.5 cm long, stout, rugose especially distally when dry. *Panicle* to 8 cm long, terete or angular, densely pale fulvous hirsute, axillary or terminal; unbranched or singly branched, branchlets to 1.5 cm long; *bracteoles* fugaceous, unknown. *Flowers* distichous; *bud* to 12 by 5 mm, lanceolate. *Calyx* densely pale fulvous hirsute outside, glabrous within; 3 outer lobes narrowly deltoid, subacute, 2 inner lobes shorter, ovate, cuspidate. *Petals* oblong-lanceolate, white tinged with pink at base, densely pubescent on parts exposed in bud.

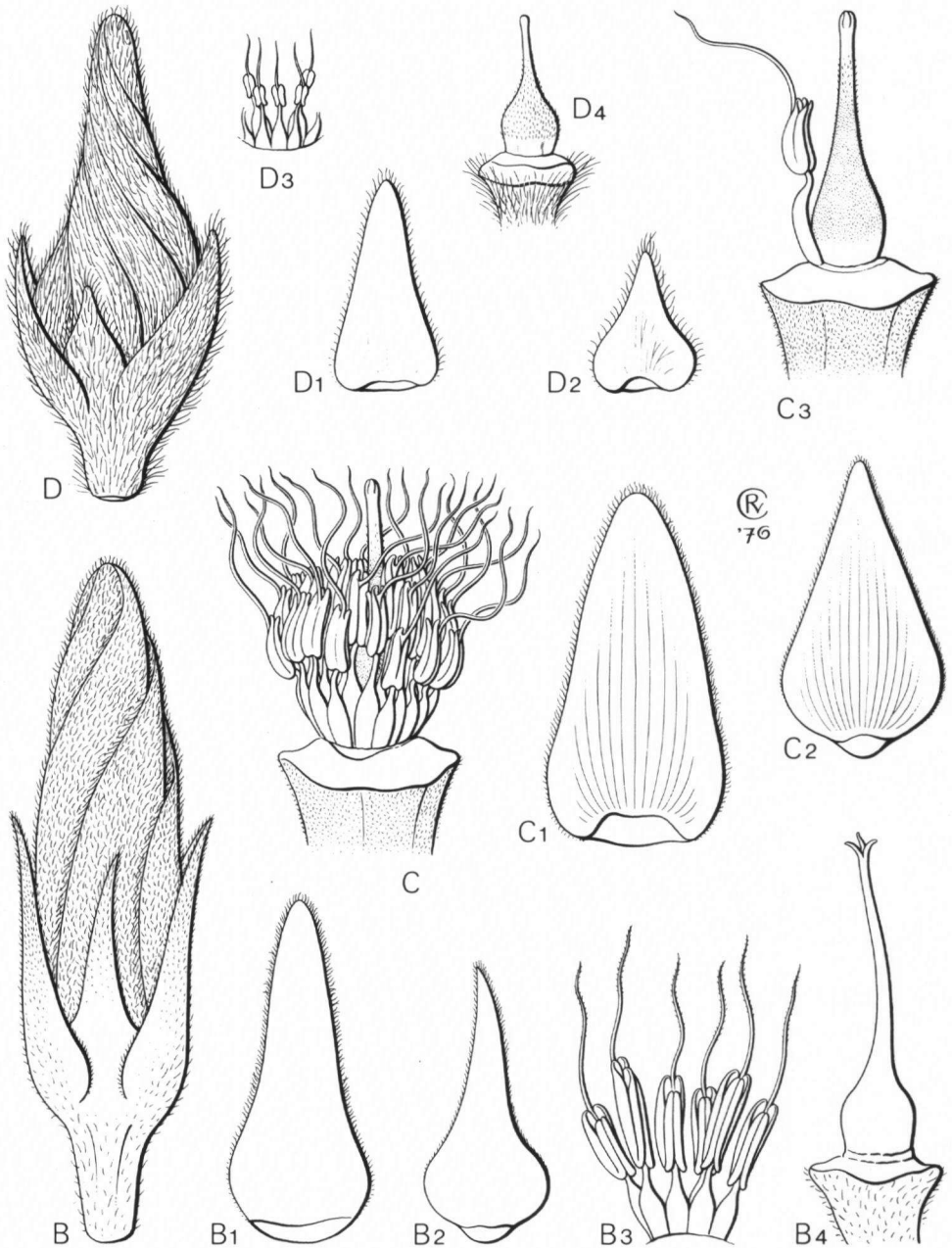


Fig. 91. Flower details in *Shorea* sect. *Anthoshorea* HEIM (B and C) and sect. *Brachypterae* HEIM subsect. *Brachypterae* (D). Sepals drawn from inside. — *S. roxburghii* G. DON. B. Bud, B1. outer sepal, B2. inner sepal, B3. stamens from inside, B4. pistil, all $\times 10$. — *S. henryana* PIERRE. C. Stamens and pistil, C1. outer sepal, C2. inner sepal, C3. one stamen in lateral view and pistil, all $\times 6$. — *S. balangeran* (KORTH.) BURCK. D. Bud, D1. outer sepal, D2. inner sepal, D3. stamens from outside, D4. pistil, all $\times 10$ (B KERR 8392, C KERR 17713, D Cult. Hort. Bog. VIII-D-6).

Stamens 17, unequal; filaments lorate, somewhat tapering, \pm as long as anthers; anthers narrowly oblong; appendage to connective filiform, stout at base, rapidly tapering to a very slender apex, 3 times length of anther, the inner 5 reaching the style apex, sericeous in the distal $\frac{1}{2}$. *Ovary* ovoid, sparsely sericeous; style filiform, trifurcate apically, sericeous in the basal $\frac{1}{2}$. *Fruit pedicel* to 5 mm long, slender. 3 longer *calyx lobes* to 9 by 1.3 cm, narrowly spatulate, subacute, 3.7 mm broad above the *c.* 8 by 8 mm subauriculate thickened base; 2 shorter lobes to 6.5 by 0.4 cm, lorate, acute, similar but narrower at base. *Nut* to 18 by 8 mm, narrowly ovoid, densely pale fulvous pubescent; style remnant to 3 mm long.

Distr. *Malesia*: Malaya (Pahang), Sumatra (P. Lingga; sterile coll.), Borneo (W. Sarawak).

Ecol. Locally frequent on yellow sandy soil on coastal hills and flat sometimes swampy land.

Vern. *Mèrantî bunbong* (Mal.).

73. *Shorea farinosa* C.E.C. FISCHER, Kew Bull. (1926) 461; *ibid.* (1927) 81; SYM. Mal. For. Rec. 16 (1943) 36, f. 19; SMITINAND, Thai For. Bull. (Bot.) 1 (1954) 23.

Large semi-deciduous tree. Leaf bud and parts of petals exposed in bud persistently cream pubescent, calyx and ovary thus at first, becoming sparsely pubescent; parts otherwise sparsely fugaceous puberulent, glabrescent. *Twig* 2–3 mm \varnothing apically, smooth, pale brown; stipule scars short, pale, slightly down-curved. *Leaves* 7.5–15 by (2–)2.5–6 cm, elliptic-oblong, thinly coriaceous; base obtuse; apex shortly acuminate or retuse; nerves 13–20 pairs, very slender, elevated on both surfaces, arched, at 60°–70°; tertiary nerves scalariform, evident on both surfaces; midrib slender but prominent and terete beneath, obscure and depressed above; *petiole* (13–)20–30 mm long, slender. *Panicles* to 10 cm long, lax, slender, terminal or axillary; singly branched, branchlets to 8 cm long, bearing to 6 distant second flowers; *flower buds* to 6 by 4 mm, broadly ellipsoid; 3 outer *sepals* ovate-elliptic, acute; 3 inner smaller, ovate, acute; *stamens* 25, filaments broad and compressed at base, gradually tapering; appendages filiform, villous in the distal $\frac{1}{2}$, *c.* $1\frac{1}{2}$ times length of the narrowly oblong tapering anthers; *ovary* narrowly ovoid, tapering into the equally long columnar deeply trifid style. *Fruit pedicel* to 4 mm long, expanding into the base of the nut; 3 longer *calyx lobes* to 14 by 2 cm, spatulate, obtuse, *c.* 8 mm wide above the 18 by 14 mm elliptic saccate thickened base; 2 shorter lobes to 10 by 0.7 cm, slender. *Nut* to 3 by 1.5 cm, ovoid, glabrous, tapering to the prominent style remnant.

Distr. S. Tenasserim, Peninsular Thailand; doubtfully from *Malesia*: Malaya (fallen leaves from N. Perlis and Kelantan).

74. *Shorea polita* VIDAL, Sinopsis (1883) 15, t. 15D; Rev. Pl. Vasc. Filip. (1886) 61; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 88; FOXW. Philip. J. Sc. 13 (1918) Bot. 190; MERR. En. Philip. 3 (1923) 98; DESCH, Mal. For. Rec. 12 (1936) 39; FOXW. Philip. J. Sc. 67 (1938)

304. — *S. mindanensis* FOXW. Philip. J. Sc. 13 (1918) Bot. 192; MERR. En. Philip. 3 (1923) 97; REYES, Philip. J. Sc. 22 (1923) 330. — Fig. 92.

Large tree. Parts of petals exposed in bud densely pubescent, young parts \pm caducously tawny puberulent, more persistent in young trees. *Twigs* *c.* 2 mm \varnothing apically, terete, smooth. *Leaf buds* small, ovoid. *Stipules* caducous, not seen. *Leaves* (3.5–)6.5–9(–14) by (1.5–)4–5(–11.5) cm, \pm elliptic, thinly coriaceous, occasionally cream lepidote beneath; margin narrowly subrevolute; base cuneate to obscure (young trees); apex shortly broadly acuminate to retuse; nerves 11–13 pairs, slender but distinctly elevated beneath, \pm applanate above, at 55°–80°; tertiary nerves remotely scalariform, hardly elevated beneath, \pm obscure; midrib prominent beneath, obscurely depressed above; *petiole* 1–2 cm long, slender, geniculate. *Panicke* to 14 cm long, slender, lax, terminal or axillary; singly branched, branchlets to 8 cm long, with to 8 second flowers; *bracteoles* to 7 by 2 mm, lanceolate, acute, caducous. *Flower bud* to 10 by 3 mm, fusiform; *sepals* ovate, the outer 3 subacute, the inner 2 acuminate; *stamens* 21–25, becoming \pm shorter than style at anthesis; anthers linear-oblong, slender; appendages aristate, scabrous distally, \pm twice length of anthers; ovary ovoid, puberulent; style columnar, slender, \pm twice length of ovary, scarious in the basal $\frac{1}{2}$, with \pm deeply trifid stigma. *Fruit pedicel* short, stout, broadening into fruit. 3 longer *calyx lobes* to 13 by 2 cm, lorate, obtuse, *c.* 6 mm wide above the to 15 by 12 mm elliptic saccate thickened base; 2 shorter lobes to 7.5 by 0.5 cm, linear-lorate, acute, similarly saccate at base; *nut* to 15 by 14 mm, ovoid, tapering to a long slender filiform style remnant.

Distr. *Malesia*: Philippines.

Ecol. Widespread but scattered in Semi-evergreen and Evergreen Lowland Dipterocarp forests.

Vern. *Lauan, malaanonan*.

Note. Closely allied to *S. gratissima* and *S. montigena*, forming a group of three allopatric species characteristic of seasonally or periodically dry forests from Thailand to the Moluccas.

75. *Shorea gratissima* (WALL. ex KURZ) DYER, Fl. Br. Ind. 1 (1874) 307; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 115; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 88, 89; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 59; BRANDIS, Indian Trees (1906) 70; BURK. J. Str. Br. R. As. Soc. 16 (1917) 167; *ibid.* 81 (1920) 51, 68; RIDL. Fl. Mal. Pen. 1 (1922) 226; CRAIB, Fl. Siam. Enum. 1 (1925) 143; FOXW. Mal. For. Rec. 10 (1932) 189, *p.p.*; BURK. Dict. (1935) 2011; SYM. Mal. For. Rec. 16 (1943) 36, f. 19; SMITINAND, Thai For. Bull. 1 (1954) 22; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 54, f. 5. — *Hopea gratissima* WALL. [Cat. (1828) n. 960, *nomen*; DC. Prod. 16, 2 (1868) 635, *nomen*] ex KURZ, J. R. As. Soc. Beng. Sc. 42, 2 (1873) 61.

Large tree. Young parts entirely shortly evenly densely pale fulvous pubescent, glabrescent except on stipules *Twig* *c.* 1.5 by 1 mm \varnothing apically, at first somewhat compressed, becoming terete, smooth,

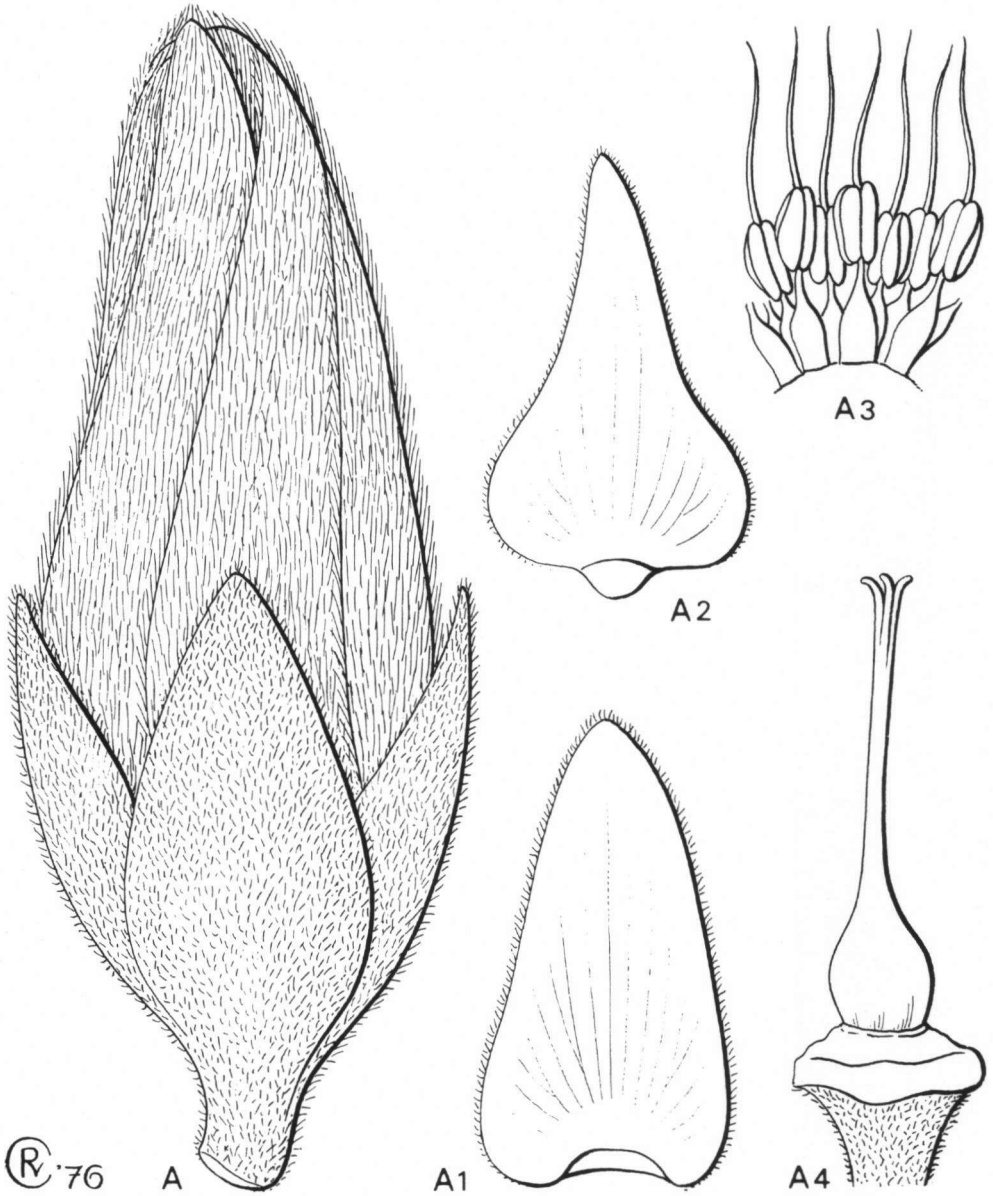


Fig. 92. Flower details in *Shorea* sect. *Anthoshorea* HEIM. — *S. polita* VIDAL. A. Bud, A1. outer sepal, A2. inner sepal, both from inside, A3. stamens from inside, A4. pistil, all $\times 5$ (CANICOSA 9734).

dark brown; stipule scars short, horizontal, obscure. *Buds* to 2 by 1 mm, ovoid, subacute. *Stipules* to 10 by 3 mm, lanceolate, acute, caducous. *Leaves* 4–10 by 1.5–4.5 cm, ovate to elliptic, coriaceous, with undulate margin; base cuneate; apex acute or with to 1 cm long slender acumen; nerves c. 12–14 pairs, slender, hardly raised beneath, arched, at 55°–65°; secondary nerves scalariform to subreticulate, remote, obscure; midrib obscure and depressed above, slender and acute beneath; *petiole* 8–15 mm long, slender. *Panicles* to 10 cm long, terete or ribbed, terminal or axillary, singly (if axillary) or doubly branched; branchlets to 4 cm long, ascending, bearing to 8 flowers; *bracteoles* to 2 mm long, linear, fugaceous. *Flower bud* to 5 by 3 mm, lanceolate. *Sepals* narrowly deltoid, 3 outer acute, 2 inner acuminate. *Stamens* 25; filaments compressed, tapering, c. 1½ times length of anthers; anther oblong, tapering; appendages very slender, c. 3 times length of anthers, villous in the distal ½. *Ovary* narrowly ovoid, glabrescent, tapering into the style; style c. 1½ times length of ovary, with prominently trifid stigma. *Fruit* glabrescent. *Pedicel* to 1.5 mm long and \varnothing ; 3 longer *calyx lobes* to 7 by 1.3 cm, lorate-spatulate, obtuse, c. 6 mm wide above the to 8 by 5 mm saccate somewhat thickened base; 2 shorter lobes to 5.5 by 0.6 cm, otherwise similar. *Nut* to 15 by 8 mm, ovoid, apiculate.

Distr. Tenasserim, Peninsular Thailand, and in *Malesia*: Malaya (Kelantan, Selangor, Singapore), W. Sumatra (Bangkinang), Borneo (N.E. Sabah from Kudat to W. Kutei).

Ecol. Locally abundant on low hills near the coast. Vern. *Meranti laut* (Malaya), *penggir* (Sabah).

76. *Shorea henryana* PIERRE in Lanessan, Pl. Util. Colon. Fr. (1886) 302; For. Fl. Coch. 3 (1889) t. 229; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 89; CRAIB, Fl. Siam. Enum. 1 (1925) 143; ASHTON, Gard. Bull. Sing. 31 (1978) 41. — *S. sericeiflora* FISCHER & HUTCH. Kew Bull. (1926) 433; SYM. ex DESCH, Mal. For. Rec. 12 (1936) 27; PARKINSON, Ind. For. Rec. (Bot.) 1 (1937) 43; SYM. J. Mal. Br. R. As. Soc. 19 (1941) 160; Mal. For. Rec. 16 (1943) 41, f. 19, 25; SMITINAND, Thai For. Bull. 1 (1954) 22. — *S. gratissima* (non (WALL. ex KURZ) DYER) FOXW. Mal. For. Rec. 10 (1932) 189. — *S. longestipulata* TARDIEU, Not. Syst. 10 (1942) 132. — Fig. 91 C–C3.

Large buttressed tree. Young twig and petiole densely evenly pale rufous caducous pubescent; leaf bud, panicles, sepals and parts of petals exposed in bud persistently so; leaves, stipules and ovary sparsely fugaceous pubescent; leaves pale pink-brown lepidote beneath. *Twigs* 1–2 mm \varnothing apically, smooth, terete, becoming chocolate-brown; stipule scars slender, short, horizontal. *Buds* to 2 by 1 mm, small, ellipsoid. *Stipules* to 20 by 3 mm, narrowly elliptic, obtuse, not at first caducous. *Leaves* (3–)4–8(–12) by (1–)2.5–4.5(–5) cm, broadly lanceolate to elliptic, coriaceous; base obtuse or rarely broadly cuneate; apex acute or with to 1 cm long broad acumen; nerves 17–20 pairs, slender, hardly raised beneath, at 80° at

the base, down to 45° towards the apex; secondary nerves densely scalariform, slender, obscure; midrib obscure and depressed above, slender but prominent and terete beneath; *petiole* 10–18 mm long, slender. *Panicles* to 11 cm long, slender, lax, terete or ribbed, terminal or more rarely axillary; doubly (if terminal) or singly branched; branchlets to 5 mm long, bearing to 6 flowers; *bracteoles* unknown. *Flower buds* to 10 by 5 mm, ellipsoid. *Sepals* lanceolate, the inner 2 somewhat shorter, more narrowly acute, than the outer 3. *Petals* white. *Stamens* 25(–30); filaments slender, tapering, c. 1½ times length of the narrowly oblong anthers; appendages very slender, c. 3 times length of anther, villous towards apex. *Ovary* ovoid; style columnar, tapering, \pm twice length of ovary, villous in the basal ½, prominently trifid at apex. *Fruit pedicel* to 3 mm long, to 2 mm \varnothing ; 3 longer *fruit calyx lobes* to 9.5 by 1.6 cm, lorate, obtuse, to 8 mm wide above the 8 by 8 mm suborbicular somewhat thickened saccate base; 2 shorter lobes to 5.5 by 0.4 cm, otherwise similar. *Nut* to 22 by 10 mm, narrowly ovoid, apiculate, glabrous.

Distr. Lower Burma, S.E. and Peninsular Thailand, and in *Malesia*: N.W. Malaya (Kedah, Perlis, Langkawi).

Ecol. Locally common in Semi-evergreen Dipterocarp forest on well drained red soils.

77. *Shorea montigena* SLOOT. Reinwardtia 2 (1952) 57, f. 18, 19. — *S. balangeran* var. *binnendijkii* BOERL. Cat. Hort. Bog. 2 (1901) 108.

Huge buttressed tree. Young parts fugaceous puberulent, ovary persistently so, panicle and parts of perianth exposed in bud persistently greyish ocherous pubescent; parts otherwise glabrous. *Twigs* c. 2 by 1 mm apically, distinctly compressed, smooth, dark brown. *Buds* minute, falcate-lanceolate. *Stipules* to 20 by 3 mm, linear-lanceolate, acute. *Leaves* 5–12 by 2–5.5 cm, ovate-lanceolate, thinly coriaceous, undulate; base cuneate; apex with to 1.5 cm long slender tapering acumen; nerves 7–9(–13 in young trees) pairs, very slender and hardly elevated on either surface, ascending at 50°–65°, sometimes with a few scattered shorter secondary nerves; tertiary nerves densely scalariform, \pm obscure; midrib slender but prominent and acute beneath, \pm obscure and depressed above; *petiole* 22–25 mm long, slender, geniculate. *Panicles* to 17 cm long, axillary or terminal, compressed, singly or doubly branched; branchlets to 12 cm long; *bracts* fugaceous. *Flower bud* to 12 by 4 mm, large; *sepals* broadly ovate, acute, subequal; *stamens* (55–)65–72, unequal; filaments compressed, tapering; appendages slender, 1½–2 times length of the narrowly oblong anthers; *ovary* ovoid, tapering into somewhat longer columnar style. *Fruit pedicel* short; 3 longer *calyx lobes* to 11 by 1.5 cm, spatulate, obtuse, 1.5 mm wide above the 1 by 1 cm ovate saccate thickened base; 2 shorter lobes to 35 by 3 mm, linear, similar at base. *Nut* to 2 by 1.5 cm, ovoid, apiculate.

Distr. *Malesia*: Moluccas (Buru, Ceram), N.E. Celebes? (leaves only).

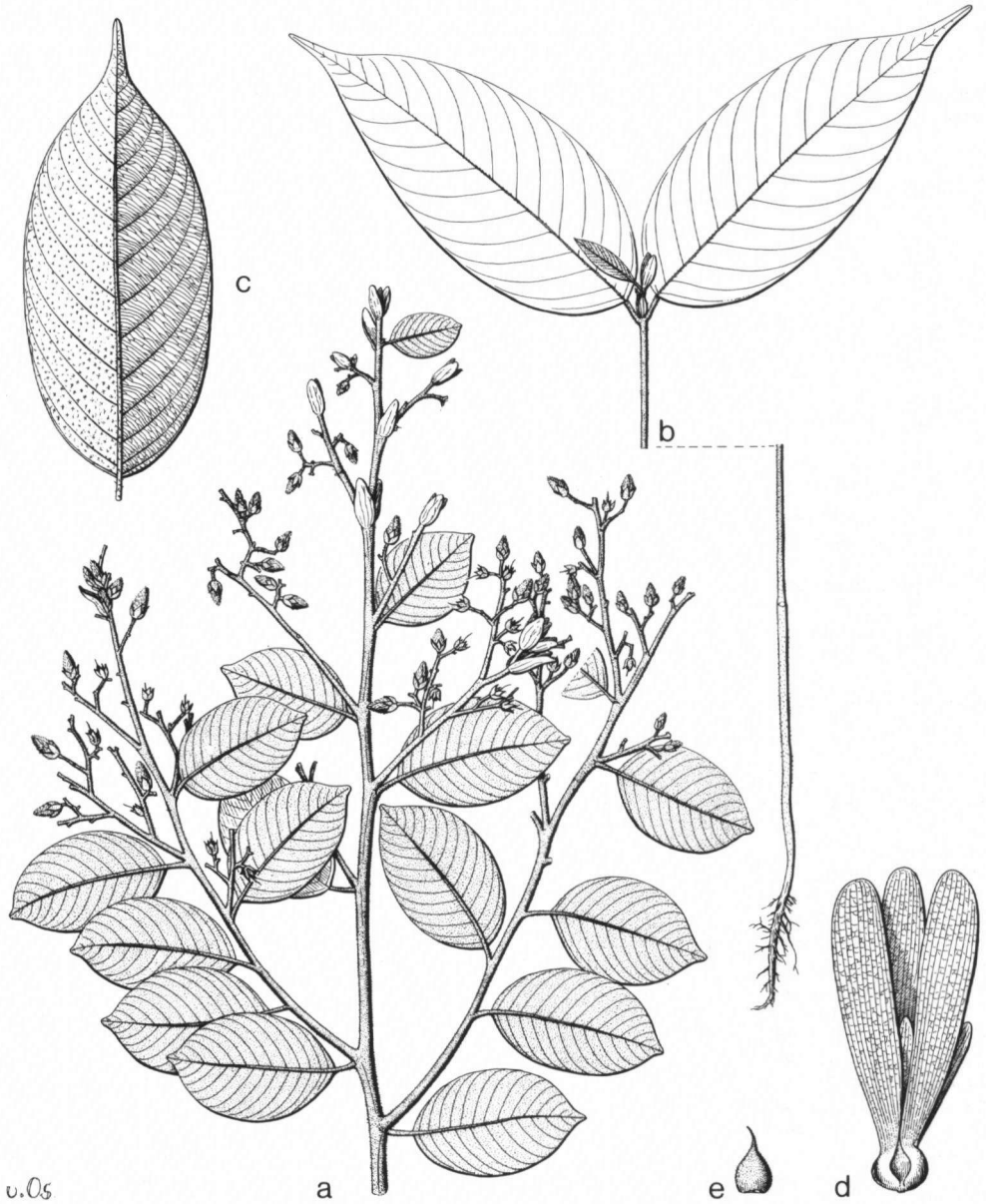


Fig. 93. *Shorea assamica* DYER ssp. *globifera* (RIDL.) SYM. a. Habit, b. seedling, c. leaf, showing hairs in the left half, veins in the right, d. fruit, e. nut, all $\times \frac{1}{2}$ (a YATES 1675, b bb. 19473, c bb. 20776, d-e KEP 87603).

Ecol. Common, frequently gregarious, on hills in *S. selanica* forest.

Vern. *Bahut, kayu bapa, gawa, babat* (Buru), *umale* (Ceram).

Notes. Differing from the Philippine species *S. polita* principally in the greater number of stamens and related, through it, to the widespread but disjunct *S. gratissima* of drought prone evergreen forest. GOTTWALD & PARAMESWARAN (Bot. Jahrb. 85, 1966, 457, 458) placed this species in *sect. Shorea* on the basis of xylem anatomy, but noted its unusually low density for that section, the presence of oxalate crystals and red colour.

78. *Shorea assamica* DYER, Fl. Br. Ind. 1 (1874) 307; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 85; Indian Trees (1906) 70; FOXW. Philip. J. Sc. 4 (1909) Bot. 516; TROUP, Ind. Woods and Uses (1909) 241; Silv. Ind. Trees (1921) 133; GAMBLE, Man. Ind. Timb. (1922) 83; PEARSON & BROWN, Commer. Timb. Ind. 1 (1932) 119; KANJILAL & DAS, Fl. Assam (1934) 136; PARKINSON, Ind. For. Rec. (Bot.) 1 (1937) 40; SYM. Gard. Bull. S. S. 9 (1938) 331; ASHTON, Gard. Bull. Sing. 31 (1978) 43. — Fig. 93.

KEY TO THE SUBSPECIES

1. Branchlets of panicle usually simple
 - ssp. assamica*
1. Branchlets of panicle bifurcate or fascicled.
 2. Appendage to connective as long as anther
 - a. ssp. globifera*
 2. Appendage to connective twice length of anthers.
 3. Leaves epilose beneath . . . *b. ssp. koordersii*
 3. Leaves usually sparsely velutinate beneath
 - c. ssp. philippinensis*

a. ssp. globifera (RIDL.) SYM. Gard. Bull. S. S. 9 (1938) 331, pl. 20; Mal. For. Rec. 16 (1943) 31, f. 19, 20; ASHTON, Gard. Bull. Sing. 31 (1978) 44. — *S. globifera* RIDL. Fl. Mal. Pen. 1 (1922) 232; FOXW. Mal. For. Rec. 3 (1927) 35; *ibid.* 10 (1932) 191; BURK. Dict. (1935) 2010; SYM. ex DESCH. Mal. For. Rec. 12 (1936) 27. — *S. sororia* SLOOT. Bull. Bot. Gard. Btzg III, 18 (1949) 247, f. 9, 10. — Fig. 93.

Large buttressed tree. Twigs, panicles, parts of perianth exposed in buds, stipules outside (subglabrous to sparsely puberulent within), petioles, midribs above and leaf undersurface persistently \pm densely shortly evenly pale ochreous buff to rufous pubescent; fruit sparsely persistently puberulent; leaf undersurface densely pale rufous lepidote (mature trees only). Twigs to 2 by 1.5 mm \varnothing apically, \pm compressed, smooth, becoming dark brown; stipule scars short, pale, transverse, with a prominent rib proceeding down the internode from the base. Buds to 3 by 2 mm, ovoid, subacute, compressed. Stipules to 15 by 4(–7) in young trees) mm, broadly or narrowly ovate, acute, subauriculate, not at first caducous. Leaves (4–)5–9(–10) by 2–4(–6) cm, ovate, elliptic or rarely obovate, \pm coriaceous; base obtuse to subcordate; acumen to 8 mm long, narrow; nerves 13–18 pairs,

slender, obscure above, at 50°–65°, arched near the margin; tertiary nerves densely scalariform, slender; midrib obscurely depressed above, terete and prominent beneath; petiole 5–7 mm long, short, slender. Panicles to 6 cm long, short, ribbed, terminal or axillary; branchlets usually bifurcate or fascicled, lax. Flower bud to 8 by 4 mm, ellipsoid. Sepals narrowly deltoid, subacute, the 3 outer somewhat narrower, longer than the inner 2. Petals white, pink at base within, broadly elliptic, obtuse. Stamens 15, shorter than the style at anthesis; filaments slender, tapering, as long as the slender lorate anthers; appendages to connectives very slender, $\frac{2}{3}$ –1 times length of anthers. Ovary ovoid, glabrous; style columnar, *c.* 3 times length of ovary, distinctly trifid at apex. Fruit pedicel to 2 by 2 mm. 3 longer calyx lobes to 11 by 2 cm, subulate, obtuse, *c.* 5 mm broad above the to 12 by 10 mm saccate thickened base; 2 shorter lobes to 9 by 0.8 cm, linear, subacute, similar at base. Nut to 15 by 15 mm, ovoid, tapering to an up to 6 mm long slender style remnant.

Distr. Peninsular Thailand, and in *Malesia*: Malaya (Perak and Central Pahang northwards), Sumatra (west of the Barisan Divide from S. Atjeh to Bencoolen), ?S.E. Borneo (sterile coll.).

Ecol. Evergreen forests on fertile clay soil; on well drained flat land, especially by streams, and slopes to 1000 m; in areas liable to periodic drought. Locally common, especially in northern Malaya.

Vern. *Mèranti pipit, m. lampong, m. pasir, lèmsa kulat, l. néram* (Mal.), *sogar baringin nabotar, s. b. narara, bayang ayèr, kèlikung, ngèrawan, mèrkunyt* (Sum.).

Note. Indistinguishable from *ssp. philippinensis* when sterile.

b. ssp. koordersii (BRANDIS) SYM. Gard. Bull. S. S. 9 (1938) 331. — *S. koordersii* BRANDIS ex KOORD. Med. Lands Pl. Tuin 19 (1898) 355; Ic. Bog. 1 (1901) t. 80; Fl. N.O. Celebes Suppl. 2 (1922) 8; *ibid.* Suppl. 3 (1922) 44, t. 91; KOORD.-SCHUM. Syst. Verz. 3 (1914) 88; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 303; *ibid.* ed. 2 (1927) 1107, 1120; ENDERT, Tectona 28 (1935) 258; SLOOT. Reinwardtia 2 (1952) 42, f. 14, 15. — *Aporosa minahassae* KOORD. Med. Lands Pl. Tuin 19 (1898) 625. — *Vatica celebica* KOORD. ex SYM. Gard. Bull. S. S. 9 (1938) 331, *nomen in syn.*

Defining characters: Leaves peltate lepidote but epilose beneath. Branchlets of panicle usually bifurcate or fascicled. Appendage to connective \pm twice length of anther. Stigma \pm unlobed. 3 longer fruit calyx lobes to 7 cm long.

Distr. *Malesia*: Celebes (widespread), Moluccas (Sula, Batjan & Obi Is., ?Amboin), Philippines (Mindanao, Luzon).

Ecol. Common, often gregarious, on fertile soil in primary semi-evergreen forest on hills in lowlands.

Uses. The major timber source where it grows; the clear crystalline resin, '*damar tenang*', was once much exploited.

Vern. *Malueh, haro, waro, rama wuring, induk,*

tambija, *damar lari*, *d. larieh*, *maru waru*, *karmungku* (Celebes), *honi*, *pini*, *p. boti pien*, *ténang*, *t. puteh*, *t. mèrah*, *t. babudo* (Moluccas).

c. ssp. philippinensis (BRANDIS) SYM. Gard. Bull. S. S. 9 (1938) 331. — *S. philippinensis* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 88; FOXW. Philip. J. Sc. 6 (1911) Bot. 272; *ibid.* 13 (1918) Bot. 190; *ibid.* 67 (1938) 302; MERR. En. Philip. 3 (1923) 98; DESCH. Mal. For. Rec. 12 (1936) 27. — *S. aff. harmandii* (non PIERRE) FOXW. Philip. J. Sc. 6 (1911) Bot. 272. — *S. pallida* FOXW. Philip. J. Sc. 13 (1918) Bot. 190.

Defining characters as *ssp. koordersii* but leaves sparsely velutinate beneath.

Distr. *Malesia*: Philippines (widespread), S.E. Borneo.

Ecol. Scattered in semi-evergreen and evergreen forest both in seasonal and relatively non-seasonal regions.

79. *Shorea ochracea* SYM. Gard. Bull. S. S. 8 (1935) 285, pl. 27; BROWNE, For. Trees Sarawak & Brunei (1955) 158; ASHTON, Man. Dipt. Brun. (1964) 165, f. 15; *ibid.* Suppl. (1968) 94, pl. 19 (bark); MEIJER & WOOD, Sabah For. Rec. 5 (1964) 57. — 'Majau' DURANT, Rep. For. Brunei (1933) 43.

Medium-sized to large tree with dark brown bark. Twig, leaf bud, stipule and petiole densely persistently rufous-brown powdery pubescent; partially caducous, sparse, on leaf beneath. *Twig* 4–5 mm \varnothing apically, stout, terete, becoming smooth, with 2 mm long, short, cuneate, horizontal or slightly ascending stipule scars. *Bud* 3–6 by 3–5 mm, globose to ovoid, obtuse. *Stipule* to 2 by 1.5 cm, elliptic, obtuse, caducous. *Leaves* 12–18 by 7–10 cm, broadly elliptic-oblong, coriaceous, bright yellow lepidote beneath; base cordate; acumen *c.* 5 mm broad; nerves 25–30 pairs, prominent beneath, curved, at *c.* 110° at base, *c.* 20° towards the apex, with slender indistinct scalariform tertiary nerves; *petiole* 1.3–2 cm long, short, stout. *Panicle* to 10 cm long, terminal or axillary, terete, lax, densely greenish yellow puberulent; regularly singly or doubly branched, branchlets bearing to 8 flowers; *bracts* and *bracteoles* to 2 by 1 cm, large, elliptic, obtuse, subpersistent, puberulent. *Flower bud* to 8 by 3 mm, lanceolate, subacute. *Calyx* densely yellow-brown tomentose outside, glabrous within; lobes deltoid, slightly revolute, acuminate; 3 outer lobes slightly longer, broader, obtuse; 2 inner lobes acute, narrow at base. *Petals* lanceolate, subacute, shortly pubescent on parts exposed in bud, puberulent elsewhere. *Stamens* 15, subequal; filaments slightly longer than anther, rather narrow, tapering gradually; anther oblong, tapering; appendage to connective somewhat longer than anther, reaching below style apex, stout, acute. *Ovary* ovoid, densely pubescent; style stoutly filiform, pubescent in the basal half, otherwise glabrous, obscurely trifurcate apically. *Fruit calyx lobes* shortly pubescent, densely so at base; 3 longer lobes to 10 by 2 cm, oblong, obtuse, to 1 cm broad above the slightly broadened shortly auriculate

centrally thickened and saccate base; 2 shorter lobes unequal, to 4.5 by 0.5 cm, obtuse, similar at base. *Nut* *c.* 1.5 by 1 cm, ovoid, shortly densely tomentose; style remnant to 2.5 mm long.

Distr. *Malesia*: Borneo (Lower Kapuas, Sarawak to S.W. Sabah, Kinabatangan, Tidung to Puruktjau).

Ecol. Scattered on undulating land and hills to 750 m, in Mixed Dipterocarp forest.

Vern. *Raruk* (Iban), *mèlapi daun bèsar* (Sabah), *maro*, *m. hitam*, *kodahang* (S.E. Borneo), *kontoi tèmbuga* (W. Borneo).

80. *Shorea virescens* PARIJS in Fedde, Rep. 33 (1933) 244; Bijdr. Kennis Oost-Ind. Damarhars (1933) 120; SLOOT. Bull. Bot. Gard. Btjg III, 18 (1949) 240, f. 5, 6; ROJO, Kalikasan 5 (1976) 99, f. 1; ASHTON, Gard. Bull. Sing. 31 (1978) 44. — *S. lamellata* (non FOXW.) ASHTON, Man. Dipt. Brun. (1964) 167, f. 15, *p.p.*; *ibid.* Suppl. (1968) 94, *p.p.*

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

Distr. *Malesia*: Borneo, Philippines (Mindanao, Samar).

Ecol. Widespread but very local, flat and undulating land and low hills, to 500 m.

Vern. *Kèbang*, *baung raja*, *pakit*, *kontoi raba*, *k. tjongil*, *madja kèruing*, *m. lilin* (W. Borneo), *mahumbong* (S. Borneo), *tègèlam*, *bèlobunio*, *pèlèpak batu* (S.E. Borneo), *manggasinorong-lakihan* (Mindanao).

81. *Shorea javanica* K. & V. Bull. Inst. Bot. Btjg 2 (1899) 3; Bijdr. (1900) 121; MOLL & JANSSONIUS,

Mikrogr. Holz (1906) 361; BACKER, Schoofl. (1911) 110; KOORD. Exk. Fl. Java 2 (1912) 622; KOORD.-SCHUM. Syst. Verz. 1 (1913) Dipt. 4; ENDERT, Tectona 28 (1935) 288, 488; SLOOT. Bull. Bot. Gard. Btzg III, 18 (1949) 230, f. 1; BACKER & BAKH. f. Fl. Java 1 (1963) 331. — *S. vandekoppelii* PARIJS in Fedde, Rep. 33 (1933) 244; Bijdr. Kennis Oost-Ind. Damarhars (1933) 112, incl. *var. grandifolia* PARIJS, l.c. 118. — Fig. 16.

Large tree. Twig, leaf buds, stipule outside, panicles, calyx, parts of petals exposed in bud, ovary and nut persistently evenly tawny brown pubescent; becoming sparse, scabrous, on fruit calyx, stipule within, petiole and leaf nervation beneath. *Twig* 2–3 mm \varnothing apically, terete, becoming smooth. *Leaf bud* to 7 by 4 mm, ovoid-falcate, acute. *Leaves* (6.5–)10–15 by (3.5–)4–8 cm, elliptic-oblong to ovate, occasionally obovate, \pm thinly coriaceous; base obtuse to shallowly caudate; acumen to 7 mm long, short, \pm abrupt; nerves 19–25 pairs, very slender but \pm prominent beneath, appanate above, arched, at 65°–70°; tertiary nerves densely scalariform, very slender but evident and slightly elevated beneath; midrib slender but prominent beneath, obscure and depressed above; *petiole* 16–22 mm long, slender. *Panicle* to 14 cm long, slender, terminal or axillary, lax; singly branched, branchlets to 4 cm long, bearing to 3 second flowers. *Flower buds* to 10 by 5 mm, ellipsoid; *sepals* narrowly ovoid, acuminate, somewhat unequal; *petals* white; *stamens* 15, shorter than style at anthesis; filaments very long and slender, with scabrous apices, $2\frac{1}{2}$ –3 \times length of anthers. *Ovary* small, ovoid, puberulent, tapering imperceptibly into a tapering puberulent stylopodium twice its length and long filiform glabrous style thrice its length. *Fruit pedicel* c. 2 mm long and \varnothing , base of fruit obtuse. 3 longer *calyx lobes* to 18 by 1.5 cm, spatulate, obtuse, c. 7 mm broad above the 11 by 10 mm elliptic saccate thickened base; 2 shorter lobes to 7 by 0.5 cm, lorate, subacute, similar at base. *Nut* to 14 by 10 mm, ovoid, prominently apiculate.

Distr. *Malesia*: Sumatra (W. coast from southern Atjeh southwards; east from Palembang southwards), Central Java (Subah in Pekalongan Res.; rare).

Ecol. Scattered in north, becoming gregarious in many areas in south Sumatra, in primary and secondary lowland forests.

Uses. A once valuable producer of clear crystalline resin as well as timber; grown in plantations in *S. Sumatra*.

Vern. *Damar puteh* (Atjeh), *d. sibosa*, *sibosa* (Tapanuli), *d. saga* (W. coast), *d. kacha*, *d. mata kuching* (Palembang), *mēsēgar*, *mēntēgar*, *kacha* (Bencoolen), *d. ata*, *d. dacha*, *d. mata kuching* (Lampong), *pēlalar*, *p. lēngo* (Java).

82. *Shorea lamellata* FOXW. Mal. For. Rec. 10 (1932) 278; BURK. Dict. (1935) 2014; DESCH. Mal. For. Rec. 12 (1936) 27, 28; *ibid.* 14 (1941) 16, 17; SYM. Mal. For. Rec. 16 (1943) 39, f. 19, 23; SLOOT. Bull. Bot. Gard. Btzg III, 18 (1949) 236, f. 3; ASHTON, Man. Dipt.

Brun. (1964) 164, f. 15, pl. 40 (stem-base), *p.p.*; *ibid.* Suppl. (1968) 94, *p.p.*; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 56, pl. 1a (bark).

Differing from *S. javanica* only as follows: Tomentum uneven, scabrid. Anthers twice as long as broad, broadly oblong.

Distr. *Malesia*: Malaya (Perak), Sumatra (Lingga, Singkep), throughout Borneo but for N.E. Sarawak and N. and W. Sabah.

Ecol. Local, undulating land and low hills; rarely to 650 m in Malaya.

Vern. *Mēranti lapis* (Mal.), *tenam* (W. Borneo), *buniau* (W. Kutei), *pakit* (S. Borneo).

Note. The distribution of this species and *S. javanica* is entirely allopatric; both are widespread, and the many collections of each confirm that their differences, though apparently slight, are consistent and serve always to allow indisputable determination.

83. *Shorea roxburghii* G. DON, Gen. Hist. (1831) 813; KASHYAPA, J. Bomb. Nat. Hist. Soc. 58 (1961) 543. — *Hopea floribunda* WALL. Cat. (1828) 964, *nomen*; DC. Prod. 16, 2 (1868) 635, *nomen*. — *S. talura* ROXB. [Hort. Beng. (1814) 93, *nomen*] Fl. Ind. ed. Carey 2 (1832) 618; DYER, Fl. Br. Ind. 1 (1874) 304; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 84; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 265, fig.; BRANDIS, Indian Trees (1906) 70; TALBOT, For. Fl. Bombay 1 (1909) 110; TROUP, Silv. Ind. Trees (1921) 133; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 261; PARKINSON, Ind. For. Rec. (Bot.) 1 (1937) 38; SYM. J. Mal. Br. R. As. Soc. 19 (1941) 160; Mal. For. Rec. 16 (1943) 42, f. 19, 26; SMITINAND, Thai For. Bull. 1 (1954) 5, 6, 23. — *S. laccifera* HEYNE ex WALL. [Cat. (1828) 967, *nomen*] in DC. Prod. 16, 2 (1868) 630; BEDD. Fl. Sylv. (1869) t. 6. — *Vatica laccifera* (WALL. ex DC.) W. & A. Prod. 1 (1834) 84; WIGHT, Ic. Pl. Ind. Or. 1 (1839) t. 164. — *Saul iallarea* ROXB. ex W. & A. Prod. 1 (1834) 84, *nomen*. — *S. laurifolia* WALL. Cat. (1828) 967, *nomen*; ex STEUD. Nom. Bot. ed. 2, 2 (1841) 575, *nomen*; DC. Prod. 16, 2 (1868) 632, *nomen*. — *Vatica laurifolia* (WALL.) STEUD. Nom. Bot. ed. 2, 2 (1841) 745, *nomen*. — *S. floribunda* (WALL.) KURZ ex DYER, Fl. Br. Ind. 1 (1874) 304; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 85, t. 2, f. 19, 20; Indian Trees (1906) 70; SYM. J. Mal. Br. R. As. Soc. 19 (1941) 160. — *S. harmandii* PIERRE ex LANESSAN, Pl. Util. Colon. Fr. (1886) 302; PIERRE, For. Fl. Coch. 3 (1889) t. 231; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 85; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 266. — *S. cochinchinensis* PIERRE, For. Fl. Coch. 3 (1889) t. 230; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 84; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 266; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 381, fig., incl. *var. saigonensis* GUÉRIN; CRAIB, Fl. Siam. Enum. 1 (1925) 142; LECOMTE, Bois Indochine (1926) 112; FOXW. Mal. For. Rec. 10 (1932) 182; BURK. Dict. (1935) 2008; CORNER, Wayside Trees 1 (1940) 213. — *S. saigonensis* PIERRE, For. Fl. Coch. 3 (1889) 257. — *S. attopoensis* PIERRE, l.c. 257, t. 232. — *S. obtusa* WALL.

var. subevenis BOERL. Cat. Hort. Bog. 2 (1900) 106. — Fig. 91 B–B4.

