FAGACEAE (E. Soepadmo, Bogor)

Monoecious trees or rarely shrubs, in Mal. evergreen, sometimes buttressed or with stilt-roots; growth mode flushwise, with perular buds. Hairs simple or stellate or fasciculate, rarely with resiniferous colleters, or scales on pits on the underside of the leaf. *Leaves* simple, spirally arranged, rarely in whorls of 3 or distichous, sometimes crowded near the top of each flush, penninerved, in Mal. entire or rarely crenate or sinuate. *Stipules* present, caducous or rarely rather long persistent, rarely interpetiolar or peltately attached. *Inflorescence* a cyme or a simple or branched spike, bracteate, ♂, ♀, androgynous (with the ♀ flowers borne on the lower part) or mixed. *Flowers* unisexual or functionally so. — ♂ *Flowers*: solitary or in dichasial clusters of 2–30 along the rachis, sessile or pedicelled; perianth campanulate or tubular, 6(–9)–lobed, or irregularly incised; stamens (4–)6–12(–90), filaments filiform, long exserted, free or rarely connate at the base; anthers linear to reniform, dorsi- or basifixed, lengthwise dehiscent; pistillode absent or present, densely hairy. — ♀ *Flowers*: sessile, solitary or in dichasial clusters of 2–15, surrounded by a cupule; ovary inferior, 2–6(–9)–celled, usually hairy; ovules anatropous, 2 per cell, apical and collateral; perianth usually regularly 6–lobed, sometimes poorly developed; staminodes 6–12, or absent; styles as many as ovary cells, terete, rather short, conical or tongue-shaped; stigmas capitate, punctiform, or covering the inner surface of the styles. *Cupules* solitary or in dichasial clusters, often woody, rarely reduced or absent, from saucer- or cup-shaped to enclosing the fruit, indehiscent or splitting into 2–8 or more ± equal segments, rarely consisting of 2 free segments, variously muricate, spiny, squamose, or with concentric or spiral lamellae, very rarely almost smooth. *Fruit* an indehiscent nut (achene), 1–3–celled, sometimes falsely multiseptate, rounded or sharply 2–3–angular. *Seed* one, exalbuminous; embryo large; cotyledons large, flat-convex, plicate or ruminate; germination epigeal or hypogeal.

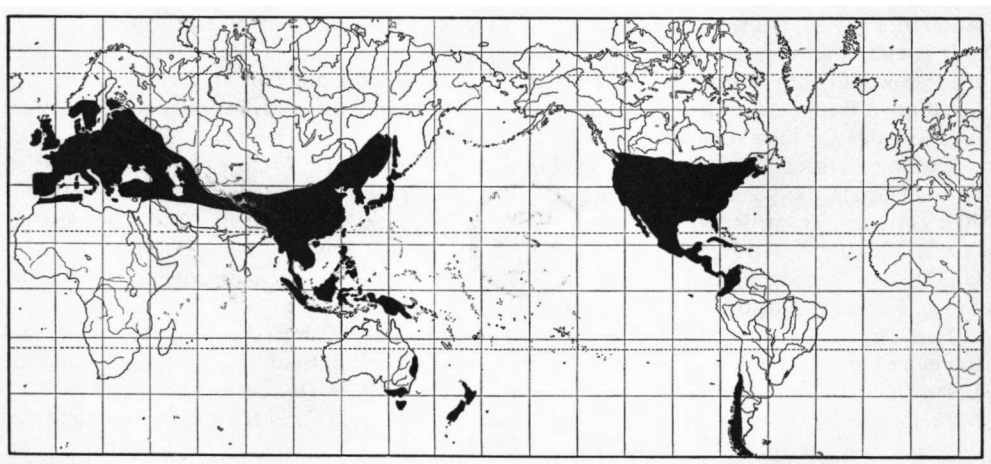

Fig. 1. Present distribution of *Fagaceae*. Add: New Caledonia.

Recent distribution. Seven genera with possibly *c.* 700 *spp.*, the majority on the northern hemisphere. In the Old World the distribution extends southwards from 62°N in Scandinavia southheastwards to Kashmir and then northeastwards to the Sea of Okhotsk at *c.* 55°N. In Africa, *Fagaceae* are confined to the northern rim in the western Mediterranean region. In Asia *Fagaceae* are absent from the dry parts of the Middle East, from the Deccan Peninsula and Ceylon, from the desert and colder parts of China, from Manchuria, and from the extreme northern parts of Japan. In America, the distribution extends from Canada and the United States southwards to Central America, as far south as a few scattered localities in Columbia, in South America. On the southern hemisphere, *Fageceae* are present in Malesia, in the scarce wet parts of East Australia, in Tasmania, New Caledonia, and in New Zealand (otherwise absent from Pacific islands); in South America they occur from Fuegia and Staten I. northwards to Argentina and on the western slopes of the Andes in Chile up to 33°S. Fig. 1.

In *Malesia*: 5 genera (*Castanea* and *Fagus* absent) with *c.* 180 *spp.*, from the Malay Peninsula eastwards to d'Entrecasteaux Is., New Britain, and the Louisiades to *c.* 153°E; they are rare in the seasonally dry parts of Central and East Java and absent in Madura and Kangean Is., the Lesser Sunda Is., the southern Moluccas (Tanimbar, Key and Aru Is.), New Ireland, the Solomons', and Woodlark I.

Notable distributional features are that *Castanopsis* and *Lithocarpus* occupy almost exactly the same range in the whole world (fig. 10 and 16), and that *Fagus* and *Nothofagus* are exclusive northern and southern hemisphere counterparts (fig. 2).

Fossil distribution. Many macrofossils (leaf impressions and fossil wood) have been described and in addition there are many fossil pollen records, especially of *Nothofagus* which possesses a characteristic pollen quite distinct from that of the other genera. These fossils occur through the Tertiary going down in the time-scale to the Upper Cretaceous (fig. 2).

The oldest records on the northern hemisphere, based largely on macrofossils, are: *Dryophyllum* from Greenland, North America (Wyoming and Colorado) and Europe (W. Germany, Bohemia, Silesia) (see p. 403), *Quercus antiquata* from Utah, *Q.* ? *fraxinifolia* from Montana, a *Fagoxylon* from Japan, and two species of *Fagophyllum* from Vancouver I. On the southern hemisphere only *Nothofagus* occurs and occurred and is described from both macro- and microfossils, the Upper Cretaceous records being located in Seymour I. (Antarctica), New Zealand and SE. Australia.

Tertiary records outside the recent range of living *Fagaceae* include southern Central Asia, the SE. Deccan Peninsula (*Castanoxylon*), almost the whole of Australia, McMurdo Sound in Antarctica (77°S), the western part of North America extending to 65°N, and Iceland.

It is clear that the warmer and moister Upper Cretaceous and Tertiary climates permitted their growth in both hemispheres far beyond their present range and that the Pleistocene Ice Age has thrown them back to lower latitudes. Besides, desiccation of several continental areas were unfavourable for their survival. See also the discussion under the genera.

Literature: BERRY, Tree Ancestor (1923) 119–145; CHANDLER, Publ. Brit. Mus. Nat. Hist. (1964) 1–151; CRANWELL, Ancient Pac. Fl. (1964) 87–98; CRANWELL *c.s.* Nature 186 (1960) 700–702; DAWSON, Trans. R. Soc. Canada 11 (1893) 53–73; LA MOTTE, Mem. Geol. Soc. Am. 51 (1952) 105–107, 150–151, 160–162, 205–206, 243, 285–301; SEWARD, Plant Life through Ages (1931); VAN STEENIS, Blumea 19 (1971) 65–98, with bibl. on *Nothofagus*; STOPES & FUJII, Phil. Trans. R. Soc. Lond. B, 201 (1910) 1–90.

Ecology. *Climate.* — In Malesia most species of *Fagaceae* shun the seasonal climate and therefore they are almost absent from the large seasonal belt in Central and East Java and the Lesser Sunda Islands. Several species, *e.g. Lithocarpus sundaicus*, *Quercus lineata* and *Q. gemelliflora* do, however, occur on some mountain summits or slopes in Central and East Java subjected

[1]) *Quercus guppyi* F. v. M. from the Solomon Is. has appeared to be a *Litsea* (*Laur.*), see FORMAN, Kew Bull. 19 (1965) 461.

to a feeble seasonal climate. A similar tolerance of minor seasonal climatic conditions is shown by *Castanopsis buruana* in some Moluccan islands.

Malesian *Fagaceae* do not possess resistance against fire and do not regenerate under pyrogenous conditions. In areas cleared by fire they can maintain themselves in the (sharp) forest borders surrounding such cleared areas; this has *e.g.* been observed in East Java, the Sula Is., Buru, and New Guinea.

Soil. — *Fagaceae* grow on a great variety of soils, including clay, sand, *etc.* and most species seem to be rather indifferent to soil-type.

However, several species are restricted to specialized soils. Species characteristic of peat swamps and wet kerangas (podsolized sands) are *Castanopsis fulva* and *Lithocarpus dasystachyus*. Species which seem to be confined to kerangas soils are *Quercus kerangasensis*, *Q. percoriacea*, *Castanopsis foxworthyi*, *C. borneensis*, and *Lithocarpus luteus*. Finally, two species seem to be characteristic of soils derived from ultrabasic bedrock, *viz Quercus lowii* and *Lithocarpus hatusimae*.

Malesian *Fagaceae* generally shun calcareous soils; in passing it may be remarked that it is said that in New Caledonia *Nothofagus* is restricted to serpentine.

Mycorrhiza. — All *Fagaceae* seem to live in symbiosis with ectotrophic mycorrhiza (of *Agaricales*), a feature which is generalized by SINGER & MORELLO (Ecology 41, 1960, 549–551) and specifically studied by them in South America (Mycopath. & Mycol. Appl. 26, 1965, 129–191). They believe that the virility and social strength of *Fagaceae*, and other *Amentiferae* and *Coniferae*, may be due to these ectotrophs, facilitating settling of pioneers and providing intolerance to other trees.

Altitude. — In Malesia *Fagaceae* occur from sea-level up to 3350 m, predominantly between 600 and 1500 m. Species of *Nothofagus* occur between 750 and 3100 m; *Trigonobalanus verticillata* is found between 850 and 1500 m; and some species of *Castanopsis*, *Lithocarpus* and *Quercus* are known from lower elevations down to sea-level. Examples are: *Castanopsis argentea* is found not far from the shore in S. Bantam (West Java); *C. acuminatissima* occurs in Depok (West Java) at 90 m, in the Sula Is. and Buru at 100 m, and in the Buna Plain (E. New Guinea) at 300 m; *C. costata* is recorded from Lingga, Riouw and Banka at *c.* 50 m; *C. fulva* grows in the Lake Gardens and Weld Hill near Kuala Lumpur (Malaya) at *c.* 70 m; *Lithocarpus elegans* occurs in Templer Park (Selangor, Malaya) and Tasek Bera (Pahang, Malaya) at *c.* 100 m; *L. platycarpus* has been collected in Nusa Kambangan (South Central Java) at 25 m; *Quercus subsericea* is found on rocky sea-shores in Cave Rachado near Port Dickson (Negri Sembilan, Malaya) at 0–10 m, facing the mangrove. It is evident that the large destruction of Malesian lowland forests explains part of the present rare occurrence of *Fagaceae* in the lowland.

Flowering. — Flowering occurs irregularly, but generally takes place soon after the dry season together with the young flush. There is a more or less strict periodicity in flowering, which is, although the individual flowers are small and insignificant, quite showy for its simultaneous profusion, particularly if coinciding with an outbreak of leaves, which are pale yellow-green, or red as in *Nothofagus* and *Lithocarpus scortechinii*. In *Castanea*, *Castanopsis*, *Lithocarpus* and *Trigonobalanus verticillata* with their erect ♂ catkins pollination is effected by insects; a disagreeable, spermatic smell has been reported in *Castanopsis* and *Lithocarpus*. In *Quercus* and *Trigonobalanus doichangensis* with their pendulous ♂ inflorescence and capitate or ligulate stigmas, pollination is by wind, as it is in *Fagus* and *Nothofagus*. The anthesis of ♂ flowers is of very short duration and the ♂ inflorescences are soon shed as a whole.

Fruiting. — In most species fruits ripen within 3–6 months after flowering. Though fruiting is often very profuse, seedlings are sometimes surprisingly scarce. This is in part due to the fact that the fruits, which are very rich in starch and/or oil, are greedily devoured by animals. Also an appreciable percentage of full-grown fruits appear to be barren. A third factor is that fruits fallen on or in the litter on the forest floor are quickly attacked by fungi. In *Trigonobalanus* a large percentage of fruits falls an early victim to insects. For successful germination it seems necessary that the nuts must be buried in the soil, in cracks, holes made by earth-worms, or covered by soil-wash, or carried by ground animals.

Hypogeal germination is found in *Castanea*, *Castanopsis*, *Lithocarpus* and *Quercus*, whereas in *Fagus*, *Nothofagus*, and probably in *Trigonobalanus*, germination is epigeal.

Dispersal. — Since the fruits are not provided with any special means of dissemination and are generally fairly large, mostly rounded, and fairly heavy, dispersal in this family must be slow. The fruits are not capable to float either in freshwater or in the sea. Not far from river-mouths the tropical beach is often strewn with acorns, but these are barren, hence buoyant and drifted downstream to the ocean (*cf.* VAN STEENIS, Trop. Natuur 29, 1940, 74). This is in complete accordance with the experiments and observations made by PREEST on *Nothofagus* in New Zealand (in GRESSITT, ed.: Pacific Basin Biogeography, 1963, 415–424); he found that the fruits do not travel very far from the stands and are poorly fitted for dispersal beyond the forest margin. A similar observation was made by KALKMAN & VINK in New Guinean *Nothofagus* (Blumea 18, 1970, 101–102). This slow dispersal makes the distribution of the family most interesting, suggesting that their present and fossil distribution is an indicator of prime importance for the presence of land in former geological epochs. See also VAN STEENIS, Blumea 19 (1971) 74–76, 91.

Fagaceae in Malesian vegetation. — Generally the species are not emergent trees, but an often dominant or co-dominant closed canopy. When the emergents (Dipterocarps, *Podocarpus*, *Agathis*, *Altingia*) have been removed for timber, the great number of *Fagaceae* show up in the remaining forests; DE VOOGD observed this on *Castanopsis* in West Java, 30 years after selective logging of *Altingia*. A similar observation is made on Fraser's Hill and Ulu Gombak (Malaya), where *Fagaceae* (namely species of *Castanopsis*, *Lithocarpus*, *Quercus* and *Trigonobalanus*) become dominant in the forests between 900 and 1200 m elevation after the removal of the big timber trees.

In some islands, *Fagaceae* show a remarkable tendency to grow socially over immense tracts, and in Malesia particularly in New Guinea. Among the phanerogamous trees of the globe, *Fagaceae* come, in term of biomass, as a single group probably second only to Conifers. In Malesia, all five genera are (co-)dominant in the montane and lower subalpine zones, together with *Lauraceae*, *Altingia*, *Schima*, *Engelhardia*, and *Podocarpus* in Java and Sumatra, and in other islands also with *Agathis* and *Phyllocladus*. Such stands often contain more than one genus of *Fagaceae* and this has induced JUNGHUHN and MIQUEL to call these forests correctly as 'Fagolauraceous'. The seeds of *Fagaceae* need shade for their germination as do all trees of the very mixed rain-forest. But we may guess that the litter of *Fagaceae*, during decay, produces (allelopathic) substances which may, together with certain fungi, prohibit or restrict the growth of other forest trees, or at least favour a better regeneration of their own kinship. Undergrowth in pure Fagaceous forests is often surprisingly poor.

Trigonobalanus verticillata reinforces its stand by soon producing additional stems next to the first one, and in *Castanopsis acuminatissima* suckers are produced by the root system which surround the mother tree as a skirt in a circle with a radius of several meters; the Sundanese in West Java pungently call it '*riung anak*', a parent surrounded by its children. Fallen trees of *Nothofagus* in mossy forest, *e.g.* of *N. pullei*, do produce side-shoots which grow vertically and also produce roots; this may lead to thickets of saplings but WOMERSLEY, who observed this, has no idea how many, if any, eventually reach mature tree size. As a whole, regeneration is almost entirely by seed.

The main accounts of the *gregarious growth* are the following:

Castanopsis. — In West Java *C. acuminatissima*, *C. argentea*, *C. javanica*, and *C. tungurrut* are the commonest constituents of the mid-montane rain-forests. JUNGHUHN recorded (Nat. Tijd. N. I. 15, 1858, 23–38) that *C. acuminatissima* occurred dominant on Mt Malabar (W. Java) and made up for 80 to 100 % of the stands, at *c.* 1500 m. A similar dominance of this species is reported by STEUP (Trop. Natuur 23, 1934, 63) from Donggala and Gorontalo (Central and North Celebes), between 800 and 1200 m, and it is said that the species is in constant association with *Agathis*, *Eugenia* and *Phyllocladus*. In the Moluccas, it occupies a similar position, as recorded first by TEYSMANN (Nat. Tijd. N. I. 37, 1876, 97) and later by BLOEMBERGEN from the Sula Is. They stated that G. Aha near Fowata is even called after this tree. In the Sula Is. it often occurs

in groves alternating with pyrogenous grassland (*kusu-kusu*), subjected to occasional shifting cultivation. Whether the production of the edible fruits contributes to the sparing of trees or that this must be ascribed to its suckering capacity which would promote gregariousness is not known with certainty, but it would well agree with the situation found in many places in New Guinea (West and East) where *C. acuminatissima* is frequently found gregarious in conjunction with pyrogenous grasslands, according to BRASS and LANE-POOLE. BRASS reported (J. Arn. Arb. 22, 1941, 291, 299, 303, 309) that Fagaceous forest forms practically pure stands on the broader ridge crests above Bernhard camp, ranging up and down the spurs in the rain-forest. The main constituents of this forest are: *Lithocarpus celebicus*, *L. megacarpus*, *Castanopsis acuminatissima* and *Engelhardia*. The forest is about 25 m tall, and the oaks grow well apart with a few substage trees; they produce a rustling ground litter which is slower to decay than that of most rain-forest leaves, accentuated by a characteristic undergrowth of the fern *Syngramma hookeri*. In the deforested area near the Balim valley, a gallery strip of forest (*c.* 10 m tall) sometimes consisted of a pure stand of *C. acuminatissima* with thick boles and spreading branches and a ground cover consisting of the fern *Humata mecidioides*. At lower levels on the Bele River camp chestnuts and oaks (*Lithocarpus schlechteri*, *L. rufovillosus*, and *L. lauterbachii*) and their associate *Engelhardia* are common in the forest as subsidiary trees of 25–30 m tall, and survive as relics on cleared lands. At altitudes between 2200 and 2350 m, these trees form limited pure stands on the broad crests of spurs, but none is encountered much above the limit of cultivation. These forests may be distinguished by their open canopy dominated by species of *Nothofagus*, the dry appearance caused by the slippery ground litter of cutinous dead leaves and by the absence of terrestrial mosses. Due to the fact that the people of several village-groups extended their communal clearings, these forests were gradually disappearing. Most of the crop-gardens were established on new lands strewn with the trunks of large trees of *Nothofagus*, brought down through the burning of their bases. Other trees killed by fire or ring-barking stood as they had grown in the original forest. BRASS is convinced that *Castanopsis* and *Lithocarpus* are sure indicators of superior arable lands.

On Mt Tafa and the Wharton Ranges, BRASS found (J. Arn. Arb. 22, 1941, 335), above the mixed rain-forest, a similar Fageceous zone situated between 500 and 2200 m, in which he found nearly pure stands of *Castanopsis acuminatissima* associated with *Lithocarpus*, *Engelhardia* and *Araucaria*. In the Vanapa Valley, however, much of this Fagaceous forest had been cleared and converted into grassland. LANE-POOLE reported a similar situation from the Buna Plains and the Hydrographer's Range (For. Res. Terr. Pap. & New Guinea, 1925, 22, 34, 79). In Malaya, *C. acuminatissima*, in association with *C. lucida*, *C. megacarpa* and several species of *Lithocarpus*, is the commonest constituent of the mid-montane forest, especially at Fraser's Hill between 900 and 1200 m. Selective felling of the dominant trees (Dipterocarps, *Agathis* and *Podocarpus*) seems to favour the growth and spread of these *Fagaceae*. As in the other islands, it is only *C. acuminatissima* which produces numerous suckers around the base of its trunk.

Lithocarpus & Quercus. — Species of these two genera are dominants or co-dominants in the mid-montane forests throughout Malesia, and the upper limit of their zone somewhat exceeds that of *Castanopsis*. On Mt Kinabalu (N. Borneo), *L. turbinatus* and *L. lampadarius* are dominants in the forests between 1800 and 2400 m, while *L. havilandii* is the only species surviving up to 3000 m, mixed with *Leptospermum flavescens*, *Dacrydrium beccarii*, and *Phyllocladus hypophyllus*. At this altitude it grows to not more than 5–10 m height, with spreading branches and rufous foliage, sticking out of the grey-green and glaucous crowns of *Leptospermum* and *Phyllocladus*. In New Guinea (Vogelkop) and adjacent islands (Normanby, Misima, Sudest and Rossel Is.), *Lithocarpus vinkii* occurs from sea-level up to 1800 m, commonly above 700 m, and on some ridges it may form pure stands.

Nothofagus. — BRASS stressed the preponderant position which *Nothofagus* species occupy in the mountain forests of New Guinea (see VAN STEENIS, J. Arn. Arb. 34, 1953, 314; Blumea 19, 1971, 71). Its range lies between (750-) 1000 and 3100 m, but *c.* 90 % of the collections are made between 1750 and 2850 m, only *N. flaviramea*, *N. rubra*, and *N. starkenborghii* descending below

1000 m down to *c.* 750 m, the first even to 600 m in New Britain. The reddish flush is characteristic, but its appearance varies in time in different localities. Of almost all species dominance is reported, or co-dominance (often noted with *Lithocarpus*, *Castanopsis*, hoop pine), but VINK & KALKMAN observed that the proper *Nothofagus* zone is often situated higher than that of the other *Fagaceae*. Mature size on broad ridges, gentle slopes and valleys is mostly 40 m or over by a diameter of *c.* 1 m, but on narrow and steep ridges dwarfing to stunted shrubs 2–5 m high are observed in *N. perryi*, *N. carrii*, and a few others. Fig. 8.

Trigonobalanus verticillata. — On Mt Kinabalu in Sabah and the Hose Mts in Sarawak this species is gregarious at 1000–1500 m, in association with *Agathis*, *Dacrydium elatum*, and *Podocarpus imbricatus*. In Malaya, it is so far only known from Fraser's Hill, where it is also gregarious along the road leading to and near the waterfall, at 850–1200 m, associated with *Agathis dammara*, *Podocarpus imbricatus*, *Schima wallichii*, several species of *Lauraceae* and species of other genera of *Fagaceae*.

Uses. In comparison with the importance of oakwood, oak tannin, beechwood, and chestnuts in the northern temperate regions, the economic value of *Fagaceae* in Malesia is slight, *Nothofagus* obviously excepted. The wood of *Castanopsis*, *Lithocarpus* and *Quercus* is often very hard and difficult to work, although it is sometimes rather beautifully and evenly grained. It is very liable to splitting, and seems rather unfit for construction purposes, for which it is occasionally used in Indonesia. Records of durability vary with the species. Some New Guinean species are supposed to be promising for furniture and veneer, but tests have not been made, and species may differ considerably in properties.

According to field notes several *Nothofagus* species, notably *N. starkenborghii*, *N. perryi*, *N. pullei*, and *N. rubra*, possess excellent very resistant hardwood, used for bridge constructions and locally used on a large scale also for general constructions under roof. The Papuans in East New Guinea plant various species (*N. grandis*, *N. pullei*, *N. perryi*) in their native homesteads, around their villages, along tracks and around their garden lands, it is said for ornamental purpose, but probably also intended for later use. For this purpose they collect seedlings in the forest.

In Borneo, Dr. J. A. R. ANDERSON informed me, that logs of some species of *Castanopsis*, *Lithocarpus*, *Quercus*, and *Trigonobalanus verticillata* are recently being tried for mushroom cultivation. This trial was apparently inspired by the success of mushroom cultivation on wood of *Quercus* species in Japan and made possible by the occurrence of closely allied edible mushrooms on Mt Kinabalu.

The fruits of some species of *Castanopsis* (*e.g. C. argentea*, *C. costata*, *C. inermis*, *C. javanica*, and *C. tungurrut*) are widely consumed after cooking or roasting, just like chestnuts in Europe and other temperate regions.

The bark in many species of *Fagaceae* contains appreciable amounts of tannin, but perhaps because of the hardness of the wood, there seems to be no commercial exploitation of it. See HEYNE (Nutt. Pl. 1927, 535–543) and BURKILL (Dict. 1935, 486–489, 1849–1859) for details.

Cultivated. On the summit of Mt Pangrango, West Java, at *c.* 3010 m, above the mountain garden Tjibodas, a specimen of *Fagus sylvatica* was introduced by the famous Curator TEYSMANN, about 1840, probably grown from seed, together with other European vegetables and fruit trees for trial. The specimen was a densely branched shrub *c.* 1½ m high; it was never bare and did not flower. Its morphology and anatomy was studied by COSTER (Ann. Jard. Bot. Btzg 35, 1925, 105–119, t. 7–10). He characterized it as a typically alpine dwarf form, the leaves having half the normal size, developing in flushes but not all simultaneously. The plant produced annual rings and had in the pith and xylem great quantities of starch which did not diminish noticeably when new leaves unfolded. The difference between 'sun' and 'shade' leaves was slighter than in Europe. Shortly after the war the plant died on account of a local fire. In Hakgalla Garden in Ceylon, at montane altitude, *Fagus sylvatica* also did not flower and remained poor; it seems not adapted to a tropical mountain climate.

Castanea sativa has since 1894 been cultivated at Tjibodas mountain garden, West Java, at *c.* 1400 m; it was reported by HEYNE (Nutt. Pl. 1927, 537) to produce fruit satisfactorily.

Morphology. *Habit.* — In Malesia most species of *Fagaceae* are trees of medium to large size, rarely shrubs of *c.* 2–5 m tall (*Lithocarpus orbicularis, L. oreophilus, Nothofagus pullei*). Buttresses and stilt-roots are often present in several species of *Lithocarpus* and *Quercus.*

Bark. — Most Malesian species of *Fagaceae* are readily recognizable in the field by their characteristic light-greyish, smooth and mottled bark; only a few have bark which is grey-brown and rather rough. In *Nothofagus* the bark is often peeling in large flakes. *Lithocarpus, Nothofagus, Quercus* and *Trigonobalanus verticillata* are very easily recognized by the same typical slash characters: a reddish-brown bark, easily detached from the smooth whitish wood, with numerous longitudinal faintly bluish lines about ½–1½ cm long and 1 mm wide and slightly depressed. The opposite parts on the inside of the bark are correspondingly slightly elevated. This typical pattern is not found in *Castanopsis.*

Terminal buds. — In Malesia the genera of *Fagaceae* possess well-developed terminal buds, which are conferted in many species of *Quercus.* The scales are either spirally (*Castanopsis, Lithocarpus, Trigonobalanus*) or decussately arranged (*Nothofagus* and most species of *Quercus*). Glandular scales are found in *Nothofagus* and some species of *Lithocarpus.*

Stipules. — *Castanopsis, Lithocarpus,* and *Quercus* have extra-petiolar, caducous stipules, and *Nothofagus* possesses stipules which are distinctly peltately attached and in the flush they develop earlier than the leaves. The stipules in *Trigonobalanus verticillata* are extra-petiolar in the first few leaves of the seedling, and later become interpetiolar.

Indumentum. — The hairs are singly distributed or in fascicles. Simple hairs and armed stellate hairs generally consist of a single cell, but they may be uniseriate, *e.g. Castanopsis* and *Trigonobalanus verticillata.* In *Lithocarpus* the arms of the stellate hairs emerge from a usually dark-coloured, occasionally bulbous central cell. In *Nothofagus* only one species (*N. pullei*) possesses hairs.

In Malesian *Nothofagus* the undersurface of the dried leaves is dotted with pale brown scales which on removal leave a small pit; the scales are actually dried up glands and their resinous exudate. Small, gland-tipped hairs often occur in all other genera, with the gland itself being 1–∞-celled. Colleters are resiniferous sausage-shaped trichomes which are only found in *Nothofagus,* namely at the insertion of the stipules and at the adaxial bases of the perulae and the cupular lamellae. Both the leaf-glands and the trichomes exude resin which may cover the underside of the leaves, the flush and the young cupules with a pale yellow waxy resin.

Phyllotaxis. — This is distichous in Malesian *Nothofagus* (consequently the perulae are in 4 rows). Some species of *Castanopsis* also possess distichous leaves. In *Trigonobalanus verticillata* the first few leaves of the seedling are spirally arranged, followed by a series of decussate leaves, and finally taking to a whorl of three phyllotaxis in the older plants. *Lithocarpus* and *Quercus* have the leaves spirally arranged, and in *Quercus* they are usually crowded at the end of each flush.

Leaves. — The leaves of Malesian *Fagaceae* are only very rarely not entire; they are at most crenate or sinuate near the upper half in some species of *Castanopsis* and *Quercus,* and remotely, shallowy crenate in a few species of *Nothofagus.* Domatia are not found in Malesian *Fagaceae.*

Inflorescence. — In *Fagus* and *Nothofagus* the inflorescence is morphologically a 1- to many-flowered dichasium or cyme, either subsessile or long-peduncled, and axillary. In *Fagus* the ♂ inflorescence is 2–20-flowered, while in *Nothofagus* it is 1- or 3-flowered. The ♀ inflorescence, on the other hand, bears 1–6 flowers in *Fagus* and 1–7 flowers in *Nothofagus*; the central flower in *Fagus* is always missing. In Malesian *Nothofagus* the ♀ inflorescence bears not more than 3 flowers. In *Castanea, Castanopsis, Lithocarpus, Quercus,* and *Trigonobalanus* the inflorescence is an unbranched or branched spike, either pendent (♂ inflorescence in *Quercus* and *Trigonobalanus doichangensis*) or erect (♂ and ♀ inflorescence in *Castanea, Castanopsis, Lithocarpus* and *Trigonobalanus verticillata*); the flowers are sessile and rarely short-stalked, being arranged in dichasial clusters of 2–30 or solitary along the rachis. Apart from the ♂ and ♀ inflorescences just described, there is also a mixed type as found in *Lithocarpus,* and an androgynous type in *Castanea, Castanopsis, Lithocarpus,* and *Trigonobalanus.* In an androgynous inflorescence the ♀ flowers are situated at the basal part of the rachis.

Flowers. — A pistillode is present in the ♂ flower of *Castanea*, *Castanopsis*, and *Lithocarpus*, and replaced by a cluster of simple stiff hairs in *Trigonobalanus verticillata* and some species of Malesian *Quercus*. In the ♀ flowers 6–12 staminodes are found in the above-mentioned genera. In some species of *Lithocarpus* (*L. ruminatus* and *L. turbinatus*) from Borneo, they are rather well developed and exceed in length the height of the perianth-lobes. The stigma is capitate in Malesian *Quercus* and *Trigonobalanus*, punctiform in *Castanea*, *Castanopsis*, and *Lithocarpus*, or forming a broad stigmatic surface on the inner side of the style-arms (*Fagus*, *Nothofagus* and extra-Malesian *Quercus*).

Cupules. — Generally present, solitary either in the axil of the leaf (*Fagus* and *Nothofagus*) or along a rachis (*Castanea*, *Castanopsis*, some *Lithocarpus*, *Quercus*, and *Trigonobalanus*), or in many species of *Lithocarpus* they are in dichasial clusters of 2–24 along the rachis. In a few species of *Nothofagus* from New Guinea the cupule is reduced to two minute loose flaps or even may be entirely absent. In *Castanea*, *Castanopsis*, *Fagus*, *Nothofagus*, and *Trigonobalanus* the cupules are completely covering the nuts, and eventually they are splitting irregularly or into regular numbers of valves or lobes. In *Quercus* and the majority of *Lithocarpus*, however, the cupules are not completely enclosing the nuts, but either saucer- or cup-shaped, and never splitting. In *Lithocarpus javensis*, *L. maingayi*, *L. turbinatus* and several more related species, the cupule is also completely covering the nut and fused to the latter, but in *L. coopertus*, *L. encleisacarpus*, *L. wrayi* and related species, though the cupule is also enclosing the entire fruit, it is completely free from the latter. See BRETT (New Phytol. 63, 1964, 96–118), FORMAN (Kew Bull. 18, 1966, 385–419), HJELMQVIST (Bot. Notis. Suppl. 2, 1948, 1–171), LANGDON (Bot. Gaz. 108, 1947, 350–371), SOEPADMO (Gard. Bull. Sing. 22, 1968, 364–368; Reinwardtia 8, 1970, 205–212) and VAN STEENIS (J. Arn. Arb. 34, 1953, 309–313) for further details on the nature, anatomy, and systematic and phylogenetic significance of the cupule.

Fruits and seeds. — In *Fagaceae* the fruit is an achene or nut, with the pericarp fused with the perianth tube. In *Lithocarpus* and *Quercus* the fruit is always rounded in cross-section, and that of the other genera is variously rounded-triangular or sharply triangular (*Fagus* and *Trigonobalanus verticillata*) or even winged (*Nothofagus*). In Malesia there seems to be a very high degree of sterility among the fruits produced by many species. For an account on the anatomy of the fruit wall see SOEPADMO, Gard. Bull. Sing. 22 (1968) 369.

Embryology. So far no study has been made on the Malesian species of *Fagaceae*. HJELMQVIST basing his observations on *Quercus robur*, *Fagus sylvatica*, and *Castanea sativa* concluded that the development of the endosperm and the embryo in *Fagaceae* is rather similar to that of *Juglandaceae*, but differs very sharply from that of *Betulaceae*.

Literature: CONRAD, Bot. Mag. 29 (1900) 408; HJELMQVIST, Phytomorph. 3 (1953) 377; Bot. Notis. 110, 2 (1957) 173–195.

Wood anatomy. *Vessels.* — Distribution solitary, ring-porous, or dendritic; scalariform perforation plates frequently occur in *Fagus* and *Quercus*; spiral thickening rather frequent in *Nothofagus*, but absent in the other genera.

Parenchyma. — Distribution apotracheal, paratracheal or rarely concentric.

Rays. — Exclusively uniseriate in *Castanea* and *Castanopsis*, uniseriate to many cells wide in the other genera.

Tracheids. — Present except in *Fagus*, distribution paratracheal.

Fibers. — Without spiral thickening, very rarely septate (*Nothofagus*); pits mostly simple, rarely bordered (*Fagus*).

Interxylary phloem, intercellular canal, raphides, oil or mucilage cells absent. Tyloses and cristals constantly present.

From an analysis on the 16 diagnostic characters selected by METCALFE & CHALK (1950), as to the wood, *Fagaceae* appear closely related to *Casuarinaceae* and *Juglandaceae*, differing from both only by the relative more frequent occurrence of dendritic patterns of vessel distribution.

Literature: DEN BERGER, Determinatietabel Houts. Mal. Fam. (1949), 36; CUTLER, Kew Bull. 17 (1964) 401–409; *ibid.* 21 (1967) 332–334; DADSWELL & INGLE, Austr. J. Bot. 2 (1954) 141–

153; JANSSONIUS, Mikrogr. Holz. 6 (1936) 359–468; Anat. Bestim. Jav. Hölz. (1940) 84–85, 108–109; Key Jav. Woods (1952) 87, 113; METCALFE & CHALK, Anat. Dicot. 2 (1950) 1309–1315.

Palynology. Observed under the light-microscope, 3 main types of pollen grains may be distinguished in *Fagaceae*, *viz* the *Quercus*-type (*Quercus*, *Fagus*, *Trigonobalanus*), the *Castanea*-type (*Castanea*, *Castanopsis*, *Lithocarpus*), and the *Nothofagus*-type (*Nothofagus*).

In the *Quercus*-type the pollen is more or less spheroidal, with average size 30 by 20 μ, 3-colporate, 3-colpate, or 3-colporoidate, exine more or less scabrate.

In the *Castanea*-type the pollen is generally ellipsoidal (perprolate), always 3-colporate, with an average size 16 by 10 μ, and the exine is more or less smooth.

Pollen of *Nothofagus* differs from the two previous types by being peroblate (horizontally flat), average size 15–20 by 30–45 μ, 4–9-colpate, and the exine is distinctly echinulate. Within the *Nothofagus* main type there are three types, the *fusca* and *menziesii* types for extra-Malesian *Nothofagus*, and the *brassii* type for all Malesian and New Caledonian species which together form the subsection *Bipartitae*. In the last case pollen morphology agrees almost with taxonomic distinction; there is even a small distinction running parallel with *Triflorae* and *Uniflorae* within the subsection. However, the *fusca* and *menziesii* types run across the main taxonomic subdivision of the genus and do not agree with the morphological classification, with no possibility towards reconciliation.

According to ERDTMAN (1952) the pollen of *Fagaceae* belongs to a type widely known in the Angiosperms, *Nothofagus* excepted.

For fossil pollen, see under the heading fossil distribution.

Main literature: VAN CAMPO & ELHAI, Bull. Soc. Bot. Fr. 103 (1956) 254–260; COOKSON & PIKE, Austr. J. Bot. 3, 2 (1955) 197–206; CRANWELL, Rec. Auckl. Inst. Mus. 2, 4 (1939) 175–196; ERDTMAN, Pollen Morph. & Tax. 1 (1952) 176–177; Bot. Notis. 120 (1967) 324–333; HARRIS, New Zeal. J. Sc. & Techn. B 37 (1956) 731–765; NAKAMURA, Res. Rep. Kôchi Univ. 5, 21 (1956) 1–5; PLANCHAIS, Pollen et Spores 4, 1 (1962) 87–93; SPOEL-WALVIUS, Acta Bot. Neerl. 12 (1963) 525–532; WALKER & WITTMANN, Pollen et Spores 7 (1965) 457–464; WODEHOUSE, Pollen Grains (1935) 373–382; YAMAZAKI & TAKEOKA, J. Jap. For. Soc. 41 (1959) 125–130.

Chemotaxonomy. All *Fagaceae* seem to be accumulators of polyphenolic compounds; flavonols, leucoanthocyanins, catechins and gallic and ellagic acid occur frequently in leaves, fruits, bark and wood. In wood of *Nothofagus* species flavanones (naringenin), flavononols (aromadendrin, taxifolin), stilbenes (pinosylvin, resveratrol) and dihydrochalcones (nothofagin, konnanin) have been observed in addition (HILLIS & INOUE, Phytochemistry 6, 1967, 59). Besides these low molecular polyphenolic compounds most members of the family contain rather large amounts of tannins. Oak bark, oak wood, oak gall-nuts and chestnut wood represent important sources of vegetable tannins. Oak trees elaborate predominantly galli- and ellagitannins in leaves, gall-nuts and wood and predominantly condensed tannins in barks. The same may be true for other members of the family. Hamamelitannin, a simple gallitannin. accompanies condensed tannins in the bark of *Castanea sativa* and *Quercus rubra*. Turkish tannin is the gallitannin of Aleppo gall-nuts. Castalgin, vescalgin, castalin and vescalin are complex ellagitannins of the wood of *Castanea sativa* and *Quercus petraea*. Pedunculagin is an ellagitannin of known structure from gall-nuts of Cental European species of *Quercus*. Besides polyphenolic compounds members of *Fagaceae* contain rather large amounts of pentacyclic triterpenes in barks, leaves and gall-nuts. Friedelin and the two epimeric friedelanols have been observed most frequently but derivatives of α- and β-amyrin as well as still other triterpenes do occur also. All species of the large genus *Quercus* seem to store quercit in leaves, bark and seeds; this represents a character of the genus *Quercus*. In conclusion it may be stated that *Fagaceae* resemble other Amentiferous families in tannin-accumulation, in the patterns of low-molecular phenolic compounds and in the tendency to produce conspicuous amounts of triterpenes. Chemistry also favours a relationship with the Hamamelidaceous and Rosaceous stock.

General reference: HEGNAUER, Chemotaxonomie der Pflanzen 4 (1966) 141–155. — R. HEGNAUER.

Chromosomes. Data on tropical and subtropical species are unfortunately scant. In various extra-Malesian species diploid numbers have been reported to be 20 or 24 (*Castanea*, *Fagus*, *Quercus*) and recently 28 in *Quercus castaneifolia* CAMUS (TUTAJUK *et al.*,). ARMSTRONG & WYLIE reported for *Nothofagus* 2n = 26. Independently KWITONG JONG (in litt.) and DING HOU found for *Trigonobalanus verticillata* 2n = 44 (DING HOU also n = 22). As to chromosome number *Fagaceae* have a great affinity with that found in other Amentiferous orders (*Betulaceae*, *Corylaceae*).

Literature: ARMSTRONG & WYLIE, Nature 205 (1965) 1940–1941; DARLINGTON & WYLIE, Chromosome Atlas Fl. Pl. (1955) 181–182; GHIMPU, Rev. Bot. Appl. & Agr. Trop. 9 (1939) 176–179; DING HOU, Acta Bot. Neerl. 20 (1971) 543–549; JAYNES, Forest. Soc. 8 (1962) 372–377; SAX, J. Arn. Arb. 11 (1930) 220–223; SUGIRA, Bot. Mag. Tokyo 45 (1931) 353–355; TUTAJUK & TURCHANINOVA, Dokl. Akad. Nauk Azerbajdzansk. S.S.R. 24 (1970) 47–50; VON WETZEL, Bot. Arch. 25 (1929) 257–283.

Taxonomy. *Historical review.* — DUMORTIER (Anal. Fam. Pl. 1829, 59–60, '*Fagineae*') was the first to recognize the family *Fagaceae*, and A. DE CANDOLLE (Prod. 16, 2, 1864, 1) was the first to frame the family in its present circumscription, using the name *Cupuliferae*. OERSTED (Kongl. Danske Vid. Selsk. Skrift. V, 9, 1871, 351) accepted DE CANDOLLE's classification and used characters of the stigma, cotyledons, and germination to subdivide the family into three subfamilies: **Quercineae** to include *Quercus* L. and *Cyclobalanopsis* OERST.; **Castanineae**: *Pasania* (MIQ.) OERST., *Cyclobalanus* (ENDL.) OERST. (including *Lithocarpus* BL.), and *Castanea* MILL. (including *Castanopsis* SPACH); and **Fagineae**: *Fagus* L. and *Nothofagus* BL.

PRANTL (in E. & P. Nat. Pfl. Fam. 3, 1, 1889, 52), who first used the name *Fagaceae* and recognized the importance of the inflorescence, divided the family into two tribes, *viz* **Fageae**: *Nothofagus* and *Fagus*; and **Castaneae**: *Castanea* (including *Castanopsis*), *Pasania* (including *Lithocarpus* and *Cyclobalanus*), and *Quercus* (including *Cyclobalanopsis*).

O. SCHWARZ (Notizbl. Berl.-Dahl. 13, 1936, 1–22), who combined the characters already mentioned by OERSTED and PRANTL, and added those of the cupule and fruit, came to the same subdivision as OERSTED. However, he recognized more genera than his predecessors, namely by splitting the genus *Quercus* into four segregates: *Quercus*, *Cyclobalanopsis*, *Erythrobalanus* O. SCHWARZ, and *Macrobalanus* O. SCHWARZ; and *Lithocarpus* into three: *Cyclobalanus*, *Lithocarpus*, and *Pasania*.

Among the recent authors who basically accept OERSTED's classification, though they used different combinations of characters, are: MELCHIOR (in Engler, Syll. Pfl. Fam. ed. 12, 2, 1964, 50) and FORMAN (Kew Bull. 17, 1964, 381–396); those who agree with PRANTL are: BRETT (New Phytol. 63, 1964, 96–118) and LUONG (Abstract Thesis, Leningrad, 1965).

On the basis of her pollen-morphological study, KUPRIANOVA (Rep. Sovjet Palyn. Publ. U.S.S.R. Ac. Sc. Moscow, 1962, 17–25) recently suggested to accommodate the genera *Nothofagus* and *Trisyngyne* BAILL. into a distinct family, *Nothofagaceae*, and place this new family in the *Euphorbiales*. Her opinion is, however, completely unacceptable to us, as we found that the resemblance between the pollen of *Nothofagus* (including *Trisyngyne*) and that of *Longetia* (*Euphorbiaceae*) is highly superficial. Furthermore, the presence of a cupule containing fruits which are nuts, is the most important feature characterizing the family *Fagaceae*, and is nowhere found among the *Euphorbiales*. Moreover, the morphology of *Nothofagus* fits admirably in with that of *Fagaceae* especially *Fagus* and not at all in with that of *Euphorbiaceae*. It is true that the pollen of *Nothofagus* is morphologically very different from that of the rest of the family. Morphologically it is even so isolated, that Mr. J. MULLER admits that if only the pollen was known, a palynologist would be at a loss to place it in any family! However, the problem in *Nothofagus* stands not alone, as there are many genera or families in which the pollen is very highly variable morphologically, and yet they are accepted as belonging to a single larger taxon.

Affinity of the Fagaceae. — According to ENGLER's system of classification, *Fagaceae* together with other Amentiferous families, are considered as the most primitive group among the Angiosperms, and their catkin-like inflorescence, simple unisexual flowers, chalazogamic mode of

fertilization, and marked interval between pollination and fertilization are considered as primitive characters, linking the group with some Gymnospermous ancestor. However, in the more recent systems of classification as advocated by BESSEY, CRONQUIST, HUTCHINSON, TAKHTAJAN, and others, *Fagaceae* is considered as a relatively advanced family, closely related to *Betulaceae* and *Corylaceae*, and most probably derived from a Hamamelidaceous ancestor; they consider the simple nature of the inflorescence and flower as advanced characters, resulting from reduction. For further discussion see: BESSEY, Bot. Gaz. 24 (1897) 145–178; Ann. Mo. Bot. Gard. 2 (1915) 109–164; CRONQUIST, Evol. Class. Fl. Pl. (1968) 170–171; HUTCHINSON, Fam. Fl. Pl. 1 (1959) 192–193; Evol. Phyl. Fl. Pl. (1969) 147–150; TAKHTAJAN, Orig. Disp. Fl. Pl. (1969) 95–107.

Generic delimitation. — Though in Malesia there is no serious difficulty in placing any specimen into the proper genus, there is in fact still some problem in delimiting some genera of *Fagaceae*, especially within the subfamily *Castaneoideae*.

For example, the distinction between *Castanea* and *Castanopsis* is obscure, and it is merely to avoid a nomenclatural instability that the genus *Castanopsis* is in this Flora regarded as distinct from *Castanea*. The only difference existing between these two genera is that in *Castanea* there is always a constant combination of the following characters: ♀ flowers situated at the basal part of the androgynous inflorescence, and the presence of 6 or more styles in each ♀ flower. For further discussion see FORMAN, Kew Bull. 18, 3 (1966) 421–426.

Fagus and *Nothofagus* can best be distinguished by the following combination of characters (VAN STEENIS, J. Arn. Arb. 34, 1953, 326–327, slightly emended):

Fagus	*Nothofagus*
Terminal buds elongate-acute, composed of imbricate, non-glandular scales.	*Terminal buds* ovoid, consists of glandular and decussately arranged scales.
Stipules never peltately attached, ligulate, flaccid, firmer towards the apex; insertion not surrounded by resinous colleters.	*Stipules* mostly peltately attached, very rarely ligulate, scarious towards apex; insertion surrounded by sausage-shaped resinous colleters.
Leaf not glandular-dotted, thin.	*Leaf* distinctly glandular-dotted, thick coriaceous.
Male flowers in a 2–20-flowered, long-peduncled, capituliform dichasium.	*Male flowers* borne in a sessile or short-peduncled, 1–3-flowered dichasium.
Anthers not apiculate, not glandular.	*Anthers* apiculate, often glandular.
Pollen grains spheroidal, 3-colporate; polar diam.: equatorial diam. = 5 : 4; exine scabrate to reticulate.	*Pollen grains* peroblate, 4–9-aperturate; polar diam.: equatorial diam. = 1 : 3 to 1 : 4; exine echinulate.
Cupular appendages seta-like, irregularly placed, without resinous colleters.	*Cupular appendages* regularly placed or in distinct lamellae, very often with resinous colleters at their adaxial base.
Female dichasium without the central or primary flower.	*Female dichasium* always with the central flower present.
Anatomy of *fruit wall* of the Fagoid-type[1].	Anatomy of *fruit wall* of the Nothofagoid-type[1]
Endocarp hairy.	*Endocarp* glabrous.
Wood-rays several cells wide; wood-fibres with bordered pits.	*Wood-rays* 1–2 cells wide; wood-fibres with simple pits.

The most important distinguishing characters between *Castanopsis* and *Lithocarpus* and between *Lithocarpus* and *Quercus* are summarized in the keys. For details see FORMAN (Kew Bull.

[1]) For details, see SOEPADMO, Gard. Bull. Sing. 22 (1968) 369–372.

17, 1964, 381–396; *ibid.* 18, 1966, 421–426) and SOEPADMO (Gard. Bull. Sing. 22, 1968, 356–357; Reinwardtia 8, 1970, 202–212).

Infrageneric subdivision of the genera of Fagaceae. — In this Flora no attempt is made to evaluate the different views dealing with subdivisions. Those who are interested are referred to works by BARNETT (Trans. Proc. Bot. Soc. Edinb. 34, 1944, 159–204), A. CAMUS (Les Chênes, 1936–1954, 3 vols.), O. SCHWARZ (Notizbl. Berl.-Dahl. 13, 1936, n. 116, 1–22), and TRELEASE (Mem. Nat. Acad. Sc. 20, 1924, 1–255).

Subdivision of the family Fagaceae. — Apart from the rather unique position of the genus *Trigonobalanus*, *Fagaceae* can best be subdivided into three subfamilies, as has been done by OERSTED and FORMAN on the basis of characters derived from the inflorescence and the flower, as follows:

1. Inflorescence spike- or catkin-like.
   2. ♂ Flowers always with a pistillode and with 10–12 stamens, with the anthers dorsifixed and versatile. ♀ Flowers always with 10–12 staminodes; stigmas terminal and punctiform. *Castanea*, *Castanopsis* (incl. *Chrysolepis* HJELMQVIST), and *Lithocarpus* (incl. *Pasania*, *Cyclobalanus*, and *Synaedrys* LINDL.) . . . . . **Subfam. Castaneoideae**
   2. ♂ Flowers without a pistillode, with 6 stamens, anthers basifixed. ♀ Flowers without staminodes or rarely with 6 staminodes; stigmas capitate or covering the inner surface of the styles. *Quercus* (incl. *Cyclobalanopsis*, *Erythrobalanus*, and *Macrobalanus*) and *Trigonobalanus* FORMAN. . . . . **Subfam. Quercoideae**
1. Inflorescence consisting of a 1–many-flowered dichasium. *Fagus* and *Nothofagus* (incl. *Trisyngyne*) . . . . . **Subfam. Fagoideae**

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Three precursory papers preceded this revision, *viz* on *Quercus* (Gard. Bull. Sing. 22, 1968, 355–427, 18 fig., 16 maps), *Castanopsis* (Reinwardtia 7, 1968, 383–410, 1 fig.) and *Lithocarpus* (*ibid.* 8, 1970, 197–308, 13 fig., 1 map).

KEY TO THE GENERA
(based on flowering specimens)

1. Inflorescence capitiform, axillary, consisting of 1–3-flowered dichasial clusters. ♂ Flowers with 10–20 stamens; anthers linear, 2–7 mm long, basifixed, apiculate; pollen grains peroblate, 4-9-colpate, exine distinctly echinulate. ♀ Flowers dimerous, perianth poorely developed, styles 2, short, tongue-shaped; stigmas papillose, covering the inner surface of the styles; ovary 2-celled, flattened. Leaves glandular-dotted; stipules peltately attached, their insertion surrounded by colleters. . . . . **1. Nothofagus**
1. Inflorescence a spike of condensed cymes, flowers solitary or in dichasial clusters of 3–30 along the rachis. ♂ Flower with 6–12 stamens; anthers 0.25–1 mm long, non-apiculate; pollen grains prolate or perprolate, 3-colpate, 3-colporate, exine scabrate or more or less smooth. ♀ Flowers 3(–6)-merous; perianth well-developed; styles 3–6 (–9), conical or terete; stigmas terminal, punctiform or capitate; ovary 3(–6)-celled, not flattened. Leaves not glandular-dotted; stipules basally inserted; no colleters.
   2. ♂ Flowers with the pistillode always present; stamens 10-12, anthers 0.25–0.35 mm long, dorsifixed; pollen grains perprolate (ellipsoidal), *c.* 16 by 10μ, exine more or less smooth. ♀ Flowers with 10–12 staminodes; stigmas punctiform. ♂ Inflorescence always erect.
      3.[1] Cupule-primordia already developed before anthesis, always solitary, with distinct vertical sutures, with 2–4(–8) separate growing-points; enclosing 1–3(–7) ♀ flowers . . . . . **2. Castanopsis**
      3.[1] Cupule-primordia not yet developed before anthesis, solitary or in dichasial clusters, ring-shaped without vertical sutures and separate growing-points; enclosing 1 ♀ flower only. **3. Lithocarpus**

[1]) To distinguish *Castanopsis* from *Lithocarpus* the ♀ flower is needed.

2. ♂ Flower without pistillode, stamens 5–6(–9), anthers ½–1 mm long, basifixed; pollen grains prolate (spheroidal), 30–40 by 20 μ, exine scabrate. ♀ Flower without staminodes or rarely with 5–6 staminodes; stigmas capitate. ♂ Inflorescence pendulous or erect.
4. Inflorescence always unisexual, simple. ♂ Inflorescence pendulous. ♀ Flowers always solitary, staminodes sometimes present; ovary rounded in cross-section. Terminal buds conferted, the scales with a tendency towards orthostichy. Leaves spirally arranged, crowded at the end of the twigs; stipules not interpetiolar. . . . . **4. Quercus**
4. Inflorescence unisexual or bisexual (androgynous), simple or much-branched. ♂ Inflorescence erect. ♀ Flowers in dichasial clusters of 3–15; ovary trigonous in cros-section; staminodes absent. Terminal buds not conferted, scales imbricate. Leaves in whorls of 3; stipules interpetiolar . . . **5. Trigonobalanus**

KEY TO THE GENERA
(*based on fruiting specimens*)

1. Cupule open and 2–16-lobed or completely enclosing the fruits; not dehiscent, or irregular so, or into 2–8 ± equal segments; always with vertical sutures. Nuts 1–15 in each cupule, rounded-angular or 2–3-gonous in cross-section.
2. Cupule lamellate or set with imbricate scales. Nuts 2–3-gonous in cross-section. Stigmas ligulate or capitate.
3. Cupule solitary, axillary, lamellate, 2-lobed, containing 1–3 nuts. Fruits 2-gonous, winged. Stigmas ligulate. Leaves distichous, glandular-dotted. Stipules not interpetiolar, peltately attached **1. Nothofagus**
3. Cupules many along a rachis, scales imbricate to concentrically set; 4–16-lobed, containing 3–15 trigonous but not winged nuts. Stigmas capitate. Leaves in whorls of 3, not glandular-dotted. Stipules interpetiolar, not peltately inserted. . . . . **5. Trigonobalanus**
2. Cupule spiny, muricate, or rarely almost smooth. Nuts rounded-angular in cross-section. Stigmas punctiform, terminal. Leaves spirally arranged. Stipules not interpetiolar. . . . . **2. Castanopsis**
1. Cupule never lobed, saucer-shaped, cup-shaped, or almost completely enclosing the fruit, indehiscent, without vertical sutures. Nut always solitary in a cupule, circular in cross-section.
4. Cupules solitary or in dichasial clusters, sometimes almost completely enclosing the fruit; variously squamose, muricate, or lamellate. Complete acorn without a ringed umbo. Stigmas punctiform. Leaves usually not crowded near the end of the branchlet, entire. Terminal buds solitary, scales imbricate. . . . . **3. Lithocarpus**
4. Cupules always solitary, saucer-shaped or cup-shaped, lamellate. Umbo of complete acorn ringed. Stigmas capitate. Leaves crowded at the end of the twig, entire or crenate in the apical half. Terminal buds conferted, scales with a tendency towards orthostichy. . . . . **4. Quercus**

KEY TO THE GENERA
(*based on sterile specimens*)

1. Leaves glandular-dotted beneath. Stipules peltately attached . . . . . **1. Nothofagus**
1. Leaves not glandular-dotted. Stipules not peltate.
2. Leaves in whorls of 3. Stipules interpetiolar. . . . . **5. Trigonobalanus**
2. Leaves spiral. Stipules not interpetiolar.
3. Leaves not crowded near the end of the twigs. Terminal buds not conferted, scales imbricate or rarely with a tendency to distichy.
4. Wood-rays (of older branches and mature wood) exclusively uniseriate . . . . **2. Castanopsis**[1]
4. Wood-rays uniseriate and many-celled . . . . . **3. Lithocarpus**[1]
3. Leaves crowded at the end of the branchlets. Terminal buds conferted, scales with a tendency to orthostichy. . . . . **4. Quercus**

1. NOTHOFAGUS[2]

BLUME, Mus. Bot. Lugd. Bat. 1 (1850) 307, *nom. cons.*; OERST. Vidensk. Selsk. Skr. V, 9 (1871) 354; STEEN. Blumea 7 (1952) 146; J. Arn. Arb. 34 (1953) 332, with full synonymy; *ibid.* 35 (1954) 266. — *Fagaster* SPACH, Hist. Nat. Vég. Phan. 11 (1842) 142. — *Calucechinus* HOMBR. & JACQ. in Dumont d'Urville, Voy. Pol Sud

[1] See for the difference in slash characters under Morphology-bark, p. 271.
[2] Elaborated by C.G.G.J. VAN STEENIS.

& Oc. (Astrolabe & Zélée) Bot. Atlas, Dicot. (1844) t. 6 Θ; (1845) t. 7 Z, 8 II. — *Calusparassus* HOMBR. & JACQ. *l.c.* (1844) t. 6 E; (1845) t. 7 T, 8 ψ. — *Lophozonia* TURCZ. Bull. Soc. Imp. Nat. Moscou 1858, I (1858) 396. — *Fagus subg. Caluspa-rassus et subg. Calucechinus* MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 103. — *Fagus sect. Eufagus* A.DC. Prod. 16, 2 (1864) 117, *pro spp.* 4–8; *sect. Nothofagus* A.DC. *l.c.* 121; *emend.* B. & H. Gen. Pl. 3 (1880) 410. — *Trisyngyne* BAILL. Adan-sonia 11 (1873) 136; BAUMANN-BODENHEIM, Bull. Mus. Hist. Nat. Paris II, 25 (1953) 419. — *Nothofagus subg. Lophozonia et subg. Molischia* KRASSER, Ann. Hofmus. Wien 11 (1896) 162. — *Parafagus* OLIV. Trans. Proc. R. Soc. New Zeal. 66 (1936) 292, *gen. foss.* — **Fig. 3–9.**

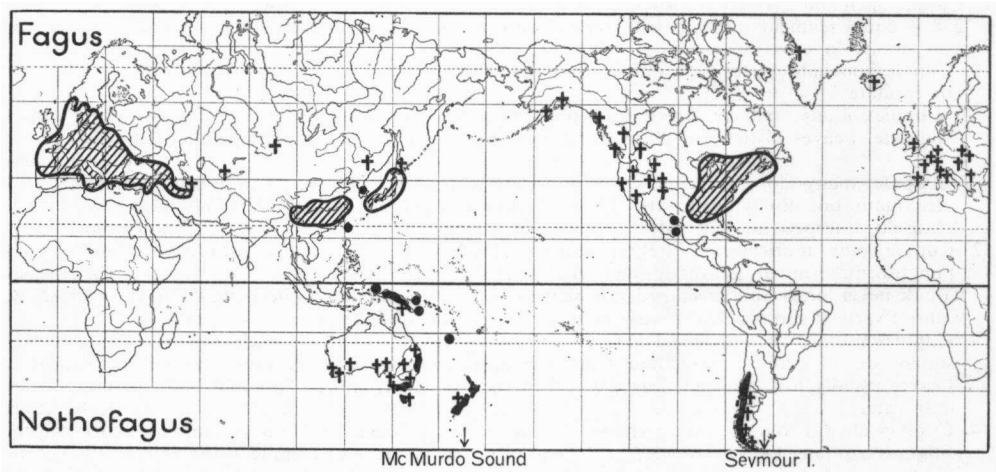

Fig. 2. Distribution of the genera *Fagus* on the northern and *Nothofagus* on the southern hemisphere. Fossil localities indicated by crosses including also the Antarctic localities at Seymour I. and McMurdo Sound (*Courtesy Blumea*).

Distr. From southern South America (incl. Staten I.) beyond 33° S to New Zealand, Tasmania, E. Australia, New Caledonia, and New Guinea (incl. the adjacent d'Entrecasteaux Is, Goodenough & Nor-manby, and New Britain), in all 37 *spp.* (South America 11, New Zealand 4, Tasmania 2 (1 endemic), Australia 2, New Caledonia 5, New Guinea *c.a.* 13). Fig. 2.

Taxon. The genus is subdivided as follows (STEEN. 1953, *l.c.*):

1. Deciduous. Leaves plicate in bud, texture always thin. South America, Tasmania ... **1.** *Sect.* **Nothofagus** *Calucechinus* HOMBR. & JACQ., *Lophozonia* TURCZ., *Fagus subg. Calucechinus* MIQ., *N. sect. Calu-cechinus* KRASSER, *N. subg. Lophozomia* KRASSER, *N. sect. Deciduae* STEEN. Blumea 7 (1952) 146, *N. sect. Plicatae* STEEN. *l.c.* 306, *laps. cal.*
2. Cupule 4-valved, 3–7-flowered. South America, Tasmania (8 *spp.*), type subsection. **1a.** *Subsect.* **Antarcticae** STEEN.
2. Cupule 2-valved, with linear valves. ♀ Flower 1. South America (1 *sp.*) . **1b.** *Subsect.* **Pumiliae** STEEN.
1. Evergreen. Leaves not plicate in bud, flattish or folded along the midrib in bud, exposing the under-surface, with firm texture. . . . . **2.** *Sect.* **Calusparassus** (HOMBR. & JACQ.) KRASSER *Calusparassus* HOMBR. & JACQ., *N. sect. Sempervirentes* STEEN., *N. sect. Planae* STEEN.
3. Cupule 4-valved, lamellae subentire to lobed, parted or divided into appendages. Lateral ♀ flowers normally 3-merous. South America (3 *spp.*), New Zealand (3 *spp.*), Tasmania & E. Australia (2 *spp.*) **2a.** *Subsect.* **Quadripartitae** STEEN.
3. Cupule 3-valved, with undivided lamellae. New Zealand (1 *sp.* with 2 *spp.*). **2b.** *Subsect.* **Tripartitae** STEEN.

3. Cupule 2-valved, the valves connate or free, with usually entire lamellae, or cupule reduced. ♂ Flowers solitary or in triads, ♀ flowers 1 or 3 per cupule. New Guinea (13 *spp.*), New Caledonia (5 *spp.*).
2c. *Subsect.* **Bipartitae** STEEN.

Ecol. The ecological range of *Nothofagus* is defined by an everwet climate from the cold subantarctic and temperate-montane to tropical-montane and tropical thermo-ecological conditions; lowland tropical species are found in New Caledonia and descent of *Nothofagus* to *c.* 600 m is observed in New Britain and to 750 m in the mainland of New Guinea and d'Entrecasteaux Is.

As other *Fagaceae*, *Nothofagus* shows a distinct social occurrence, past and present, mostly gaining *dominance* or *co-dominance*, as usual in the family, to which the occurrence in the montane forest in New Guinea makes no exception. The impression is gained that this is largely due to the symbiosis with ectomycorrhiza (*cf.* STEEN. Blumea 19, 1971, 72).

Nothofagus is found susceptible to fire, and does not possess fire-resistant characters.

Pollination is by wind and protandry seems to prevail. Anthesis occurs simultaneously and enormous quantities of pollen are produced which under certain conditions are observed (in New Zealand) to form clouds above the forest. Scattered pollen grains have been found at thousands of miles from the source area in windy austral areas.

A symbiont of the crown, *viz* all species of the genus *Cyttaria* (*Discomycetes*), occurs throughout its range except in New Guinea and New Caledonia.

Dispersal of the nuts of *Nothofagus* is very restricted and very slow. HOLLOWAY (1954) has shown that *Nothofagus* cannot stand transport by seawater. The nuts are compressed or triangular, possess mostly a sharp border, but are not provided with any special means of dispersal. They are rather small, but dispersal by wind will not carry them far. PREEST (1963) estimated the absolute maximum dispersal distance at *c.* 2–3 km and concluded that long-distance dispersal, either by wind, by birds, or by ice-bergs is excluded. In New Guinea KALKMAN & VINK (1970) found dispersal and regeneration confined to the stands. Consequently dispersal, past and present, seems to be bound to close distance of land.

Wood anat. According to METCALFE & CHALK (Anat. Dicot. 2, 1950, 1309–1315) within *Fagaceae* the wood anatomy of *Fagus* and *Nothofagus* is most closely allied.

Palyn. Within the family *Fagaceae* the pollen of *Nothofagus* is very characteristic and is not closely allied to that of the other genera. Within it, three main types are distinguished, the *fusca*, *menziesii* and *brassii* types. These types do not correspond with a single infrageneric taxon. As to the species, some of the latter type can be distinguished specifically by their pollen, but many of them cannot. Hence, one 'pollen species' may correspond with several botanical species. See COOKSON & PIKE (Austr. J. Bot. 3, 1955, 197–206) and WALKER & WITTMANN (Pollen et Spores 7, 1965, 457–464).

In Australia (incl. also New Guinea & New Caledonia), New Zealand and South America all three types are represented among the living species.

Hybrids. In New Zealand and in South America hybrids and introgression has been recorded. As yet we have no indications of this to occur in New Guinea.

Fossils. Both macro- and microfossils have with certainty been found in SE. New Guinea, Australia, New Zealand, Antarctica: McMurdo Sound (*c.* 165° E, 77° S) & Seymour I. (*c.* 64° W, 57° E) and Fuegia from the Tertiary onwards. In Victoria, New Zealand, Seymour I. and Fuegia fossil pollen is even found in Upper Cretaceous deposits, partly of the *brassii* and partly of the *fusca* pollen types. The *menziesii* pollen type appeared later, in the Eocene in Australia and in the Oligocene in New Zealand. In New Guinea fossil pollen is only known to occur as yet from the Upper Miocene and Pliocene; this belongs all to the *brassii* pollen type. In Australia and New Zealand fossil leaves and pollen of *Nothofagus* are so common that it is generally assumed that *Nothofagus* was abundant throughout (at least the eastern and southern parts of) the continent in pluvial Tertiary times. There are a fairly large number of subtypes or individual 'pollen species' known to be extinct in Australia and New Zealand, so that we may safely conclude that the genus has produced since the Upper Cretaceous a hundred species in austral Pacific lands.

Records of fossil pollen from the northern hemisphere and from Africa are due to misidentifications.

Among the living species the *brassii* pollen type occurs only in the New Guinean and New Caledonian species which form together *subsect. Bipartitae* and also in *N. alessandrii* ESPINOSA from S. Chile. This pollen type is one of the two ancient types and is found in fossil state throughout the known *Nothofagus* range; it occurs widely in the Australian and New Zealandian Tertiary and as in *Metasequoia* the fossils (in this case pollen) had been described before the living plants were known. See for the fossil sites fig. 2 and for the literature on it Pacific Plant Areas vol. 2 (Blumea Suppl. 5, 1966, 290–292, map 163, & references), and my recent paper in Blumea 19 (1971) 78–82, f. 97–98, tab. 1.

Systematics & Phylogeny. *Nothofagus* is a strictly southern hemisphere counterpart of the nearest allied but quite separate genus *Fagus* of the northern hemisphere, of which the most southern stations are at present found in southern Yunnan and Formosa. These two genera form together the subfamily *Fagoideae*. I have called *Nothofagus* a key genus for plant geographical and phyletic conclusions, as it meets the three criteria for safe reasoning, *viz* a sound taxonomy, an ample fossil record, and diaspores which require almost continuous land for dispersal. The ancestry of *Nothofagus* and *Fagus* cannot be divorced and they must have originated from a common ancestral matrix. Though their ranges do not

meet at present, the subtropical and tropical-montane area between southern Yunnan and Queensland seems the most likely place for the situation of their cradle. This area contained possibly the entire ancestral Fagaceous matrix from which they differentiated, *Fagus* possibly at the northern end and *Nothofagus* at the southern end. This cradle area harbours even at present, either inside itself or along its northern border the total range of morphological diversity of the family contained in the seven genera of *Fagaceae*. And in it is the highly interesting endemic genus *Trigonobalanus* which may be a palaeo-allopolyploid. The spreading from the matrix area must have started before the Upper Cretaceous, as Fagaceous fossils are known from the northern hemisphere at that time and also of *Nothofagus* in austral regions. Morphologically quite primitive species and appreciable diversity are still found in South America. In the warmer Cretaceous and Tertiary, when the major floral zones extended towards Antarctica *Nothofagus* could freely spread on available southern land areas. This wealth was brought to an in geological terms of time-scale abrupt end with the onset of cooler conditions at the end of the Tertiary followed by the havoc caused by the Ice Age: the retreat of the floral zones by the southern glaciation and the dramatic desiccation of most of the Australian continent. See for a more complete exposition of the theory, VAN STEENIS (Blumea 19, 1971, 65–98).

1. Section Calusparassus

(HOMBR. & JACQ.) KRASSER, Ann. Hofmus. Wien 11 (1896) 163; STEEN. J. Arn. Arb. 34 (1953) 336. — *Calusparassus* HOMBR & JACQ. in Dumont d'Urville, Voy. Pol Sud & Oc. (Astrolabe & Zélée) Bot. Atlas, Dicot. (1844) t. 6 E; (1845) t. 7 T, 8 *ψ*. — *Nothofagus sect. Sempervirentes* STEEN. *et sect. Planae* STEEN. Blumea 7 (1952) 146, 306.

1. *Subsection Bipartitae*

STEEN. Blumea 7 (1952) 146, *incl. ser. Triflorae et ser. Uniflorae* STEEN.; J. Arn. Arb. 34 (1953) 338.

Monoecious, evergreen, sometimes buttressed, trees or shrubs; bark grey, usually coming off in flakes. Innovations usually varnished by (sometimes yellow) resin exuded by colleters and glands underneath the leaves. Perular bracts in 4 orthostichies, with colleters. *Leaves* (in Mal.) distichous, in bud conduplicate, exposing the lower surface, entire, rarely crenate, tip emarginate, beneath glandular-dotted. Stipules peltately attached, at and near insertion with many colleters. — ♂ *Flowers* in the lower part of the flush, axillary, the lower often between a pair of efoliar stipules, solitary or in ebracteolate triads, sessile or short-pedicelled or -peduncled; bud ± club-shaped, perianth closed, often glandular-dotted, later rupturing at apex, basal part sometimes constricted. Stamens *c.* 12–18, filaments usually basally connate, not rarely lax-haired; anthers linear, basifixed, often glandular and/or laxly haired, dehiscence latrorsely; connective apiculate. — ♀ *Flowers* in the upper part of the flush, axillary, 1 or 3, usually in a cupule. Ovary sessile, flat, sometimes with a narrow marginal wing, mostly with 2 shoulders (perianth), rarely (abnormal?) with a hornlet below the apex on the flat side, usually glabrous; 2-celled; style short with 2 stigmatic arms. *Cupule* 2-lobed, rarely split to the base, usually with 1 or more lamellae, the latter at the adaxial side with colleters, finally often woody and gaping; cupule rarely reduced to 2 minute free elamellar thin flaps, or entirely absent. *Nuts* flat, ± orbicular to ovate, rarely lined with a thin margin, 1-seeded, apiculate by the style-base. *Seed* with membranous testa; cotyledons thin, folded, with fatty reserve. Germination epigeal.

Distr. New Guinea (13 *spp.*) and New Caledonia (5 *spp.*).

Ecol. Throughout New Guinea in the tropical-montane everwet rain-forest, largely between 1000 and 3100 m, but in several places recorded from 900, 850 and 750 m (*N. flaviramea*, *N. starkenborghii*). In

Normanby I. *N. carrii* and *N. rubra* occur down to 750 m, and in New Britain *N. starkenborghii* has been collected as low as 600 m. Some of the New Caledonian species descend or grow in the lowland hills or are even confined to the lowland forest, the lowest locality being 100 m.

In New Guinea on deep soils *Nothofagus* trees grow to large straight trees, sometimes to over 45 m tall with a diameter of 1, or even 1½ m. Fig. 3. On stony ridge crests and other localities with shallow poor soil trees may be dwarfed and represent gnarled poor shape or be shrubby, as observed in several species. Fig. 8.

As to soils, there seems to be in New Guinea no preference; there are a few records of *Nothofagus* growing on limestone (bedrock). The New Caledonian species are said to be restricted to serpentine.

Dominance or co-dominance is reported for almost all species, especially for *N. pullei* (9 times), *N. perryi* and *N. grandis* (both 5 times), *N. starkenborghii*, *N. rubra*, and *N. flaviramea* (each 3 times). Dominance can easily be observed from the air when the trees are in reddish flush. Co-dominants consist, for a large part, of other *Fagaceae*, notably *Castanopsis* and *Lithocarpus*; other frequent genera are *Araucaria*, *Libocedrus*, *Weinmannia*, *Engelhardia*, and *Cryptocarya*. BRASS, ROBBINS, and KALKMAN & VINK are of the opinion that co-dominance with *Castanopsis* and *Lithocarpus* is less manifest than collectors sometimes suggest, and observed that usually the *Nothofagus* zone is above the zone dominated by these two other genera.

Wood anat. DADSWELL & INGLE (Austr. J. Bot. 2, 1954, 141–153, 3 pl.) found that the wood anatomy of the species of the subsection appears to be homogeneous and differs to some extent from other species of the genus. The wood structure of the twigs of New Caledonian species is similar to that of the New Guinean species, but not exactly so.

Morph. In the New Caledonian species the phyllotaxis is not strictly distichous as in the New Guinean ones, but ± spiral.

In most species the ♂ flowers occur in either sessile or stalked triads, but some 4 Papuan species have the ♂ flowers solitary.

The ♀ flowers occur in threes per cupule or are solitary; in some of the latter the cupule is merely a vestige or may even be quite suppressed. Solitary ♀ flowers occur also in one or two New Caledonian species.

The primitive state is obviously a well-developed, many lamellate cupule with 3 ♀ flowers and stalked triads of ♂ flowers, from which the other states can be derived by reduction. Testimony of this derivation are very occasional aberrations; for instance I have found in one cupule of *N. brassii* the 2 lateral flowers not developed but aborted as rudiments. I have also found in one cupule of *N. flaviramea* 2 minute abortive lateral ♀ flowers in addition to the central nut, testimony of its derived status.

I have formerly attached taxonomical value to the occurrence of 3 versus 1 ♀ flower per cupule and distinguished *ser. Triflorae* and *ser. Uniflorae*. But new closer study of the New Caledonian species and new finds in Papua have induced me to view this distinction not as a phylogenetical cleft, and hence give it no value for natural distinction. Specific affinities point distinctly to parallel reduction from flowers in several species lineages. Therefore, I have not maintained these series.

Specific delimitation. The five New Caledonian species are clearly distinct at first sight, even in sterile state; all possess coarse, hard leaves with characteristic shapes.

Specific distinction by vegetative characters is for New Guinean species less easy, and I am not certain that all sterile specimens have been properly named.

Great value is given to the characters of the mature cupule, but of some species these are not known in the fully mature state and in other specimens it is sometimes difficult to decide from the herbarium material whether the mature state is reached. I have allowed a greater variability in cupule structure in *N. pullei* than in my monograph. A problem remains with *N. resinosa* and *N. pseudoresinosa*, which almost only differ in the absence or presence of a cupule. Observations on development of cupular structure in numbered trees may provide a better insight in this problem.

The ♂ flowers do not provide reliable characters, but 4 species have them solitary instead of in triads, *viz N. pullei*, *N. crenata*, *N. resinosa*, and *N. pseudoresinosa*. In *N. starkenborghii* and *N. carrii* the ♂ perianth is more cup-shaped than in the others where it is tubular. In *N. carrii* and *N. grandis* triads appear more clustered than in other species.

Uses. Some species provide obviously excellent timber of big dimensions, *e.g. N. perryi*, which seems durable also underground. Also the timber of *N. starkenborghii* and *N. pullei* seems good. Papuans use this timber; they also plant these species around their villages and fields for which they use seedlings taken from the forest.

Notes. Collecting adequate *Nothofagus* material is far from easy, partially by the large size of the trees, partially by the short period of the flush in which ♂ and ♀ flowers are produced, but also partially by the proportionally scarce and often very inconspicuous cupules or nuts.

Since the cupules furnish the most important characters for identification, collectors should carefully examine many twigs of felled trees to search for them, as they are scarce on a single twig and easily overlooked. As in the forest more than one species may be present one should be very careful to correlate fallen cupules with freshly collected specimens, but it is certainly very worthwhile to pick them from the forest floor underneath the tree and state so in the field notes.

Leaves may vary considerably in texture and size in conjunction with the condition of the tree during collecting and also on the age of the tree and furthermore with the habitat; in exposed sites they are gener-

ally smaller and more coriaceous. Sterile material from immature trees or from lower branches of mature trees is mostly impossible to identify.

In 1953 only 36 collections were available; at present there are nearly 400; this has necessitated some reductions, but also yielded 2 new species.

For using the key to the species one needs to have material with cupules. A number of species can be distinguished on vegetative characters (material from mature trees) and these have been listed separately for practical purposes.

KEY TO THE SPECIES[1]

1. Cupule 3-flowered.
 2. Leaves upwards crenate, usually ovate to elliptic-oblong, *c.* 5–10 by 2½–4½ cm. Peduncle of cupule *c.* 1½–3 cm.
  3. Cupule well-developed, lamellate, *c.* 1½–2 cm through, the nuts not or hardly exserted. Leaves usually ovate-oblong, more or less pointed to the apex; glands underneath less than or at most up to 1 mm spaced. Stipules early caducous, at least not present on fruiting twigs. Peduncle of ♂ triads 10–25 mm . . . . . **1. N. perryi**
  3. Cupule hardly developed, less than ½ cm long, consisting of 2 poorly developed valves each with an indistinct lamella, the nuts almost entirely protruding. Stipules persistent, even on fruiting twigs. Leaves elliptic-oblong, not or hardly pointed. Glands underneath more widely (1–2 mm) spaced. **2. N. nuda**
 2. Leaves entire, elliptic in outline, up to 5½ by 2½ cm.
  4. Midrib sulcate above, without trace of an elevated ridge over its entire length. Anthers *c.* 2½ mm long. Peduncle of cupule 2–4 mm . . . . . **3. N. starkenborghii**
  4. Midrib at least in the basal half with an elevated ridge. Anthers *c.* 5–6 mm. Peduncle of cupule 5–15 mm. . . . . **4. N. brassii**
1. ♀ Flowers solitary, cupule present or absent.
 5. Cupule entirely absent.
  6. Leaves waxy beneath, elliptic, margin towards apex faintly crenate or minutely toothed, 4½–10 by 2–5 cm; nerves *c.* 9 pairs, rather parallel and extending towards the margin; petiole 5–8 mm. Stipules 4–6 mm caducous. ♂ Flowers 1, 6–7 by 3½–4 mm; anthers 5–6 mm. Nut hairy, ovate-oblong . . . . . **7. N. resinosa**
  6. Leaves not waxy beneath, ± ovate-elliptic, entire, 2½–4 by 1½–2¼ cm; nerves *c.* 6 pairs, looped at apex; petiole 2–3 mm. Stipules 3–4 mm, rather persistent. . . . . **5. N. pullei**
 5. Cupule present, each valve consisting of at least an elamellate flap.
  7. Cupule only represented by 2 small, free, elamellate flaps very much shorter than the nut.
   8. Leaves ± obovate to obovate-oblong, rarely *also* some ± elliptic, 2—4½ by 1–2½ cm; nerves 5–7 pairs; midrib above sulcate with ridge to halfway; petiole 2½–5 mm. Ultimate twigs ± thin. Nuts *c.* 6–7 by 4–5 mm. . . . . **9. N. carrii**
   8. Leaves ovate-oblong, flat, acutish towards apex, or even ± acuminate (very rarely blunt and elliptic), 6½– 13 by 2½–5½ cm; nerves 8–10 pairs; midrib not sulcate, the ridge prominent at least halfway, often to apex; petiole 7–10 mm. Nuts *c.* 8–10 by 5–7 mm. . . . . **10. N. flaviramea**
  7. Cupular valves at least provided with 1 lamella.
   9. Cupules already in the young state distinctly stalked.
    10. Leaves ovate-oblong, distinctly acutish towards the apex.
     11. Leaves smallish, *c.* 2½–5 by 1¼–2 cm, crenate towards the apex. Cupule with *c.* 3 lamellae, the valves oval. Nut *c.* 5 mm, narrowly winged, about as large and of similar shape as the cupule halves. . . . . **6. N. crenata**
     11. Leaves much larger, *c.* 4½–9 by 2½–4 cm, entire.
      12. Cupule on a thin stalk, *c.* 10–15 mm, with 1 rather apical lamella, much smaller and narrower than the nut, *c.* 6 mm long. Nut ovate-acute, *c.* 10 by 6 mm, winged towards apex. **13. N. womersleyi**
      12. Cupule sessile to provided with a thick, obconical stalk-like extension *c.* 5 mm long, large, with 3–4 lamellae, finally woody, 12–13½ by 7½–10 mm. Nut rhomboid, *c.* 7–10 by 9½–10 mm, smaller than the cupular valves. Twigs coarse, greyish. . . . . **11. N. grandis**
    10. Leaves elliptic, not acutish towards the apex.
     13. Leaves large, with distinct, somewhat prominent venation above, *c.* 4½–7 by 2½–4 cm. Twigs coarse, greyish. Mature cupules large, *c.* 12–20 by 7½–10 mm. Nut large, rhomboid, *c.* 8–10 mm . . . . . **11. N. grandis**
     13. Leaves much smaller, *c.* 1¾–2¾ by 1–1½ cm, reticulations fine-tessellate, not prominent. (Immature) cupules *c.* 3–4 mm, immature nut suborbicular, about the same size . **12. N. rubra**

[1] Leaf-sizes cannot be taken from young trees or watersprouts. Cupule structure is that of mature cupules, but this is sometimes difficult to ascertain and in some species unknown.

9. Cupules sessile or almost so.
14. Leaves thin, (minutely) crenulate or minutely toothed towards apex, waxy underneath, *c.* 2½–5 by 1¼–2½ cm; nerves 7–8 pairs. Cupule *c.* 7–8 by 4–5 mm, with (1–)2 lamellae. ♂ Flowers solitary . . . . . **8. N. pseudoresinosa**
14. Leaves quite entire, not waxy, not thin.
15. Rather coarse. Leaves longer than 3 cm. Cupules woody, not split to the base in mature state.
16. Leaves large, *c.* 4½–7 by 2½–4 cm, rather thin-coriaceous (also on twigs with mature cupules), with distinct and ± prominent venation above. Twigs greyish, rather thick. Cupules *c.* 12–20 by 7½–10 cm, with 3–4 lamellae. Nut *c.* 7–10 mm ø. . . . . **11. N. grandis**
16. Leaves mostly hard-coriaceous, sometimes convex or with recurved margin, smooth above, but the nerves (not the fine-tessellate veins) thickish and obtusely prominent, *c.* 2½–5 by 1¼–3 cm. Cupules smaller, at most 12 by 6 (10–12) mm, with 2–3 lamellae. Nut *c.* 4–5 mm ø **12. N. rubra**
15. Less coarse. Leaves less than 3 cm long.
17. Young twigs hairy to puberulous, at least minutely so on the innovations. Cupule with 1 lamella, not seldom irregularly incised-dentate, mostly split to the base, almost always narrower than the nut. ♂ Flowers solitary . . . . . **5. N. pullei**
17. Twigs glabrous. Leaves generally hard-coriaceous, smooth above, but the nerves thickish and obtusely prominent, sometimes convex or with recurved margins. Cupule with 2–3 lamellae, woody, not split to the base, as broad as or broader than the nut. ♂ Flowers in triads . . . . . **12. N. rubra**

SOME CHARACTERS FACILITATING IDENTIFICATION
of sterile, very young, inadequate or ♂ material

Leaves crenate towards apex:
Nerves ending in the incision of the crenation: *N. perryi, N. nuda, N. crenata.*
Nerves (or accessory vein) ending in the crenation or tooth: *N. resinosa, N. pseudoresinosa.*
Young foliage with abundant resin: *N. resinosa, N. pseudoresinosa.*
Leaf apex pointed: *N. perryi, N. crenata, N. flaviramea, N. womersleyi,* very rarely slightly in *N. grandis.*
Midrib above, sulcation without trace of ridge: *N. starkenborghii.*
Midrib above not in a depressed sulcation, but sharply prominent as a ridge: *N. flaviramea.*
Innovations hairy, sometimes minutely puberulous: *N. pullei.*
Very slightly so in *N. resinosa* where also the nut and the perianth of the ♂ flower is puberulous.
Twigs flattened with yellowish bark (not an exclusive decisive character): *N. flaviramea.*
Cupules peduncled: *N. brassii, N. nuda, N. crenata,* some forms of *N. rubra, N. womersleyi,* shortly in *N. starkenborghii.* In *N. grandis* sometimes a short thick peduncle-like obconical attenuation.
♂ Flowers solitary: *N. pullei, N. crenata, N. resinosa, N. pseudoresinosa.*
♂ Triads rather crowded, forming pseudo-glomerules: *N. carrii, N. starkenborghii, N. flaviramea,* and often in *N. grandis.*

1. Nothofagus perryi STEEN. Blumea 7 (1952) 146; J. Arn. Arb. 34 (1953) 347, f. 3–2′, 6. — **Fig. 4, 9b–b²**.

Large tree, (14–18–)25–40 m and 60–160 cm ø. Ultimate twigs ± zigzag, ± applanate, sometimes yellowish. Stipules *c.* 7 by 3 mm, attached at lower third. *Leaves* ovate-oblong, coriaceous, 4½–11 by 2–4½ cm (I = 2–2½), shallowly crenate in upper half to ± pointed apex; ridge on midrib to ¾ or almost to top; nerves 6–8 pairs, rather straight, prominent beneath, not or rather distinctly so above; reticulation above usually indistinct, beneath often weakly prominent, a veinlet running to the toothlet; petiole 4–6 mm. — ♂ *Flowers* in 4–12 mm peduncled triads, sessile to 1 mm stalked; perianth ± truncate-campanulate, 5 by 3 mm. Stamens *c.* 13–15; filaments connate beyond perianth, free for 12–15 mm; anthers 4–5 mm. — ♀ *Flowers*: cupule *c.* 4 mm peduncled, consisting of two thin elamellar flabs *c.* 2 by 3 mm; stigmas just protruding. *Fruiting cupule* coarse, woody, on a straight or curved, 15–25 mm long, usually rather coarse, upwards obconically thickened peduncle, 3-lamellar, 10–15 by 11–18 mm. *Nut* ovate, apically ± winged, ± ovate, 5–8 by 5–6 mm.