Small or large, hardly buttressed, deciduous or evergreen tree. Leaf bud persistently shortly evenly pale rust pubescent, leaf undersurface, petiole, stipules and young twigs usually at first \pm sparsely pubescent, caducous (in Malesia) or sometimes persistent. *Twigs* c. 2 mm \varnothing apically, \pm terete, becoming smooth, pale to dark brown, sometimes minutely pale lenticellate; stipule scars short, horizontal, the internode frequently ribbed beneath their apices. *Buds* to 4 by 2 mm, ellipsoid. *Stipules* to 10 by 3 mm, linear obtuse. *Leaves* 7.5–19 by 2.5–7 cm, elliptic-oblong, thin; margin undulate; base broadly cuneate to subcordate; apex acute or with to 6 mm long, short, broad acuminate; nerves 12–20 pairs, slender, rather prominent beneath, tending to bifurcate near the margin, rather straight, at c. 60°–70°; secondary nerves slender, remote, subscalariform; midrib evident towards base, appanate to somewhat depressed, above, prominent and terete beneath; *petiole* 1.4–4.5 cm long, frequently somewhat swollen in the distal half and geniculate. *Panicle* to 8 cm long, axillary to ramiflorous, rarely terminal, slender, terete, glabrescent, lax; singly branched, branchlets to 4 cm long, ascending, bearing to 3 flowers; *bracteoles* fugaceous. *Flower buds* to 8 by 4 mm, lanceolate. *Sepals* glabrescent, fimbriate, deltoid, acute, the 2 inner somewhat the shorter, subacuminate. *Petals* white, tinged red at base within. *Stamens* 15; filaments slender, compressed, tapering, equal to the lorate anthers as also the slender filiform appendages. *Ovary* ovoid, glabrous; style slender filiform, c. 4 times length of ovary, obscurely trifid. *Fruit* glabrous. *Pedicel* obscure, expanding into the receptacle; 3 longer *calyx lobes* to 9 by 1.2 cm, spatulate, obtuse, c. 4 mm \varnothing above the to 10 by 7 mm ovate saccate thickened lustrous base; 2 shorter lobes to 4.5 by 0.6 cm, lorate, otherwise similar. *Nut* to 15 by 10 mm, narrowly ovoid, tapering to an up to 5 mm slender filiform style remnant.

Distr. Peninsular India, Burma, Thailand, Indochina and in *Malesia*: N.W. Malaya (Kedah, Perlis, Langkawi).

Ecol. Common, locally gregarious in *Schima*-bamboo forests and on limestone; also occurring in Semi-evergreen Dipterocarp forests (outside Malesia in teak and other deciduous forests and in semi-evergreen forests).

Vern. *Tĕmak* (Mal.).

84. *Shorea bentongensis* FOXW. Mal. For. Rec. 10 (1932) 169, pl. 12; BURK. Dict. (1935) 2007; SYM. Gard. Bull. S. S. 8 (1935) 280, pl. 24; Mal. For. Rec. 16 (1943) 33, f. 19. — *S. pahangensis* FOXW. Mal. For. Rec. 10 (1939) 193, pl. 15; BURK. Dict. (1935) 2019.

Large buttressed tree. Young twigs, leaf buds, stipules outside (glabrous within) petiole and raceme \pm persistently evenly shortly buff to pale rufous pubescent; leaf nervation beneath and midrib above sparsely puberulent or glabrescent; ovary densely caducous puberulent. *Twigs* c. 2 mm \varnothing apically, terete

to slightly compressed, becoming smooth, dark brown; stipule scars short, pale, transverse. *Buds* to 3 by 2 mm, ellipsoid, obtuse. *Stipules* to 12 by 7 mm, broadly elliptic, obtuse, caducous. *Leaves* 7–15 by 4–8 cm, broadly ovate, rarely obovate, coriaceous; margin subrevolute; base subcordate to broadly cuneate; acuminate to 1.5 cm long, prominent, slender; nerves 13–16 pairs, prominent beneath, curved, set at 50°–65°; secondary nerves scalariform, slender; midrib obscure, depressed above, terete and prominent beneath; *petiole* 8–13 mm long, short, stout. *Panicles* to 6 cm long, terminal or axillary, terete, singly branched; *bracteoles* unknown. *Mature flowers* unknown: *Sepals* narrowly deltoid, the 3 outer acute, the 2 inner prominently acuminate. *Petals* pale yellow. *Stamens* 15; filaments equal to anthers, lorate, tapering; anthers oblong-lorate; appendages very slender, c. 3 times length of anthers. *Ovary* ovoid, surmounted by an equally long puberulent cylindrical tapering stylopodium and equally long tapering style. *Fruit* glabrous. *Pedicel* to 3 by 3 mm, stout, becoming impressed. *Calyx lobes* vestigial; 3 longer lobes to 7.5 by 0.8 cm, lorate, obtuse, tapering slightly above the to 20 by 23 mm large prominently saccate thickened base; 2 shorter lobes with only to 12 by 2 mm linear projection above the similar base. *Nut* to 20 by 25 mm, subglobose, resinous, hidden in the sepals, crowned by an up to 4 mm long linear style remnant.

Distr. *Malesia*: Malaya (Selangor, Pahang, Johore).

Ecol. Local, low lying land in deep valleys.

Vern. *Mĕranti mĕngkai*, *m. sĕga*, *bok*.

85. *Shorea hypochra* HANCE, J. Bot. 14 (1876) 242; PIERRE, For. Fl. Coch. 3 (1889) t. 228; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 89; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 266; GUÉRIN, Fl. Gén. I.-C. 1 (1910) 383; CRAIB, Fl. Siam. Enum. 1 (1925) 143; FOXW. Mal. For. Rec. 10 (1932) 187; BURK. Dict. (1935) 2012; SYM. Mal. For. Rec. 16 (1943) 37, f. 19, 22. — *S. maritima* PIERRE in Lanessan, Fl. Util. Colon. Fr. (1886) 302; For. Fl. Coch. 3 (1889) t. 229; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 89. — *S. cambodiana* PIERRE, For. Fl. Coch. 3 (1889) t. 229; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 89. — *S. crassifolia* RIDL. Fl. Mal. Pen. 1 (1922) 231.

Very large tree. Young parts evenly densely pale golden pubescent, fugaceous except on stipule, panicle, sepals and parts of petals exposed in bud; leaf undersurface and petiole persistently pinkish to cream lepidote (young tree excepted). *Twig* c. 4 by 3 mm towards apex, stout, somewhat compressed, becoming smooth to slightly rugulose, terete, pale brown; stipule scars short, horizontal, obscure. *Buds* to 4 by 3 mm, broadly ovoid, acute. *Stipules* to 4 by 3 mm, ovate, obtuse, caducous. *Leaves* 7–18 by 4.5–8 cm, ovate to elliptic, thickly coriaceous; base broadly cuneate to obtuse; apex obtuse, acute or with to 1 cm long stout acuminate; nerves 15–20 pairs, slender, rather straight, at to 90° at the base, to 50° near the apex; secondary nerves slender, subreticulate; midrib ob-

scure and depressed above, prominent and terete beneath; *petiole* 2–4 cm long, terete, stout. *Panicles* to 20 cm long, terminal or axillary, somewhat compressed, singly branched; branchlets to 7 cm long, lax, bearing to 4 flowers; *bracteoles* unknown. *Flower bud* to 10 by 5 mm, lanceolate. *Sepals* lanceolate, acute, subequal, the outer 3 acute, the inner 2 acuminate. *Petals* pale yellow. *Stamens* 15; filaments slender, tapering, equal in length to the narrowly oblong anthers; appendages slender, *c.* $1\frac{1}{2}$ × length of anthers. *Ovary* ovoid, deeply trifid at apex. *Fruit pedicel* to 6 mm long, *c.* 4 mm \varnothing , stout, expanding into the base of the fruit. 3 longer *calyx lobes* to 17 by 2.6 cm, lorate, obtuse or subacute, *c.* 8 mm wide above the to 2 by 1.5 cm elliptic saccate thickened base; 2 shorter lobes to 12 by 0.9 cm, slender, otherwise similar. *Nut* to 4.5 by 2.5 cm, ovoid, glabrous, tapering to the 4 mm long tapering style remnant.

Distr. Cochinchina, Cambodia, S.E. and Peninsular Thailand, and in *Malesia*: Malaya (Selangor and Pahang northwards) and N.E. Sumatra (Riouw, Lingga).

Ecol. Locally common on flat land and undulating hills near the coast, and on inland hills in more seasonal zone, in Semi-evergreen Dipterocarp forest and Evergreen Dipterocarp forest prone to periodic drought.

Vern. *Mēranti tēmak, tēmak, t. bunga, t. nasi, t. kacha, tērbak, t. paya, m. tērbak.*

86. *Shorea symingtonii* WOOD, Gard. Bull. Sing. 17 (1960) 493; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 57, pl. 1b (phot.), f. 6.

Very large buttressed tree. Parts of petals exposed in bud densely persistently pubescent; twig apices, leaf buds and stipules ± persistently densely tawny puberulent; *petiole*, nervation beneath, *calyx* and *panicle* sparsely caducously so. *Twig c.* 4 by 2 mm, stout, ± compressed, becoming dark brown, terete. *Buds c.* 4 by 3 mm, ovoid-falcate, acute. *Stipules* to 12 by 5 mm, lanceolate, acute, fugaceous. *Leaves* (9–)10–18 by (4–)5–8 cm, oblong to narrowly obovate, coriaceous; base cordate or obtuse; apex tapering abruptly to 1 cm long acumen; nerves 18–22 pairs, prominent beneath, typically shallowly depressed above, at 45°–70° the base excepted; tertiary nerves densely scalariform, elevated beneath, evident above; midrib stout beneath, evident and ± depressed above; *petiole* 1–2 cm long, stout. *Panicle* to 17 cm long, lax, pendant, terminal or axillary; singly branched, branchlets to 11 cm long, bearing to 5 flowers. *Flower bud* to 10 by 4 mm, large, fusiform. *Sepals* lanceolate, slender, subacuminate, slightly unequal. *Stamens* 15, shorter than style; filaments rather short, broad and compressed at base, tapering; anthers narrowly oblong; appendages slender, scarious near apices, *c.* $2\frac{1}{2}$ × length of anthers; *ovary* ovoid, puberulent; style stoutly columnar, obscurely trifid at apex, sparsely puberulent in the basal $\frac{1}{2}$. *Fruit pedicel c.* 5 mm \varnothing , very stout and prominent, expanding into the receptacle. 3 longer *calyx lobes* to 18 by 2.5 cm, lorate-lanceolate, obtuse to subacute,

not tapering above the concave incrassate base; 2 shorter lobes to 13 by 1.5 cm, narrower, acute but otherwise as in longer lobes. *Nut* to 2.5 by 1 cm, narrowly ellipsoid-ovoid, prominently apiculate.

Distr. *Malesia*: Borneo (E. Sabah).

Ecol. Scattered on well drained undulating land in Mixed Dipterocarp forest below 250 m.

Vern. *Mēlapi bunga.*

87. *Shorea retinodes* SLOOT, Bull. Bot. Gard. Btzg III, 18 (1949) 243, f. 7–8.

Large buttressed tree. Young twigs, leaf buds, outside of stipules and parts of petals exposed in bud ± persistently grey-brown puberulent; *panicle*, *calyx*, leaf nervation beneath and *petiole* fugaceous so (densely pubescent in young trees). *Twig c.* 1 mm \varnothing apically, terete, slender, much branched. Leaf bud minute. *Stipules* to 8 mm long, linear, fugaceous. *Leaves* 5.5–12 by 1.8–4.8 cm, narrowly elliptic to lanceolate, thinly coriaceous, dull densely lepidote and drying coppery brown beneath; base broadly cuneate to obtuse; acumen to 1 cm long, tapering; nerves 15–18 pairs, slender but distinctly elevated beneath, evident above, ascending at 50°–65°; tertiary nerves densely scalariform, ± unraised, ± obscure; midrib slender but prominent beneath, obscurely depressed above; *petiole* 12–20 mm long, slender, geniculate. *Panicle* to 12 cm long, slender, terminal or axillary, ± doubly branched; flowers secund; *bracteoles* fugaceous. *Flower buds* to 6 by 3 mm, fusiform. *Sepals* ovate, the outer 3 subacuminate, the inner 2 prominently subcaudate. *Stamens* 15, subequal, shorter than style at anthesis; filaments slender, tapering; anthers narrowly oblong; appendages slender, distinctly scarious, *c.* 3 × length of anther. *Ovary* ovoid, glabrous; style slender, filiform, obscurely trifid. *Fruit pedicel* to 2 mm long, slender, base of fruit obtuse; 3 longer *calyx lobes* to 7.5 by 1 cm, spatulate, obtuse, tapering to *c.* 5 mm broad above the *c.* 7 by 5 mm elliptic saccate thickened base; 2 shorter lobes to 4 by 0.3 cm, linear, similar at base. *Nut* to 8 by 5 mm, ovoid, apiculate.

Distr. *Malesia*: Sumatra (Barisan Range from Toba to Musi Ulu, and down West coast; also Kuantan Distr. in east; Pulau Musala, Pulau Sitambarat).

Ecol. Scattered, rarely common, in lowland coastal and hill forests to 1000 m.

Vern. *Damar mērilem, mērilem, marilem* (Tapanuli), *d. mansarai, mansarai, bēlamsarai* (Tapanuli, Padang), *serga, s. gunong* (Panobasan), *mēranti saga, saga, damar saga, banio sapek, b. rawan, d. puteh* (W. coast).

88. *Shorea cordata* ASHTON, Gard. Bull. Sing. 22 (1967) 285, pl. 31; Man. Dipt. Brun. Suppl. (1968) 93. f. 12.

Large tree. Young twig and *petiole* densely caducous puberulent; leaf nervation beneath sparsely so, bud persistently so, stipule outside sparsely persistently so. *Twig c.* 3 by 2 mm \varnothing apically, somewhat

compressed, becoming terete, smooth to rugulose; stipule scars horizontal, broad, pale, prominent. *Bud* to 7 by 4 mm, ellipsoid, compressed, acute. *Stipule* to 12 by 6 mm, elliptic, obtuse. *Leaves* 8–15 by 5.5–10.5 cm, oblong to obovate; base typically cordate, sometimes obtuse; apex obtuse, retuse or abruptly to 8 mm long acuminate; nerves 15–18 pairs, prominent beneath, at 30°–40°; tertiary nerves slender, densely scalariform, set diagonally to nerves; midrib depressed above, prominent beneath; *petiole* 12–25 mm long, terete, frequently rugulose. *Panicle* to 12 cm long, terminal or axillary, lax, compressed or ribbed; singly branched, branchlets to 5 cm long, bearing to 5 ± secund flowers; *bracts* to 10 by 3 mm, lanceolate, acute, puberulent, fugaceous; *bracteoles* to 10 by 5 mm, elliptic, obtuse, not at first caducous. *Flower bud* to 10 by 5 mm, fusiform. *Calyx* sericeous outside, glabrous within; lobes narrowly deltoid-lanceolate, narrowly obtuse, the 3 outer somewhat longer than the 2 inner. *Petals* oblong-lanceolate, sericeous outside, glabrous within. *Stamens* 15, in 3 unequal verticils or with the outer vestigial and devoid of anthers; filaments longer than anther, narrow, compressed, tapering; anthers elliptic-oblong; appendage to connective to 6 times as long as anther, filiform, tapering somewhat shorter than style apex. *Ovary* ovoid, glabrous; style columnar, c. 2 × length of ovary, tapering, sericeous in the basal $\frac{1}{3}$, obscurely trifurcate apically. *Fruit* glabrous. *Pedicel* obscure, tapering into the base of the fruit. 3 longer calyx lobes to 13 by 2.5 cm, lorate, obtuse, c. 8 mm broad above the c. 12 by 12 mm orbicular saccate thickened base; 2 shorter lobes to 6.5 by 0.8 cm, narrowly lanceolate, acute, similar at base. *Nut* to 14 by 10 mm, globose, closely and completely enveloped by the calyx; style remnant c. 4 mm long.

Distr. *Malesia*: Borneo (West Borneo to Central Sarawak).

Ecol. Rare, fertile soils on igneous rocks.

89. *Shorea bracteolata* DYER, Fl. Br. Ind. 1 (1874) 305; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 117; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 264; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 85; BURK. J. Str. Br. R. As. Soc. 76 (1917) 164, fig.; *ibid.* 81 (1920) 73, fig.; Gard. Bull. S. S. 3 (1923) 36; RIDL. Fl. Mal. Pen. 1 (1922) 229; BAKER f. J. Bot. 62, Suppl. (1924) 10; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 260; HEYNE, Nutt. Pl. ed. 2 (1927) 1115; FOXW. Mal. For. Rec. 1 (1921) 80; *ibid.* 3 (1927) 28, 3 pl.; *ibid.* 10 (1932) 183, pl. 1 (root syst. seedling); SLOOT. in Merr. Pl. Elm. Born. (1929) 202; EDWARDS, Mal. For. Rec. 9 (1931) 141; BURK. Dict. (1935) 2007; DESCH. Mal. For. Rec. 12 (1936) 27; *ibid.* 14 (1941) 16; SYM. Mal. For. Rec. 16 (1943) 34, f. 18, 19, 21; SLOOT. Bull. Jard. Bot. Btzg III, 18 (1949) 259, f. 13; BROWNE, For. Trees Sarawak & Brunei (1955) 158; ASHTON, Man. Dipt. Brun. (1964) 163, f. 15; *ibid.* Suppl. (1968) 93; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 53, f. 1a. — *S. joveolata* SCORT. ex FOXW. Mal. For. Rec. 10 (1932) 183, *nomen in syn.*

Medium-sized to large tree. All parts at first sparsely pale brown pubescent, surfaces covered with a scurfy waxy deposit; becoming glabrous except for the pubescent bud and panicle. *Twig* to 2 mm \varnothing apically, somewhat compressed, becoming smooth, glabrous; stipule scars short, inconspicuous. *Bud* 3–5 by 2 mm, shortly falcate, compressed, subacute. *Stipule* c. 1 cm long, linear, fugaceous. *Leaf* 9–14 by 4–6 cm, oblong-ovate to elliptic, ± thinly coriaceous; base obtuse; acumen 8–15 mm long; nerves 12–15 pairs, slender, curved, at c. 60°–70°; tertiary nerves distant, scalariform to subreticulate; *petiole* 1–2 cm long, slender. *Panicle* to 10 cm long, terminal or axillary, slender, terete, straight, usually singly branched; *bracteoles* to 12 by 5 mm, lanceolate, sparsely pubescent. *Flower bud* to 10 by 5 mm, ellipsoid, obtuse. *Calyx* densely pubescent outside, sparsely so within; 3 outer lobes broadly ovate-hastate, obtuse; 2 inner lobes narrowly ovate, acuminate, slightly shorter, thinner. *Petals* pale yellow tinged pink at base within, large, oblong-lanceolate, obtuse, shortly pubescent on parts exposed in bud. *Stamens* 15, the inner 5 somewhat longer than the outer 10; filaments broad, compressed at base, tapering gradually and filiform distally; anthers narrowly oblong; appendage to connective 3–4 × length of anther, slender, scabrous. *Ovary* ovoid, sparsely pubescent towards apex; style c. 2 × length of ovary, distinctly trifid towards apex. *Fruit calyx* puberulent, ± glabrescent; 3 longer lobes to 10 by 1.7 cm, spatulate, obtuse, to 4–5 mm broad above the c. 10 by 7 mm thickened saccate base; 2 shorter lobes 5–8 by 0.7 cm, unequal and sometimes almost as long as the larger lobes, spatulate, obtuse, similar at base. *Nut* c. 2 by 1 cm, narrowly ovoid; style remnant to 4 mm long, acute, short.

Distr. *Malesia*: Malaya, Singapore, Sumatra (excluding Atjeh), Borneo.

Ecol. Coastal hills and undulating land, in valleys occasionally to 600 m; on deep well drained soils.

Vern. *Mèranti pa'ang*, *m. kètapak*, *m. ségor*, *mèluit*, *mèmbantai*, *sama rupa mèranti*, *sèpa pètoi*, *tèmak* (Mal.), *kèdontang*, *k. abang*, *mèranti kasih*, *m. kunyit*, *m. kèpala*, *manisan* (Sumatra), *lampong bahei*, *l. mit*, *l. mèrahan*, *bènyau* (S.E. Borneo).

Note. A widespread and variable species.

90. *Shorea resinosa* FOXW. Mal. For. Rec. 10 (1932) 234, pl. 19; BURK. Dict. (1935) 2021; SYM. Mal. For. Rec. 16 (1943) 40, f. 19, 24; ASHTON, Man. Dipt. Brun. Suppl. (1968) 94, f. 12.

Large tree. Young twigs, buds, stipules outside and petioles shortly buff fugaceous puberulent. *Twig* c. 2 mm \varnothing apically, terete, smooth; stipule scars short, horizontal, obscure. *Bud* to 3 by 2 mm, ellipsoid, obtuse. *Stipule* to 12 by 8 mm, elliptic obtuse. *Leaves* 6.5–13 by 3.5–7 cm, lanceolate to elliptic, undulate; base narrowly to broadly cuneate; acumen to 12 mm long, slender; nerves 10–13 pairs, slender but prominent beneath, at 40°–50°; tertiary nerves slender, scalariform, at c. 90° to the nerves; midrib depressed above, prominent beneath; *petiole* 9–17 mm long,

drying rugose. *Panicle* to 8 cm long, terminal or axillary, terete, caducous puberulent, singly branched. Flower bud to 12 by 4 mm, fusiform. *Calyx* glabrous; 3 outer lobes narrowly lanceolate, acute; 2 inner somewhat shorter, broader. *Petals* pale yellow, lorate, obtuse, puberulent on parts exposed in bud. *Stamens* 15, in 2 unequal verticils; filaments compressed at base, tapering; anthers narrowly oblong; appendage to connective *c.* $2\frac{1}{2}$ × length of anthers, filiform, slender, glabrous. *Ovary* ovoid, glabrous, surmounted by a long slender glabrous style *c.* 3 × length of ovary; style trifid towards apex. *Fruit* glabrous. *Pedicele* to 4 mm long, *c.* 3 mm \emptyset , terminating abruptly at the obtuse base of the fruit. 3 longer *calyx lobes* to 9.5 by 2.5 cm, spatulate, obtuse, *c.* 7 mm broad above the to 14 by 14 mm subglobose saccate thickened base; 2 shorter lobes to 7 by 0.6 cm, linear, similar at base. *Nut* to 1.5 by 1.5 cm, ovoid; style remnant to 6 mm long, persistent, frequently lustrous with a film of resin.

Distr. *Malesia*: Malaya, Central Sumatra (Indragiri, sterile coll.), Borneo (W. Sarawak).

Ecol. Scattered on undulating land or hills to 500 m.

Vern. *Mĕranti bĕlang, lemesa, sama rupa mĕranti* (Mal.).

91. *Shorea agamii* ASHTON, Gard. Bull. Sing. 19 (1962) 270, pl. 9. — *S. assamica ssp. philippinensis* (non SYM.) BROWNE, For. Trees Sarawak & Brunei (1955) 151.

a. ssp. agamii ASHTON, Man. Dipt. Brun. (1964) 161, f. 15, pl. 41 (stem-base, bark); *ibid.* Suppl. (1968) 93; Gard. Bull. Sing. 22 (1967) 285; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 51, f. 4.

Large tree. Young twig, panicle, bud, stipule, petiole and midrib beneath caducous pale brown pubescent. *Twig* 2–3 mm \emptyset at the apex, becoming smooth, terete; stipule scars short, inconspicuous. *Bud* *c.* 4 by 2.5 mm, ovoid to falcate, slightly pubescent or glabrous, obtuse. *Stipule* *c.* 10 by 3 mm, oblong, obtuse, shortly caducous pubescent outside, glabrous within. *Leaves* 10–15 by 6–10 cm, broadly ovate to oblong, coriaceous; base obtuse or subcordate; acumen 0.5–1 cm long, broad; nerves 9–13 pairs, well spaced, curved, at *c.* 90° at the leaf base, *c.* 40° at the apex; tertiary nerves densely scalariform, at 90° to nerves; *petiole* 1–1.5 cm long. *Panicle* 6–10 cm long, terminal or axillary, terete to angular apically; singly or doubly irregularly branched, branchlets short, bearing to 5 flowers; *bracts* fugaceous; *bracteoles* to 3 mm long, narrowly elliptic, subacute, shortly pale buff-tawny puberulent, caducous. *Flower bud* to 5 by 2.5 mm, small, narrowly ellipsoid, subacute. *Calyx* densely shortly pale yellowish buff pubescent; 3 outer lobes narrowly ovate, subacuminate; 2 inner lobes $\frac{1}{2}$ as long, narrow, prominently caudate. *Petals* small, ovate-elliptic, acute, densely pubescent on parts exposed in bud, puberulent elsewhere on outer surface. *Stamens* 15 in 3 subequal verticils; filaments \pm

same length as anthers, rather narrow, tapering; anthers oblong, somewhat tapering; appendage to connective *c.* 3 times length of anther, slender, extending to style apex. *Ovary* ovoid, densely pubescent; style slightly longer than the ovary, sparsely pubescent in the basal half, glabrous distally, stoutly filiform, tapering, obscurely trifurcate. *Fruit calyx* shortly fugaceous pubescent; 3 longer lobes 10–12 by 1.5–2.2 cm, spatulate, obtuse, tapering to 5 mm broad above the 1–1.5 cm broad strongly saccate thickened base; 2 shorter lobes to 6 by 0.4 cm, linear, unequal, similar at base. *Nut* to 2 by 1.5 cm, ovoid, glabrescent; style remnant 3–4 mm long, acute; base of fruit impressed at the short pedicel.

Distr. *Malesia*: Borneo (Bintulu north-eastwards to Sabah and Tidung).

Ecol. Leached soils on undulating land and shale hills below 700 m.

Vern. *Mĕranti puteh timbul* (Brun.), *mĕlapi agama* (Sabah).

b. ssp. diminuta ASHTON, Gard. Bull. Sing. 22 (1967) 285, pl. 30; Man. Dipt. Brun. Suppl. (1968) 93.

Leaf 4.5–10 by 2.5–4 cm, narrowly ovate.

Distr. *Malesia*: Borneo (W. Sarawak, Kapuas and Rejang hinterlands, Muara Tewe).

Ecol. As *ssp. agamii*.

92. *Shorea confusa* ASHTON, Gard. Bull. Sing. 31 (1978) 44. — *S. virescens* (non PARUS) ASHTON, Man. Dipt. Brun. (1964) 167; *ibid.* Suppl. (1968) 95; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 60, f. 6.

Large tree. Leaf bud, panicle, stipule outside, petiole, and very young twig caducous pubescent. *Twig* 2–3.5 mm \emptyset apically, frequently rugulose; stipule scar short, obscure. *Bud* 3–4 by 2 mm, conical, acute. *Stipule* *c.* 8 by 3 mm, linear to deltoid, subacute. *Leaves* 6–12 by 3.5–3 cm, elliptic to slightly obovate; base obtuse; acumen broad, 0.5–1.0 cm long; nerves (10–)13–18 pairs, curved, at 90° at the base, *c.* 40° at the apex; tertiary nerves densely scalariform, at 90° to nerves; *petiole* 1–1.5 cm long, *c.* 1 mm \emptyset , rather slender. *Panicle* to 22 cm long, terminal or axillary, terete, lax; singly or doubly branched, branchlets to 10 cm long, bearing to 6 flowers; bracts and bracteoles unknown. *Flower bud* to 9 by 5 mm, narrowly ovoid, obtuse. *Calyx* puberulent outside, glabrous within; lobes equal, narrowly deltoid, obtuse. *Petals* large, narrowly ovate, acute, puberulent on parts exposed in bud. *Stamens* 15, in 3 subequal verticils; filaments *c.* $1\frac{1}{2}$ × length of anther, slender, tapering gradually; anthers oblong, tapering; appendage to connective *c.* 3 × length of anther, reaching $\frac{2}{3}$ length of style. *Ovary* small, ovoid, puberulent; style stoutly filiform, *c.* 3 × length of ovary, glabrous in the apical $\frac{1}{3}$, otherwise puberulent, shallowly trifurcate. *Fruit pedicel* stout. *Calyx* glabrous; 3 longer lobes to 12 by 1.5 cm, narrowly spatulate, obtuse, hardly tapering, slightly broadening at the thickened saccate base; 2 shorter lobes to 6 by 0.5 cm, unequal, linear, similar at base; base of calyx obconical, tapering into the pedicel. *Nut*

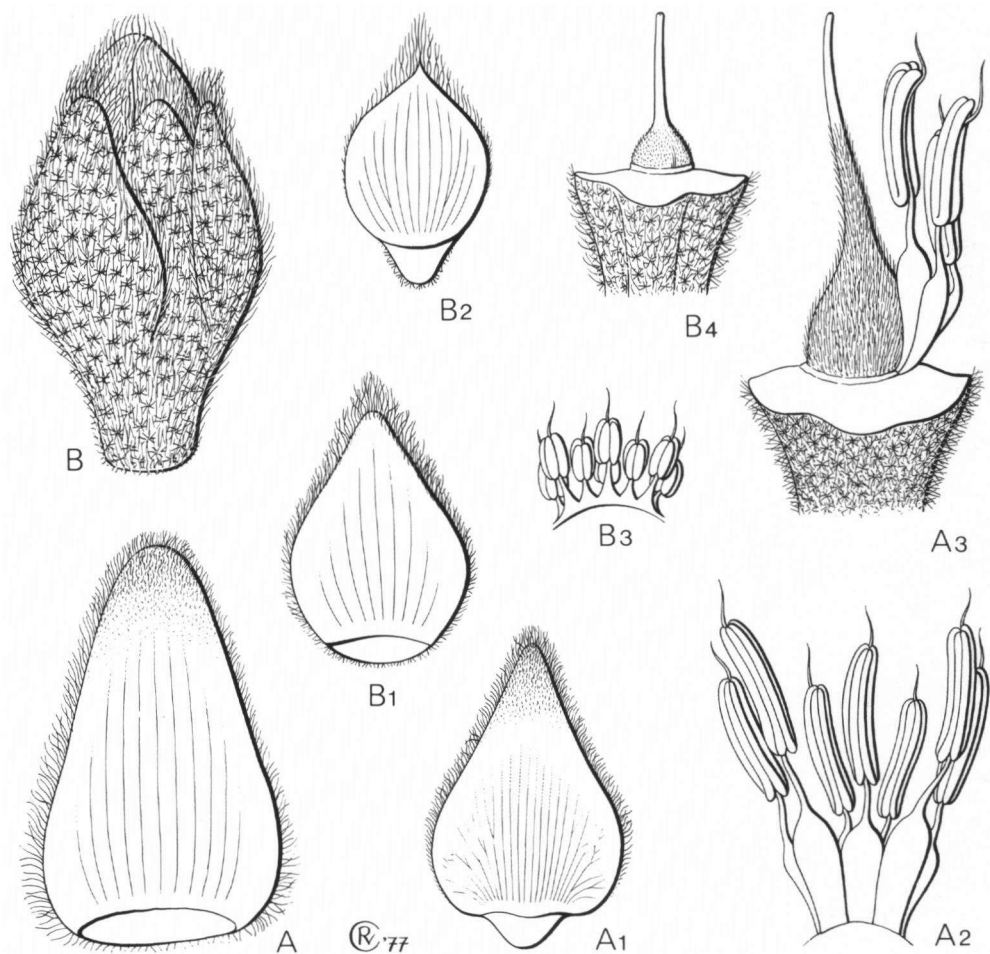


Fig. 94. Flower details in *Shorea* sect. *Rubella* ASHTON. All $\times 10$. Sepals drawn from inside. — *S. albida* SYM. A. Outer sepal, A1. inner sepal, A2. stamens from inside, A3. stamens and pistil. — *S. elliptica* BURCK. B. Bud, B1. outer sepal, B2. inner sepal, B3. stamens from inside, B4. pistil (A TAHIR 12250, B ROSLI & ASAH 3373).

to 2 cm long, ovoid, glabrescent; style remnant c. 6 mm long, slender.

Distr. *Malesia*: N.E. Borneo (N.E. Sarawak, Sabah S.E. to Sangkulirang).

Ecol. Scattered, undulating land and hills below 650 m, on leached clay soils in Mixed Dipterocarp forest.

Vern. *Meranti sulang saling*.

6. Section *Rubella*

ASHTON, Gard. Bull. Sing. 20 (1963) 267; Man. Dipt. Brun. (1964) 117. — Fig. 94, 95.

Flower buds medium size, fusiform. *Petals* generally cream suffused with pink, lanceolate, contorted and imbricate at base forming a goblet enclosing the

anthers, connate on falling. *Stamens* 15–50; filaments lorate, long, tapering gradually or abruptly below the anthers; anthers with 4 glabrous linear-oblong pollen sacs; appendage to connective short or to $\frac{3}{4}$ length of the pollen sacs, becoming \pm reflexed at anthesis, glabrous. *Ovary* with or without distinct stylopodium. *Leaf* white lepidote beneath, with scalariform tertiary nerves; midrib above evident or obscure (*S. albida*). Large stoutly buttressed trees. *Bark surface* prominently V-section fissured. *Wood* red, without silica deposits; vessels solitary or in small clusters.

Distr. *Malesia*: Philippines, northern Borneo.

Ecol. Lowland evergreen forests, scattered or gregarious (*S. negrosensis*, *S. albida*).

Note. The androecium and gynoecium characters in most respects resemble those of *sect. Anthoshorea*. WHITMORE (Gard. Bull. Sing. 19, 1962, 2) has shown that the bark anatomy of *S. albida* also in most respects conforms with that section. The wood anatomy conforms by contrast entirely with SYMINGTON's (Mal. For. Rec. 16, 1943, 58) and DESCH's (*ibid.* 14, 1941, 34) Red Meranti Group.

93. *Shorea albida* SYM. [ex THOMAS, Mal. For. 3 (1934) 147, *nomen*] Gard. Bull. S. S. 8 (1935) 283, pl. 26; BROWNE, For. Trees Sarawak & Brunei (1955) 137; ANDERSON, Gard. Bull. Sing. 20 (1963) 158; ASHTON, Man. Dipt. Brun. (1964) 175, f. 19, pl. 42 (stem), 43 (stand), 44 (stand in swamp); *ibid.* Suppl. (1968) 104; BRÜNING, Commonw. For. Rev. 52 (1973) 260. — Fig. 8, 94 A–A3, 96, 97.

Small, medium-sized or vast buttressed tree. Twig, leaf bud, stipule, petiole and leaf nervation beneath shortly densely persistently red-brown puberulent; leaf beneath cream lepidote. *Twig* to 5 by 2 mm \varnothing apically, compressed, becoming smooth; stipule scars short, straight, thin. *Bud* to 10 by 6 mm, ovoid to hastate, compressed, acute. *Stipules* to 20 by 8 mm, oblong, obtuse. *Leaves* 7.5–15 by 4.5–6.5 cm, oblong-elliptic, coriaceous; base obtuse; acumen to 6 mm long, broad; nerves 16–20 pairs, slender, hardly raised beneath, at 55°–70°, with shorter intermediates; tertiary nerves slender, densely scalariform, diagonal to nerves; midrib prominent beneath, obscure and depressed above; *petiole* 2–3.5 cm long. *Panicle* to 18 cm long, terminal or axillary, compressed, shortly densely cream puberulent; doubly branched, branchlets bearing to 3 flowers; *bracteoles* to 8 by 3 mm, lanceolate, acute, densely pubescent outside, glabrous within. *Bud* to 9 by 5 mm, broadly ellipsoid, acute. *Calyx* densely puberulent outside, glabrous within; 3 outer lobes deltoid, obtuse; 2 inner shorter, deltoid, acuminate. *Petals* cream, ovate, obtuse, pubescent on parts exposed in bud. *Stamens* 20–25, of variable length, the inner 5 somewhat longer than the others; filament broad at base, tapering and filiform distally; anther narrowly oblong, longer than the filament; appendage to connective short, slender, erect, less than $\frac{1}{2}$ length of anther. *Ovary* ovoid, shortly pubescent; style twice length of ovary, densely pubescent in basal half. *Fruit calyx* persistently sparsely pubescent at base, glabrescent elsewhere; 3 longer lobes to 8 by 1.4 cm, narrowly spatulate, obtuse, to 4 mm broad above the to 7 by 7 mm suborbicular thickened saccate base. *Nut* to 12 by 9 mm, ovoid, densely greyish buff pubescent; style remnant to 2 mm long.

Distr. *Malesia*: N.W. Borneo (Kapas swamps through Sarawak to the Limbang Valley).

Ecol. Local on podsols on terraces and plateaux in Heath forest to 1200 m. Gregarious and dominant on oligotrophic peat swamps except at the margin and sometimes centre.

The peat swamp forests where *S. albida* occurs can be classified into a succession of concentric 'phasic' communities according to the performance of this and other dominant species (ANDERSON, 1963): 1. A mixed species forest at the periphery lacking *S. albida*. 2. With *S. albida* dominant and sometimes reaching 6.5 m tall, but forming an incomplete heterogeneous canopy and rarely successfully regenerating. 3. With *S. albida* forming a complete even canopy, regenerating patchily and becoming smaller towards the centre. 4. With *Litsea palustris* a dominant or codominant, forming an even canopy but not exceeding 40 m tall. Here regeneration is abundant though largely through coppicing.

S. albida does not occur in the innermost communities. Lightning and wind damage form conspicuous gaps in the even canopy of phasic community (BRÜNING, 1973), but mortality over much greater areas, in large sharply defined patches totalling thousands of hectares in all, is attributed to an unidentified moth larva, belonging to the Himantidae (*cf.* Imp. For. Rev. 40, 1961, 19).

Uses. The largest trees, towards the margins of the swamps, are all hollow and are very hard wooded; those towards the centre are too small and the wood is soft; trees in the intermediate zone are an important source of red meranti timber.

Vern. *Alan* (Sar.), *séringawan* (Brun.).

Note. The vegetative parts are strikingly similar to those of *S. balangeran* in *sect. Brachypteræ*, which shows an apparently identical ecological range and replaces it in Indonesian Borneo. The stamens at once distinguish these species, but the presence of abnormal stamens of the *S. balangeran* type in the flowers examined by SYMINGTON suggests that the affinity is genuine. The obscure midrib above and slender nerves distinguish *S. albida* from other species in this section

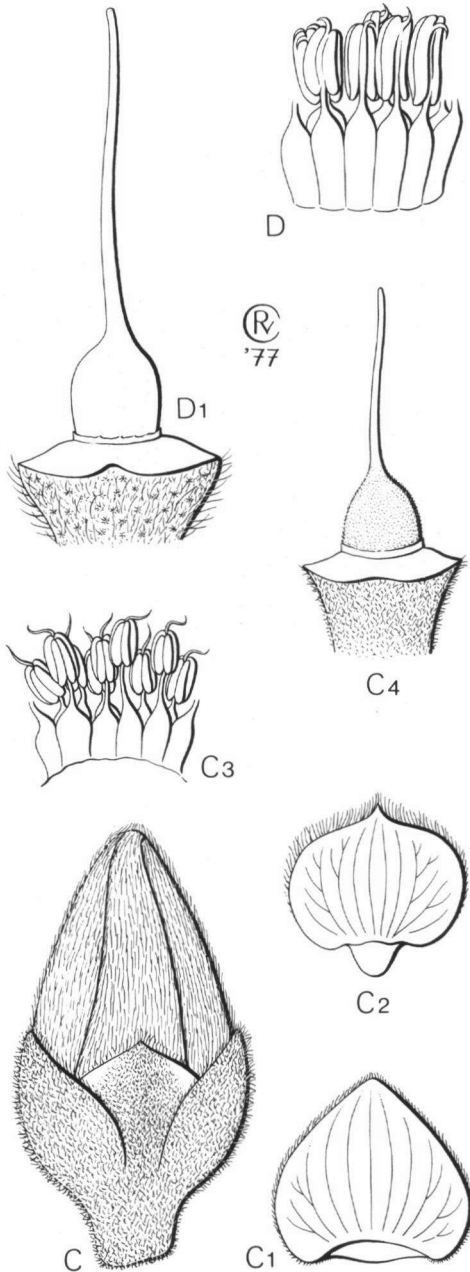


Fig. 95. Flower details in *Shorea* sect. *Rubella* ASHTON. All $\times 10$. Sepals drawn from inside. — *S. dispar* ASHTON. C. Bud, C1. outer sepal, C2. inner sepal, C3. stamens from inside, C4. pistil. — *S. rubella* ASHTON. D. Stamens, from outside, D1. pistil (C S 29208, D BRUN 3078).

and evoke *S. coriacea* and its allies in sect. *Brachypterae*, as well as sect. *Anthoshorea* generally.

94. *Shorea rubella* ASHTON, Gard. Bull. Sing. 19 (1962) 307, pl. 27; Man. Dipt. Brun. (1964) 216, f. 19, pl. 57 (habit & bark); *ibid.* Suppl. (1968) 118; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 143. — Fig. 1, 95 D–D1.

Medium-sized to large tree. Young parts evenly shortly pale cream to pink-buff pubescent, persistent only on panicle, bud and stipule. *Twig* 2–3 mm \varnothing at apices, ridged and compressed apically on drying, becoming terete, smooth, stout; stipule scars c. 1.5 mm long at first, \pm horizontal, narrowly cuneate. *Bud* 6–9 by 2–3 mm, narrowly ovoid or slightly falcate. *Stipule* to 18 by 6 mm, hastate to falcate, acute. *Leaves* 9.5–14 by 6–8 cm, broadly ovate, thickly coriaceous, cream lepidote beneath; base obtuse; acumen to 1 cm long; margin sometimes slightly revolute; nerves 5–7 pairs, prominent beneath, curved, well spaced, at c. 45°–60°, with or without minute axillary domatia; tertiary nerves at c. 90°, slender, densely scalariform; midrib appanate on upper surface or slightly depressed. *Petiole* 2.3–3.5 cm long. *Panicles* to 15 cm long, terminal or axillary, ribbed on drying; singly or doubly branched, branchlets to 5 cm long, lax, bearing to 5 distichous flowers; *bracts* and *bracteoles* unknown. *Flower bud* to 7 by 3 mm, narrowly ovoid, acute. *Calyx* shortly densely pale pink-grey pubescent outside, glabrous within; lobes ovate, subequal, the inner 2 slightly broader and shorter than the outer 3. *Petals* pale pink, darkening towards base, oblong, obtuse, only slightly contorted, hardly adhering on falling, shortly pubescent on parts exposed in bud. *Stamens* 15, closely congested round the ovary and style, subequal; filaments reaching the ovary apex, lorate, abruptly tapering apically; anther as long as filament, narrowly oblong; appendage to connective short, stout, becoming slightly recurved. *Ovary* small, globose, glabrous; stylopodium indistinct; style 3 times as long as ovary, glabrous, filiform. *Fruit calyx* subglabrous; 3 longer lobes to 8 by 1.5 cm, spatulate, obtuse, with to 10 by 7 mm ovate saccate thickened base; 2 shorter lobes to 5 by 0.6 cm, linear, similar at base. *Nut* to 18 by 12 mm, ovoid, densely buff pubescent, acute.

Distr. Malesia: Borneo (Rejang valley to S.W. Sabah).

Ecol. Local on deep yellow sandy soils on coastal hills below 400 m.

95. *Shorea elliptica* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 215; BRANDIS J. Linn. Soc. Bot. 31 (1895) 99; MERR. En. Born. (1921) 404; BROWNE, For. Trees Sarawak & Brunei (1955) 138; ASHTON, Man. Dipt. Brun. Suppl. (1968) 151, f. 13, pl. 20 (bark). — Fig. 94 B–B4.

Medium-sized tree. *Twig*, bud, stipule outside, nerves and midrib beneath densely scabrid ochereous to cream pubescent; midrib above evenly so; nerves above and stipule within sparsely evenly so; leaf



Fig. 96. *Shorea albida* SYM., alan-forest, centre of peat swamp. Brunei (Photogr. ASHTON).

undersurface densely cream lepidote. *Twig* c. 2 mm \varnothing apically, much branched, terete to subcompressed, smooth or rugulose; stipule scars short, horizontal. *Bud* to 8 by 6 mm, ovoid, obtuse, compressed. *Stipule* to 10 by 6 mm, narrowly ovate, acute, caducous. *Leaves* 7–10 by 4–9 cm, elliptic to oblong, thickly coriaceous; base broadly cuneate to subcordate; apex obtuse or shortly broadly acuminate; nerves 11–16 pairs, prominent beneath, at 75° at base, 45° – 55° towards the apex; tertiary nerves slender, densely scalariform, at c. 90° to the midrib; midrib shallowly depressed above, prominent beneath; *petiole* 1.5–3.3 cm long, terete, rugose distally. *Panicle* to 12 cm long, terminal or axillary, \pm compressed at first, becoming terete, densely persistently ocherous scabrid pubescent; singly or doubly branched, branchlets to 2 cm long, bearing to 3 \pm distichous flowers; *bracteoles* to 2

by 1 mm, small, elliptic, obtuse, pubescent, caducous. *Flower bud* to 4 by 3 mm, narrowly ovoid. *Sepals* pubescent on parts exposed in bud, ovate, acute, the inner 2 relatively shorter, narrower than the outer 3. *Petals* pale yellow, pubescent on parts exposed in bud, narrowly oblong. *Stamens* 19–20; filaments compressed, slender, somewhat tapering; anthers oblong, almost as long as filaments, crowned by a short relatively stout glabrous appendage somewhat shorter than the anthers. *Ovary* ovoid, glabrous; style filiform, c. 2 times as long as ovary, trifid at apex, glabrous. *Fruit pedicel* to 3 mm long, swelling into the base of the fruit. *Calyx* sparsely shortly pubescent; 3 longer lobes to 8 by 1.5 cm, narrowly spatulate to sublobate, obtuse, c. 4 mm broad above the to 10 by 6 mm elliptic saccate \pm thickened base. *Nut* to 15 by 12 mm, ovoid, acute, densely evenly buff pubescent.

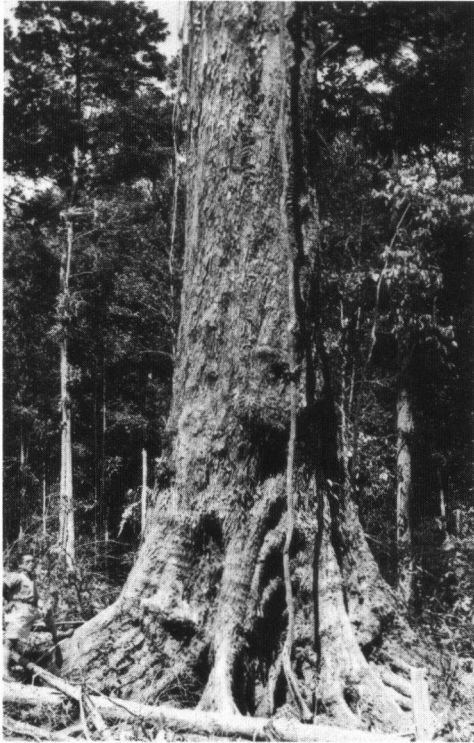


Fig. 97. Trunk of *Shorea albida* SYM. Brunei (Photogr ASHTON).

Distr. *Malesia*: Borneo (N.W. Kalimantan, W. Sarawak).

Ecol. Local, leached soils in Mixed Dipterocarp forest below 500 m.

Vern. *Méranli lang* (Sar.).

96. *Shorea dispar* ASHTON, Gard. Bull. Sing. 31 (1978) 45. — Fig. 95 C–C4.

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

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

Distr. *Malesia*: Borneo (Central Sarawak; once collected).

Ecol. Mixed Dipterocarp forest on inland hills.

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

97. *Shorea negrosensis* FOXW. Philip. J. Sc. 6 (1911) Bot. 274, pl. 44; *ibid.* 13 (1918) Bot. 192; *ibid.* 67 (1938) 315; MERR. En. Philip. 3 (1923) 97; REYES, Philip. J. Sc. 22 (1923) 327.