Distr. *Malesia*: East New Guinea (Western Highlands: Wabag, Lai R., Nondugl, Al River Mts, Jimmi Valley, Bleekep, Mt Hagen, Mt Oga, Nona Camp, Kubor Range, Giluwe, near Kuli; Central Div.: East Mt Tafa, near Nemodi; Morobe Distr.: Trist; Eastern Highlands: Upper Chimbu, near Raregigl, Mt Michael, Goroka). In all 41 collections of which 13 fertile.

Ecol. Mountain forests, not rarely abundant or dominant, on Mt Elimbari at 2100 m also on limestone, 1600–2600 m. ♂ *Fl.* Febr., July, *fr.* June-Sept., *flush* June-July, Dec. (once Sept., Febr.).

Near Wabag dominant at 2400 m, near Goroka dominant in ridge forest with *Lithocarpus* co-dominant, at Baime Creek (Yamap, Wau) co-dominant with hoop pine, in Bena Bena Valley (Goroka) the dominant tree in ridge forest associated with *Lithocarpus*, on Mt Michael co-dominant with *Castanopsis* at 2000 m, on Mt Tafa to-

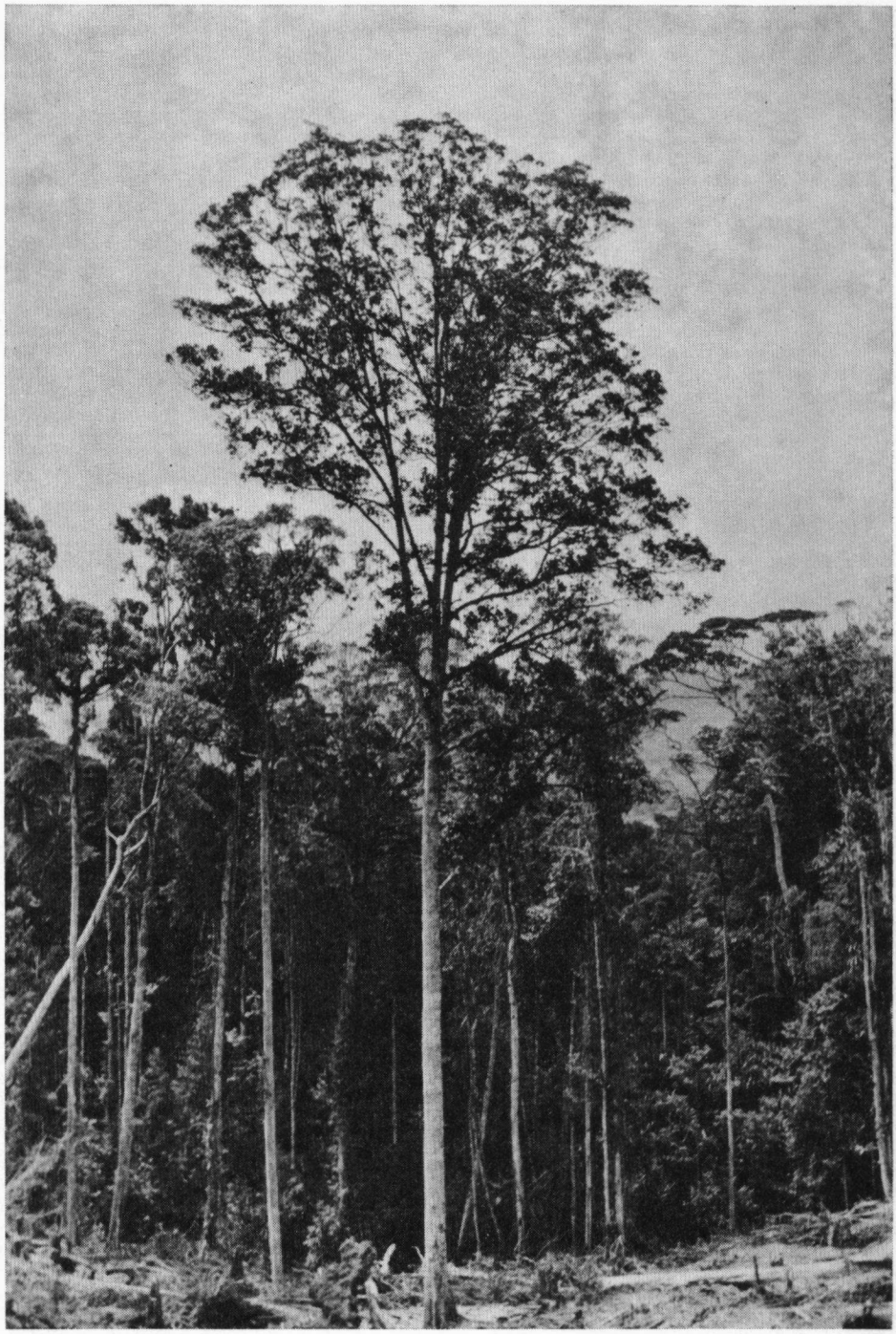

Fig. 3. *Nothofagus grandis* STEEN., some 40 m tall, along a clearing for coffee plantation, at Aiyura, T.N.G. (*cf.* NGF 3389)(WOMERSLEY, Sept. 1951).

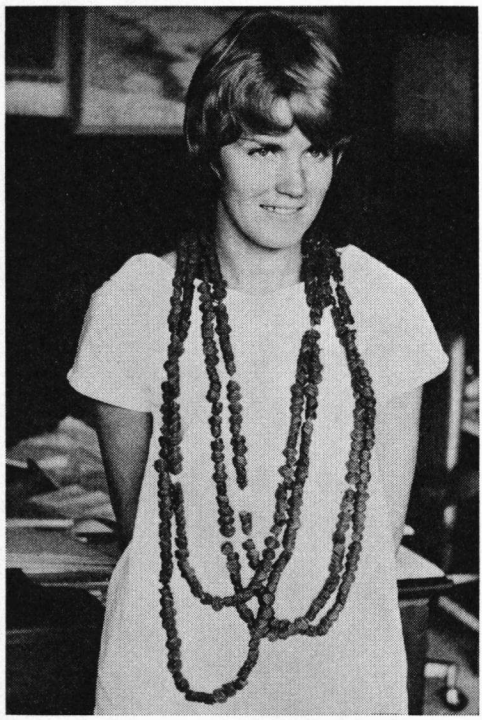

Fig. 4. Necklace of cupules of *Nothofagus cf. perryi* STEEN., adorning Miss J. VANDENBERG, of the Division of Botany, Lae, at the Lae Show, 1968; an Aseki exhibit.

wards Nemodi dominant as tall forest with *Lithocarpus* at 2100 m, at Lake Trist (Morobe) dominant tree on spurs and side-slopes at 1650 m.

Uses. Apparently a very useful species for its excellent hardwood; on Mt Michael and on Mt Kubor used for building purposes. On Hagen and Chimbu recorded to be planted along roads and in Chimbu also on edges of coffee gardens.

Vern. *Tar(a), taro, t. karap*, Wabag, Enga lang., *iumba, suker*, Chimbu, *garaip, gripe*, Hagen, *sama*, Mt Tafa, Waitape, *yembeh*, Minj, *jufeta*, Bena Bena.

Notes. By its large, coarse, crenate leaves, peduncled triads of ♂ and ♀ flowers, and multilamellar woody cupules the most primitive among the New Guinean species.

An allied species is *N. nuda* (see there) and the New Caledonian *N. discoidea* (BAUM.-BOD.) STEEN., but that species is crenate almost along the entire margin, with veins ending in the crenation-bays, ± scattered leaves, sessile, few-lamellate cupules with only 1 nut.

Even in fairly hard smallish leaves of old trees or from exposed habitats the leaf-shape is always somewhat pointed towards the apex.

Of young trees, saplings or lower branches the leaves are thinner and much larger (up to 17½ by 6½ cm in a tree 15 m high!) and resemble in shape those of *N. flaviramea* and *N. womersleyi*; but they have always some coarse crenulations towards the apex and are generally thicker in texture. In all three the ridge on the midrib above extends almost to the leaf apex.

2. Nothofagus nuda STEEN., *nov. sp.* — **Fig. 5.**

Nothofagi perryi affinis, differt foliis ellipticis (index 2½–3), obtusis, subtus glandulis 1–3 mm sibi remotis, valvis cupularibus minutissimus, c. 2–3 mm longis liberis unilamellatis. — *Typus*: R. PULLEN 6582, holotype CANB, isotypes A, L, LAE.

Tree, *c.* 20 m. Stipules 7–9 by 3–4 mm, peltate, rather persistent. *Leaves* distichous, elliptic (I = 2½–3), coriaceous, towards apex shallowly crenate, 8–10 by 3–4 cm, apex blunt, emarginate; midrib above with prominent ridge except near apex, very prominent beneath; nerves 7–9 pairs, prominent on both sides; venation prominent on both sides, fine-tessellate above, a veinlet ending in the incision of the crenations; petiole *c.* 10 mm, thick.— ♂ Unknown. — ♀ *Peduncle* 2–2½ cm, thin. *Cupular valves* free, thin, *c.* 3–4 mm high, emarginate to 2-lobed, obviously with 1 lamella. *Nuts* 3 per cupule, ovate, *c.* 10 by 6–7 mm, 3-dentate at apex by the style base and 2 erect, perianth teeth.

Distr. *Malesia*: East New Guinea (Upper Wenna Creek, branch of Tauri R., near Paina village, Gulf Distr. in Papua). One collection.

Ecol. Mixed lower montane rain-forest, associated with *Castanopsis*.

Vern. *We-úkwe*, Nauti lang.

Notes. Allied with *N. perryi*, but differing in the extremely small, not woody, 1-lamellate cupule, the leaf-shape, the wider spaced glands, the thin peduncle, the prominent venation, and the veinlet ending in the bay of the crenation instead of in the tooth. A primitive species but with a reduced cupule.

Also resembling the New Caledonian *N. balansae* (BAILL.) STEEN., but this differs by obovate leaves, large cupules and nuts.

3. Nothofagus starkenborghii STEEN. Blumea 7 (1952) 347; J. Arn. Arb. 34 (1953) 347, f. 7.

Generally a large tree, 16–45 m and 24–over 100 cm ø; bark shedding in hard, thin sheets or large scales, often defoliating in large, ± rectangular plates. *Leaves* elliptic (rarely some leaves ± obovate), subcoriaceous, 3–8 by 1¼–3½ cm (I = 2½–3½); midrib sulcate above without a ridge; nerves 6–10 pairs, as the reticulations rather indistinct on both surfaces; petiole ½–1 cm. Stipules up to *c.* 6–7 mm, acute at both ends or rounded below, inserted at the lower 1/3. — ♂ *Flowers*: 1–2 mm stalked triads, many together as in a glomerule; buds at base stalk-like for 1–2 mm, then 3–4 mm ellipsoid, when open perianth wide-campanulate cup-shaped, 3–4 mm high; filaments connate to above the perianth rim. Stamens *c.* 12–14; anthers 2½–3½ mm. — ♀ *Flowers* 3. *Cupule* rather woody, 2–5 mm peduncled by an obconical stipe, with 3–4 lamellae, split about halfway or more, the

Fig. 5. *Nothofagus nuda* STEEN. *a.* Habit, × ⅔, *b.* mature cupule carrying 3 nuts, *c.* nuts, *d.* cupule, all ×2 (PULLEN 6582).

halves obovoid, *c.* 11–15 by 10–11 mm. *Nuts* not seen.

Distr. *Malesia*: West New Guinea (Ransiki; Wissel Lake area; Balim; Habbema Camp) and East New Guinea (Western Highlands: Mt Hagen, Wankl village, Mt Kum; Eastern Highlands: Aiyura Subdistr., Kainantu; Southern Highlands: Anga village, Lake Kutubu), New Britain (Torlu R. and Pomio area, 5°30′-6°N, 151°–151°30′ E). In all 24 collections, of which 12 fertile (5 ♂, 7 ♀).

Ecol. Often common large tree in mountain forest, 1200–2400 m, but stands are found at Kutubu Lake at 810 and 900 m, and full-grown trees in New Britain at 600 m, the lowest locality of the genus in Papuasia. In New Britian (Torlu R.) reported from limestone in *Eugenia* ridge forest. *Flush* twice noted: Aug., Oct. ♂ *Fl.* May, July, Aug. Sept., Nov., *fr.* July, Nov., Febr.

Common on Mt Hagen and near Wissel Lakes, reported dominant at Habbema, at 2250 m, at Agunamura near Kainantu (Eastern Highlands) in some places in practically pure stands with a high volume per acre; dominant at Telefomin on middle slopes, and at Aiyura.

Uses. At Telefomin the timber is used for house posts. The Lutheran Mission at Raipinka reported the timber to be very resistant, posts having been 16 years in the ground without deterioration. About Agunamura very abundant and used for bridge-decking, fence posts, *etc.* The timber is hard to cut, the largest trees being 45 m by 1 m plus ø; older trees are inclined to be stag-headed.

Vern. *Senoko*, Ransiki, Manikiong lang., West New Guinea; *katula*, New Britain, Pomio area.

Notes. The species is characterized by a narrow, elliptic leaf-shape and absence of any ridge on the sulcate midrib above; furthermore by glomeruled, almost sessile ♂ triads which are often found laterally on twigs with mature leaves as in *N. carrii* (but that species has only 1 ♀ flower per cupule).

As usual in the genus leaves of saplings and young trees are large: those of a tree 16 m high measured 11 by 4 cm, but the leaf-shape is constant.

In SCHODDE 1544 I found an abnormal flower in which the stigmas were swollen and obviously not fertile; one of the ♀ flowers was flanked by the bud of a ♂ flower.

The nearest allied species seems to be the New Caledonian *N. aequilateralis* (BAUM.-BOD.) STEEN.

4. Nothofagus brassii STEEN. Blumea 7 (1952) 146; J. Arn. Arb. 34 (1953) 350, f. 8, 9. — *N. recurva* STEEN. Blumea 7 (1952) 146; J. Arn. Arb. 34 (1953) 343, f. 4, *incl. var. microphylla* STEEN. *l.c.* 345, f. 5. — *N. pseudoresinosa var. microphylla* STEEN. Blumea 7 (1952) 147, *sphalm.* — Fig. 7.

Generally a large tree, 24–45 m by 25–100 cm ø, sometimes dwarfed to a shrub, 2–6 m, or small tree (Arfak). *Leaves* elliptic-oblong or ovate to ovate-oblong, coriaceous, not rarely hard, the margin often recurved, apex sometimes acutish, (2½–)3½–9 by 1½–4 cm (I = 1½–2½); ridge on midrib at least halfway sometimes to apex; nerves 7–9 pairs, above sometimes depressed, sometimes elevated, venation indistinct; petiole 4–7 mm. Stipules 5–10 by 2½–3 mm. — ♂ *Flowers*: triads sessile or almost so; perianth ± tubular, 7–9 mm. Stamens *c.* 15; anthers 5–7 mm. — ♀ *Flowers* 3; cupule *c.* 4–5 mm ø; 1–2 laterals sometimes abortive or sterile; style 1–2½ mm. *Cupule* on a 5–15 mm long curved or straight peduncle, with 4–5 lamellae, thick, *c.* 10–15 by 12–15 mm, sometimes smaller, 7–10 by 5–9 mm (always mature?). *Nut* 6–10 by 4–6 mm, sometimes only 4–5 mm and orbicular.

Distr. *Malesia*: West New Guinea (Arfak: Angi Lakes; Wissel Lakes; Habbema Camp; Mt Cycloop) and East New Guinea (Morobe Distr.: Mt Rawlinson; Eastern Highlands: Chimbu, Goroka). In all 16 collections, of which 15 fertile.

Ecol. Mountain forests, sometimes frequent

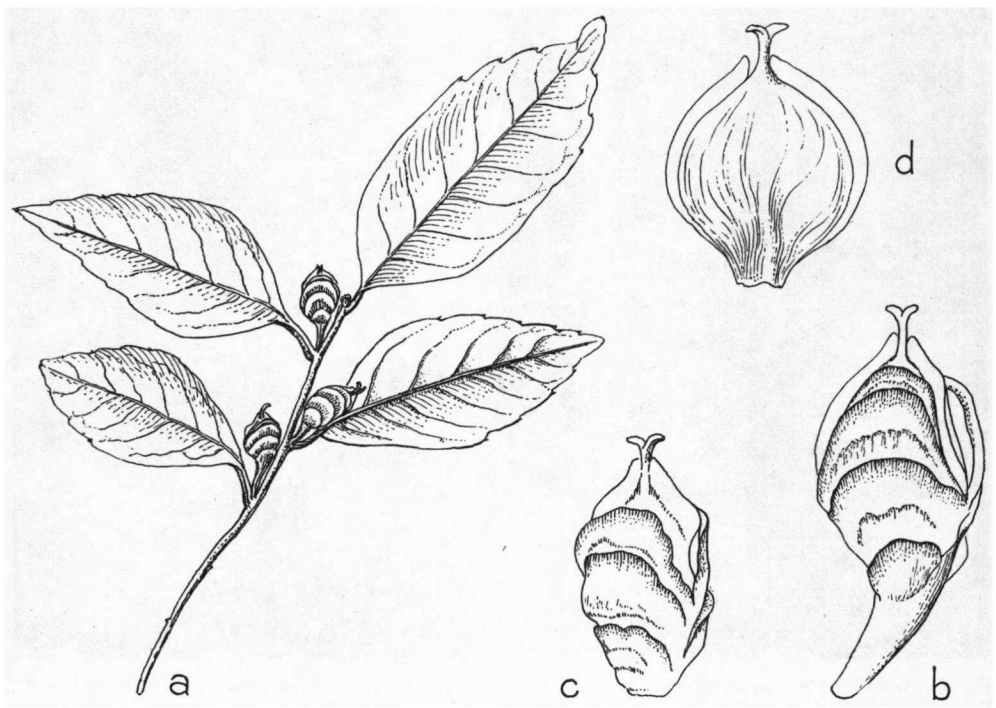

Fig. 6. *Nothofagus crenata* STEEN. *a.* Twig with cupules, nearly nat. size, *b–c.* cupules, ×3, *d.* nut, ×3; all immature (BRASS 11335)(*Courtesy Journal Arnold Arboretum*).

Fig. 7. *Nothofagus brassii* STEEN. Mature forest at Bele R. valley, a southern tributary of the Balim R., West New Guinea, at 2450 m alt., most undergrowth and smaller trees removed as a preliminary to felling; big tree on left charred at base by fire (BRASS, Nov. 1938).

very common or dominant, 1550–2700 m. ♂ *Fl.* Oct.-Nov., April, *fr.* Jan.-Febr., Sept.-Nov., *flush* Sept. (once), Febr. (once).

At Arfak Mts and Wissel Lakes frequent or very common, sometimes in old secondary forest, at Habbema dominant tree 40 by 1 m at 2300 m, at Chimbu growing together with *N. perryi*.

Notes. More material has shown that the differences between *N. recurva* and *N. brassii* do not hold: in one specimen fully mature cupule peduncles may be recurved or straight and this is also true in *N. perryi*. Also *N. recurva var. microphylla* cannot be upheld; there appears to be a rather great variation in the size of the cupules, from small ones as in this variety to large ones.

Also in the leaf-texture and hence degree in elevation of the venation there is quite some variation, from very stiff hard smooth leaves with recurved margin to rather flattish less hard leaves.

In a few specimens some very faint crenations occur, but no vein is running towards the crenations as in *N. perryi*.

5. Nothofagus pullei STEEN. Blumea 7 (1952) 146; J. Arn. Arb. 34 (1953) 353, f. 10. — ? *N. cornuta* STEEN. Blumea 7 (1952) 147; J. Arn. Arb. 34 (1953) 359, f. 3–10′, 15.

A fairly large, finally often flat-topped tree, 20–50 m by 25–100 cm ø, rarely (juvenile) smaller, or dwarfed to a 2–4 m high crooked shrub on ridges. Twigs in the typical form densely patent yellow-pubescent, but with gradations to minutely puberulous, also petiole and midrib underneath puberulous. Flush generally distinctly pale-dotted with scales underneath. *Leaves* small, coriaceous, smooth above and with recurved margin to flat and thinner and with prominent venation, broad-elliptic to elliptic-oblong, 1–4½ by ¾–2¾ cm; ridge on midrib about halfway; nerves *c.* 6 pairs; reticulation dense; petiole 1–3 mm. Stipules *c.* 4–5 by 2 mm, tardily caducous, attached at lower 1/3. — ♂ *Flowers* solitary, perianth rather tubular 5–6 mm long; filaments *c.* 10–15, connation not emerging from the perianth; anthers 3–4 mm. — ♀ *Flowers* sessile or 1 mm stalked, with a distinct style and often 2 mucronate shoulders. *Cupule* split to the base, with a single lamella, apical part often irregularly laciniate, narrow, elliptic, 2½–5 by 2 mm or shorter (3 by 1 mm), shorter and narrower than the nut at maturity only the lower part lignified and thick. *Nut* acute-orbicular to elliptic, 5–6 by 3½–5 mm.

Distr. *Malesia*: West New Guinea (Arfak: Angi; Mt Hellwig) and East New Guinea (Western Highlands: Sirunki on Mt Kabanunt, Mt Hagen, Mt Kum, Mt Oga, Wabag, Kepilam village; Southern Highlands: Mt Giluwe, Tari Subdistr. foot of Mt Né; Mt Ambua; Central Highlands: Chimbu, Nondugl, Kerowagi, Mt Karigomna; Eastern Highlands: Mt Otto, Goroka; Morobe Distr.: Edie Creek, base of Mt Saruwaged, Kaindi). In all 31 fertile and 35 sterile collections.

Ecol. Often gregarious or dominant, on ridges sometimes dwarfed down to a shrub of 2–4 m (type), (1650–1950–)2000–3000 m. ♂ *Fl.* mainly July-Aug., *fr.* mainly July-Aug., *flush* mainly July-Sept.

SLEUMER & VINK found a single surviving small tree of 9 m in a pyrogenous fern-sedge vegetation near Angi Gigi (Arfak) at 2500 m. Reported also from steep limestone at Mt Lu (Kuara River Valley) and at Wabag.

Frequently on ridges (Mt Hellwig, Edie Creek, Goroka, Nondugl) or crest of spur (Mt Otto), but also on slopes, often dominant, *e.g.* at Kaindi the principal dominant on the upper part of the mountain above the *N. grandis* zone (BRASS), on Mt Otto forming pure forest between 2630–2680 m on crest of spur (BRASS), at Nondugl gregarious on ridge at 1650 m, on Mt Giluwe dominant at 2500 m, and at Kepilam village at 2400 m; also dominant on Mt Hindenburg mainly on ridges, at Wabag dominant over large areas, sometimes in pure stands, at 2700 m, at Laiagam Distr. dominant at 2700 m, and further reported dominant at Habbema. From Wabag regeneration is reported under *Castanopsis*, but also dominance in large pure stands. Also in mixed forests with *Litsea*, *Pandanus*, *Cinnamomum*, *Xanthomyrtus*, *Phyllocladus*, *Weinmannia*, and *Podocarpus*.

Uses. Obviously a valued timber tree appreciated by the Papuans. FRODIN reports it from the vicinity of Lei Camp on the SE. slope of Mt Ambua for local bridge construction; HOOGLAND & PULLEN reported from Mt Hagen, 2550 m, that it is planted along houses and creeks, and occasionally along the track from seedlings brought up from lower altitude; also at Chimbu planted in garden areas.

Vern. *Ta(r)*, Laiagam, *taro pulau*, Wabag, *taro yam yam*, *t. yum yum*, Poget, all Enga lang., *garaip*, *graip*, *gripe*, *karaap*, Hagen, Minj lang., *garap*, Kubor, Minj lang., *jomba*, *yomba*, Giluwe & Mairi, Mendi lang., *pu*, Giluwe: Ialibu, *zopa*, Durantina, *asaro*, Kefamo, *jobbailua*, *jowara-'aiwa*, Chimbu: Masul, *danda*, Nondugl: Bleekep, *igamuk*, Hindenburg Ra.

Notes. The material is not homogeneous. The species is typified by a patent, yellowish, rather stiff and persistent hairiness on the twigs, the single Malesian species possessing this, and there are quite a number of collections agreeing with the type from both West and East New Guinea. However, there is a grading towards a very fine white puberulence which is only well visible on the twigends.

As could be suspected the variation of *N. pullei* is only now better understood with *c.* 65 collections at hand (*c.* 40% fertile), as contrasted with the one collection it was based on. In exposed situations the leaf is thick and ± convex, smooth above, and hairiness is distinct, often yellowish. However, in small fertile trees and in less exposed conditions leaves are flatter, thinner, often larger, with raised venation on both sides, and with the indument on the innovations reduced to an extremely short and also sparser white puberulence. These latter often have also somewhat smaller stipules (3–5 mm). But there is a full intergradation and one cannot find minor breaks.

The cupule has only 1 lamella, which is usually irregularly incised and narrower than the nut, and

the valves free. But in a few specimens the cupule is almost as wide and the valves are connate at the very base, fallen cupules appearing 2-valved (BRASS 30894, HOOGLAND & SCHODDE 7532, PULLEN 5400); these specimens are all very fine-puberulous at twig ends.

I have tentatively reduced *N. cornuta* to *N. pullei*; it cannot be distinguished vegetatively; this is possibly a freak without a cupule, the type specimen (EYMA 5122) besides being extremely poor; two specimens resembling '*N. cornuta*' are VAN ROYEN & SLEUMER 7281 and 8013, with ♂ and young ♀ flowers, both from the Vogelkop.

6. Nothofagus crenata STEEN. Blumea 7 (1952) 147; J. Arn. Arb. 34 (1953) 355, f. 3-6', 11. — **Fig. 6.**

Tree to 40 m by over 1 m ø. *Leaves* flat, thin-coriaceous, ovate-oblong, pointed towards apex and distinctly crenate, 2½–5 by 1¼–2 cm; ridge on midrib prominent almost to apex; nerves 5–6 pairs; venation above ± prominent; petiole 4–5 mm. Stipules ovate, early caducous, *c.* 5 by 2 mm. — ♂ *Flowers* solitary (only loose ones found); anthers 5 mm. — ♀ *Flowers* solitary; immature cupules split halfway, *c.* 5 mm stalked, with 3–4 lamellae, about as large as the developed ♀ flower, 4½–6 by 5–6 mm. *Immature nut* ± orbicular, narrowly winged, style distinct, *c.* 5 by 4 mm.

Distr. *Malesia*: Central West New Guinea (Bele R. near Habbema Lake), only the type collection.

Ecol. Common in forests, 2300 m, young ♀ Nov.

Vern. *N'gi.*

Note. It is peculiar that of this rather characteristic species no additional specimens have become known.

7. Nothofagus resinosa STEEN. Blumea 7 (1952) 147; J. Arn. Arb. 34 (1953) 356, f. 3-7', except NGF 5134 (which is *N. flaviramea*). — **Fig. 9 d–d¹.**

A large tree, (15–)20–50 m by 40–104 cm ø, young parts characteristic by a conspicuous cover of pale yellowish waxy or resinous exudate. *Leaves* elliptic to broad-elliptic, coriaceous, flat, rounded at both ends, margin apically not quite entire, but with minute teeth causing a fine undulation, 4–10 by 2–5 cm; upper face smooth, the midrib ridge at least up to halfway; nerves 8–10 pairs, rather parallel towards the edge, prominent beneath; petiole 5–10 mm. Stipules early caducous, elliptic, 5 by 3 mm. — ♂ *Flowers* solitary, almost sessile, ± tubular, 7 mm, puberulous. Stamens 13–15; anthers 3–5 mm. — ♀ *Flowers* solitary, ecupular, sessile, ovate-oblong, puberulous, 6–7 by 3½–4 mm. *Nut* broadly elliptic, puberulous, 9–10 by 6½–7½ mm, with persistent style base.

Distr. *Malesia*: West New Guinea (Wissel Lakes, Habbema) and East New Guinea (Western Highlands: Kubor, Lagaip, Minj, Keglsugl; Eastern Highlands: Upper Chimbu; Morobe Distr.: Samanzing). In all 12 collections of which 6 fertile.

Ecol. Mountain forest, often common, reported as dominant between 2500–2800 m at Habbema and Kubor, and completely dominant at Tambua–Keglsugl, 2300–2850 m. *Flush* Febr., July-Sept.

Uses. Once said to be planted by Papuans at Kepilam village, Lagaip Valley, Western Highlands from seed said to be obtained from Wabag. Must be a good timber tree of large dimension.

Vern. *Garuwa*, Wissel Lakes, Kapauku lang., *ndak*, *yembeh*, Western Highlands, Minj lang., *garaip*, Togoba.

Notes. Young parts are studded with sulphur-yellowish waxy resin, which tardily disappears on the underside of the leaves, a conspicuous character in common with *N. pseudoresinosa*, and at first sight astonishingly alike that species.

The main difference with the latter is the complete absence of a cupule and the puberulous nut; also the ♂ perianth, the twig-ends, petiole and stipules are more or less finely white-puberulous (not to be confused with blackish 'hairs' which belong to a fungus); furthermore by the usually more acutish leaf apex.

One might suppose the absence of the cupule to represent a freakish state, but the 5 ♀ fertile specimens are exactly matching.

In 1953, *l.c.*, I added that the cupule could have a basal appendage, on the strength of NGF 5134, but this was an error, the specimen belonging to *N. flaviramea*.

8. Nothofagus pseudoresinosa STEEN. Blumea 7 (1952) 147; J. Arn. Arb. 34 (1953) 358, f. 13, 16 d–h. — **Fig. 9 e–e².**

Tall tree, sometimes short flanged, 30–45 m by 90 to over 100 cm ø. *Leaves* 2½–5½ by 1¼–2½ cm, rarely 8–9 by 4–5 cm, flat, elliptic-oblong, some rather narrow, undersurface and young parts with a pale or pale yellowish, rather persistent waxy or resinous exudate; ridge on midrib up to halfway; nerves 8–9 pairs only distinct beneath, venation indistinct; petiole 5–10 mm. Stipules early caducous, 5–6 mm, attached at lower third. — ♂ *Flowers* solitary, perianth tubular, *c.* 7 mm, slightly puberulous or glabrous. *Cupule* sessile, split to base, rather narrow, valves (5–)6–7 by (2–)3 mm, with 1–2 lamellae, somewhat shorter and narrower than the nut or ± equally long. *Nut* solitary, ovate, glabrous, 7–8 by 4–5 mm, the smallest (mature?) 5 by 3 mm.

Distr. *Malesia*: East New Guinea (Morobe Distr.: Mt Sarawaket; Western Highlands: Wabag along Wapu R.; Eastern Highlands: Finisterre Ra.); 3 fertile collections (CLEMENS 5849, PULLEN 6083, HOOGLAND & SCHODDE 7204).

Ecol. Mountain forest, 2300–3100 m, very common, dominant on ridges and valleys at Wabag and the Finisterre Ra., co-dominant at Lake Habbema. *Flush & fl.* April, July, *fr.* Oct.

— Uses. None known, but by the large dimension it must be a valuable timber tree.

Vern. *Tart*, Poio, Enga lang., *mépa*, Finisterre Ra., Naho lang.

Note. In habit extremely like *N. resinosa*, but different by the presence of a distinct lamellate cupule about as long as the nut and absence of the minute puberulous hairs on nut, flush and stipules.

9. Nothofagus carrii STEEN. Blumea 7 (1952) 147; J. Arn. Arb. 34 (1953) 359, f. 3-9′, 14.

Tree, 20–45 m (bole 18–24 m), dbh 25–130 cm. *Leaves* usually obovate, more rarely elliptic, coriaceous, rather flat, 2–6 by 1–3 cm; ridge on midrib in lower half; nerves 5–7 pairs, rather indistinct on both sides; reticulations not prominent; petiole 2½–5 mm; very young flush often waxy. Stipules early caducous. — ♂ *Flowers* sessile in 1–3 mm peduncled triads ± crowded on very short (to 10 mm) efoliate twiglets in the axils of normal leaves; perianth hypanthium-like contracted at base, campanulate-urceolate, *c.* 3½–4 mm. Stamens *c.* 10; anthers 2½–3 mm. — ♀ *Flowers* solitary, 1–1½ mm peduncled, only sustained by an elamellar flap much smaller and narrower than the flower, 2–3 mm long; flower itself ovate-oblong, 5 by 3 mm; style *c.* 1–1½ mm. *Nut* elliptic to ovate-oblong, 7–11 by 4–5 mm.

Distr. *Malesia*: West New Guinea (Arfak, Wissel Lakes), East New Guinea (Ok Denim R.; West Sepik: Telefomin; Western Highlands: Laiagam, Mt Giluwe, Minj-Nona Divide; Southern Highlands: Ialibu, Anga Valley, Habono; Morobe Distr.: Kaindi, Sarawaket, Goroka; Eastern Highlands: Kerowagi, Bundi Gap), and d'Entrecasteaux Is. (Normanby & Goodenough Is.). In all 21 collections, of which 14 fertile.

Ecol. Mountain forests, sometimes low mossy forest, or shrubby growths on summits or ridges, 1900–2850 m. *Fl.* Dec., Jan., also *flush* June-Aug.

On Normanby I. at 900 m on summit shrubby growths the major constituent 2–5 m tall; on Mt Kaindi in low mossy forest also only 3 m. Forming extensive forests at Bundi Gap at 2700 m and at Laiagam (Kandep Road) the dominant tree at 2850 m, but also found dominant at Ialibu at 1950 m and Habono at 2100 m.

Uses. None reported, but it must be a valuable timber tree of often great dimension.

Vern. *Dierie* = *didamé*, Wissel Lakes, Kapauku lang., *kundap*, West Sepik, Telefomin, *yomba*, Southern Highlands, Mendi lang.; Eastern Highlands, Bundi Gap, Chimbu lang., *taggiruba*, Southern Highlands, Habono, *taro*, Western Highlands, Laiagam, Enga lang., *garaip*, Hagen.

Notes. Vegetatively some specimens show resemblance to *N. starkenborghii* by the fine tessellate-reticulate venation and sometimes an almost absent ridge on the midrib above, and ± elliptic leaves; furthermore both species share the character of clustered ♂ triads.

The cupule under the solitary nut is only represented by 2 small, elamellate flaps, and this is consistent with all ♀ fertile collections.

10. Nothofagus flaviramea STEEN. Nova Guinea, n.s. 6 (1955) 281, f. 1. — *N. resinosa* (*non* STEEN.) STEEN. J. Arn. Arb. 35 (1954) 267, f. 1 f. — *Shorea sp.*, SLOOT. Reinwardtia 2 (1952) 61.

Tree, 15–45 m by 25–150 cm ø, sometimes buttressed; bole 10–25 m. Twigs usually ± flattish, and sulphur-yellow, rather coarse. *Leaves* ovate-oblong, acutish attenuate to short-acuminate, entire, flat, usually chartaceous, *c.* 5–12 by 2¾–5 cm, at base broadly acute to rounded, the sulcate midrib above with a ridge; nerves 8–10 pairs, rather prominent on both sides as are the reticulations; petiole *c.* 5–10 mm. Stipules early caducous. — ♂ *Flowers* in ± sessile triads; perianth *c.* 5 by 2½ mm, very truncate. — ♀ *Flowers* solitary; cupule sessile, consisting of 2 free, tiny, suborbicular flaps without lamellae; in fruit *c.* 1–2 mm, caducous. *Nut* obovate-apiculate, when mature *c.* 9–10 by 6–7 mm.

Distr. *Malesia*: West New Guinea (Fak Fak, Arfak, Mt Cycloop, Bernhard, Habbema, Wissel Lakes, Star Mts) and East New Guinea (Sepik: Telefomin; Western Highlands: Aweta Bridge, Minj; Finschahfen; N. Div.: Hydrographers Ra.; Eastern Highlands: Kainantu). In all 35 collections of which 10 fertile.

Ecol. Mountain forest, sometimes mossy, on slopes and spurs, 750–2450 m (mainly 1000–2000 m). *Fr.* April, June, Oct., Dec., *flush* Oct.-Dec.

Common on Mt Arfak (Genofa, *etc.*), dominant on Aifat R. (Arfak) at 1400 m, and near Trist (Morobe Distr.), on Mt Cycloop at Tamrau co-dominant with *Castanopsis acuminatissima* at 1350 m, on slopes of the Stars Mts dominant with *Araucaria*. Once reported on limestone at Chimbu (SIMONETT 69).

Uses. Seems to be a good timber tree, often of large dimension.

Vern. *Essamene*, Fak Fak, Arguni lang., *snokko* Arfak, Anggi Gigi, *gripe*, Hagen, *diedame*, Wissel Lakes, Kapauku lang.

Notes. In KALKMAN 4266 I found in a single cupule 2 aborted ♀ flowers besides the central fertile one.

Related to *N. womersleyi* which has, however, long-peduncled cupules, with a distinct large inner lamella.

See further the note under *N. grandis*.

11. Nothofagus grandis STEEN. Blumea 7 (1952) 147; J. Arn. Arb. 34 (1953) 363, pl. 1, f. 17, 18. — **Fig. 3, 9 c–c⁴.**

Large tree, (12–)25–45 m by (18–)45–150(–250) cm ø (bole 10–25 m), sometimes slightly buttressed. Twigs terete, often pale greyish, lenticellate. *Leaves* elliptic-oblong, often dull greyish above and pale brown beneath, 4½–10 by 2–5 cm; ridge on midrib at least halfway; midrib red; nerves *c.* 7–9 pairs, as the veins somewhat prominent on both sides; petiole 3–10 mm. Stipules 5–7 by 3½–4 mm. — ♂ *Flowers* orange, in 2–9 mm peduncled triads, perianth sessile, tubular, *c.* 6–7 mm. Stamens yellow to red, 10–17; anthers 4–5 mm. — ♀ *Flowers* solitary, surrounded by a cupule as large as the flower already when in anthesis, orbicular, *c.* 9 mm ø. *Cupule* in fruit large, woody, 13–17 by 8–14 mm, provided with (2–)3–4 lamellae, sessile or rarely on a 1–4 mm long stalk. *Nut* rhomboid or mostly orbicular, 7–10 by 9½–10 mm.

Distr. *Malesia*: West New Guinea, rare or uncertain (twice: Kebar, BW 10414, Wissel Lakes, BW 3260), one of the commonest species in East

New Guinea; in all 52 collections of which 22 fertile.

Ecol. Mountain forest, 1350–2600 m. ♂ *Fl.* mostly June-July, *fr.* almost in all months, *flush* May-Aug., Dec.-Jan.

Not seldom very common and forming massive forests *e.g.* in Western Highlands (Wabag), Central Highlands (Goilala, Wahgi Divide), Southern Highlands (Ialibu, dominant at 2000 m; Mt Giluwe, S. slopes, dominant on dissected ash plains, with *Pandanus*, a single time as a shrub, 2 m, SCHODDE 1450), Eastern Highlands (Al R.; Nondugl in almost pure stands at 2100 m), Mt Hagen (common, Aiyura, Wau), Morobe Distr. (Edie Creek; Kaindi, overwhelmingly dominant, 2000–2400 m), Milne Bay Distr. (Mt Dayman, dominant from 1800 m to summit), sometimes associated with *Phyllocladus*.

Uses. Planted at Bomkan village (Upper Chimbu) for ornament around villages, E. Mt Wilhelm, for ? ornament, seedlings brought from Bundi Gap, and Bismarck Ra., *ditto* near native homesteads and in garden lands.

Vern. *Peil*, Mendi, *ufoiya*, Anona, *ifoya*, Aiyura, *unuza*, Kamano, *graip*, *gripe*, Hagen, *jomba*, Chimbu: Masul, *dzopa*, Asaro: Kefamo, *ififi*, Fiyugi: Oriko, *taro*, *t. korn*, *t. porgere*, *t. pulen*, Wabag, Enga lang., *kaarao*, Nondugl, *traf* or *trap*, Telefomin, *iew*, Kebar, Nettoti Mts, *diri*, Wissel Lakes, Kapauku lang., *arape*, *membi*, *peti*, Giluwe: Mendi.

Notes. In 1953 I have added two sterile collections from West Guinea (BRASS & VERSTEEGH 13553 & 13147) which I now believe belong to *N. flaviramea*; the latter has always rather large, ovate-acutish, flattish leaves with the ridge on the midrib running to the apex, and usually yellowish twig bark, not grey and lenticellate as in *N. grandis*. It appears, however, that certain specimens which certainly belong to *N. grandis* may have acutish leaves, although mostly of more elliptic shape; these are usually from pole trees or saplings (*e.g.* ANU 2814, NGF 18291). In *N. grandis* the midrib is sulcate with a prominent ridge, in *N. flaviramea* the ridge is on the flat leaf surface.

Its scarcity in West New Guinea is remarkable.

12. Nothofagus rubra STEEN. Blumea 7 (1952) 147; J. Arn. Arb. 34 (1953) 368, f. 20. — *N. eymae* STEEN. *l.c.* 147; *l.c.* 370, f. 3–15′, 21. — *N. dura* STEEN. *l.c.* 147; *l.c.* 371, f. 22. — *N. bernhardii* STEEN. *l.c.* 147; *l.c.* 361, f. 16 a–c (excl. d–h). — *N. decipiens* STEEN. *l.c.* 147; *l.c.* 367, f. 19.

Tree, 17–45 m, 25–65 cm ø. Perules rather long-persistent. *Leaves* ovate-oblong to elliptic, rounded or even notched at both ends, coriaceous to hard-coriaceous, entire, flattish but often bullate,

Fig. 8. *Nothofagus cf. rubra* STEEN. Poorly developed, small tree (see Papuan in front of it) in semi-devastated terrain with macchia-like heath, on exposed hillock at 1700 m, Wissel Lakes, West New Guinea (RAPPARD, Oct. 1955, to be related to BW 3302).