Large buttressed tree. Twigs, buds, stipules, midrib above, panicles, parts of petals exposed in bud and ovary densely persistently yellow-brown pubescent; petiole, leaf beneath and calyx sparsely so; bracteoles puberulent. *Twig* c. 2 mm \varnothing apically, terete, becoming smooth; stipule scars short, obscure. *Buds* to 2 by 1 mm, conical; stipules to 15 by 4 mm, lanceolate, acute. *Leaves* 6.5–17 by 3–7.5 cm, ovate to elliptic, thinly coriaceous; base cuneate to obtuse, frequently unequal; acumen to 2 cm long, slender, prominent, tapering; nerves (8–)11–15 pairs, slender but prominent beneath, arched, at 60°–70°, frequently with small tomentose axillary domatia; tertiary nerves scalariform, elevated beneath; midrib prominent beneath, evident but shallowly depressed above; *petiole* 18–25 mm long, slender but geniculate. *Panicle* to 14 cm long, slender; singly branched, branchlets to 15 mm long, rather short, bearing to 4 second flowers; *bracteoles* to 4 by 3 mm, ovate, obtuse, caducous. *Flower bud* to 7 by 4 mm, broadly ellipsoid; *sepals* ovate, the outer 3 acute, the inner 2 acuminate; *stamens* c. 48, subequal, exceeding style at anthesis; filaments very long and slender, lorate, slightly tapering; anthers linear-oblong; appendages to $\frac{1}{8}$ length of anther but usually much shorter, slender, glabrous; *ovary* ovoid, puberulent; style shorter than ovary, columnar, glabrous. Mature fruit unknown. *Fruit* subsessile; 3 longer *calyx lobes* c. 7 by 1.3 cm, spatulate, obtuse, c. 9 mm broad above the 10 by 10 mm suborbicular thickened saccate base; 2 shorter lobes to 30 by 4 mm, linear-lorate, acute, similar at base; *nut* ovoid, apiculate.

Distr. *Malesia*: Philippines.

Ecol. Widespread, common and often gregarious, in Evergreen and Semi-evergreen \pm seasonal Dipterocarp forests in lowlands.

Vern. *Red lauan*, *mangachapuy*.

Note. Some sterile collections, apparently of this species, bear significantly smaller leaves; flowering material is needed to establish their identity.

7. Section *Brachypterae*

HEIM, Rech. Dipt. (1892) 46; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 76, *p.p.*; ASHTON, Gard. Bull. Sing. 20 (1963) 270; Man. Dipt. Brun. (1964) 117. — *Shorea*, *Red Meranti* group, *S. pauciflora* subgroup SYM. Mal. For. Rec. 16 (1943) 58. — Fig. 91 D, 98–100.

Flower buds + ovoid. Corolla as in *sect. Rubella*. Filament broad and compressed at base, tapering ± abruptly medially and filiform below anthers; anthers 4-celled, subglobose or broadly oblong; appendage to connective aristate, $1\frac{1}{2}$ – $3\frac{1}{2}$ times length of anthers. Ovary with distinct stylopodium: ovary and stylopodium ± pyriform; or without distinct stylopodium but with style frequently pubescent towards base. Panicle lax, branchlets long. Stipules and bracteoles sometimes somewhat persistent. Leaf with scalariform tertiary nerves; midrib evident, elevated, or obscurely depressed above. Vessels solitary or in small groups; ray cells without silica. Medium-sized or large stoutly prominently buttressed trees.

Distr. Non-seasonal western *Malesia* including the Philippines; one species in the Moluccas.

Ecol. Scattered in lowland forests and on mountain ridges (*S. venulosa*, *S. monticola*) to 1800 m; a few species (*S. balangeran*, *S. selanica*) are gregarious, even forming pure stands.

Vern. *Red mēranti*, *mēranti merah* (Mal., Sum.), *mērawan* (Iban), *red lauau* (Philippines).

Note. The floral morphology is closely similar to the pattern of *sect. Anthoshorea*, making assignment difficult without anatomical investigation. With the notable exception of *S. parvistipulata* and the clearly closely related short-sepalled *S. fallax*, species in this section are well defined; though several, e.g., *S. pauciflora*, *S. johorensis*, *S. almon*, and *S. kunstleri* do exhibit some local variation.

7a. Subsection *Smithiana*

ASHTON, Gard. Bull. Sing. 20 (1963) 270; Man. Dipt. Brun. (1964) 118. — Fig. 98.

Stamens 22–26. Style very short, ovary with prominent columnar stylopodium. Bark surface with deep V-section fissures, inflaked, as in *sect. Mutica* but with sheet-like rhytidome layers as in *sect. subsect. Brachypterae* and other flaky-barked groups.

98. *Shorea smithiana* SYM. Gard. Bull. S. S. 9 (1938) 345, pl. 26; ASHTON, Man. Dipt. Brun. (1964) 223, f. 17; *ibid.* Suppl. (1968) 119; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 148, pl. 10 (habit), f. 16. — *Shorea* sp. (ELMER 21606) SLOOT. *ex* MERR. Pl. Elm. Born. (1929) 205. — Fig. 98.

Large buttressed tree. Young twig, leaf bud, stipule outside (puberulent within), petiole, leaf beneath, midrib above and panicle persistently grey-brown to rust scabrid tomentose, leaf above caducous puberulent. Twig 3–4 mm ø apically, stout, ribbed, smooth, glabrous; stipule scars to 2 mm long at first, broad, falcate, descending. Bud 5–8 by 3–4.5 mm, ovoid, slightly compressed. Stipule to 20 by 6 mm, broadly hastate, subacute. Leaves 12–20 by 6.5–11.5 cm, broadly obovate to oblong or ovate, grey lepidote beneath, coriaceous; base obtuse or subcordate; acumen to 1.5 cm long, broad; nerves 14–17 pairs, prominent beneath, curved, at 50°–60° distally, more spreading at base; tertiary nerves scalariform, well

spaced, sinuate; midrib prominent, stout, rounded, beneath, rather narrow and slightly depressed above; petiole 2.2–2.8 cm long, stout. Panicle to 25 cm long, terminal or axillary, terete, regularly singly branched, the branchlets bearing to 7 secund flowers; bracteoles to 5 by 4 mm, ovate, subacute, shortly pubescent on both surfaces, falling before the corolla opens. Flower bud to 10 by 3 mm, narrowly ovoid, subacute. Calyx densely pubescent outside, glabrescent within; lobes broadly deltoid to ovate, acute, subequal, the 2 inner the narrower. Petals pink, narrowly oblong, short, densely yellowish brown pubescent on parts exposed in bud. Stamens 22–26, of 3 sizes; filaments basally expanded, abruptly tapering and filiform distally; anthers broadly oblong; appendage to connective almost twice as long as anthers, reaching to $\frac{3}{4}$ length of ovary and style, not reflexed. Ovary and stylopodium narrowly pyriform, puberulent; style cylindrical, glabrous. Fruit calyx glabrescent; 3 longer lobes to 20 by 2.8 cm, narrowly spatulate, coriaceous, narrowly

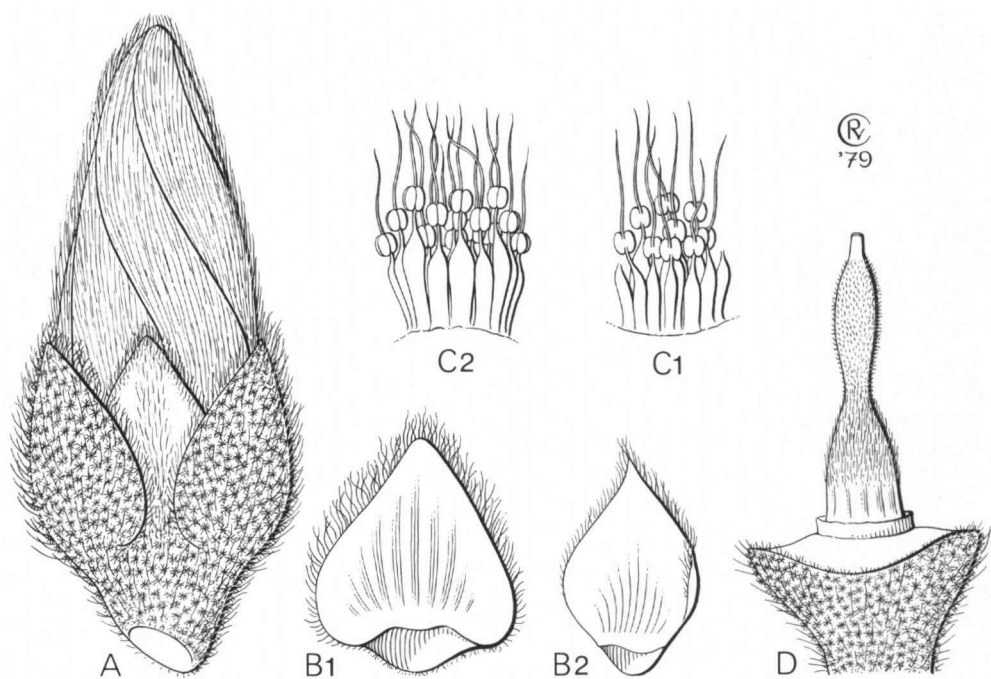


Fig. 98. Flower details in *Shorea* sect. *Brachypterae* HEIM subsect. *Smithiana* ASHTON. — *S. smithiana* SYM. A. Bud, B1. outer sepal, B2. inner sepal, C1. stamens from outside, C2. stamens from inside, D. pistil, all $\times 10$ (bb. 34816).

obtuse, c. 1.3 cm broad and often slightly revolute above the to 1.5 by 1.8 cm broadly ovate shallowly saccate thickened base; 2 shorter lobes to 13 by 0.9 cm, linear, similarly expanded at base. *Nut* to 2.7 by 1.8 cm, ovoid; style remnant to 3.5 mm long, tapering, densely evenly shortly pale cream-buff pubescent.

Distr. *Malesia*: Eastern Borneo (N.E. Sarawak, Sabah, S.E. Borneo to Sampit).

Ecol. Frequent on deep sandy clay soils on undulating land and to 400 m.

Uses. One of the chief sources of light red meranti timber in N.E. Borneo.

Vern. *Chempaga* (Nunukan), *lempong mérémbong*, *l. tembaga*, *awang* (Kutei), *mahambung* (Sampit), *sēraya timbau* (Sabah), *mēranti rambai*, *mēraka belong* (Brunei), *ēngkabang* (*mangkabang*), *rambai* (Iban), *bérat* (Murut).

7b. Subsection *Brachypterae*

ASHTON, Gard. Bull. Sing. 20 (1963) 271. — *Shorea* sect. *Pachyclamys* DYER ex KING, J. As. Soc. Beng. Sc. 62, 2 (1893) 109. — *Pachyclamys* (DYER ex KING) DYER ex RIDL. Fl. Mal. Pen. 1 (1922) 233. — Fig. 91D, 99–100.

Stamens 15. Style generally as long as or longer than ovary. Bark surface square-section fissured, generally appearing flaky rather than fissured; phloem matrix proliferation tissue with pale stone cells in conspicuous simple laminae; phelloderm thin, inconspicuous.

99. *Shorea inaequalateralis* SYM. Gard. Bull. S. S. 8 (1935) 281, pl. 25; BROWNE, For. Trees Sarawak & Brunei (1955) 153; ANDERSON, Gard. Bull. Sing. 20 (1963) 158; ASHTON, Man. Dipt. Brun. (1964) 191, f. 17; *ibid.* Suppl. (1968) 109. — ‘*Semayor*’ DURANT, Rep. For. Brunei (1933) 37, 42.

Large, buttressed, fissure-barked tree with pendent branches. Young parts shortly densely evenly pale tanny tomentose, persistent on young twig, panicle, leaf bud, outside of stipule, petiole and midrib above; persistently puberulent, appearing glabrous, on inside of stipule, lamina on both surfaces, and midrib beneath. *Twig* c. 2.5 by 1.5 mm \varnothing apically, slightly compressed at first, becoming terete with a decurrent rib below the petiole insertion each side, becoming glabrous, smooth; stipule scars to 1.5 mm long, narrowly falcate, descending, obscured by tomentum. *Bud* 3–6 by 1.5–2.5 mm, ovoid, slightly compressed, acute. *Stipule* to 20 by 5 mm, subsistent, narrowly hastate, acute. *Leaves* 9–14 by 4.5–7.5 cm, ovate, thin; base subcordate, distinctly unequal; acumens to 2 cm long, prominent, caudate; nerves 11–13 pairs, slender, raised beneath, at more than 90° at base, ascending towards apex; tertiary nerves slender, scalariform, well spaced, at c. 90° to nerves; midrib narrow, prominent, rounded beneath, evident but applanate above; *petiole* 5–8 mm long, short, stout. *Panicle* to 7 cm long, terminal or axillary, terete, pendent; singly branched, branchlets to 1.5 cm long, bearing to 4 flowers; *bracteoles* to 10 by 3 mm, narrowly deltoid, pubescent outside, glabrescent within. *Flower bud* to 12 by 3 mm, linear, acute. *Calyx* densely shortly pubescent on both surfaces; 3 outer lobes deltoid, subacute; 2 inner lobes shorter, prominently acuminate. *Petals* narrowly hastate, subacute, sparsely pubescent on parts exposed in bud. *Stamens* 15, in 3 subequal verticils; filaments broad, compressed at base, tapering abruptly medially and filiform distally; anther oblong; appendage to connective c. 3 times length of anther, reaching $\frac{1}{2}$ length of style, slender, erect, scabrous towards apex. *Ovary* ovoid, tapering, sparsely pubescent, without distinct stylopodium; style about twice length of ovary, filiform, sparsely pubescent in the basal half, otherwise glabrous. *Fruit calyx* glabrescent but for the sparsely tawny pubescent base; 3 longer lobes to 14 by 2 mm, elliptic saccate thickened base; 2 shorter lobes to 12 by 0.9 cm, long, narrowly spatulate, acute, to 4 mm broad above the to 13 by 9 cm, unequal, narrowly spatulate, similar at base. *Nut* to 1.8 by 1.4 cm, ovoid, densely buff pubescent; style remnant to 6 mm long, slender, subsistent, filiform.

Distr. *Malesia*: N.W. Borneo (Sarawak, Brunei).

Ecol. Locally abundant in Mixed Peat Swamp forest.

Uses. A valuable heavy construction timber.

Vern. *Semayur* (Brun.).

Note. An isolated species apparently related to the following.

100. *Shorea selanica* BL. Mus. Bot. Lugd.-Bat. 2

(1852) 33, *incl. var. latifolia* BL.; WALP. Ann. 4 (1857) 338; DC. Prod. 16, 2 (1868) 629; HANCE, J. Bot. 14 (1876) 242; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 216, *incl. var. obtusa* BURCK; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 86; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 266; MERR. Int. Rumph. (1917) 375; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 306; *ibid.* ed. 2 (1927) 1124; SLOOT. Reinwardtia 2 (1952) 50, f. 16, 17. — *Dammara selanica* RUMPH. [Herb. Amb. 2 (1743) 168, t. 56] *ex* LAMK, Encycl. 2 (1786) 259, *inval.* — *Unona selanica* DC. Prod. 1 (1824) 92. — *Engelhardtia selanica* BL. Fl. Jav. 1 (1828) 8. — *Hopea selanica* W. & A. Prod. (1834) 85; HASSK. Cat. Hort. Bog. (1844) 209; WALP. Rep. 5 (1845) 128; MIQ. Fl. Ind. Bat. 1, 2 (1959) 504; DC. Prod. 16, 2 (1868) 635.

Vast buttressed tree. Young parts, twigs, buds, stipules, leaf undersurface, petiole, panicle, ovary and parts of petals exposed in bud densely persistently pale cream-brown pubescent; densely so at first on calyx, becoming sparsely so; young trees sparsely darker pubescent. *Twigs* 2–3 mm \varnothing apically, ribbed and sometimes compressed at first, becoming terete, smooth; stipule scars short, pale, horizontal. *Bud* c. 2 by 1 mm, ovoid, obtuse; *stipules* to 10 by 4 mm, lanceolate, acute, \pm fugaceous. *Leaves* (7–)9–18 by 3–7 cm (larger in immature trees), oblong-ovate, thinly coriaceous, cream below (mature trees); base obtuse to subcordate, \pm unequal, apex shortly acuminate; nerves 19–23 pairs, slender but prominent beneath, \pm applanate above, at c. 65°; tertiary nerves densely scalariform, hardly elevated beneath; midrib prominent beneath obscurely depressed above; *petiole* 8–12 mm long, slender. *Panicles* to 15 cm long, slender, somewhat lax, terminal or axillary; singly branched, branchlets to 3 cm long, bearing to 7 flowers. *Flower buds* to 6 by 3 mm, fusiform; *sepals* broadly ovate, the outer 3 acute, the inner 2 acuminate; *stamens* 15, unequal; filaments broadly compressed at base, tapering medially and filiform beneath the broadly ellipsoid anthers; appendages very slender, scarious near the apices, twice length of anthers; *ovary* ovoid, puberulent; style filiform, slender, twice length of ovary, glabrous. *Fruit pedicel* c. 1 mm long, slender; 3 longer *calyx lobes* to 10 by 1.5 cm, narrowly spatulate, obtuse, c. 5 mm wide above the 7 to 8 mm ovate saccate thickened base; 2 shorter lobes to 4.5 by 0.6 cm, linear, similar at base. *Nut* to 15 by 8 mm, ovoid, apiculate.

Distr. *Malesia*: Moluccas (Buru, Sula Is.: Mangole, Sanana; Obi Is.; Ambon).

Ecol. Gregarious and dominant in the Moluccan semi-evergreen lowland forests on well drained land with fertile soils, sometime overlying limestone.

Uses. The most valuable construction timber of the Moluccas.

Vern. *Kayo bapa* (Buru, Ambon, Sanana, Mangole), *sehu*, *boba* (Samuja), *luma*, *bahut*, *biahgawa* (Buru).

Note. Two sterile collections (bb. 22808, 31349 from Buru) differ in their larger leaves drying distinct purplish beneath, with relatively longer petioles (*cf.* VAN SLOOTEN, *l.c.* 60: *Shorea* ? *spec. nov.*).

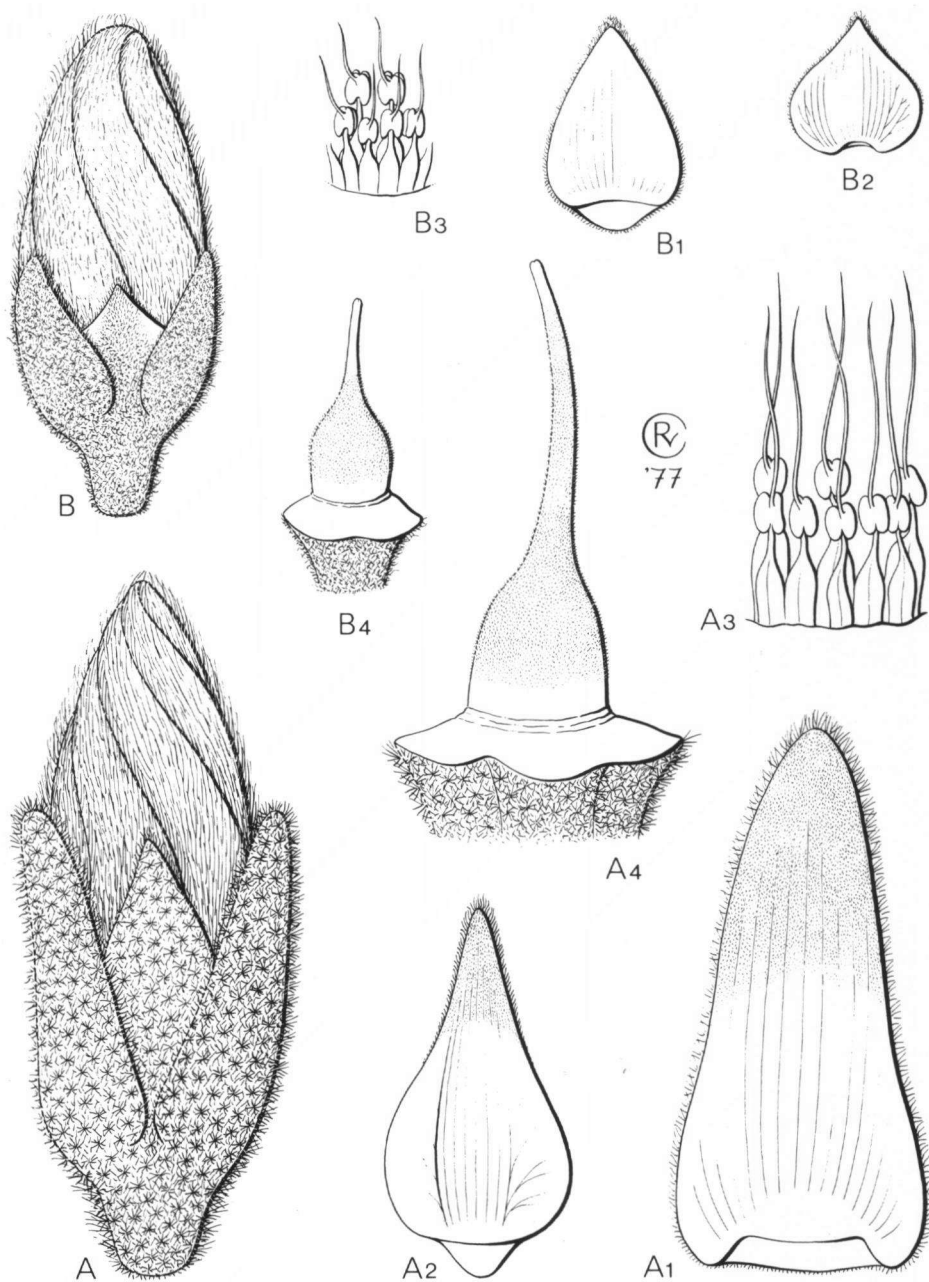


Fig. 99. Flower details in *Shorea* sect. *Brachypterae* HEIM subsect. *Brachypterae*. All $\times 10$. Sepals drawn from inside. — *S. scaberrima* BURCK. A. Bud, A1. outer sepal, A2. inner sepal, A3. stamens from outside, A4. pistil. — *S. venulosa* WOOD ex MEIJER. B. Bud, B1. outer sepal, B2. inner sepal, B3. stamens from outside, B4. pistil (A Cult. Hort. Bog. VIII-D-54, B SAIDI 9486).

The only red meranti east of Wallace's line, this striking species enigmatically shares its characteristic leaf shape, as well as its pendent inflorescence, flower structure and very hard durable wood with that equally distinctive denizen of the N.W. Borneo peat swamps *S. inaequilateralis*. If only their evolution could be traced!

101. *Shorea flemmichii* SYM. Gard. Bull. S. S. 10 (1939) 378, pl. 26; BROWNE, For. Trees Sarawak & Brunei (1955) 147; ASHTON, Man. Dipt. Brun. (1964) 190, f. 17, pl. 48 (bark); *ibid.* Suppl. (1968) 108.

Large tree with dark deeply fissured flaky bark and stout buttresses. Young twig, panicle, leaf bud, stipule outside (glabrescent within), petiole, midrib beneath and at base above and nervation beneath densely persistently scabrid golden-tawny tufted tomentose; leaf above scabrid puberulent. *Twig* stout though tapering to 2 mm \varnothing apically, much branched, terete, verruculose; stipule scars short, horizontal, obscured by the tomentum. *Bud* 3–6 by 2–4 mm, ovoid, slightly compressed, subacute. *Stipule* to 8 by 2.5 mm, narrowly hastate, acute, fugaceous. *Leaves* 5–9 by 3–4.5 cm, broadly elliptic or ovate (young trees), cream lepidote beneath; base obtuse; acumen to 5 mm long, narrow; margin revolute; nerves 14–17 pairs, dense, prominent beneath, at 45°–65°; tertiary nerves scalariform, sinuate, diagonal to nerves; midrib narrow and slightly depressed above, prominent beneath; *petiole* 7–9 mm long, short. *Panicle* to 8 cm long, terminal or axillary, terete or slightly compressed; singly or doubly irregularly branched, branchlets to 5 cm long, lax, rather zig-zag, bearing to 8 distichous flowers; *bracteoles* to 6 by 5 mm, suborbicular, obtuse, shortly puberulent outside, glabrous within. *Flower bud* to 4.5 by 3.5 mm, subglobose, obtuse. *Calyx* densely tawny pubescent outside, glabrous within; 3 outer lobes somewhat longer, narrowly ovate, subacute; 2 inner lobes narrowly deltoid, subacute. *Corolla* dark wine-red, strongly contorted, apically recurved, the imbricate bases forming a deep cup; petals oblong-lanceolate, obtuse, twisted, densely tomentose on parts exposed in bud. *Stamens* 15, the 5 inner slightly longer than the others; filaments broad at base, tapering abruptly and filiform distally; anthers subglobose; appendage to connective c. 3 times as long as anther, reaching almost to style apex. *Ovary* and *stylopodium* ovoid-conical, puberulent towards the apex, tapering; style glabrous, filiform, as long as ovary. *Fruit* subsessile. *Calyx* puberulent; 3 longer lobes to 6.5 by 1.5 cm, spatulate, narrowly obtuse, to 2.5 mm broad above the to 7 by 6 mm ovate-elliptic shallowly saccate slightly thickened base; 2 shorter lobes to 20 by 1.5 mm, linear, similar at base. *Nut* subacute, ovoid, to 1.5 by 1 cm, shortly densely pale buff pubescent.

Distr. *Malesia*: N.W. Borneo (Sarawak & Brunei).

Ecol. Very local, deep yellow sandy soils in Mixed Dipterocarp forest below 400 m, on present or Pleistocene coastal hills.

Vern. *Mèranti raya* (Brun.).

102. *Shorea almon* FOXW. Philip. J. Sc. 67 (1938) 313, pl. 7; BROWNE, For. Trees Sarawak & Brunei (1955) 150; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 93, f. 1; ASHTON, Man. Dipt. Brun. Suppl. (1968) 104, f. 13. — *S. furfuracea* (non MIQ.) ROLFE, J. Bot. 23 (1885) 110; VIDAL, Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 98; FOXW. Philip. J. Sc. 4 (1909) Bot. 517; WHITFORD, Philip. J. Sc. 4 (1910) Bot. 712; Bull. Bur. For. Philip. 10 (1911) 63. — *S. eximia* (non (MIQ.) SCHEFF.) FOXW. Philip. J. Sc. 6 (1911) Bot. 276; *ibid.* 13 (1918) Bot. 191; MERR. En. Philip. 3 (1923) 96; REYES, Philip. J. Sc. 22 (1923) 331. — Fig. 7.

Large buttressed tree. Twig, bud, stipule outside, petiole and leaf nervation beneath densely persistently pink-brown scabrid tomentose; stipule inside and nervation above sparsely, midrib above densely evenly so. *Twig* c. 2 mm \varnothing apically, terete, smooth; stipule scars short, horizontal, obscure. *Bud* to 4 by 3 mm, ovate, compressed, acute. *Stipule* to 10 by 5 mm, lanceolate, acute, caducous. *Leaves* 9–16 by 3.5–7 cm, chartaceous, undulate, the lower surface markedly concave; base broadly cuneate to obtuse; acumen to 8 mm long, short, broad; nerves 17–20 pairs, slender but prominent beneath, at 40°–60° (to 100° at the base); tertiary nerves densely scalariform, at 90° to midrib, appanate above, prominent beneath; *petiole* 10–18 mm long, slender. *Panicle* 20 cm long, terminal or axillary, terete, slender, ascending, lax, densely shortly unevenly persistently pale pink-brown pubescent; singly branched, branchlets to 2.5 cm long, bearing to 10 distichous flowers; *bracteoles* to 5 by 3 mm, elliptic, obtuse, yellow-brown puberulent, persistent until the formation of young fruit. *Flower bud* to 7 by 3 mm, lanceolate, small. *Sepals* pubescent on parts exposed in bud; 3 outer deltoid, acute, 2 inner ovate, acuminate, smaller. *Petals* lanceolate, hirsute on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, abruptly tapering medially and filiform below the subglobose anthers; appendage to connective slender, glabrous, c. 3 \times length of anther. *Ovary* ovoid, pubescent; style filiform, to $1\frac{1}{2}$ \times length of ovary, pubescent in the basal $\frac{1}{3}$. *Fruit pedicel* to 3 mm long, prominent. *Calyx* pale yellow-brown pubescent at base, glabrescent distally; 3 longer lobes to 14 by 2.5 cm, broadly spatulate, obtuse, c. 8 mm broad above the to 13 by 12 mm ovate thickened saccate base; 2 shorter lobes to 8 by 1 cm, lorate, obtuse, similar at base. *Nut* to 2 by 1.5 cm, ovoid, very shortly mucronate at the otherwise obtuse apex, shortly evenly pale buff pubescent.

Distr. *Malesia*: N.E. Borneo (N.E. Sarawak, rare; E. Sabah, Tidung), Philippines (non-seasonal areas).

Ecol. Undulating hills in Mixed Dipterocarp forest, clay soil.

Vern. *Séraya kèrukup* (Sabah), *almon* (Philippines).

Note. Particularly variable in Mindanao, where the leaves are very small, and the tomentum more sparse and scabrid in some trees.

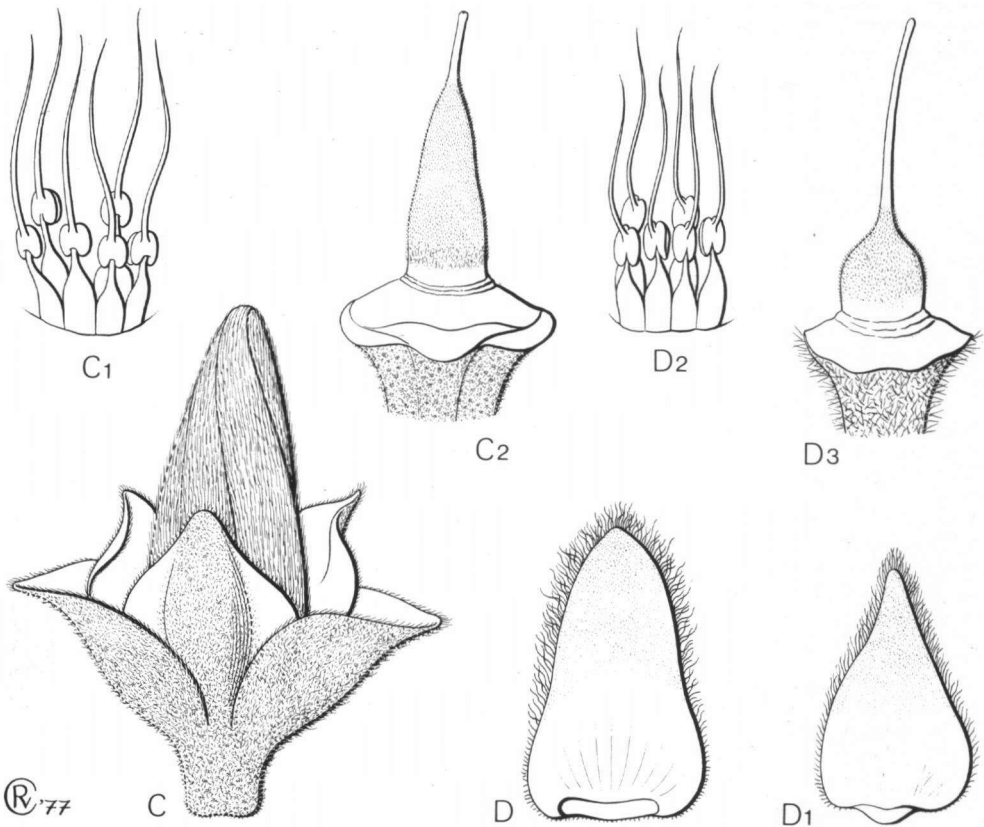


Fig. 100. Flower details in *Shorea* sect. *Brachypterae* HEIM subsect. *Brachypterae*. All $\times 10$. Sepals drawn from inside. — *S. flaviflora* WOOD ex ASHTON. C. Bud, C1. stamens from inside, C2. pistil. — *S. johorensis* FOXW. D. Outer sepal, D1. inner sepal, D2. stamens from outside, D3. pistil (C ASHTON 5664, D SAN 31246).

103. *Shorea parvistipulata* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 974; ASHTON, Gard. Bull. Sing. 31 (1978) 46.

KEY TO THE SUBSPECIES

1. Leaf not lepidote beneath.
 2. Nerves 13–21 pairs. Longer fruit calyx lobes to 20 cm long a. *ssp. parvistipulata*
 2. Nerves at most 15 pairs. Longer fruit calyx lobes to 9 cm long b. *ssp. nebulosa*
1. Leaf silvery lepidote beneath. Nerves 13–21 pairs c. *ssp. albifolia*

a. *ssp. parvistipulata*. — BRANDIS, J. Linn. Soc. Bot. 31 (1895) 95; MERR. En. Born. (1921) 406 ('*parvistipula*'); MEIJER & WOOD, Sabah For. Rec. 5 (1964) 132; ASHTON, Man. Dipt. Brun. Suppl. (1968) 114, f.

14. — *S. squamata* (non BENTH. & HOOK. f.) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 92; MERR. En. Born. (1921) 407, p. p. *quoad sp. Born.* — *S. dyeri* (non THW. ex TRIM.) HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 957. — *S. cristata* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 97; MERR. En. Born. (1921) 404; ASHTON, Man. Dipt. Brun. (1964) 106, f. 17; *ibid.* Suppl. (1968) 106; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 102.

Very large thinly scaly-barked buttressed tree. Leaf bud, stipule outside, twig, petiole and leaf nervation beneath shortly persistently pale yellow to grey-brown scabrid tomentose, stipule inside and midrib above evenly, not scabridly, so. Twig c. 2 mm \varnothing , terete, slender, becoming smooth; stipule scars short, pale, prominent, horizontal or descending. Bud to 6 by 4 mm, ovoid, acute. Stipule to 14 by 7 mm, ovate, subacute. Leaves 6–20 by 3–9 cm, very variable in size and shape, \pm oblong, chartaceous; base typically

cordate, sometimes broadly cuneate or obtuse; acumen to 1 cm long; nerves 13–21 pairs, usually slender, at 50°–80° except at the base, without secondary nerves; tertiary nerves slender, densely scalariform; midrib evident but appanate to depressed above, prominent beneath; *petiole* 12–15 mm long, short, terete. *Panicle* to 16 cm long, terminal or axillary, terete, lax, straight, ascending, densely shortly persistently pale brown scabrid pubescent; singly branched, branchlets to 4 cm long, bearing to 11 distichous flowers; *bracteoles* to 5 by 3 mm, deltoid, acute, puberulent, not at first caducous. *Flower bud* to 7 by 3 mm, lanceolate. *Sepals* pubescent on parts exposed in bud; 3 outer narrowly deltoid, acute, 2 inner ovate, narrowly acuminate, shorter and thinner at margins than outer 3. *Petals* cream suffused with pink at base, lanceolate, pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments broad and compressed at base, tapering abruptly and filiform beneath the anthers; appendage to connective slender, glabrous, about twice length of anthers. *Ovary* ovoid, densely pubescent; style filiform, about as long as ovary, glabrous but for a pubescent ring at base. *Fruit pedicel* to 2 mm long, to 3 mm \varnothing . *Calyx* puberulent towards base, glabrescent distally; 3 longer lobes to 20 by 2.5 cm, lorate-spatulate, obtuse, c. 11 mm broad above the to 14 by 18 mm broadly ovate saccate thickened base; 2 shorter lobes to 8 by 0.4 cm, linear, similar at base. *Nut* to 2.5 by 2 cm, ovoid, frequently crowned by a persistent filiform style remnant, densely evenly buff pubescent.

Distr. *Malesia*: Borneo (excepting S.W.).

Ecol. Widespread on clay-rich soils on alluvium and especially hillsides and low ridges to 1300 m.

Vern. *Seraya lapa* (Sabah), *engkabang pinang*, *e. p. bëršisek* (Sarawak), *kawang pinang* (Brunei), *tengerawan kuning* (Nunukan), *kènuar kepas* (S.E. Borneo).

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

b. *spp. nebulosa* (MEIJER) ASHTON, Gard. Bull. Sing. 31 (1978) 46. — *S. nebulosa* MEIJER, Act. Bot. Neerl. 12 (1963) 337; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 123.

Leaves at most 13 by 6 cm, with at most 15 pairs of nerves. *Fruit calyx lobes* at most 9 by 1.8 cm.

Distr. *Malesia*: N.E. Borneo (Crocker Range and Mt Kinabalu region).

Ecol. Hill forests between 800–1300 m.

c. *spp. albifolia* ASHTON, Gard. Bull. Sing. 31 (1978) 46.

Differing in the silvery pink lamina undersurface.

Distr. *Malesia*: Borneo: N.E. Sarawak (Niah), Brunei and S.E. Sabah southwards to Balikpapan.

Ecol. Fertile soils on undulating land and periodically inundated alluvium.

Note. A collection of this subspecies from E.

Kalimantan with short fruit sepals emphasises the doubtful distinctness of *S. fallax* from this species.

104. *Shorea balangeran* (KORTH.) BURCK, Ann. Jard. Bot. Btzig 6 (1887) 214; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 297; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 86; BOERL. Cat. Hort. Bog. 2 (1901) 108, *incl. var. angustifolia* BOERL.; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 297; *ibid.* ed. 2 (1927) 1115; MERR. En. Born. (1921) 404; SLOOT. Bull. Bot. Gard. Btzig III, 18 (1949) 256, f. 12. — *Hopea balangeran* KORTH. Kruidd. (1841) 74, t. 7 f. 1–14; BL. Mus. Bot. Lugd.-Bat. 2 (1852) 34; WALP. Rep. 5 (1845) 128; Ann. 4 (1857) 339; MIQ. Fl. Ind. Bat. 1, 2 (1859) 503; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 84, 85; DC. Prod. 16, 2 (1868) 634; HEYNE, Nutt. Pl. ed. 2 (1927) 1115. — *Parahopea balangeran* HEIM, Rech. Dipt. (1892) 66. — *Parashorea balangeran* MERR. En. Born. (1921) 404 — Fig. 91 D–D4.

Large buttressed tree. Twig, leaf bud, stipule, petiole, midrib and nerves beneath, panicle and calyx outside shortly densely persistently red-brown puberulent; leaves beneath cream lepidote; nut apex sparsely puberulent. *Twigs* c. 2 mm \varnothing apically, slender, terete, smooth. *Buds* 5 by 3 mm, ovoid, acute; *stipule* to 7 by 4 mm, ovate, acute. *Leaves* 7–18 by 3–8 cm, oblong-elliptic to lanceolate, coriaceous, conspicuously cream beneath; base broadly cuneate to obtuse; acumen to 1.5 cm long, slender, tapering; nerves 13–18 pairs, slender, barely elevated beneath, evident above, at 45°–55°; tertiary nerves densely scalariform, obscure; midrib slender but prominent beneath, obscurely depressed above; *petioles* 2–3 cm long, slender. *Panicle* to 8 cm long, slender, terminal or axillary; doubly branched, branchlets to 3 cm long, with to 7 second flowers. *Flower buds* to 6 by 3 mm, fusiform; 3 outer *sepals* narrowly lanceolate, subacute; 2 inner short, ovoid, prominently acuminate. *Stamens* 15, shorter than style at anthesis; filaments compressed at base, gradually tapering and filiform below the broadly ovoid anthers; appendages very slender, glabrous, twice length of anthers; *ovary* ovoid, puberulent; style columnar, c. $1\frac{1}{2}$ \times length of ovary, puberulent towards base, not trifid. *Fruit pedicel* short, slender. 3 longer *calyx lobes* to 50 by 7 mm, spatulate, obtuse, c. 2 mm broad above the to 4 by 3 mm ovate saccate thickened base; 2 shorter lobes to 15 by 2 mm, linear, similar at base. *Nut* to 6 by 4 mm, ovoid, apiculate.

Distr. *Malesia*: Borneo (throughout Indonesian part), Sumatra (Banka, Billiton).

Ecol. Common, often gregarious, in peat swamp forests.

Vern. *Balangeran*, *kawi*, *kahoi*, *tomi*, *kelansauw* (Borneo), *malangsir* (Banka).

Uses. A major timber produced in the swamps of Indonesian Borneo.

Note. In many ways resembling *S. albida* (q.v.).

105. *Shorea coriacea* BURCK, Ann. Jard. Bot. Btzig 6 (1887) 214; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 100;

MERR. En. Born. (1921) 404; BROWNE, For. Trees Sarawak & Brunei (1955) 146; ASHTON, Man. Dipt. Brun. (1964) 182, f. 17; *ibid.* Suppl. (1968) 106; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 102.

Large buttressed tree with dark brown, fissured, flaky bark. Young parts densely clothed in minute adpressed pale grey hairs, caducous on all but panicle, stipule outside and bud. *Twig* 2–3 mm \varnothing at apex, stout, terete or slightly compressed, smooth or rugulose; stipule scars at first c. 1 mm wide, c. 1.5 mm long, cuneate, pale brown, horizontal or slightly descending. *Bud* to 6 by 3 mm, ovoid. *Stipule* to 20 by 5 mm, narrowly oblong, acute. *Leaves* 10–15 by 5–8 cm, ovate, coriaceous, lustrous; base obtuse, subpeltate; acumen c. 1 cm long; margin revolute; nerves 16–20 pairs, slender, hardly raised beneath, at 60°–70°, curved towards margin; tertiary nerves slender, densely scalariform; midrib prominent beneath, obscure and slightly depressed above; *petiole* 2.5–4 cm long, geniculate, glabrous. *Panicle* to 14 cm long, terminal or axillary, \pm terete; singly (doubly if terminal) branched, branchlets regular, short, bearing to 10 secund flowers; *bracteoles* to 4 by 2.5 mm, ovate, subacute, sparsely pubescent outside, glabrescent within. *Flower bud* to 6 by 1.2 mm, narrowly lanceolate, acute. *Calyx* densely pale grey pubescent outside, glabrous within; 3 outer lobes narrowly deltoid, subacute, slightly revolute; 2 inner lobes smaller, acute, not revolute. *Petals* pink, linear, densely pubescent on parts exposed in bud. *Stamens* 15, of 2 lengths, the inner 5 an anther's length longer; anther subglobose; appendage to connective 2–3 times as long as anther, slender, not reflexed, reaching almost to style apex. *Ovary* ovoid, densely shortly pubescent except at the base; style filiform, as long as ovary, glabrous but for the setose base; stylopodium indistinct. *Fruit calyx* shortly sparsely pubescent or glabrescent except towards base; 3 longer lobes to 9 by 1.5 cm, spatulate; chartaceous, narrowly obtuse, 3–4 mm broad above the c. 8 by 5 mm deltoid thickened saccate base; 2 shorter lobes to 3.5 cm long, subequal, linear, similar at base. *Nut* c. 18 by 9 mm, ovoid, shortly grey pubescent distally; style remnant c. 3 mm long, slender, acute.

Distr. *Malesia*: Borneo (Lower Kapuas, Sarawak, Brunei, S.W. Sabah, Sandakan Distr., W. Kutei, and Muara Teweh).

Ecol. Heath forest on podsols, terraces and plateaus to 1000 m: on ultrabasics in E. Borneo.

Vern. *Samar benua*, *mēranti jurai* (W. Borneo), *lampong mēngkabang* (S.E. Borneo), *mēranti tangkai panjang* (Sarawak), *sēraya t.p.* (Sabah).

106. *Shorea venulosa* WOOD ex MEIJER, Act. Bot. Neerl. 12 (1963) 342, p. 10; Sabah For. Rec. 5 (1964) 153; ASHTON, Man. Dipt. Brun. (1964) 226, f. 17; *ibid.* Suppl. (1968) 122. — Fig. 99 B–B4.

Large buttressed tree with dark brown, fissured, flaky bark. Young parts at first densely dotted with minute adpressed hair tufts, fugaceous on all but stipule outside and leaf bud; stipule persistently

shortly pubescent within. *Twig* c. 1 mm \varnothing apically, slender, much branched, terete, rugulose or smooth, glabrous; stipule scars narrow, slightly paler at first, almost or completely amplexicaul, \pm ascending. *Bud* to 7 by 2 mm, fulvous pale grey, lanceolate, compressed, acute. *Stipule* to 20 by 3.5 mm, hastate, acute, fugaceous. *Leaves* 6–10 by 3–5 cm (rarely much smaller in exposed places), ovate, coriaceous; base obtuse; acumen to 6 mm long; margin sometimes slightly revolute; nerves 15–18 pairs, slender, hardly or not elevated beneath, dense, at 35°–40°, curved towards the margin, sometimes with prominent axillary pore-like domatia; tertiary nerves very slender, densely scalariform, diagonal to nerves; midrib raised beneath, obscure and depressed above; *petiole* 1.7–3 cm long, slender, geniculate. *Panicle* to 11 cm long, terminal or axillary, slender, lax, \pm terete, shortly densely persistently cream to pale grey pubescent; singly or doubly branched, the branchlets short, bearing to 10 secund flowers; *bracteoles* to 3.5 by 2 mm, ovate, obtuse, sparsely pubescent outside, glabrous within. *Bud* to 5 by 2.5 mm, narrowly ovoid, subacute. *Calyx* densely pale grey pubescent outside, glabrous within; 3 outer lobes narrowly deltoid, subacute, slightly revolute; 2 inner lobes smaller, acute, not revolute. *Petals* pink, oblong-lanceolate, pubescent on parts exposed in bud. *Stamens* 15, the inner 5 slightly longer than the others; filaments broad at base, rather abruptly tapering and filiform distally; anther oblong; appendage to connective over twice as long as anther, reaching almost to style apex. *Ovary* narrowly ovoid, shortly pubescent, longer pubescent towards apex; stylopodium indistinct; style filiform, somewhat shorter than ovary, glabrous but for shortly pubescent base. *Fruit calyx* sparsely puberulent, more densely so at base; 3 longer lobes to 6 by 1.3 cm, chartaceous, spatulate, narrowly obtuse, c. 3.5 mm broad above the c. 7 by 5 mm deltoid saccate thickened base; shorter lobes to 3 by 0.3 cm, subequal, linear, similar at base. *Nut* c. 20 by 8 mm, narrowly ovoid, shortly pubescent towards the apex, otherwise glabrous; style remnant acute.

Distr. *Malesia*: Northern Borneo (Sarawak, Brunei, Sabah).

Ecol. On podsols in Heath forest, on terraces, plateaus and ridges to 1600 m; locally common; on ultrabasics in E. Sabah.

Vern. *Mēranti tangkai panjang padi* (Brunei), *sēraya kērangas* (Sabah).

Note. Closely resembling *S. coriacea*, within whose range it is confined, and occupying similar habitats. No record yet exists though of intermediate forms.

107. *Shorea waltoni* WOOD ex MEIJER, Act. Bot. Neerl. 12 (1963) 344, pl. 11; Sabah For. Rec. 5 (1964) 155.

Tall buttressed tree with deeply fissured bark. Twigs, leaf buds, stipules, petioles, nervation beneath and panicle \pm densely cream lepidote; calyx at first densely so, becoming sparse, \pm caducous in fruit; midrib above and sometimes nerves, ovary and parts of petals exposed in bud densely persistently cream-

brown pubescent. *Twigs* c. 3 mm \varnothing apically, stout, terete, becoming smooth, dark brown; stipule scars \pm amplexicaul, slender. *Buds* small, conical; *stipules* to 20 by 8 mm, elliptic-lanceolate, acute. *Leaves* 10–25 by 5.5–12 cm, oblong to ovate or obovate, coriaceous, cream lepidote beneath; base obtuse or shallowly cordate; apex abruptly to 1 cm long acuminate; nerves 18–22 pairs, slender but prominent beneath, drying dark, \pm appanate above; tertiary nerves scalariform, elevated beneath; midrib prominent beneath, obscure and depressed above, *petiole* 2.5–4.5 cm long, stout. *Panicle* to 12 cm long, rather stout, terminal or axillary; singly or doubly branched, branchlets to 5 cm long; *bracts* to 10 mm long, amplexicaul. *Flower bud* to 8 by 3 mm, fusiform; *sepals* ovate, the outer 3 longer, acute, the inner 2 broader, acuminate. *Stamens* 15, unequal; filaments broadly compressed at base, abruptly tapering and filiform distally; anthers broadly oblong; appendages slender, scarious apically, c. 2 \times length of anthers. *Ovary* broadly ovoid; style equal in length to ovary, rather short, puberulent in the basal $\frac{1}{2}$. *Fruit pedicel* c. 3 mm long, stout; 3 longer *calyx lobes* to 14 by 2.3 cm, spatulate, obtuse, coriaceous, c. 11 mm wide above the c. 8 by 15 mm transversely elliptic saccate thickened base; 2 shorter lobes to 10 by 0.8 cm, lorate, spatulate, narrowly obtuse. *Nut* to 25 by 18 mm, ovoid, apiculate.