Fig. 9. *Nothofagus womersleyi* STEEN. *a*. Habit, ×⅔, *a*¹. cupule, with 1 nut, ×2. — *N. perryi* STEEN. *b*. Young ♀ flower, *b*¹. cupule, *b*². nut, all ×2. — *N. grandis* STEEN. *c*. ♂ Mature bud, *c*¹. triad in anthesis, *c*²–*c*⁴. mature cupules, *c*⁵–*c*⁶. mature nuts, all ×2. — *N. resinosa* STEEN. *d*. Habit, with nut, ×⅔, *d*¹. nut (probably mature; without cupule), ×2. — *N. pseudoresinosa* STEEN. *e*–*e*¹. Cupule in lateral and dorsal view, *e*². nut, all ×2 (*a*–*a*¹ BW 10320, *b* ROBBINS 511, *b*¹–*b*² PULLEN 5420, *c*–*c*¹ HOOGLAND & PULLEN 5856, *c*²–*c*³ NGF 20212, *c*⁴–*c*⁵ NGF 6050, *c*⁶ NGF 4823, *d*–*d*¹ SAUNDERS 765, *e* PULLEN 6083, *e*¹–*e*² HOOGLAND & SCHODDE 7204).

2½–9½ by 1½–4½ cm, midrib with a ridge well over halfway, upper surface rather smooth with no prominent tessellation but the *c.* 5–7 pairs of nerves bluntly prominent, undersurface with fine-tessellate but not prominent venation; petiole 2–5 mm. Stipules oblong, early caducous, 4–9 by 2–4 mm. — ♂ *Flowers* in ± sessile triads; perianth *c.* 5–6 mm long, the central flower sometimes pedicelled and shorter. Stamens 10–12. — ♀ *Flowers* solitary, slightly winged. *Cupule* usually sessile but sometimes shortly (up to 7 mm) stalked, at least halfway split; valves rather woody, sometimes unequal, with 2–3 lamellae, rather variable in size, gaping when mature 7–10 by 7–14 mm. *Nut* orbicular to broad-ovate, *c.* 4–6 mm ø.

Distr. *Malesia*: West New Guinea (Nettoti, Arfak, Cycloop, Bernhard, Habbema, Wissel Lakes, Star Mts), East New Guinea (Western Highlands: Minj, Kubor, Wabag; Southern Highlands: Tari, Onim, Giluwe, Kufubu, Mt Né) and d'Entrecasteaux Is. (Normanby). In all 36 collections, of which 14 fertile

Ecol. Mountain forest, sometimes in poor situations a shrub (Enarotali, 4 m, in boggy heathland at 1800 m), in boggy forest (Wabag, Ialibu, Onim), on exposed summits or ridges reduced to a stiff gnarled shrub 2–5 m and sometimes major component (Bernhard at 2150 m; Normanby in stunted open *Dacrydium* forest at 850 m), not rare in mossy forest (Normanby at 950 m; Nettoti Mts, main constituent at 1700 m; Idenburg R. at 2150 m), 1700–2850 m, but on Normanby I. 750–850 m. ♂ *Fl.* mostly June-Aug., but also noted Febr., May, Oct., *fr.* mostly July-Sept., but also Jan.-March, *flush* May-Aug., also Febr.

A common species often abundant (Bernhard, Arfak, Wissel Lakes), dominance noted on Mt Cycloop above the *Castanopsis* zone, on Nettoti Mts in submossy forest, at Habbema at 2840 m, on the Kutubu-Tari track at 1950 m.

Uses. Obviously an excellent timber tree, found planted on the Upper Chimbu from seedlings brought from the Bundi Gap.

Vern. *Diedamé, diri*, Wissel Lakes, Enarotali, Kapauku lang., *snokko*, Arfak, Manikiong lang., *pémmèm*, Arfak, Hattam lang., *taro*, Wabag, Enga lang., *yomba*, Giluwe, Mendi lang.

Notes. VINK found the first leaves on a seedling spirally arranged, but already on the first lateral branchings distichous.

Through the increased collections I felt compelled to combine five specific names, which were based on one or few specimens in different ontogenetic stages. Experience with *N. grandis* learned that a smallish stalk under the cupule is of no taxonomic importance. In *N. rubra* the cupule is usually sessile, in *N. bernhardii* and *N. eymae* short-stalked, and in *N. decipiens* (immature) distinctly stalked, and I have come to the conclusion that in *N. rubra* there is a situation similar to that in *N. grandis*.

In sterile state *N. rubra* is hard to distinguish from *N. brassii*.

13. Nothofagus womersleyi STEEN. *nov. sp.* — **Fig. 9 a–a¹.**

Nothofagi flaviramea affinis, differt: cupulae longe pedunculatae, dimidiis liberis e squama basali unilamellata unica compositis, lamella achenam ovato-oblongam semiaequante. — *Typus*: BW 10320 VERSTEEGH, holotype L, isotypes A, CANB, K, LAE.

Tree, *c.* 20 m, dbh 40 cm ø; young twigs dark-red with elongate yellow dots; twigs terete, those of innovations ± flattened; glabrous. *Leaves* ovate-oblong, rounded at base, pointed and ± acuminate to apex, entire, *c.* 5–9 by 2½–4 cm, rather flat, midrib ± convex, sulcate above with the ridge running rather high up; nerves 7–9 pairs, venation above not or little prominent but rather well so beneath; petiole 5–8 mm. Stipules peltate, ellipsoid, *c.* 5 mm. — ♂ Unknown. — ♀: *Cupule c.* 10–15 mm peduncled, apart from the two basal bracts with only one rather apical lamella, immature rather thin, about half as long as and narrower than the single nut; valves almost free to the base, but sometimes (mostly unilaterally) connate for 3 mm. *Nut* (not fully mature) flat, ovate-oblong, glabrous, distinctly (1 mm) winged towards apex, 7–10 by 5–6½ mm; style 0; stigmas 2.

Distr. *Malesia*: NW. New Guinea (Vogelkop Peninsula: Watjetoni Mts near Kebar Valley), one collection.

Ecol. Primary forest on peaty soil, common, 1200 m. ♀ Nov.

Vern. *Iew*, Kebar lang.

Notes. General shape of leaf resembling that of *N. flaviramea*, which has, however, an obovate nut and a much smaller, sessile cupule consisting only of a tiny elamellate flap.

Cupule and nut are described from the immature stage of the type.

2. CASTANOPSIS

SPACH, Hist. Veg. Phan. 2 (1842) 185; MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 103, 118; BENTH. & HOOK. *f.* Gen. Pl. 3 (1880) 409; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 93; SCHNEIDER, Illust. Handb. Laubh. 1 (1906) 159; REHD. & WILS. in Sargent, Pl. Wils. 3 (1916) 97; A. CAMUS, Chât. (1930) 243; HICKEL & A. CAMUS, Fl. Gén. I. -C. 5 (1930) 1007; SOEPADMO, Reinwardtia 7 (1968) 384. — *Callaeocarpus* MIQ. Pl. Jungh. (1851) 13. — *Chrysolepis* HJELMQVIST, Bot. Notis. Suppl. 2, 1 (1948) 117; FORMAN, Kew Bull. 18 (1966) 425. — **Fig. 12–15.**

Trees of medium to large size. *Innovations* densely yellowish brown to fulvous pubescent or stellate-hairy. Terminal buds ovoid to ellipsoid, scales ovate to linear. Stipules extrapetiolar, deltoid to linear-acute, caducous. *Leaves* spirally arranged, rarely with a tendency to distichy, thin- to thick-coriaceous, concolorous to distinctly discolorous, glabrous or beneath hairy or scaly, margin entire or rarely (in non-Malesian species frequently) serrulate in the apical half. Petiole more or less thickened at the base, terete or flat or shallowly furrowed adaxially. *Inflorescence* erect, male, female, androgynous, or mixed, including bracts and bracteoles densely stellate-pubescent. *Male rachis* slender to rigid, solitary in the axil of a lower leaf or in dense paniculate clusters on the lateral or subterminal new shoots, mostly simple; ♂ flowers solitary or in clusters of 3–7 along the rachis or in an androgynous inflorescence along the upper part of the rachis; perianth campanulate, (5–)6(–7)-lobed; stamens (10–) 12(–15), filaments filiform, glabrous, anthers dorsifixed, reniform, 0.25–0.35 mm long, 2-celled, 4-lobed, lengthwise dehiscent; pistillode rudimentary (usually less developed than in *Lithocarpus*), more or less rounded-triangular, densely woolly pubescent. *Female, androgynous,* or *mixed inflorescence* simple, rigid, solitary in the axil of a higher leaf or on the upper part of the paniculate cluster; ♀ flowers solitary or in clusters of 3–7 along the rachis[1], or in an androgynous inflorescence along the basal part of the rachis, perianth campanulate, (5–)6(–7)-lobed; staminodes 10–12, rudimentary; styles 3–5, conical to terete and slender, connate to recurved, densely hairy at the base, stigmas terminal and punctiform. *Cupule* completely enclosing the 1–7 fruits except for the persistent styles and perianth, at maturity splitting into a regular number of segments (valves) or irregularly, variously spiny or tubercled or with a few undulating ridges, the spines simple or in bundles or stellate, on the 2–4(–8) cupule segments with the sutures in between. *Fruit* more or less rounded with the adjoining sides flat, wall bony to woody; scar small to almost occupying the entire surface, glabrous, dull, rugose; the remaining part free from the cupule, densely yellowish brown to fulvous tomentellous or glabrous. Cotyledons flat-convex. Germination hypogeal.

Distr. In her monograph, A. CAMUS recognized not less than 120 species. The distribution covers NE. India (Nepal, Bhutan, Assam), Burma, China (except in the N. and NW. parts),Korea, Japan, Formosa, Hainan, Indochina, Siam, Malesia, and SW. North America (1 *sp.*). The greatest assemblage and most primitive forms are found in SE. Asia (Indochina and Malesia). In *Malesia* 34 *spp.* (see fig. 11); the genus has been recorded from most islands except in the eastern half of Java and in the Lesser Sunda Islands; the largest number of species is found in Borneo. The only representative of the genus outside Asia, namely *C. chrysophylla* from SW. North America, has been recognized by HJELMQVIST (1948) and FORMAN (1966) as a separate genus, *Chrysolepis*, an opinion which I cannot share. Fig. 10.

Fossil records. Very little is known about the geological history of the genus. In Europe two doubtful records were made, *viz* a wood fragment recovered from the Tertiary Brown Coal deposits in Germany (SCHÖNFELD, Ber. Freiberg. Geol. Gesch. 10, 1925, 18–24), and several pollen grains discovered in the London Clay and Bembridge Floras (CHANDLER, Publ. Brit. Mus. Nat. Hist. 1964, 1–151). In Asia the fossil record of the genus is even more meagre. OGURA (Jap. J. Bot. 14, 1949, 15–18) reported the finding of a wood fragment resembling *Castanopsis* from the Tertiary of Nagano Prefecture, Japan, and MULLER (Proc. 10th Int. Bot. Congr. Edinb. 1964, 271) recorded several pollen grains of *Castanopsis*-type from the Tertiary of North Borneo. In Australia and North America there have been several records (leaf-impression, pollen grains) from various Tertiary deposits. The identity of these records, however, should be considered with great caution, as the genera of *Fagaceae* are not always easily distinguishable by the characters of the wood, pollen grains or leaf alone.

[1] In species with more than 1 ♀ flower per cupule, there is a tendency that the upper cupules on a rachis have less or even only 1 ♀ flower (and of course fruit).

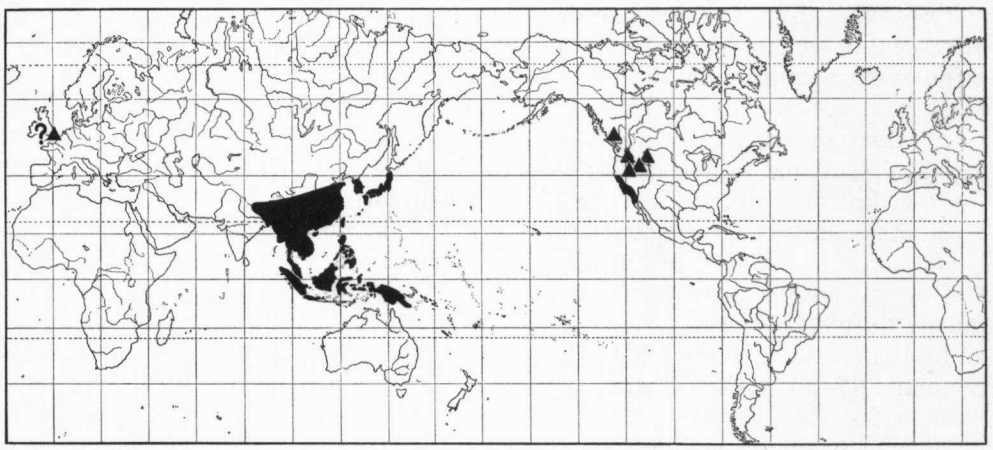

Fig. 10. Distribution of the genus *Castanopsis*, the fossil records indicated by triangles.

Ecol. In Malesia the genus occurs from the everwet lowland to the montane forest, between 0–2500 m, mostly between 1000–1500 m, and on various types of soil, except limestone. On the whole *Castanopsis* shuns a seasonal climate. For this reason it is absent from Central Java, except in a few local everwet rain-forest complexes (Mts Muria, Ungaran, Telomojo), East Java, and the Lesser Sunda Islands. *C. buruana* is largely a rain-forest species, but has been observed to survive locally in a seasonally dry area in SW. Ceram which is subject to fire. Of the 34 *spp.* recognized, only 12, *viz. C. borneensis, catappaefolia, curtisii, fulva, inermis, johorensis, lucida, malaccensis, motleyana, oligoneura, pedunculata,* and *wallichii,* are apparently confined to lowland forest (below 500 m); the rest occurs both in the lowland and the submontane or montane forests. Most species start flowering during the rainy season, the ripe fruit being developed about six months later. In New Guinea, *C. acuminatissima* sometimes forms an almost pure stand, and occurs commonly as a codominant together with *Anisoptera* (*Dipt.*), *Lithocarpus* or *Nothofagus,* between 1000–1500 m.

KEY TO THE SPECIES[1]

(based on fruiting specimens)

1. Cupule enclosing one fruit only.
 2. Greater part of the fruit adnate to the cupule.
  3. Cupule almost smooth or beset with short prismatic tubercles.
   4. Cupule almost smooth; peduncle *c.* 1 cm. Leaves glabrous on both surfaces . . **1. C. curtisii**
   4. Cupule beset with short prismatic tubercles except on the adaxial side, sessile to almost so. Leaves densely adpressed stellate-tomentose beneath . . . . . **2. C. nephelioides**
  3. Cupule covered with various types of spines.
   5. Spines ½–1 cm long, simple, sturdy, flat.
    6. Spines densely but irregularly arranged.
     7. Cupule more or less globose. Petiole ½–1½ cm.
      8. Leaves glabrous or sparsely stellate-tomentose.
       9. Cupule sparsely set with short (*c.* ½ cm) spines. Petioles flat adaxially; reticulation dense, scalariform . . . . . **3. C. rhamnifolia**
       9. Cupule densely set with spines 1 cm long. Petiole adaxially sulcate; reticulation areolate or subscalariform.
        10. Leaves glabrous on both surfaces; midrib and nerves thin on both surfaces; reticulation areolate. . . . . **4. C. borneensis**
        10. Leaves sparsely stellate-tomentose beneath; midrib and nerves strongly prominent beneath, impressed above; reticulation lax, subscalariform. . . . . **5. C. johorensis**

(1) The term 'tomentose' is used for any indument which is continuous interwoven and does not show the parenchyma beneath, *irrespective* of its thickness and the size of the hairs; the latter may be of microscopical dimension and the tomentum very thin.

The size of the cupule is including the spines.

8. Leaves densely reddish brown stellate-tomentose. . . . . **6. C. wallichii**
7. Cupule ovoid-ellipsoid. Petiole 2–3 cm.
11. Leaves elliptic- to ovate-lanceolate, densely pale greyish brown adpressed stellate-tomentose; nerves 5–7 pairs . . . . . **7. C. oligoneura**
11. Leaves elliptic-oblong, glabrous; nerves 7–13 pairs . . . . . **8. C. endertii**
6. Spines arranged in regular arching rows with gaps in between.
12. Leaves beneath densely set with reddish brown, adpressed, stellate and woolly simple hairs.
13. Leaves thick-coriaceous, rigid; nerves 14–16 pairs, dense, reticulation distinct beneath. Petiole 2–3 mm thick . . . . . **9. C. densinervia**
13. Leaves thin-coriaceous; nerves lax, 9–10 pairs; reticulation obscure on both surfaces. Petiole 1 mm thick . . . . . **10. C paucispina**
12. Leaves glabrous or almost so.
14. Cupule 2–2½ by 1½ cm; spines ½–1 cm, simple or in bundles. Leaves with a more or less areolate reticulation . . . . . **11. C. clemensii**
14. Cupule up to 5 by 3 cm; spines rigid, flat, always simple. Leaves with a scalariform reticulation. . . . . **12. C. oviformis**
5. Spines much branched, needle-shaped, 1–2½ cm long.
15. Cupule 4–6 by 3–5 cm.
16. Cupule ovoid-globose. Leaves ovate-elliptic, 3½–10 by 2½–5 cm, underneath densely set with reddish brown, adpressed, stellate hairs; nerves 7–9 pairs. . . . . **13. C. malaccensis**
16. Cupule obovoid-ellipsoid. Leaves ovate-oblong or elliptic-oblong, 10–17 by 3½–6 cm, underneath with a dense cover of sordid silvery grey, adpressed, stellate hairs, or subglabrous; nerves 11–19 pairs.
17. Leaves densely set with sordid silvery grey, adpressed, stellate hairs. Cupule 5–6 by 3–4 cm. Fruit wall thinner than 1 mm . . . . . **14. C. tungurrut**
17. Leaves subglabrous. Cupule 4–4½ by 3–3½ cm. Fruit wall 2–3 mm thick . . . **15. C. evansi**
15. Cupule 7–10 by 5–7 cm.
18. Leaves densely set with yellowish to greyish brown adpressed, stellate hairs and erect, simple or stellate hairs beneath; reticulation scalariform, distinct beneath. Spines set in 6–8 regular, well-spaced curved lines. . . . . **16. C. hypophoenicea**
18. Leaves with a dense cover of reddish brown or greyish brown adpressed stellate scales underneath; reticulation obscure on both surfaces. Spines densely but irregularly set. **17. C. megacarpa**
2. Greater part of the fruit free from the cupule.
19. Cupule ovoid-globose or discoid, symmetrical, 1½–5 by 1½–4 cm. Branchlets densely set with large, warty lenticels . . . . . **18. C. javanica**
19. Cupule asymmetrically ovoid, adaxially flat, 0.7–1½ by 1–2 cm. Branchlets densely or sparsely set with minute lenticels.
20. Cupule sparsely set with simple, sharp spines. Petiole 1–1½ cm, adaxially sulcate. **19. C. buruana**
20. Cupule irregularly tuberculate. Petiole ½–1 cm, adaxially flat . . . . **20. C. acuminatissima**
1. Cupule enclosing more than one fruit, usually three.
21. Cupule densely or sparsely set with various types of spines.
22. Leaves glabrous, reticulation irregular.
23. Spines slender, much-branched, regularly set. . . . . **21. C. foxworthyi**
23. Spines sturdy, simple, densely but irregularly set. . . . . **22. C. schefferiana**
22. Leaves densely set with various types of hairs.
24. Leaves linear-lanceolate, 5–9 by 1–1½ cm. . . . . **23. C. microphylla**
24. Leaves ovate-elliptic or lanceolate-oblong, (7–)10–40 (–50) by (2½–)3–13(–19) cm.
25. Leaves 35–50 by 14–19 cm; nerves 23–27 pairs; petiole 1–1½ cm, ½–¾ cm ø **24. C. catappaefolia**
25. Leaves 10–23 by 5–10 cm; nerves 9–21 pairs; petiole (½–)1–2½(–3) cm, (1–)2–3(–5) mm ø.
26. Leaves densely set with silvery, glaucous, adpressed stellate hairs or scales . . **25. C. argentea**
26. Leaves with a dense cover of yellowish to reddish brown adpressed, stellate and woolly or erect hairs.
27. Petiole *c.* ½ cm. Spines and cupule densely reddish brown tomentose . **26. C. scortechinii**
27. Petiole 1–3 cm. Spines more or less glabrous.
28. Leaves elliptic-oblong, 9–17 by 3–6 cm; densely fulvous stellate and woolly pubescent beneath; petiole adaxially flat; nerves fewer than 15 pairs . . . . . **27. C. fulva**
28. Leaves ovate-elliptic, obovate-oblong, or oblong-lanceolate, 14–23 by 5–10 cm, densely set with yellowish to reddish brown adpressed stellate or simple hairs, or almost glabrous; nerves usually more than 15 pairs.
29. Leaves densely set with reddish brown, adpressed stellate hairs and woolly stellate hairs; reticulation fine, dense obscure on both surfaces. Cupule 2–3 (–4) cm through. **28. C. costata**

29. Leaves densely set with yellowish to greyish brown adpressed stellate hairs and simple or stellate erect hairs; reticulation lax, subscalariform, distinct beneath. Cupule 3–5 by 3–6 cm. **29. C. motleyana**

21. Cupule set with short tubercles to almost smooth.
30. Leaves glabrous.
31. Cupule almost smooth, peduncle 1–1½ cm long. . . . . **30. C. pedunculata**
31. Cupule short-tuberculate; the tubercles sometimes recurved; sessile or on short peduncle. **31. C. psilophylla**
30. Leaves densely set with adpressed stellate hairs beneath.
32. Cupule not transversely ridged. Leaves thin-coriaceous; petiole shorter than 2 cm and thinner than 2 mm. Branchlets sparsely lenticellate.
33. Leaves elliptic-oblong or elliptic-lanceolate, apex rounded or abruptly acute; nerves 10–15 pairs. Cupule and tubercles woody . . . . . **32. C. inermis**
33. Leaves ovate-elliptic to ovate-lanceolate; apex gradually acute to 2 cm acuminate; nerves less than 10 pairs. Cupule thin, tubercles soft, sometimes recurved . . . . . **33. C. philipensis**
32. Cupule with 3–4 distinct, bold, rounded ridges, set with short but sturdy spines. Leaves thick-coriaceous; petiole up to 3½ cm long, 2–3 mm thick. Branchlets densely set with large warty lenticels . . . . . **34. C. lucida**

1. Castanopsis curtisii KING, Ann. R. Bot. Gard. Calc. 2 (1889) 107, t. 103; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 405; RIDL. Fl. Mal. Pen. 3 (1924) 392; A. CAMUS, Chât. (1930) 466, t. 68: 5–6; SOEPADMO, Reinwardtia 7 (1968) 389.

Tree, *c.* 20 m by *c.* 30 cm ø. Innovations densely set with short stellate hairs. Branchlets glabrous, with minute lenticels; terminal bud ellipsoid, 2–3 by 1 mm; scales linear. Stipules linear-acute, 5–7 by 1 mm, soon caducous. *Leaves* chartaceous, lanceolate- or elliptic-oblong, 6–13 by 2–5 cm, entire; surfaces more or less concolorous, glabrous; base rounded and abruptly acute, slightly asymmetrical, apex 5–10 mm acuminate; midrib and nerves prominent beneath, slightly so above; nerves 10–13 pairs, parallel, ascending, at an angle of 60–70° with the midrib, arcuating towards the margin; reticulation fine, dense, scalariform, distinct beneath; petiole 5–10 mm, slender, glabrous, slightly thickened at base, adaxially flat. *Cupule* excentrically pear-shaped, adaxially flat, 2–3 cm ø, gradually tapering towards the 1 cm long peduncle; wall ½–1 mm thick; surface sparsely set with patches of flattish tubercles except on the adaxial side, indehiscent. *Fruit* solitary, pear-shaped or reniform, excentric, *c.* 3 by 2 cm, wall woody, *c.* 1 mm thick, completely adnate to the cupule.

Distr. *Malesia*: Malay Peninsula (Selangor, Penang).

Ecol. In lowland forest up to 300 m. *Fl. fr.* Aug.-Sept.

Notes. Very close to *C. nephelioides* and *C. rhamnifolia*, but differing from both by its glabrous leaf and by its almost smooth, peduncled cupule.

The inflorescence is still unknown.

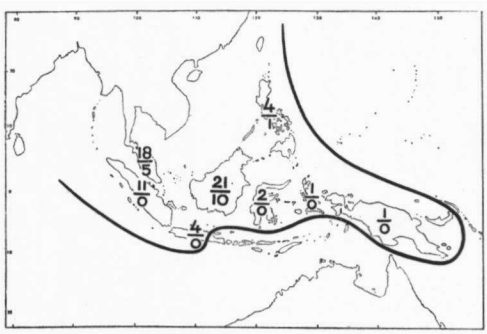

Fig. 11. Species density of *Castanopsis* in Malesia, above the hyphen the number of non-endemic species, below the hyphen the number of endemic species in the island or island group.

2. Castanopsis nephelioides KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 624; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 106, t. 102; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 464; A. CAMUS, Chât. (1930) 467, t. 69: 1–2; SOEPADMO, Reinwardtia 7 (1968) 396.

Tree, 10–20 m by 20–60 cm ø. Innovations densely set with yellowish brown woolly hairs. Branchlets glabrous, densely or sparsely minute-lenticellate; terminal bud ovoid-ellipsoid, 3–4 by 2 mm; scales narrowly ovate-acute. *Leaves* thin-coriaceous, ovate-elliptic or ovate-lanceolate, 8–15 by 3–6 cm; surfaces more or less discolorous, above glabrous, dull greenish grey, underneath with a dense cover of adpressed stellate hairs; base rounded and abruptly acute, margin entire, recurved, apex acute or abruptly 5 mm acuminate; midrib and nerves prominent beneath, flattish or impressed above; nerves 8–14 pairs, parallel, at an angle of 45–70° with the midrib, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure on both surfaces; petiole slender, 5–10 mm, glabrous, adaxially furrowed. *Male rachises* solitary or in paniculate clusters, 10–20 cm; bracts and bracteoles ovate-acute; ♂ flowers in clusters of 3–7; perianth 6-lobed, lobes acute, 1–1½ mm, densely rufous-tomentose outside, stamens mostly 12, filaments 2–3 mm, anthers *c.* ¼ mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis* 10–20 cm; ♀ flowers solitary; perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1–1½ mm long. *Infructescence c.* 10 cm, rachis 2–3 mm ø, densely minute-lenticellate, carrying 1–3 cupules. *Cupule*

sessile, asymmetrically obovoid-globose or pear-shaped, adaxially flat, 2–3½ by 1½–2 cm; wall 3–4 mm thick; surface, except for the adaxial side, densely set with short, woody, pyramidal tubercles. *Fruit* solitary, obovoid or pear-shaped, 1½ by 2½ cm, wall ½–1 mm thick, rugose, completely adnate to the cupule.

Distr. *Malesia*: Malay Peninsula (Kelantan, Kedah, Selangor, Perak, Pahang, Malacca, Johore).

Ecol. Forests, 60–1200 m. *Fl.* Febr.-June, *fr.* July-Dec.

Note. Close to *C. rhamnifolia* but differing by its cupule with shorter but more rigid tubercles, and by its thicker indument on the undersurface of the leaf.

3. Castanopsis rhamnifolia (MIQ.) A.DC. Prod. 16, 2 (1864) 113; HOOK. *f.* Fl. Br. Ind. 5 (1888) 624; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 105, t. 100B; A. CAMUS, Chât. (1930) 469, t. 69: 3–5; SOEPADMO, Reinwardtia 7 (1968) 402. — *Quercus rhamnifolia* MIQ. Fl. Ind. Bat. 1, 1 (1858) 853. — *Callaeocarpus rhamnifolia* (MIQ.) MIQ. Sumatra (1861) 353. — *Castanea rhamnifolia* (MIQ.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 378. — *C. pachycarpa* A. CAMUS, Bull. Mus. Nat. Hist. Paris II, 6 (1934) 92. — **Fig. 15 g–i**

Tree, 10–25 m by 15–40 cm ø; bark surface smooth, grey. Branchlets initially densely set with short stellate hairs, later subglabrous, dark grey, finely fissured or lenticellate; terminal bud ovoid-globose, 2–3 by 1–2 mm, scales ovate or linear-acute. *Leaves* chartaceous, ovate-elliptic, (5–)8–10 (–13) by (2–)3–4(–5) cm, entire; surfaces more or less concolorous, above glabrous, dull or glossy, underneath with sparse stellate hairs, acute or abruptly ½–1 cm acuminate; base rounded and abruptly acute; midrib and nerves thin, prominent on both surfaces, stronger beneath; nerves 8–11 pairs, parallel, ascending, at an angle of 60–70°, arcuating and anastomosing near the margin; reticulation fine, dense, scalariform, obscure on both surfaces; petiole ½–1 cm, 1 mm ø, adaxially flat. *Male rachises* 5–10 cm by 1–2 mm, in dense paniculate clusters; bracts and bracteoles ovate-acute, 1–1½ mm, densely tomentose outside; ♂ flowers in clusters of 3; perianth deeply incised, lobes 6, ovate-acute, 1½–2 by 0.7 mm, densely tomentose outside, stamens 12, filaments 3–4 mm, anthers ¼ mm long, pistillode subglobose, 1.2–1.5 mm ø. *Female* or *androgynous rachises c.* 5 cm by 1–2 mm; bracts and bracteoles ovate-acute, 1–1½ mm; ♀ flowers solitary; perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1–1½ mm long. *Young cupule* ovoid-globose, densely set with short tubercles. *Ripe cupule* sessile, asymmetrically depressed-subglobose, 3½–4 by 2½–3½ cm, indehiscent; spines sparsely set, rigid, flat, with sharp tip, *c.* ½ cm. *Fruit* solitary, of the same shape as the cupule, 3–3½ by 2–3 cm, wall 2–3 mm thick, rugose, completely adnate to the cupule.

Distr. *Malesia*: Sumatra, Malay Peninsula, Banka.

Ecol. In lowland to submontane forests from sea-level up to 1500 m. In Banka sometimes small trees grow in poor sandy soils derived from granite. *Fl.* July-Sept., *fr.* Sept.-June.

Notes. The type of *C. rhamnifolia* (HORSFIELD HB 4268) from Banka, has very young cupules; it is matched by TEIJSMANN HB 4432, in fruit, from Lampong in S. Sumatra. Leaves 7–12 cm long, ± concolorous, scales and hairs very sparse, cupule at least 2¾ cm through, subsessile with tapering base, densely tomentellous, spines 3–4 mm long, 2–5 mm apart. There is a great resemblance with later collected (non-fruiting) materials from Banka.

KURZ 2202 from Burma, which has been referred to this species, belongs to *C. armata* SPACH.

4. Castanopsis borneensis KING, Ann. R. Bot. Gard. Calc. 2 (1889) 99, t. 90; A. CAMUS, Chât. (1930) 297, t. 29: 1–3; SOEPADMO, Reinwardtia 7 (1968) 387.

Tree, 10–33 m by 15–50 cm ø, sometimes with stout buttresses; bark smooth, pale ochre-brown, shallowly flaky. Branchlets glabrous, slender, bark finely fissured, greyish; terminal bud ovoid, 2–3 by 2 mm, scales linear-acute, 2–3 by ½ mm. Stipules linear-acute, 2–3½ by ½ mm. *Leaves* chartaceous, 5–13 by 2–4 cm (index 2.3–3.6), widest at the middle to slightly below; base rounded and abruptly acute, top ± abruptly acuminate (tip ½–2 cm); surfaces glabrous, ± discolorous, above greenish and glossy, beneath green-brownish and less glossy; midrib slightly prominent on both surfaces, stronger beneath; nerves 5–8 pairs, thin, flattish on both surfaces, at an angle of 70–80°, subparallel, arcuating and anastomosing near the margin; reticulation irregular, sometimes obscure; petiole 0.8–1½ cm, blackish towards the base, adaxially sulcate. *Male rachis* 10–15 cm by 1–2 mm; bracts broadly ovate-rounded, membranous, 0.7 by 1 mm, bracteoles lanceolate-rounded, membranous, 0.7–1 by 0.3–0.4 mm; ♂ flowers in clusters of 3; perianth deeply incised, lobes 6, membranous, elliptic-acute, 1–1½ by 0.7 mm, hairy outside, stamens 6–8, filaments 2½–3 mm, anthers 0.2–0.25 mm long, pistillode 1–1½ mm ø. *Female rachis* 10 cm by 1–2 mm; bracts and bracteoles ovate-acute, 0.7 by 1–1½ mm; ♀ flowers solitary; perianth deeply incised, lobes 6, membranous, ovate-acute, 0.7–1 by 0.4–0.6 mm, densely hairy outside, staminodes 12, rudimentary, styles 3, conical, 1–1½ mm. *Ripe cupule* sessile, subglobose, 2½–3 by 2–2½ cm; wall 1 mm thick, sparsely hairy, mostly very densely set (except the narrow adaxial sector and abaxial suture) with slender to rather sturdy spines 6–12 mm long, in bundles, not branched, straight to slightly recurved, subglabrous; indehiscent. *Fruit* solitary, ovoid to compressed-reniform, 1½–2 by 1–1½ cm, adaxially flat, wall 1–2 mm thick, woody, completely adnate to the cupule, rugose and glabrous; cotyledons flat-convex.

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

Ecol. Heath or kerangas forest, also in disturbed primary forest, on black soil and deep yellow sands,

in hilly country below 250 m. *Fl.* March-July, *fr.* June-Dec.

Notes. Records of this species for SE. China, Hainan, and Formosa could not be confirmed.

Near *C. johorensis* and *C. wallichii*; see the key.

5. Castanopsis johorensis SOEPADMO, Reinwardtia 7 (1968) 393.

Tree, *c.* 10 m by 10–20 cm ø; bark smooth, grey-brown. Branchlets initially fulvous-hairy, soon glabrescent, slender, greyish black, with sparse minute lenticels; terminal bud ovoid-ellipsoid, 3–4 by 2 mm, scales ovate or elliptic, acute, 2–3 by 1 mm. Stipules linear-acute, 3–4 by 0.7–1 mm. *Leaves* 7–15 by 2–5 cm (index 2.5–3.1), widest about the middle; base attenuate, top gradually to abruptly acuminate with a tip of 1–2 cm; surfaces both glabrous and then concolorous, rather glossy, to underneath sparsely set with adpressed stellate scales (magnification 40!) and then pale dull brownish; midrib and nerves strongly prominent beneath, sunken above, nerves 7–11 pairs at an angle of 60–80°, ascending, subparallel, arcuating and anastomosing near the margin; petiole 1–2 cm, dark-coloured towards the base, adaxially sulcate. *Female rachis c.* 5½ cm, 1½ mm ø; bracts broadly ovate-acute, 1 by 1 mm; ♀ flowers solitary, perianth deeply incised, lobes 6, ovate-acute, densely hairy on both sides, staminodes 12, rather well developed and ± exceeding the perianth, styles 3, cylindrical, recurved, 1–1½ mm long. *Cupule* sessile, compressed-globose, 2–3 cm through; wall subglabrous, very densely spiny, less densely in the adaxial sector, the spines in bundles, 8–10 mm, unbranched, slender, ± straight, subglabrous. *Fruit* solitary, ellipsoid-complanate, 1½–2 by 1–1½ cm, wall woody, 1–2 mm thick, completely adnate to the cupule, rugose, glabrous; cotyledons flat-convex.

Distr. *Malesia*: Central Sumatra (east of Pajakumbuh), Malay Peninsula (Johore).

Ecol. Lowland forest, up to 500 m. *Fl.* Aug. (Sumatra), *fr.* July (Malay Peninsula).

Note. Male inflorescences are still unknown.

6. Castanopsis wallichii KING *ex* HOOK *f.* Fl. Br. Ind. 5 (1888) 624; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 106, t. 101A; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 464; A. CAMUS, Chât. (1930) 470; CORNER, Ways. Trees (1940) 293; SOEPADMO, Reinwardtia 7 (1968) 403.

Tree, 12–15 m by 45–60 cm ø. Branchlets initially densely brownish tomentose, late glabrescent, slender, bark greyish, finely fissured, with minute lenticels; terminal bud obovoid-globose, 2-3 by 1½–2 mm, scales ovate-linear, acute, 2–3 by 1 mm. Stipules triangular, 3–4 by 1½ mm. *Leaves* thin-coriaceous or chartaceous, 3½–9 by 1–3½ cm (index 2.2–3.5), widest at the middle to sometimes below; base ± rounded and acute, top acute to ½–1½ cm acuminate; surfaces discolorous, above greenish, more or less glossy, glabrous, beneath brownish, dull, not scaly but densely covered with short stellate hairs, their branches sometimes partly adpressed; midrib and nerves ± prominent beneath, midrib sunken above; nerves 6–8 pairs at an angle of 45–60°, ascending, parallel, arcuating and anastomosing towards the margin; reticulation scalariform, fine, rather obscure beneath; petiole ½–1 cm, adaxially sulcate. *Male rachis* 5–10 cm, 1–2 mm ø; ♂ flowers in clusters of 3, perianth deeply incised, lobes 6, ovate-acute, ½–1 mm long, stamens 12, filaments 2½–3 mm, anthers ¼ mm long, pistillode *c.* 1 mm ø. *Female rachis c.* 4 cm, 1 mm ø, bracts and bracteoles ovate-acute, 0.7–1 mm; ♀ flowers solitary, perianth lobes 6, rounded, 0.4–0.5 mm long, densely hairy, staminodes 12, rudimentary, styles 3, conical, recurved, 0.7–1 mm. *Cupule* subsessile, subglobose to obovoid with flattish adaxial side, 3–4 by 2½–3½ cm; wall 1–3 mm thick, outside with dark brown pubescence, spines rather densely set except in the adaxial sector, solitary and unbranched, sturdy, ± straight, 5–6 mm, densely fulvous puberulous with glabrous tip. *Fruit* solitary, similarly shaped as the cupule, 1½–3 by 1–2 cm, wall 1–2 mm thick, almost completely adnate to the cupule, glabrous, rugose.

Distr. *Malesia*: Malay Peninsula (Penang, Kedah, Perak, Malacca, Singapore), few collections.

Ecol. Primary forest at 300–400 m. *Fl.* Dec. – May, *fr.* June–Oct.

7. Castanopsis oligoneura SOEPADMO, Reinwardtia 7 (1968) 397.

Tree, 10–25 m by 20–25 cm ø; bark smooth, lenticellate, or scaly, greenish brown. Branchlets initially with some reddish brown tomentum, glabrescent, slender, sparsely lenticellate; terminal bud ovoid-globose, 2–3 by 2 mm, scales ovate-linear, acute. (Stipules not seen.) *Leaves* stiff-coriaceous, 7–15 by 3–6 cm (index 2.4–3.4), widest at the middle; base attenuate, acute, top (sub)acuminate; surfaces discolorous, above more or less glossy greenish, glabrous, beneath dull pale brownish, more or less densely covered with adpressed stellate scales (magnification 30–60!) and virtually no hairs; midrib and nerves prominent beneath, thinly prominent or flat above; nerves 5–7 pairs at an angle of 45–60°, ascending, subparallel, arcuating near the margin; reticulation fine, scalariform, obscure above; petiole 1½–3 cm, slender, adaxially flat, base thick. *Male rachis* 5–10 cm, 1½–2 mm ø, subglabrous, bracts ovate-acute, 1–1½ by 0.7 mm, thick-coriaceous, subglabrous, bracteoles ovate-rounded, 0.7 by 0.4 mm, membranous, with dense tomentum outside; ♂ flowers solitary or more commonly in clusters of 3–7, perianth deeply incised, lobes 4–6, ovate-acute, 1 by 1 mm, densely tomentose, stamens 8–12, filaments 3–3½ mm, anthers 0.2–0.25 mm long, pistillode 1 mm ø. *Female rachis* (sometimes *androgynous*) 5–8 cm; ♀ flowers solitary, perianth ½–1 mm incised, lobes 6, ovate-acute, densely hairy outside, staminodes 12, strongly reduced, styles 3, cylindrical-conical, recurved, 1–2 mm; ovary rounded-triangular. *Cupule* subsessile, ellipsoid-globose, 2½–3 by 2–2½ cm, adaxially slightly flattened; wall *c.* 2 mm thick, with some fulvous

puberulence but largely glabrous, except for the adaxial sector rather laxly but evenly covered with sturdy spines 6–10 mm, mostly solitary but sometimes in bundles, somewhat recurved, sparsely puberulous; dehiscence into 3 (?) parts or irregular. *Fruit* solitary, ellipsoid-globose, 2–2½ by 2 cm, wall 1 mm thick, hard, almost completely adnate to the cupule; when ripe rugose and glabrous; cotyledons flat-convex.

Distr. *Malesia*: Borneo (Sabah), various collections.

Ecol. Lowland forest to 300 m. *Fl.* April-May, *fr.* June-Sept.

8. Castanopsis endertii HATUS. *ex* SOEPADMO, Reinwardtia 7 (1968) 390.

Tree, 15–20 m by 25–60 cm ø. Branchlets initially with a dense stellate tomentum, soon glabrescent, inconspicuously lenticellate; terminal bud ovoid-ellipsoid, 3–7 by 2–3 mm, scales ovate-acute or linear-acute. Stipules linear, acute, *c.* 5 by 1 mm, soon caducous. *Leaves* thick-coriaceous, elliptic-oblong, (8–)10–15(–19) by (3½–)5–6(–7) cm, entire; surfaces concolorous, glabrous; base rounded, apex abruptly acute or ½–1 cm acuminate; midrib and nerves strongly prominent beneath, slightly so or flattish above; nerves 7–13 pairs, subparallel, ascending, at an angle of 60–70°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, distinct on both surfaces; petiole 2–3 cm, 1–2 mm ø, glabrous, adaxially flat. *Male rachis* 10–12 cm, 1–2 mm ø, solitary or in paniculate clusters; bracts and bracteoles ovate-acute; ♂ flowers in clusters of 3; perianth deeply incised, lobes 6, acute, 1–1½ mm, densely stellate tomentose outside, stamens 12, filaments 2–2½ mm, anthers *c.* ¼ mm long, pistillode subglobose, *c.* 2 mm ø. *Young infructescence*: rachis 15–20 cm, 2–3 mm ø, carrying 1–2 cupules. *Young cupule* ovoid-ellipsoid, sessile, 1½–2 cm through, adaxially flat and smooth; spines densely but irregularly set, ½–1 cm, glabrous, flat, tips sharp. *Fruit* solitary.

Distr. *Malesia*: Borneo (two collections from W. Kutei in Kalimantan).

Ecol. Forests up to 450 m. *Fl.* Sept., *fr.* Nov.

Note. The female flowering rachis is not yet collected.

9. Castanopsis densinervia SOEPADMO, Reinwardtia 7 (1968) 389.

Tree, 12–36 m by 35–50 cm ø. Branchlets initially with dense reddish brown adpressed stellate tomentum and woolly stellate hairs, glabrescent, sturdy with short internodes, greyish black, with sparse but large lenticels; terminal bud ovate, angular, acute, red-brownish, 3–10 by 3–4 mm, scales ovate, rounded to acute, 3–9 by 2–3 mm. Stipules (not known) leaving distinct scars. *Leaves* thick-coriaceous, 6–17 by 3–8 cm (index 1.9–3), widest mostly below the middle to rarely above; base rounded to subcordate to sometimes acute, occasionally asymmetrical, top rounded and subacuminate to ± abruptly ½–1 cm acuminate, tip sharp or blunt; surfaces discolorous, above greenish, glabrous, glossy, underneath brownish, dull, with a dense cover of more or less adpressed, stellate scales (waxy when older), often interspersed with shorter or longer stellate hairs, on the nerves only the latter; midrib broad and strong, dark coloured like the petiole; nerves 12–18 pairs at an angle of 45–60°, distinct underneath, parallel, ascending, arcuating and disappearing towards the margin; reticulation fine, obscure, scalariform, rather dense; petiole ½–1½ cm, to 3 mm ø, adaxially deeply sulcate. *Male rachis* 3–7 cm, 3–4 mm ø, bracts broadly ovate-acute, thick-coriaceous, 1–1½ mm, bracteoles lanceolate-acute, membranous, ¼ by 0.7 mm; ♂ flowers in clusters of 3, perianth deeply incised, lobes 6, ovate-acute, 1½–2 mm deep, densely hairy, stamens 12, filaments 2½–3 mm, anthers 0.2–0.25 mm long, pistillode 2–3 mm ø. *Female rachis* 2–3 cm, 3–4 mm ø, bracts broadly ovate-acute, thick-coriaceous, 1½ by 1½ mm; ♀ flowers solitary, perianth lobes 6, rounded or acute, 1 mm deep, densely hairy, staminodes 12, well-developed, exceeding the perianth, styles 3, conical, recurved, 2–2½ mm long. *Young infructescence*: rachis 5–10 cm, 4–5 mm ø; carrying 5–10 young ovoid-ellipsoid, subsessile cupules, adaxially flat and scaly, laterally with short reddish brown spines. *Cupule* (almost ripe) on stalk a few mm long and thick, excentrically compressed, obovoid, *c.* 3 by 4 cm, black in colour; wall 1–2 mm thick, glossy, glabrous, spiny except in the adaxial sector, spines in bundles arranged in 3–4 curving bands, unbranched, rather slender, ± straight or sometimes reflexed, 8–10 mm, glabrous. *Fruit* solitary, reniform or ovoid, base rounded, top acute, 2–2½ cm; wall woody, 2–3 mm thick, adnate to the cupule except the top, rugose, glabrous; cotyledons flat-convex.

Distr. *Malesia*: Borneo (Sabah: Mt Kinabalu; Mt Lamaku in the Crocker Range; NE. Kalimantan: Mt Kemul in W. Kutei).

Ecol. Primary forest, 1000–1800 m. *Fl. fr.* Sept. –April.

10. Castanopsis paucispina SOEPADMO, Reinwardtia 7 (1968) 398.

Tree, 12–30 m by 20–60 cm ø; bark dark-grey, smooth or cracked. Branchlets initially with dense, brownish, short-stellate tomentum; glabrescent, slender, densely lenticellate; terminal bud ovoid-globose, 2–3 mm by 2–3 mm, scales ovate-acute. Stipules ovate-acute, 2 by 1 mm. *Leaves* 8–14 by 3–5½ cm (index 2.4–3.2), widest below the middle to sometimes about the middle; base rounded acute, top attenuate and acute to 1 cm acuminate; surfaces discolorous, above more or less glossy, greenish, glabrous, beneath dull cinnamon-brown, with thick cover of adpressed, stellate scales (magnification 20!) and on the veins some (often acroscopically bent) hairs often branched near their base; midrib and nerves prominent beneath, flattish above; nerves 9–10 pairs at an angle of 45–60°, ascending, subparallel, arcuating towards the margin; reticulation fine, dense, scalariform, sometimes obscure above; petiole slender, 1–1½ cm, adaxially shallowly furrowed. *Male rachis* 5–10

cm, 1–1½ mm ø; bracts and bracteoles ovate-acute; ♂ flowers in clusters of 3, perianth deeply incised, lobes 6, rounded-acute, 1 by ½–1 mm, with dense tomentum outside, stamens 12, filaments 2½–3 mm, anthers ¼ mm long, pistillode *c.* 1 mm ø. *Female rachis* 5–10 cm, in the axil of an ovate-acute bract on the upper part of a new shoot; ♀ flowers solitary, perianth deeply incised, lobes 6, rounded-acute, 1 by 1 mm, with dense tomentum outside, staminodes 12, rudimentary, ovary 3-locular, styles 3, conical, 1–1½ mm. *Ripe cupule* chocolate-brownish, subsessile, obovoid-globose but adaxially flattened, 4–4½ by 3–3½ cm, base attenuating into the short peduncle; wall 2–4 mm thick, with some sparse fulvous puberulence and very sparsely set with 3–4 curved rows of mostly solitary spines, sturdy, often somewhat flat and recurved, 5–7 mm long, subglabrous, the adaxial sector not spiny. *Fruit* solitary, obovoid-globose, *c.* 4 by 3 cm, wall woody, 5–7 mm thick, completely adnate to the cupule, when ripe rugose and glabrous.

Distr. *Malesia*: Borneo (Central Sarawak: Anap; Sabah: Keningau Distr.).

Ecol. Mixed Dipterocarp forest on basalt derived soil, 700–1100 m. *Fl.* Aug. – Oct., *fr.* Sept.

11. Castanopsis clemensii SOEPADMO, Reinwardtia 7 (1968) 388.

Tree, 10–30 m by 15–30 cm ø; buttresses up to 1 m tall; bark smooth, lenticellate, greyish brown. Branchlets initially with dense, yellowish brown stellate tomentum; glabrescent; internodes sometimes short, slender, dark purplish brown-grey, with minute lenticels; terminal bud ovoid-globose or ellipsoid, 3–5 by 2–3 cm, scales ovate, elliptic, acute, 3–4 by 2 mm. Stipules ovate, triangular, blunt, 5–10 by 3–5 mm, rather long persistent. *Leaves* thin-coriaceous, 6–12 by 2–6 cm (index 1.8–2.6), widest mostly below to rarely above the middle; base rounded to subcordate, usually asymmetrical, top rounded and subacuminate to 1 cm acuminate with blunt to acute tip; surfaces green-brownish, above glabrous, rather glossy, beneath dull, nerves rather densely set with bunch-like stellate hairs, the branches of the latter straight to somewhat curly, scales non; midrib and nerves weakly prominent on both surfaces; nerves 8–10 pairs at an angle of 50-60°, subparallel, ascending, arcuating and disappearing near the margin; reticulation fine, distinct on both surfaces, more or less irregular; petiole ½–1 cm, terete or adaxially flat. *Female rachis* 3–7 cm, 1 mm ø, bracts and bracteoles ovate-acute, 0.6–1 by 1–1½ mm; ♀ flowers solitary, perianth deeply incised, lobes 6, ovate-acute, 0.6 mm long, densely hairy on both sides, staminodes 12, rudimentary, styles 3, conical, 1.2–1.5 mm, recurved. *Cupule* (not yet ripe) *c.* 5 mm stalked, obovoid-ellipsoid, 2–2½ by 1½ cm, tapering towards the base, dark-coloured; wall *c.* 1 mm thick, sparsely fulvous-puberulent, spiny except the adaxial sector and abaxial sutures; spines laxly set in bundles arranged in more or less parallel curving lines, 5–8 mm long, sparsely branched near the base or simple, rather slender, mostly straight, sometimes reflexed, subglabrous. Unripe *fruit* solitary, ellipsoid, 1½ by 1 cm, wall 1 mm thick, completely adnate to the cupule, rugose and glabrous; cotyledons flat-convex.

Distr. *Malesia*: Borneo (Sabah: Mts Kinabalu and Trusmadi).

Ecol. Primary forest, 750–1800 m, on black rocky soil. *Fl.* Sept., *fr.* Nov. – May.

Notes. Close to *C. oviformis*; see the note under that species.

The male inflorescence and the mature cupule are not yet known.

12. Castanopsis oviformis SOEPADMO, Reinwardtia 7 (1968) 397.

Tree, 15–30 m by 20–45 cm ø; buttresses small, sometimes branched; bark smooth or shallowly fissured, greyish brown, lenticellate. Branchlets initially with brownish, adpressed stellate indumentum, late glabrescent; rather slender, grey-brownish or dark-purplish, sparsely set with minute lenticels; terminal bud ovoid-globose, 2–3 by 2 mm, scales ovate, linear, acute. Stipules ovate-acute, 3–5 by 2–3 mm. *Leaves* sometimes tending to distichy, more or less thinly coriaceous, 6–15 by 4–6½ cm (index 2.2–3), widest somewhat below to somewhat above the middle; base ± rounded and acute, top mostly rounded and abruptly acuminate with a tip of ½–1 cm; surfaces green-brownish, above very glossy, glabrous, beneath sometimes dull, very sparsely to very densely set with adpressed stellate scales (magnification 30–60!), sometimes with a few stellate hairs on the nerves; midrib prominent beneath, flattish or slightly elevated above; nerves 8–13 pairs at an angle of 60–80°, ascending, parallel, arcuating towards the margin; reticulation dense, fine, scalariform, distinct underneath; petiole 1–1½ cm, adaxially flat. *Male rachis* 5–15 cm, 1–2 mm ø, bracts ovate-acute, 1–1½ by 1 mm; ♂ flowers in clusters of 3–7, perianth deeply incised, lobes 6, 1–1½ mm long, acute, with dense tomentum outside, stamens usually 12, filaments 1–1½ mm, anthers ¼ mm long. *Female rachis* 5–10 cm, androgynous inflorescence with ♂ flowers in its apical part; bracts 1½–2 by 1–1½ mm, with dense tomentum; ♀ flowers solitary, perianth deeply incised, lobes 6, ovate-acute, 1 by 1 mm, with dense tomentum outside, staminodes 12, rudimentary, styles 3, cylindrical-conical, 2 mm. *Cupule* ¾–1 cm stalked, ellipsoid to obovoid, with tapering base, 2½–5 by 1½–3 cm, wall ½–1 mm thick, sparsely puberulous, spines arranged in arching lines on both sides of the cupule except on the adaxial sector, solitary or in bundles, sparsely set and 2–3 mm long to rather densely set and 8–10 mm long, unbranched, sturdy, straight to somewhat recurved, densely fulvous-puberulous; dehiscence irregular or in two equal halves. *Fruit* solitary, 2–3½ by 1½–2 cm, obovoid-cylindrical, wall ½–1 mm thick, completely adnate to the cupule, rugose, glabrous; cotyledons flat-convex.

Distr. *Malesia*: Borneo (scattered all over the island).

Ecol. Primary forest, sometimes kerangas forest, at low altitude (also montane? see note), on sandy loamy soil. *Fl.* June-Aug., *fr.* Sept.-July.

Notes. In ENDERT 3610 from Mt Kemul in Central East Borneo at 1200 m, the leaves are elliptic, to 11 by 6¼ cm, underneath densely set with both scales and stellate hairs. In S 20139 from Ulu Baram in NE. Sarawak at 1080 m the leaves are elliptic, to 9½ by 6 cm, with some scales and few hairs underneath. These two specimens, both in flower, are suggestive of *C. clemensii*, which is known from somewhat higher elevations. Most material of *C. clemensii* is not in fruit, the only cupules available being from the type, SAN 25315, from Sg. Mentaki in the Ranau District at 750 m. Here the leaves have underneath a few stellate, somewhat curled hairs and, unlike the rest of the *clemensii* material, have virtually no scales. The cupule, however, differs distinctly from that of *C. oviformis* in the smaller size, blackish colour, subglabrous surface, and branched spines.

The leaves in KORTHALS *s.n.* from Martapura, are up to 14½ by 5 cm and underneath thickly covered with scales and also have hairs on the nerves; those of S 18532 seem to be intermediate between these and the rest of the material.

13. Castanopsis malaccensis GAMBLE, Kew Bull. (1914) 178; J. As. Soc. Beng. 75, ii (1915) 445; A. CAMUS, Chât. (1930) 319, t. 32: 11–13; CORNER, Ways. Trees (1940) 293; SOEPADMO, Reinwardtia 7 (1968) 395.

Tree, *c.* 15 m by *c.* 30 cm ø; bark yellowish brown, fissured. Branchlets greyish black, with minute lenticels, initially densely set with fulvous stellate tomentum; terminal bud ovoid, 2–3 by 1–2 mm; scales ovate-acute, with dense stellate tomentum. *Leaves* thin-coriaceous, 3½–10 by 2½–5 cm (index 1.8–2), widest below or at the middle; surfaces strongly discolorous, above glabrous, glossy, greyish green, underneath with a dense cover of rufous, adpressed, stellate hairs; base rounded and abruptly acute, apex acute or abruptly ½ cm acuminate; midrib and nerves prominent beneath, impressed above; nerves 7–9 pairs, parallel, ascending, at an angle of 50–70°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure on both surfaces; petiole 1–3 cm, 1 mm ø, adaxially flat. *Male rachises* 4–7 cm, 1–2 mm ø, in paniculate clusters, densely rufous stellate-tomentose; bracts and bracteoles ovate-acute; ♂ flowers in clusters of 3, perianth deeply incised, lobes 6, ovate, 1–1½ mm, densely stellate-tomentose outside, stamens 12, filaments 3–4 mm, anthers 0.2–0.3 mm long, pistillode subglobose, 1½–2 mm ø. *Cupule* ovoid-globose, 3½–4½ cm; wall 1–2 mm thick; peduncle ½–1 cm; spines much-branched, needle-shaped, 1–2 cm, densely set; dehiscence into two equal halves or irregular. *Fruit* solitary, ovoid-conical, adaxially flat, 1½–2½ cm; wall ½–1 mm thick, glabrous, rugose, adnate to the cupule except for the top which is set with a thin cover of silvery tomentum; cotyledons flat-convex.

Distr. Peninsular Siam, *Malesia*: Sumatra (Riouw: Kuantan Distr.), Malay Peninsula (Negri Sembilan, Selangor, Malacca, Johore, Singapore).

Ecol. Forest up to 300 m. *Fl. fr.* Jan.-May.

Note. The female rachis and flowers are not yet known.

14. Castanopsis tungurrut (BL.) A.DC. J. Bot. 1 (1863) 182; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 97, t. 87; A. CAMUS, Chât. (1930) 358, t. 44: 6–10; BACKER & BAKH. *f.* Fl. Java 2 (1965) 4; SOEPADMO, Reinwardtia 7 (1968) 403. — *Castanea tungurrut* BL. Bijdr. (1826) 525; Fl. Jav. Cupul. (1829) 42, t. 22; K. & V. Bijdr. 10 (1904) 7; KOORD. Atlas 1 (1913) t. 39. — *Castanea tungurrut f. sumatrana* MIQ. Sumatra (1861) 353. — *C. ridleyi* GAMBLE, Kew Bull. (1914) 180, *p.p. lectotypi* GOODENOUGH 1479. — *C. conspersispina* MERR. Pap. Mich. Ac. Sc. 19 (1934) 152, t. 17.

Tree, 20–25 m by 60 cm ø; bark rough, fissured. Branchlets initially with fulvous tomentum, later glabrescent, rather sturdy, dull greyish black, smooth, sparsely lenticellate; terminal bud ovoid-ellipsoid, 3–5 by 2–3 mm, scales ovate, elliptic, acute, 3–4 by 2 mm. Stipules boat-shaped, ovate-triangular, 4–6 by 2–3 mm. *Leaves* (8–)12–15(–23) by (3½–)5–6(–9) cm (index 2–3), widest about the middle to slightly below; base rounded-acute, sometimes asymmetrical, top tapering and subacuminate; more or less discolorous, above rather glossy, green-brownish, glabrous, beneath dull with a faint greyish tinge, densely covered with a waxy mass in which stellate scales are very closely adpressed (magnification 60!), and also with some longer hairs (the latter in Sumatra almost wanting); midrib prominent on both surfaces, stronger beneath; nerves 11–19 pairs at an angle of 60–70°, parallel, arcuating and disappearing near the margin, prominent beneath, flattish above; reticulation fine, dense, scalariform, sometimes obscure above; petiole (½–)1–1½(–2) cm, adaxially flat or shallowly sulcate. *Inflorescences* male, female, or androgynous. *Male rachis* 10–25 cm by 1–2 mm; bracts and bracteoles ovate-acute, 2–3 by 1–1½ mm, hairy outside; ♂ flowers in clusters of 3, perianth deeply incised, lobes 5–6, acute, 2–2½ by 1–1½ mm, hairy on both sides, stamens 10–12, filaments 3–4 mm, anthers 0.2–0.25 mm long, pistillode 1½ mm ø. *Female* or *androgynous rachis* 5–15 cm, bracts thick-coriaceous, ovate-acute, 2–2½ mm, densely hairy outside; ♀ flowers solitary, perianth lobes 5–6, acute, 0.7–1 mm, densely hairy, staminodes 12, rudimentary, styles 3, conical, recurved, 2–2½ mm. *Young cupule* sessile, ovoid, on the rounded lateral sides with spine-like tubercles, on the flat median sides scaly. *Ripe cupule* subsessile, obovoid-ellipsoid, 5–6 by 3–4 cm; wall 1–2 mm thick, covered partly with fulvous puberulence, and mostly all over with scattered bundles of slender spines branched in the basal half and easily reflexed 10–23 mm long, sparsely puberulous; dehiscence none or irregular. *Fruit* solitary, ovoid-ellipsoid, 3–4 by 1½–2 cm, wall 1 mm thick, completely adnate to the cupule, when ripe rugose and glabrous; cotyledons flat-convex.

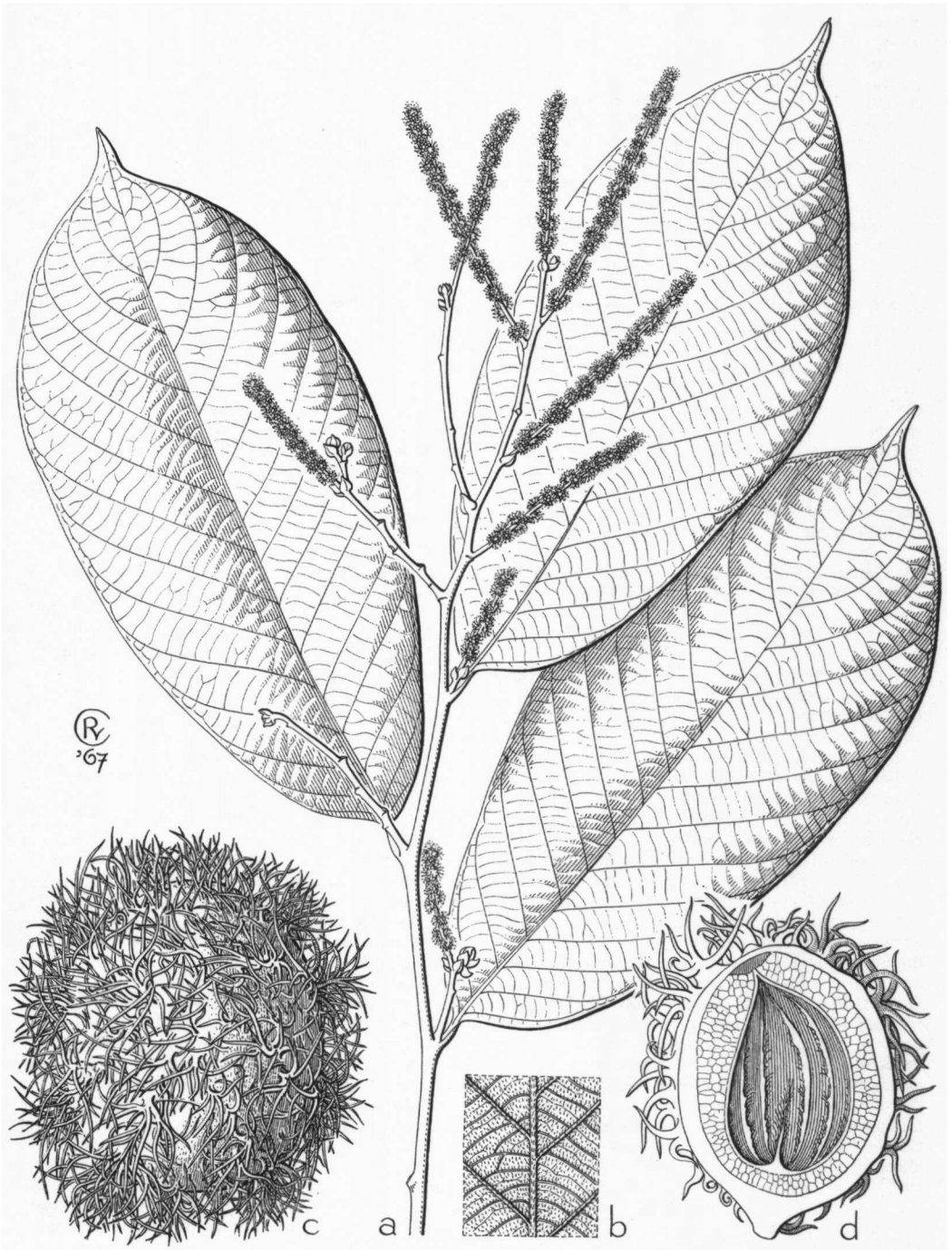

Fig. 12. *Castanopsis hypophoenicea* (SEEMEN) SOEPADMO. *a.* Habit, ×⅔, *b.* underside of leaf, nat. size, *c.* ripe cupule, ×⅔, *d.* longitudinal section of cupule and fruit, ×⅔ (*a–c* SAN 47196, *d* SAN 40316).

Distr. *Malesia*: Sumatra (scattered from Tapanuli in the north to Lampong in the south), Malay Peninsula, also in Simalur and Banka Is. and West Java (rather common).

Ecol. Forests, from swampy lowlands up to 1500 m. *Fl. fr.* ± throughout the year.

Vern. *Kalimorot*, *tungeureut*, S, with variants.

Notes. In the type of *C. conspersispina*, the cupule is but sparsely spiny.

In the past many specimens belonging to this species have been erroneously identified.

15. Castanopsis evansii ELMER, Leafl. Philip. Bot. 5 (1913) 1778; SOEPADMO, Reinwardtia 7 (1968) 391. — *C. javanica* (*non* A.DC.) MERR. En. Philip. 2 (1923) 24. — *C. woodii* MERR. Philip. J. Sc. 29 (1926) 362. — *C. elmeri* MERR. Pl. Elm. Born. (1929) 42; A. CAMUS, Chât. (1930) 442, t. 76: 6–8.

Tree, 5–24 m by 15–50 cm ø; bark grey, smooth. Branchlets initially with some tomentum, soon glabrescent, slender, smooth or finely fissured, rather glossy dark purplish brown, sparsely lenticellate; terminal bud ovoid-globose 3–5 by 3 mm, scales ovate-acute, 3 by 2 mm. Stipules triangular, 5–6 by 2 mm, rarely persistent. *Leaves* 10–17 by 3½–5½ cm (index 2.3–3.4), widest about the middle; base tapering to rarely rounded and abruptly acute, apex bluntly acute to ½–1 cm acuminate with sharp tip; surfaces green to brownish, above more or less glossy, glabrous, beneath duller and mostly greyish with wax in which adpressed stellate scales are mostly discernible (magnification 60!) with very sparse longer hairs mostly only on the nerves; midrib strongly prominent beneath, slightly so above; nerves 11–14 pairs at an angle of 60–70°, parallel, ascending, arcuating towards the margin, slightly prominent beneath, flattish above; reticulation fine, dense, scalariform; petiole 1–2½ cm, adaxially flat. *Male rachis* 10–15 cm, 1–2 mm ø, bracts ovate-acute, 1½ by 1 mm, bracteoles 1 by 0.7 mm; ♂ flowers in clusters of 3; perianth lobes 4–6, connate at the base only, 1–1½ by 0.7–1 mm, ovate-acute, densely hairy, stamens 10–12, filaments 1½–2½ mm, anthers 0.2–0.25 mm, pistillode 1½ mm ø. *Female rachis* 5–10 cm, bracts ovate-acute, 1 by 1 mm; ♀ flowers solitary, perianth deeply 6-lobed, the lobes 1 by 0.7 mm, densely hairy; staminodes 12, rudimentary, styles 3, recurved, conical, 1–2 mm long. *Young infructescence c.* 10 cm long, carrying numerous solitary cupules. *Young cupule* ovoid, bearing short, simple spines on the rounded lateral sides, and scales on the median sides. *Ripe cupule* ½ cm stalked, obovoid-ellipsoid, 4–4½ by 3–3½ cm; wall 2–4 mm thick, inside brown tomentose, outside with some brownish puberulence, otherwise glabrous, spines sparsely to densely set sparsely puberulous, sturdy and blackish to slender and rather soft and brownish, in bundles, often branched in the basal part with the branches reflexed, 10–23 mm long in all; dehiscence none or irregular. *Fruit* solitary, ovoid, adaxially flat or depressed, 3–3½ by 2–3 cm, wall 2–3 mm thick, woody, adnate to the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Palawan), Borneo (Sabah: rather common; SE. Kalimantan: region of Balikpapan, Riko; also Banguey I.).

Ecol. Lowland forests to 500 m altitude, on brown soil and clayey loam. *Fl.* Jan.-May, *fr.* May-Dec.

16. Castanopsis hypophoenicea (VON SEEMEN) SOEPADMO, Reinwardtia 7 (1968) 392. — *Quercus hypophoenicea* VON SEEMEN, Bot. Jahrb. 23, Beibl. 57 (1897) 52. — *Lithocarpus hypophoenicea* (VON SEEMEN) BARNETT, Trans. & Proc. Bot. Soc. Edinb. 34 (1944) 171; A. CAMUS, Chênes 3 (1954) 890. — *C. dispersispina* MERR. Univ. Calif. Publ. Bot. 15 (1929) 41; A. CAMUS, Chât. (1930) 442. — **Fig. 12.**

Tree, 12–30 m by 10–60 cm ø; buttresses up to 1.8 m tall, 1 m out; bark surface grey-brown, smooth or finely fissured. Branchlets initially densely set with yellowish brown stellate and simple tomentum, later subglabrous, smooth or finely fissured, or sparsely lenticellate; terminal bud ovoid, 3–5 mm, scales ovate. Stipules ovate-acute, 3–5 mm. *Leaves* thin-coriaceous, elliptic-oblong, (6–)10–15(–19) by (2½–)4–5(–7) cm, entire, discolorous, above glabrous except the midrib and veins, dull or glossy, greyish green or chocolate brown, underneath with a dense cover of yellowish brown, adpressed stellate hairs and simple long hairs; base rounded and abruptly acute or cuneate, sometimes asymmetrical, apex bluntly acute or 1–1½ cm acuminate; midrib and nerves prominent beneath, flattish or impressed above; nerves (9–)11–13(–15) pairs, parallel, ascending, at an angle of 60–70°, arcuating but not anastomosing near the margin; reticulation dense, fine, subscalariform, distinct beneath; petiole 5–15 by 2 mm, densely stellate-tomentose, glabrescent, thickened and rugose at base, adaxially flat or shallowly furrowed. *Male rachises* 5–10 cm, in lax paniculate clusters; bracts and bracteoles ovate-lanceolate, 0.7–1 by 0.7 mm; ♂ flowers in clusters of 3; perianth deeply incised, lobes 6, ovate, 1½–2 by 1–1½ mm, stamens 10–12, filaments 3–4 mm, anthers 0.25–0.30 mm long, pistillode subglobose, 1½–2 mm ø. *Ripe cupule* ovoid-ellipsoid, sessile, 7–10 by 5–7 cm; wall woody, 2–3 mm thick; spines much-branched, needle-shaped, 1–2 cm long, regularly set in more or less 6–8 curving lines with space in between the rows; dehiscence apparently irregular. *Fruit* solitary, ovoid-ellipsoid, 4–6 by 3–5 cm, wall woody, rugose, 3–7 mm thick, completely adnate to the cupule; adaxially flat.

Distr. *Malesia*: Borneo (Sarawak, Kalimantan, Sabah).

Ecol. Forests up to 650 m. *Fl.* Sept.-May, *fr.* June-Dec.

Note. The female rachis and flowers are not yet known.

17. Castanopsis megacarpa GAMBLE, Kew Bull. (1914) 180; J. As. Soc. Beng. 75, ii (1915) 462; A. CAMUS, Chât. (1930) 440, *t.* 61: 1–3; CORNER, Ways. Trees (1940) 293, f. 94; SOEPADMO, Reinwardtia 7 (1968) 395.

Tree, 12–36 m by 30–90 cm ø; buttresses up to 2 m tall; bark surface smooth or shallowly fissured,

pale greyish brown. Branchlets initially densely set with reddish brown adpressed stellate tomentum, later greyish brown, sparsely lenticellate; terminal bud ovoid-globose, 3–5 by 3–4 mm, scales ovate-acute. *Leaves* thick-coriaceous, lanceolate-oblong or elliptic-oblong, 10–25 by 3–10 cm; surfaces strongly discolorous, above glabrous, glossy, greyish green, underneath with a thick cover of reddish brown adpressed stellate hairs; base rounded or acute, sometimes asymmetrical, margin entire recurved, apex rounded or abruptly acute; midrib and nerves prominent beneath, flattish above; nerves 8–16 pairs, parallel, ascending, at an angle of 60–70°, arcuating but not anastomosing near the margin; reticulation fine, subscalariform, obscure on both surfaces; petiole subglabrous, thickened and rugose at the base, adaxially flat or shallowly furrowed, 1½–2½ cm by 2–3 mm. *Male rachises* 10–20 cm, in paniculate clusters; bracts ovate-acute; ♂ flowers in clusters of 3, perianth deeply incised, lobes 6, acute, 1–2 mm, stamens 12, filaments 3½–4 mm, anthers 0.20–0.25 mm long, pistillode rounded, *c.* 1 mm ø. *Female rachis* 10–15 cm; ♀ flowers solitary, ovary rounded triangular in cross-section, 3-locular, perianth 6-lobed, staminodes 12, rudimentary, styles 3, terete, *c.* 1 mm, recurved. *Ripe cupule* ovoid-globose, subsessile, 8–10 by 6–7 cm; wall woody, 2–4 mm thick; spines much-branched, 1–1½ cm long, with sharp tip, rigid, densely but irregularly set; dehiscence into two equal halves or irregular. *Fruit* solitary, ovoid, 6–8 by 3–5 cm, wall woody, 3–4 mm thick, rugose, adnate to the cupule; cotyledons flat-convex.

Distr. *Malesia*: Malay Peninsula (also Singapore), Borneo.

Ecol. Forests, up to 1350 m. *Fl.* March-Aug., *fr.* Sept.-June.

Note. The syntype of *C. ridleyi* GAMBLE, KING'S Coll. 6831, I refer to *C. megacarpa*.

18. Castanopsis javanica (BL.) A.DC. J. Bot. 1 (1863) 182; Prod. 16, 2 (1864) 111, *incl. var. montana* (BL.) A.DC.; HOOK. *f.* Fl. Br. Ind. 5 (1888) 620; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 97, t. 88; GAMBLE, Kew Bull. (1914) 180; A. CAMUS, Chât. (1930) 316, t. 32: 7–10; BACKER & BAKH. *f.* Fl. Java 2 (1965) 4; SOEPADMO, Reinwardtia 7 (1968) 393. — *Fagus javanica* BL. Flora 7 (1824) 295. — *Castanea javanica* BL. Bijdr. (1826) 525, *incl.* unnamed variety *l.c.* 526; Fl. Jav. Cupul. (1829) 44, t. 23, *incl. var. montana l.c.* 45, t. 24, and *var. fuscescens l.c.* 45; K. & V. Bijdr. 10 (1904) 9; KOORD. Atlas 1 (1913) t. 38. — *Castanea montana* BL. Bijdr. (1826) 526; HASSK. Cat. Hort. Bogor. Alt. (1844) 73. — *Quercus discocarpa* HANCE, J. Bot. 12 (1874) 242; HOOK. *f.* Fl. Br. Ind. 5 (1888) 616; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 76, t. 70; CORNER, Ways. Trees (1940) 302, f. 97. — *C. discocarpa* (HANCE) HANCE, J. Bot. 16 (1878) 201; A. CAMUS, Chât. (1930) 356, t. 43: 4–9. — *Quercus javanica* DRAKE in Morot, J. de Bot. 4 (1890) 153. — *Pasania discocarpa* (HANCE) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 447. — *Synaedrys discocarpa* (HANCE) KOIDZ. Bot. Mag. Tokyo 30 (1916) 186. — *C. lentiginosa* E. F. WARB. Kew Bull. (1936) 20. — *C. penangensis* A. CAMUS, Bull. Soc. Bot. Fr. 94 (1947) 4.

Tree, 10–40 m, trunk sometimes fluted, 20–100 cm ø. Branchlets initially rather densely set with reddish brown, adpressed, stellate hairs and fimbriate scales, mixed with patent hirsute bundle-hairs, later glabrescent; rather slender with dark grey, sometimes brownish bark full of distinct lenticels, especially when older; terminal bud ovoid-globose, 3–9 by 2–4 mm, scales roundish, 3–5 by 2–3 mm. Stipules 3–4 by 1½ mm, recurved, hairy, very soon caducous. *Leaves* thick-coriaceous, (6–)10–13(–18) by (2–)3–6(–8) cm (index 1.9–3.6), widest about the middle to slightly lower or higher; base attenuate-acute to rarely rounded-acute, apex bluntly acute to ½–2 cm acuminate; surfaces with a livid tinge, discolorous, above greenish and more or less glossy, glabrous, beneath light brown and more or less dull, sometimes with a distinct cover of wax with scales hardly discernible (magnification 60!), often also with scattered hairs simple or in 2–3-fid bundles, sometimes glabrous; midrib prominent beneath, flat or impressed above; nerves (8–)9–11(–13) pairs, thin, ascending, at an angle of 45–70°, subparallel, arcuating towards the margin; reticulation scalariform, thin and obscure on both surfaces; petiole ½–1 cm, adaxially flat. *Male rachis* 10–15 cm, slender, bracts ovate-acute, 1–1.2 mm; ♂ flowers solitary or in clusters of 3, perianth lobes 6, connate at the base only, 1.2–1.5 by 1 mm, densely hairy on both sides; stamens 12, filaments 3–4 mm, anthers 0.2–0.25 mm long, pistillode 1.2–1.5 mm ø. *Female rachis* 5–10 cm, slender, bracts ovate, sometimes irregularly lobed, 1–1½ by 2–2½ mm; ♀ flowers laxly scattered, solitary, perianth 6-lobed, the lobes ovate, 0.8–1 by 0.3–0.5 mm, staminodes 12, rudimentary, styles 3, conical-cylindrical, recurved, 2–3 mm. *Young cupule* 3–5 mm stalked, densely covered with irregularly placed spines or with sparse spines in 4–5 ± concentric rows. *Mature cupule* on peduncle 4–5 mm ø, globose or discoid-conical, 2½–5 by 1.3–4 cm, base rounded or concave; wall 1½ mm thick, inside silky with fulvous hairs, outside densely fulvous-velvety, spines 2–21 mm long, tree-like branched (sometimes twice) or sometimes in bundles, straight to very slightly recurved, or round the base the whole spine bundles reflexed, densely hairy to subglabrous, arranged with few sturdy ones in 4–5 ± concentrical rows with much of the cupule practically smooth, to densely covering the whole cupule surface with many slender ones; dehiscence into 4 equal segments or irregularly. *Fruit* solitary and hence round on section, depressed-conical, 1–1½ by 2–2½ cm; apex acute to rounded or depressed, umbonate; wall 2 mm thick, scar ¼–⅓ part, flat or convex, the free part hairy.

Distr. *Malesia*: Sumatra (from the north to the Palembang area; also Banka), Malay Peninsula (Perak, Selangor, several collections; also Penang), West Java (common), and Borneo (not seen from western Kalimantan).

Ecol. Primary, sometimes secondary forests, up to 1650 (–2000) m. *Fl.* Sept.-March, *fr.* March-Dec.

DOCTERS VAN LEEUWEN (Zoocecidia, 1926, 105) described a stem-gall caused by a psyllid, and (in Ned. Kruidk. Arch. 51, 1941, 134) a stem-gall caused by a *Lepidopteron*, both from Java.

Vern. *Kalimorot, ki hijur*, S.

Uses. Although a tree of poor shape, one of the most durable timbers in the Kelabit Highlands, central Sarawak, and widely used for house posts. Bark used for making kegs for storing rice.

Notes. Young growth scurfy brown or reddish.

In all islands there is a continuous variation in the texture and pubescence of the leaf, and also in the density and arrangement of the spines. Specimens below 500 m usually have thinner and less pubescent leaves and fewer and more regularly spaced spines, resembling *C. discocarpa* from Banka. Those from 500-1000 m match in all respects *C. lentiginosa* from Sarawak, whilst specimens from higher altitudes agree with *C. javanica*. In Java, the influence of altitude on variation is particularly distinct. Plants from Depok (at 100 m), Janlappa (at 90 m), and Bogor (at 250 m), have thinner and less pubescent leaves and less spiny cupules than the many collections from 1000 m and above. In Sumatra, Malay Peninsula, and Borneo, the same pattern of variation occurs and no distinctions appear to hold good in the considerable range of diversity.

The species is quite different from *C. echidnocarpa* from India and from our *C. acuminatissima* with which HANCE compared it; rather it is related to *C. ferox* from India, with which E. F. WARBURG compared his *C. lentiginosa*, but it differs in its lenticellate branchlets, fewer nerves, shorter spines, and a tomentose fruit. The cupule, whatever its outward resemblance with that of *C. costata*, contains 3 fruits in the latter. The leaves of *C. javanica* are, on the average, smaller than in *C. costata*, with thinner veins and more obscure reticulation. Its brachlets, anyway the older ones, are strikingly rich in lenticels, and the scales of the terminal bud are broader.

A malformed specimen labelled "in sylvis montis Dieng 5–6000′ Hb. Waitz" (L) belongs here; BLUME identified this *in sched.* as *Quercus angustata*. Since all other collections are from West Java, a mistake in the labelling is assumed.

19. Castanopsis buruana MIQ. Ann. Mus. Bot. Lugd. – Bat. 1 (1863) 120; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 107, t. 101B; A. CAMUS, Chât. (1930) 475, t. 72: 13–14; SOEPADMO, Reinwardtia 7 (1968) 387. — *C. buruana f. grandifolia* MIQ. Ann. Mus. Bot. Lugd. – Bat. 1 (1863) 120. — *Castanea buruana* (MIQ.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 377.

Tree, up to 20 m by 10–30 cm ø; bark shallowly fissured or scaly, greyish brown. Branchlets initially densely set with brownish erect stellate hairs, later subglabrous, greyish black, terete, densely minute-lenticellate; terminal bud ovoid-globose or compressed ovoid, 3–4 by 1½–3 mm, scale ovate-acute. Phyllotaxis with a tendency to distichy. *Leaves* thin-coriaceous, elliptic-lanceolate, rarely ovate-elliptic, (7–)10–15(–24) by (2½–)4–5(–8) cm, discolorous, above glabrous, glossy, underneath with a dense cover of chocolate-brown fimbriate scales and erect stellate hairs; base rounded and abruptly acute or cuneate, margin entire, recurved, apex acute or more commonly ½–1½ cm, acuminate, with a sharp tip; midrib and nerves thinly prominent beneath, flattish or impressed above; nerves 8–15 pairs, subparallel, ascending at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform, obscure on both surfaces; petiole 1–1½ cm by 1 mm, thickened and rugose at base, adaxially shallowly furrowed. *Male rachises* solitary or more commonly in paniculate clusters, 10–15 cm; bracts ovate acute, membranous, 1–1½ mm; ♂ flowers in clusters of 3; perianth deeply incised, lobes 6, membranous, *c.* 1 mm, stamens mostly 12, filaments 2½–3½ mm, anthers 0.2–0.25 mm long, pistillode subglobose, 1.2–1.5 mm ø. *Female rachis* 10–15 cm; ♀ flowers solitary, perianth membranous, 6-lobed, staminodes 12, well developed and exceeding the perianth, styles 3, cylindrical, recurved, 2–2½ mm. *Infructescence* 10–25 cm, rachis terete, densely minute-lenticellate, carrying 10–20 cupules. *Cupule* sessile, asymmetrically compressed ovoid-conical, 1–2 cm through, wall thin, completely enclosing the fruit except for the rather long persistent perianth and styles; spines sparsely set in 4–5 curving rows, sharp, 3–5 mm; dehiscence irregular. *Fruit* ovoid-conical, more or less rounded-triangular in cross-section, 1–1½ cm; free part occupying the greater surface, densely yellowish brown simple-tomentose, base rounded, scar flat or convex, rugose, glabrous.

Distr. *Malesia*: Borneo (Sabah, once), Celebes (fairly common), Moluccas (Sula, Buru, Batjan, Morotai, Obi, Ceram).

Ecol. In primary or secondary forest on low hills, up to 1000 m. In SW. Ceram it survives in secondary forest under the influence of constant burning (during the long dry period). *Fl.* Aug.-Jan., *fr.* Jan.-July.

Note. Near to *C. acuminatissima*, but different by its somewhat larger leaf with entire margin, sulcate petiole, and by its cupule set with spines arranged in 4–5 curving rows.

20. Castanopsis acuminatissima (BL.) A.DC. J. Bot. 1 (1863) 182; A. CAMUS, Chât. (1930) 433; HICKEL & A. CAMUS, Fl. Gén. I.–C. 5 (1930) 1012; SOEPADMO, Reinwardtia 7 (1968) 385. — *Castanea acuminatissima* BL. Mus. Bot. 1 (1850) 283. — *Castanea sessilifolia* BL. *l.c.* 284. — *Quercus lineata* (*non* BL.) MIQ. Pl. Jungh. (1851) 10. — *Quercus varingaefolia* MIQ. *l.c.* 12. — *Quercus junghuhnii* MIQ. Fl. Ind. Bat. 1, 1 (1856) 853; OUDEM. Versl. Med. Kon. Ak. Wet. Natuurk. 12 (1861) 205; MIQ. Ann. Mus. Bot. Lugd.–Bat. 1 (1863) 117 ("*iunghuhnii*"); OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 16, t. 9; WENZIG, Jahrb. Bot.

Fig. 13. *Castanopsis acuminatissima* (BL.) A.DC. Tree surrounded by a skirt of root suckers. G. Telaga, above Puntjak Pass, Mt Gedeh, W. Java, *c.* 1500 m alt. (VAN STEENIS, May 1939).