Distr. *Malesia*: N. E. Borneo (Sandakan Distr.).

Ecol. Scattered on well or moderately drained land in lowlands.

Vern. *Sĕraya kĕlabu*.

108. *Shorea pachyphylla* RIDL. [DURANT, Rep. For. Brunei (1933) 41, *nomen*] ex SYM. J. Mal. Br. R. As. Soc. 19 (1941) 163, pl. 7; BROWNE, For. Trees Sarawak & Brunei (1955) 148; ANDERSON, Gard. Bull. Sing. 20 (1963) 159; ASHTON, Man. Dipt. Brun. (1964) 205, f. 17, pl. 54 (habit, bark); *ibid.* Suppl. (1968) 112. — Fig. 101.

Large buttressed tree with pale flaky and prominently fissured bark. Young parts very shortly densely evenly tawny pubescent, caducous on all but leaf bud, panicle and stipule (puberulent on inner surface). *Twig* c. 4 mm \varnothing , stout, terete, slightly ridged and compressed apically, becoming smooth or rugulose; stipule scars c. 0.5 mm broad, horizontal, normally amplexicaul. *Bud* 5–8 by 2–4 mm, compressed or terete, narrowly ovoid to broadly falcate. *Stipule* to 20 by 7 mm, lanceolate, acute, fugaceous. *Leaves* 10–20 by 9–16 cm, broadly ovate to suborbicular, thickly coriaceous; base obtuse or broadly cuneate; apex obtuse or with short, to 5 mm long, acumen; margin slightly but distinctly revolute; nerves 7–9 pairs, well spaced, prominent beneath, arched at margin, at c. 40°–55°; midrib appanate and broad above, terete and prominent beneath; tertiary nerves slender, densely scalariform, at 90° to midrib; *petiole* 4–6 cm long, stout. *Panicle* to 11 cm long, terminal or axillary, compressed, ridged when dry; doubly branched, the branchlets bearing to 5 distichous flowers; *bracteoles* to 3 by 2 mm, ovate, acute, shortly pubescent. *Flower*

bud to 6 by 4 mm, narrowly ovoid, acute. *Calyx* densely pubescent outside; lobes ovate, deltoid, acuminate, the 3 outer somewhat longer, more obtuse, than the 2 inner lobes. *Petals* broadly lanceolate, obtuse, hardly contorted, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 lengths, the inner 5 an anther's length longer than the outer 5; filaments broad at base, tapering and stoutly filiform distally; anthers subglobose; appendage to connective 3–4 \times length of anther, pubescent towards apex, otherwise glabrous; *stylopodium* indistinct, sparsely pubescent, tapering into style; style and stylopodium longer than ovary. *Fruit calyx* entirely glabrous; 3 longer lobes to 16 by 3.5 cm, spatulate, obtuse, c. 7 mm broad above the to 2 by 1.5 cm thickened saccate base; 2 shorter lobes to 8 by 0.6 cm, narrowly spatulate, similarly saccate at base. *Nut* to 3.3 by 1.8 cm, ovoid, pruinose, buff pubescent towards the apex; style remnant c. 1.5 mm long, acute.

Distr. *Malesia*: N.W. Borneo (Sarawak, Brunei and Kalimantan: Lower Kapuas and Barito).

Ecol. Locally gregarious, mixed peat swamp forests, especially on and beside white sand raised beaches.

Vern. *Kukup, kĕrukup, mĕranti kĕrukup* (Brunei).

109. *Shorea pauciflora* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 116; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 98; BURK. J. Str. Br. R. As. Soc. 81 (1920) 51, 69, fig.; RIDL. Fl. Mal. Pen. 1 (1922) 228; FOXW. Mal. For. Rec. 3 (1927) 51, *p.p.*; *ibid.* 10 (1932) 218; SLOOT. in Merr. Pl. Elm. Born. (1929) 203; BURK. Dict. (1935) 2020; SYM. Mal. For. Rec. 16 (1943) 87, f. 37A, 38, 52; BROWNE, For. Trees Sarawak & Brunei (1955) 149; ASHTON, Man. Dipt. Brun. (1964) 207, f. 17, pl. 46 (bark); *ibid.* Suppl. (1968) 114; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 133, f. 15; ASHTON, Gard. Bull. Sing. 31 (1978) 47.

Large buttressed tree. Leaf bud, stipule and panicle persistently shortly pale gold-brown pubescent; nervation, petiole and young twig sparsely dotted with minute caducous hair tufts. *Twig* 1.5–2.5 mm \varnothing , terete at first smooth, becoming flaky; stipule scars pale, short, narrow, horizontal. *Bud* 4–8 by 2–3.5 mm, ovoid, acute. *Stipule* to 13 by 4 mm, hastate, acute. *Leaves* 9–15 by 4–5.5 cm, ovate, \pm thinly coriaceous, frequently subequal; base obtuse to broadly cuneate; acumen 0.6–1.2 cm long, narrow; nerves 8–9 pairs, slender but prominent beneath, at c. 40°–50°, straight, slightly curved at the margin, occasionally with a few glabrous domatia; tertiary nerves very slender, densely scalariform, diagonal to the nerves; midrib narrowly depressed above, prominent beneath; petiole 1.3–1.8 cm long. *Panicle* to 15 cm long, terminal or axillary, ribbed or slightly compressed, lax; doubly or trebly branched, the branchlets bearing to 19 second flowers; bracteoles to 4 by 2.5 mm, oblong, subacute, shortly densely pale yellow-brown to pubescent fugaceous. *Flower bud* c. 7 by 3.5 mm, ovoid, subacute. *Calyx* densely pale yellowish buff pubescent outside, glabrous within; lobes subequal, deltoid, obtuse, the 2



Fig. 101. *Shorea pachyphylla* RIDL. ex SYM. a. Habit, b. twig apex with leaf, c. fruit, d. nut, all $\times \frac{1}{2}$ (a bb. 31414, b-d S 11245).

inner slightly narrower. *Petals* pale yellow, oblong, obtuse, densely pubescent on parts exposed in bud. *Stamens* 15, the inner 5 slightly longer than the other 10; filaments expanded at base, abruptly narrowing distally; anthers broadly oblong; appendage to connective *c.* $2 \times$ length of anther, setose towards the apex, the inner 5 reaching the style apex. *Ovary* and *stylopodium* ovoid to conical, shortly densely pubescent; style glabrous, slightly shorter than ovary and stylopodium. *Fruit* subsessile. *Calyx* sparsely pubescent, more densely so at base; 3 longer lobes to 9 by 1.5 cm, spatulate, narrowly obtuse, *c.* 4 mm broad above the *c.* 8 by 11 mm rounded thickened saccate base; 2 shorter lobes to 5 by 0.5 cm, linear, similar at base. *Nut* *c.* 1.4 by 1.2 cm, broadly ovoid, obtuse or with a short acute style remnant, densely pale buff tomentose.

Distr. *Malesia*: Malaya, Sumatra (extreme north and the south excepted, incl. P. Siberut), Borneo.

Ecol. Scattered, rarely common, on deep soils on undulating land and hills below 700 m.

Uses. A valuable heavy red meranti.

Vern. *Nĕmesu*, *lamsa*, *lemesa*, *lemesa samak*, *mĕsu*, *mĕranti benia*, *m. samak*, *kala samak*, *mĕndamak*, *pinang baik*, *sĕraya*, *s. batu*, *tĕmpayan mas* (Malaya), *katuko*, *k. andilan*, *k. tikau*, *mĕranti udang* (Sumatra), *ubar suluk* (Sabah), *mĕranti samak*, *ĕngkabong cheriak* (Sar.), *pĕrawan samak* (Iban), *lampong merantias*, *l. tahan*, *pĕlĕpak*, *kĕlapak*, *k. undang*, *putang lanan*, *awang kulat*, *a. laying*, *mĕrĕkabong* (S.E. Borneo), *tĕngkawang tijang*, *t. rambai*, *kontoi*, *k. lemak* (W. Borneo), etc.

Note. Variable in leaf size and colour: small-leaved forms tend to have leaves drying rust-red, large-leaved chocolate-brown with the nerves and petiole distinctly paler.

110. *Shorea johorensis* Foxw. Mal. For. Rec. 10 (1932) 236, pl. 21; BURCK. Dict. (1935) 2012; SYM. Mal. For. Rec. 16 (1943) 72, f. 38; ASHTON, Gard. Bull. Sing. 22 (1967) 294. — *S. polysperma* (non MERR.) KEITH, North Born. For. Rec. 2 (1938) 238. — *S. leptoclados* SYM. Gard. Bull. S. S. 10 (1939) 376, pl. 25; Mal. For. Rec. 16 (1943) 77; BROWNE, For. Trees Sarawak & Brunei (1955) 140; ASHTON, Man. Dipt. Brun. (1964) 195, f. 17; *ibid.* Suppl. (1968) 110; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 112, f. 13, pl. 6 (habit). — Fig. 100 D–D3.

Large buttressed tree. Twig, panicle, leaf bud, stipule, petiole, nervation beneath and midrib above shortly evenly persistently grey-buff pubescent; young leaf caducously so. *Twig* 2–3 mm \varnothing apically, much branched, slightly ribbed and compressed when young, becoming terete, drying glabrous, smooth; stipule scars 1.5–2 mm long, pale, falcate, descending. *Bud* 6–8 by 2–3 mm, ovoid, compressed. *Stipule* to 3.5 by 0.7 mm, \pm caducous, lanceolate, acute, constricted at base. *Leaves* 9–14 by 4.2–7.5 cm, chartaceous to thinly coriaceous, ovate; base obtuse to subcordate; acumen to 7 mm long; nerves 10–12 slender but prominent pairs, at 90° at base, *c.* 40°–50° towards apex; first 3–6 pairs usually with prominent scale-like

domatia, the basal two pairs of which fused along the midrib on each side; tertiary nerves very slender, densely scalariform, sinuate, diagonal to nerves; *petiole* slender, 1.5–2 cm long. *Panicle* to 15 cm long, terminal or axillary, terete or slightly compressed, slender; regularly singly or doubly branched, branchlets long, lax, bearing to 18 second flowers; *bracts* to 7 mm long, narrowly ovate, obtuse, pubescent on both surfaces, fugaceous. *Flower bud* to 8 by 3.5 mm, ovoid to lanceolate, acute. *Calyx* densely pale grey pubescent outside, glabrous within; lobes subequal, acute, slightly revolute towards the apices. *Petals* pale yellow, narrowly lanceolate, obtuse, densely pubescent on parts exposed in bud. *Stamens* 15, the 5 innermost only slightly longest; filaments expanded at base, abruptly narrowing and filiform distally; anthers oblong, somewhat tapering; appendage to connective *c.* $3 \times$ length of anther, reaching $\frac{3}{4}$ length of style, glabrous. *Ovary* globose, shortly densely pubescent in apical half, stylopodium indistinct; style over twice as long as ovary, filiform, glabrous but for base. *Fruit* calyx shortly pubescent towards base, glabrescent; 3 longer lobes to 12 by 2.3 cm, subequal, spatulate, narrowly obtuse, *c.* 6 mm broad above the to 1.4 by 1.2 cm deltoid saccate thickened base; 2 shorter lobes to 6.5 by 0.6 cm, unequal, linear but similar at base. *Nut* to 2 by 1.4 cm, broadly ovoid, densely shortly pale buff tomentose; style remnant short.

Distr. *Malesia*: Malaya (E. Johore), Sumatra (East coast: Simelungun, Djambi, Palembang), Borneo (Sarawak, Sabah, S.E. Borneo to Muara Tewe and Pleihari).

Ecol. Common in Palembang and E. Borneo, local or rare elsewhere, on fertile soils on hillsides, well-drained alluvium and undulating land below 600 m alt.

Vern. *Mĕranti pepijat* (Mal.), *mĕrukuyong* (Sum.), *kĕnuar*, *kĕnbĕwar*, *langko*, *pĕlĕpak* (S.E. Borneo), *majau* (Sabah), *sĕlangan pĕlandok* (Brunei), *mĕrampu* (Iban).

Note. Collections from West Sarawak and the Malay Peninsula lack the basal domatia that so facilitate distinction of sterile material from *S. palembanica*.

111. *Shorea palembanica* MIQ. Sum. (1861) 487; DC. Prod. 16, 2 (1868) 632; WALP. Ann. 7 (1868) 379; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 219; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 103; SYM. Gard. Bull. S. S. 7 (1933) 141, pl. 41; Mal. For. Rec. 16 (1943) 83, f. 38; BROWNE, For. Trees Sarawak & Brunei (1955) 141; ASHTON, Man. Dipt. Brun. Suppl. (1968) 112, f. 13. — *S. aptera* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 210, t. 22; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 264; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 78; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 296; MERR. En. Born. (1921) 403; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 260. — *S. brachyptera* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 571; MERR. En. Born. (1921) 404. — *Pachychlamys beccarianus*, *P. brachypterus* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 77,

nomina pro syn. — *S. lepidota* (non BL.) FOXW. Mal. For. Rec. 10 (1932) 166, p.p.

Small or medium-sized, rarely large tree. Young twig, leaf bud, and stipule outside densely evenly pale buff pubescent, stipule inside, petiole and leaf nervation sparsely so, sometimes glabrescent. *Twig* c. 2 mm \varnothing , compressed apically, becoming smooth, terete; stipule scar short, horizontal. *Bud* to 13 by 6 mm, lanceolate, falcate, acute. *Stipule* to 15 by 3 mm, lanceolate, acute, caducous. *Leaves* 8–25 by 4–10 cm, ovate to oblong, chartaceous, undulating; base broadly cuneate to subcordate; acumen to 1 cm long, broad; nerves 12–16 pairs, slender but prominent beneath, at 45°–65°; tertiary nerves slender, dense; midrib appanate to depressed above, prominent beneath; *petiole* 14–25 mm long, drying ribbed. *Panicle* to 16 cm long, terminal or axillary, terete, shortly evenly persistently pale buff pubescent; doubly branched, branchlets to 5 cm long, bearing to 10 second flowers; *bracteoles* to 4 by 2 mm, ovate, acute, puberulent, caducous. *Flower bud* to 7 by 3 mm, fusiform. *Sepals* ovate, densely pubescent on parts exposed in bud; 3 outer acute, 2 inner smaller, thinner towards the fimbriate margins, acuminate. *Petals* pale yellow, lanceolate, pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed at base, tapering medially and filiform below the broadly ellipsoid anthers; appendage to connective slender, c. 2 \times length of anthers. *Ovary* ovoid, tapering, pubescent; style filiform, c. 2 \times length of ovary, pubescent in the basal $\frac{1}{4}$. *Fruit pedicel* to 2 mm long. *Calyx* puberulent, glabrescent, short, 3 longer lobes to 5 by 0.7 cm, lorate, obtuse, with to 2.5 by 2.5 cm ovate thickened prominently saccate base; 2 shorter lobes to 3 cm long, otherwise similar. *Nut* to 3.5 by 2.5 cm, ovoid, apiculate, densely evenly shortly persistently pale yellow-brown pubescent.

Distr. *Malesia*: Malaya (Perak and E. coast), Sumatra (Palembang), Borneo (excluding Sabah, Brunei and Sarawak west of the Lupar).

Ecol. River banks, fresh water swamps and rarely low moist hillsides, locally abundant.

Vern. *Mèrantî têngkawang ayèr, singkawang, têngkawang, mèrpak* (Malaya), *mèrkuyung, mèlèbèkan* (Sumatra), *èngkabang asu* (Sarawak), *kèlèpak, majau, tènkwang, t. rambut, t. ringgit, mêngkabang* (W. Borneo).

112. *Shorea andulensis* ASHTON, Gard. Bull. Sing. 19 (1962) 275, pl. 11; Man. Dipt. Brun. (1964) 178, f. 17; *ibid.* Suppl. (1968) 105; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 97.

Medium-sized to large tree. Twig, panicle, leaf bud, midrib above. Stipule (both surfaces) and petiole shortly densely persistently yellowish buff puberulent, more sparsely so on nervation beneath and midrib above. *Twig* 1.5–2 mm \varnothing apically, slender, compressed when young, becoming terete, smooth, glabrous; stipule scars short, inconspicuous. *Bud* 3–6 by 1.5–3 mm, ovoid, compressed, subacute. *Stipule* to 14 by 5 mm, hastate, subacute. *Leaves* 6–9 by 3–5 cm,

elliptic-ovate, lepidote beneath in mature tree; base obtuse; acumen to 8 mm long; nerves 10–13 pairs, straight, abruptly curved near margin, slender but prominent beneath, at 40°–50° except at base; tertiary nerves slender, scalariform, sinuate, diagonal to nerves; *petiole* 1–1.2 cm long, 1–1.5 mm \varnothing , shortly cream puberulent and rugose on drying. *Panicle* to 12 cm long, terminal or axillary, terete or slightly compressed; singly or doubly branched, the branchlets bearing to 10 distichous flowers; *bracts* and *bracteoles* to 3 by 1.2 mm, ovate, subacute, shortly grey puberulent outside, glabrescent within. *Flower bud* to 8 by 2.5 mm, narrowly ovoid, subacute, the calyx spreading. *Calyx* densely shortly pubescent outside, puberulent within; lobes subequal, ovate, acute to subacuminate, the inner 2 more attenuate than the outer 3. *Petals* bright lilac within, paler outside, narrowly lanceolate, acute, twisted, shortly pubescent on parts exposed in bud, saccate at base. *Stamens* 15, the inner 5 only slightly longer than the others; filaments basally expanded, abruptly tapering; anther broadly oblong; appendage to connective c. 3 \times length of anther, straight, unreflexed, reaching almost to the style apex on the 5 inner stamens. *Ovary* small, globose, glabrous; stylopodium indistinct; style c. 2 \times length of ovary, filiform, sparsely pubescent in the basal half. *Fruit calyx* shortly pubescent, more densely so at base; 3 longer lobes to 5 by 1.2 cm, broadly spatulate, narrowly obtuse, c. 2.5 mm broad above the c. 6 by 4 mm narrowly ovate thickened saccate base; 2 shorter lobes to 2.5 by 0.2 cm, linear, subequal, similar at base. *Nut* to 14 by 7 mm, ovoid, abruptly shortly apiculate, shortly densely grey-buff pubescent.

Distr. *Malesia*: Northern Borneo (Ulu Kapuas, Sarawak, Brunei, E. Sabah).

Ecol. Rare, on sandy soils in Mixed Dipterocarp forest; on ultrabasics in E. Sabah.

Vern. *Mèrantî daun puteh* (Brun.).

113. *Shorea polysperma* (BLCO) MERR. Publ. Govt. Lab. Philip. 27 (1905) 22; *ibid.* 29 (1905) 29; Philip. J. Sc. 1 (1906) Suppl. 98; EVERETT & WHITFORD, Bull. Bur. For. Philip. 5 (1906) 26; FOXW. Philip. J. Sc. 2 (1907) Bot. 356, 357, 394; MERRITT, Bull. Bur. For. Philip. 8 (1908) 16, 48; FOXW. Philip. J. Sc. 4 (1909) Bot. 423, 510, 518; WHITFORD, *ibid.* 4 (1910) Bot. 703; Bull. Bur. For. Philip. 10 (1911) 66; FOXW. Philip. J. Sc. 6 (1911) Bot. 277; *ibid.* 13 (1918) Bot. 191; MERR. Sp. Blanc. (1918) 269; En. Philip. 3 (1923) 99; REYES, Philip. J. Sc. 22 (1923) 328; FOXW. *ibid.* 67 (1938) 309. — *Mocanera polysperma* BLCO, Fl. Filip. 1 (1837) 448. — *Dipterocarpus polyspermus* BLCO, Fl. Filip. ed. 2 (1845) 312; *ibid.* ed. 3, 2 (1878) 213; DC. Prod. 16, 2 (1868) 614; DYER, J. Bot. 12 (1874) 108. — *Hopea tangili* BL. Mus. Bot. Lugd.-Bat. 2 (1852) 35, *nom. illeg.*; WALP. Ann. 4 (1857) 339; DC. Prod. 16, 2 (1868) 635. — *S. talura* (non ROXB.) F.-VILL. Nov. App. (1880) 21. — *S. warburgii* GILG, Bot. Jahrb. 18, Beibl. 45 (1894) 38; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 98; BRANDIS & GILG in E. & P. Pf. Fam. ed. 1, 3, 6 (1895)

264; Foxw. Philip. J. Sc. 6 (1911) Bot. 278; *ibid.* 13 (1918) Bot. 191; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 260. — *S. teysmanniana* (non DYER) FOXW. Philip. J. Sc. 6 (1911) Bot. 278; *ibid.* 13 (1918) Bot. 192; WHITFORD, Bull. Bur. For. Philip. 10 (1911) 68; MERR. En. Philip. 3 (1923) 99; REYES, Philip. J. Sc. 22 (1923) 326. — Fig. 7.

Large buttressed tree. Twigs, buds, stipules, panicles, bracts and parts of petals exposed in bud ± densely persistently cream puberulent, petioles, nervation beneath, calyx and ovary so at first becoming glabrous on all but ovary. *Twig* c. 2–3 mm \varnothing apically, compressed at first, becoming terete, smooth, blackish; stipule scars short, horizontal. *Buds* c. 2 by 1 mm, small, ellipsoid, stipules to 15 by 8 mm, lanceolate, acute, caducous. *Leaves* 7.5–15 by 2.5–6.5 cm, elliptic, thinly coriaceous, occasionally cream lepidote beneath; base cuneate; acumen to 2 cm long, tapering; nerves 9–12 pairs, slender but prominent beneath, slightly elevated above, arched, at 55°–75°, frequently with glabrous pore-like axillary domatia; tertiary nerves densely scalariform, sinuate, very slender, barely elevated beneath, obscure above; midrib slender but prominent beneath, obscurely depressed above; petiole 16–22 mm long, slender geniculate. *Panicle* to 16 cm long, terminal or axillary, doubly branching, spreading, many-flowered; branchlets to 7 cm long; *bracts* to 5 by 3 mm, ovate-deltoid, acute. *Buds* to 4 by 2 mm, small, fusiform; sepals broadly ovate, the outer 3 acute, the inner 3 smaller, shortly acuminate; *stamens* 15, shorter than style at anthesis; filaments broadly compressed at base, tapering abruptly medially and filiform beneath the subglobose anthers; appendage slender, ± glabrous, c. $2\frac{1}{2}$ × length of anthers; *ovary* subglobose, abruptly crowned by a slender glabrous style c. 2 × its length. *Fruit pedicel* to 3 mm long, stout, broadening into the receptacle; 3 longer *calyx lobes* to 9 by 1.8 cm, spatulate, obtuse, coriaceous, c. 6 mm broad above the c. 10 by 10 mm broadly ovate saccate thickened base; 2 shorter lobes to 5 by 0.4 cm, lorate, obtuse, similar at base; *nut* to 18 by 14 mm, ovoid, apiculate.

Distr. *Malesia*: Philippines.

Ecol. Widespread and often common, evergreen Mixed Dipterocarp forest on hills.

Vern. *Tangile* (Tag.), *abuhungan* (Al.), *adamini* (Bis.), *araka* (Ilk.), *balakbákan* (Neg.), *belagáyan* (Mangyan), *damilang* (Ibn.), *malignal* (Tang.), *manaog* (C. Bis.), *mayapis* (Tayabas), *pata* (Pang).

114. *Shorea platyclados* SLOOT. ex [ENDERT, M. O. Born. Exp. 1925 (1926) 261, 266, 267, 272, *nomen*] FOXW. Mal. For. Rec. 10 (1932) 214; ENDERT, Tectona 26 (1933) 410; DE VOOGD, *ibid.* 26 (1933) 703; BOON, *ibid.* 32 (1939) 839; BURK. Dict. (1935) 2020; DESCH, Mal. For. Rec. 12 (1936) 2, 43, 63, 65; SYM. J. Mal. Br. R. As. Soc. 14 (1936) 336, 339, 340, 348; Gard. Bull. S. S. 10 (1939) 377; Mal. For. Rec. 16 (1943) 89, f. 38, 54; DESCH & THOMAS, Mal. For. Rec. 13 (1940) 4; SLOOT. Bull. Bot. Gard. Btzg III, 17 (1941) 110, f. 16; ASHTON, Man. Dipt. Brun. (1964) 212, f. 17,

pl. 47 (stem-base); *ibid.* Suppl. (1968) 115; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 139; NG, Mal. For. 39 (1976) 91, f. 1–9.

Large tree with dark, flaky and fissured bark. Young parts grey puberulent, fugaceous except on stipule and panicle. *Twig* c. 3 by 1.5 mm \varnothing apically, compressed, glabrous, smooth; stipule scars c. 2 mm long, linear, pale, horizontal. *Leaf bud* to 4 by 1.5 mm \varnothing apically, compressed, acute. *Stipule* to 13 by 3.5 mm, hastate, acute. *Leaves* alternate, 6–9 by 2–3 cm, lanceolate; base cuneate and with revolute margin; acumen c. 1 cm long; margin undulate; nerves 15–18 pairs, slender, hardly elevated beneath, ± obscure, with short secondary nerves running $\frac{1}{2}$ way to margin; tertiary nerves very slender, densely scalariform, diagonal to nerves; midrib narrow, obscure and depressed above, slender but sharply prominent beneath; *petiole* 1–1.5 cm long, slender, compressed laterally. *Panicle* to 7 cm long, terminal or axillary, compressed; singly branched, branchlets to 1.8 cm long, bearing to 7 second flowers; *bracteoles* unknown. *Flower bud* to 8 by 3 mm, ovoid, ellipsoid. *Calyx* densely shortly puberulent outside, glabrous within; 3 outer lobes ovate, acuminate, 2 inner lobes smaller, more narrowly acuminate. *Petals* pale yellow, lanceolate, slender, acute, densely pubescent on parts exposed in bud. *Stamens* 15, of 2 lengths; filament broad at base, tapering ± abruptly and filiform distally; anther subglobose; appendages to connective c. 4 × length of anther, slender, glabrous. *Ovary* and *stylopodium* pyriform, puberulent towards apex; style glabrous, as long as ovary and stylopodium. *Fruit calyx* glabrescent; 3 longer lobes to 10 by 1 cm, narrowly spatulate, obtuse, to 4 mm broad above the to 7 by 7 mm broadly ovate saccate thickened base; 2 shorter lobes to 5 by 0.4 cm, linear, acute, similar at base. *Nut* to 1.5 by 1 cm, glabrescent; style remnant acute.

Distr. *Malesia*: Sumatra, Borneo.

Ecol. Widespread in mountainous districts, usually between 700–1300 m, but occasionally down to 200 m in valley bottoms near mountains.

Vern. *Méranti bukit, jalak* (Malaya).

Note. NG *l.c.* found that if the orthotropic leader shoot is damaged it is replaced by new orthotropic leaders from dormant accessory buds, not by lateral plagiotropic shoots.

115. *Shorea scaberrima* BURCK, Med. Lands Pl. Tuin 3 (1886) 22; Ann. Jard. Bot. Btzg 6 (1887) 208; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 78; MERR. En. Born. (1921) 406; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 306; *ibid.* ed. 2 (1927) 1124; BROWNE, For. Trees Sarawak & Brunei (1955) 143; ASHTON, Man. Dipt. Brun. (1964) 219, f. 17, pl. 49 (bark). — Fig. 99 A–A4.

Medium-sized tree. Young twigs, panicle, leaf bud, stipule outside (puberulent within), petiole, leaf beneath and midrib above densely persistent-scabrid tawny tomentose; leaf above fugaceous pubescent. *Twig* 2–3 mm \varnothing apically, terete, becoming rugulose, verrucose, much branched; stipule scars to 1.5 mm

long at first, 0.5 mm thick, shortly cuneate, obscured by tomentum. Bud 4–6 by 4–5 mm, broadly ovoid, slightly compressed, subacute. *Stipule* to 18 by 8 mm, broadly hastate, subacute, constricted at base, caducous. *Leaves* 7–20 by 4–9 cm, oblong-obovate to oblong-ovate, thinly coriaceous; base obtuse, rarely subcordate; acumen to 8 mm long, short, deltoid; nerves 14–17 pairs, rather slender, curved, at 40°–50°, more widely at base; tertiary nerves distinct, rather densely scalariform; midrib prominently terete beneath, slightly depressed or applanate above; *petiole* 1.8–2.5 cm long. *Panicle* to 8 cm long, short, lax, terminal or axillary, terete or ribbed; singly branched, the branchlets bearing to 3 ± secund flowers; *bracteoles* to 4.5 by 3 mm, narrowly deltoid, acute, scabrid pale fulvous pubescent outside, puberulent within, fugaceous. *Flower bud* to 8 by 5 mm, ovoid, obtuse. *Calyx* densely yellow-brown pubescent; 3 outer lobes deltoid to ovate, frequently acuminate, acute; 2 inner lobes similar but smaller. *Petals* pink, narrowly lanceolate, densely setose on parts exposed in bud. *Stamens* 15, the 5 innermost somewhat longer than the other; filaments basally expanded, abruptly contracted and filiform distally; anther ± oblong; appendage to connective reaching the style apex on 5 inner stamens, more than twice as long as anther cells, becoming curved but not reflexed. *Ovary* subglobose, small, shortly densely pubescent; style and stylopodium 3 times as long as ovary, filiform with glabrous apex, swelling slightly below it and densely shortly pubescent; frequently further swollen in the basal half. *Fruit calyx* shortly evenly fulvous pubescent; 3 longer lobes to 4.5 by 1 cm or shorter, unequal, variable, shortly spatulate, subacute, to 7 mm broad above the to 2 by 3.5 cm broadly ovate shallowly saccate thickened base, closely adpressed to the base of nut; 2 shorter lobes to 3 by 0.3 cm, linear, similarly expanded at base. *Nut* to 5 by 2.5 cm large, obovoid, tapering to an acute apical style remnant, densely evenly fulvous pubescent, becoming the same length or slightly longer than the calyx.

Distr. *Malesia*: N.W. Borneo (through Sarawak to S.W. Sabah); S.E. Borneo (Puruktau, sterile collection?).

Ecol. Frequent, sandy clay soils on low hills, alluvium and locally on ridges and volcanic plateaux to 850 m.

Vern. *Engkabang bintang, kantai, k. lilin, k. tēm-baga, tēntung, tēngkawang kijang* (W. Borneo), *meranti paya, m. paya bērsisek* (Brunei), *ēngkabang pinang* (Iban), *sēraya mēmpelas* (Sabah).

116. *Shorea fallax* MEIJER, Act. Bot. Neerl. 12 (1963) 335, pl. 7; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 105; ASHTON, Man. Dipt. Brun. (1964) 186, f. 17; *ibid.* Suppl. (1968) 107. — *S. oleosa* MEIJER, Act. Bot. Neerl. 12 (1963) 338, pl. 8; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 124. — *S. squamata* (non BENTH. & HOOK. f.) BROWNE, For. Trees Sarawak & Brunei (1955) 144.

Medium-sized to large buttressed tree. Young twig,

panicle, leaf bud, stipule outside (glabrescent or shortly pubescent within), petiole beneath, leaf beneath and midrib above sparsely persistently pale brown scabrid tomentose. *Twig* 2–2.5 mm \varnothing apically, terete, ribbed below the stipule scars, becoming smooth; stipule scar c. 2 mm long, c. 0.5 mm thick, pale, cuneate, slightly falcate, horizontal or slightly ascending. *Leaf bud* 5–8 by 4–6 mm, ovoid, subacute. *Stipule* to 15 by 5 mm, hastate, acute. *Leaves* 12–24 by 5.5–11 cm, broadly oblong to ovate, ± thinly coriaceous; base obtuse; acumen to 1.2 cm long; nerves 15–19 pairs, prominent, at 60°–70°, curved distally; short secondary nerves frequently present; tertiary nerves prominent, well spaced, at 90° to nerves; midrib prominent, terete beneath, applanate but evident above; *petiole* 1–1.5 cm long, short. *Panicle* to 22 cm long, terminal or axillary, terete or ribbed, lax, regularly alternately singly or doubly branched, the branchlets bearing to 7 secund flowers; *bracts* and *bracteoles* to 7 by 3 mm, ovate, acute, pubescent outside, glabrous within, not at first caducous. *Flower bud* to 8 mm long, narrowly ovoid, acute. *Calyx* shortly densely pale grey-brown pubescent outside, glabrous within; 3 outer lobes longer, ± deltoid to ovate, subacute; 2 inner lobes shorter, narrowly deltoid to ovate, acute, acuminate. *Petals* pale cream-yellow, narrowly oblong, densely pubescent on parts exposed in bud. *Stamens* 15, the 5 inner anther's length longer than the others; filaments basally expanded, abruptly tapering and filiform distally; anthers oblong; appendage to connective reaching to style apex on 5 inner stamens, more than twice as long as anthers, curved but not reflexed. *Ovary* and *stylopodium* pyriform, densely pubescent in the distal half, shortly densely pubescent basally; style as long as ovary and stylopodium, filiform, glabrous. *Fruit* subsessile. *Calyx* glabrescent; 3 longer lobes to 5 by 0.8 cm, spatulate, subequal, to 3.5 mm broad above the to 1.5 by 1.2 cm ovate glabrous shallowly saccate thickened base; 2 shorter lobes to 2.5 by 1.5 mm, linear, similar at base. *Nut* to 2.7 by 1.0 cm, ovoid, shortly buff pubescent, apiculate, shorter than longer calyx lobes.

Distr. *Malesia*: Borneo (N.E. Sarawak and Sabah to Berau).

Ecol. Widespread on clay soils in Mixed Dipterocarp forest, on well drained alluvium, undulating land and hillsides to 600 m.

Vern. *Engkabang layar, e. pinang* (Sar.), *mēntalun, mēranti sēpit undang* (Brun.), *sēraya minyak* (Sabah), *tuntong sēluing, kantai* (S.E. Borneo).

Note. Doubtfully distinct from *S. parvistipulata* (see *sub ssp. albifolia*).

117. *Shorea pubistyla* ASHTON, Gard. Bull. Sing. 22 (1967) 297, pl. 43; Man. Dipt. Brun. Suppl. (1968) 116, f. 14, pl. 21 (bark). — Fig. 102.

Large tree. *Twig*, leaf bud, petiole and midrib beneath densely dark fulvous scabrid tomentose; more shortly, sparsely so on nervation beneath, midrib above and stipule outside; stipule within

evenly densely pale fulvous caducous pubescent. *Twig* c. 7 mm \varnothing towards the apex, stout, prominently ribbed at first, becoming terete; stipule scars c. 2 mm long, horizontal, obscure. *Bud* to 1.3 mm long and \varnothing , ovoid, compressed. *Stipule* to 2.5 by 0.7 cm, lanceolate, subcaudate, caducous. *Leaves* 11–19 by 7–12 cm, broadly oblong to obovate, thickly coriaceous; base obtuse to cordate; apex obtuse, subtretuse or shortly acuminate; nerves 14–18 pairs, obscurely depressed above, prominent beneath, at 110° at the base, 45° at the apex; tertiary nerves remotely scalariform, prominent beneath; *petiole* 2.5–4 cm long, stout. *Panicle* to 20 cm long, ribbed, densely shortly fulvous scabrid tomentose, lax, axillary; singly branched, branchlets to 6 cm long, bearing to 12 secund flowers; *bracteoles* to 8 by 5 mm, oblong-ovate, subacute, shortly evenly caducous pubescent. *Flower bud* to 7 by 3 mm, lanceolate. *Sepals* densely pubescent; 3 outer ovate, acute, 2 inner ovate, thinner at the fimbriate margins, narrower at base, than the outer 3. *Petals* pink outside, crimson within, elliptic-lanceolate, pubescent on parts exposed in bud. *Stamens* 15, the inner 5 slightly longer than the outer 10 and reaching the style apex at anthesis; filaments broad and compressed at base, tapering abruptly medially and filiform below the broadly ellipsoid anthers; appendage to connective slender, 2–3 times length of anther, glabrous. *Ovary* ovoid, densely pubescent, crowned by a somewhat longer stoutly columnar densely pubescent stylopodium and short glabrous style. *Fruit pedicel* to 3 mm long, to 3 mm \varnothing , stout. *Fruit calyx* at first sparsely pubescent towards base, becoming entirely glabrous; 3 longer lobes to 14 by 2.5 cm, spatulate, obtuse, c. 8 mm broad above the to 1.3 by 1.4 cm broadly ovate saccate thickened base; 2 shorter lobes to 12 by 1.2 cm, lorate, obtuse, otherwise as in longer lobes. *Nut* to 3 by 1.8 cm, narrowly ovoid, densely shortly evenly pale cream-brown pubescent; stylopodium to 4 mm long, apiculate.

Distr. *Malesia*: N.W. Borneo (W. and Central Sarawak).

Ecol. Scattered on leached clay soils on low hills in Mixed Dipterocarp forest.

Vern. *Mēranti bulu mērah*.

118. *Shorea palosapis* (BLCO) MERR. Sp. Blanc. (1918) 271; En. Philip. 3 (1923) 98; REYES, Philip. J. Sc. 22 (1923) 325. — *Dipterocarpus palosapis* BLCO, Fl. Filip. ed. 2 (1845) 312; *ibid.* ed. 3, 2 (1878) 214; DC. Prod. 16, 2 (1868) 614; DYER, J. Bot. 12 (1874) 108. — *Hopea squamata* TURCZ. Bull. Soc. Nat. Mosc. 31 (1858) 239; DC. Prod. 16, 2 (1868) 635; WALP. Ann. 7 (1868) 379. — *S. squamata* BENTH. & HOOK. f. [Gen. Pl. 1 (1862) 193] ex DC. Prod. 16, 2 (1868) 632; VIDAL, Phan. Cuming. (1885) 97; Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 92; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 267; MERR. Philip. J. Sc. 2 (1907) Bot. 285; FOXW. Philip. J. Sc. 2 (1907) Bot. 386; MERRITT, Bull. Bur. For. Philip. 8 (1908) 16, 48; FOXW. Philip. J. Sc. 4 (1909) Bot. 519; WHITFORD, *ibid.* 4 (1910) Bot. 715;

Bull. Bur. For. Philip. 10 (1911) 66; FOXW. Philip. J. Sc. 6 (1911) Bot. 275; in Elmer, Leaf. Philip. Bot. 6 (1913) 1957; Philip. J. Sc. 13 (1918) Bot. 191; MERR. En. Born. (1921) 407; FOXW. Philip. J. Sc. 67 (1938) 310. — *S. floribunda* (non KURZ) F.-VILL. Nov. App. (1880) 21. — *S. rugosa* (non HEIM) FOXW. Philip. J. Sc. 13 (1918) Bot. 191.

Large buttressed tree. Midrib and nerves above, branchlets of panicle, bracteoles, ovary and parts of petals exposed in bud \pm densely persistently cream puberulent; calyx at first so, becoming sparse, glabrescent; twigs, buds, bracts, stipules, petioles and nervation beneath \pm sparsely persistently scabrid pubescent. *Twig* 2–3 cm \varnothing apically, rather stout, ribbed, becoming terete, smooth; stipule scars pale, distinct, amplexicaul. *Bud* to 15 by 10 mm, ovate, acute, compressed. *Stipules* to 1.5 by 11 mm, ovate-auriculate, prominent, not at first caducous. *Leaves* 12–24 by 8–11 cm, large, oblong, thinly coriaceous; base \pm shallowly cordate or sometimes obtuse; apex obtuse or to 2 cm long slender acuminate (young trees); nerves 14–19 pairs, prominent beneath, \pm depressed above as also the midrib and tertiary nerves, set at c. 45° towards the apex, at c. 90° at the base, usually with short less prominent secondary nerves; tertiary nerves remotely scalariform; *petiole* 1.5 to 2.5 cm long, rather stout. *Panicles* to 25 cm long, terminal or subterminal axillary, stout, spreading, many-flowered, singly (if axillary) or doubly branched; branchlets to 3 cm long, bearing to 8 flowers; *bracts* as stipules but somewhat smaller, *bracteoles* to 6 by 3 mm, elliptic, subacute, neither at first caducous. *Flower bud* to 6 by 3 mm, fusiform. *Sepals* narrowly ovate; outer 3 acute, inner 2 slightly shorter, prominently acuminate. *Stamens* 15, unequal, slightly shorter than style at anthesis; filaments broadly compressed at base, abruptly tapering and filiform distally; appendages slender, glabrous, 3–4 \times length of the subglobose anthers. *Ovary* and *stylopodium* pyriform, densely pubescent; style somewhat shorter, filiform, glabrous. *Fruit pedicel* to 2 mm long, stout; 3 longer *calyx lobes* to 12(–17) by 1.5 cm, spatulate, coriaceous, obtuse, c. 6 mm broad above the to 12 by 10 mm ovate saccate thickened base; 2 shorter lobes to 3.5 by 0.3 cm, linear, similar at base; *nut* to 23 by 14 mm, ovoid, acute.

Distr. *Malesia*: Philippines.

Ecol. Widespread, often abundant, in lowland evergreen Mixed Dipterocarp forest on fertile well-drained soils in non-seasonal areas below 300 m.

Vern. *Mayápis, tabak* (Tag.), *purá* (Bik.), *kalián* (Lan.), *alam* (Tag., Mang.).

119. *Shorea bullata* ASHTON, Gard. Bull. Sing. 19 (1962) 283, pl. 15; Man. Dipt. Brun. (1964) 181, f. 17; *ibid.* Suppl. (1968) 105.

Medium-sized tree with golden brown cracked and patchily flaked bark. Outside of stipule, twig, panicle, petiole and nervation beneath persistently scabrid fulvous pubescent; more densely tomentose on leaf buds and midrib above; caducous hispid on lamina above; shortly pubescent on stipule within. *Twig* c. 2

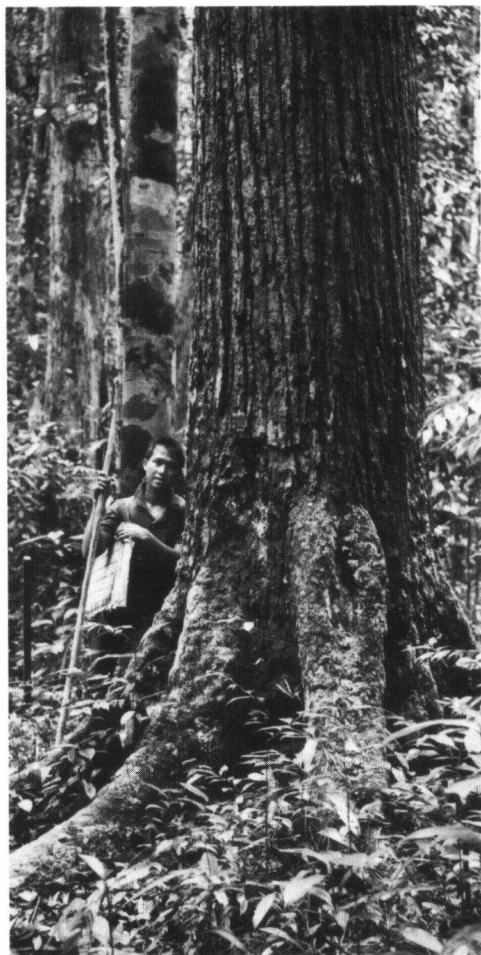


Fig. 102. Trunk of *Shorea pubistyla* ASHTON. Sarawak, Semengoh Arboretum (Photogr. ASHTON).

mm \varnothing apically, becoming thinly papery flaked, terete, much branched; stipule scars short, horizontal, obscured by tomentum. *Bud* 3–4 by 2–3 mm, broadly ovoid. *Stipule* to 7 by 2 mm, narrowly hastate, acute. *Leaves* 6.5–10 by 3–4.5 cm, chartaceous, frequently cupped, elliptic to oblong-ovate; base narrowly obtuse or broadly cuneate; apex obtuse or with to 5 mm long short acumen; margin usually revolute; nerves 10–12 pairs; tertiary nerves well spaced, scalariform, at 90° to nerves; nervation depressed above; *petiole* 0.8–1 cm long, short. *Panicle* to 11 cm long, terminal or axillary, terete, lax, regularly singly (or doubly if terminal) branched; branchlets to 3.5 cm long, bearing to 8 \pm second flowers; bracts unknown; *bracteoles* to 6 by 3.5 mm, broadly elliptic, obtuse,

pale grey puberulent. *Flower bud* to 15 by 3 mm, fusiform, obtuse. *Calyx* small, densely pale greyish pubescent outside, glabrous within; lobes subequal, broadly ovate to suborbicular. *Petals* pale cream pink at base, linear, obtuse, densely pubescent on parts exposed in bud, loosely adhering on falling. *Stamens* 15, congested, the 5 inner longer by an anthers length, the outer 10 subequal; filaments connate at base, broad, tapering abruptly and filiform distally; anthers oblong; appendages to connective to 4 times length of anther, exceeding style apex, very slender, twisted. *Ovary* and *stylopodium* ovoid, densely shortly pubescent; style almost twice their length, the basal half thickened and setose. *Fruit calyx* persistently sparsely pale buff pubescent at base, glabrescent towards apex; 2 longer lobes to 9 by 1.3 cm, spatulate, obtuse, to 5 mm broad above the to 6 by 6 mm prominently saccate thickened base; 2 shorter lobes to 5 by 3 mm, linear, obtuse, similar at base. *Nut* to 10 by 7 mm, ovoid, shortly densely cream pubescent, acute.

Distr. *Malesia*: Northern Borneo (N.E. Sarawak, Brunei).

Ecol. Rare, yellow sandy soils in Mixed Dipterocarp forest below 800 m.

Vern. *Mēranti mēlechor*.

120. *Shorea flaviflora* WOOD ex ASHTON, Gard. Bull. Sing. 19 (1962) 289, pl. 18; Man. Dipt. Brun. (1964) 188, f. 17; *ibid.* Suppl. (1968) 108; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 107. — Fig. 100 C–C2.

Medium-sized tree, often misshapen. Young parts shortly pale grey pubescent with minute adpressed hair tufts, caducous except on panicle, leaf bud and stipule. *Twig* 2–3 mm \varnothing apically, terete, glabrous, smooth, pale brown; stipule scars 1.5–2 mm long at first, narrow, ascending, half encircling twigs. *Bud* 6–12 by 1.5–3 mm, acute, falcate. *Stipule* to 24 by 7 mm, narrowly hastate, acute, fugaceous. *Leaves* 12–18 by 5.5–7 cm, thinly coriaceous, narrowly ovate; base obtuse or broadly cuneate; acumen to 1.5 cm long, slender; nerves 6–7 pairs, curved, well spaced, slender, prominent beneath, at c. 40°–50°, with small axillary domatia; midrib appanate above, prominent beneath; tertiary nerves very slender, diagonal to nerves, densely scalariform; *petiole* 2–3 cm long. *Panicle* to 15 cm long, terminal or axillary, pendent, terete, rugose on drying; doubly branched at to 3 cm intervals, the branchlets bearing to 12 distichous flowers; *bracteoles* to 5 by 2.5 mm, elliptic, obtuse, densely shortly pale grey pubescent outside, sparsely pubescent within. *Flower bud* to 14 by 4.5 mm, large, fusiform, obtuse. *Calyx* glabrous but for the setose margin: lobes equal, broadly ovate, thickened, closely adpressed at the corolla. *Petals* rich yellow, narrowly lanceolate, acute, firmly connate at base, strongly contorted and twisted, imbricate, the basal half forming a broad cup when open, shortly pubescent on parts exposed in bud. *Stamens* 15, of 3 distinct lengths; filaments expanded at base, abruptly tapering and filiform distally; anthers large, reniform, cells indistinct; appendage to connective c. 3 \times length of anther,

the longest reaching half length of style. *Ovary* and *stylopodium* pyriform, shortly densely pubescent; style as long as ovary and stylopodium, filiform, glabrous. *Fruit calyx* glabrous; 3 longer lobes to 13 by 3 cm, broadly spatulate, obtuse, to 11 cm broad above the to 1.0 by 1.2 cm deeply saccate thickened base; 2 shorter lobes to 8 by 1.3 cm, subequal, similarly saccate. *Nut* to 2.5 by 1.3 cm, ovoid, shortly densely buff pubescent; stylopodium to 1 cm long, tapering.

Distr. *Malesia*: N. Borneo (Rejang hinterland, Crocker Range and Kinabalu).

Ecol. High hill ridges (150–)400–1300 m; locally common.

Vern. *Sëlangan mèrah bukit* (Brunei), *sëraya daun bësar* (Sabah).

121. *Shorea monticola* ASHTON, Gard. Bull. Sing. 19 (1962) 297, pl. 22; Man. Dipt. Brun. (1964) 200, f. 17; *ibid.* Suppl. (1968) 111; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 121.

Medium-sized or relatively large tree. Young twig, leaf bud, petiole and nervation at first shortly yellowish buff pubescent, caducous on all but bud. *Twig* to 3 mm \varnothing apically, stout, terete, becoming smooth but for the minute pale elliptic warty lenticels; stipule scars subamplexicaul or amplexicaul, pale, prominent. *Bud* 5–10 by 2–4 mm, narrowly ovate, acute, falcate. *Stipule* unknown. *Leaves* 8–13 by 5–8 cm, thickly coriaceous, elliptic; undersurface golden lepidote at first, becoming mauve-grey; base obtuse or broadly cuneate; acumen to 5 mm long, short, broad; nerves 13–16 pairs, prominent beneath, curved towards margin, at 45°–55°; tertiary nerves slender, densely scalariform, diagonal to nerves; midrib stout, prominent, sharply ridged beneath, obscurely depressed above; *petiole* 2–2.5 cm long. *Panicle* to 12 cm long, terminal or axillary, terete, densely pale tawny pubescent; singly branched, branchlets bearing to 12 distichous flowers. *Bracts* and *bracteoles* unknown. *Flower bud* to 7 by 3 mm, lanceolate, subacute. *Calyx* shortly pubescent outside, glabrous within; 3 outer lobes narrowly ovate, obtuse; 2 inner lobes $c. \frac{1}{2}$ as long, broader, ovate, acute, constricted at base. *Petals* oblong, obtuse, shortly pubescent on parts exposed in bud. *Stamens* 15, in 3 verticils, the inner 5 somewhat longer than the rest; filaments exposed in bud, broad at base, tapering abruptly, filiform distally; anthers broadly oblong; appendage to connective 2–3 times length of anther, slender. *Ovary* and *stylopodium* pyriform, shortly pubescent; style as long as ovary, filiform, glabrous. *Fruit calyx* puberulent at base, otherwise glabrous; 3 longer lobes to 7 by 1.5 cm, spatulate, obtuse, only slightly tapering above the to 1.5 by 1.5 cm shallowly saccate thickened base; 2 shorter lobes to 3.5 by 0.6 cm, narrowly oblong, similar at base. *Nut* to 1.6 by 1 cm, ovoid, shortly acute, densely shortly pubescent.

Distr. *Malesia*: N. Borneo (West Borneo to Kinabalu and Trusmadi).

Ecol. Mountains, between 1000–1500 m; locally common.

Vern. *Mëranti gunong* (Brunei), *sëraya gunong* (Sabah).

122. *Shorea kunstleri* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 116; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 154, t. 186; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 93; RIDL, Fl. Mal. Pen. 1 (1922) 228; FOXW. Mal. For. Rec. 3 (1927) 51; *ibid.* 10 (1932) 204; BURK. Dict. (1935) 2012; SYM. Mal. For. Rec. 16 (1943) 72, f. 38, 44; BROWNE, For. Trees Sarawak & Brunei (1955) 154; ASHTON, Man. Dipt. Brun. (1964) 192, f. 17, pl. 50 (habit, bark); *ibid.* Suppl. (1968) 109; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 109.

Large buttressed tree. Young parts shortly pale buff puberulent, \pm caducous on twig, petiole and leaf, more dense and persistent on panicle, leaf bud and stipule outside (sparse within). *Twig* $c. 2$ mm \varnothing at apices, much branched, ribbed at first, becoming terete, smooth or rugulose; stipule scars \pm horizontal, $c. 2$ mm long, cuneate, cream-grey. *Bud* 5–7 by 2–2.5 mm, falcate. *Stipule* to 1.2 by 0.4 cm, narrowly lanceolate, acute, fugaceous. *Leaves* 8–12 by 4.5–7 cm, broadly ovate, coriaceous, frequently twisted to one side, normally glabrous (rarely pubescent); base obtuse or broadly cuneate; acumen to 1 cm long; nerves 6–8 pairs, slender, hardly raised beneath, curved, at $c. 50^{\circ}$ – 60° , with or without minute axillary domatia; midrib appanate; tertiary nerves slender, scalariform, at 90° to midrib; *petiole* 2–3.5 cm long. *Panicle* to 15 cm long, terminal (rarely axillary), slender, slightly compressed on drying; regularly singly or doubly branched, the branchlets lax, bearing to 9 secund flowers; *bracteoles* to 5 by 3.5 mm, elliptic, obtuse, shortly densely pale greyish pubescent. *Flower bud* to 9 by 3 mm, narrowly ovoid-lanceolate, acute. 3 outer *sepals* longer, deltoid, acuminate; 2 inner ovate, acuminate. *Corolla* pale yellow, pink at base, shortly pubescent on parts exposed in bud; petals narrowly lanceolate, obtuse, twisted, slightly saccate. *Stamens* 15, the inner 5 only slightly longest; filaments expanded at base, narrowing abruptly distally; anthers broadly oblong; appendage to connective more than twice length of anther, the inner 5 reaching almost to style apex. *Ovary* and *stylopodium* pyriform, shortly pubescent; style filiform, glabrous but for the sparsely pubescent base, somewhat shorter than ovary. *Fruit calyx* entirely glabrous; 3 longer lobes to 8.5 by 1.8 cm, spatulate, narrowly obtuse, $c. 5$ mm broad above the $c. 1.2$ cm long and broad strongly saccate thickened base; 2 shorter lobes to 4 by 0.4 cm, unequal, linear, similarly saccate at base. *Nut* to 2 by 1.5 cm, ovoid, densely shortly buff pubescent; style remnant $c. 3$ mm long, conical.

Distr. *Malesia*: Malaya (Perak and E. coast), N. Sumatra (Langsa, Atjeh), Borneo (Lower Kapuas, West Borneo; Sarawak; E. Sabah and S.E. Borneo to Sampit).

Ecol. Local on infertile leached sandy clay soils on low hills and ridges, rarely to 800 m; on ultrabasics in Sabah.

Vern. *Damar laut mèrah*, *mëranti pahang*, *sëlambar*,

Revel
1977

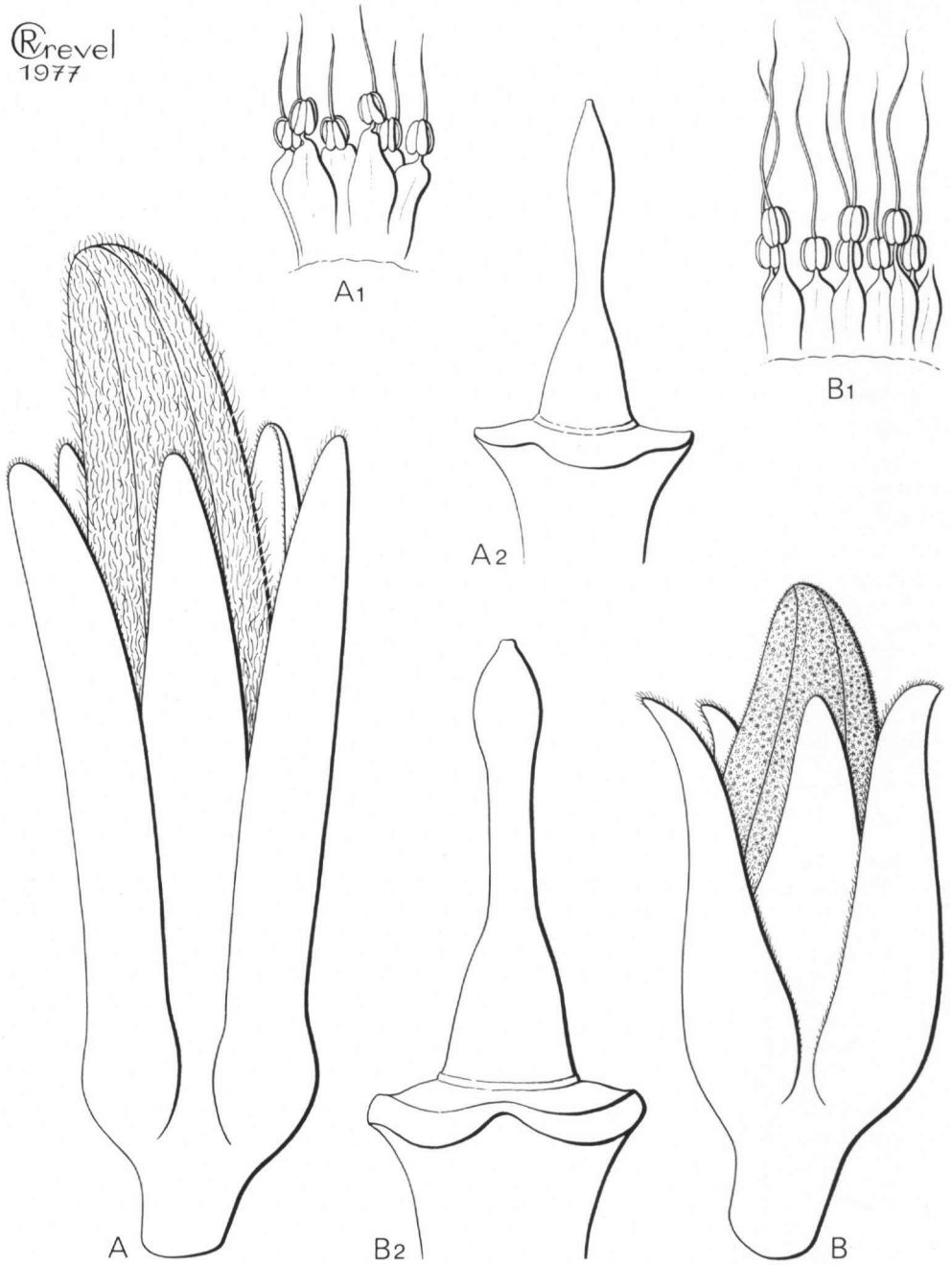


Fig. 103. Flower details in *Shorea* sect. *Pachycarpae* HEIM. All $\times 10$. — *S. pinanga* SCHEFF. A. Bud, A1. stamens from inside, A2. pistil. — *S. rotundifolia* ASHTON. B. Bud, B1. stamens from inside, B2. pistil (A JACOBS 5330, B S 29226).

têngkawang bukit, t. batu, tərbak, sėraya, s. kitan, balau mərəh (Malaya).

Note. Collections from the Kapuas valley differ in

having the lamina somewhat bullate between the nerves, which are slightly more numerous and more ascending than in the type.

8. Section Pachycarpae

HEIM, Rech. Dipt. (1892) 44; ASHTON, Gard. Bull. Sing. 20 (1963) 269 ('*Pachycarpa*'); Man. Dipt. Brun. (1964) 118. — *Shorea* sect. *Pinanga* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 90. — Fig. 103, 104.

Flower buds ovoid or fusiform; corolla as in sect. *Rubella*; *stamens* 15, in 3 subequal verticils; filaments lorate, adnate along their margins thus forming a tube round the ovary, tapering \pm abruptly below the anthers; anthers subglobose or broadly oblong; appendage to connective filiform, slender, glabrous, erect, 2- ∞ times length of anther; *ovary* small, glabrescent or glabrous; style filiform, stylopodium indistinct, or both spindle-shaped, tapering distally and basally. 3 outer *fruit calyx lobes* lorate, broad at base. *Stipules, bracts* and *bracteoles* persistent, large. *Leaf* with scalariform tertiary nerves; midrib above evident, \pm depressed. Small or large stoutly buttressed trees. Bark surface remaining smooth and hoop-marked longer than in other sections, later becoming \pm flaky, sometimes scroll marked. *Wood* as in sect. *Brachypterae*.

Distr. *Malesia*: Borneo.

Ecol. In lowland forest below 1200 m.

Vern. *Langgai, ęngkabang* (Iban, Sarawak), *tęngkawang, abang*.

Note. Flowers of *S. splendida* and *S. stenoptera* are visited by small *Hymenoptera* as well as thrips (*S. APPANAH*) and are thought to be pollinated by them. The only uniform and constantly distinguishable widespread species is *S. mecistopteryx*; all others exhibit much geographical variability, with high uniformity within populations nevertheless, and apparent hybridization with one or more species in some part of their range. Embryogenesis appears to be normal, self-incompatibility high (CHAN H. T.) and the group appears therefore to be undergoing active speciation.

123. *Shorea pilosa* ASHTON, Gard. Bull. Sing. 19 (1962) 304, pl. 25; Man. Dipt. Brun. (1964) 209, f. 18, pl. 55 (slash, bark); *ibid.* Suppl. (1968) 115; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 136.

Medium-sized to large tree. *Twig, leaf bud, petiole*, both surfaces of midrib, leaf beneath and panicle densely persistently scabrid gold tomentose; leaf above puberulent or glabrescent. *Twig* 2-2.5 mm \varnothing apically, slightly compressed, becoming terete, much branched; stipule scars narrow, almost horizontal, amplexicaul. *Leaf bud* 3-7 by 1.5-3 mm, ovoid, obtuse or subacute. *Stipule* to 3.5 by 1.3 cm, hastate, acute; base slightly constricted; relatively persistent. *Leaves* 10-17 by 4-7.5 cm, ovate or elliptic, somewhat coriaceous; base obtuse; acumen to 1.3 cm, long, narrow; margin frequently narrowly revolute; nerves 12-15 close slightly curved pairs, at 45°-50°, with hispid axillary domatia; tertiary nerves densely scalariform, at c. 90° to the nerves; *petiole* 1-1.3 cm long, short. *Panicle* to 14 cm long, singly branched, terminal or axillary, terete. *Flower bud* to 8 by 3 mm, lanceolate. *Sepals* narrowly deltoid, subequal, densely pubescent on parts exposed in bud. *Petals* cream tinted with

pink, lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15, the inner 5 slightly the longest; filaments compressed, connate, abruptly tapering below the broadly ellipsoid anthers; appendage to connective aristate, c. 4 \times length of anthers. *Ovary* ovoid, glabrous; style and stylopodium spindle-shaped, glabrous. *Fruit calyx* glabrescent; 3 longer lobes by 17 by 2.5 cm, subequal, oblong-spatulate, obtuse, c. 1.3 cm broad above the c. 1.3 by 1.5 cm thickened deeply saccate base, adpressed to and hiding the nut; 2 shorter lobes to 12 by 1 cm, spatulate, similar at base. *Nut* to 2 by 1.8 cm, ovoid, abruptly constricted below the to 1 cm long narrow-conical apex; style remnant acute, densely shortly buff pubescent.

Distr. *Malesia*: N.W. Borneo (Kapuas hinterland, W. Borneo, to W. Sabah).

Ecol. Local, on sandy clay soils on undulating land and low hills.

Vern. *Kawang bulu* (Brun.), *langgai* (Iban).

Note. Collections from Sabah and Brunei differ in their distinctly buff tomentum and prominent tomentose leaf domatia. Those from W. Borneo could be interpreted as a hybrid with *S. amplexicaulis*.

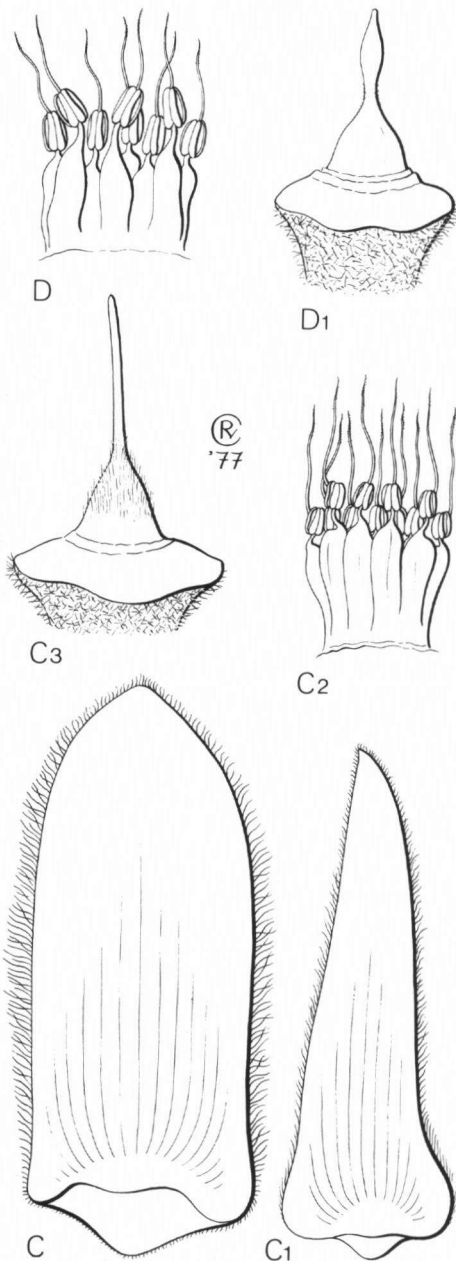


Fig. 104. Flower details in *Shorea* sect. *Pachycarpae* HEIM. All $\times 10$. — *S. beccariana* BURCK. C. Outer sepal, C1. inner sepal, both from inside, C2. stamens from inside, C3. pistil. — *S. macrophylla* (DE VRIESE) ASHTON. D. Stamens from inside, D1. pistil (C JACOBS 5563, D bb. 29722).

124. *Shorea splendida* (DE VRIESE) ASHTON, Gard. Bull. Sing. 20 (1963) 279; Man. Dipt. Brun. Suppl. (1968) 119, f. 15. — *Hopea splendida* DE VRIESE, Minjak Tengkawang (1861) 28. — *S. martiniana* SCHEFF. Nat. Tijds. N. I. 32 (1873) 408; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 208, t. 29, f. 2; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 78; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 306; MERR. En. Born. (1921) 405; HEYNE, Nutt. Pl. ed. 2 (1927) 1123; BACKER & BAKH. f. Fl. Java 1 (1963) 331; BROWNE, For. Trees Sarawak & Brunei (1955) 140.

Small to medium-sized tree. Vegetative parts glabrous. Twig c. 3 by 1 mm \varnothing apically, smooth, compressed, ribbed; stipule scars to 1 mm thick, prominent, amplexicaul, pale. Bud c. 8 by 6 mm, a loose aggregation of young leaves and stipules. Stipule to 2.5 by 1.5 cm, prominent, subsistent, ovate, acute or subacute, with cordate subequal base. Leaves 8.5–23 by 4.2–11 cm, oblong, chartaceous, undulate, \pm lustrous; base typically cordate, sometimes obtuse or broadly cuneate; acumen to 1 cm long; nerves 9–12 pairs, slender but prominent beneath, at 45° – 65° to the midrib; tertiary nerves sinuous, remotely scalariform, vertical to the nerves; midrib prominent beneath, applanate above; petiole 11–22 mm long, drying rugose. Panicle to 20 cm long, terminal or axillary, glabrous, terete, ascending; singly branched, branchlets to 7 cm long, bearing to 10 flowers; bracts to 18 by 8 mm, as stipules, caducous; bracteoles to 6 by 4 mm, elliptic, obtuse, subsistent, prominent. Flower bud to 10 by 3 mm, lanceolate. Sepals narrowly deltoid, acute, subequal, sparsely pubescent on parts exposed in bud. Petals lanceolate, sparsely pubescent on parts exposed in bud. Stamens 15, the inner 5 longer than the outer 10; filaments compressed and connate along $\frac{3}{4}$ of their length, abruptly tapering below the broadly ellipsoid anthers; appendage to connective 4–5 times length of anthers, almost reaching style apex, slender, sericeous in the distal $\frac{1}{2}$. Ovary ovoid, glabrous; style and stylopodium spindle-shaped, glabrous. Fruit pedicel to 7 mm long, to 4 mm \varnothing , large. Calyx glabrous; 3 major lobes to 7.5 by 2.3 cm, narrowly oblong to broadly spatulate, c. 12 mm broad above the to 22 by 18 mm ovate saccate thickened base; 2 inner lobes to 6.5 by 1.2 cm, as long as or somewhat exceeding the nut, oblong, similar at base. Nut to 5.5 by 3 cm, ovoid, acute, shortly densely evenly pale buff pubescent.

Distr. *Malesia*: Borneo (Kapus valley, Sarawak west of the Lupar; Muara Tewe, planted?).

Ecol. Frequent, locally abundant, on clay-rich periodically flooded alluvium, sometimes planted.

Uses. An important producer of Borneo illipe fat (*buah têngkawang*).

Vern. *Têngkawang*, t. *rambai* (W. Borneo), *mëlingdang*, t. *lëmying* (Muara Tewe), *êngkabang rambai* (Sarawak).

Notes. Though variable, the leaf shape and broad, cordate, subsistent stipules make this species generally easy to recognize; possibly occasionally hybridizing with *S. pinanga*.

Some populations in Kapuas appear to hybridize with *S. stenoptera*.

125. *Shorea stenoptera* BURCK, Med. Lands Pl. Tuin 3 (1886) 11; Ann. Jard. Bot. Btzig 6 (1887) 209, t. 21; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 78; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 264; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 308; MERR. En. Born. (1921) 407; GILG in E. & P. Pfl. Fam. ed. 2, 21 (1925) 260; HEYNE, Nutt. Pl. ed. 2 (1927) 1113, 1125; BROWNE, For. Trees Sarawak & Brunei (1955) 144; ASHTON, Man. Dipt. Brun. Suppl. (1968) 120, f. 15.

Small tree. Twig apex, petiole and midrib above sometimes densely ocherous pubescent (immature tree?), more commonly glabrous; stipule outside occasionally sparsely pubescent. Twig 3–4 mm \varnothing apically, somewhat compressed to terete, becoming smooth; stipule scars pale, prominent, descending, amplexicaul. Bud 4 by 3 mm, ellipsoid, obtuse, usually obscured by stipules. Stipule to 2 by 1 cm, ovate, deltoid, obtuse, subauriculate at base, subsperisistent. Leaves 18–40 by 8–22 cm, large, oblong, thickly coriaceous; base broadly cuneate to cordate; acumen to 2 cm long, \pm prominent; nerves 10–14 pairs, stout, prominent, beneath, at 45°–60° along the midrib, to 110° near its base; tertiary nerves remotely scalariform; midrib evident but appanate above, prominent and terete beneath; petiole 2.3–4.5 cm long, stout. Panicle to 35 cm long, terminal or axillary, glabrous or (rarely) sparsely pubescent towards the base; borne behind the twig apices in the axils of fugaceous rudimentary leaves, a chain of short internodes being concealed in a dense profusion of the straight terete inflorescences with ascending branchlets; branchlets to 10 cm long; bracts and bracteoles to 6 by 4 mm, identical, ovate, acute, glabrous, not at first caducous. Flower bud to 7 by 3 mm, lanceolate. Sepals deltoid, acute, densely pubescent outside, sparsely so within; inner 2 smaller, relatively narrower than outer 3. Petals deep pink, lanceolate, sparsely pubescent on parts exposed in bud. Stamens 15, the inner 5 somewhat longer than the others and exceeding the style apex; filaments compressed, lorate, connate at margins along $\frac{3}{4}$ of their length, tapering abruptly below the ellipsoid anthers; appendage to connective slender, 3–4 \times length of anther, sericeous towards the apex. Ovary narrowly ovoid, glabrous; style and stylopodium spindle-shaped, slender, glabrous. Fruit pedicel to 4 mm long and \varnothing , prominent. Calyx glabrous; 3 longer lobes to 7.5 by 2 cm, spatulate, obtuse, to 1 cm broad above the to 2.5 by 2 cm ovate thickened saccate base; 2 shorter lobes to 5.5 by 0.8 cm, lorate-spatulate, obtuse, similar at base. Nut to 5 by 3 cm, ovoid, apiculate, large, densely shortly evenly buff pubescent.

Distr. *Malesia*: Borneo (Kapuas valley, Sarawak west of the Saribas; Muara Tewe, planted?).

Ecol. Locally common on \pm poorly drained sandy soils on alluvium and plateaux at low altitudes.

Vern. *Tĕngkawang layar*, *t. tungkul*, *t. rambai*, *t. tajan*, *t. tĕlur* (W. Borneo), *ĕngkabang rusa* (Sarawak).

Notes. A remarkably variable species. Sometimes a big tree, when it may differ from *S. macrophylla* only in the glabrous midrib and could be a hybrid. Usually small, but even then differing greatly between provenances; in West Sarawak the inflorescences are always axillary, born in groups between short internodes and subtended by modified or no leaves.

Some cultivated plants at Kepong flower almost annually, while one of the provenances planted at Haurbentes in West Java flowers almost continuously; it is said that the wild parents of the latter also did so.

126. *Shorea macrophylla* (DE VRIESE) ASHTON, Gard. Bull. Sing. 20 (1963) 278; Man. Dipt. Brun. (1964) 196, f. 18, 20; *ibid.* Suppl. (1968) 110, pl. 22 (illipe nuts); MEIJER & WOOD, Sabah For. Rec. 5 (1964) 156. — *Hopea macrophylla* DE VRIESE, Minjak Teng-kawang (1861) 28. — *S. gysbertsiana* BURCK, Med. Lands Pl. Tuin 3 (1886) 15; Ann. Jard. Bot. Btzig 6 (1887) 211, t. 23, 30, f. 2–3, *incl. var. scabra* BURCK, *l.c.*, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 93; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 301; MERR. En. Born. (1921) 405; HEYNE, Nutt. Pl. ed. 2 (1927) 1113, 1114, 1119; FISCHER, Kew Bull. (1932) 177; BROWNE, For. Trees Sarawak & Brunei (1955) 139; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 45, 108, 156, f. 1d. — *S. bakeriana* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 974; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 96; MERR. En. Born. (1921) 404. — *Pachychlamys gysbertsiana* RIDL. Fl. Mal. Pen. 1 (1922) 233 (*'ghysbertiana'*). — Fig. 104 D–D1.

Medium-sized to large tree. Young twig, leaf bud, stipules, petiole, leaf beneath and midrib above persistently densely evenly caducous pale brown pubescent. Twig 2.5–4 by 2–3 mm \varnothing apically, compressed, becoming smooth, glabrous; stipule scars to 1 mm thick, amplexicaul, pale cream, \pm horizontal, smooth, glabrous. Bud 12–18 by 4–6 mm, compressed, hastate, narrowly obtuse. Stipule to 5 by 1.3 cm, broadly hastate, obtuse, constricted at base. Leaves 17–35 by 10–14 cm, elliptic-oblong, \pm coriaceous; base obtuse or subcordate; acumen to 1.5 cm long; nerves 11–20 pairs, prominent beneath, well spaced, at 55°–65°; tertiary nerves distinct, well spaced, scalariform, at 90° to nerves; midrib prominent, rounded, beneath, broad and appanate above; petiole 1.5–3 cm long. Panicle to 17 cm long, terminal or axillary, ribbed and compressed when dry, shortly evenly persistently buff pubescent, singly branched; bracteoles to 1.2 by 0.5 cm, oblong, subacute. Flower bud to 8 by 5 mm, broadly or narrowly ellipsoid. Calyx lobes densely pale brown pubescent outside, glabrous within; lobes subequal, broadly elliptic to deltoid, obtuse to acuminate. Petals pale pink, broadly ovate, obtuse, densely pubescent on parts exposed in bud. Stamens 15, of 2 lengths, the inner 5 an anther's length longer than the outer 10; filaments broad, compressed, united in a tube round the ovary, tapering distally and filiform below the oblong anthers; appendage to connective c. 2 \times length of anther, slender, glabrous.

Ovary ovoid, densely pubescent in the distal half; stylopodium and style glabrous, spindle shaped, as long as ovary. *Fruit calyx* glabrous; 3 longer lobes to 11 by 3 cm, coriaceous, oblong, obtuse, to 1.5 cm broad above the to 1.8 by 2.3 cm horizontally elliptic deeply saccate thickened base; 2 shorter lobes to 8 by 1.5 cm, similar at base, base obscured by larger lobes. *Nut* to 6 by 4 cm, obovoid, persistently evenly shortly pale buff pubescent; style remnant, small, short, acute.

Distr. *Malesia*: Borneo (widespread, but especially W. and Central Sarawak, Kapuas valley, Tidung and Berau).

Ecol. Locally abundant on clay-rich periodically flooded alluvium and river banks, uncommon on hillsides, below 600 m.

Uses. The principal source of the Bornean Illipe nut; sometimes planted.

Vern. *Tĕngkawang*, *t. jantong*, *t. guntjong*, *tukung* (West Borneo), *ĕngkabang jantong* (Sarawak, Iban), *kawang*, *k. jantong* (Brun.), *abang* (Mur., Dusun, S. Borneo), *kĕkawang buah* (Berau), *mĕngkalang* (Tidung), *orai tolloi* (Muara Tewe).

Note. The form occurring in E. Sabah shares certain characters (stipule scars, length of petiole, smaller nut) of *S. pinanga* and suggests hybridisation.

127. *Shorea praestans* ASHTON, Gard. Bull. Sing. 22 (1967) 297, pl. 42; Man. Dipt. Brun. Suppl. (1968) 115, f. 14.

Small tree. All parts apparently glabrous. *Twigs* c. 5 by 3 mm towards the apices, stout, compressed, smooth; stipule scars slender but clearly evident, amplexicaul. *Bud* to 25 by 7 mm, falcate-lanceolate, compressed, acute. *Stipules* to 11 by 5 cm, very large, elliptic, subacute, not at first caducous. *Leaves* 24–35 by 11–18 cm, large, ± broadly oblong, thickly coriaceous; base cordate; apex obtuse or shortly broadly acuminate; nerves 11–13 pairs, obscure above, prominent beneath, at 45°–70°, remotely subscalariform, slender but evident beneath; midrib appanate above, prominent beneath; *petiole* 4–6.5 cm long, stout, drying rugose. *Flowers* and *inflorescences* unknown. *Fruit* entirely glabrous. *Pedice*l to 5 mm long and \emptyset , stout. 3 longer *calyx lobes* to 15 by 3 cm, spatulate, obtuse, glabrous, tapering to c. 1.5 cm broad above the to 1.5 by 1.8 cm broadly elliptic saccate thickened base; 2 shorter lobes to 10.5 by 1.5 cm, spatulate, subacute, similar at base. *Nut* to 2 by 2 cm, ovoid, glabrous; style remnant to 4 mm long, filiform.

Distr. *Malesia*: Borneo (Central Sarawak).

Ecol. Rare, deep yellow sandy soils in Mixed Dipterocarp forest on coastal hills.

Note. Vicarious with *S. stenoptera*, of which it appears to be a segregate; specimens from the Saribas valley in particular approach an intermediate leaf-shape.

128. *Shorea rotundifolia* ASHTON, Gard. Bull. Sing. 22 (1967) 299, pl. 44; Man. Dipt. Brun. Suppl. (1968) 117, f. 14. — Fig. 103 B–B2.

Medium-sized tree. Young twig, petiole and stipule pruinose, otherwise glabrous. *Twig* c. 3 by 2 mm \emptyset apically, terete or slightly compressed, smooth; stipule scars amplexicaul, prominent. *Bud* to 20 by 8 mm, large, lanceolate, compressed. *Stipule* to 6 by 2 cm, lanceolate-falcate, obtuse, subsistent. *Leaves* alternate, 9–21 by 8–14 cm, broadly ovate to suborbicular, coriaceous, lustrous; base obtuse to cordate; acumen to 1 cm long, cuspidate; nerves 9–11 pairs, curved, prominent beneath, at to 115° towards the base, 45° towards the apex; tertiary nerves remotely scalariform; midrib appanate above, prominent and terete beneath. *Petiole* 3–4 cm long, very long. *Panicle* to 15 cm long, terminal or axillary, lax, glabrous, compressed; regularly singly branched, branchlets to 2 cm long, bearing remote distichous flowers; *bracts* to 10 by 6 mm, elliptic-lanceolate, acute, glabrous, fugaceous; *bracteoles* to 8 by 4 mm, similar. *Flower bud* to 10 by 4 mm, fusiform. *Calyx* glabrous; lobes narrowly deltoid, subequal, subacute. *Petals* lanceolate, shortly pubescent on parts exposed in bud. *Stamens* 15, the 5 innermost slightly longest; filaments broad, connate, tapering abruptly beneath the ellipsoid anthers; appendages c. 3 \times length of anther, aristate. *Ovary* ovoid, glabrous, surmounted by a spindle-shaped style and stylopodium. *Fruit* glabrous. *Pedice*l c. 6 mm long, 3 longer fruit calyx lobes c. 13 by 2.5 cm, spatulate, obtuse, c. 6 mm broad above the c. 15 by 18 mm somewhat saccate thickened base; shorter lobes to 8 by 0.7 cm, narrowly lanceolate, subacute, similar at base. *Nut* c. 2.5 by 1.08 cm, ovoid, glabrous; style remnant to 7 mm long.

Distr. *Malesia*: Borneo (Central Sarawak).

Ecol. Local on inland ridges at 300–500 m.

Notes. A local species apparently derived from *S. amplexicaulis* with which it occurs.

Occurring as small groups or scattered individuals, with some local differentiation even within its small range.

129. *Shorea amplexicaulis* ASHTON, Gard. Bull. Sing. 19 (1962) 273, pl. 10; Man. Dipt. Brun. (1964) 177, f. 18, 20, pl. 53 (bark); *ibid.* Suppl. (1968) 104; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 95, f. 11. — Fig. 105.

Medium-sized to large tree. All parts, including stipule (both surfaces), caducous or persistently pale buff to golden pubescent. *Twig* to 3 by 2 mm \emptyset apically, slightly compressed when young, slender, becoming terete, glabrous, smooth; stipule scars c. 0.5 mm thick, horizontal, ± amplexicaul. *Bud* 10–15 by 3–5 mm, hastate, obtuse. *Stipule* to 25 by 8 mm, hastate, subacute, subsistent. *Leaves* 11–21 by 5–8 cm, elliptic, coriaceous; base cuneate; acumen to 1 cm long; nerves 9–12 pairs, curved, at 50°–70°, prominent beneath; tertiary nerves distinct, remotely scalariform; midrib prominent and terete beneath, ± appanate above; *petiole* 1.5–2.5 cm long. *Panicle* to 24 cm long, terminal or axillary, lax, slender, compressed; regularly singly branched, branchlets to 10 cm long, bearing to 11 distichous flowers; *bracts* to 13 by 8 mm, lanceolate, acute, glabrous, fugaceous;

v. Os

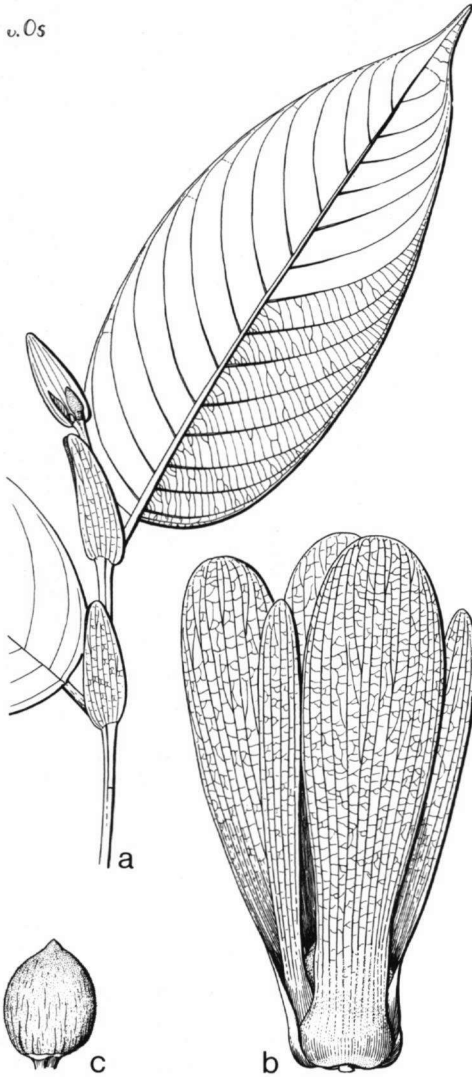


Fig. 105. *Shorea amplexicaulis* ASHTON. a. Habit, b. fruit, c. nut, with part of indumentum, all $\times \frac{1}{2}$ (a SAN 22690, b-c S 6502).

bracteoles to 11 by 5 mm, oblong, obtuse, glabrescent or persistently puberulent outside, glabrous within, subsistent. *Flower bud* to 10 by 3.5 mm, lanceolate, obtuse. *Calyx* densely shortly pale grey pubescent outside, glabrous within; lobes subequal, narrowly deltoid, obtuse, slightly expanded at base. *Petals* pale yellow, narrowly lanceolate, subacute, shortly pubescent on parts exposed in bud. *Stamens* 15, the 5 inner slightly longest; filaments broad, united in a ring,

tapering abruptly beneath the narrowly oblong anthers; appendage to connective over twice as long as anther, not reflexed. *Ovary* ovoid, somewhat longer than ovary; no distinct stylopodium. *Fruit* impressed at base. *Calyx* puberulent or glabrescent; 3 longer lobes to 18 by 3 cm, oblong-spatulate, obtuse, to 2 cm broad above the to 1.6 by 2.2 cm broadly ovate saccate thickened base; 2 shorter lobes to 13 by 0.8 cm, similar at base. *Nut* to 3.7 by 2.5 cm, broadly ovoid, persistently evenly densely gold-buff pubescent; style remnant short, acute.

Distr. *Malesia*: Borneo (S.W. excepted).

Ecol. Widespread, often common, on clay soils, especially ridges, from sea level to 700 m.

Vern. *Kawang pinang*, *mèranti kawang pinang lichin* (Brun.), *langgai* (Iban), *abang* (Dus.), *kawang bukit* (Sabah), *orai lanyung*, *awang rambut* (S.E. Borneo), *èngkabang pipit*, *tèngkawang megeh tèlur* (W. Borneo).

Notes. Sometimes difficult to distinguish from *S. beccariana*, especially when young; the amplexicaul stipule scars and crimson young parts are typical of the present species, and the golden-yellow stellate-hairy young parts and leaf undersurface of *S. beccariana* typically distinguish them.

In S.E. Borneo apparently hybridizing with *S. pinanga*, in W. Borneo with *S. pilosa* (q.v.).

130. *Shorea mecistopteryx* RIDL. Kew Bull. (1925) 280; SLOOT. in Merr. Pl. Elm. Born. (1929) 203; SYM. Gard. Bull. S. S. 9 (1938) 348; ASHTON, Man. Dipt. Brun. (1964) 198, f. 18, pl. 52 (bark), *ibid.* Suppl. (1968) 111; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 119, f. 2a, pl. 7 (habit). — *S. chrysophylla* RIDL. Kew Bull. (1926) 470; SLOOT. in Merr. Pl. Elm. Born. (1929) 202.

Large tree. Young twig, panicle, leaf bud, stipule outside, petiole and leaf beneath shortly evenly \pm persistently gold-tomentose. *Twig* to 6 by 2.5 mm \varnothing apically, compressed, becoming terete, smooth; stipule scars initially to 2.5 mm long, cuneate, horizontal. *Leaf bud* 5–8 by 2.5–5 mm, ovoid, compressed, obtuse. *Stipule* to 25 by 7 mm, hastate, acute. *Leaves* 13–20(–30) by 6–10(–12) cm, oblong, chartaceous; base cordate; acumen to 8 mm long, broad; nerves 16–20 pairs, curved, at 45° – 65° along midrib and to 120° at base; tertiary nerves densely scalariform, at 90° to nerves; midrib prominent and terete beneath, rather narrow, \pm applanate above; *petiole* 2.5–3.5 cm long. *Panicle* to 12 cm long, terete or compressed, terminal or axillary, singly branched; *bracteoles* to 7 by 2 mm, oblong, subacute, densely pubescent outside, sparsely so within. *Flower bud* to 12 by 4 mm, lanceolate. *Calyx* densely shortly greyish pubescent outside, glabrous within; lobes narrowly deltoid, subequal, \pm patent, the 2 inner slightly shorter, thinner, slightly expanded at base. *Corolla* shortly pubescent on parts exposed in bud; *petals* linear, subacute. *Stamens* 15, the 5 inner somewhat longer than the others; filaments united in the basal half, tapering to the anthers in the distal half; anthers

oblong; appendage to connective over twice as long as anthers, not reflexed. *Ovary* narrowly ovoid-conical, glabrous; stylopodium somewhat longer than ovary, thickened in the distal half; style stout. *Fruit pedicel* to 6 mm long, stout. *Fruit calyx* glabrescent or persistently puberulent at base; 3 longer lobes to 23 by 3.3 cm, spatulate, narrowly obtuse, to 1.8 cm broad above the to 2 by 2.5 cm broadly ovate saccate thickened base; 2 shorter lobes to 15 by 1.2 cm, linear, similar at base, base enveloped by larger lobes. *Nut* to 4.2 by 2.5 cm, ovoid, persistently shortly evenly yellowish buff pubescent; style remnant acute.

Distr. *Malesia*: Borneo.

Ecol. Local: undulating land and low hills on sandy clay soils in Mixed Dipterocarp forest below 400 m.

Vern. *Těngkawang layar* (Kapuas), *těntang pakar* (M. Tewe), *ěngkabang larai* (Sarawak), *rěbah* (Iban), *kawang tikus*, *kawang burong* (Sabah).

Note. The most uniform and distinct species in the section.

131. *Shorea beccariana* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 213; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 87; MERR. En. Born. (1921) 404; BROWNE, For. Trees Sarawak & Brunei (1955) 138; ASHTON, Gard. Bull. Sing. 20 (1963) 280; Man. Dipt. Brun. (1964) 180, f. 18, 20; *ibid.* Suppl. (1968) 105; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 100. — *S. franchetiana* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 956; Mem. Ass. Franç. Besançon 1892 (1893) 459. — *S. beccarii* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 87, *nomen in syn.* — Fig. 104 C–C3.

Medium-sized or large tree. Young twig, panicle, leaf bud, stipule (both surfaces), and petiole shortly evenly densely deep rufous-brown puberulent, becoming pale mauve-grey, sparsely so on nervation beneath and midrib above. *Twig* 3–6 by 1–2.5 mm \varnothing apically, compressed, becoming smooth, glabrous; stipule scars to 2 mm long, shortly cuneate or falcate, \pm ascending, sometimes horizontal, prominent. *Bud* 7–11 by 3.5–4.5 mm, hastate, compressed, acute. *Stipule* to 14 by 5 mm, small, oblong, obtuse, fugaceous. *Leaves* 11–20 by 5.5–7 cm, elliptic to ovate; coriaceous, gold lepidote beneath, becoming mauve-grey in mature trees; base obtuse or broadly cuneate; acumen to 8 mm long, broad; nerves 11–14 pairs, curved, not strongly raised beneath, at 50°–60°, to 90° at base; tertiary nerves remotely scalariform, slightly diagonal to nerves; midrib prominent beneath, \pm depressed above; *petiole* 2–4 cm long. *Panicle* to 20 cm long, terminal or axillary, lax, \pm compressed; singly branched, branchlets to 2.5 cm long, short, bearing to 8 distichous flowers; *bracts* to 15 by 9 mm, oblong, obtuse, shortly pubescent outside, puberulent within, fugaceous; *bracteoles* to 13 by 8 mm, otherwise as with bracts, caducous. *Flower bud* to 9 by 3 mm, lanceolate, obtuse. *Calyx* outside shortly pubescent or glabrescent, glabrous within; lobes subequal, deltoid, the inner 2 slightly shorter, thinner, somewhat expanded at base. *Petals* pink, paler along margins, lanceolate, obtuse, sparsely pubescent on parts exposed in bud.

Stamens 15, the inner 5 slightly longer; filaments broad, tapering in the distal half, united in a ring at the base; anthers oblong; appendage to connective 2–3 \times length of anther, reaching almost to style apex. *Ovary* ovoid, frequently sparsely pubescent apically; style and stylopodium cylindrical, $1\frac{1}{2}$ –2 \times length of ovary, rather short, glabrous. *Fruit* base frequently impressed. *Calyx* glabrescent, sparsely dotted with minute hair tufts; 3 longer lobes to 19 by 2.7 cm, spatulate, obtuse, to 1.2 cm broad above the to 1.2 by 1.8 cm broadly ovate deeply saccate thickened base; 2 shorter lobes to 10.5 by 0.9 cm, subequal, linear, similar at base. *Nut* to 4 by 2.8 cm, broadly ovoid, shortly persistently evenly pale buff tomentose; style remnant to 4 mm long, conical.

Distr. *Malesia*: Northern Borneo (Ulu Kapuas, Sarawak to Sabah and Nunukan).

Ecol. Common on deep leached soils in lowlands and along dry sandstone and shale ridges to 1350 m.

Vern. *Měranti langgai*, *kawang* (Brun.), *langgai* (Iban), *abang* (Dus.), *sěraya langgai* (Sabah), *těngkawang těngkal*, *t. raraing*, *t. bagok*, *t. layar*, *t. bėnua*, *t. tangga*, *ěngkabang maha* (W. Borneo).

Note. Closely allied to *S. amplexicaulis*.

132. *Shorea pinanga* SCHEFF. Nat. Tijd. N. I. 31 (1870) 350; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 211, t. 24, 30, f. 1; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 94, t. 2, f. 17–18; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 267; BECC. For. Born. (1902) 570; Bull. Ort. Bot. Napoli 2 (1904) 92; MERR. En. Born. (1921) 406; SLOOT. in Merr. Pl. Elm. Born. (1929) 203; BACKER & BAKH. f. Fl. Java 1 (1963) 331; ASHTON, Gard. Bull. Sing. 20 (1963) 281; Man. Dipt. Brun. (1964) 210, f. 18, 20; *ibid.* Suppl. (1968) 115; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 137, pl. 9. — *S. gysbertsiana* BURCK var. *scabra* BURCK, Med. Lands Pl. Tuin 3 (1886) 17, p.p. — *S. compressa* BURCK, Med. Lands Pl. Tuin 3 (1886) 26; Ann. Jard. Bot. Btzg 6 (1887) 212; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 87; MERR. En. Born. (1921) 404. — Fig. 103 A–A2.