Gart. Berl. 4 (1886) 237; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 72, t. 73; CRAIB, Kew Bull. (1911) 471; LANE-POOLE, For. Res. New Guinea (1925) 78. — *Quercus fagiformis* JUNGH. Bonplandia 6 (1858) 83, see REHD. J. Arn. Arb. 1 (1919) 122, note; K. & V. Bijdr. 10 (1904) 54. — *Quercus acuminatissima* (BL.) A. DC. Prod. 16, 2 (1864) 102, *non* MERR. 1908; BACKER & BAKH. *f.* Fl. Java 2 (1965) 6. — *Pasania acuminatissima* OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 84; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 448. — *C. schlenkerae* BAILEY, Queensl. Agr. J. 22 (1909) 149; A. CAMUS, Chât. (1929) 436, t. 60: 18–20. — *Synaedrys fagiformis* KOIDZ. Bot. Mag. Tokyo 30 (1916) 187. — *C. junghuhnii* (MIQ.) MARKGR. Bot. Jahrb. 59 (1924) 62, f. 1: A–D. — *C. nebularum* HICKEL & A. CAMUS, Bull. Mus. Hist. Nat. Paris 32 (1926) 398. — *C. longispicata* HU, Bull. Fan Mem. Inst. Biol. Peiping, Bot. 10 (1940) 86. — *C. bejaudii* A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 13 (1942) 479. — **Fig. 13.**

Tree, 10–36 m by 30–90 cm ø; buttresses to 2 m tall, 1½ m out; bark greyish brown, rough, fissured, inner bark 1–2 cm thick, pale to reddish brown. *Branchlets* initially with a dense layer of rufous fimbriate scales and adpressed stellate hairs; slender, later glabrescent, with minute lenticels, greyish black, finely fissured, at the base with scars of the bud scales; terminal bud ovoid or flat-ellipsoid, mostly found when having attained a size of 4–8 by 2–3 mm, apparently waiting for some time before developing further, the scales imbricate or mostly distichous, membranous, ovate-acute, 1–1½ by 1–1.2 mm, densely hirsutely ciliate, persistent for some time. Stipules ovate-acute, 3–4 by 1 mm, caducous. *Leaves* thin-coriaceous, 4½–17 by 2½–6 cm (index 2.4–3.5 (–4)), widest at or below the middle; base rounded or attenuate, acute to sometimes decurrent, margin entire and undulate or remotely serrate in the apical half, top tapering and acuminate with sharp tip 1–2½ cm; surfaces discolorous, above glossy green, glabrous, underneath dull brown to sometimes silvery with a mostly thick cover of adpressed scales, no hairs; midrib and nerves prominent beneath, flattish or slightly sunken above; nerves 10–14 pairs at an angle of 45–60°, subparallel, ascending, arcuating and disappearing towards the margin, reticulation fine, scalariform or irregular, obscure on both surfaces; petiole ½–1 cm, adaxially flat. *Inflorescences* male, female, or androgynous. *Male rachis* 5–10 cm, slender with sparse simple hairs, bracts ovate-acute, membranous, 1–2 by 1–1½ mm, ciliate, bracteoles reduced to a cluster of simple hirsute hairs; ♂ flowers densely arranged but solitary, perianth lobes 6, almost free, ovate-rounded, 1–2 by 1½ mm, membranous, ciliate, stamens 12–14, filaments slender, 2–3½ mm, anthers 0.3–0.45 mm long, pistillode rudimentary, 1–1½ mm ø. *Female* and *androgynous rachis* 5–10 cm, slender, with sparse simple hairs, bracts ovate-acute, 1½–2 by 1–1.2 mm, membranous, densely ciliate, bracteoles 1 by 0.7 mm; androgynous rachis with a few ♂ flowers in the apical part; ♀ flowers solitary, perianth membranous, deeply incised, lobes 6, 1–1.2 by 0.7 mm, densely hairy, staminodes 12, styles 3, recurved, cylindrical, 1–1½ mm, sparsely tomentose at the base. *Young infructescence* 10–15 cm, carrying 10–20 young cupules more or less ovoid-globose, sessile, enclosing the fruit except for the persistent perianth and styles, surface covered all over with scale-like appendages. *Ripe cupule* 1–1½ by 0.7–1.2 cm, (sub)sessile, more or less globose with the fruit partly emerging; wall ½–1 mm thick, inside sparsely hairy, outside densely grey-fulvous puberulous, rather densely set with acroscopical firm scales or small flat-triangular spines, irregular or in 5–7 ± regular transversal rows, to 2 mm long with a sharp glabrous tip or obtuse; dehiscence irregular or medianly into 2 equal segments. *Fruit* solitary, ovoid-conical, pointed, 1–1½ by ¾–1 cm, longitudinally ribbed (also in the fresh state?), scar flat or rounded, ± ¼ part, the remainder free, with dense rufous tomentum, glabrescent.

Distr. India (E. Bengal), Burma (Upper Burma, Tenasserim), China (Kweichow, Yunnan), also Taiwan, Siam (NE. and SE. part), Indo-China (Tonkin, Laos, Annam); in *Malesia*: N. Sumatra (Atjeh, one collection), Malay Peninsula (Kedah, Salangor, Pahang), Java (mountains between Gede and Wilis), N. Borneo (Mt Kinabalu), Celebes (scattered in the mountains), New Guinea (very common), also Japen, Misima, Fergusson, and Goodenough Is., and New Britain.

Ecol. In primary or relict forest, often on loamy sandy soil, 300–2500 m. In New Guinea it may form pure stands on ridges up to 1500 m, or grow together with *Lithocarpus*, *Intsia*, *Anisoptera*, or *Nothofagus* as co-dominants. Fertile almost throughout the year.

Vern. *Riung anak*, S, derived from its peculiar capacity to produce a circle of suckers (youngsters) round the base of the stem.

The record in the Kew Index of '*C. junghuhnii* in HAYATA, Ic. Pl. Formos. VI Suppl. (1917) 72' is enigmatic; the name is not in the General Index to that work, and the supplements are of 1925 and later.

Notes. Close to *C. tribuloides*, *C. echidnocarpa* and *C. ferox* from India and Burma, *C. brevispina* and *C. chinensis* from Formosa and China, and *C. cuspidata* from Japan; it differs mainly in the cupule which is covered with short tubercles and not with spines, and to some extent also in the pubescence on the lower surface of the leaves. From its nearest ally in Malesia, *C. buruana*, it may be distinguished by its smaller leaves with incised margin in the apical half, and by its smaller cupule with shorter tubercles.

In several specimens the trunk was recorded to produce many coppices round the base.

21. Castanopsis foxworthyi SCHOTTKY, Bot. Jahrb. 49 (1913) 358; SOEPADMO, Reinwardtia 7 (1968) 391. — *C. kinabaluensis* A. CAMUS, Bull. Soc. Bot. Fr. 75 (1928) 698; Chât. (1930) 357, t. 44: 1–5. — **Fig. 14 h–i.**

Tree, (5–)15–36 m by 10–50 cm ø, occasionally

fluted or with stout buttresses; bark greyish brown, smooth or finely fissured, (always?) flaky. Branchlets initially densely set with fulvous, small, stellate hairs and larger bundle-hairs, or glabrous from the beginning; terminal bud ovoid, 3–4 by 2–3 mm, scales ovate-acute or linear. Stipules 6–8 by 1–2 mm. *Leaves* thick-coriaceous, 8–22½ by 4–8 cm (index 2.1–3.6), widest about the middle, sometimes above, or below; base attenuate or rounded-acute, apex somewhat rounded and acutish to rather abruptly acuminate with a sharp tip ½–2 cm; surfaces glabrous, ± discolorous, above glossy and olive-greenish, beneath duller and brownish; midrib strongly prominent beneath, slightly so above; nerves 9–14 pairs at an angle of 60–80°, subparallel, ascending, arcuating and disappearing towards the margin, thin and subprominent on both surfaces, reticulation fine, scalariform to irregular, obscure on both surfaces; petiole ¾–2½ cm, adaxially flat or shallowly furrowed. *Male rachis* 10–15 cm, 1 mm ø; bracts and bracteoles ovate-acute; ♂ flowers in clusters of 3, perianth lobes ovate-rounded, 1 mm long, with dense tomentum outside; stamens 12, filaments 2½–3 mm, anthers 0.25 mm long, pistillode 1–1½ mm ø. *Female rachis* 10–25 cm by 2–3 mm, bracts ovate-acute; ♀ flowers in clusters of 3, perianth lobes ovate-acute, 1 mm long, with dense tomentum outside, staminodes 12, sometimes considerably developed and producing good pollen grains; ovary rounded-triangular, styles 3, conical, 1–1½ mm. *Young cupule* ½–1 cm stalked, ovoid-globose, the segments between the 4 sutures covered with spines. *Ripe cupules* on slender peduncle, obovoid-globose, more or less distinctly 2–4-lobed, 3–3½ by 2–3 cm, wall 1–2 mm thick, outside velvety and more or less densely set with rather sturdy spines 8–13 mm long, simple or in bundles or tree-like branched and arranged in 4–5 concentric bands, fulvous puberulous with glabrous top; inside densely fulvous-tomentose. *Fruit* 3 per cupule, more or less ovoid-conical, 1½–2 by 1–1½ cm, the scar covering 1/5–¼ part, convex; wall 1 mm thick, the free part densely fulvous-tomentose; cotyledons flat-convex.

Distr. *Malesia*: Malay Peninsula (Trengganu); Borneo (Sarawak and Sabah; also Nunukan I.).

Ecol. Primary or secondary peat-swamp and kerangas forests, also montane forests, up to *c.* 2400 m. *Fl.* July–April, *fr.* May-Febr.

Note. In the kerangas forest the twigs are rather straight and slender, in the mountains ("*C. kinabaluensis*") they are rather sturdy with shorter internodes, sometimes richer in lenticels, and with brown leaves in the dried state; in both habitats the leaves are smaller, thicker coriaceous, and with fewer nerves than under more favourable lowland conditions.

22. Castanopsis schefferiana HANCE, J. Bot. 16 (1878) 200; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 105, t. 99; A. CAMUS, Chât. (1930) 456, t. 66: 4–6; SOEPADMO, Reinwardtia 7 (1968) 402. — *C. andersonii* GAMBLE, Kew Bull. (1914) 179; J. As. Soc. Beng. 75, ii (1915) 458 ('*andersoni*'); A. CAMUS, Chât. (1930) 342. *t.* 39: 1–4.

Tree, 10–24 m by 30–60 cm ø; buttresses up to 1.2 m tall, 5 cm thick; bark smooth, grey. Branchlets initially tomentellous or glabrous; slender to rather sturdy, sparsely lenticellate; terminal bud ovoid-globose or ellipsoid, 3–5 by 2–3 mm, scales ovate-acute. Stipules linear, 3–7 mm long, very early caducous. *Leaves* thick-coriaceous, (6–)8–12(–18) by (1–)3–5(–7) cm (index 2.2–3), widest about the middle to rarely below; base attenuate to rounded, and acute, apex acute to ½—1 cm acuminate; glabrous, mostly concolorous, glossy above, dull beneath; midrib strongly prominent beneath, slightly so above; nerves 10–15 pairs, ± prominent beneath, flattish above, at an angle of 45–70°, parallel, ascending, arcuating towards the margin; reticulation fine, dense, more or less regularly scalariform, obscure on both surfaces; petiole 1–2½ cm, adaxially flat to deeply sulcate. *Male rachis* 10–17 cm, 1–2 mm ø; bracts and bracteoles ovate-acute, 1 by 1 mm; ♂ flowers in clusters of 3–7, perianth lobes membranous, 0.8–1 by 0.5–0.7 mm, densely hairy outside; stamens 12, filaments 2 mm long, anthers 0.2 mm long, pistillode 1–1½ mm ø. *Female* or *androgynous rachis* 10–15 cm, 2–3 mm ø, bracts and bracteoles ovate-acute, 1 by 1 mm; ♀ flowers in clusters of 3, perianth lobes 0.7–1 by 0.5–0.7 mm, membranous, densely hairy; staminodes 12, rudimentary, styles 3, cylindrical-conical, 1–1½ mm. *Young infructescence*: rachis 20–25 cm, 3 mm ø. *Young cupule* obovoid-globose, the segments between the 4 sutures covered with spines. *Ripe cupules* scattered along the rachis, (sub)sessile, obovoid-globose, sometimes distinctly 4-lobed, 3½–4 cm through; wall 1½ mm thick, inside with long, ferruginous, silky hairs, outside more or less densely hoary-puberulous or felty, rather densely set with sturdy somewhat recurved spines 4–15 mm long, solitary or in bundles, hairy with glabrous top; dehiscence into 4 segments or irregular. *Fruits* 2–3 per cupule, ovoid-conical, 1–1½ cm through, scar occupying ¼–⅓ part, flat-convex; free part of the wall with brownish silky tomentum.

Distr. *Malesia*: NE. Sumatra (Langkat at 4° N), also Riouw and Lingga Arch., Malay Peninsula (scattered; also Singapore).

Ecol. Forests, to 1000 m. *Fl.* Nov.-Dec. *fr.* April-Dec.

Note. The species was included in *C. javanica* by J. D. HOOKER and by KING.

23. Castanopsis microphylla SOEPADMO, Reinwardtia 7 (1968) 395.

Tree, 20–30 m by 40–60 cm ø. Branchlets initially with a tomentum of fulvous stellate hairs of various size, later glabrescent, mostly slender, dark purplish brown, smooth, sparsely lenticellate; terminal bud ellipsoid, 5–7 by 2–3 mm, scales linear-acute, 5–6 by 1–2 mm, hairy. Stipules linear-acute, 5–7 by 1–2 mm, hairy. *Leaves* chartaceous, 5–9 by 1½–3 cm (index 2.5–4.6), widest at the middle to slightly below; base attenuate-acute to

seldom nearly rounded, top gradually acuminate with a sharp to blunt tip ½–1 cm; surfaces ± discolorous, above glabrous and rather dull, beneath densely to very sparsely set with stellate scales (magnification to 60!), their nucleus often orangish, and on the nerves, particularly when young, long simple hairs; midrib ± prominent on both surfaces; nerves 8–10 pairs at an angle of 45–60°, ascending, parallel, arcuating towards the margin, thin; reticulation ± scalariform, fine, dense, obscure on both surfaces; petiole 3–10 mm, adaxially flat. *Male rachis* 5–10 cm by 1 mm ø; bracts and bracteoles ovate-acute; ♂ flowers in clusters of 3–7, perianth lobes ovate-acute, 1 by 1 mm, densely tomentose outside, stamens 12, filaments 1–1½ mm, anthers 0.2 mm long, pistillode 1 mm ø. *Female rachis* 3–5 cm long, 1 mm ø, bracts and bracteoles ovate-acute; ♀ flowers in clusters of 3, perianth lobes ½ mm long, densely stellate-tomentose outside, staminodes 12, rudimentary, styles 3, conical, 1 mm. *Young infructescence*: rachis 5–7 cm by 2 mm ø, carrying 1–8 young cupules ovoid-globose, sessile, 5 by 5 mm, outside with 4 distinct clusters of short spines alternating with the scaly later sutures. *Fruits* 3, immature, completely enclosed by the cupule.

Distr. *Malesia*: Borneo (Sarawak, Sabah, Kalimantan: Sanggau in the western part, and western Kutei).

Ecol. Lowland dipterocarp forest to submontane forest up to 1600 m, often on slopes; one record from basalt derived soil. *Fl.* Aug.–Oct.

Notes. Vegetatively distinct; somewhat suggestive of *C. acuminatissima*, but the latter has leaves with a different indumentum, often remotely serrulate, and a single fruit in each cupule, whereas in *C. microphylla* there must be 3.

The mature cupule and fruit are unknown.

24. Castanopsis catappaefolia KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 621 ('*catalpaefolia*'); KING, Ann. R. Bot. Gard. Calc. 2 (1889) 100, t. 92; A. CAMUS, Chât. (1930) 341, t. 38; SOEPADMO, Reinwardtia 7 (1968) 388.

Tree, 20–27 m by 35–50 cm ø. Branchlets terete, blackish brown with purple tinge, with minute lenticels; tomentum consisting of small stellate hairs, glabrescent; terminal bud ovoid, 1–1½ by 0.8 cm, scales ovate-acute, 1 by 0.4 cm, with stellate tomentum outside. *Leaves* thick-coriaceous, rigid, lanceolate-oblong, 35–50 by 14–19 cm; base attenuate-rounded, top rounded-emarginate or shortly acute; above olive-greenish, glossy, glabrous, beneath dull, with dense cover of appressed stellate scales (magnification 30!), interspersed with a few bundle-hairs, like the midrib above chocolate-brownish; midrib prominent on both surfaces; nerves 23–27 pairs at an angle of ± 80°, parallel, arcuating and anastomosing near the margin, flat to impressed above, prominent beneath; reticulation lax, scalariform except near the midrib, distinct beneath; petiole 1–1½ cm by 5–7 mm, distinctly swollen at the base. *Female rachis* 25–30 cm; bracts ovate-acute, 2 by 2 mm; ♀ flowers solitary or in clusters of 3, perianth lobes rounded-acute, 5 by 5 mm, with dense stellate tomentum outside; staminodes 12, rudimentary, ovary ± rounded-trigonous, 1 by 1 mm, styles 3–4, conical, 1 mm. *Cupule* (nearly ripe) enclosing the fruits but for a small opening at the top, ± ovoid-globose, sometimes distinctly 2-lobed, flat and smooth adaxially, 3½–4 by 3 cm, base attenuating towards the short peduncle, top rounded-acute; wall thin, inside with red-brown silky hairs, outside with some fulvous felt, rather densely set with sturdy simple or little-branched spines 6–8 mm long, dull brown and subglabrous (dehiscence not observed). *Fruits* 1 or 3 per cupule, ± ovoid, 1½–3 by 3 cm; the scar comparatively small; free part of the wall reddish, densely covered with short simple silky fulvous hairs.

Distr. *Malesia*: Malay Peninsula (Goping in Perak), one collection known.

Ecol. In open jungle on low hill, 100–170 m. *Fr.* Sept.

Notes. The spelling of the name was corrected by KING in the year after its first publication.

The male inflorescence is as yet unknown.

25. Castanopsis argentea (BL.) A.DC. J. Bot. 1 (1863) 182; A. CAMUS, Chât. (1930) 308, t. 31: 4–5; BACKER & BAKH. *f.* Fl. Java 2 (1965) 4; SOEPADMO, Reinwardtia 7 (1968) 387. — *Fagus argentea* BL. Flora 7 (1824) 291. — *Castanea argentea* BL. Bijdr. (1826) 525; Fl. Jav. Cupul. (1829) 40, t. 21; KOORD. Teysmannia 11 (1900) 134; K. & V. Bijdr. 10 (1904) 5; KOORD. Atlas 1 (1913) t. 37. — *Castanea argentea var. rigida* BL. Mus. Bot. 1 (1850) 283.

Tree, 15–30 m by ½–1 m ø; bark dark grey, fissured and lenticellate. Branchlets initially densely to sparsely fulvous stellate hairy, later dark-coloured, glabrescent, densely lenticellate; terminal bud 6–10 by 3–5 mm, scales linear, acute, 5–10 by 1 mm, glabrescent. Stipules linear, acute, 10–15 by 2–3 mm, subglabrous. *Leaves* thin-coriaceous, (9–)13–16(–20) by (3–)5–7(–12) cm (index 2–3.5), widest at the middle, seldom above or below; surfaces discolorous, above glabrous, glossy in various shades, beneath silvery-grey with dense, stellate scales (magnification 30!), subglabrescent; base rounded, attenuate-acute, top acute to 1–2 cm sharply acuminate; midrib and nerves strongly prominent beneath, slightly so above; nerves (9–)11–13(–15) pairs at an angle of 60–70°, subparallel, arcuating, not confluent; reticulation fine, rather lax, more or less scalariform, distinct on both surfaces; petiole (½–)1–1½(–2½) cm, adaxially flat. *Male rachis* 15–25 cm by 2–3 mm ø, sometimes with short branches near the base; bracts and bracteoles ovate, rounded to acute, coriaceous, 1½–3 by 1–1½ mm; ♂ flowers in clusters of 3–7, perianth lobes ovate-acute, 1½–2 by 1–1½ mm, hairy outside, stamens 12, filaments 2–3 mm, anthers 0.2–0.25 mm long, pistillode 1–2 mm ø. *Female rachis* 5–15 cm by 2–4 mm ø, bracts and bracteoles thick-coriaceous, broadly ovate-acute, 3–5 by 3–4 mm; ♀ flowers in clusters of 3, perianth lobes ovate-acute, 1–1½ by 1 mm, hairy on both sides, staminodes 12, well-developed,

styles 3, conical, 1½–2 mm, slightly recurved. *Young infructescence* 15–30 cm long; *young cupule* subglobose, the spines in 4 sectors with scaly parts in between. *Ripe cupule* ½–1 cm stalked, ovoid-globose, 3–4 cm through; wall 1–2 mm thick, outside with dense very short fulvous indumentum, the spines densely set in bundles of sturdy and slender ones, 1–1½ cm long, unbranched, mostly straight; dehiscence into 4 segments or irregular. *Fruits* 3 in a cupule, ovoid-conical with acute top, 2–2½ by 1–1½ cm, scar comparatively small, wall 1 mm thick, the free part densely reddish-brown tomentose; cotyledons flat-convex.

Distr. *Malesia*: Sumatra (scattered), Java (common, eastwards to Mt Ungaran, 110° 20′ E, and on Mt Wilis at Ngebel).

Ecol. Forests, *c.* 150–1400 m. *Fl.* Aug.–Oct., *fr.* Nov.–Febr.

Use. The fruits are edible.

Notes. The leaves underneath are more distinctly silvery than in the other scaly species.

Records for Burma have generally been based on specimens of *C. hystrix*.

26. Castanopsis scortechinii GAMBLE, Kew Bull. (1914) 178; J. As. Soc. Beng. 75, ii (1915) 455; A. CAMUS, Chât. (1930) 334, t. 34: 9–11; SOEPADMO, Reinwardtia 7 (1968) 402.

Small tree. Branchlets initially densely set with fulvous tomentum, later glabrescent, greyish black; terminal bud ovoid, *c.* 5 by 3 mm, scales linear-acute. Stipules linear-acute, *c.* 10 by 3 mm, densely fulvous tomentose, soon caducous. *Leaves* thin-coriaceous, elliptic-oblong or oblong-lanceolate, 10–12½ by 3–4½ cm; discolorous, above glabrous, glossy, dark chocolate-brown, underneath with a dense cover of fulvous adpressed, minute stellate hairs and erect long simple hairs; base, acute or rounded, margin entire, recurved, apex abruptly acute or ½–1 cm sharp acuminate; midrib and nerves prominent beneath, flattish above; nerves 10–15 pairs, parallel, ascending, at an angle of *c.* 70°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, distinct beneath; petiole *c.* 5 mm, 2 mm ø, terete, densely fulvous tomentose. *Female rachis* 15–20 cm; ♀ flowers in clusters of 3. *Cupule* subglobose, 2–3 cm through; spines much-branched, tips sharp, 1–1½ cm long, densely fulvous tomentose, densely but irregularly set. *Fruits* ovoid-conical, asymmetrical, 1–1½ cm through, adaxially flat; wall thin, free part densely fulvous tomentose; scar small, convex or flat.

Distr. *Malesia*: Malay Peninsula (Perak and Cameron Highlands).

Ecol. Forests, 1000–1200 m.

Notes. Quite near to *C. fulva*, but different by its leaf with a shorter petiole, and different indumentum, and by its cupule set with long, densely fulvous-tomentose spines.

The male inflorescence is not yet known.

27. Castanopsis fulva GAMBLE, Kew Bull. (1914) 179; A. CAMUS, Chât. (1930) 327, t. 33: 6–9; SOEPADMO, Reinwardtia 7 (1968) 391.

Tree, 18–24 m by 25–50 cm ø. Branchlets initially angular and covered with dense fulvous tomentum, later glabrescent, rather sturdy, sparsely lenticellate; terminal bud ovoid-globose, 3 by 3 mm, scales ovate-acute 3 by 1–2 mm. Stipules 10 by 4 mm, elliptic with acute top. *Leaves* 9–17 by 3–6½ cm (index 2.1–3.2), widest at the middle to sometimes above; base rounded and abruptly acute, top sharply acute to acuminate; discolorous, above glossy (greenish) brown, glabrous, beneath dull brown, sparsely to densely covered with closely adpressed, stellate scales (magnification 30!) and, particularly on the nerves, with some longer simple or 2–3-fid hairs, sometimes late glabrescent; midrib strongly prominent beneath, slightly so above; nerves 10–15 pairs at an angle of 60–70°, ascending, parallel, arcuating and disappearing near the margin, prominent beneath, flattish above; reticulation fine, scalariform, obscure on both surfaces; petiole 1–3 cm, shallowly furrowed adaxially, with distinct basal joint. *Male rachis* 10–20 cm, bracts ovate-acute, thick-coriaceous, 1½–2 by 1–1½ mm, bracteoles membranous, smaller; ♂ flowers in clusters of 3–7, perianth lobes membranous, ovate-acute, 1 by 1 mm, densely hairy, stamens 12, filaments 1½–2 mm, anthers 0.2–0.25 mm long, pistillode 1½–2 mm ø. *Female rachis* 10–15 cm, 2–3 mm ø, bracts and bracteoles thick-coriaceous, broadly ovate-acute, 1–1½ by 1½–2 mm; ♀ flowers in clusters of 3, perianth lobes membranous, 0.7 by 0.7 mm, densely hairy on both sides, staminodes 12, rudimentary, styles 3, conical, slightly recurved, 1 mm. *Young infructescence*: rachis 15–20 cm, 3–5 mm ø, young cupule sessile, ovoid-globose, ½–1 by ½ cm, the 4 spiny and 4 scaly sectors ± equal. *Cupule* (nearly ripe) on a stalk ½ cm long and wide, or subsessile with tapering base, ovoid-globose, 2–2½ cm through; wall 1 mm thick, inside hairy, outside fulvous pubescent, densely set with sturdy, recurved spines ½–1 cm long, in bundles and/or branched themselves, arranged in 4–6 concentric rows, except the top densely puberulous; dehiscence (always?) irregular. *Fruit* (only one of the 3 well-developed!) ovoid-conical with acute top, 1½–2 cm through, scar comparatively small, wall 1 mm thick, free part densely fulvous-pubescent; cotyledons flat-convex.

Distr. *Malesia*: Central Sumatra (SW. of Pakanbaru), Malay Peninsula (Perak, Selangor, Pahang, Johore), Borneo (W. Kalimantan: G. Kenepai; Sarawak; Brunei; Sabah).

Ecol. Primary lowland dipterocarp forest, in the hills up to 200 m, on poor sandy soil. *Fl.* Sept.-May, *fr.* July-Jan.

28. Castanopsis costata (BL.) A.DC. J. Bot. 1 (1863) 182; Prod. 16, 2 (1864) 110; HANCE, J. Bot. 13 (1875) 367; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 456; A. CAMUS, Chât. (1930) 328, t. 33: 10–11; SOEPADMO, Reinwardtia 7 (1968) 388. — *Castanea costata* BL. Mus. Bot. 1 (1850) 284. — *Castanea brevicuspis* MIQ. Fl. Ind. Bat. 1, 1 (1858)

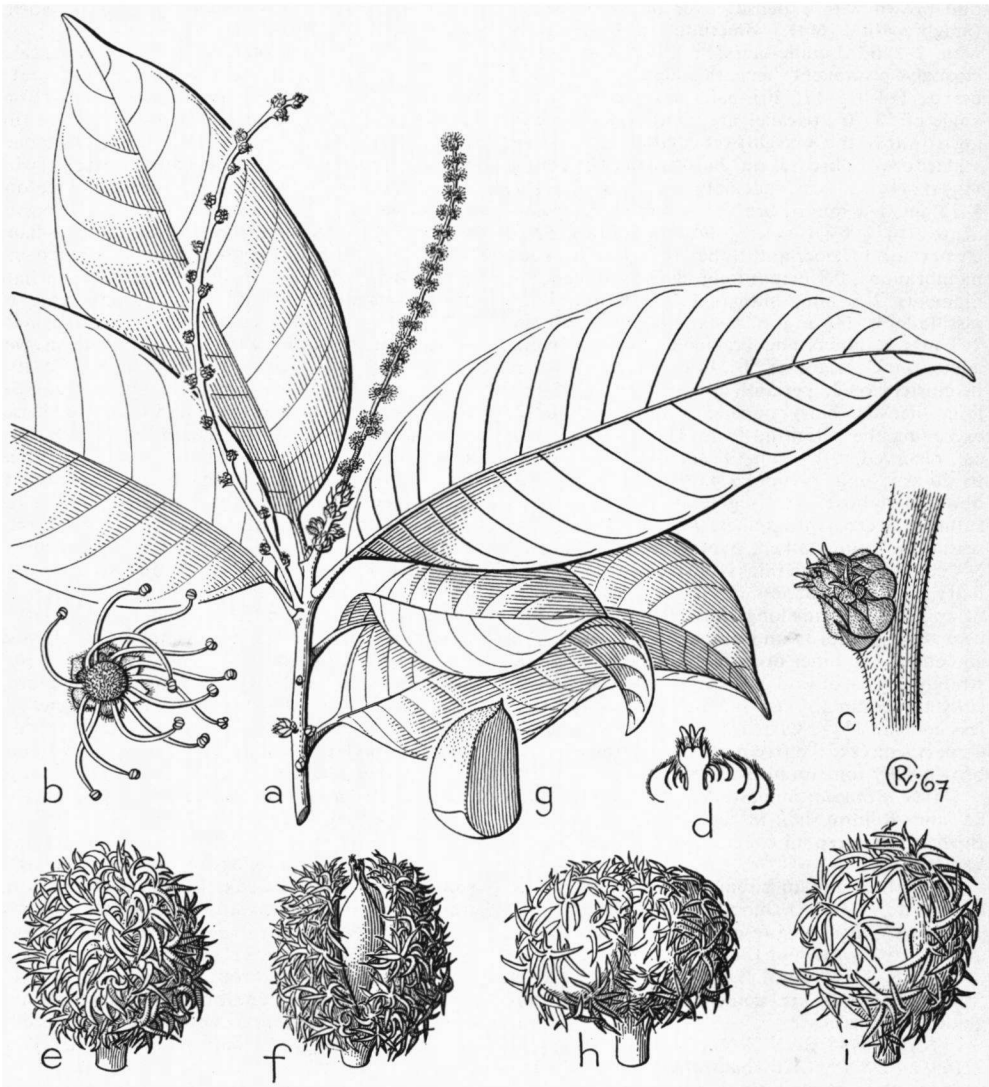

Fig. 14. *Castanopsis costata* (BL.) A. DC. *a.* Habit, ×⅔, *b.* ♂ flower, *c.* ♀ flowers, *d.* longitudinal section of a ♀ flower, *e.* ripe cupule, abaxial side, *f.* ripe cupule, adaxial side, *g.* fruit. — *C. foxworthyi* SCHOTTKY. *h.* Ripe cupule, abaxial side, *i.* ripe cupule, side view. All flowers ×4, cupules and fruit nat. size (*a* RASTINI 203, *b* DELMAAR 1899, *c–d* KURNIASIH 29, *e* SAR 15116, *f–g* SAN 16747, *h–i* SAR 4416).

866. — *Castanea spectabilis* MIQ. *l.c.* — *C. brevicuspis* (MIQ.) A.DC. J. Bot. 1 (1863) 182. — *C. spectabilis* (MIQ.) A.DC. *l.c.* — *C. trisperma* SCHEFF. Nat. Tijd. N. I. 31 (1870) 362. — *C. costata β bancana* SCHEFF. *l.c.* — **Fig. 14 a–g.**

Tree, 10–36 m by 15–80 cm ø; bark yellowish to reddish brown, smooth and peeling off profusely. Branchlets when young densely set with fulvous bundle-hairs, later glabrescent, slender, greyish or blackish brown, with many minute lenticels; terminal bud ovoid, 3–5 by 2–3 mm, scales ovate-acute, 3–4 by 2–3 mm. Stipules linear-triangular, 13 by 1½ mm. *Leaves* sometimes thickly coriaceous, (9–)14–17(–25) by (4–)5–8(–10) cm (index (1.7–)2.5(–3.2)), widest at or below the middle to sometimes above; base attenuate-acute or rarely rounded and abruptly acute, apex bluntly acute or sharply ½–1 cm acuminate; above glabrous or sometimes on and near the midrib with a few hairs, glossy olive-green, underneath

dull brown with a dense cover of stellate scales (magnification 60!), sometimes also roughish with 2–3-fid bundle-hairs; midrib and nerves strongly prominent beneath, slightly so above; nerves (14–)16–17(–20) pairs, ascending, at an angle of 50–70°, parallel, arcuating and disappearing towards the margin; reticulation fine, dense, scalariform, obscure on both surfaces; petiole (½–)1–1½(–2) cm, adaxially flat. *Male rachis* 5–15 cm, 1–2 mm ø; bracts and bracteoles ovate-acute, 1–1½ by 1 mm; ♂ flowers solitary or in clusters of 3–7, perianth lobes rounded or acute, membranous, 0.7–1 mm long, densely tomentose; filaments 2–3 mm, anthers 0.2–0.25 mm long; pistillode ¾–1½ mm ø. *Female rachis* 10–20 cm, 2–3 mm ø, bracts and bracteoles broadly ovate-acute, thick-coriaceous, 1–1½ by 1 mm; ♀ flowers in clusters of 3; perianth lobes acute, ¾–1 mm long, densely hairy outside; staminodes 10–12, exceeding the perianth; styles 3, conical-cylindrical, recurved, 1–1½ mm. *Young infructescence* up to 20 cm; young cupules numerous, subsessile, obovoid-globose; the segments between the 4 sutures covered with spines. *Ripe* (?) *cupule* subsessile to 7 mm stalked, ovoid-globose, 2½–3 by 3–4 cm; wall 1–2 mm thick, outside densely fulvous hairy, and more or less densely set with bundles of spines 4–14 mm long, fulvous-puberulous except the top, sturdy and more or less recurved or sometimes the inner ones of a bundle slender and straight; inside of wall with dense yellowish brown, silky tomentum. *Fruits* 1–3 per cupule, more or less conical, 1½–2 by 1–1½ cm, the scar covering ¼ part, convex; the free part with dense yellowish brown silky tomentum; wall thin.

Distr. *Malesia*: Sumatra (scattered), also Banka and Billiton Is., Malay Peninsula (Perak), Borneo (scattered all over), also Laut and Nunukan Is.

Ecol. Lowland to submontane forests, up to *c.* 1500 m. *Fl.* March-June, *fr.* Sept.-May.

Notes. The cupule resembles those of *C. fulva* and *C. foxworthyi*, but the leaf is different.

In SAN 27360 from North Borneo, in young fruit, the leaves are completely glabrous, and glaucous underneath.

In SAN 16445, SAN 28260, CLEMENS 10791 and 32169, all from Mt Kinabalu, the leaves, although with the characteristic close, parallel nerves, have underneath the long hairs much more densely set than in the other specimens; the young twigs being also very densely hairy. In SAN 16445, the fruit is 5½ cm in largest ø, the spines being very sturdy and 1–2 cm long.

29. Castanopsis motleyana KING, Ann. R. Bot. Gard. Calc. 2 (1889) 96, t. 86 ('*mottleyana*'); A. CAMUS, Chât. (1930) 339, t. 37: 6–10; SOEPADMO Reinwardtia 7 (1968) 396. — *C. javanica* (*non* A.DC.) ELMER, Leafl. Philip. Bot. 3 (1910) 936. — *C. pearsonii* MERR. Philip. J. Sc. 30 (1926) 79.

Tree, 10–40 m by 20–70 cm ø; buttresses up to 3–4 m tall, 1–2 m out, 5–10 cm thick, spreading; bark rough, fissured or flaky, chocolate- or reddish brown. Branchlets when young with dense fulvous indumentum of longer and mostly also shorter bundle-hairs, glabrescent, slender to sturdy; terminal bud ovoid-ellipsoid, 5–10 by 3–5 mm, scales ovate- or linear-acute, 4–5 by 1–2 mm. Stipules ovate-acute, 7–10 by 3 mm. *Leaves* thick-coriaceous, (7–)15–23(–32) by (2½–)7–10(–16) cm (index 2–2.8(–3.5)), widest at the middle to sometimes above; base attenuate-acute, top acute with a small sharp acumen; above variable in colour and shine, when young sometimes near the nerves sparsely set with simple or 2–3-fid bundle-hairs which leave a pit when disappeared, underneath dull brown, glabrous to densely set with stellate scales (magnification 30–60!), and/or simple or 2–3-fid bundle-hairs; midrib and nerves strongly prominent beneath, slightly so above; nerves (11–)14–18(–21) pairs at an angle of (50–)70–80°, mostly parallel, ascending, arcuating and anastomosing near the margin; reticulation coarse, dense, subscalariform, distinct beneath; petiole (½–)1–1½(2½) cm, hairy as the twig, adaxially flat. *Male rachis* 10–20 cm, 2–3 mm ø; bracts and bracteoles membranous, ovate-acute, 10 by 7 mm; ♂ flowers in clusters of 3–7, perianth 4–6-lobed, the lobes acute, 1–1½ by 0.7–1 mm, densely yellowish brown stellate-tomentose; stamens 10–12, filaments 2–2½ mm, anthers 0.2–0.25 mm long, pistillode rounded-triangular, 1½ mm ø. *Female rachis* 15–25 cm, 3–5 mm ø; bracts and bracteoles thick-coriaceous, ovate-acute, 1 by 0.7 mm; ♀ flowers in clusters of 3, perianth 6-lobed, the lobes 0.7–1 by 0.3–0.6 mm, with dense stellate tomentum on both surfaces; staminodes 12, rudimentary; styles 3, conical, recurved, 1–1½ mm. *Young infructescence* 10–20 cm, rachis 3–5 mm ø, carrying 10–25 young fruits. *Young cupule* sessile, depressed-globose, with short, sharp, slender and/or flat sturdy spines pointing to all directions. *Ripe cupule* ellipsoid-globose, 3–4 cm through, sometimes flattened adaxially and asymmetrical; wall densely hairy both outside and inside, 3–4 mm thick, densely set with spines ¾–1½ cm long and densely fulvous or golden puberulous (magnification 10!), their top glabrous, of a slender, straight kind and in bundles, and/or of a sturdy kind like trees with recurved branches; dehiscence into 4 segments or irregular. *Fruit* ovoid-conical, 2–2½ by 1½–2 cm, the scar covering ¼ part, flat or convex, the free part densely yellowish brown tomentose, top acute; wall 1 mm thick; cotyledons flat-convex.

Distr. *Malesia*: Borneo (throughout), also Nunukan I., Philippines (Mindanao).

Ecol. Primary, rarely secondary or disturbed forest in hilly country up to 500 m, the soil recorded sandy clayey. *Fl.* Sept.-May, *fr.* May-Dec.

Notes. In D. D. WOOD (coll. EVANGELISTA) 1151 from North Borneo, the type of *C. pearsonii*, the cupule (detached from the leaves) is 5 by 6½ cm, the sutures being free of spines.

In the few Philippine specimens partly the leaves resemble those of the type of *C. pearsonii*, *i.e.* lanceolate with comparatively few arcuating veins under a sharp angle, and scaly beneath, partly they resemble other materials from Borneo,

with wider leaves, more and parallel veins under a wider angle, and glabrous beneath.

Leaves longer than 20 cm were never found to be scaly beneath, but no further correlations could be detected in the considerable diversity as contained in the above description, neither in structure nor in geographical or ecological distribution, and the extremes are all connected by intergrades.

30. Castanopsis pedunculata SOEPADMO, Reinwardtia 7 (1968) 399.

Tree, 18 m. Branchlets greyish brown, glabrous, densely lenticellate; terminal bud ovoid-globose, 2–3 by 2 mm, with dense stellate tomentum, glabrescent. *Leaves* concolorous, elliptic-oblong, 8–16 by 2–2½ cm; base rounded and abruptly acute, apex acute to ½–1 cm acuminate; glabrous on both surfaces; midrib prominent beneath, flat above; nerves 10–13 pairs, ascending, subparallel, arcuating towards the margin, slightly prominent on both surfaces; reticulation distinct on both sides; petiole 1–2 cm, adaxially shallowly furrowed. Rachis of the *infructescence* rigid, up to 18 cm, ½ cm thick, densely lenticellate, with adpressed stellate tomentum, glabrescent. *Ripe cupule* compressed obovoid-globose, more or less symmetrically 4-lobed, thin-walled, completely enclosing the fruits; surface with regular undulating ridges of flattened minute tubercles, fulvous-hoary, 2–3 by 3–3½ cm; dehiscence into 4 ± equal segments; peduncle 1–1½ by ½ cm, rugose and usually twisted. *Fruits* 3 in each cupule, ovoid-conical, 1½–2 by 1.5–1.8 cm, the adjoining sides of both central and lateral fruits found concave, the scar covering 1/3–2/5 part, the free part glossy with a thin short indumentum; top abruptly pointed; cotyledons flat-convex.

Distr. *Malesia*: North Borneo (one collection).

Ecol. Forest at 300 m. *Fr.* Sept.

Notes. Distinct by its almost smooth cupule on the long peduncle.

Inflorescences are unknown.

31. Castanopsis psilophylla SOEPADMO, Reinwardtia 7 (1968) 401. — *C. inermis* (*non* B. & H.) MERR. Pl. Elm. Born. (1929) 42. — Fig. 15 e–f.

Tree, 10–27 m by 20–45 cm ø; buttresses up to 2 m tall, ¾ m out; bark greyish brown, smooth or scaly. Branchlets glabrous almost from the beginning, smooth, dark purplish brown, lenticels none or very few; terminal bud ovoid-ellipsoid, 2–3 by 1–2 mm, scales linear-acute, sparsely puberulous. Stipules linear, 3–4 mm, very early caducous. *Leaves* somewhat discolorous, mostly glossy above, glabrous on both sides, (6–)10(–16) by (1–)3½(5) cm (index (2.3–)2.8–4.2), widest about the middle, sometimes below; base rounded to acute, slightly decurrent, top acute to sharply acuminate with tip ½–2 cm; midrib and nerves more or less prominent on both surfaces; nerves 9–12 pairs at an angle of 60–70°, parallel, arcuating and disappearing towards the margin; reticulation fine, obscure on both surfaces; petiole ½–1½ cm, adaxially flat or shallowly sulcate, glabrous. *Inflorescence* male, female, or mixed. *Male rachis* 5–15 cm, 1–2 mm ø, with dense stellate tomentum; bracts ovate-acute, 1 by 5 mm, also hairy; ♂ flowers in clusters of 3–7, perianth deeply 6-lobed, the lobes 1 mm long, hairy outside; stamens 12, filaments 1½–2 mm, glabrous, anthers 0.2–0.25 mm long, pistillode rounded-triangular, 1 mm ø, densely woolly pubescent. *Female* or *mixed rachis* 6 cm, with dense stellate tomentum; ♀ flowers in clusters of 3–7, perianth deeply 6-lobed, lobes 0.5–0.75 mm long, acute, hairy outside; staminodes 12, well-developed and producing good pollen or rudimentary; styles 3, conical, recurved, 1 mm. *Young infructescence* to 20 cm, carrying 4–12 young fruits. *Young cupule* subsessile, turbinate, beset with concentric bands of short tubercles. *Ripe cupule* asymmetrically pear-shaped or depressed-obovoid, with 2 or more lobes, completely enclosing the 3–7 fruits, green-brownish velvety with stellate or simple hairs, 1½–2½ cm through; wall ½ mm thick, covered with several symmetrical ridges of short tubercles sometimes recurved; dehiscence into 2–4 segments, more or less regular. *Fruits* 3 or more, ovoid-complanate, 1½–2 cm through, scar covering 2/5–4/5 part of the surface, the remainder densely brownish tomentose.

Distr. *Malesia*: Borneo (Sabah, common; Sarawak, rare, in the northern parts; Kalimantan, scattered in the eastern half), also Banguey I., Philippines (Palawan, EBALO 408).

Ecol. In forests on sandy or basaltic soil, in the lowlands up to 1000 m. *Fl.* April and July, *fr.* June and Nov.

Notes. The nearly ripe fruit recorded green.

Nearest to *C. inermis* and *C. philipensis*; see the key. Bornean records of *C. inermis* belong here.

C. brevispina SCHOTTKY, Bot. Jahrb. 49 (1913) 358, *non* HAYATA 1911, might belong here, but the description of the cupule does not agree in all points, and the type specimen, FOXWORTHY 156 from Sarawak, seems to be lost.

32. Castanopsis inermis (LINDL. *ex* WALL.) B. & H. Gen. Pl. 3 (1880) 409; A. CAMUS, Chât. (1930) 447, t. 63, *p.p.*; CORNER, Ways. Trees (1940) 292, f. 93, pl. 219; SOEPADMO, Reinwardtia 7 (1968) 392. — *Castanea inermis* LINDL. *ex* WALL. Pl. As. Rar. 2 (1830) 6; A.DC. Prod. 16, 2 (1864) 116. — *Castanea glomerata* [*non* (ROXB.) WALL. *ex* BL.] BL. Mus. Bot. 1 (1850) 283, *quoad specimina, excl. syn.* — *Calleocarpus sumatrana* MIQ. Pl. Jungh. (1851) 14; Fl. Ind. Bat. 1, 1 (1858) 868. — *C. sumatrana* (MIQ.) A.DC. J. Bot. 1 (1863) 182; Prod. 16, 2 (1864) 113; HOOK. *f.* Fl. Br. Ind. 5 (1888) 623, *p.p.*; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 103, t. 97; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 460. — *Castanea sumatrana* (MIQ.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 378. — *C. mitifica* HANCE, J. Bot. 16 (1878) 200.

Tree, 10–30 m by 30–90 cm ø; bark grey, rough and lenticellate. Young branchlets greyish black, tomentose, older ones glabrous, lenticellate; terminal bud ovoid-ellipsoid, 5 by 2 mm, scales ovate-acute, 5 by 2 mm, more or less hairy. Stipules, if distinct, triangular, 1 mm, caducous. *Leaves* (6–)10–15(–20) by 4–7½ cm (index 2.1–3), widest

slightly below to slightly above the middle; discolorous, upper surface glabrous, dull, lower surface with greyish brown stellate tomentum (magnification 35!); base rounded to acute, somewhat decurrent, apex more or less acute; midrib and nerves ± prominent beneath, slightly so above; nerves 10–15 pairs at an angle of 60–80°, parallel, arcuating towards the margin; reticulation fine, parallel, obscure on both surfaces; petiole glabrous, 1–2 cm, adaxially flat or shallowly furrowed. *Male rachis* 10–15 cm, 1 mm ø; bracts ovate-acute, ½ by ½ mm, with dense tomentum; ♂ flowers solitary or in clusters of 3–7; perianth deeply 6-lobed, lobes rounded, ½ mm long, hairy; stamens 12, filaments 2–3 mm, glabrous, anthers 0.1–0.2 mm long; pistillode rounded-triangular, 1 mm ø, densely woolly pubescent. *Female* and *mixed androgynous rachis* 10–15 cm, 1–2 mm ø; ♀ flowers solitary or in cluster of 3–4; perianth deeply 6-lobed, lobes rounded, ½ mm long hairy, staminodes 12, styles 3, conical-cylindrical, ½ mm, pubescent at base. *Young cupule* on stalk 2–5 mm, subglobose, densely covered with the future spines pointing to the top. *Ripe cupule* 2–4 by 2–3 cm, hoary with minute fulvous hairs, depressed obovoid-globose, regularly or irregularly 3–4-lobed, sometimes constricted at both ends; surface marked with 4–5 more or less parallel, curving bands bearing short, more or less distinct thick tubercles; wall 1–2 mm thick, completely enclosing the 1–4 fruits. Dehiscence badly known; by 4 valves? *Fruits* 1–4, with dense reddish brown tomentum, 2–3 by 1½–2 cm, completely free from the cupule except for the convex, glabrous, rugose base; central fruit in cross-section asymmetrically rounded-triangular, ovoid-conical, flattened laterally and rounded adaxially; lateral fruits smaller, ovoid-globose, flattened adaxially and rounded on the free sides.

Distr. *Malesia*: Sumatra (mostly in the southern part; twice found in Tapanuli), also Banka and Lingga Is., and Malay Peninsula (common; also Singapore).

Ecol. Forests, mostly in the hills, also found in bamboo forest, and in groves on a river-bank; up to 600 m. *Fl.* Oct.-June, *fr.* July-Dec.

Vern. *Berangan*, with variants.

Notes. Branches spreading. Leaves darkish green. Flowers cream-coloured or the lobes brownish-tipped; stamens white. Fruit when unripe pale bluish green or greyish.

Materials from Burma formerly reckoned here, generally belong under *C. lanceaefolia*, which differs in the cupule having concentrical rings outside and a single fruit inside.

C. inermis, *C. psilophylla* from Borneo, and *C. philipensis* from the Philippines are closely related, *C. lucida* being more remote. They can best be distinguished by comparison and then will be found to differ in a number of correlating characters, summarized in the key.

Records of this species from Borneo relate to *C. psilophylla*.

33. Castanopsis philipensis (BLANCO) VIDAL, Rev. Pl. Vasc. Filip. (1886) 265 (*'philippinensis'*); MERR. Philip. J. Sc. 3 (1908) Bot. 319 (*'philippensis'*); BROWN, Min. Prod. Philip. For. 2 (1921) 260, f. 11; MERR. En. Philip. 2 (1923) 25; SOEPADMO, Reinwardtia 7 (1968) 399. — *Fagus philipensis* BLANCO, Fl. Filip. ed. 2 (1845) 503; ed. 3, 3 (1879) 132. — *C. sumatrana* (*non* A.DC.) F.-VILL. Nov. App. (1880) 210; VIDAL, Sinopsis Atlas (1883) 41, t. 92: 4; ELMER, Leafl. Philip. Bot. 3 (1910) 936. — *C. javanica* (*non* A.DC.) VIDAL, Sinopsis Atlas (1883) 41, t. 92: 1; ELMER, Leafl. Philip. Bot. 3 (1910) 936; MERR. En. Philip. 2 (1923) 24. — *C. glabra* MERR. Philip. J. Sc. 9 (1914) Bot. 354. — *C. inermis* (*non* B. & H.) MERR. En. Philip. 2 (1923) 24. — **Fig. 15 a–d.**

Tree, 6–28 m by 0.2–1 m ø; bark yellowish or greyish brown, smooth, densely lenticellate. Innovations with dense stellate tomentum. Branchlets soon glabrous, dark purplish coloured, with sparse minute lenticels; terminal bud ovoid or ellipsoid, 2–3 by 1 mm, scales ovate- or linear-acute, 2–3 by 1 mm. Stipules linear-acute, 3–4 by 1 mm, very soon caducous. *Leaves* 6–16 by 2–5 cm (index 2.3–4.2), widest below the middle to rarely above, discolorous, above green-brownish and often glossy, glabrous, beneath dull brownish with adpressed scale-like stellate tomentum (magnification 35!); base acute to rarely rounded, slightly decurrent, ± asymmetrical; apex mostly gradually tapering and acuminate with a sharp or blunt tip ½–2 cm; midrib and nerves on both surfaces brownish and more or less prominent; nerves 7–10 pairs, ascending, subparallel, arcuating and disappearing towards the margin, at an angle of 50–70°; reticulation obscure on both surfaces; petiole (3–)5–10(–20) mm, adaxially flat. *Male rachis* 10–25 cm rather densely tomentose; bracts and bracteoles ovate-acute, 2 by 1 mm, densely hairy; ♂ flowers in clusters of 3–7, perianth lobes 1 mm long, rounded or acute, densely hairy outside; stamens 12, filaments 2–2½ mm, glabrous, anthers 0.2–0.25 mm long; pistillode rounded-triangular, 1–1½ mm ø, densely woolly pubescent. *Female rachis* 10–20 cm, rather densely tomentose; bracts and bracteoles ovate-acute, 1½–2 by 1 mm; ♀ flowers in clusters of 3 or sometimes solitary, perianth lobes ½–1 mm long, rounded or acute, densely hairy outside; staminodes 12, rudimentary; styles 3, conical, recurved, 1–2 mm. *Young cupule* subsessile to 7 mm stalked, obovoid-globose, covered all over with thick, scale-like appendages. *Ripe cupule* pear-shaped or depressed-subglobose, 2–3 by 3–4 cm, with two rounded lobes more or less symmetrical; surface with undulate ridges of short, pointed tubercles, hoary to velvety with fulvous to brownish hairs; peduncle 5–7 mm long, 3–4 mm thick. *Fruits* 3 (rarely 1?) per cupule, the scar covering about half the surface, the remainder free and red-brown, with golden hairs; central fruit 1½ by 2 cm, lateral ones as large to slightly smaller.

Distr. *Malesia*: Philippines (Luzon, Mindanao, Leyte, Basilan, Samar, Mindoro).

Ecol. Forested slopes, *c.* 400–1800 m. Dec.-May, *fr.* June-Oct.

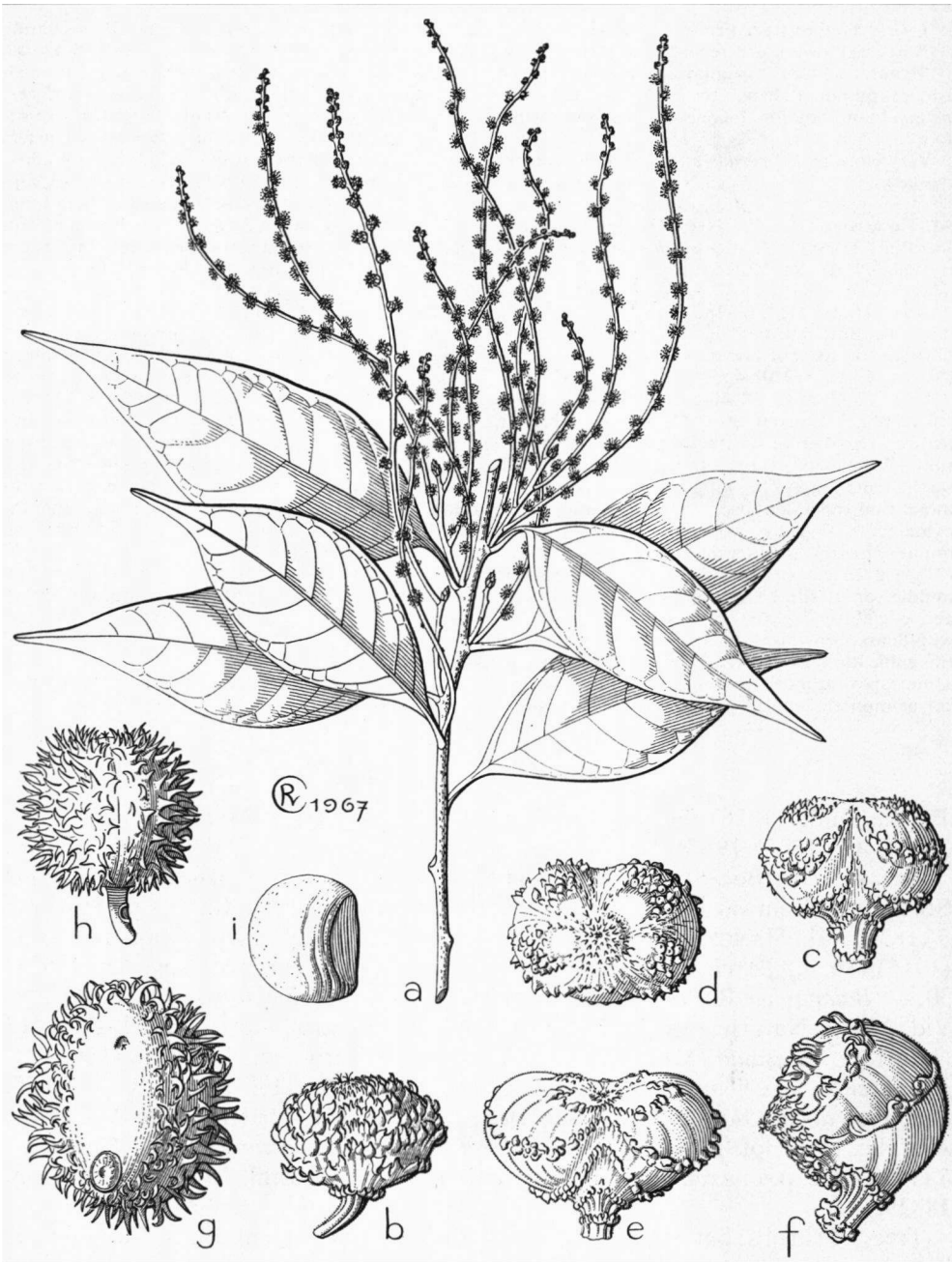

Fig. 15. *Castanopsis philipensis* (BLANCO) VIDAL. *a.* Habit, ×⅔, *b.* young cupule, *c.* ripe cupule, abaxial view, *d.* ripe cupule, seen from above, all nat. size. — *C. psilophylla* SOEPADMO. *e.* ripe cupule, abaxial view, *f.* ripe cupule, side (lateral) view, both nat. size. — *C. rhamnifolia* (MIQ.) A. DC., *g.* ripe cupule, adaxial view, *h.* ripe cupule, abaxial view, *i.* ripe fruit, side view, all ×⅔ (*a* VIDAL 611, *b* AHERN'S Coll. 8100, *c–d* ELMER 11315, *e–f* SAN 25953, *g* MEIJER 7660, *h–i* GRASHOFF 362).

Uses. Timber tree. Fruits edible; see BROWN.

Notes. Flowers are recorded as being white.

MERRILL (1908), assuming a typographical error, proposed to change the name into *C. philippensis*. In our opinion, there is not enough evidence to adopt this.

Very close to *C. inermis* and *C. psilophylla*; see the key.

34. Castanopsis lucida (NEES) SOEPADMO, Reinwardtia 7 (1968) 394. — *Alseodaphne lucida* NEES in Wall. Pl. As. Rar. 2 (1831) 72. — *Laurus lucida* WALL. Cat. (1830) 2590, *nomen*. — *C. hullettii* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 623; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 104, t. 98; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 459; A. CAMUS, Chât. (1930) 453.

Tree, 12–20 m by 40–60 cm ø; buttresses up to 1.6 m tall, 1.2 m out, straight; bark pale-brown, fissured. Innovations with dense stellate tomentum. Branchlets sturdy, initially dull dark-coloured, later greyish, with many lenticels; terminal bud ovoid-globose, 3–6 by 2–4 mm, scales ovate-acute, 3–5 by 2–3 mm. Stipules deltoid, minute. *Leaves* thick-coriaceous, (10–)16–20 by (3½–) 8–10 cm (index 1.7–3), widest about the middle, on sterile basal shoots to 38 by 18 cm; above glabrous, glossy sometimes dull, beneath with dense, brownish, stellate scale-like tomentum (magnification 50!); base rounded to attenuate-acute, apex rounded to acutish, sometimes ½–1 cm acuminate; midrib prominent on both sides; nerves 15–20 pairs, parallel, ascending, arcuating towards the margin, at an angle of (45–)70–80 (–90)°, prominent beneath, flat to subprominent above; reticulation fine, obscure on both surfaces; petiole 1½–3½ cm, adaxially flat. *Male rachis* 10–20 cm, bracts ovate-acute; ♂ flowers in clusters of 3–7, perianth deeply 6-lobed, lobes rounded-acute, 1 by 1 mm, hairy outside; stamens 12, filaments 3½–4 mm, glabrous, anthers 0.25 mm long; pistillode roundish, 1–1½ mm ø, woolly pubescent. *Female rachis* 10 cm; ♀ flowers in clusters of 3(–4–5); perianth deeply 6-lobed, lobes acute, ½ cm long, hairy outside; staminodes 12, rudimentary; styles 3, conical, ½–1 mm. *Young cupule* sessile, subglobose, the future spines scale-like, densely set all over the surface, acroscopical. *Ripe cupule* subsessile, depressed-subglobose or sometimes constricted at base and top, 3–4-lobed, 3½–4 cm through, thick, woody, covered with 3–4 prominent, transverse, curved ridges bearing sharp short spines; dehiscence into 3–4 equal segments. *Fruits* 2–4 in each cupule, complanate-subglobose, 1½–2 cm through, shining, smooth, with sparse, adpressed, stellate tomentum; base convex, rugose, glabrous.

Distr. *Malesia*: Malay Peninsula (Penang, Perak, Negri Sembilan, Malacca), also Singapore; Borneo (SW. and NE. Kalimantan).

Ecol. Lowland forests, to *c.* 500 m. *Fl.* Aug.–May, *fr.* April-May.

Note. KING's record for Riouw and Billiton is not confirmed; he may have had *C. inermis*.

3. LITHOCARPUS

BLUME, Bijdr. (1826) 526; Fl. Jav. Cupul. (1829) 34; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 19; REHD. & WILS. in Sargent. Pl. Wils. 3 (1917) 205; BARN. Trans. & Proc. Bot. Soc. Edinb. 33 (1942) 332; A. CAMUS, Chênes 3 (1954) 511; SOEPADMO, Reinwardtia 8 (1970) 197. — *Synaedrys* LINDL. Intr. Nat. Syst. ed. 3 (1836) 441; HANCE in Hook. J. Bot. 1 (1849) 175; KOIDZ. Bot. Mag. Tokyo 30 (1916) 186, *p.p., excl. sect. Chlamydobalanus*. — *Arcaula* RAFIN. Alsog. Am. (1838) 30. — *Balanaulax* RAFIN. Alsog. Am. (1838) 28. — *Cyclobalanus* (ENDL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 80; SCHWARZ, Notizbl. Berl.-Dahl. 13 (1936) 6. — *Pasania* (MIQ.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81, *p.p., excl. subg. Chlamydobalanus*; PRANTL in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 55, *p.p., excl. ditto*; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 411; HICKEL & A. CAMUS, Ann. Sc. Nat. Bot. 3 (1921) 386, *p.p., excl. sect. Pseudocastanopsis*; Fl. Gén. I.-C. 5 (1930) 962, *p.p., excl. ditto*; SCHWARZ, Notizbl. Berl.-Dahl. 13 (1936) 6. — **Fig. 18–29.**

Trees or shrubs; buttresses or stilt-roots occasionally present. Innovations densely yellowish brown to rufous tomentose by simple or stellate hairs. Terminal bud ovoid to ellipsoid; scales spirally imbricate. Stipules extrapetiolar, mostly caducous. *Leaves* spirally arranged, entire, thin- to thick-coriaceous, margin sometimes strongly recurved, glabrous or variously hairy at least beneath. Petiole terete or adaxially flat or furrowed. *Inflorescence* male, female, androgynous, or mixed, always erect, including bracts and bracteoles variously densely hairy. *Male rachis* solitary in the axil of a lower leaf or in a dense paniculate cluster

on lateral or subterminal shoots, simple or much-branched; ♂ flowers solitary or in dichasial clusters of 3–7(–30) along the rachis, or in an androgynous inflorescence along the upper part of the rachis; perianth campanulate, (4–)6(–7)-lobed; stamens (8–)12(–15); filaments filiform, glabrous, anthers reniform, dorsifixed, 0.2–0.3(–0.5) mm long; pistillode always present, globose or subglobose, sometimes compressed, hairy. *Female, androgynous* or *mixed rachis* solitary in the axil of a higher leaf or on the upper part of the paniculate cluster; ♀ flowers solitary or in dichasial clusters of 3–7(–15) along the rachis, or in an androgynous inflorescence along the basal part of the rachis; perianth regularly 6-lobed, staminodes 10–12, rudimentary or well-developed and exceeding the perianth, sometimes polliniferous; style 3–6(–15), conical or terete, more or less connate or recurved, densely tomentose at base, stigma punctiform, terminal. *Cupule* solitary or in dichasial clusters of 3–7(–15) along the rachis, sessile or ½–2 cm stalked, enclosing a solitary fruit, cup-shaped, saucer-shaped to almost globular, variously lamellate, squamose, tuberculate or muricate, never truly spiny, never with vertical sutures; dehiscence none or irregular. *Fruit* in cross-section rounded, sometimes falsely multi-septate by intrusions of the endocarp; pericarp woody or bony, for the greater part free to adnate to the cupule, scar small to very large, glabrous or hairy. *Cotyledons* flat-convex. *Germination* hypogeal.

Distr. About 300 *spp.*, in the NE. parts of India (Nepal, Bhutan, Assam), Burma, China (except in the NW. and W. parts), Korea, Japan, Formosa, Hainan, Indochina, Siam, Malesia, and 1 species in the SW. part of the United States. The most primitive species (*L. elegans*) occurs in most areas except in Korea, Japan, Hainan, and the United States. In *Malesia c.* 110 *spp.*, distributed throughout the region eastwards to Sudest and Rossel Is. The genus is rare in the E. part of Java, absent in Madura, the Lesser Sunda Islands, and the SE. Moluccas. Fig. 16–17.

Fossil records. Very few fossils have been recorded, *viz* those enumerated by LA MOTTE (Mem. Am. Geol. Soc. 51, 1952, 205–206) from various Miocene-Pliocene deposits in several localities in the United States, and probably also some pollen grains mentioned by MULLER (Proc. 10th Int. Bot. Congr. Edinb. 1964, 371) from the Tertiary of Borneo.

Ecol. In Malesia the genus occurs mainly in the everwet lowland to montane forest, between 0–3000 m, more commonly below 1500 m, on various types of soil including limestone. In Central Java a few species have been recorded from pockets of everwet forest on Mts Diëng, Merapi, Ungaran, Muria, Lawu, and in E. Java on Mts Wilis, Kawi, Ardjuno, Tengger, and Idjen.

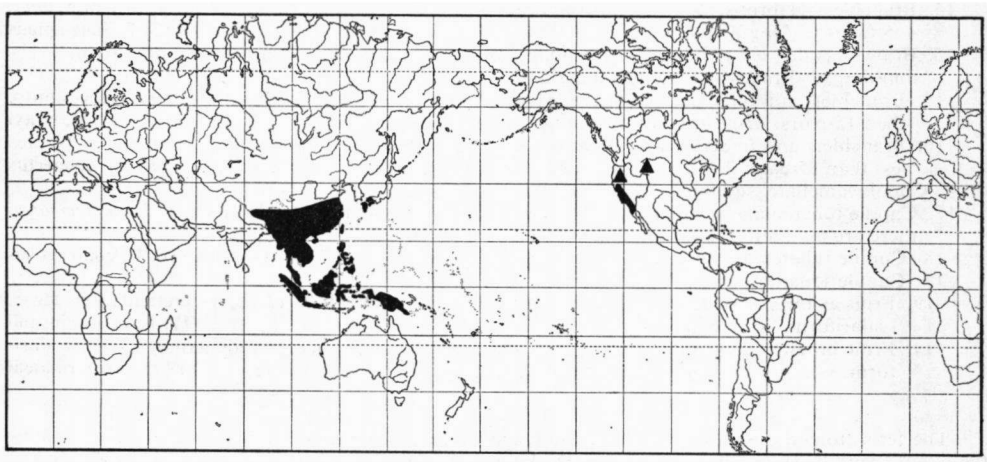

Fig. 16. Distribution of the genus *Lithocarpus*, the fossil records indicated by triangles.

KEY TO THE SPECIES[1]

1. Fruit for the greater part adnate to the cupule, *i.e.* the scar occupying the greater part of its surface.
2. Cupule variously lamellate.
3. Leaves with an areolate reticulation; nerves obscure on both sides . . . . . **1. L. javensis**
3. Leaves with scalariform or subscalariform reticulation; nerves prominent beneath.
4. Cupule and fruit as broad as or broader than long.
5. Leaves (15–)18–22(–30) by (6–)8–10 (–13) cm; nerves 10–16 pairs.
6. Cupule 5–7 cm long and wide, smooth but set with spiral or rarely concentric rings. **2. L. hallieri**
6. Cupule 2–3 cm long, 3–4½ cm ø; surface strongly ridged with the ridges recurved or folded towards the base . . . . . **3. L. porcatus**
5. Leaves (6–)9–12(–15) by (2–)4–6(–8) cm; nerves fewer than 10 pairs.
7. Cupule 3–4½ cm long, 5–6 cm ø, apical opening up to 3 cm ø; fruit wall woody, ½–1½ cm thick, ruminate. . . . . **4. L. ruminatus**
7. Cupule 2–3½ cm long and wide, completely enclosing the fruit or with an apical opening of 3 mm ø.
8. Cupule sessile; lamellae 7–10, denticulate. Fruit wall thinner than 1 mm. Leaves thick-coriaceous; petiole 1–2 cm . . . . . **5. L. hendersonianus**
8. Cupule ½–1 cm stalked; lamellae 3–4, entire. Fruit wall woody, 2–5 mm thick. Leaf thin-coriaceous; petiole ½–1 cm . . . . . **6. L. burkillii**
4. Cupule and fruit longer than wide.
9. Cupule with a truncate top. Leaf thick-coriaceous, rigid . . . . . **7. L. turbinatus**
9. Cupule umbonate at the top. Leaf coriaceous but not rigid.
10. Cupule lengthwise ridged, especially when young. Leaves (7–)10–12(–16) by 3–6 cm; petiole 1–2 cm; nerves 5–9 pairs . . . . . **8. L. beccarianus**
10. Cupule not lengthwise ridged, even when young. Leaves (13–)17–20(–22) by (5–)6–8(–10) cm; petiole 2–3 cm; nerves (13–)16–20(–22) pairs . . . . . **9. L. maingayi**
2. Cupule tuberculate or muricate.
11. Cupule obovoid, pear-shaped, the lower ⅔ part smooth or lengthwise ridged, the remainder tuberculate. Leaf thin-coriaceous; nerves 9–11 pairs . . . . . **10. L. rotundatus**
11. Cupule obconical, surface covered all over with short thick tubercles or with recurved, hook-shaped thick scales. Leaf thick-coriaceous, rigid; nerves (9–)11–18(–22) pairs.
12. Leaves densely greyish tomentose beneath; midrib and nerves thin on both sides; nerves 9–13 pairs; reticulation obscure on both sides. Cupule set with hook-shaped, thick scales 2–5 mm long. **11. L. echinifer**
12. Leaves densely yellowish to rufous tomentose; midrib and nerves thick, strongly prominent beneath; nerves 12–22 pairs; reticulation distinct beneath. Cupule tuberculate . . **12. L. pulcher**
1. Fruit for the greater part free from the cupule, though sometimes enclosed by it, *i.e.* scar relatively small.
13. Greater part of the fruit enclosed by the cupule, although not adnate to its wall.
14. Cupule densely set with soft or stiff, spine-like appendages of 2–15 mm long.
15. Branchlets glabrous. Appendages of the cupule soft, 1–1½ cm long. Styles 2–2½ mm long, 4–5 times as long as the perianth . . . . . **13. L. longispinus**
15. Branchlets densely pubescent. Appendages of the cupule rigid, shorter than 5 mm. Styles 1–1½ mm long, 2–3 times as long as the perianth.
16. Branchlets and undersurface of the leaves densely pubescent by stiff simple hairs. Nerves more than 15 pairs. Fruit broader than long . . . . . **14. L. wrayi**
16. Branchlets and undersurface of the leaves densely pubescent by woolly, stellate hairs. Nerves less than 15 pairs. Fruit as long as or longer than broad. . . . . **15. L. coopertus**
14. Cupule lamellate, squamose, tuberculate, to almost smooth.
17. Cupule tuberculate or squamose with the scales adpressed and irregularly set; in *L. kostermansii* there are in addition 3–4 thin lamellae in the basal part.
18. Cupule tuberculate; wall up to 2 mm thick. . . . . **16. L. confragosus**
18. Cupule squamose; wall thinner than 1 mm.
19. Fruit as long as or longer than broad. Leaves with more than 12 nerves; reticulation dense, scalariform, distinct beneath . . . . . **17. L. neorobinsonii**
19. Fruit broader than long. Leaves with less than 12 pairs of nerves; reticulation lax, subscalariform, obscure on both sides . . . . . **18. L. kostermansii**

[1] The term 'tomentose' is used for any indument which is continuous interwoven and does not show the parenchyma beneath, *irrespective* of its thickness and the size of the hairs; the latter may be of microscopical dimension and the tomentum very thin.

17. Cupule lamellate, or squamose with the scales set in concentric lines to almost smooth.
20. Fruit densely fulvous to silvery tomentose; top not elongate-acuminate.
21. Leaves thick-coriaceous, rigid; petiole 2–4 mm thick. Cupule sessile. Fruit densely rufous tomentose . . . . . **19. L. pattaniensis**
21. Leaves coriaceous but not rigid; petiole thinner than 2 mm. Cupule ½–2½ cm stalked. Fruit densely yellowish to silvery tomentose.
22. Leaves 8–15 by 4–6 cm; nerves less than 12 pairs. Cupule 1–2½ cm stalked.
23. Cupule with a rounded top, outside with distinct longitudinal streaks. Leaves dark greyish brown; petiole *c.* 1 cm; nerves anastomosing near the margin; reticulation lax, subscalariform to irregular . . . . . **20. L. encleisacarpus**
23. Cupule with an acute top, smooth or with obscure longitudinal streaks. Leaves greenish to chocolate-brown; petiole 1½–2½ cm; nerves not anastomosing near the margin; reticulation dense, scalariform . . . . . **21. L. mariae**
22. Leaves 15–22 by 6–8 cm; nerves more than 12 pairs. Cupule subsessile . . **22. L. macphailii**
20. Fruit glabrous, top elongate-acuminate . . . . . **23. L. blumeanus**
13. Greater part of the fruit exserted from the cupule.
24. Cupule and fruit larger than 3½ cm ø.
25. Cupule variously lamellate.
26. Lamellae prominent.
27. Cupule ½–2½ cm stalked.
28. Reticulation areolate. Fruit glabrous.
29. Branchlet yellowish grey. Reticulation obscure on both sides.Lamellae strongly prominent. Fruit with a depressed-umbonate top . . . . . **24. L. platycarpus**
29. Branchlet blackish brown. Reticulation distinct beneath. Lamellae not strongly prominent. Fruit with a rounded top . . . . . **25. L. perakensis**
28. Reticulation scalariform. Fruit densely tomentose . . . . . **26. L. sericobalanus**
27. Cupule sessile.
30. Reticulation obscure, areolate or irregular.
31. Leaves glabrous; top not acuminate; nerves thin, obscure on both sides; petiole 2–5 mm long. Cupule woody, lamellae strongly prominent. Fruit glabrous, wall 3–5 m thick. **27. L. lucidus**
31. Leaves tomentose beneath; top 1–1½ cm acuminate; nerves prominent beneath; petiole 10–15 mm long. Cupule and its lamellae thin. Fruit densely tomentose, wall *c.* 1 mm thick. **28. L. eichleri**
30. Reticulation scalariform, distinct beneath . . . . . **29. L. korthalsii**
26. Lamellae obscure.
32. Scar of the fruit deeply concave, conical in longitudinal section. Rim of the cupule recurved. **30. L. urceolaris**
32. Scar of the fruit flat to convex. Rim of the cupule not recurved.
33. Fruit longer than broad. Rim of the cupule thinner than ½ mm . . . . . **31. L. indutus**
33. Fruit broader than long. Rim of the cupule thicker than 1 mm.
34. Leaves (18–)20–25(–30) by (6–)7–9(–12) cm; nerves 14–20 pairs, strongly prominent beneath. Fruit with a depressed-umbonate top; scar strongly convex . . . . . **32. L. cyclophorus**
34. Leaves (7–)9–12(–15) by (2½–)3½–5(–6) cm; nerves 9–12 pairs, thin on both sides. Fruit with an acute or rounded top; scar flat . . . . . **33. L. luteus**
25. Cupule variously muricate or squamose.
35. Cupule obconical, 3–3½ cm high, 4½–5½ cm ø, covering ⅔ part of the fruit; rim thin, incurved over the rounded top of the fruit . . . . . **34. L. schlechteri**
35. Cupule broadly saucer-shaped or cup-shaped, 1–2¼ cm high, 4–5½ cm ø, covering ¼–½ part of the fruit.
36. Leaves thick-coriaceous, rigid, concolorous. Scar of the fruit concave to slightly convex at the centre.
37. Petiole 6–10 mm, 2–2½ mm ø. Leaf-margin not strongly recurved; top acute to ½–1 cm acuminate. Cupule with a thick rounded rim; scales concentrically set. Scar of the fruit 2½–4 cm ø, concave but convex at the centre . . . . . **35. L. megacarpus**
37. Petiole 5–6 mm, 3–4 mm ø. Leaf margin strongly recurved; top rounded-emarginate or bluntly acute. Cupule with a thin rim; scales imbricate. Scar of the fruit 2–2½ cm ø, concave. **36. L. revolutus**
36. Leaves thin-coriaceous, not rigid, discolorous. Scar of the fruit strongly convex to conical.
38. Cupule 1½–2¼ cm high, 4–4½ cm ø; scales adpressed. Fruit 2½–3 cm long, 3–4 cm ø; wall 5–7 mm thick. Nerves 7–10 pairs.
39. Cupule with a thick rounded rim; scales adpressed, obscure. Leaves with an acute top; reticulation obscure . . . . . **37. L. brassii**
39. Cupule with a thin rim; scales woody, thick, distinct. Leaves ½–1 cm acuminate; reticulation distinct beneath . . . . . **38. L. lauterbachii**

38. Cupule ½–1 cm high, 3½–5 cm ø; scales patent, woody, conical, 2–3 mm long. Fruit 1–2 cm long, 3–4½ cm ø; wall thinner than 3 mm. Nerves 11–16 pairs . . . . . **39. L. pallidus**
24. Cupule and fruit smaller than 3½ cm ø.
40. Cupule variously lamellate.
41. Branchlet and leaf densely tomentose by adpressed stellate hairs and erect simple or tuft-hairs.
42. Nerves anastomosing near the margin; reticulation coarse, distinct beneath.
43. Fruit densely greyish tomentose by adpressed simple hairs, top long-acuminate. Leaf-base acute; indumentum yellowish brown to rufous . . . . . **40. L. conocarpus**
43. Fruit densely fulvous tomentose by simple and stellate hairs, without a long-acuminate top. Leaves with a rounded to subcordate base; indumentum greyish brown . **41. L. atjehensis**
42. Nerves not anastomosing near the margin; reticulation fine, obscure on both sides.
44. Leaf thick-coriaceous, rigid; nerves 12–14 pairs. Scar of the fruit deeply concave. **42. L. dasystachyus**
44. Leaf papery to thin-coriaceous; nerves 8–10 pairs. Scar of the fruit flat to convex. **43. L. caudatifolius**
41. Branchlet and leaf densely tomentose by adpressed stellate hairs to glabrous.
45. Rim of the cupule thinner than ½ mm.
46. Leaves with regular, scalariform or subscalariform reticulation.
47. Fruit variously tomentose.
48. Scar of the fruit deeply concave. Nerves (11–)12–15(–16) pairs.
49. Leaves thin-coriaceous; nerves and reticulation dense . . . . . **44. L. ewyckii**
49. Leaves thick-coriaceous, rigid; nerves and reticulation lax.
50. Cupule ½ cm stalked. Nerves (12–)14–15(–16) pairs; reticulation distinct beneath. **45. L. cantleyanus**
50. Cupule sessile. Nerves 11–13 pairs; reticulation obscure . . . . . **46. L. meijeri**
48. Scar of the fruit flat or convex. Nerves (7–)8–10(–12) pairs.
51. Leaves 7–13 by 3–5 cm, index (1⅔–)2–2½(–3⅓), broadest at or below the middle.
52. Cupule obconical; lamellae 8–10, entire. Nerves not anastomosing near the margin. **47. L. daphnoideus**
52. Cupule cup-shaped; lamellae 5–8, denticulate. Nerves anastomosing near the margin. **48. L. philippinensis**
51. Leaves 12–17 by 5–8 cm, index (1⅔–)2(–3), broadest about the middle.
53. Leaf thick-coriaceous, rigid; midrib prominent on both sides; nerves flattish above. Cupule ½ cm stalked, all over with distinct lamellae. Fruit as long as or longer than broad . . . . . **49. L. apoensis**
53. Leaves thin-coriaceous, not rigid; midrib flattish above; nerves impressed above. Cupule sessile, lower part ridged or tuberculate, upper part with 5–7 obscure lamellae. Fruit broader than long . . . . . **50. L. glutinosus**
47. Fruit glabrous.
54. Leaf thin-coriaceous.
55. Cupule ⅓–1 cm high, 2–2½ cm ø. Scar of the fruit flat.
56. Indumentum of the branchlet and leaf greyish brown. Cupule cup-shaped, ½–1 cm high, covering ¼–⅓ part of the fruit . . . . . **51. L. solerianus**
56. Indumentum yellowish brown. Cupule saucer-shaped, ⅓–½ cm high, covering the basal part of the fruit . . . . . **52. L. mindanaensis**
55. Cupule ½ cm high, 1–1½ cm ø. Scar of the fruit concave.
57. Reticulation obscure. Fruit longer than broad, top rounded-acute . . **53. L. bennettii**
57. Reticulation distinct beneath. Fruit broader than long, top abruptly acuminate. **54. L. confertus**
54. Leaf thick-coriaceous, rigid.
58. Leaf strongly bullate; petiole shorter than 5 mm . . . . . **55. L. bullatus**
58. Leaf not bullate; petiole 7–15 mm long.
59. Leaf sparsely pubescent; base long decurrent down to the base of the petiole; margin strongly recurved; petiole 5–6 mm ø . . . . . **56. L. rigidus**
59. Leaf densely tomentose beneath; base short decurrent; margin not strongly recurved; petiole thinner than 3 mm.
60. Fruit broader than long. Leaf index 1.6–2, blade broadest at or below the middle.
61. Reticulation obscure. Cupule and fruit usually smaller than 2 cm ø; lamellae 4–6. **57. L. nodosus**
61. Reticulation distinct beneath. Cupule and fruit usually larger than 2 cm ø; lamellae 7–10 . . . . . **58. L. woodii**
60. Fruit longer than broad. Leaf index 2–3, blade broadest at or above the middle.
62. Leaf with a thin cover of pale yellowish brown tomentum beneath; nerves not anastomosing near the margin. Cupule ½ cm high, 1.2–1.7 cm ø. Scar of the fruit concave. **59. L. hatusimae**

62. Leaf with a thick cover of fulvous to rufous tomentum beneath; nerves anastomosing near the margin. Cupule 1 cm high, 2.2 cm ø. Scar of the fruit flat . . **60. L. vidalii**

46. Leaf with an areolate or irregular reticulation.
63. Fruit tomentose.
64. Nerves with shorter ones not reaching the margin in between . . . . **61. L. reinwardtii**
64. Leaves without extra shorter nerves.
65. Leaf thin-chartaceous, (6–)9–11(–13) by (2½–)4–5(–6) cm, index 2–2⅓, broadest about the middle . . . . . **62. L. sulitii**
65. Leaves thick-coriaceous, (9–)12–20(–23) by (4–)5–8(–10), index 1⅔–2½, broadest about the middle.
66. Leaf discolorous; petiole 5–12 mm long; nerves anastomosing near the margin. **63. L. bancanus**
66. Leaf concolorous; petiole 15–25 mm long; nerves not anastomosing near the margin. **64. L. ovalis**
63. Fruit glabrous.
67. Leaf orbicular; petiole 3 mm long, 2 mm ø . . . . . **65. L. orbicularis**
67. Leaf not orbicular; petiole 5–20 mm long, 1–1½ mm ø.
68. Cupule ⅓ cm high, ¾–1⅓ cm ø . . . . . **66. L. pusillus**
68. Cupule ½–1 cm high, 1½–2⅔ cm ø.
69. Leaf *c.* 15–20 by 5–8 cm; nerves 14–15 pairs . . . . . **67. L. gracilis**
69. Leaf 5–13 by 2–4 cm; nerves less than 14 pairs.
70. Cupule with 6–10, prominent lamellae. Fruit broader than long. Petiole up to 2 cm. **68. L. rassa**
70. Cupule with 5–6 thin lamellae. Fruit as long as or longer than broad. Petiole shorter than 1 cm.
71. Midrib strongly prominent on both sides; nerves anastomosing near the margin. Fruit dark purplish brown . . . . . **69. L. andersonii**
71. Midrib thin on both sides; nerves not anastomosing near the margin. Fruit pale chocolate-brown . . . . . **70. L. vinkii**

45. Rim of the cupule thicker than 1 mm.
72. Leaf elliptic-lanceolate. Cupule sessile, sometimes in clusters of 2–3, 1–1½ cm high, 2–2½ cm ø. Fruit broader than long, top rounded . . . . . **71. L. clementianus**
72. Leaf ovate-elliptic. Cupule ⅓–½ cm stalked, ⅔–1 cm high, 2–2½ cm ø, always solitary. Fruit as long as or longer than broad, top acute . . . . . **72. L. suffruticosus**

40. Cupule squamose to muricate.
73. Cupule variously squamose.
74. Cupules, even when ripe, in clusters of 3–10.
75. Leaf and fruit glabrous.
76. Leaf pale brown, (9–)12–17(–20) by (3–)4–6(–8) cm, index (1½–)2–3(–5), base acute or rounded. Cupules in clusters of (3–)5–7(–10), scales distinct . . . . . **73. L. elegans**
76. Leaf greyish green, (18–)24–40(–56) by (5–)9–11(–16) cm, index 3–4, base cordate to auriculate. Cupules in clusters of 3, scales obscure . . . . . **74. L. jacobsii**
75. Leaf and fruit tomentose.
77. Fruit broader than long, densely yellowish brown tomentose. Leaf with a distinct, scalariform reticulation.
78. Leaf densely glaucous to greyish brown tomentose by adpressed stellate hairs beneath. Branchlet and petiole sturdy. Cupule larger than 2 cm ø. Scar of the fruit up to 2 cm ø. **75. L. lampadarius**
78. Leaf densely yellowish brown tomentose by adpressed stellate hairs and erect tuft-hairs beneath. Branchlet and petiole slender. Cupule smaller than 1½ cm ø. Scar of the fruit smaller than 1 cm ø . . . . . **76. L. wallichianus**
77. Fruit longer than broad, densely rufous tomentose. Leaf with an irregular, obscure reticulation . . . . . **77. L. erythrocarpus**
74. Cupules solitary, rarely in clusters of 2.
79. Leaf with a rounded or obtuse top.
80. Leaf 2½–5 by 1½–4 cm, index (1–)1½(–2); base rounded to subcordate; reticulation areolate; petiole 2–3 mm long, 1–1½ mm ø. Cupule *c.* 2½ cm ø. . . . . **78. L. oreophilus**
80. Leaf 6–13 by 3–7 cm, index 1½–2½; base acute; reticulation scalariform or subscalariform; petiole 5–13 mm long, 1–5 mm ø. Cupule smaller than 1½ cm ø.
81. Leaf without glandular papillae, thick-coriaceous, rigid, margin strongly recurved; nerves flattish on both sides, anastomosing near the margin. Indumentum consisting of adpressed and erect stellate hairs . . . . . **79. L. obtusifolius**
81. Leaf with glandular papillae above, not rigid coriaceous; margin not strongly recurved; nerves prominent beneath, impressed above, not anastomosing near the margin. Indumentum consisting exclusively of adpressed stellate hairs . . . . . **80. L. papillifer**

79. Leaf with an acute or acuminate top.
82. Leaf concolorous, glabrous, rarely sparsely pubescent.
83. Fruit densely reddish brown tomentose, as broad as or broader than long.
81. L. ferrugineus
83. Fruit glabrous, longer than broad.
84. Petiole (8–)10-15(-20) mm long.
85. Bud-scales densely silvery tomentose by simple hairs. Nerves (12–)14–17(–20) pairs, anastomosing near the margin . . . . . **82. L. falconeri**
85. Bud-scales densely fulvous tomentose by stellate hairs. Nerves (6–)9–10(–12) pairs, not anastomosing near the margin . . . . . **83. L. crassinervius**
84. Petiole 2–6 mm long.
86. Leaf sparsely pubescent by stellate hairs on both sides; base rounded to subcordate; nerves 10–13 pairs, anastomosing near the margin. . . . . **84. L. kunstleri**
86. Leaf glabrous; base attenuate-acute; nerves 7–8 pairs, not anastomosing near the margin.
85. L. pseudokunstleri
82. Leaf discolorous, densely tomentose at least beneath.
87. Fruit glabrous.
88. Branchlet and undersurface of the leaf with a thick cover of yellowish brown to rufous, adpressed, stellate hairs and erect, glandular tuft-hairs with bulbous base.
86. L. havilandii
88. Branchlet and undersurface of the leaf with a thin cover of greyish to fulvous adpressed and erect, non-glandular, stellate hairs without bulbous base.
89. Scar of the fruit conical. Cupule with obscure lamellae on the lower half.
87. L. sogerensis
89. Scar of the fruit flat to concave. Cupule all-over with distinct scales set in concentric lines or imbricate.
90. Fruit longer than broad; scar deeply concave . . . . . **88. L. celebicus**
90. Fruit broader than long; scar flat to shallowly concave.
91. Indumentum on the branchlet and leaf consisting of adpressed, stellate hairs and curled or erect tuft-hairs. Nerves (10–)12–14(–16) pairs; reticulation scalariform.
89. L. sundaicus
91. Indumentum of the branchlet and leaf consisting exclusively of adpressed, stellate hairs. Nerves 10–12 pairs; reticulation irregular to subscalariform . **90. L. pseudomoluccus**
87. Fruit variously tomentose.
92. Leaf smaller than 10 by 4 cm; nerves 6–8 pairs . . . . . **91. L. submonticolus**
92. Leaf larger than 10 by 4 cm; nerves more than 9 pairs.
93. Cupule 3–10 mm stalked; rim never undulate.
94. Fruit longer than broad; scar strongly convex. Petiole (7–)10(–11) mm long. Older branchlet glabrous . . . . . **92. L. castellarnauianus**
94. Fruit as broad as or broader than long; scar deeply concave, rarely flat. Petiole 3–6 mm long. Branchlet densely tomentose . . . . . **93. L. leptogyne**
93. Cupule sessile, rarely subsessile, rim often undulate.
95. Indumentum of the branchlet and leaf consisting of adpressed, stellate hairs and erect long simple hairs. Nerves strongly prominent beneath, anastomosing near the margin.
94. L. nieuwenhuisii
95. Indumentum of the branchlet and leaf consisting exclusively of adpressed stellate hairs. Nerves not strongly prominent beneath and not anastomosing near the margin.
95. L. curtisii

73. Cupule variously muricate.
96. Leaf glabrous.
97. Leaf thick-coriaceous, rigid; nerves more than 8 pairs; petiole 10–13 mm long. Fruit longer than broad, glabrous, scar deeply concave . . . . . **96. L. scortechinii**
97. Leaf coriaceous but not rigid; nerves less than 8 pairs, usually 6–7; petiole 4–8 mm long. Fruit as broad as or broader than long, densely fulvous tomentose, scar flat . . . **97. L. kingianus**
96. Leaf variously tomentose or pubescent.
98. Leaf concolorous, greenish grey, beneath with a thin cover of stellate tomentum.
99. Leaf (3½–)5–6(–8) by (1½–)2½–3(–3½) cm, index 2–2.7; petiole 4–6 mm long. Cupule cup-shaped, scales concentrically set. Fruit longer than broad, scar *c.* 6 mm ø.
98. L. luzoniensis
99. Leaf (9–)13–18(–21) by (3–)4–6(–7) cm, index 3–3½; petiole 8–15 mm long. Cupule flat saucer-shaped, scales irregularly set. Fruit broader than long, scar up to 1½ cm ø.
99. L. echinulatus
98. Leaf discolorous, not greenish grey, indumentum thick, consisting of adpressed, stellate hairs and erect or curled, simple or tuft-hairs.
100. Leaf 6–10 by 4–5 cm, index 1.3–2; indumentum yellowish brown.