Medium-sized or large tree. Young twig, panicle, leaf bud, stipule and petiole shortly densely fugaceous to persistently gold-brown pubescent; sparsely so on leaf beneath. *Twig* 4–6 by 2–3 mm \varnothing apically, compressed, becoming smooth; stipule scars to 3 mm long, to 1.5 mm thick at base, strongly falcate, descending. *Bud* to 10 by 4 mm, hastate, subacute, usually hidden by stipules. *Stipule* to 6 by 1.5 cm, glabrescent, hastate, subacute, somewhat persistent. *Leaves* 11–24 by 4–9 cm, elliptic to narrowly ovate, \pm thinly coriaceous, with broadly cuneate to subcordate base and to 1.5 cm long deltoid acumen; nerves 10–20 pairs, slender, curved, at 50°–70° but to 90° at base; tertiary nerves densely scalariform, diagonal to nerves; midrib prominent and terete beneath, \pm applanate and narrow above; *petiole* 1.5–2.3 cm long, slender. *Panicle* to 24 cm long, terminal or axillary, lax, compressed; singly branched, the branchlets long, bearing to 15 distichous flowers; *bracts* to 15 by 7 mm, lanceolate, acute, glabrous to pubescent, fugaceous;

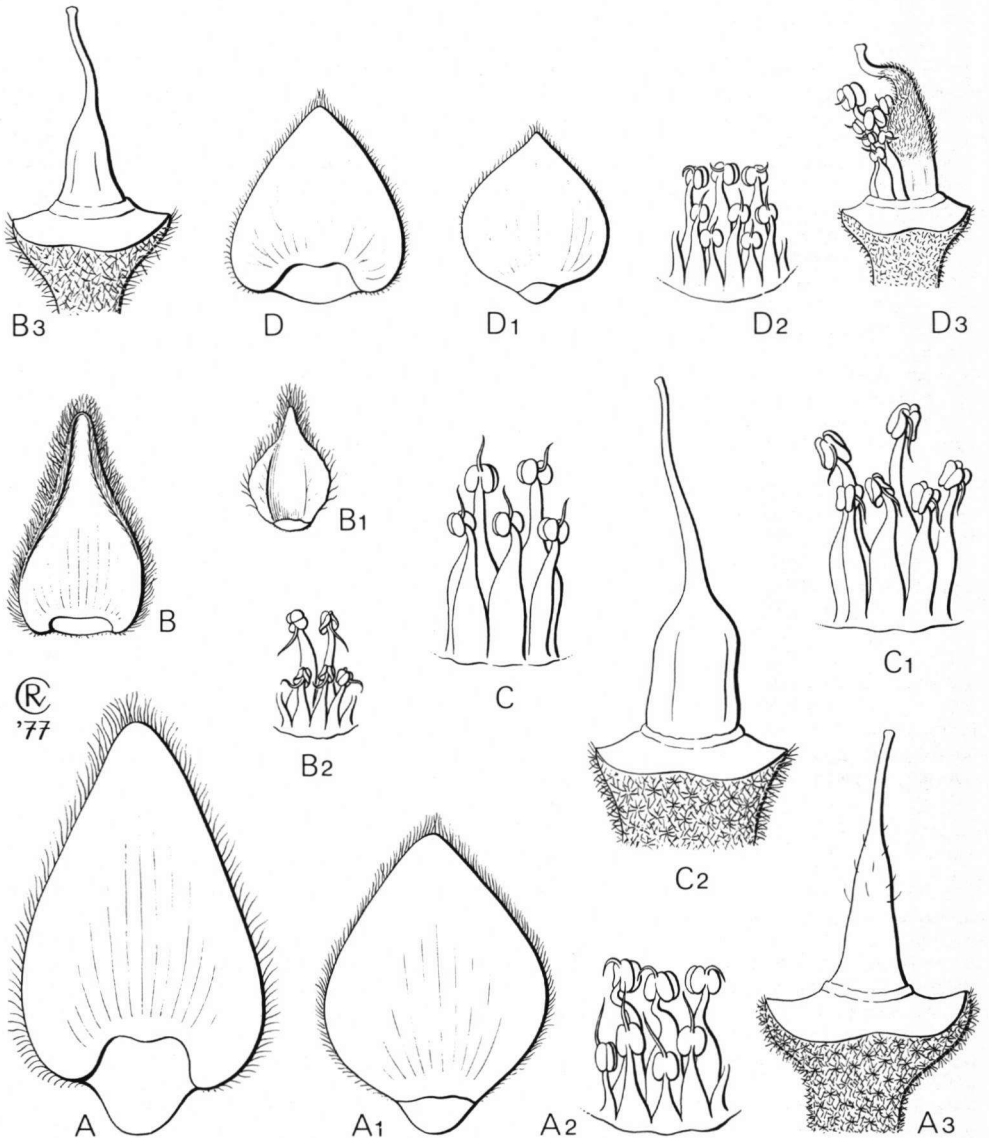


Fig. 106. Flower details in *Shorea* sect. *Mutica* BRANDIS. All $\times 10$. Sepals drawn from inside. — *S. slootenii* WOOD ex ASHTON. *A*. Outer sepal, *A1*. inner sepal, *A2*. stamens from outside, *A3*. pistil. — *S. platycarpa* HEIM. *B*. Outer sepal, *B1*. inner sepal, *B2*. stamens from outside, *B3*. pistil. — *S. macrantha* BRANDIS. *C*. Young stamens from outside, *C1*. older stamens from outside, *C2*. pistil. — *S. macroptera* DYER. *D*. Outer sepal, *D1*. inner sepal, *D2*. stamens from outside, *D3*. pistil (*A* ROSLI & ASAH 3365, *B* Neth. Ind. For. Serv. I-E-2P-694, *C* HAVILAND 2119, *D* SAN 36703 = NT 592).

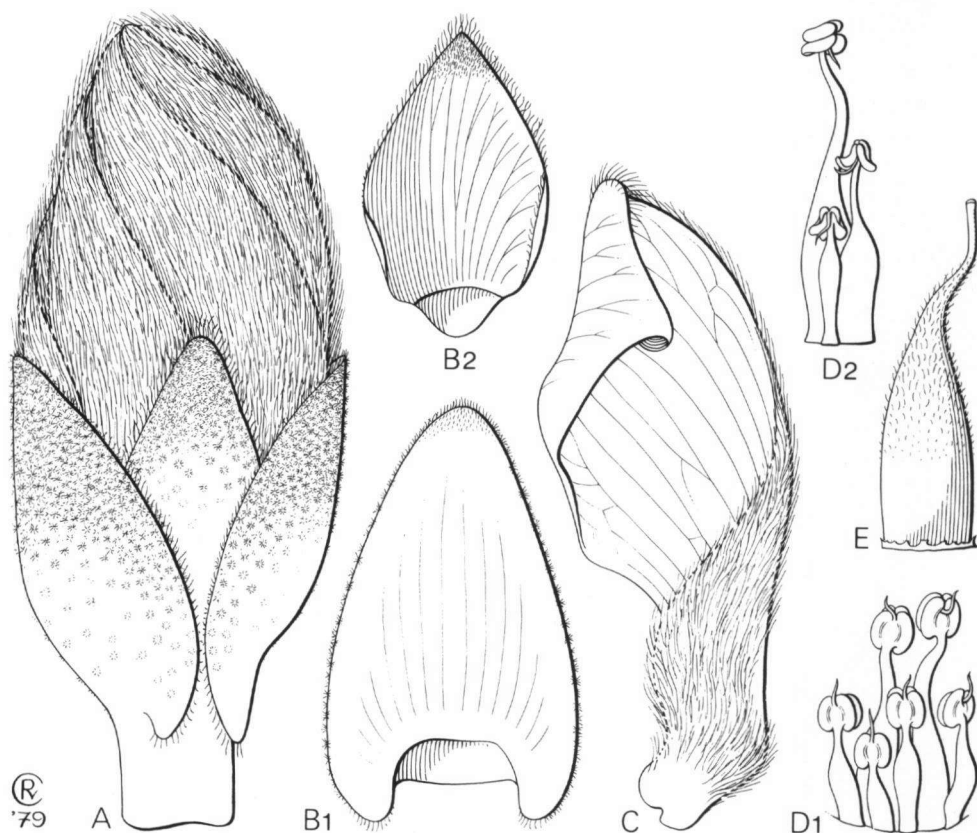


Fig. 107. Flower details in *Shorea* sect. *Mutica* BRANDIS subsect. *Auriculatae* ASHTON. — *S. myrionerva* SYM. ex ASHTON. A. Bud, B1. outer sepal, B2. inner sepal, C. petal, D1. stamens from a young bud, D2. stamens from mature bud, E. pistil, all $\times 10$ (JACOBS 5371).

bracteoles to 10 by 8 mm, broadly ovate, acute, glabrous to pubescent, subpersistent. *Flower bud* to 10 by 3 mm, linear, subacute. *Calyx* glabrous or pubescent outside; lobes subequal, linear, subacute. *Petals* deep pink, hardly contorted, long, linear-lanceolate, sparsely pubescent on parts exposed in bud. *Stamens* 15, the innermost 5 slightly the longest; filaments broad, united in a ring round the ovary, tapering abruptly distally; appendage to connective many times length of anther, reaching to style apex. *Ovary* subglobose, surmounted by a long narrow style and stylopodium about twice its length, the latter 2 distended in the distal half; entirely glabrous. *Fruit calyx* glabrescent; 3 longer lobes to 28 by 3.5 cm, coriaceous, narrowly spatulate, narrowly obtuse, to 2.3 cm broad above the to 1.5 by 2.5 cm broadly ovate saccate thickened base; 2 shorter lobes to 17 by 1.2 cm, subequal, linear, similar at base. *Nut* to 2.3 cm long and broad, broadly ovoid, shortly evenly pale yellow-

ish buff pubescent; style remnant to 2 mm long, slender, acute.

Distr. *Malesia*: Borneo.

Ecol. Clay-rich soils especially on ridges below 700 m; locally common.

Vern. *Langgai* (Iban), *mēranti langgai bukit* (Brunei), *kawang pinang* (Sabah), *awang lanying*, *a. kēlalai*, *a. boi*, *a. labuan*, *abang burong*, *kakan mērah* (S.E. Borneo), *ēngkabong bukit*, *tēngkawang amung*, *t. tēlur*, *t. kērayung*, *t. gunong*, *t. sambai*, *t. bunga*, *t. minggi*, *t. rēput*, *t. lumut*, *t. umba*, *t. tēlaga*, etc. (W. Borneo).

Notes. This, and to a lesser extent the two previous species, varies greatly and almost continuously in tomentum density, and also in leaf shape, number of nerves and relative length of petiole; the twig shape, and stipule scars are the most reliable characters to distinguish them.

The species may hybridize with *S. macrophylla* and *S. amplexicaulis* in restricted parts of its range.

9. Section Mutica

BRANDIS, J. Linn. Soc. Bot. 31 (1895) 100; ASHTON, Gard. Bull. Sing. 20 (1963) 268; Man. Dipt. Brun. (1964) 117. — *Shorea*, Red Meranti group, *S. parvifolia* subgroup, SYM. Mal. For. Rec. 16 (1943) 59, f. 36 (map). — Fig. 106, 107.

Flower buds ± ovoid. *Corolla* as in sect. *Rubella*. *Stamens* 15, in 3 verticils; filaments broad at base, tapering gradually to anthers; anthers with 4 pollen sacs, broadly oblong to subglobose; appendage to connective aristate, rather short, becoming reflexed at least on outer anthers. *Ovary* with distinct stylopodium, both ± densely tomentose; style shorter than ovary or very slightly longer. Branchlets of *raceme* short; flowers dense. *Stipules*, *bracts* and *bracteoles* usually caducous, rarely subsistent (*S. quadrinervis*, *S. acuminata*). *Leaf* with scalariform tertiary nerves; midrib ± evident above. *Bark surface* usually becoming V-section fissured. *Wood* as in sect. *Brachypterae*.

Distr. Peninsular Thailand and *Malesia*: Malaya, Sumatra, Banka, Borneo.

Ecol. Scattered in lowland evergreen forest below 1600 m.

Vern. *Red mēranti*, *mēranti mērah* (Mal., Sum.), *pērawan*, *lop* (Iban).

9a. Subsection Auriculatae

ASHTON, Gard. Bull. Sing. 22 (1967) 300. — Fig. 107.

Fruit calyx lobes auriculate at base. *Bark surface* remaining smooth or, after passing through an ephemeral shallowly V-section fissured stage, becoming flaky.

Distr. As section.

Note. This subsection consists of two very distinct species, *S. slootenii* and *S. myrionerva*, and those others which cluster round the geographically very variable *S. macroptera*. *S. macroptera* is known in Malaya to be thrip pollinated, and variably apomictic through adventive polyembryony (CHAN H. T.), all but *S. macroptera* are endemic to Borneo: *S. macroptera* itself manifests great morphological uniformity except in that island where it is highly variable.

133. *Shorea slootenii* WOOD ex ASHTON, Gard. Bull. Sing. 19 (1962) 312, pl. 29; Man. Dipt. Brun. (1964) 222, f. 16; *ibid.* Suppl. (1968) 119; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 147. — Fig. 106 A–A3.

Twig, panicle, leaf bud, stipule outside (pubescent within), petiole and leaf beneath densely persistently scabrid pale fulvous tufted tomentose, the tufts short, hard and knob-like; midrib above shortly pubescent. *Twig* to 5 by 3 ∅ apically, stout, compressed and ribbed at first, later terete, verrucose owing to the persistent bases of the hair-tufts; stipule scars to 3 mm long, 0.5 mm thick at base at first, long cuneate, slightly ascending. *Bud* 6–10 by 5–8 mm, broadly ovoid, slightly compressed, obtuse. *Stipule* to 25 by 8 mm, oblong, obtuse. *Leaves* 11–22 by 4–7 cm, broadly oblong, coriaceous, deeply cupped; base obtuse; acumen to 1.5 cm long; nerves (25–)27–34 pairs, dense, depressed above, prominent beneath, arched at margin at 50°–60°; tertiary nerves scalariform, prominent beneath, slightly diagonal to nerves or at 90°; midrib prominently terete beneath, depressed above; *petiole* 1.7–2.3 cm long, stout. *Panicle* to 18 cm long,

terminal or axillary, stout, brittle, ± compressed; singly or doubly regularly branched, branchlets short, bearing to 4 flowers; *bracteoles* to 3 by 2 mm, ovate to deltoid, obtuse, densely yellowish brown pubescent outside, glabrous within, caducous. *Flower bud* to 12 by 7 mm, ovoid to ellipsoid, obtuse. *Calyx* shortly densely tawny pubescent outside, glabrous within; 3 outer lobes ovate acuminate, longer than the 2 acute inner lobes. *Petals* pale yellow, lanceolate, subacute, densely shortly tawny pubescent on parts exposed in bud. *Stamens* 15, the 5 inner reaching the base of the style, about twice as long as the other 10, the latter of two different heights; filaments tapering gradually, slightly twisted in bud; anthers globose; appendage to connective shorter than anther, reflexed on 5 inner stamens; twice as long as anthers, hardly reflexed, on 10 outer stamens. *Ovary* and *stylopodium* narrowly ovoid to lanceolate, sparsely setose in distal half, surmounted by a broadly filiform style almost as long as the ovary, glabrous. *Fruit calyx* lustrous, puberulent, more densely so towards the base; 3 longer lobes to 17 by 1.8 cm, oblong, obtuse, hardly tapering towards base; base with an ovoid to 2 by 1.2 cm

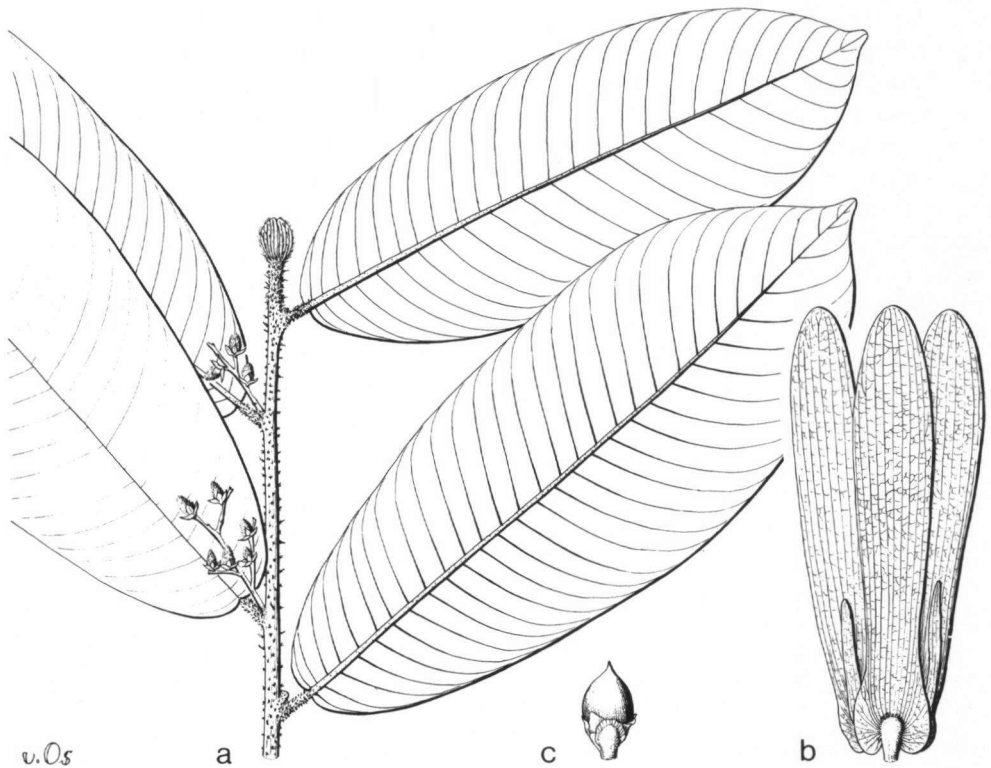


Fig. 108. *Shorea myrionerva* SYM. ex ASHTON. a. Habit, b. fruit, c. seed, all $\times \frac{1}{4}$ (a S 31986, with terminal bud from bb. 14614, b-c S 15591).

saccate thickened central area adpressed to nut, the lobes continuing laterally as to 1 cm broad auricles, tapering abruptly at pedicel; 2 shorter lobes 5.5 by 0.7 cm, unequal, linear, similarly expanded and auriculate at base. *Nut* to 3.5 by 1.3 cm, ovoid, densely shortly pale brown to buff pubescent; style remnant to 4 mm long, tapering, acute.

Distr. *Malesia*: N.W. Borneo (Lower Kapuas, Sarawak to S.W. Sabah).

Ecol. Local, sandy clay soils on hills near the present or Pleistocene coastline, to 400 m.

Vern. *Mèranti képong*, *m.k. kasar* (Sar., Brun.), *kawang raung* (Dusun).

134. *Shorea myrionerva* SYM. ex ASHTON, Gard. Bull. Sing. 19 (1962) 299, pl. 23; Man. Dipt. Brun. (1964) 201, f. 16; *ibid.* Suppl. (1968) 111; MELJER & WOOD, Sabah For. Rec. 5 (1964) 122. — *Shorea* sp. BROWNE, For. Trees Sarawak & Brunei (1955) 145. — Fig. 107–109.

Medium-sized, occasionally large, tree. Twig and petiole persistently dotted with scattered pale fulvous-

brown long hair tufts; nervation beneath and stipule more shortly so; fully expanded leaf glabrescent. *Twig* 2.5–3.5 mm \varnothing apically, stout, straight, little branched, terete; stipule scars to 2 mm long, to 1 mm wide, pale, cuneate. *Bud* to 10 by 7 mm, a loose group of bud-scales, compressed. *Stipule* to 17 by 7 mm, broadly hastate, subauriculate, subacute, subsistent (more so in young trees and saplings). *Leaves* 12–22 by 4.5–9 cm, narrowly oblong, chartaceous; base obtuse; apex tapering abruptly; acumen to 8 mm long, broad; nerves 24–28 slender close pairs, prominent beneath, curved towards the margin; tertiary nerves slender, scalariform, at c. 90°; midrib depressed above; *petiole* 1.2–2 cm long, short, stout. *Panicle* to 8 cm long, axillary, rarely terminal, becoming ramiflorous, terete, ribbed on drying, lax, glabrous but for sparse fulvous tufts towards base; singly branched, the branches short, bearing to 5 distichous flowers; *bracts* to 8 by 1.5 mm, narrowly lanceolate, acute, puberulent outside, glabrous within; *bracteoles* to 5 by 3 mm, ovate, obtuse. *Flower bud* to 5 by 3 mm, elliptic, obtuse. *Calyx* shortly densely pubescent outside,

glabrous within; lobes subequal, ovate, the outer 3 rather narrower and subacuminate. *Petals* dark red with a pale margin, narrowly ovate, obtuse, densely yellowish gold pubescent on parts exposed in bud. *Stamens* 15, of 3 lengths, the inner 5 much longer than the others and almost reaching the style apex; filaments thick, tapering gradually; anthers broadly oblong, slightly tapering; appendages to connective short, becoming reflexed. *Ovary* and *stylopodium* narrowly conical to pyriform, shortly pubescent; style somewhat shorter than ovary and stylopodium, broadly filiform, glabrous. *Fruit calyx* glabrous; 3 longer lobes to 17 by 2.5 cm, oblong, obtuse, thinly chartaceous, not tapering basally; base thickened and saccate at the centre, with 2 thin, to 1.5 cm broad, lateral auricles; 2 shorter lobes subequal, to 8 by 0.7 cm, linear, saccate but not auriculate. *Nut* to 2.5 by 1.3 cm, ellipsoid, pruinose, glabrous; style remnant c. 1.5 mm long, acute.

Distr. Malesia: Borneo (Rejang hinterland to S.W. Sabah, E. Kutei).

Ecol. On moist clay hillsides, alluvium and river-banks.

Vern. *Abang gunong* (Kutei), *kawang tikus* (Brunei), *sĕraya urat*, *banyak* (Sabah), *pitun* (Dus.), *abang* (Murut), *langgai*, *sĕpit undang*, *ĕngkabang* (Iban).

135. *Shorea sagittata* ASHTON, Gard. Bull. Sing. 22 (1967) 299, pl. 45, 352 (phot. habit); Man. Dipt. Brun. Suppl. (1968) 118, f. 15, pl. 23 (stem-base).

Large tree. Leaf above evenly caducous cream-buff pubescent, other vegetative parts densely shortly persistently pink-brown scabrid tomentose. *Twig* c. 2 mm \varnothing at first, terete, ribbed, becoming red-brown verruculose; stipule scars short, ascending. *Bud* to 7 by 7 mm, broadly ovoid. *Stipule* to 10 by 8 mm, ovate, subacute, saccate, caducous. *Leaves* 7–15 by 3–6 cm, narrowly oblong to lanceolate; base obtuse; acumen to 1.5 cm long, slender; nerves 19–25 pairs, slender but prominent beneath, at 70°–80° near the base, 50° near the apex; tertiary nerves slender, densely scalariform; midrib depressed above, prominent beneath; petiole 9–17 mm long. *Panicle* imperfectly known, at least 6 cm long, singly branched, densely persistently pink-brown scabrid tomentose. *Fruit calyx* sparsely puberulent; 3 longer lobes to 11 by 2.5 cm, lorate-spatulate, obtuse, tapering only slightly above the prominently sagittate-auriculate base, base in all to 18 mm broad, with to 6 by 4 mm elliptic thickened saccate central disc; 2 shorter lobes to 2 cm long, c. 3 mm wide, linear, acute, not auriculate at base. *Nut* 15 by 8 mm, ellipsoid, shortly apiculate, puberulent towards the apex.

Distr. Malesia: N.W. Borneo (Central and W. Sarawak, Ulu Kapuas in W. Borneo; ?Tidung, ?Puraktjau, sterile collections).

Ecol. Locally frequent on sandy clay soils on low hills and ridges to 1000 m, in Mixed Dipterocarp forest.

Vern. *Mĕranti luang* (Sarawak).

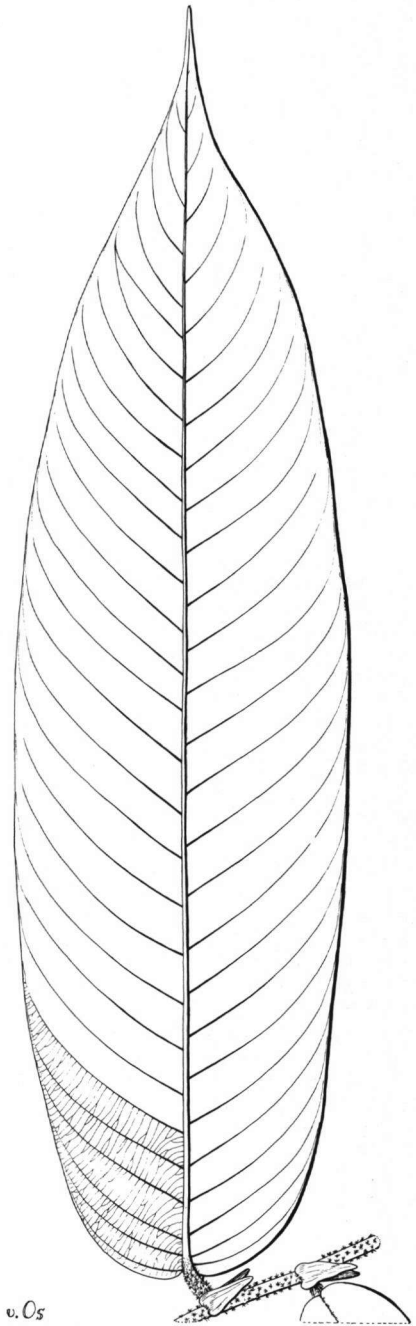


Fig. 109. *Shorea myrionerva* SYM. ex ASHTON. Part of twig and leaf of 3 m high sapling, $\times \frac{1}{2}$ (BRUN 5200).

136. *Shorea macroptera* DYER, Fl. Br. Ind. 1 (1874) 308; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 90; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 267. — Fig. 106 D-D3.

Note. Beside the subspecies described at least two forms (one in Melawi, one in S. Central Kalimantan) exist in Indonesian Borneo, for which more complete material is required. See also under the next species, *S. ferruginea*.

KEY TO THE SUBSPECIES

1. Panicles singly branched or doubly branched at base.
 2. Twigs, petioles and panicles densely evenly shortly buff pubescent . . . a. *ssp. macroptera*
 2. Twigs, petioles and panicles sparsely tufted tomentose or glabrescent . . . b. *ssp. baillonii*
1. Panicles doubly branched; tomentum dense, even, persistent.
 3. Leaves (9-)18-23 by (4-)6.5-9.5 cm; nerves 13-15 pairs . . . c. *ssp. sandakanensis*
 3. Leaves 8-16 by 4-6 cm; nerves 10-14 pairs . . . d. *ssp. macropterifolia*

a. *ssp. macroptera*. — KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 113; RIDL, Agr. Bull. Str. & F.M.S. 1 (1901) 57; Fl. Mal. Pen. 1 (1922) 225; BURK. J. Str. Br. R. As. Soc. 76 (1917) 164, fig.; *ibid.* 81 (1920) 51, 70, 75, fig.; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 305; *ibid.* ed. 2 (1927) 1123; FOXW. Mal. For. Rec. 3 (1927) 30; *ibid.* 8 (1930) 21; *ibid.* 10 (1932) 195; EDWARDS, Mal. For. Rec. 9 (1932) 145; BURK. Dict. (1935) 2016; SYM. Mal. For. Rec. 16 (1943) 78, f. 38, 48; ASHTON, Gard. Bull. Sing. 20 (1963) 276. — *S. auriculata* SCORT. ex FOXW. Mal. For. Rec. 10 (1932) 195, *nom. in syn.*

Large tree. Young twig, panicle, leaf bud, stipule outside (puberulent within), petiole, midrib above at base and nervation beneath densely evenly shortly pale brown pubescent. *Twig* to 2 mm \varnothing apically, frequently slightly compressed, becoming terete, glabrous; stipule scars short, narrowly cuneate, \pm horizontal. *Bud* 4-6 by 2.5-4 mm, ovoid, subacute. *Stipules* to 8 by 3 mm, oblong, subacute, fugaceous. *Leaves* 10-15 by 3-5 cm, elliptic or oblong, coriaceous; base broadly cuneate; acumen to 1 cm long; nerves 12-15(-18) pairs, prominent beneath, curved, at 40°-50°; tertiary nerves slender, densely scalariform, sinuate, diagonal to nerves; midrib prominent and terete beneath, slightly depressed above; *petiole* 1.5 cm long. *Panicle* to 10 cm long, terminal or axillary, slightly compressed or terete, lax; singly branched or doubly branched near base, the branchlets bearing to 7 distichous flowers; bracteoles to 3.5 by 2.5 mm, elliptic, obtuse, shortly yellowish brown pubescent outside, glabrous within, fugaceous. *Flower bud* to 5 by 3 mm, ovoid. *Calyx* outside densely shortly pale yellowish brown pubescent, glabrescent within; lobes subequal, ovate, the 3 outer acuminate, the 2 inner acute. *Petals* cream to pink at base, linear, acute, twisted, yellow pubescent on parts exposed in bud.

Stamens 15, of 3 lengths, the longest reaching just above the ovary; filaments tapering gradually; anthers broadly oblong; appendage to connective short, becoming reflexed. *Ovary* and *stylopodium* \pm conical, densely pale grey pubescent, glabrous near base; style c. 1/2 length of ovary, slender, glabrous. *Fruit calyx* shortly sparsely puberulent, glabrescent; 3 longer lobes to 12 by 2.3 cm, spatulate, obtuse, to 1 cm broad above base; base with to 7 by 5 mm ovoid saccate thickened centre and 2 lateral narrow auricles, the whole to 1.2 cm broad, abruptly tapering at pedicel; 2 shorter lobes to 6 by 0.6 cm, narrowly oblong, similar at base. *Nut* to 1.8 by 1.2 cm, ovoid, densely evenly shortly pale buff pubescent; style remnant 2 mm long, acute.

Distr. Peninsular Thailand, and *Malesia*: Malaya (excepting seasonal areas), Singapore, Singkep, Lingga, E. Sumatra (Djambi, Indragiri, Kuantan Distr., Langkat).

Ecol. Well drained Mixed Dipterocarp forest, especially in hills, to 900 m, common.

Vern. *Mélanta*, *mèranti mèlantai*, *m. bèlantai*, *m. kunyit*, *m. kètapah*, *kèpong labu*, *k. sègar*, *tèmak* (Malaya), *lukup* (Riouw), *mèranti undang*, *m. sabut*, *m. piring*, *m. tèlor*, *m. mangu*, *m. tampalu*, *m. kunyit* (Sumatra).

b. *ssp. baillonii* (HEIM) ASHTON, Gard. Bull. Sing. 20 (1963) 277, f. 16, pl. 51 (bark); Man. Dipt. Brun. Suppl. (1968) 111; BROWNE, For. Trees Sarawak & Brunei (1955) 137. — *S. bailloni* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 973.

Defining characters: Small tree. Twigs, petioles and panicle sparsely tufted pubescent or glabrescent, drying blackish. *Leaves* 12-19 by 3.5-7 cm, narrowly elliptic; base narrowly cuneate; apex tapering; nerves 11-14(-15) pairs, prominent but terete beneath. *Panicles* c. 13 cm long, singly branched or doubly so at base; branchlets to 2.5 cm long. 3 longer *fruit calyx lobes* to 13 cm long.

Distr. *Malesia*: W. Borneo (Sampit, Lower Kapuas, Sarawak west of Bintulu).

Ecol. Clay soils on low hills to 600 m, common.

Vern. *Mèranti mèlantai* (Sar.), *sèpit undang* (Iban).

c. *ssp. sandakanensis* (SYM.) ASHTON, Gard. Bull. Sing. 20 (1963) 277. — *S. macroptera* SLOOT. in Merr. Pl. Elm. Born. (1929) 203; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 116, f. 14, *p.p.* — *S. sandakanensis* SYM. Gard. Bull. S. S. 9 (1938) 343, pl. 25.

Defining characters: Large tree. *Leaves* (9-)18-23 by (4-)6.5-9.5 cm, narrowly oblong; base obtuse; apex abruptly attenuate; nerves 13-15 pairs, prominently acute beneath; petiole to 2 cm long. *Panicles* to 16 cm long, doubly branched, branchlets to 8 cm long. 3 longer *fruit calyx lobes* to 14 cm long.

Distr. *Malesia*: E. Borneo (Kudat to Balikpapan: wrongly recorded from Sarawak by BROWNE, For. Trees Sarawak & Brunei p. 143).

Ecol. As *ssp. baillonii*.

Vern. *Seraya mēlantai* (Sabah), *tēgērangān sibu*, *t. batu* (Nunukan).

d. ssp. macropterifolia ASHTON, Gard. Bull. Sing. 20 (1963) 277; Man. Dipt. Brun. (1964) 197; *ibid.* Suppl. (1968) 111; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 116.

Defining characters: Large tree. *Leaves* 8–16 by 4–6 cm, narrowly ovate, coriaceous; base obtuse; apex tapering; nerves 10–14 pairs, slender but sharply prominent beneath; petiole to 1.5 cm long. *Panicles* to 16 cm long, twice branched; branchlets to 8 cm long. 3 longer *fruit calyx lobes* to 14 cm long.

Distr. *Malesia*: northern Borneo (Rejang hinterland to W. Sabah).

Ecol. Clay soils on undulating land and hillsides to 600 m, local.

Vern. *Mērāntimēlantai* (Brun.), *sēpit undang* (Iban).

137. *Shorea ferruginea* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 91; BECC. For. Born. (1902) 570; MERR. En. Born. (1921) 405; BROWNE, For. Trees Sarawak & Brunei (1955) 139; ASHTON, Gard. Bull. Sing. 20 (1963) 281; Man. Dipt. Brun. (1964) 187, f. 19; *ibid.* Suppl. (1968) 108; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 106. — *S. discolor* HEIM, Rech. Dipt. (1892) 67, *nomen*.

Large tree. Young twig, panicle, leaf bud, stipule outside (glabrescent or shortly pubescent within), petiole beneath and leaf above sparsely persistently pale brown scabrid puberulent. *Twig* 2–2.5 mm \varnothing apically, terete, ribbed below the stipule scars, becoming smooth; stipule scar c. 2 mm long, c. 0.5 mm thick, pale, cuneate, slightly falcate, horizontal or slightly ascending. *Leaf bud* 5–8 by 4–6 mm, ovoid, subacute. *Stipule* to 15 by 5 mm, hastate, acute. *Leaves* 12–24 by 5.5–11 cm, broadly oblong to ovate, thinly coriaceous; base obtuse; acumen to 1.2 cm long; nerves 15–19 pairs, prominent, at 60°–70°, curved apically; short secondary nerves frequently present; tertiary nerves elevated, remote, at 90° to nerves; midrib prominent and terete beneath, depressed above; *petiole* 1–1.5 cm long, short. *Panicle* to 22 cm long, terminal or axillary, terete or ribbed, lax, regularly alternately singly or doubly branched, the branchlets bearing to 7 second flowers; *bracts* and *bracteoles* to 7 by 3 mm, ovate, acute. *Calyx* shortly densely pale grey-brown pubescent, glabrous within; 3 outer lobes longer, \pm deltoid to ovate, subacute; 2 inner lobes shorter, narrowly deltoid to ovate, acute, acuminate. *Petals* narrowly oblong, densely pubescent on parts exposed in bud. *Stamens* 15, the 5 inner an anther's length longer than the others; filaments basally expanded, abruptly tapering and filiform distally; anthers oblong; appendage to connective reaching to style apex on 5 inner stamens, more than twice as long as anthers, curved but not reflexed. *Ovary* and *stylopodium* pyriform, densely pubescent in the distal half, shortly densely pubescent basally, style as long as ovary and stylopodium, filiform, glabrous. *Fruit* subsessile. *Calyx* glabrescent; 3 longer lobes to 5 by 0.8 cm, spatulate,

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Fig. 110. *Shorea acuta* ASHTON. a. Tip of sterile twig, b. fruit, c. nut, all $\times \frac{1}{2}$ (a SAN 17474, b-c BRUN 3291).

subequal, to 3.5 mm broad above the to 1.5 by 1.2 cm ovate glabrous shallowly saccate thickened base; 2 shorter lobes to 23 by 1.5 mm, linear, similar at base. *Nut* to 2.7 by 1.0 cm, ovoid, shortly buff pubescent, apiculate, shorter than longer calyx lobes.

Distr. *Malesia*: Borneo.

Ecol. Widespread on skeletal soils along ridges to 1100 m.

Vern. *Seraya melantai kechil* (Sabah), *meranti menalit* (Sar.), *tehan betung*, *t. paru*, *t. parei*, *t. lutup*, *lampong tahan* (S.E. Borneo).

Note. Collections from Melawi which I ascribe to *S. macroptera* on account of their prominent nervation possess the indumentum of this species and underline the close relationship between the two. I maintain this species separately from *S. macroptera* because, throughout its range in East Malaysia I never saw morphologically intermediate individuals though the two species commonly grow in mixture.

138. *Shorea acuta* ASHTON, Gard. Bull. Sing. 19 (1962) 268, pl. 8; Man. Dipt. Brun. (1964) 174, f. 16; *ibid.* Suppl. (1968) 104. — Fig. 110.

Large tree. Young twig, panicle, leaf bud, stipule (both surfaces), petiole, nervation beneath and midrib above evenly persistently shortly pale brown puberulent, glabrescent on nervation and midrib. *Twig* to 4 mm \varnothing , slightly compressed at first, becoming terete, glabrous, smooth; stipule scars initially to 3 mm long, to 1 mm thick, cuneate, horizontal. *Bud* 6–10 by 4–6 mm, ovoid, subacute. *Stipule* to 12 by 5 mm, oblong, obtuse. *Leaves* 14–26 by 6.5–12 cm, elliptic, thickly coriaceous; base obtuse, sometimes broadly cuneate; acumen to 2 cm long, \pm narrowly deltoid; nerves 10–13 pairs, prominent beneath, curved, at 45°–55° along the midrib, to 90° at the base; tertiary nerves slender, sinuate, densely scalariform, diagonal to nerves; midrib prominent and terete beneath, narrowly slightly depressed above; *petiole* 1.5–2 cm long, stout. *Panicle* to 8 cm long, terminal or axillary, compressed; singly or doubly branched at 2 cm intervals, branchlets to 6 cm long, bearing to 9 distichous flowers; *bracteoles* to 3.5 by 2.5 mm, elliptic, obtuse, shortly yellowish brown puberulent outside, glabrous within, caducous. *Flower bud* to 9 by 4 mm, narrowly ellipsoid, obtuse. *Calyx* shortly densely yellowish buff pubescent outside, glabrous

within; lobes subequal, ovate, subacute. *Corolla* dark crimson, pubescent on parts exposed in bud; petals linear, subacute. *Stamens* 15, of 3 lengths, the longest reaching just above the ovary, filaments tapering gradually; anthers subglobose; appendage to connective short, becoming reflexed. *Ovary* and *stylopodium* narrowly conical to ovoid, long tomentose towards the apex, shortly so at base; style c. $\frac{1}{2}$ length of ovary and stylopodium filiform, glabrous. *Fruit calyx* shortly sparsely glabrescent; 3 longer lobes to 15 by 2.8 cm, spatulate, obtuse, to 1.5 cm broad above the base; base to 18 mm broad, with to 8 by 7 mm ovate saccate thickened centre and 2 lateral auricles, abruptly tapering to the pedicel; 2 shorter lobes to 8 by 0.7 cm, linear, unequal, similar at base. *Nut* to 3 by 2 cm, ovoid, shortly evenly densely pale fulvous to buff pubescent; style remnant short, acute.

Distr. *Malesia*: Borneo (N.E. Sarawak, Brunei).

Ecol. Locally common below 400 m, on deep sandy soils in Mixed Dipterocarp forest.

Vern. *Mëlantai*, *kawang tikus*, *ëngkabang tikus*, *mëranti kawang tikus* (Brun.), *mërabubok*, *langgai* (Iban).

9b. Subsection *Mutica*

ASHTON, Gard. Bull. Sing. 22 (1967) 301 ('*Muticae*'). — *Shorea* subg. *Rubroshorea* MEIJER, Act. Bot. Neerl. 12 (1963) 322. — Fig. 106.

Fruit calyx lobes not auriculate. *Bark surface* early becoming deeply and persistently V-section fissured, only rotting off in very large trees.

Distr. As section.

Note. Species of this subsection are, with the exception of *S. scabrida* and *S. retusa* easy to identify. Many are widespread and morphologically remarkably uniform. *S. parvifolia*, which is usually variable for the subsection, and consists of at least two ecotypically and partially geographically separate forms is linked with several sibling species endemic in Borneo (*S. rubra*, *S. foraminifera*, *S. scabrida*, *S. retusa*, *S. revoluta*); it is known to be partially apomictic through adventive polyembryony (MAURY). Hybridization is known among some species but is exceptionally rare. All species are thrip pollinated, and sympatric species flower sequentially (CHAN, H. T.).

139. *Shorea quadrinervis* SLOOT. Bull. Bot. Gard. Btzg III, 17 (1942) 220, f. 21; BROWNE, For. Trees Sarawak & Brunei (1955) 142; ASHTON, Man. Dipt. Brun. (1964) 213, f. 16, pl. 56 (habit); *ibid.* Suppl. (1968) 116; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 140. — Fig. 111.

Medium-sized, occasionally large, tree. Young parts shortly densely tawny pubescent, largely caducous on stipule, leaf bud and leaf beneath; leaf above glabrous but for midrib. *Twig* c. 3 mm \varnothing at apex, terete, stout, strongly ridged below stipule scars, becoming minutely cracked longitudinally; stipule scars c. 3 mm long, c. 1 mm broad, pale, falcate or amplexicaul-descending. *Bud* to 2 by 1.3 cm, loosely enclosed by stipular bud scales, compressed, subcordate. *Stipule* to 2.5 by 1.3 cm, ovate to subcordate, subsistent, glabrescent, persistently ridged along the 5 nerves; stipule pairs sometimes united at base.

Leaves 10–18 by 5–8 cm, broadly ovate to elliptic, strongly cupped; margin usually slightly revolute; base obtuse; acumen to 1.3 cm long; nerves c. 4 pairs, strongly curved, at c. 40°–70° with 1 or more secondary nerves of varying length; tertiary nerves slender, scalariform, at c. 90° to nerves; midrib depressed above; *petiole* 8–10 mm long. *Panicle* to 28 cm long, terminal or axillary, large, spreading, lax, terete or angular, densely persistently pale rust pubescent; doubly, sometimes trebly branched, branchlets 1–8 cm long, straight, bearing to 6 second flowers; *bracts* as the stipules, \pm caducous; *bracteoles* to 2 by 1 mm, ovate to elliptic, obtuse, densely grey pubescent outside, puberulent within. *Flower bud* to 4.5 by 5.5 mm, broadly elliptic to subglobose, obtuse. *Calyx* shortly pale grey pubescent outside, glabrous within; lobes \pm patent, subequal, ovate, the inner 2 slightly more acute. *Petals* pink, paler at margins, elliptic,

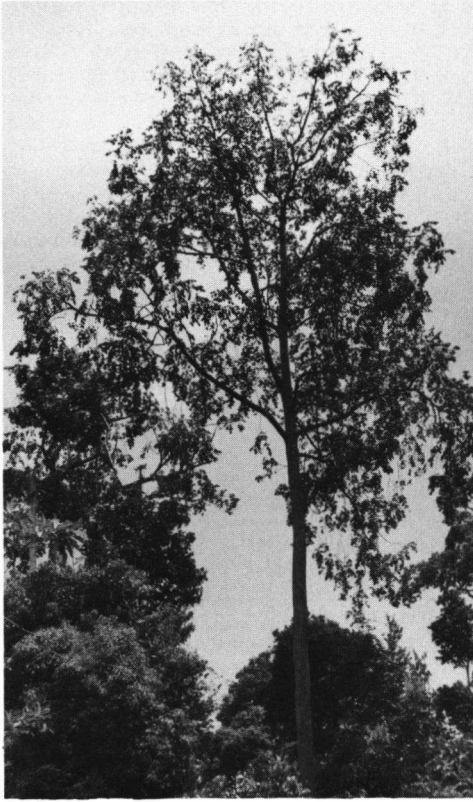


Fig. 111. Habit of *Shorea quadrinervis* SLOOT. with drooping branches. Brunei (Photogr. ASHTON, 1959).

obtuse, densely pubescent on parts exposed in bud. *Stamens* 15, the inner 5 longest, the outer 10 sometimes vestigial; filaments tapering gradually; anther subglobose; appendage to connective shorter than anther, becoming reflexed. *Ovary* and *stylopodium* conical, densely pubescent; style short, frequently expanded at the stigma. *Fruit calyx* shortly sparsely pubescent; 3 longer lobes to 8 by 1.3 cm, narrowly spatulate, obtuse, 2–3 mm broad above the c. 5 by 4 mm thickened base; 2 shorter lobes to 5.5 by 0.7 cm, unequal, tapering to c. 2 mm broad, base as in longer lobes. *Nut* to 1.5 by 0.7 cm, narrowly ovoid, shortly buff pubescent; style remnant c. 1.5 mm long, slender, acute.

Distr. Malesia: N.W. Borneo (Ulu Kapuas, Sarawak to W. Sabah).

Ecol. Common on sandy clay soil on low hills, occasionally to 700 m.

Vern. Tēngkolong, tēmpilong, mēranti tēmpilong (W. Borneo), *mēranti sudu* (Sarawak), *sēraya sudu* (Sabah).

140. *Shorea acuminata* DYER, Fl. Br. Ind. 1 (1874) 305; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 113;

BRANDIS, J. Linn. Soc. Bot. 31 (1895) 91; RIDL, Agr. Bull. Str. & F.M.S. 1 (1901) 58; Fl. Mal. Pen. 1 (1922) 225; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 296; *ibid.* ed. 2 (1927) 1115; FOXW. Mal. For. Rec. 3 (1927) 32; *ibid.* 8 (1930) 23; *ibid.* 10 (1932) 197; EDWARDS, Mal. For. Rec. 9 (1931) 139; BURK. Dict. (1935) 2006; SYM. Mal. For. Rec. 16 (1943) 65, f. 38, 39; SLOOT. Bull. Bot. Gard. Btzg III, 18 (1949) 251, f. 11.

Large buttressed tree, to 50 m. Young parts densely buff pubescent, persistent on twig apices, midrib above, petioles, panicles, parts of perianth exposed in bud, ovary and calyx, caducous elsewhere; becoming sparse on fruit calyx and expanding stipules. *Twigs* c. 2 mm \varnothing apically, terete, smooth, pale brown; stipule scars prominent, horizontal. *Leaf buds* small, conical, acute, generally hidden in the conspicuous, to 30 by 8 mm, oblong cordate obtuse lustrous concave subpersistent stipules. *Leaves* 6–12 by 2.6–6 cm, ovate-falcate, coriaceous, lustrous beneath; base subequal, obtuse to broadly cuneate; margin subrevolute; acumen to 1.8 cm long, slender; nerves 7–11 pairs, arched, ascending, slender but \pm prominent beneath, frequently spaced irregularly along the midrib and with \pm prominent short secondary nerves; tertiary nerves scalariform, obscure; midrib slender but prominent, terete, beneath, evident above; *petiole* 7–9 mm long, short. *Panicles* to 12 cm long, terminal or axillary, singly (if axillary) or doubly branched; branchlets to 2 cm long, bearing to 6 congested secund flowers; *bracts* as stipules, frequently subpersistent in terminal inflorescences. *Flower bud* to 4 by 2 mm, lanceolate; *sepals* broadly ovate, the 3 outer somewhat larger, acute, the 2 inner acuminate; *petals* dark wine red, paler towards base; *stamens* 15, in 3 unequal verticils; filaments lorate, tapering; anthers small, subglobose; appendages shorter than anthers, becoming reflexed on inner 2 verticils; *ovary* ovoid, tapering into a somewhat longer columnar tapering style. *Fruit pedicel* to 2 mm long, slender; 3 longer *calyx lobes* to 9 by 1.2 cm, narrowly spatulate, obtuse, c. 2 mm broad above the to 6 by 4 mm ovate thickened saccate base; 2 shorter lobes to 25 by 2 mm, linear, similar at base. *Nut* to 1.5 by 6 mm, lanceolate, prominently apiculate.

Distr. Malesia: Malaya (from Lower Perak and Trengganu R. southwards), Sumatra (Langsa and P. Musala south to northern Palembang), Lingga.

Ecol. Common in Mixed Dipterocarp forest, on undulating land and hills to 400 m.

Vern. Mēranti rambai daun, m. hijau (Malaya), *damar tēték, m. samarupa, samarupa* (Achin), *latuko, mēranti bunga, m. gombang* (Tapanuli), *mēranti sarang burung, m. sarang punai, m. bēros, m. kēpala, sēsawoh* (E. coast Sumatra), *madang kuaun* (W. coast), *mēranti djuntah, m. kēpala tupai, m. kērang, bēnio, m. hitam batang, m. samak bēnio* (Riouw), *mēranti bawang* (Djambi), *mērakunyt bētina, mēlas uwai* (Palembang).

Note. Two collections from S.E. Sumatra appear to represent hybrids between this species and *S. parvifolia*.

141. *Shorea macrantha* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 97; MERR. En. Born. (1921) 405; SYM. Gard. Bull. S. S. 7 (1933) 131, pl. 34; Mal. For. Rec. 16 (1943) 77, f. 38; BROWNE, For. Trees Sarawak & Brunei (1955) 148; ANDERSON, Gard. Bull. Sing. 20 (1963) 158; ASHTON, Man. Dipt. Brun. Suppl. (1968) 110, f. 13. — *S. hemsleyana* (non KING) FOXW. Mal. For. Rec. 10 (1932) 167, p.p. — Fig. 106 C–C2.

Small or medium-sized tree. Twig, bud, stipule outside, petiole and nervation beneath densely persistently yellow-brown scabrid tomentose; stipule inside and midrib above densely evenly, nerves above sparsely evenly yellow-brown pubescent. *Twig* 2–4 mm \varnothing apically, terete, becoming smooth; stipule scars short, dark, horizontal or descending. *Bud* 6 by 3 mm, ovoid, subacute. *Stipule* to 16 by 5 mm, lanceolate, subacute, subsistent. *Leaves* 6–17 by 2.5–8 cm, of variable size, narrowly ovate, coriaceous; base cordate, subequal; acumen to 1.5 cm long, slender; nerves 13–17 pairs, prominent beneath, at 110° towards the base, 35° towards the apex; tertiary nerves scalariform, prominent beneath, set at c. 90° to the nerves; midrib beneath prominent; midrib and nervation frequently somewhat depressed and the lamina bullate above; *petiole* 5–6 mm long, very short. *Panicles* to 10 cm long, terminal or axillary, terete, persistently fulvous to yellow-brown scabrid pubescent; singly branched, branchlets short, the flowers congested. *Flower bud* to 14 by 4 mm, lanceolate. *Sepals* pubescent on parts exposed in bud; outer 3 deltoid, acute; inner 2 smaller than outer 3, narrowly ovate, with thinner margin. *Petals* dark red within, paler outside (Borneo) or white throughout (Malaya), lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed, tapering to the small subglobose anthers; appendage to connective slender, about as long as anther, becoming reflexed at anthesis. *Ovary* ovoid, shortly pubescent; style filiform, glabrous, about twice as long as ovary. Fruit subsessile. *Calyx* sparsely yellow-brown pubescent; lobes to 2.5 by 2 cm, subequal, ovate, acute, saccate towards the base. *Nut* to 5.5 by 2.5 cm, ellipsoid, acute, pale yellow-brown pubescent.

Distr. *Malesia*: Malaya (Perak, E. coast in Pahang and Johore), E. Sumatra (Indragiri), N.W. Borneo (Central and W. Sarawak).

Ecol. Local, in Mixed Peat Swamp forest at their inland margins, and on white sand terraces (Borneo).

Vern. *Kèpong*, *k. hantu*, *chèngal pasir*, *mèranti pasir* (Malaya), *èngkabang bungkus* (Sar.), *pèrawan lampong kijang* (Iban).

Note. In Perak the tree has an even, soft tomentum and appanate leaves with the nervation not depressed above.

142. *Shorea hemsleyana* (KING) KING ex FOXW. Mal. For. Rec. 10 (1932) 167, p.p.; SYM. Gard. Bull. S. S. 7 (1933) 129, pl. 33; BURK. Dict. (1935) 2011; BROWNE, For. Trees Sarawak & Brunei (1955) 147; ASHTON, Gard. Bull. Sing. 22 (1967) 293.

a. ssp. hemsleyana. — SYM. Mal. For. Rec. 16 (1943) 70, f. 38, 43. — *Balanocarpus hemsleyanus* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 134; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 160; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 109. — *Pachychlamys hemsleyanus* RIDL. Fl. Mal. Pen. 1 (1922) 234; FOXW. Mal. For. Rec. 3 (1927) 38.

Small or medium-sized tree. Twig, bud, stipule outside, petiole and nervation below densely persistently yellow-brown scabrid tomentose; stipule inside and midrib above densely evenly, nerves above sparsely evenly, yellow-brown pubescent. *Twig* 2–4 mm \varnothing apically, terete, becoming smooth; stipule scars short, pale, ascending. *Bud* to 6 by 3 mm, lanceolate, subacute. *Stipule* to 16 by 5 mm, lanceolate, subacute, not at first caducous. *Leaves* 14–35 by 6–15 cm, oblong, coriaceous; base obtuse; acumen to 1 cm long, slender; nerves 14–17 pairs, straight and prominent beneath, at 45°–55°; tertiary nerves remote, scalariform; midrib prominent beneath; nervation somewhat depressed above; *petiole* 14–20 mm long, short. *Panicle* to 25 cm long, axillary, terete, very shortly persistently yellow-brown scabrid pubescent; singly branched, branchlets short, the flowers congested. *Flower bud* to 18 by 6 mm, lanceolate, large. *Sepals* pubescent on parts exposed in bud; 3 outer ovate, acuminate, fimbriate along the lateral margins. *Petals* dark red within, paler outside, lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils, the inner 5 exceeding the style apex; filaments compressed, tapering to the small subglobose anthers; appendage becoming reflexed at anthesis. *Ovary* ovoid, pubescent; style filiform, glabrous, as long as ovary, surmounting a short pubescent stylopodium. *Fruit* subsessile; *pedicel* to 1 mm long, obscure and expanding into fruit. *Calyx* pale fulvous partially caducous pubescent; 3 outer lobes to 25 by 18 mm, as short as or shorter than the ripe nut, lanceolate, acute, chartaceous, thickened and somewhat saccate at the base; 2 inner lobes to 20 by 18 mm, ovate, acute. *Nut* to 7 by 3 cm, ovate, shortly apiculate, densely evenly pale fulvous pubescent.

Distr. Peninsular Thailand, in *Malesia*: N.W. Malaya (Perak), E. Sumatra (Indragiri).

Ecol. Shallow peat swamps; local.

Vern. *Chengal pasir daun bèsar*, *mèranti bakau* (Mal.), *m. kunyit* (Sumatra).

b. ssp. grandiflora (BRANDIS) ASHTON, Gard. Bull. Sing. 22 (1967) 293; Man. Dipt. Brun. Suppl. (1968) 109, f. 13. — *S. grandiflora* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 93; MERR. En. Born. (1921) 405.

Differing as follows: *Leaves* 10–23 by 4–11 cm; *petiole* 6–12 mm; *panicle* to 4 cm long.

Distr. *Malesia*: N.W. Borneo (Lower Kapuas, Central & West Sarawak).

Ecol. Local in Mixed Dipterocarp forest on leached sandy soils below 400 m.

143. *Shorea singkawang* (MIQ.) MIQ. Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 84; ASHTON, Gard. Bull. Sing. 31 (1978) 47.

a. ssp. singkawang. — BURCK, Ann. Jard. Bot. Btzg 6 (1887) 219; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 87; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 307; FOXW. Mal. For. Rec. 10 (1932) 164; BURK. Dict. (1935) 2022; SYM. Mal. For. Rec. 16 (1943) 92, f. 38, 56; ASHTON, Gard. Bull. Sing. 31 (1978) 47. — *Hopea singkawang* MIQ. Sum. 1 (1860) 489, 191; DC. Prod. 16, 2 (1868) 635; WALP. Ann. 7 (1868) 379; HEYNE, Nutt. Pl. ed. 2 (1927) 1125. — *S. thiseltonii* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 122; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 77, t. 2, f. 13–14; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 265; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 155, t. 188; BURK. J. Str. Br. R. As. Soc. 86 (1922) 285; HEYNE, Nutt. Pl. ed. 2 (1927) 1125. — *S. forbesii* KING ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 77, nom. in syn. — *Pachychlamys thiseltonii* RIDL. Fl. Mal. Pen. 1 (1922) 233; FOXW. Mal. For. Rec. 3 (1927) 38. — *Pachychlamys beccaridnus* (non DYER ex BRANDIS) RIDL. Fl. Mal. Pen. 1 (1922) 233.

Small, occasionally large tree with somewhat scaly fissured bark. Young twigs, petioles, midrib and fruit calyx caducous ocherous-buff puberulent; panicles, parts of perianth exposed in bud and nut persistently so. *Twig* 2–5 mm \varnothing apically, typically stout, terete, pale brown, \pm prominently ribbed; stipule scars short, horizontal. *Leaf bud* to 3 by 2 mm, ovoid, obtuse; stipule to 12 by 6 mm, deltoid-lanceolate, falcate, acute, fugaceous. *Leaves* (8–)12–24 by (2.3–)5.5–9 cm, oblong-lanceolate, coriaceous; base \pm broadly cuneate; acumen to 1.5 cm long, tapering; nerves 7–12 pairs, ascending, prominent beneath as also the terete midrib; tertiary nerves densely scalariform, sinuate, very slender but evident beneath; *petioles* (6–)12–17 mm long, \pm stout. *Panicles* to 8 cm long, axillary, erect, with to 1 cm long, short, branchlets bearing to 5 flowers. *Flower buds* to 10 by 4 mm, lanceolate; sepals narrowly ovate, the 3 outer longer, acute, the 2 inner subacuminate; corolla pale red to dark purple-red, variable; *stamens* 15, in 3 unequal verticils; filaments loriate, tapering; anthers subglobose; appendages shorter than anthers, becoming reflexed; ovary narrowly ovoid, tapering into the filiform glabrous somewhat shorter style. *Fruit* sessile; 3 longer calyx lobes to 8 by 0.8 cm, short, loriate, obtuse, expanding into a 14 by 11 mm ovate thickened saccate base; 2 shorter lobes to 3 cm long, with similar base; nut to 6 by 2.5 cm, ellipsoid to ovoid or obovoid, acute.

Distr. Peninsular Thailand, in *Malesia*: Malaya, Lingga, E. Sumatra (Indragiri, Palembang, Lampong).

Ecol. Frequent in lowland Mixed Dipterocarp forest on well drained undulating land, sometimes by streams, below 400 m.

Vern. *Mēranti sengkawang*, *sengkawang* (Malaya, Sumatra), *m. sengkawang merah*, *m. gajah*, *m. bahru*, *m. sékan*, *siput mēlantai* (Malaya).

b. ssp. scabrosa ASHTON, Gard. Bull. Sing. 31 (1978) 48. — *Shorea* sp. C SYM. Mal. For. Rec. 16 (1943) 95.

Differing as follows: Twigs, buds, stipules, petioles,

midrib on both surfaces and nerves beneath, panicles and calyx outside at first densely scabrid fulvous pubescent, becoming sparse on nervation beneath, caducous on calyx but otherwise persistent. *Leaves* thickly coriaceous; base usually with obtuse or cordate base; apex shortly acuminate or obtuse; nerves 12–17 pairs.

Distr. *Malesia*: E. Malaya (coastal Pahang and Trengganu).

Ecol. Forests on low hills, sometimes on soils with impeded drainage, near the coast.

Vern. *Tēngkawang lampong*.

144. *Shorea retusa* MEIJER, Act. Bot. Neerl. 12 (1963) 340, pl. 9; Sabah For. Rec. 5 (1964) 141; ASHTON, Man. Dipt. Brun. Suppl. (1968) 117, f. 14.

Small or medium-sized tree. Young parts greyish sericeous, glabrescent except on buds and stipules outside. *Twig* c. 1 mm \varnothing apically, terete, much branched, smooth; stipule scars pale, short, horizontal. *Bud* to 3 by 2 mm, ellipsoid, obtuse. *Stipule* to 7 by 3 mm, elliptic, obtuse, caducous. *Leaves* 3–9 by 1.5–5 cm, small, elliptic, coriaceous, lustrous; base cuneate; apex retuse; nerves 7–10 pairs, slender, hardly raised beneath, at 40°–60°; tertiary nerves slender, obscure, densely scalariform; midrib prominent beneath, depressed above; *petiole* 6–9 mm long, short. *Panicle* to 10 cm long, terminal or axillary, terete, caducous buff sericeous; singly, or doubly if terminal, branched, branchlets bearing to 7 \pm distichous flowers; *bracteoles* to 3 by 2 mm, elliptic, obtuse, pubescent. *Flower buds* to 8 by 3 mm, lanceolate. *Sepals* densely pubescent on parts exposed in bud; outer 3 ovate, acute; inner 2 shorter, narrower, thinner towards margin than outer 3, fimbriate distally, flanged at base. *Petals* pale yellow, lanceolate, fimbriate, pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed, slender, tapering; anthers subglobose, the inner 5 much longer than the outer 5; appendage to connective slender, c. 4 \times length of anther on inner stamens, c. 2 \times on medium stamens, about same length on outer stamens, becoming reflexed at anthesis. *Ovary* and *stylopodium* narrowly conical, shortly densely buff sericeous, crowned by a short glabrous style. *Fruit pedicel* to 1 mm long. *Calyx bud* sericeous, caducous except at base; 3 longer *calyx lobes* to 10 by 1.8 cm, spatulate, obtuse, c. 4 mm broad above the to 7 by 6 mm ovate saccate thickened base; 3 shorter lobes to 5.5 by 0.4 cm, loriate, obtuse, similar at base. *Nut* to 13 by 2 mm, ovoid; *stylopodium* to 3 mm long.

Distr. *Malesia*: Borneo (S.E. and S. Borneo, Tawau Distr., W. Sarawak).

Ecol. Local on skeletal podsols in Heath forest on coastal hills.

Vern. *Mēranti daun tumpul* (Sarawak), *sēraya daun tumpul* (Sabah), *lampong*, *lanan putèh*, *awang*, *a. pèringet*, *damar lantang* (S.E. Borneo).

Note. See note under 154. *S. scabrida*.

145. *Shorea lepidota* (KORTH.) BL. Mus. Bot. Lugd.-

Bat. 2 (1852) 32; WALP. Ann. 4 (1857) 338; MIQ. Fl. Ind. Bat. 1 (1859) 503; Sum. (1860) 191; DC. Prod. 16, 2 (1868) 629; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 217; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 96; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 304; *ibid.* ed. 2 (1927) 1113, 1114, 1121; FOXW. Mal. For. Rec. 10 (1932) 166; SYM. Gard. Bull. S. S. 7 (1933) 135, pl. 38; Mal. For. Rec. 16 (1943) 73, f. 38, 45; BURK. Dict. (1935) 2014. — *Vatica lepidota* KORTH. Kruidk. (1841) 73; WALP. Rep. 5 (1845) 127; DC. Prod. 16, 2 (1868) 629. — *Vatica stipulosa* MIQ. Sum. (1860) 486; HEYNE, Nutt. Pl. ed. 2 (1927) 1121. — *S. nitens* MIQ. Sum. (1860) 488, 191; DC. Prod. 16, 2 (1868) 632; WALP. Ann. 7 (1868) 379; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 219; HEYNE, Nutt. Pl. ed. 2 (1927) 1121. — *S. stipulosa* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 220. — *S. megistocarpa* FOXW. Mal. For. Rec. 10 (1932) 216, pl. 17; BURK. Dict. (1935) 2019.

Large, buttressed tree. Panicles, parts of perianth exposed in bud and nut persistently buff puberulent; young twigs, midrib above, petioles and fruit calyx caducously so. *Twigs* c. 3 by 2 mm \varnothing apically, \pm compressed, becoming smooth, dark brown; stipule scars short, horizontal. *Leaf bud* small, ovoid, acute; *stipule* to 20 by 4 mm, \pm persistent, lanceolate. *Leaves* 6–14 by 3–6 cm, narrowly obovate to oblong, subcoriaceous; base obtuse or broadly cuneate; acumen to 1 cm long, turned down and frequently bent over on pressing; nerves 14–16 pairs, rather straight and only arching towards the ends, slender but distinctly elevated beneath, evident above as also the densely scalariform tertiary nerves and the midrib; *petioles* 7–11 mm long, slender. *Panicle* to 7 cm long, terminal or axillary, with to 1.5 cm long branchlets bearing to 5 second flowers; *bracteoles* to 4 by 3 mm, oblong, concave, glabrous. *Flower bud* to 10 by 2 mm, lanceolate. *Sepals* ovate, the 3 outer acute, the 2 inner subacuminate. *Petals* cream. *Stamens* 15, in 3 unequal verticils; filaments lorate, tapering; anthers subglobose, becoming reflexed at least on the inner 2 verticils; appendage as long as anthers; *ovary* broadly ovoid, sericeous, crowned by an equally long filiform style. *Fruit pedicel* to 3 by 3 mm, \pm impressed into the receptacle; 3 longer *calyx lobes* to 11 by 2.5 cm, broadly lorate-spatulate, subacute, c. 11 mm broad above the to 10 by 11 mm suborbicular saccate thickened base; 2 shorter lobes to 7 by 0.7 cm, linear-lanceolate, similar at base; *nut* to 16 by 11 mm, ovoid, apiculate.

Distr. *Malesia*: Malaya, Sumatra (West coast from Pariaman and Ophir to Sibolga and Padang; Kuantan Distr. in east).

Ecol. Frequent or common in Lowland Dipterocarp forest on undulating land and low hills below 350 m.

Vern. *Mèrantí langgong*, *m. pala*, *m. sega*, *m. labu*, *damar siput* (Malaya), *meranti katuko*, *katuko*, *m. taratung*, *m. sitarah* (W. coast Sumatra), *m. galur*, *m. sabat* (Kuantan Distr. Sumatra).

146. *Shorea foraminifera* ASHTON, Gard. Bull. Sing. 22 (1967) 295, pl. 40; Man. Dipt. Brun. Suppl. (1968)

108. — *S. teysmanniana* (non DYER ex BRANDIS) ASHTON, Man. Dipt. Brun. (1964) 225, *p.p.*

Medium-sized or large buttressed tree. Young parts (leaf and stipule excepting) fugaceous puberulent. *Twig* 1–2 mm \varnothing apically, at first slightly compressed, becoming terete, smooth; stipule scar short, \pm horizontal. *Bud* to 8 by 5 mm, ovoid, compressed, subacute. *Stipule* to 10 by 5 mm, oblong to elliptic, obtuse, caducous. *Leaves* 6–9 by 4–7 cm, broadly ovate, coriaceous; base cordate to obtuse; acumen to 5 mm long, somewhat falcate; nerves 8–9 pairs, stout, prominent beneath, with large pore-like axillary domatia, arched, at 55°–70° except at the base; tertiary nerves densely scalariform, obscure; midrib evident, applanate, above, stout, terete, prominent beneath. *Petiole* 10–15 mm long. *Flower* and *inflorescence* unknown. *Fruit pedicel* c. 1 mm long, short. *Calyx* buff puberulent in the basal half, sparsely so distally; 3 longer lobes to 7 by 1.2 cm, spatulate, subacute, c. 4 mm broad above the to 11 by 5 mm ovate thickened saccate base; 2 shorter lobes to 1.5 by 0.4 cm, lorate, acute, similar at base. *Nut* to 15 by 10 mm, ovoid, persistently buff sericeous, shortly apiculate.

Distr. *Malesia*: Borneo (Rejang valley to Brunei).

Ecol. Locally common on shallow peat on alluvium in small swampy valleys; rare on hillsides.

Vern. *Mèrantí lobang hidong* (Brun.).

147. *Shorea teysmanniana* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 100; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 309; *ibid.* ed. 2 (1927) 1126; SYM. Gard. Bull. S. S. 7 (1933) 134, pl. 37; Mal. For. Rec. 16 (1943) 94, f. 38, 57; BROWNE, For. Trees Sarawak & Brunei (1955) 144; ANDERSON, Gard. Bull. Sing. 20 (1963) 159; ASHTON, Man. Dipt. Brun. (1964) 225, f. 16, *p.p.*; *ibid.* Suppl. (1968) 121; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 152. — *S. cochinchinensis* var. *oligoneura* BOERL. Cat. Hort. Bog. 2 (1901) 107. — *S. balangeroides* BOERL. *l.c.* — *S. paludosa* FOXW. Mal. For. Rec. 10 (1932) 277; BURK. Dict. (1935) 2019.

Medium-sized buttressed tree. Young twig and petiole shortly densely evenly grey-brown caducous pubescent; outside of stipule and leaf bud persistently so. *Twig* c. 2 mm \varnothing apically, slightly compressed when young, becoming terete, much branched, smooth; stipule scars prominent, cuneate, c. 2 mm long, 1 mm thick, pale, \pm horizontal. *Leaf bud* 4–8 by 2–5 mm, compressed, ovoid, subacute. *Stipule* to 14 by 5 mm, ovate to oblong, tapering at base, subacute, fugaceous. *Leaves* 7.5–11 by 3.5–7 cm, ovate, entirely glabrous, lustrous, \pm coriaceous; base obtuse; acumen to 8 mm long; nerves 8–11 pairs, slightly raised beneath, strongly curved, at c. 60°–70° at the base; with or without 1–3 pairs of small basal domatia; midrib narrow, depressed above, sharply prominent beneath. *Petiole* 1.2–1.8 cm long. *Panicle* to 8 cm long, terminal or axillary, terete, shortly buff pubescent; singly branched. *Flower bud* to 14 by 5 mm, ovoid. *Calyx lobes* deltoid, subequal, subacute, densely buff pubescent outside, glabrous within. *Petals*

linear, sparsely pubescent on parts exposed in bud. *Stamens* 15, of 3 lengths; filaments tapering gradually; anther subglobose; appendage to connective short, becoming reflexed. *Ovary* and *stylopodium* narrowly conical, the former densely shortly cream pubescent, the latter more coarsely so; style *c.* $\frac{1}{2}$ length of ovary and stylopodium, glabrous. *Fruit calyx* sparsely pubescent towards apex, more densely so towards base; 3 longer lobes to 8 by 1 cm, spatulate, obtuse, to 8 mm broad above the to 9 by 9 mm expanded saccate base; 2 shorter lobes to 3 by 0.5 cm, linear, similar at base. *Nut* to 12 by 8 mm, ovoid, densely shortly buff pubescent; style remnant to 2 mm long, short, acute.

Distr. *Malesia*: Malaya (Selangor), E. Sumatra (Labuan Batu, Bengkalis, Palembang, Siak), Karimun, Banka, Borneo (Lower Kapuas in West Borneo, S.E. Borneo to Sampit, Sarawak and Brunei to W. Sabah).

Ecol. Local, sometimes common, in Mixed Peat Swamp forest, at sea level (one record at 900 m).

Vern. *Mēranti bunga* (Malaya, Sumatra), *m. kait*, *m. daun kalus* (Sumatra), *kēlēpak* (S.E. Borneo), *lintang*, *bangkirai* (Sampit), *mēranti lilin* (Sarawak).

148. *Shorea argentifolia* SYM. Gard. Bull. Sing. 17 (1960) 489; BROWNE, For. Trees Sarawak & Brunei (1955) 187; ASHTON, Man. Dipt. Brun. (1964) 179, f. 16; *ibid.* Suppl. (1968) 105; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 98, f. 12.

Medium-sized or large buttressed tree. Young twig, panicle, leaf bud, stipule (both surfaces), petiole, leaf beneath and midrib above shortly evenly densely persistently pink-gold velutinate. *Twig c.* 2 by 1 mm \varnothing apically, compressed when young, becoming terete, slender, rugulose, glabrous; stipule scars *c.* 1.5 mm long, short, thin, horizontal, obscure. *Bud c.* 4 by 2.5 mm, ovoid, slightly compressed, subacute. *Stipule* to 20 by 7 mm, not at first caducous, oblong-hastate, acute, base subcordate. *Leaves* 6–11 by 2.5–4.5 cm, oblong-lanceolate, thinly coriaceous; base obtuse; acumen *c.* 5 mm long; nerves *c.* 20–25 pairs, with prominent short secondary nerves, dense, curved towards the margin, at *c.* 66°–70°; tertiary nerves slender, densely scalariform, at *c.* 90°; midrib narrow and slightly depressed above, prominent and terete beneath; *petiole* 8–10 mm long, short, rugose. *Panicle* to 12 cm long, terminal or axillary, compressed; singly branched, the branchlets short, compact, bearing to 6 distichous flowers; *bracteoles* to 8 by 3.5 mm, oblong-elliptic, obtuse, caducous. *Flower bud* to 6 by 3 mm, ovoid, subacute. *Calyx* \pm patent, densely pubescent outside, glabrous within; 3 outer lobes ovate-deltoid, obtuse; 2 inner lobes *c.* $\frac{1}{2}$ as long, ovate, subacute. *Petals* pink, oblong, obtuse, densely pale golden pubescent on parts exposed in bud, hardly connate at base. *Stamens* 15, the 5 inner almost twice as long as the others, reaching the base of the style; filaments tapering gradually; anthers subglobose; appendage to connective short, becoming reflexed. *Ovary* and *stylopodium* pyriform, shortly pubescent; style as long as ovary, glabrous. *Fruit calyx* shortly pubescent; 3

longer lobes to 7.5 by 1.2 cm, narrowly spatulate, narrowly obtuse, 3–4 mm broad above the to 7 by 6 mm ovate thin saccate base; 2 shorter lobes, 10–30 by 1.5 mm, unequal, linear, similar at base. *Nut* to 1.4 by 0.9 cm, ovoid, shortly buff pubescent; style remnant tapering, *c.* 2.5 mm long.

Distr. *Malesia*: N.E. Borneo (Rejang valley north-eastwards to Sabah and Nunukan).

Ecol. Locally frequent in Mixed Dipterocarp forest, especially on clay soils on undulating land and in valleys, below 600 m.

Vern. *Sēraya daun mas* (Sabah), *mēranti binatoh*, *binatoh* (Sar.), *sēnkajang* (Iban), *mērangang* (Brun.).

149. *Shorea uliginosa* FOXW. Mal. For. Rec. 10 (1932) 210, 277; BURK. Dict. (1935) 2023; ASHTON, Gard. Bull. Sing. 22 (1967) 294; Man. Dipt. Brun. Suppl. (1968) 121, f. 15. — *Shorea sp.* FOXW. Mal. For. Rec. 3 (1927) 36. — *S. rugosa* (non HEIM) SYM. Gard. Bull. S. S. 7 (1933) 132, *p.p. quoad spec. Malay.* — *S. rugosa var. uliginosa* SYM. Gard. Bull. S. S. 10 (1939) 372; Mal. For. Rec. 16 (1943) 91, f. 38; ANDERSON, Gard. Bull. Sing. 20 (1963) 159.

Large buttressed tree with dark fissured bark. Twig, leaf bud, stipule outside, petiole and leaf beneath densely shortly pale chocolate-brown scabrid tomentose, stipule within, midrib and nerves above evenly so; leaf above puberulent or glabrescent. *Twig* 3–4 mm \varnothing apically, terete, at first prominently ribbed by the decurrent lateral petiolar bundles, becoming smooth; stipule scars short, pale, horizontal. *Bud* to 6 by 4 mm, ovoid, subacute, compressed. *Stipule* to 14 by 5 mm, elliptic, subacute. *Leaves* 12–22 by 6–12 cm, medium-sized to large, elliptic-oblong, somewhat chartaceous, prominently boat-shaped with the lower surface concave; base broadly cuneate to subcordate; acumen to 1 cm long, acute; nerves 16–21 pairs, prominent beneath, at 50°–70° except at the base, tertiary nerves scalariform, at 90° to the nerves; midrib evident but depressed above, prominent beneath; *petiole* 2.2–3.2 cm long, stout, terete. *Panicle* to 16 cm long, terminal or axillary, ribbed, densely chocolate-brown scabrid tomentose; doubly branched, branchlets bearing to 6 \pm distichous flowers; *bracteoles* to 3 by 2 mm, elliptic, subacute, pubescent outside, glabrous within, fugaceous. *Flower bud* to 5 by 3 mm, small, ellipsoid. *Sepals* densely pubescent on parts exposed in bud, ovate, acute, the 2 inner smaller than the 3 outer, thinner towards margin, flanged at base. *Petals* pale yellow, elliptic-lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments compressed, slender, tapering; anthers small, subglobose; appendage to connective about as long as anther, becoming reflexed with anther at anthesis. *Ovary* and *stylopodium* conical, densely pubescent; style filiform, glabrous, slender, as long as ovary and stylopodium. *Fruit pedicel* to 1 mm long, short. *Fruit calyx* persistently sericeous towards base, otherwise glabrescent; 2 longer lobes to 6 by 1.2 cm, spatulate, obtuse, to 4 mm broad above the to 5 by 4 mm elliptic

slightly thickened saccate base; 2 shorter lobes to 2 cm long, linear, similar at base. *Nut* to 8 by 6 mm, ovoid, acute, densely buff pubescent.

Distr. *Malesia*: Malaya (Perak, Selangor), E. Sumatra (Labuan Batu, Bengkalis, Palembang, Indragiri, Asahan), Karimun, Banka, W. Borneo (Sampit, Sukadana, Lower Kapuas and Sarawak west of the Baram).

Ecol. Mixed Peat Swamp forest, locally abundant.

Uses. Important as a source of dark red meranti timber.

Vern. *Mēranti sēngkawang*, *m. s. mērah*, *sēngkawang*, *m. gajah*, *m. bahru*, *m. sēkam*, *siput mēlantai* (Malaya), *mēranti segar*, *m. kait kait*, *m. daun lebar* (Sumatra), *sēraya* (Banka), *mēranti lang* (Borneo), *lanan buaya* (Sampit), *mēranti buaya*, *m. paya* (Sarawak), *pērawan buaya* (Iban).

150. *Shorea rugosa* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 973; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 96; MERR. En. Born. (1921) 406; SYM. Gard. Bull. S. S. 7 (1933) 132, pl. 35; ASHTON, Man. Dipt. Brun. (1964) 218, f. 16; *ibid.* Suppl. (1968) 118; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 144. — *S. verruculosa* DYER ex BRANDIS, J. Linn. Soc. Bot. 31 (1895) 96, *nom. in syn.* — *S. almon* (non FOXW.) BROWNE, For. Trees Sarawak & Brunei (1955) 150.

Medium-sized or large buttressed tree with dark fissured bark. Young twig, panicle, bud, stipule outside, petiole and nervation beneath densely persistently purplish brown scabrid tomentose; stipule inside, midrib above and leaf beneath shortly evenly so. *Twig* to 2.5 mm \varnothing apically, ribbed at first, becoming terete, rugulose; stipule scars 2 mm long at first, 0.5 mm thick, pale, slightly descending, falcate or horizontal, obscured by tomentum. *Bud* 4–6 by 3–5 mm, ovoid, subacute. *Stipule* to 14 by 5 mm, oblong-elliptic, subacute. *Leaf* 9–17 by 4–9 cm, oblong-ovate to oblong-obovate; base obtuse; acumen to 9 mm long, broad; margin frequently somewhat revolute; nerves variable, 14–19 pairs, slightly curved, prominent beneath, at 60°–75°; tertiary nerves scalariform, slightly diagonal to nerves; midrib terete and prominent beneath, evident but somewhat depressed above; *petiole* 1.3–2.3 cm long. *Panicle* to 12 cm long, terminal or axillary, lax, terete or slightly compressed; regularly alternatively singly or doubly branched, branchlets bearing to 6 distichous flowers; *bracteoles* to 4 by 3 mm, \pm elliptic, subacute, pubescent outside, glabrous within, fugaceous. *Flower bud* to 7 by 4 mm, broadly ovoid. *Calyx* densely rust-brown pubescent on parts exposed in bud; lobes subequal, ovate; 3 outer lobes obtuse, 2 inner acute to subacuminate. *Petals* yellow, oblong, obtuse, densely long gold-brown pubescent on parts exposed in bud. *Stamens* 15, the 5 inner somewhat longer and reaching the style apex; filaments much twisted, tapering gradually; anthers subglobose; appendage to connective very short, becoming reflexed. *Ovary* and *stylopodium* conical, densely pale grey pubescent in the distal half, glabrous at base; style short, cylindrical, glabrous.

Fruit calyx shortly sparsely fulvous-brown to buff pubescent; 3 longer lobes to 10.5 by 2.5 cm, spatulate, narrowly obtuse, to 4–7 mm broad above the to 1.4 by 1 cm elliptic to ovate saccate thickened base; 2 shorter lobes subequal, to 5 by 0.4 cm, linear, acute, similar at base. *Nut* to 2.3 by 1.5 cm, ovoid, persistently shortly evenly buff fulvous pubescent; style remnant acute.

Distr. *Malesia*: Borneo (Puruktau and Lower Dayak in S. Borneo, Melawi in W. Borneo, W. Sarawak to S.W. Sabah).

Ecol. Local on leached yellow and occasionally white sandy soils in Mixed Dipterocarp forest and its ecotone with Heath forest below 400 m, subcoastal.

Note. Some collections from South and South-East Borneo bear larger leaves and closely resemble *S. furfuracea* MIQ. (*q.v.*) a Sumatran species that may prove, when flowers are collected, to be conspecific.

151. *Shorea leprosula* MIQ. Sum. (1860) 487, 191; Ann. Mus. Bot. Lugd.-Bat. 3 (1867) 84; DC. Prod. 16, 2 (1868) 631; WALP. Ann. 7 (1868) 379; SCHEFF. Nat. Tijds. N. I. 31 (1870) 349; DYER, Fl. Br. Ind. 1 (1874) 305; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 215; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 110; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 100; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 55; BECC. For. Born. (1902) 570, 571; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 304; BURK, J. Str. Br. R. As. Soc. 76 (1917) 161, fig.; *ibid.* 79 (1918) 41; *ibid.* 81 (1920) 75, fig.; MERR. En. Born. (1921) 405; RIDL. Fl. Mal. Pen. 1 (1922) 222; BAKER f. J. Bot. 68, Suppl. (1924) 11; THORENAAR, Med. Proefst. Boschw. 16 (1926) 117, t. 20; HEYNE, Nutt. Pl. ed. 2 (1927) 1122; FOXW. Mal. For. Rec. 3 (1927) 26, 3 pl.; SLOOT, in Merr. Pl. Elm. Born. (1929) 203; EDWARDS, Mal. For. Rec. 9 (1931) 144; FOXW. Mal. For. Rec. 10 (1932) 220; DESCH, Mal. For. Rec. 12 (1936) 43, pl. 7, f. 1; *ibid.* 14 (1941) 36, pl. 15, f. 1; *ibid.* 15 (1941) 136, pl. 40, f. 1, pl. 43, f. 3; SYM. Mal. For. Rec. 16 (1943) 75, f. 38, 46, 47; SLOOT, Bull. Bot. Gard. Btzg III, 18 (1949) 262, f. 14; BROWNE, For. Trees Sarawak & Brunei (1955) 110; BACKER & BAKH. f. Fl. Java 1 (1963) 331; ASHTON, Man. Dipt. Brun. (1964) 193, f. 16; *ibid.* Suppl. (1968) 110; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 110. — *Hopea? maranti* MIQ. Sum. (1860) 489, 192; DC. Prod. 16, 2 (1868) 635; WALP. Ann. 7 (1868) 379; HEYNE, Nutt. Pl. ed. 2 (1927) 1122. — *S. maranti* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 217; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 120; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 101; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 306; *ibid.* ed. 2 (1927) 1122. — *S. astrosticta* SCORT. ex FOXW. Mal. For. Rec. 10 (1932) 220, *nom. in syn.*

Large buttressed tree. *Twig*, panicle, leaf bud, stipule, petiole and nervation beneath persistently evenly densely shortly pale buff pubescent. *Twig* c. 1.5 mm \varnothing apically, terete, ridged when young, much branched, slender, becoming glabrous, smooth; stipule scars short, horizontal, obscure. *Bud* 3–5 by 2–3 mm, compressed, broadly ovoid, subacute. *Stipule* to 10 by 3.5 mm, oblong to broadly hastate, obtuse, fugaceous. *Leaves* 8–14 by 3.5–5.5 cm, elliptic to

ovate, thinly coriaceous, cream below in mature trees; base obtuse or broadly cuneate; acumen short, to 8 mm long; nerves 12–15 pairs, slender, curved towards margin, set at c. 40°–55°; tertiary nerves very slender, densely scarlariform, obscure except in young trees; midrib narrow and depressed above and prominent beneath, in young trees beset from the base up more or less its length with lines of small, pale, scale-like domatia occasionally extending also on the nerves; *petiole* 1.0–1.5 cm long. *Panicle* to 14 cm long; terminal or axillary, terete, lax, slender, sparsely or densely evenly persistently pale brown to cream pubescent; regularly singly, rarely doubly, branched, branchlets short, bearing to 12 ± secund flowers; *bracteoles* to 3 by 2 mm, elliptic, obtuse, shortly pubescent, fugaceous. *Flower bud* to 6 by 3 mm, fusiform, subacute. *Calyx* densely pale brown pubescent outside, glabrous within; 3 outer lobes narrowly ovate, obtuse; 2 inner lobes broadly ovate, shorter, shortly acuminate. *Petals* pale yellow, narrowly oblong, densely pale yellowish grey pubescent on parts exposed in bud. *Stamens* 15, the inner 5 twice as long as the others and reaching half the length of the style; filaments long, tapering gradually; anthers subglobose; appendage to connective short, becoming reflexed. *Ovary* and *stylopodium* ovoid, glabrous; style filiform, twice as long as ovary and stylopodium, glabrous. *Fruit calyx* glabrescent or persistently shortly pubescent at base; 3 longer lobes to 10 by 2 cm, spatulate, obtuse, c. 5 mm broad above the to 8 by 6 mm thickened elliptic shallowly saccate base; 2 shorter lobes to 5.5 by 0.3 cm, unequal, similarly saccate at base. *Nut* to 2 by 1.3 cm, ovoid, densely pale buff pubescent; style remnant c. 2 mm long, tapering, acute.

Distr. Thailand (Pattani) and in *Malesia*: Malaya (excluding seasonal areas), Sumatra, Banka, Billiton, Borneo.

Ecol. Common, often abundant, on deep clay soils in Mixed Dipterocarp forest below 700 m.

Vern. *Mēranti tēmbaga*, *m. bētul*, *m. bunga*, *m. lampong*, *m. tēmak*, *m. hijau*, *m. sabut*, *m. kait kait* (Malaya, Sumatra), *m. sēpang* (Palembang), *lampong* (Kutei), *pērawan lop* (Sarawak), *sēraya tēmbaga* (Sabah), *kontoi* (Melawi), *lētang* (Sampit) and many others.

152. *Shorea platycarpa* HEIM, Bull. Mens. Soc. Linn. Paris 2 (1891) 956; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 94; BECC. For. Born. (1902) 510; MERR. En. Born. (1921) 406; SYM. Gard. Bull. S. S. 7 (1933) 133, pl. 36; Mal. For. Rec. 16 (1943) 88, f. 38, 53; BROWNE, For. Trees Sarawak & Brunei (1955) 142; ANDERSON, Gard. Bull. Sing. 20 (1963) 159; ASHTON, Man. Dipt. Brun. (1964) 211; *ibid.* Suppl. (1968) 115. — *S. leprosula* (non MIQ.) BOERL. Cat. Hort. Bog. 2 (1899) 110. — *S. palustris* RIDL. Fl. Mal. Pen. 1 (1922) 224; Foxw. Mal. For. Rec. 3 (1927) 381; *ibid.* 10 (1932) 212; BURK. Dict. (1935) 2019. — Fig. 106 B–B3.

Large buttressed tree. Young twig, panicle, bud and petiole densely shortly persistently rust-brown scabrid

pubescent, sparsely so on stipule, midrib above and leaf beneath, glabrescent on leaf above. *Twig* c. 3 mm \varnothing apically, stout, ridged, verrucose; stipule scars short, narrow, ascending, obscure. *Bud* 4–6 by 3.5–5 mm, broadly ovoid, obtuse. *Stipule* to 10 by 6 mm, ovate, subacute. *Leaves* 9–17 by 5.5–10 cm, medium-sized to large, elliptic-oblong or broadly ovate, thinly coriaceous; base obtuse; acumen to 1 cm long, short, broad; nerves 16–20 pairs, close, straight, curved near margin, with or without scale-like axillary domatia (without in old trees); tertiary nerves distant, scarlariform, slender but distinct, slightly diagonal to nerves; midrib broad, terete beneath, narrow yet hardly depressed above; *petiole* 1.5–2 cm long, stout. *Panicle* to 9 cm long, terminal or axillary, ribbed, straight, densely shortly persistently rust-brown scabrid pubescent; singly or doubly branched; *bracteoles* to 4 by 3 mm, broadly ovate, acute, densely shortly pubescent outside, glabrous within. *Flower bud* to 3 by 4 mm, ellipsoid-ovoid, obtuse. *Calyx* densely pubescent outside, glabrous within; 3 outer lobes ovate, obtuse, c. 2 × length of 2 inner lobes; inner lobes broadly ovate, prominently caudate. *Petals* pale yellow, narrowly lanceolate, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 unequal verticils, the longest almost as long as the ovary; filaments compressed, tapering gradually; anthers subglobose; appendage to connective as long as anther, becoming reflexed. *Ovary* and *stylopodium* glabrescent, narrowly ovoid; style as long as ovary and stylopodium, filiform, glabrous. *Fruit* subsessile, calyx shortly persistently pubescent towards base, otherwise glabrescent; 2 longer lobes to 6.5 by 1.2 cm, narrowly spatulate, narrowly obtuse, to 4 mm broad above the to 5 by 4 mm elliptic slightly thickened saccate base; 2 shorter lobes to 2 cm long, linear, similar at base. *Nut* to 8 by 6 mm, ovoid, densely buff pubescent; style remnant short, acute.

Distr. *Malesia*: Malaya (both coasts), Sumatra (Palembang, Siak), Banka, Billiton, Borneo (except E. Sabah).

Ecol. Locally common, widespread, in Mixed Peat Swamp forests.

Vern. *Mēranti paya*, *m. kait kait*, *m. sēgar* (Malaya).

Note. With close affinities to *S. leprosula* of the lowland forests.

153. *Shorea curtisii* DYER ex KING, J. R. Soc. Beng. Sc. 62, 2 (1893) 111; BRÜHL & KING, Ann. R. Bot. Gard. Calc. 5, 2 (1896) 152, t. 185; ASHTON, Gard. Bull. Sing. 31 (1978) 48.

a. ssp. curtisii. — BRANDIS, J. Linn. Soc. Bot. 31 (1895) 101; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 58; Fl. Mal. Pen. 1 (1922) 223; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 299; *ibid.* ed. 2 (1927) 1116; BURK. J. Str. Br. R. As. Soc. 81 (1920) 71, fig.; Foxw. Mal. For. Rec. 1 (1921) 78; *ibid.* 3 (1927) 39; *ibid.* 10 (1932) 226; BURK. Dict. (1935) 2009; CORNER, Wayside Trees 1 (1940) 213; SYM. Mal. For. Rec. 16 (1943) 67, f. 38, 40, 41;

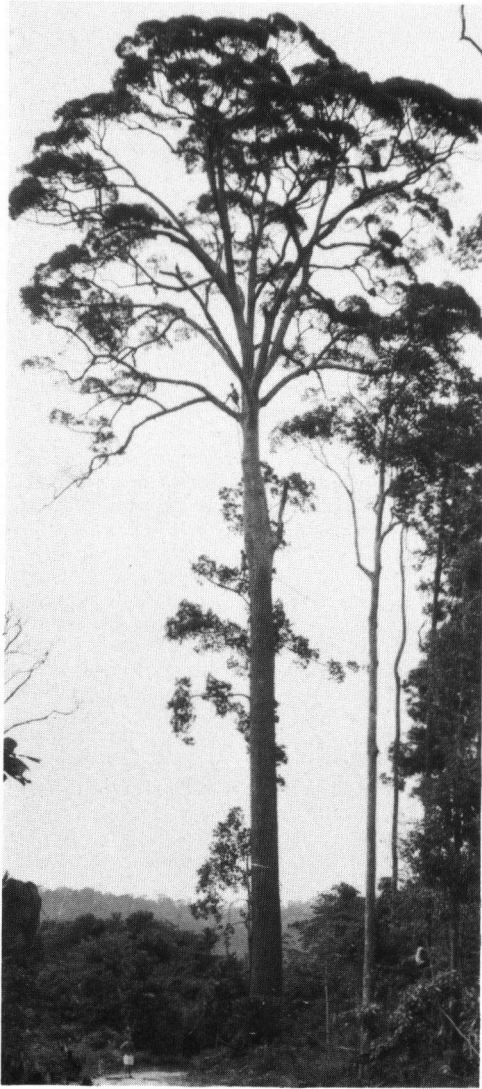


Fig. 112. Habit of a big tree of *Shorea curtisii* DYER ex KING. Note man at bottom left from tree, one tree climber halfway up, one in fork of first branch. Brunei, Labi Road (Photogr. ASHTON).

BROWNE, For. Trees Sarawak & Brunei (1955) 147; ASHTON, Man. Dipt. Brun. (1964) 185, f. 16, pl. 45 (habit, bark); *ibid.* Suppl. (1968) 106; MELJER & WOOD, Sabah For. Rec. 5 (1964) 103; BURGESS, F.R.I. Res. Pamphlet 66 (1975). — Fig. 6, 112, 113.

Large buttressed tree. Young twig, panicle, leaf bud, stipule outside (glabrescent within) petiole, and

midrib and nerves beneath densely shortly evenly caducous pale pink-brown to grey puberulent. *Twig* c. 1.5 mm \varnothing apically, terete, much branched, slender, becoming smooth, glabrous; stipule scars short, cuneate, horizontal, obscure. *Bud* 4–9 by 2.5–3.5 mm, subacute, ovate to slightly falcate, slightly constricted at base. *Stipule* to 10 by 4 mm, obtuse, slightly constricted at base. *Leaves* 6–9 by 2.5–3.5 cm, ovate-lanceolate, pale pink to grey lepidote beneath; base broadly cuneate; acumen to 8 mm long, narrow; nerves 9–11 pairs, curved, slender, hardly raised beneath, at 50°–60°; tertiary nerves slender, densely scalariform, obscure, diagonal to nerves; midrib slender, prominently terete beneath, narrow depressed above; *petiole* 1–1.3 cm long, slender. *Panicle* to 6 cm long, terminal or axillary, terete; singly or doubly branched, branchlets short, bearing to 12 distichous flowers; *bracteoles* to 2.5 by 2 mm, subacute, shortly pale grey pubescent outside, glabrous within, fugaceous. *Bud* to 5 by 3 mm, ovoid, obtuse. *Calyx* densely pale grey puberulent outside, glabrous within; lobes ovate, 3 outer longer, narrow, obtuse; 2 inner broad, acuminate. *Petals* pale cream yellow (Malaya) or deep crimson (Borneo), linear, obtuse, connate at base, densely pubescent on parts exposed in bud. *Stamens* 15, the outer 10 sometimes aborting, the inner 5 longer, reaching the ovary apex; filaments tapering gradually to the anther, markedly gibbous; anther subglobose; appendage to connective short on outer 10 stamens, rudimentary on inner 5, reflexed. *Ovary* and *stylopodium* ovoid, densely pubescent except at base; style short, broadening at the apex, glabrous. *Fruit* pedicel c. 1 mm long, short. *Fruit calyx* puberulent at base, otherwise glabrous; 3 longer lobes to 7 by 1 cm, narrowly spatulate; apex narrowly obtuse, tapering to c. 2.5 mm broad above the to 6 by 5 mm ovate shallowly saccate thickened base; 2 shorter lobes to 4 by 0.3 cm, unequal, linear, similarly expanded at base. *Nut* to 1.2 by 0.9 cm, ovoid, tapering to a short 1 mm long apiculus, shortly densely pale buff pubescent.

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

Ecol. Deep dry soils on coastal hills; in Malaya continuing up ridges and gregarious in Hill Dipterocarp forests between 300–850 m. See for detailed ecology BURGESS (1975).

Uses. The major dark red meranti timber in Malayan hills.

Vern. *Sēraya*, *s. sabut*, *s. bukit*, *mēranti lampong*, *m. sutra*, *m. sēraya*, *penak lampong*, *bohor*, *jarang*, *mēntanam* (Malaya), *sēraya* (Riouw).

Note. Small groups of hybrid trees between this species and *S. leprosula* exist on Bukit Timah, Singapore and Bukit Lagong, Selangor; this subspecies may have the same origin. The two species often occur together at the margin of their respective ecological ranges, and it is curious that morphologically intermediate trees are not more common.

b. ssp. grandis ASHTON, Gard. Bull. Sing. 31 (1978) 48. — *Shorea* sp. *B* SYM. Mal. For. Rec. 16 (1943) 95.

Differing as follows: *Twig* c. 4 by 2 mm \varnothing apically, compressed. *Leaves* 11–17 by 5–8 cm, elliptic; nerves 10–13 pairs; *petiole* 2–2.5 cm long.

Distr. *Malesia*: Malaya (Perak).

Ecol. As *ssp. curtisii*.

Vern. *Sēraya daun besar*.

154. *Shorea scabrida* SYM. Gard. Bull. S. S. 8 (1935) 287, pl. 28; BROWNE, For. Trees Sarawak & Brunei (1955) 143; ANDERSON, Gard. Bull. Sing. 20 (1963) 159; ASHTON, Man. Dipt. Brun. (1964) 221, f. 16, pl. 58 (habit, stem-base); *ibid.* Suppl. (1968) 119; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 146.

Medium-sized tree. Young twig, panicle, leaf bud, outside of stipule, midrib on both surfaces and nervation beneath \pm persistently densely tawny-brown scabrid pubescent. *Twig* c. 2 mm \varnothing apically, much branched, terete, becoming smooth, glabrous; stipule scars short, horizontal, obscure. *Bud* 2.5–5 by 1.5–3 mm, ovoid, compressed, obtuse. *Stipule* to 6 by 3 mm, oblong, obtuse, fugaceous. *Leaves* 5–9 by 3–5 cm, small, obovate or elliptic, coriaceous; base broadly cuneate, rarely obtuse; apex retuse, obtuse or with to 5 mm long acumen; nerves 8–11 pairs, slightly curved, at c. 25°–40°, rarely with domatia; tertiary nerves slender, scalariform, diagonal to nerves; midrib narrow and depressed above, terete and prominent beneath; *petiole* 9–11 mm long, short, rugose. *Panicle* to 8 cm long, terminal or axillary, short, terete or slightly compressed; singly, rarely doubly, branched, branchlets short, rather irregular, bearing to 7 \pm distichous flowers; *bracteoles* to 3.5 by 2.5 mm, ovate, subacute, shortly buff pubescent outside, glabrescent within. *Flower bud* to 8 by 3.5 mm, lanceolate, obtuse. *Calyx* densely pale buff pubescent outside, glabrous within; 3 outer lobes deltoid to ovate, subacute; 2 inner lobes smaller, broadly ovate, subacuminate. *Petals* cream, pink at base, lanceolate, acute, densely pubescent on parts exposed in bud. *Stamens* 15, in 3 distinct verticils; filaments tapering gradually; anther subglobose; appendages to connective slightly longer than anther, the longest reaching to the base of the style, becoming reflexed. *Ovary* and *stylopodium* narrowly conical, densely pubescent except at the base; style almost half length of ovary and stylopodium, glabrous. *Fruit calyx* glabrescent; 3 longer lobes to 7 by 1.5 cm, spatulate, c. 3 mm wide above the to 7 by 5 mm ovate saccate thickened base; 2 shorter lobes to 3 by 0.3 cm, linear, similar at base. *Nut* to 10 by 8 mm, ovoid, shortly densely buff pubescent, shortly apiculate.

Distr. *Malesia*: E. Sumatra (Lower Langkat, Langsa, Lingga), Borneo.

Ecol. Local in fresh water swamp forest on shallow peat overlying sand, and on skeletal sandy soil on ridges and plateaux, in Heath forest and Mixed Dipterocarp forest.

Vern. *Kulap daun*, *mēranti tembalang*, *m. pepak lantai*, *pēngērawan* (W. Borneo), *lanan lutung*, *l.*

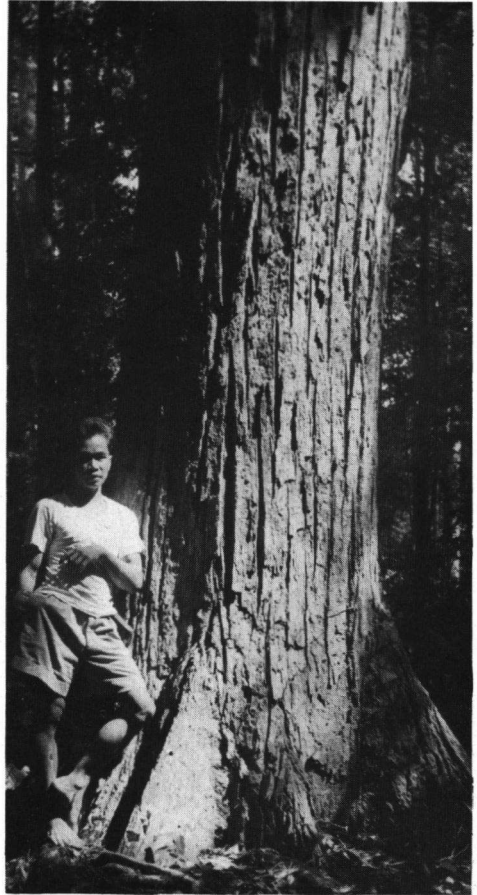


Fig. 113. Trunk-base of *Shorea curtisii* DYER *ex* KING, with V-shaped fissure bark. Brunei (Photogr. ASHTON).

tēmbaga (S.E. Borneo), *bangkirai lutung* (S.E. Borneo), *sēraya lop* (Sabah), *mēranti tēhur* (Kedayan), *m. lop* (Sarawak).

Notes. A variable species with several local ecotypes varying principally in leaf shape and persistence and evenness of tomentum.

Doubtfully distinct from *S. retusa*; apparently intermediate forms occur in S.E. Borneo (sterile collections).

155. *Shorea revoluta* ASHTON, Gard. Bull. Sing. 19 (1962) 304, pl. 26; Man. Dipt. Brun. (1964) 215, f. 16; *ibid.* Suppl. (1968) 117; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 142.

Medium-sized tree. Twig, panicle, leaf bud, stipule outside (pubescent within) and petiole densely shortly



Fig. 114. Hill dipterocarp forest with *Shorea ovata* DYER ex BRANDIS amidst the common bertam palm, *Eugeissona triste*. Malaya (Photogr. WYATT-SMITH, 1948).

pale brown to fulvous somewhat scabrid pubescent; nervation beneath and midrib above more sparsely so, glabrescent. *Twig* c. 2–3 mm \varnothing apically, at first slightly ribbed and compressed, becoming terete, stout, smooth, glabrous; stipule scars to 2 mm long at first, horizontal, narrow, obscure. *Bud* 4–7 by 3–5 mm, ovoid, compressed, subacute. *Stipule* to 1.5 by 0.7 cm, elliptic to oblong, obtuse. *Leaves* 10–15 by 5.5–10 cm,

ovate, coriaceous, lustrous; base obtuse to subcordate; acumen to 1.5 cm long, narrow; margin revolute; nerves 9–12 pairs, curved, prominent beneath, well spaced, at to 90° at the base and down to 45° towards the apex, with small glabrous axillary domatia; tertiary nerves slender, scalariform, diagonal to nerves; midrib narrow and slightly depressed above, prominent beneath; *petiole* 1.3–1.5 cm long. *Panicle* to 22 cm

long, singly or doubly branched, terminal or axillary, straight. *Flower bud* to 7 by 4 mm. *Sepals* narrowly deltoid-ovate, subacute, pubescent on parts exposed in bud, the inner 2 smaller than the outer 3. *Petals* lanceolate, hispid on parts exposed in bud. *Stamens* 15, in 3 unequal verticils; filaments slender, compressed, tapering to the small subglobose anthers; appendage to connective slender, short, as long as anther, anthers and appendages becoming reflexed. *Ovary* and *stylopodium* narrowly conical, densely pubescent; style slender, filiform, glabrous, *c.* $\frac{1}{2}$ length of ovary and stylopodium. *Fruit pedicel* to 1.5 cm long. *Calyx* puberulent; 3 longer lobes to 7.5 by 1.3 cm, narrow, spatulate, obtuse, *c.* 3 mm broad above the *c.* 6 by 5 mm ovate thickened saccate base; 2 shorter lobes to 3.5 by 0.2 cm, subequal, linear, acute, similar at base. *Nut* to 1.5 by 0.8 cm, ovoid, pale buff pubescent; style remnant *c.* 1.5 mm long, tapering.

Distr. *Malesia*: Borneo (N.E. Sarawak, Brunei, S.W. Sabah).

Ecol. Local, Heath forest on terraces and sandstone plateaux to 1200 m.

Vern. *Mēranti kērangas* (Sarawak), *sēraya daun tajam* (Sabah).

156. *Shorea ovata* DYER *ex* BRANDIS, J. Linn. Soc. Bot. 31 (1895) 91; MERR. En. Born. (1921) 406; SYM. Gard. Bull. S. S. 7 (1933) 140, pl. 40; Mal. For. Rec. 16 (1943) 82, f. 38, 50; BROWNE, For. Trees Sarawak & Brunei (1955) 148; ASHTON, Man. Dipt. Brun. (1964) 230, f. 16; *ibid.* Suppl. (1968) 112; MEIER & WOOD, Sabah For. Rec. 5 (1964) 127, pl. 8A. — *S. parvifolia* (*non* DYER) KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 112, *p.p.*; FOXW. Mal. For. Rec. 10 (1932) 199. — *S. plagata* FOXW. Philip. J. Sc. 13 (1918) Bot. 192; *ibid.* 67 (1938) 308. — *S. agsaboensis* W.L. STERN, Brittonia 17 (1965) 36, f. 1–2; ROJO, Pterocarpus 3 (1977) 70, fig. — Fig. 114.

Small or medium-sized tree. Young twig, panicle, leaf bud, stipule (both surfaces), petiole, midrib above and leaf beneath densely persistently evenly ochraceous to rust pubescent, scabrid on raceme and nervation beneath. *Twig* *c.* 1 mm \varnothing apically, slender, much branched, terete, becoming smooth, glabrous; stipule scars *c.* 1 mm long, thin, slightly descending. *Bud* 3–6 by 1.5–3 mm, ovoid, obtuse. *Stipule* to 13 by 5 mm, ovate, subacute, fugaceous. *Leaves* 4–8 by 2.5–4.5 cm, small, coriaceous, broadly ovate; base subequal to equal, obtuse; acumen to 1 cm long, narrow; margin slightly revolute; nerves 8–10 pairs, curved, prominent beneath, at *c.* 50°–70°, with (in Borneo) small pilose axillary domatia; tertiary nerves slender, densely scalariform, set diagonally to the nerves; midrib slightly depressed above; *petiole* 1–1.3 cm long. *Panicle* to 11 cm long, terminal or axillary, terete or slightly compressed; singly or doubly branched, branchlets to 3 cm long, bearing to 8 \pm distichous flowers; *bracteoles* to 3.5 by 2 mm, oblong, obtuse, sparsely puberulent outside, glabrescent within. *Flower bud* to 6 by 2.5 mm, ovoid, subacute. *Calyx* densely golden-brown pubescent outside, gla-

brescent within; 3 outer lobes narrowly ovate, acuminate; 2 inner shorter, broader, more acuminate; *petals* pale pink with cream margin, lanceolate, obtuse, pubescent on parts exposed in bud, loosely connate on falling. *Stamens* of 3 lengths, the outer 5 often aborting, the inner 5 about twice their length; filaments tapering gradually; anthers subglobose, narrower apically; appendage to connective short, becoming reflexed. *Ovary* ovoid, with a band of hairs at the apex, otherwise glabrous, tapering into the rather short glabrous style. *Fruit calyx* glabrescent, \pm persistently puberulent at base; 3 longer lobes to 5.5 by 1 cm, spatulate, obtuse, to 4 mm broad above the to 7 by 6 mm ovate shallowly saccate thickened base; 2 shorter lobes to 3 by 0.3 cm, subequal, linear, similarly saccate at base. *Nut* to 11 by 8 mm, broadly ovoid, tapering, shortly evenly densely buff pubescent; style remnant to 2.5 mm long, acute.

Distr. *Malesia*: Malaya, Sumatra (W. coast: Tapanuli, Sibolga to Painan, Bangkinang; P. Musala), Borneo (Kapuas hinterland, Sarawak to S.W. Sabah, S.E. Borneo), Philippines (Mindanao).

Ecol. Sandy soils on coastal hills (especially in Borneo); inland ridges to 1500 m (especially in Malaya and Sumatra).

Vern. *Mēranti sarang punai bukit* (Malaya), *mandirawan* (Sumatra), *sēraya punai bukit* (Sabah).

Notes. Formerly I pointed out (Gard. Bull. Sing. 31, 1978, 47) that *S. plagata* and *S. agsaboensis* (from Mindanao) represented the same species and referred these names to *S. pauciflora*, owing to the leaf shape and 8 pairs of nerves, pointing out, however, that the Philippine plants differed in the usually small leaf-size and the usual but not consistent presence of small axillary domatia up to the midrib. I also indicated that flowers would be needed for confirmation. J. P. ROJO has now collected and described (1977, *l.c.*) these flowers (ROJO 292, Agusan del Norte, Mindanao) and correctly pointed out that they place the species in a different section, *Mutica*, *S. pauciflora* being in *sect. Brachypterae*. ROJO's excellent field description alludes to the fissured bark and bluish-red corolla, pink at the base. This matches *Shorea sect. subsect. Mutica*, while the description of the corolla is distinctive and clearly matches that of *S. ovata*, in which the leaves also bear 8 pairs of nerves and pubescent axillary domatia. Though not closely resembling the leaves of *S. ovata* as it occurs in Borneo, the Philippine specimens so much resemble specimens from Sumatra and West Malaysia, that I am convinced of their conspecificity. This conclusion is strengthened by ROJO's comment that it is in Mindanao a species of high ridges, exactly as is *S. ovata*, except in northern Borneo where it spreads down onto sandy soils in the lowlands.

157. *Shorea rubra* ASHTON, Gard. Bull. Sing. 19 (1962) 309, pl. 28; Man. Dipt. Brun. (1964) 217, f. 16; *ibid.* Suppl. (1968) 118; MEIER & WOOD, Sabah For. Rec. 5 (1964) 144.

Medium-sized or large buttressed tree with dark

bark. Twig, panicle, bud, stipule (both surfaces, shorter within), petiole, midrib above and leaf beneath densely persistently deep rufous-brown scabrid pubescent. *Twig* to 1.5 mm \varnothing apically, terete, much branched, becoming smooth; stipule scars *c.* 1 mm long, short, narrow, descending. *Bud* 4–7 by 3–4.5 mm, compressed, ovoid, broadly acute. *Stipule* to 16 by 5 mm, hastate, subacute. *Leaves* 8–13 by 4–7.5 cm, broadly ovate, thinly coriaceous; base obtuse; acumen to 1.3 cm long; margin narrowly revolute; nerves 11–13 pairs, prominent beneath, curved distally, at 40°–50°; tertiary nerves slender, densely scalariform, diagonal to nerves; midrib prominently terete beneath, narrow and shallowly depressed above; *petiole* 1–1.4 cm long. *Panicle* to 14 cm long, terminal or axillary, terete, rather straight and ridged; singly or doubly regularly branched, branchlets short, compact, bearing to 5 distichous flowers; *bracteoles* to 4 by 3.5 mm, broadly ovate, subacute, imbricate round the bud, shortly pale buff pubescent outside, more sparsely so within. *Flower bud* to 7 by 4 mm, ellipsoid to subglobose, obtuse. *Calyx* densely pale grey pubescent outside, glabrous within; 3 outer lobes deltoid-ovate, obtuse; 2 inner lobes smaller, broadly ovate, acute. *Petals* pale yellow, narrowly oblong, subacute, shortly pubescent on parts exposed in bud. *Stamens* 15, of 3 lengths, the inner 5 being almost twice as long as the others; filaments of outer 10 tapering gradually to anther, filaments of inner 5 oblong, broad, tapering abruptly distally; anthers subglobose; appendage to connective shorter than anther, becoming slightly reflexed. *Ovary* and *stylopodium* ovoid-conical, densely pubescent except at the base; style shorter than ovary, glabrous. *Fruit calyx* sparsely puberulent, glabrescent; 3 longer lobes to 11 by 1.6 cm, narrowly spatulate, obtuse, to 5 mm broad above the to 8 by 6 mm deeply saccate thickened base; 3 shorter lobes to 4.5 by 0.4 cm, subequal linear, acute, similarly expanded at base. *Nut* to 10 by 9 mm, broadly ovoid, shortly densely evenly pale buff pubescent. Style remnant to 2 mm long, tapering.

Distr. *Malesia*: Northern Borneo (West Borneo; Rejang valley to West Sabah and Tawau).

Ecol. Uncommon, on sandy clay soils on low hills and ridges to 1350 m.

Vern. *Mĕranti mĕrah kesumba* (Brun.).

158. *Shorea dasyphylla* Foxw. Mal. For. Rec. 10 (1932) 224, pl. 18; BURK. Dict. (1935) 2010; SYM. Mal. For. Rec. 16 (1943) 69, f. 38, 42; BROWNE, For. Trees Sarawak & Brunei (1955) 138; ASHTON, Man. Dipt. Brun. Suppl. (1968) 106, f. 13.

Medium-sized or large buttressed tree. Twigs, buds, stipules, petioles, leaf beneath and midrib above densely persistently shortly scabrid golden-brown pubescent, leaf above puberulent. *Twig* *c.* 2 mm \varnothing towards apices, terete; stipule scars short, obscure. *Bud* to 3 by 2 mm, ovoid, obtuse. *Stipules* to 6 by 4 mm, broadly ovate, obtuse, caducous. *Leaves* 7–14 by 3–6 cm, ovate to elliptic, coriaceous, margin somewhat revolute; base obtuse or broadly cuneate;

acumen to 1 cm long, slender; nerves 11–15 pairs, prominent beneath, at 50°–65°; tertiary nerves scalariform, elevated beneath; midrib \pm depressed above, prominently terete, striated, beneath; *petiole* 12–15 mm long. *Panicle* to 8 cm long, terminal or axillary, terete or ribbed, densely persistently shortly golden-brown scabrid pubescent; singly branched, branchlets to 1 cm long, bearing to 4 flowers; *bracteoles* to 3 by 2 mm, elliptic, obtuse, pubescent, caducous. *Flower bud* to 4 by 3 mm, ovoid. *Calyx* densely pubescent outside, sparsely so within; 3 outer lobes deltoid-ovate, 2 inner lobes smaller, broadly ovate. *Petals* cream-yellow, oblong, obtuse, densely pubescent on parts exposed in bud. *Stamens* 15, of 3 lengths, the inner 5 about twice the length of the others; filaments tapering gradually to the subglobose anthers; appendages to connective short, slender, becoming reflexed. *Ovary* and *stylopodium* ovoid to conical, densely pubescent; style shorter than ovary, glabrous. *Fruit pedicel* to 2 mm long. *Calyx* glabrescent; 3 longer lobes to 9 by 1.3 cm, narrowly spatulate, subacute, *c.* 4 mm broad above the to 8 by 6 mm ovate saccate thickened base; 2 shorter lobes to 40 by 4 mm, linear, similar at base. *Nut* to 18 by 9 mm, ovoid, shortly evenly buff pubescent, shortly apiculate.

Distr. *Malesia*: Malaya (excluding seasonal area), Sumatra (Palembang north to Langkat and Labuan Batu in east), Borneo (Sarawak west of the Lupar).

Ecol. Scattered in Mixed Dipterocarp forest on well drained flat land and low hills and occasionally to 1000 m.

Vern. *Mĕranti batu*, *m. tĕmbaga*, *m. sarang punai*, *m. sabut* (Mal.), *m. gambong*, *m. sabut*, *kĕtuho andilan* (Sumatra).

159. *Shorea parvifolia* DYER, Fl. Br. Ind. 1 (1874) 305; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 112, *p.p.*; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 92, *p.p.*; RIDL, Agr. Bull. Str. & F. M. S. 1 (1901) 57; Fl. Mal. Pen. 1 (1922) 224; BURK. J. Str. Br. As. Soc. 81 (1921) 517; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 306; *ibid.* ed. 2 (1927) 1123; FOXW. Mal. For. Rec. 3 (1927) 31; SLOOT, in Merr. Pl. Elm. Born. (1929) 203; EDWARDS, Mal. For. Rec. 9 (1931) 146; SYM. Gard. Bull. S. S. 7 (1933) 137, pl. 39; Mal. For. Rec. 16 (1943) 85, f. 37C, 38, 51; BROWNE, For. Trees Sarawak & Brunei (1955) 141; ASHTON, Gard. Bull. Sing. 20 (1963) 278; Man. Dipt. Brun. (1964) 206, f. 16; *ibid.* Suppl. (1968) 113; MEIJER & WOOD, Sabah For. Rec. 5 (1964) 128, f. lc.

a. ssp. parvifolia. — *S. scutulata* KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 110; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 102; BURK. J. Str. Br. R. As. Soc. 81 (1920) 71, fig.; RIDL, Fl. Mal. Pen. 1 (1922) 222; FOXW. Mal. For. Rec. 10 (1932) 201; BURK. Dict. (1935) 2022. — *S. gentilis* PARIJS in Fedde, Rep. 33 (1933) 244.

Large tree. Young twig, panicle, leaf bud, stipule, petiole and midrib above shortly evenly persistently pale brown pubescent or glabrous, otherwise glabrous. *Twig* *c.* 2 mm \varnothing apically, terete, much branched, becoming glabrous, smooth; stipule scars

short, inconspicuous. *Bud* 4–7 by 3–5 mm, ovoid, compressed, obtuse. *Stipule* to 12 by 4 mm, oblong to ovate, obtuse. *Leaves* 5–9 by 2.5–5 cm, broadly ovate, thinly coriaceous, base obtuse or cordate with occasionally a pair of large pale scale-like domatia; acumen to 1 cm long, margin slightly revolute; nerves 10–13 pairs, slightly curved, slender, hardly elevated beneath; tertiary nerves slender, closely scalariform diagonal to nerves, midrib narrow and depressed above; *petiole* 1–1.5 cm long. *Panicle* to 12 cm long, terminal or axillary, slender, terete or slightly compressed; regularly singly, rarely doubly, branched, branchlets short, compact, bearing to $8 \pm$ secund flowers; bracteoles to 6 by 3 mm, elliptic-oblong, obtuse, shortly sparsely pale buff pubescent. *Bud* to 7 by 5 mm, broadly ovoid to subglobose, obtuse. *Calyx* densely pubescent outside, glabrous within; 3 outer lobes deltoid-ovate; 2 inner lobes smaller, broadly ovate, acute, thin at base. *Petals* cream suffused with pink at base, oblong, obtuse, shortly pubescent on parts exposed in bud. *Stamens* 15, of 3 lengths, the 5 inner about twice length of others; filaments tapering gradually; anther subglobose; appendage to connective short, slender, becoming reflexed. *Ovary* and *stylopodium* ovoid to conical, densely pubescent except at base; style shorter than ovary, glabrous. *Fruit* calyx shortly sparsely pale brown pubescent; 3 longer lobes to 9 by 1.5 cm, thin, spatulate, obtuse, c. 4 mm broad above the c. 5.5 by 5 mm elliptic thickened saccate base; 2 shorter lobes to 3.5 by 0.2 cm, linear, subequal, similarly saccate at base. *Nut* to 14 by 7 mm, ovoid, shortly buff pubescent, style remnant c. 2.5 mm long, tapering, acute.

Distr. Thailand (Pattani) and in *Malesia*: Malaya, Sumatra, P. Musala, Borneo.

Ecol. Perhaps the commonest dipterocarp in the region, on clay soils on hills below 800 m.

Uses. A very important timber tree, the main source of light red meranti.

Vern. *Mēranti sarang punai*, *m. bunga*, *m. samak*, *m. daun halus*, *m. choh*, *m. lēm̄esa bung* (Malaya), *m. sabut*, *m. kapala tupai*, *tambong sawa* (Sumatra), *sawang puteh*, *awang belah* (Mahakam), *ponga pipit*, *p. payur*, *p. bahaya* (Melawi), *lampung*, *l. nasi*, *l. tēmbaga*

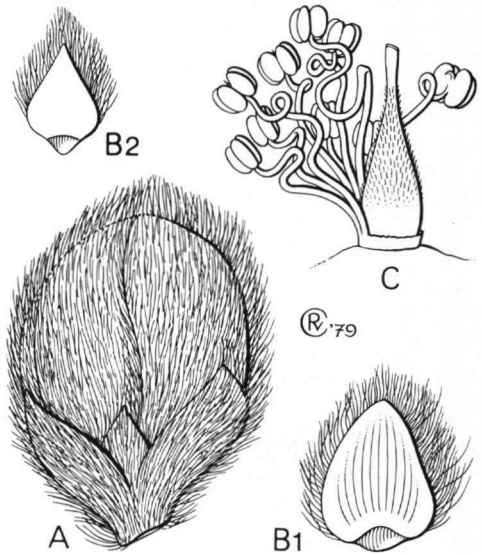


Fig. 115. Flower details in *Shorea* sect. *Ovalis* ASHTON. — *S. ovalis* (KORTH.) BL. A. Bud, B1. outer sepal, B2. inner sepal, C. stamens and pistil, all $\times 10$ (SAN 19266).

(Kutei), *kontoi*, *k. burong* (W. Borneo), *merangan*, *m. nasi* (Nunukan), *dangar siak*, *d. burau* (Murut), *p̄rawan lop* (Iban), etc.

b. *ssp. velutinata* ASHTON, Gard. Bull. Sing. 20 (1963) 278.

Differing as follows: *Leaves* 6–11 by 3.5–6 cm, ovate or elliptic; base obtuse or cuneate; nerves stoutly prominent evenly sparsely scabrid pubescent, beneath; margin often narrowly revolute.

Distr. *Malesia*: Malaya (E. Pahang, E. Johore), Sumatra, Borneo.

Ecol. As *ssp. parvifolia* but mainly near the coast.

10. Section Ovalis

ASHTON, Gard. Bull. Sing. 20 (1963) 268; Man. Dipt. Brun. (1964) 117. — *Shorea*, Red Meranti group, *S. ovalis* subgroup, SYM. Mal. For. Rec. 16 (1943) 58. — Fig. 115.

Flower buds broadly ovoid, obtuse; corolla as in *sect. Rubella*; *stamens* 50–70; filaments very long, filiform, folded in bud; anthers subglobose, with 4 pollen sacs; appendage to connective vestigial; *ovary* and *stylopodium* narrowly conical, densely pubescent; style short. *Stipules*, *bracts* and *bracteoles* subpersistent. *Leaf* tertiary nervation scalariform; midrib obscure and depressed above. *Bark surface* deeply V-section fissured. *Wood* as in *sect. Brachypterae*.

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

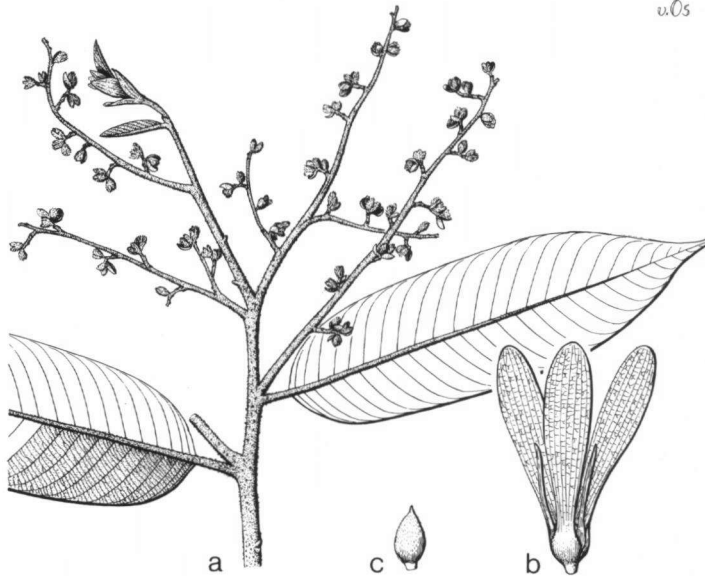


Fig. 116. *Shorea ovalis* (KORTH.) BL. *ssp. ovalis*. a. Young inflorescence, b. fruit, c. nut, all $\times \frac{1}{2}$ (a bb. 20237, b-c SAN 16474).

160. *Shorea ovalis* (KORTH.) BL. Mus. Bot. Lugd.-Bat. 2 (1852) 33; WALP. Ann. 4 (1857) 338; MIQ. Fl. Ind. Bat. 1, 2 (1859) 503; DC. Prod. 16, 2 (1968) 631. — Fig. 115–118.

KEY TO THE SUBSPECIES

1. Leaves oblong-ovate, \pm bent upwards along the midrib, base obtuse.
2. Twig and nervation and lamina beneath \pm shortly scabrid pink-brown pubescent
 - a. *ssp. ovalis*
2. Twig and nervation beneath rufous tufted tomentose, lamina beneath glabrous, lustrous
 - b. *ssp. sarawakensis*
1. Leaves oblong-obovate, boat-shaped with the lower surface concave; base cuneate
 - c. *ssp. sericea*

a. *ssp. ovalis*. — BURCK, Ann. Jard. Bot. Btzig 6 (1887) 219; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 103; MERR. En. Born. (1921) 406; SYM. Gard. Bull. S. S. 10 (1939) 370; Mal. For. Rec. 16 (1943) 80, f. 37B, 38, 49; BROWNE, For. Trees Sarawak & Brunei (1955) 132; ASHTON, Gard. Bull. Sing. 20 (1963) 274; MEIJER & WOOD, Sabah For. Rec. 5 (1954) 125, f. 1b, pl. 8b. — *Dilleniaceae*? *nervosa* WALL. Cat. (1832) 6635, *nomen*. — *Vatica ovalis* KORTH. Kruidk. (1841) 73; WALP. Rep. 5 (1845) 127; DC. Prod. 16, 2 (1868) 623. — *Vatica eximia* MIQ. Sum. (1861) 486; DC. Prod. 16, 2 (1868) 623; WALP. Ann. 7 (1868)

378. — *Vatica sublacunosa* MIQ. Sum. (1861) 486, 191; DC. Prod. 16, 2 (1868) 623; WALP. Ann. 7 (1868) 378. — *Hopea aspera* DE VRIESE, Minyak Tengkawang (1861) 28. — *S. eximia* SCHEFF. Nat. Tijd. N. I. 31 (1870) 349; BURCK, Ann. Jard. Bot. Btzig 6 (1887) 218, *incl. var. angustifolia* BURCK; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 121; HEYNE, Nutt. Pl. ed. 2 (1927) 1116; SYM. Gard. Bull. S. S. 7 (1933) 143, pl. 43. — *S. sublacunosa* SCHEFF. Nat. Tijd. N. I. 31 (1870) 350; HEYNE, Nutt. Pl. ed. 2 (1927) 1116. — *S. furfuracea* (non MIQ.) BRANDIS, J. Linn. Soc. Bot. 31 (1895) 98, *p.p.*; SLOOT, *ex* HEYNE, Nutt. Pl. ed. 1, 3 (1917) 299; RIDL. Fl. Mal. Pen. 1 (1922) 232, *p.p.* — Fig. 116, 117.

Large tree. Twig, petiole, nervation beneath, leaf undersurface, midrib above, panicle and parts of perianth exposed in bud densely persistently pink-brown scabrid pubescent. Twig to 3 mm \varnothing apically, stout, terete, becoming smooth; stipule scars cuneate, c. 2 mm long, slightly ascending. Bud to 8 by 6 mm, ovoid, obtuse. Stipule to 13 by 7 mm, ovate, acute, prominently nerved, abruptly constricted at base, subsistent. Leaves to 10–18 by 3–7 cm, oblong or narrowly ovate, attenuate, coriaceous; base obtuse; acumens to 8 mm long, narrow; margin \pm revolute; nerves (20–)22–25 pairs, dense, prominent beneath, curved, set at 55°–70°; tertiary nerves distinct, scalariform, at 90° to nerves; midrib prominently terete beneath, shallowly depressed above; petiole 7–9 mm long. Panicle to 18 cm long, terminal or axillary,



Fig. 117. *Shorea ovalis* (KORTH.) BL. *ssp. ovalis*. Shoot of 3 m high sapling, $\times \frac{1}{2}$ (SAN 19446).

terete; singly or doubly regularly branched, branchlets short, compact, bearing to 8 flowers; *bracteoles* to 8 by 6 mm, broadly elliptic, obtuse, tightly cupped round the buds, pink-brown pubescent outside, glabrous within, falling at anthesis. *Flower bud* to 5 mm long, broadly ovoid to globose. *Calyx* densely golden-brown pubescent outside, glabrous within; 3 outer lobes narrowly ovate, acuminate; 2 inner lobes shorter, subacute. *Petals* cream with a pink tinge towards base, ovate, obtuse, densely pubescent on parts exposed in bud. *Stamens* 50–70, of varying lengths, the innermost almost twice as long as the style and almost as long as the petals; filaments filiform, much twisted and folded in bud; anthers elliptic to oblong, the cells rather narrow; appendage to connective short, vestigial. *Ovary* and *stylopodium* narrowly conical, densely shortly pubescent in the distal half, glabrous at base; style short, cylindrical, glabrous. *Fruit calyx* puberulent; 3 longer lobes to 11 by 1.4 cm, spatulate, narrowly obtuse, to 7 mm broad above the thickened base; 2 shorter lobes to 6 by 0.4 cm, linear,

similar at base. *Nut* to 2.2 by 1.3 cm, shortly evenly densely rufous pubescent; style remnant to 2.5 mm long, tapering, acute.

Distr. Malesia: Malaya (Penang, E. coast), Singapore, E. Sumatra (Indragiri), Banka, Billiton, Borneo (E. Sabah and Indonesian Borneo).

Ecol. Scattered in lowland Mixed Dipterocarp forest, usually in moist places in valleys and low-lying ground, to 500 m.

Vern. *Mēranti kepong, kepong labu, k. segar* (Malaya), *mēranti mērah, m. sabut* (Sumatra), *lampung, l. rasa, l. mērambung* (E. Borneo), *damar salēmsung, d. putang, mēsēlurang* (S.E. Borneo), *sēbong gunung putēh* (E. Kutei), *tahan lētup* (Lower Dayak).

b. *ssp. sarawakensis* ASHTON, *Gard. Bull. Sing.* 20 (1963) 275; *Man. Dipt. Brun.* (1964) 202, f. 19; *ibid. Suppl.* (1968) 111.

Defining characters: Twigs prominently rufous tufted tomentose, tufts to 3 mm long; leaf nervation beneath, petiole and panicle shortly sparsely so;

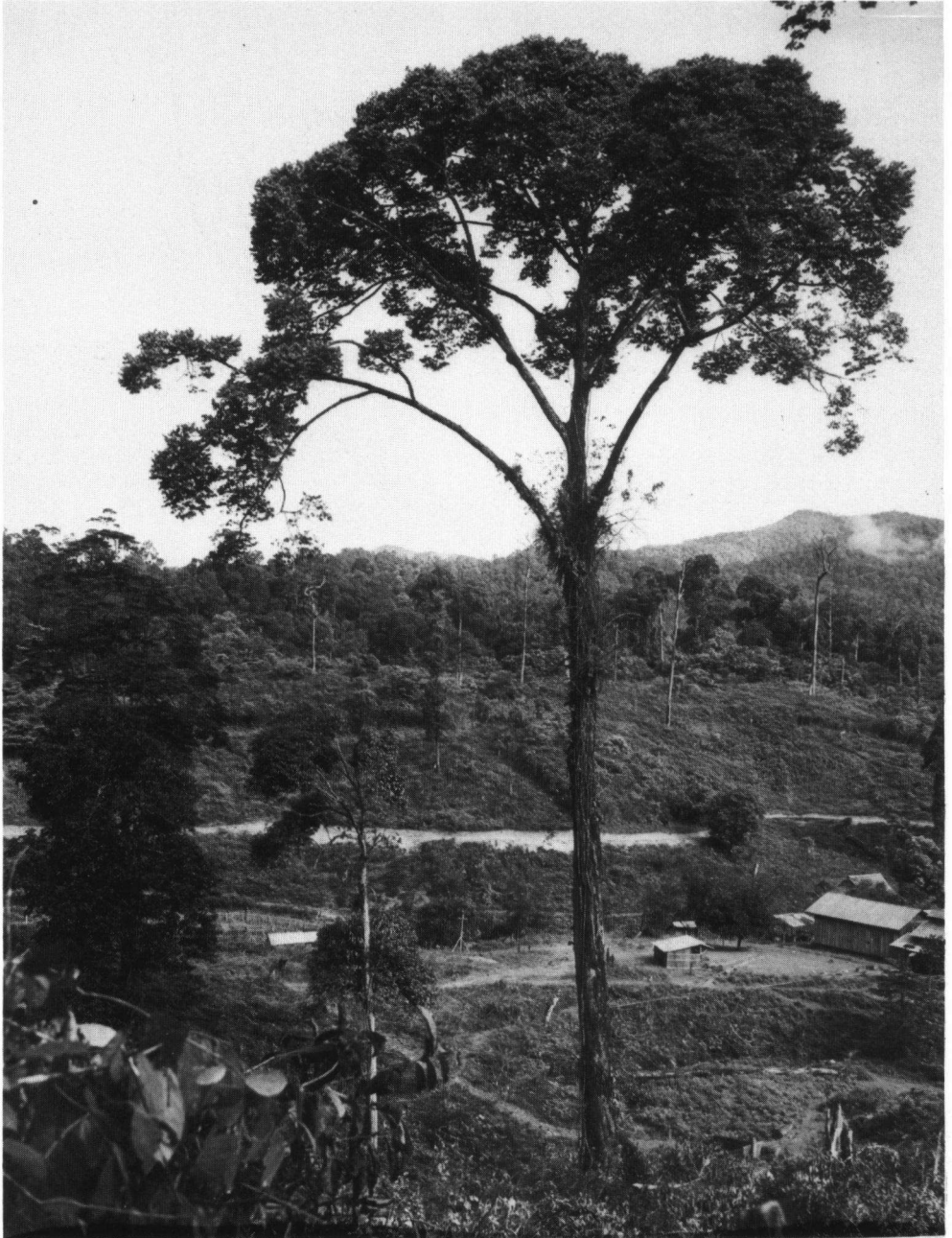


Fig. 118. *Shorea ovalis* (KORTH.) BL. Forest relict tree in Trengganu (Photogr. CORNER, 1935).

lamina beneath glabrous, lustrous. *Leaves* 12–17 by 2–4.5 cm, narrowly oblong, margin prominently revolute, base obtuse, nerves at 55°–65°.

Distr. *Malesia*: Borneo (Sarawak and W. Sabah).
Ecol. As *ssp. ovalis*.

c. ssp. sericea (DYER) ASHTON, Gard. Bull. Sing. 20 (1963) 255. — *S. sericea* DYER, Fl. Br. Ind. 1 (1874) 306; KING, J. R. As. Soc. Beng. Sc. 62, 2 (1893) 111; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 101, *p.p.*; BRANDIS & GILG in E. & P. Pfl. Fam. ed. 1, 3, 6 (1895) 267; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 58; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 308; BURK. J. Str. Br. R. As. Soc. 81 (1920) 73, fig.; FOXW. Mal. For. Rec. 1 (1921) 80; MERR. En. Born. (1921) 406; RIDL. Fl. Mal. Pen. 1 (1922) 223; HEYNE, Nutt. Pl. ed. 2 (1927) 1116; FOXW. Mal. For. Rec. 3 (1927) 33; SLOOT in Merr. Pl. Elm. Born. (1929) 204; FOXW. Mal. For. Rec. 8 (1930) 23; EDWARDS, Mal. For. Rec. 9 (1931) 147; FOXW. *ibid.* 10 (1932) 229; BURK. Dict. (1935) 2022. — *S. fusca* BURCK, Ann. Jard. Bot. Btzg 6 (1887) 207; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 83. — *S. rigida* BRANDIS in Hook. f. Ic. Pl. (1895) t. 2402; J. Linn. Soc. Bot. 31 (1895) 102; RIDL. Agr. Bull. Str. & F.M.S. 1 (1901) 58; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 306; BURK. J. Str. Br. R. As. Soc. 76 (1917) 164, fig.; *ibid.* 81 (1920) 73; RIDL. Fl. Mal. Pen. 1 (1922) 223; HEYNE, Nutt. Pl. ed. 2 (1927) 1124; FOXW. Mal. For. Rec. 3 (1927) 33.

Defining characters: Twigs and leaves beneath ± shortly evenly pink-brown pubescent. *Leaves* 14–22 by 4–10 cm, broadly oblong or obovate, deeply boat-shaped with the lower surface concave, base cuneate, nerves at 50°–55°.

Distr. *Malesia*: Malaya, S. Sumatra (Angkola, Bangkinang and Djambi southwards), Banka, Billiton.

Ecol. As *ssp. ovalis*.

Vern. As *ssp. ovalis*; also *kujung*, *kalup*, *kĕlukung daun* (Sumatra).

Note. This subspecies is known to be tetraploid and to reproduce largely apomictically through adventive polyembryony (KAUR *c.s.*, Nature 271, 1978, 440).

Insufficiently known

Flowers are unknown from the following three species which can therefore not be placed in a section with certainty.

161. *Shorea carapae* ASHTON, Gard. Bull. Sing. 22 (1967) 294, pl. 39; Man. Dipt. Brun. Suppl. (1968) 105, f. 13.

Medium-sized tree with pale flaky bark. Twig, leaf bud, stipule and petiole persistently densely evenly buff sericeous, nervation and midrib above sparsely so. *Twig* *c.* 3 by 2 mm \varnothing apically, compressed, drying rugose at first, becoming terete, smooth; stipule scar prominent, almost amplexicaul. *Bud* *c.* 7 by 2 mm, lanceolate, acute. *Stipule* to 25 by 20 mm, oblong-lanceolate, subacute, caducous. *Leaves* 14–18 by 7–10

cm, broadly ovate, elliptic, coriaceous; base obtuse to cordate; acumen short, broad; nerves 11–13 pairs, stout, prominent beneath, at 50°–70°; tertiary nerves slender, densely scalariform, unraised; midrib appanate to somewhat depressed above, prominent beneath; *petiole* 23–35 mm long, terete. *Flowers* unknown. *Panicle* to 15 cm long, terminal or axillary, terete, smooth or rugulose, densely shortly evenly pale buff pubescent, singly branched; bracteoles to 16 by 5 mm, lanceolate, acute, densely pubescent outside, sparsely so within. *Fruit calyx* and *pedicel* sparsely evenly buff pubescent. *Pedicel* short, stout. 3 longer calyx lobes to 7 by 1.5 cm, spatulate, subacute, *c.* 5 mm broad above the to 6 by 5 mm ovate saccate thickened base; 2 shorter lobes to 25 by 3 mm, linear, similar at base. *Nut* to 10 by 7 mm, ovoid, glabrous, acute.

Distr. *Malesia*: Borneo (Central Sarawak, W. Kutei).

Ecol. Volcanic plateaux at 800–1200 m; locally abundant.

Vern. *Awang jangut* (Kutei), *abang uloh* (Kenyah).

Note. Bark and wood characters suggest that this species belongs to *sect. Brachypterae*.

162. *Shorea furfuracea* MIQ. Sum. (1861) 488, 191; WALP. Ann. 7 (1868) 379; BURCK, Ann. Jard. Bot. Btzg 6 (1887) 219; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 98, *p.p.*; HEYNE, Nutt. Pl. ed. 1, 3 (1917) 299. — *S. purpurea* DC. Prod. 16, 2 (1868) 632, *sphalm.*

Medium-sized or large tree, up to 50 m. Twigs, buds, stipules, petioles, leaves beneath and midrib above densely persistently pale chocolate-brown scabrid pubescent. *Twigs* *c.* 2 mm \varnothing apically, much branched, terete, becoming smooth. *Buds* to 3 by 2 mm, ovoid, acute. *Stipules* to 6 by 4 mm, ovate, acute, fugaceous. *Leaves* 6–13 by 2.5–6 cm, ovate-oblong, thinly coriaceous; base obtuse; apex shortly acuminate (more prominently so in young trees); nerves 14–17 pairs, slender but prominent beneath, obscurely depressed above, at 65°–75°, with short intermediate secondaries in young trees; tertiary nerves densely scabridiform, distinct and elevated beneath; midrib prominent beneath, evident but ± depressed above; *petiole* 9–14 mm long, rather slender. *Flower* and *fruit* unknown.

Distr. *Malesia*: Sumatra (Atjeh, Ophir, Sibolga; P. Musala).

Ecol. Mixed primary forest, up to 400 m.

Vern. *Mĕranti tĕrutung*, P. Musala, *m. udang*, *m. bunga*, Sibolga, *habung banio*, *suantan hambang*, Sum. W. coast, *kĕtrahan silang*, Atjeh.

Note. There are similarities in leaves and buds with *S. dasyphylla* and *S. rugosa* of *sect. Mutica*, but also with *S. scaberrima* of *sect. Brachypterae*.

163. *Shorea pallidifolia* ASHTON, Gard. Bull. Sing. 22 (1967) 296, pl. 41; Man. Dipt. Brun. Suppl. (1968) 113, f. 14.

Small to medium-sized tree with V-section fissured bark. Twigs, buds, stipule, petiole and nervation

beneath persistently pale yellowish brown scabrid pubescent, lamina beneath very shortly densely persistently ocherous scabrid pubescent. *Twig* c. 6 by 3 mm \varnothing towards apex, stout, compressed and ribbed at first, becoming terete; stipule scars c. 2 mm long, horizontal, prominent. *Bud* to 10 by 8 mm, broadly ovoid-conical, compressed. *Stipule* to 7 by 5 mm, oblong, obtuse. *Leaves* 13–22 by 7–13 cm, broadly oblong to ovate or obovate, thickly coriaceous; base obtuse or subcordate; acumen short; nerves 12–19 pairs, obscure above, prominent beneath, arched, at 110° at the base, 45°–70° near the apex; tertiary nerves slender, hardly elevated, densely scalariform; midrib obscure and depressed above, prominent beneath; *petiole* 2–3.5 cm long, stout, drying rugose. *Panicle* to 15 cm long, compressed and prominently angled, axillary, rarely terminal; singly or doubly branched, branchlets to 3 cm long, bearing to 6 distichous flowers; bracteoles to 4 by 3 mm, elliptic, obtuse, shortly evenly pubescent outside, glabrous within, caducous. *Flower bud* to 6 by 3 mm, ellipsoid. *Sepals* pubescent on parts exposed in bud; outer 3 deltoid, acute, inner 2 ovate, smaller and thinner at margin than outer 3. *Petals* elliptic, pubescent on parts exposed in bud; outer 3 deltoid, acute, inner 2 ovate, smaller and thinner at margin than outer 3. *Stamens* unknown. *Ovary* ovoid, glabrous; style filiform, glabrous, somewhat longer than ovary. *Fruit pedicel* and *calyx* shortly sparsely evenly pubescent. *Pedicel* c. 1 mm long and \varnothing , small. 3 longer calyx lobes to 7 by 1.5 cm, broadly spatulate, obtuse, c. 7 mm broad above the to 10 by 8 mm broadly ovate saccate somewhat thickened base; 2 shorter lobes to 4 by 0.3 cm, linear, similar but smaller at base. *Nut* to 12 by 9 mm, ovoid, shortly apiculate, densely shortly pale buff pubescent.

Distr. *Malesia*: N.W. Borneo (W. and Central Sarawak).

Ecol. Rare, on podsols in Heath forest at low altitude.

Note. The shape of the ovary, as well as fruit, bark and wood characters, suggested that this species belongs to *sect./subsect. Mutica*.

Dubious

Caryolobis indica GAERTN. Fruct. 1 (1789) 215, t. XLV.

GAERTNER based this genus on a fruit in the Leyden Botanical Institute, said to have come from Ceylon, with the vernacular name *berelie*. It was mostly reduced to the genus *Doona* THW., possibly in part due to the fact that a common name for *Doona* in Ceylon is *beraliya dun*. Unfortunately its type could not be traced in the Leiden carpologica.

The fruit figured seems not to agree with that of *Shorea sect. Doona*, for this is characterized by the extremely unequal cotyledons, one of which is minute and acicular, whereas the picture shows two equal cotyledons. The description is too poor, and in absence of type material unidentifiable in *Dipterocarpaceae*.

Excluded

Cotylelobiopsis beccariana HEIM, Rech. Dipt. (1892) 125; BRANDIS, J. Linn. Soc. Bot. 31 (1895) 116; MERR. En. Born. (1921) 408; SLOOT. Bull. Jard. Bot. Btzg III, 10 (1929) 395.

HEIM based this monotypic genus on a BECCARI specimen consisting of sterile material only, the number of which he did not cite. HEIM annotated many of his types at Kew, but BRANDIS, who conjectured that BECCARI 467 was the type, was clearly unsure from which it may be guessed that this specimen, now lost, was not annotated. The Florence duplicate of this number fits HEIM's description, and represents the fallen leaflets of the *Leguminosae Pseudosindora palustris* SYM. Proc. Linn. Soc. 155th sess. (1944) 285; the specimen, mounted with another of the same species numbered 3468, is quoted by DE WIT when he made his new combination *Copaifera palustris* (SYM.) DE WIT (Webbia 9, 1954, 462). HEIM's detailed description of leaf morphology, and especially petiole anatomy, conforms with that of this species and he noted that the latter was atypical of *Dipterocarpaceae*. HEIM's genus and species antedates that of SYMINGTON. Nevertheless the Paris duplicate of BECCARI 467, now also lost, was referred to *Cotylelobium melanoxylo* (Hook. f.) PIERRE by the latter (Fl. For. Coch. 3, 1889, t. 235). There must therefore remain some question as to the real identity of the Kew duplicate of BECCARI 467, which anyway cannot with certainty be accepted as the holotype of *Cotylelobiopsis*. Until refound this name must be regarded as doubtful.