101. Leaf thick-coriaceous, rigid, margin strongly recurved; reticulation fine, dense, scalariform; indumentum velvety. Fruit longer than broad. . . . . **100. L. jordanae**
101. Leaf coriaceous but not rigid, margin not strongly recurved; reticulation coarse, lax subscalariform, arched. Fruit as broad as or broader than long . . . **101. L. aspericupula**
100. Leaf 10–20 by 3½–7 cm, index 2–3.3; indumentum fulvous to rufous.
102. Fruit and cupule smaller than 2 cm ø. Nerves less than 9 pairs . . . . **102. L. buddii**
102. Fruit and cupule 2–3½ cm ø. Nerves more than 9 pairs, usually 10–14.
103. Indumentum consists of adpressed stellate hairs and curled stellate or tuft-hairs. Nerves less than 12 pairs, usually about 10; reticulation lax. Fruit chocolate-brown, top rounded. **103. L. rufovillosus**
103. Indumentum consists of adpressed stellate hairs and erect stellate or tuft-hairs. Nerves 12–16 pairs; reticulation dense. Fruit dark purplish brown, top with a long acuminate end, especially when young . . . . . **104. L. hystrix**

1. Lithocarpus javensis BL. Bijdr. (1826) 527; Fl. Jav. Cupul. (1829) 35, t. 20; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 19, t. 11; A. CAMUS, Chênes 3 (1954) 572, t. 351: 1–20; SOEPADMO, Reinwardtia 8 (1970) 249. — *Quercus costata* BL. Bijdr. (1826) 522; Fl. Jav. Cupul. (1829) 25, t. 13, *incl. var. β, l.c.* 26, t. 14; KORTH. Kruidk. (1844) 212; BL. Mus. Bot. 1 (1850) 301, *incl.*

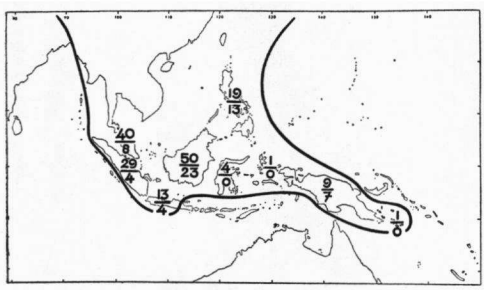

Fig. 17. Species density of *Lithocarpus* in Malesia, above the hyphen the number of non-endemic species, below the hyphen the number of endemic species in the island or island group.

var. convexa et var. subrecurvata BL. *l.c.* 302; MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 116; A.DC. Prod. 16, 2 (1864) 93, *incl. var. convexa* BL. *l.c.* 94; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 239; K. & V. Bijdr. 10 (1904) 60; KOORD. Atlas 1 (1913) t. 46; BACKER & BAKH. *f.* Fl. Java 2 (1965) 6. — *Quercus javensis* (BL.) MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 117; A.DC. Prod. 16, 2 (1864) 104; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 238; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 83, t. 76 B; K. & V. Bijdr. 10 (1904) 58; KOORD. Atlas 1 (1913) t. 48; BACKER & BAKH. *f.* Fl. Java 2 (1965) 6. — *L. scutigera* OUDEM. Versl. Med. Kon. Ak. Wet. Natuurk. 12 (1861) 207; Natuurk. Verh. Kon. Akad. 11 (1865) 20, t. 12. — *Cyclobalanus javensis* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Cyclobalanus costata* (BL.) OERST. *l.c.* — *Pasania javensis* (MIQ.) PRANTL in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 55. — *Synaedrys javensis* (BL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 189. — *Synaedrys costata* (BL.) KOIDZ. *l.c.* 188. — *L. costata* (BL.) REHD. J. Arn. Arb. 1 (1919) 124; A. CAMUS, Chênes 3 (1954) 580, t., *incl. var. convexa* (BL.) A. CAMUS, *l.c.* 582, t. 353: 1–9. — *L. costata var. scutigera* (OUDEM.) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 254; Chênes 3 (1954) 582, t. 354: 1–5. — *L. costata var. typica* A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 254; Chênes 3 (1954) 582, t. 353: 10–15, t. 354: 6–8. — **Fig. 18.**

Tree 20–50 m, 30–100 cm ø; buttresses up to 1½ m tall; bark grey, shallowly fissured. *Branchlets* initially with a dense reddish brown indument, later glabrous, pale to greyish brown, sparsely lenticellate; terminal bud ovoid-ellipsoid, 3–5 by 2–3 mm, scales narrowly ovate to linear. Stipules narrowly ovate or subulate, 5–9 by 1–2 mm, rather long persistent. *Leaves* thick-coriaceous, (5–)8–12(–16) by (2–)3–4(–6) cm (index 2–3), broadest at or slightly below the middle; surfaces more or less concolorous, above glabrous, dull, beneath densely greyish tomentose by adpressed, stellate hairs, glabrescent; base acute to cuneate, rarely rounded, margin entire, recurved, top bluntly acute to ½–1 cm acuminate; midrib prominent beneath, slightly so above; nerves 10–14 pairs, obscure on both sides, subparallel, at an angle of 45–60°, arcuating and anastomosing towards the margin; reticulation fine, areolate, distinct beneath; petiole ½–1½ cm, 1–2 mm ø, adaxially flat. *Inflorescence* male, androgynous, or mixed, densely fulvous-tomentose by stellate hairs; bracts linear-acute, 1–3 by ½–1 mm, bracteoles ovate-acute, 1–1½ by ⅔–1 mm. *Male rachis* 10–20 cm, 1–2 mm ø; ♂ flowers in clusters of 3–7, perianth 6-lobed, stamens 12–16, filaments 3–4 mm, anthers 0.3–0.4 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 5–10 cm, 1½–2 mm ø; *female flowers* solitary, sometimes in clusters of 2–3, perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1–1½ mm, connate. Young cupule solitary or in clusters of 2–3, obovoid to ellipsoid, 1–2½ cm stalked; outside with 5–8 more or less concentric, prominent lamellae, densely greyish brown stellate-tomentose, apical opening ½–1½ cm ø. *Ripe cupule* sessile or 1–1½ cm stalked, ellipsoid-globose or obovoid, 3–5 cm long, 3½–5½ cm ø, covering the fruit almost completely or with an apical opening of ½–3 cm ø; wall woody, 2–3 mm thick, outside with 5–10 thin to strongly prominent lamellae, densely greyish tomentose by simple and stellate hairs. *Ripe fruit*

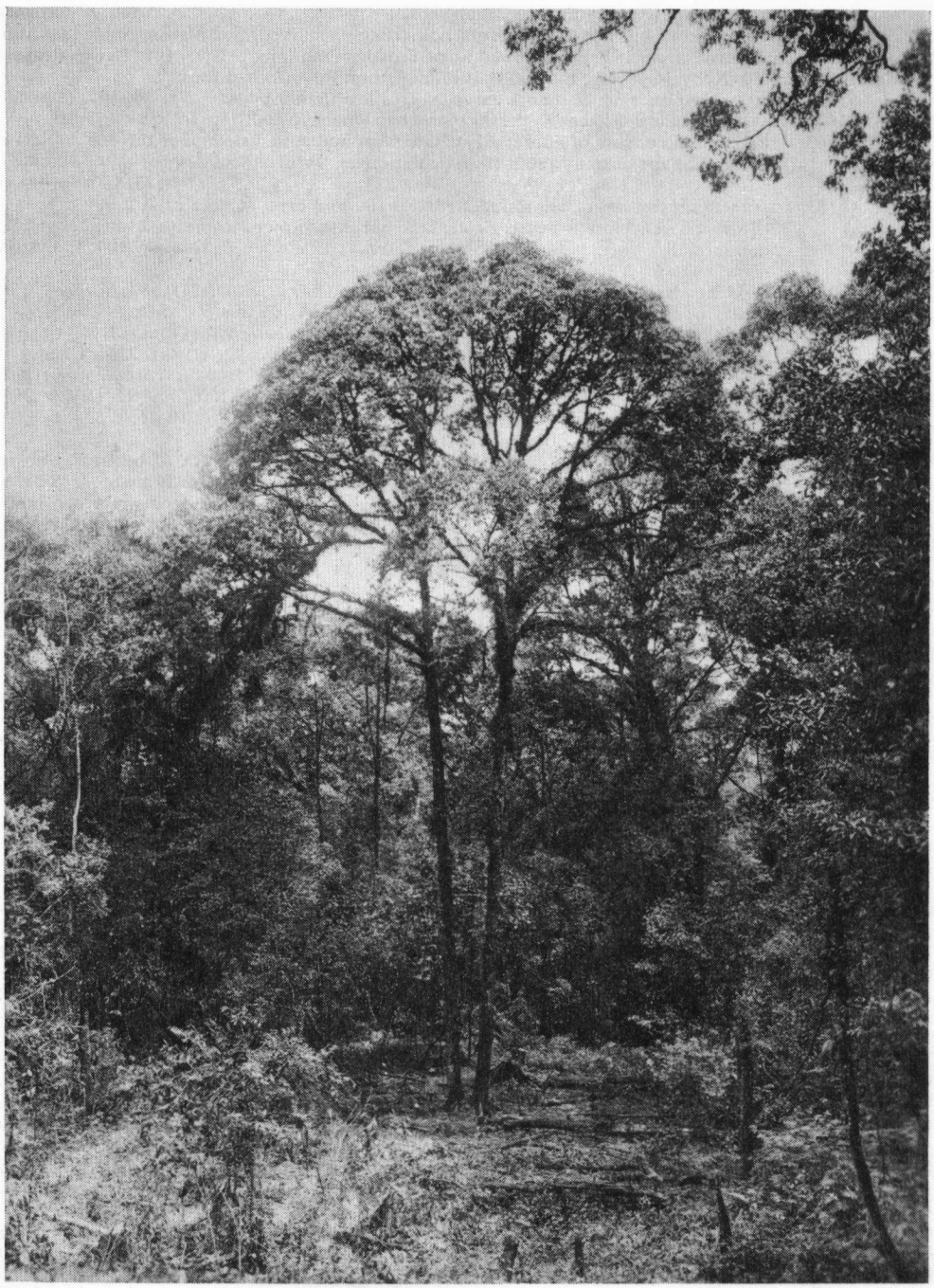

Fig. 18. *Lithocarpus javensis* BL. (*pasang batu*) in the West Javanese mountain forest of Priangan Prov. (J. VAN ROOSENDAAL, Dec. 1919).

depressed ovoid-globose, 3–4 cm long, 3½–5 cm ø; wall woody, ½–1 cm thick, for the greater part adnate to the cupule, upper free part flat to convex, ½–3½ cm ø, densely greyish brown tomentose, glabrescent; scar rounded, rugose; cotyledons flat-convex.

Distr. *Malesia*: Sumatra (various localities), also Singkep I., Malay Peninsula (rare), Java (rather common in the western parts, eastwards to Mt Ungaran in Central Java).

Ecol. Forests up to 1800 m. *Fl.* July-Sept., *fr.* Oct.-Aug.

Notes. In the previous works *L. costata* was distinguished from *L. javensis* by its cupule with apical aperture wider than ½ cm. In JUNGHUHN *n.* from Mt Malabar (described by OUDEMANS as *L. scutigera*) and JACOBS 4564 (from Mt Kerintji, Central W. Sumatra), however, the cupule is intermediate between that of *L. javensis* and *L. costata*. Furthermore the leaves of these three species are exactly the same. In 1826, and also in 1829, BLUME recognized two varieties under *Quercus costata*, differing from each other by the fruit. In the typical variety the upper free part of the fruit is flat to concave, while in the other it is convex. In 1850, BLUME named the latter variety *var. convexa*. The type specimens at Leyden show that no sharp boundary between these two varieties can be drawn. In 1888, HOOKER *f.* attributed several specimens from Malaya to *Quercus costata*, apparently without examining the original specimen of BLUME. KING (1889) followed HOOKER, and on account of the convex fruit included the Malayan specimens in *var. convexa*. GAMBLE (1914) working on the Malayan specimens only, included *Quercus costata* in the genus *Pasania*, and placed them in the subgenus *Cyclobalanus*. In 1954, A. CAMUS disagreed with HOOKER, KING, and GAMBLE, and transferred *Quercus costata* to the genus *Lithocarpus*, recognizing four distinct varieties, *viz. var. typica, convexa, scutigera* (all from Java) and *var. kingii* for the Malayan specimens. I consider *L. costata* (BL.) REHD. *var. kingii* A. CAMUS as a separate species, differing from *L. javensis* (incl. *L. costata* and its varieties, and *L. scutigera*) by its cupule enclosing the lower part of the fruit only (see 25. *L. perakensis*).

2. Lithocarpus hallieri (VON SEEMEN) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 579, t. 352; SOEPADMO, Reinwardtia 8 (1970) 244. — *Quercus hallierii* VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 11; MERR. Univ. Calif. Publ. Bot. 15 (1929) 44. — *Synaedrys hallierii* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 189.

Tree 12–48 m, 10–70 cm ø; bark smooth to flaky, lenticellate, greyish brown. *Branchlets* initially densely reddish brown adpressed-stellate-hairy, later glabrescent, terete, dark coloured, smooth to shallowly fissured; terminal buds ovoid-ellipsoid, *c.* 8 by 3 mm, scales ovate to lanceolate. *Leaves* thick-coriaceous, (15–)16–20(–30) by (6–)8–10(–11) cm (index 2–3), broadest above or at the middle; surfaces more or less concolorous, above glabrous, dull to glossy, underneath sparsely to densely greyish tomentose by stellate hairs; base rounded to cuneate, decurrent, top bluntly acute to 1 cm acuminate; midrib prominent beneath, slightly so above; nerves (8–)10–11(–13) pairs, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin, prominent beneath, impressed above; reticulation subscalariform, obscure on both sides; petiole 1–3 cm, 2–3 mm ø, adaxially flat. *Male inflorescence* not known. *Female rachis c.* 15 cm, 2 mm ø; bracts and bracteoles ovate, *c.* 1–2 by 1 mm; ♀ flowers solitary, perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, *c.* 2 mm, more or less connate. Young infructescence 15–20 cm, 4–5 mm ø, densely tomentose by stellate hairs, carrying 15–20 young cupules. *Ripe cupule* sessile to ½–1 cm stalked, obovoid-globose, 5–7 cm through; wall woody, 2–3 mm thick, outside densely greyish tomentose, with 5–7 spiral or rarely concentric lamellae; base rounded-attenuate, top rounded with a small opening of 5–7 mm ø. *Ripe fruit* subglobose, 3–4½ cm long, 4–6 cm ø; wall woody, ½—1½ cm thick, for the greater part adnate to the cupule; free part (top) truncate-umbonate, densely yellowish brown tomentose, base rounded.

Distr. *Malesia*: Borneo (scattered in the western part of Kalimantan, Sarawak, and Sabah).

Ecol. Forests up to 1350 m, on yellowish sandy soil. *Fr.* Oct.–July.

3. Lithocarpus porcatus SOEPADMO, Reinwardtia 8 (1970) 268.

Tree 10–45 m, 20–50 cm ø; bark smooth to flaky. *Branchlets* initially densely fulvous, adpressed stellate-hairy, later subglabrous, warty lenticellate; terminal buds ovoid, 3 by 2 mm, scales ovate-acute. *Leaves* thick-coriaceous, (15–)20–22 (–26) by (7–)9–10(–13) cm (index 1.8–2.5), broadest at or above the middle; surfaces more or less discolorous, above glabrous, dark chocolate-brown, glossy, underneath densely greyish tomentose by adpressed stellate hairs, subglabrescent; base abruptly rounded-acute to cuneate, margin undulate, top bluntly acute; midrib and nerves strongly prominent beneath, flat above; nerves (12–)13–14(–16) pairs, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, scalariform, obscure on both sides; petiole ½–1½ cm, 2 mm ø, rugose and thickened at base, adaxially flat. *Inflorescence* male or female, densely yellowish brown tomentose by adpressed stellate hairs; bracts and bracteoles ovate to linear, ⅔–1½ by ½–⅔ mm. *Male rachis* 10–30 cm, 1–2 mm ø; ♂ flowers in clusters of 3, rarely solitary, perianth 6-lobed, stamens 12, filaments 2–3½ mm, anthers 0.3–0.4 mm long, pistillode subglobose, *c.* 1 mm ø. *Female rachis* 10–15 cm, 3 mm ø; ♀ flowers solitary, perianth 6-lobed, staminodes 12, rudimentary, styles 3–4, terete, ⅔–1 mm. Infructescence 10–15 cm, ½–1 cm ø, densely warty lenticellate, carrying many young cupules. *Cupule* (not yet fully developed) ½–1 cm stalked, depressed-ovoid-globose, 2–3 cm long, 3–4 cm ø, top flat with a

small opening of 1–5 mm ø, base rounded; outside with 5–10 concentric or rarely spiral prominent lamellae which are sometimes folded towards the base, densely yellowish brown tomentose. *Fruit* depressed-subglobose, 1–1½ cm long, 1½–2 cm ø; wall woody 1–2 mm thick, for the greater part adnate to the cupule; top flat-umbonate, densely yellowish brown tomentose, base rounded.

Distr. *Malesia*: Borneo (SW. Sarawak: Mt Penrissen; Sabah).

Ecol. Forests up to 1500 m, usually by riverbanks. *Fl.* Sept., *fr.* Oct.–June.

4. Lithocarpus ruminatus SOEPADMO, Reinwardtia 8 (1970) 277.

Tree 10–20 m, 20–30 cm ø; bark greyish brown, smooth to flaky. *Branchlets* initially densely fulvous-tomentose by adpressed stellate hairs, later subglabrous, greyish, sparsely lenticellate; terminal buds ovoid, 2–3 by 2 mm, scales ovate. Stipules linear-acute, 2–3 by ½ mm, caducous. *Leaves* thick-coriaceous, (6–)9–12(–16) by (3–)4–5(–8) cm (index 2–3), broadest at or below the middle; surfaces more or less discolorous, above glabrous, more or less glossy, greyish green, underneath densely greyish tomentose with adpressed, stellate hairs; base rounded and abruptly acute to cuneate, margin recurved, top bluntly to sharply acute; midrib prominent beneath, slightly so above; nerves 6–8 pairs, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, lax, subscalariform, obscure on both sides; petiole ½–1 cm, 2 mm ø, thickened and rugose at base, adaxially flat. *Inflorescence* male, androgynous or mixed, densely yellowish brown to fulvous tomentose by stellate hairs; bracts and bracteoles ovate acute, ½–1 by ½ mm. *Male flowers* (seen on the upper part of an androgynous rachis) solitary, perianth 6-lobed, stamens 12, filaments 2½–4 mm long, anthers 0.35 mm long, pistillode subglobose, *c.* 2 mm ø. *Androgynous rachis* 15–20 cm, 2 mm ø; *female flowers* solitary, perianth 6-lobed, staminodes 12, well developed and exceeding the perianth, styles 3, conical, ⅔–1 mm. *Ripe cupule* subsessile, subhemispherical to depressed obovoid-globose, 3–4½ cm long, 5–6 cm ø, base attenuate-rounded, top truncate with an opening of 2–3 cm ø; wall woody, *c.* ½ cm thick, outside with 8–10 concentric lamellae, 5–6 of which on the truncate top, densely greyish brown tomentose by short stellate hairs, subglabrescent. *Ripe fruit* subhemispherical to depressed-obovoid-globose, 3–4 cm long, 4–5 cm ø; wall woody, ruminate, ½–1½ cm thick, for the greater part adnate to the cupule; top convex, depressed-umbonate at the centre, densely reddish brown tomentose, base rounded.

Distr. *Malesia*: Borneo (Sabah).

Ecol. Forests, from the lowland up to 2000 m. *Fl.* Sept., *fr.* March-Aug.

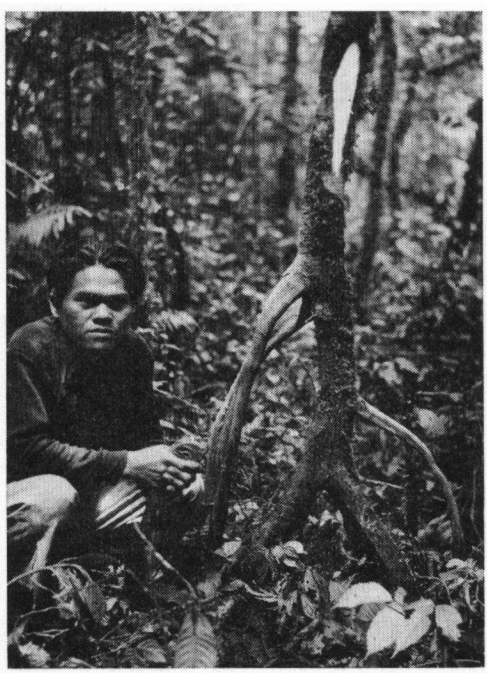

Fig. 19. Characteristic stilt-rooted stem-base of young *Lithocarpus sp.* in mountain forest at 2000 m on Mt Gedeh, West Java (W. MEIJER, Aug. 1956).

5. Lithocarpus hendersonianus A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 6 (1934) 92; Chênes 3 (1954) 589, t. 358: 9–14; SOEPADMO, Reinwardtia 8 (1970) 246.

Tree 20–30 m, *c.* 60 cm ø; bark smooth, grey. *Branchlets* initially densely yellowish brown tomentose by stellate hairs, soon glabrescent, greyish black, with dense minute lenticels; terminal buds ovoid-globose, 1–2 mm, scales ovate-acute. *Leaves* thick-coriaceous, (8–)10–15(–18) by (2½–)4–6(–7) cm (index 2½–3⅓), broadest at or below the middle; surfaces more or less concolorous, above glabrous, glossy, underneath sparsely yellowish grey tomentose by stellate hairs; base rounded and abruptly acute to cuneate, margin recurved, top abruptly acute to sharply 1–2 cm acuminate; midrib and nerves prominent beneath, obscure and flattish above; nerves 7–10 pairs, subparallel, at an angle of 45–60°, arcuating but hardly anastomosing near the margin; reticulation fine, lax, subscalariform, obscure on both sides; petiole 1–2 cm, 1–2 mm ø, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown tomentose by short stellate hairs; bract and bracteoles ovate-acute 1–1½ by 0.7 mm. *Male rachis* 5–10 cm, 1 mm ø; ♂ flowers in clusters of 3–7, perianth 6-lobed, stamens 12, filaments 1–1½ mm, anthers 0.2–0.25 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis* 5–10 cm, 1 mm ø; *female flowers* in clusters of 2–5, perianth deeply 6-lobed, staminodes 12, rudimentary, styles 3, conical, *c.* 1½ mm, recurved. *Cupule* (not fully developed) sessile, ellipsoid-globose, 2–3 cm through; wall thinner than 1 mm, outside densely

yellowish brown tomentose, with 7–10 more or less concentric, undulating, denticulate lamellae; base rounded, top truncate, with a small opening of less than 3 mm ø. *Fruit* (not fully developed) globose, 2–2½ cm through; wall thinner than 1 mm, for the greater part adnate to the cupule; free part (top) *c.* 1 cm ø, rotundate, densely tomentose, base rounded.

Distr. Peninsular Siam (Ranawang at 10° N), in *Malesia*: Malay Peninsula (Cameron Highlands).

Ecol. Forests at 1300–1500 m. *Fl.* July-April, *fr.* April.–Nov.

6. Lithocarpus burkillii A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 5 (1933) 88; Chênes 3 (1954) 578, t.; SOEPADMO, Reinwardtia 8 (1970) 225.

Tree *c.* 24 m. *Branchlets* glabrous, blackish grey, densely rusty lenticellate. *Leaves* thin-coriaceous, 6–10 by 2–4 cm (index 2¼–3), broadest at or below the middle; surfaces discolorous, above glabrous, dark greyish brown, dull, beneath densely glaucous-tomentose by adpressed stellate hairs; base rounded-acute, margin undulate, top sharply acute to acuminate; midrib more or less prominent on both sides; nerves 8–10 pairs, parallel, at an angle of *c.* 60°, arcuating but not anastomosing towards the margin, obscure on both sides; reticulation fine, subscalariform, obscure on both sides; petiole ½–1 cm, 1–2 mm ø, adaxially flat. *Inflorescence* not known. *Cupule* ½–1 cm stalked, obovoid-globose, 2½–3½ cm through; wall woody, 1–2 mm thick, outside with 3–4 more or less concentric lamellae, densely greyish brown tomentose by short stellate hairs; base rounded-attenuate, top rotundate, covering the fruit almost completely except for a very small opening at the tip. *Fruit* depressed-subglobose, 1½–2 cm long, 2–3 cm ø; wall woody, 2–5 mm thick, for the greater part adnate to the cupule; top ½–1 cm ø, depressed-umbonate, base rounded.

Distr. *Malesia*: Malay Peninsula (Fraser Hill).

Ecol. Forests at *c.* 1200 m. *Fr.* Sept.–Nov.

7. Lithocarpus turbinatus (STAPF) FORMAN, Kew Bull. 18 (1966) 423; SOEPADMO, Reinwardtia 8 (1970) 284. — *Castanopsis turbinata* STAPF, Trans. Linn. Soc. Lond. II, Bot. 4 (1894) 232. — **Fig. 20.**

Tree 5–12 m, *c.* 30 cm ø, usually crooked; bark peeling off profusely. *Branchlets* initially densely rufous-tomentose by stellate hairs, later subglabrous, sturdy with thick nodes, yellowish grey, smooth to finely fissured; terminal buds ovoid-ellipsoid, 3–6 by 3–4 mm, scales ovate-acute. Stipules linear-acute, 1½–2 by ½–⅔ mm, soon caducous. *Leaves* thick-coriaceous, rigid, (6–)8–12(–15) by (2–)3–6(–8) cm (index 1.6–2.8), broadest below or at the middle; surfaces more or less discolorous, above dull, chocolate-brown, glabrous except the midrib, beneath densely yellowish brown tomentose by adpressed stellate hairs; base rounded and abruptly acute to acute, margin recurved, top abruptly acute to 1–1½ cm acuminate, tip sharp, usually oblique; midrib and nerves strongly prominent beneath, impressed above; nerves (6–)7–9(–12) pairs, subparallel, at an angle of 60–80°, arcuating and anastomosing near the margin; reticulation fine, lax, scalariform, distinct beneath; petiole ½–1½ cm, 1–4 mm ø, adaxially flat. *Inflorescence* male, female, androgynous or mixed, densely fulvous to rufous tomentose by stellate hairs; bracts and bracteoles ovate-acute to linear, thick-coriaceous, 1½–3 by ⅔–1 mm. *Male rachis c.* 10 cm, 1½–2 mm ø; ♂ flowers solitary or in clusters of 3–7, perianth 6-lobed, stamens usually 12, filaments 4–5 mm, anthers 0.4–0.5 mm long, pistillode subglobose, 1½–2 mm ø. *Female, androgynous* or *mixed rachis* 4–6 cm, 3–5 mm ø; ♀ flowers solitary or in clusters of 3–7, perianth thick-coriaceous, 6-lobed, staminodes 12, sometimes well-developed and exceeding the perianth, styles 3–5, conical, 2½–3 mm, recurved. Rachis of the infructescence sturdy. Young cupule subsessile, in clusters of 3–7, outside with acroscopical scales arranged in concentric lines, greyish black, densely tomentose by short stellate hairs. *Ripe cupule* sessile, obovoid-ellipsoid, 6–7 cm long, 5–6 cm ø, base rounded, top rounded, depressed at the centre, opening less than ½ cm ø; wall woody, greyish black, 2–5 mm thick, outside lenticellate, with 8–10 concentric, rarely spiral, entire or denticulate lamellae, mainly on the rotundate top. *Fruit* ellipsoid-globose, 5–6 cm long, 4–5 cm ø; wall woody, 1–2 cm thick, for the greater part adnate to the cupule; top *c.* 2 cm ø, densely tomentose, base rounded.

Distr. *Malesia*: Borneo (N. Sarawak, and several localities in Sabah, especially on Mt Kinabalu).

Ecol. In mossy forest at 1200–3000 m, usually on steep ridges. *Fl.* Febr.–Oct., *fr.* Nov.–July.

Note. Though the young cupules are in clusters of 3–7, at maturity only one or two are fully developed, the others remain abortive and sometimes may be seen at the base of the well-developed cupule(s).

8. Lithocarpus beccarianus (BENTH.) A. CAMUS, Riviera Scient. 18 (1932) 39 ('*beccariana*'); Chênes 3 (1954) 575, t. 355: 1–7; SOEPADMO, Reinwardtia 8 (1970) 220. — *Quercus beccariana* BENTH. in Hook. *f.* Ic. Pl. (1880) t. 1315; HOOK. *f.* Fl. Br. Ind. 5 (1888) 618; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 83. — *Pasania beccariana* (BENTH.) PRANTL in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 55. — *Synaedrys beccariana* (BENTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 188.

Tree 15–30 m, 20–70 cm ø; bark greyish brown to dark brown, smooth to scaly, lenticellate. *Branchlets* initially densely yellowish brown tomentose by adpressed stellate hairs, late glabrescent, slender, fissured to flaky, sparsely lenticellate; terminal buds ovoid-ellipsoid, 3–4 by 2–3 mm, scales ovate to linear-acute. Stipules linear-acute, 3–4 by 1/3–½ mm, soon caducous. *Leaves* more or less coriaceous, (7–)10–12(–16) by 3–6 cm (index 2–3.7), broadest at or slightly above the middle; surfaces discolorous, above glabrous, glossy, greyish brown, underneath densely yellowish tomen-

Fig. 20. *Lithocarpus turbinatus* (STAPF) FORMAN. *a.* Habit with ♂ rachis, *b.* ♀ rachis, *c.* terminal bud, *d.* ♂ flower, *e.* ♀ flowers, *f.* longitudinal section of a ♀ flower, *g.* young cupules, *h.* ripe cupule, *i.* ripe cupule seen from above, *j.* ripe fruit, *k.* ripe fruit seen from above, *l.* longitudinal section of cupule and fruit; *a–b, g–l* ×⅔, *c–f* ×4 (*a* & *d* SAN 29053, *b* & *e* SAN A 4472, *c* & *g* CLEMENS 33654, *f* & *l* JACOBS 5777, *h–i* HOLTTUM *s.n.*, *j–k* SAR 20209).

tose by adpressed stellate hairs; base acute to cuneate, rarely rounded, margin recurved, top abruptly acute to ½–1 cm acuminate, with a blunt tip; midrib strongly prominent beneath, impressed above; nerves (5–)7–8(–9) pairs, more or less prominent beneath, impresssed above, parallel, at an angle of 45–70°, arcuating but not anastomosing towards the margin; reticulation dense, fine, scalariform, distinct beneath; petiole 1–2 cm, 1–2½ mm ø, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown tomentose by short stellate hairs; bracts and bracteoles ovate-acute, 1–1½ by 1/3–½ mm. *Male rachis* 5–10 cm, 1 mm ø; ♂ flowers in clusters of 3 or solitary, perianth 6-lobed, stamens 12, filaments 1⅓–1½ mm, anthers 0.25 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis c.* 10 cm, 2 mm ø; *female flowers* solitary, perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1–1½ mm, recurved. *Ripe cupule* 1–1½ cm stalked, ellipsoid, up to 10 by 6 cm, covering the fruit completely; wall woody, 3–5 mm thick, outside densely yellowish brown tomentose by short stellate hairs, longitudinally ridged especially when young, with 5–8 undulating lamellae; base attenuate-rounded, top rotundate-umbonate. *Ripe fruit* ellipsoid, 5–7 cm long, 4–5 cm ø; wall woody, ½–1½ cm thick, for the greater part adnate to the cupule, scar rounded-attenuate, free part convex, umbonate, densely yellowish brown tomentose by simple hairs; cotyledons flat-convex.

Distr. *Malesia*: Borneo (Sarawak, Sabah, Kalimantan, scattered).

Ecol. Forests up to 1500 m, on dark brown sandstone derived soil. *Fl.* March-May, *fr.* June-Nov.

Note. Authors who recorded this species from Penang and Singapore are supposed to have had specimens of *L. burkillii*. BANGHAM 1118 from Sumatra, referred by MERRILL to *L. beccariana*, belongs to *L. javensis*.

9. Lithocarpus maingayi (BENTH.) REHD. J. Arn. Arb. 1 (1919) 128; A. CAMUS, Chênes 3 (1954) 577, t. 356; SOEPADMO, Reinwardtia 8 (1970) 257. — *Quercus maingayi* BENTH. in Hook. *f.* Ic. Pl. (1880) t. 1314; HOOK. *f.* Fl. Br. Ind. 5 (1888) 617 ('*maingayii*'); KING, Ann. R. Bot. Gard. Calc. 2 (1889) 82, t. 77; CORNER, Ways. Trees (1940) 304, f. 98. — *Pasania maingayi* (BENTH.) SCHOTTKY, Bot. Jahrb. 47 (1912) 627; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 452. — *Synaedrys maingayii* (BENTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 189.— *L. subnucifera* A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 4 (1932) 123; Chênes 3 (1954) 583, t. 354: 9–16.

Tree 10–15 m, 30–40 cm ø. *Branchlets* initially densely rufous-tomentose by short stellate hairs, later subglabrescent, sturdy, sparsely lenticellate; terminal buds ovoid, 3–5 by 2–3 mm, scales ovate-acute. Stipules ovate-acute, ½–1 by 1/3–½ cm, soon caducous. *Leaves* thick-coriaceous, (13–)17–20(–22) by (5–)6–8(–10) cm (index 2–2.7), broadest at or below the middle; surfaces more or less concolorous, above subglabrous, dull to glossy, beneath densely yellowish brown, tomentose by adpressed, stellate hairs; base acute to cuneate, rarely rounded, margin recurved, top abruptly acute to 1 cm acuminate, tip sharp, oblique; midrib strongly prominent beneath, slightly so above; nerves (13–)16–20(–22) pairs, strongly prominent beneath, impressed above, parallel at an angle of 50–70°, arcuating and anastomosing near the margin; reticulation fine, lax, subscalariform, distinct beneath; petiole 2–3 cm, 1½–3 mm ø, adaxially flat. *Inflorescence* male or female, densely velvety rufous stellate hairy; bracts linear-acute, 1½–3½ by 0.7–1 mm, bracteoles broadly ovate-acute, 0.7 by 1 mm. *Male rachis* 10–15 cm, 1½–2 mm ø; ♂ flowers in clusters of 3–7, perianth deeply 6-lobed, stamens 12, filaments 1½–2 mm, anthers 0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Female rachis* 5–10 cm, 3 mm ø; ♀ flowers solitary, perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1–1½ mm, recurved. Young cupule 1 cm stalked, obovoid-ellipsoid, outside with 6–8 more or less concentric lamellae, base attenuate-acute, top rotundate-umbonate with an opening of 3–5 mm ø; densely rufous tomentose. *Ripe cupule* subsessile, 4–5 cm long, 3–3½ cm ø; wall 3–5 mm thick, covering the fruit almost completely except for an opening of 2–3 mm ø; base rounded-acute, top rotundate-umbonate. *Ripe fruit* ovoid-globose, 3½–4 cm long, 2½–3½ cm ø; wall woody, *c.* ½ cm thick, for the greater part adnate to the cupule, base rounded-attenuate, top (free part) rotundate-umbonate, 2–3 cm ø.

Distr. *Malesia*: Malay Peninsula (Perak, Selangor, Negri Sembilan; Fraser Hill, Pahang; Mt Ophir, Malacca; also Penang).

Ecol. Hill forest, 600–1000 m. *Fl.* Oct., *fr.* Dec.-July.

10. Lithocarpus rotundatus (BL.) A. CAMUS, Riviera Scient. 18 (1932) 41 ('*rotundata*'); Chênes 3 (1954) 624, t.; SOEPADMO, Reinwardtia 8 (1970) 275. — *Quercus rotundata* BL. Verh. Bat. Gen. K. & W. 9 (1823) 219; Bijdr. (1826) 521; Fl. Jav. Cupul. (1829) 22, t. 11; A.DC. Prod. 16, 2 (1864) 88; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 85, t. 100 A; K. & V. Bijdr. 10 (1904) 64; BACKER & BAKH. *f.* Fl. Java 2 (1965) 6. — *Pasania rotundata* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83. — *Quercus sp.* VIDAL, Sinopsis Atlas (1883) 41, t. 92: G. — *Quercus clathrata* VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 15; K. & V. Bijdr. 10 (1904) 49; KOORD. Atlas 1 (1913) t. 62. — *Quercus pyriformis* VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 17; K. & V. Bijdr. 10 (1904) 62; KOORD. Atlas 1 (1913) t. 54 ('*piriformis*'). — *Quercus curranii* MERR. Philip. J. Sc. 3 (1908) Bot. 329; En. Philip. 2 (1923) 27. — *Synaedrys clathrata* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 190. — *Synaedrys curranii* (MERR.) KOIDZ. *l.c.* 189. — *Synaedrys pyriformis* (VON SEEMEN) KOIDZ. *l.c.* 189. — *Synaedrys* '*rotunda*' (BL.) KOIDZ. *l.c.* 189. — *L. clathrata* (VON SEEMEN) REHD. J. Arn. Arb. 1 (1919) 123; A. CAMUS, Chênes 3 (1954) 603, t. 363: 1–7. — *L. curranii* (MERR.) REHD. J. Arn. Arb. 1 (1919) 124; A. CAMUS, Chênes 3 (1954) 628, t. — *L. pyriformis* (VON SEEMEN) REHD. J.

Fig. 21. *Lithocarpus echinifer* (MERR.) A. CAMUS. *a.* Habit with ♂ rachis, × ⅔, *b.* ♂ flower, ×4, *c.* section of ♀ flower with young cupule, ×2, *d.* young cupule, × ⅔, *e.* young cupule seen from above, × ⅔, *f.* ripe cupule, × ⅔, *g.* ripe cupule and fruit in longitudinal section, × ⅔ (*a–b* ELMER 20640, *c* SAN A 3456, *d–e* SAN 24792, *f–g* SAN 49504).

Arn. Arb. 1 (1919) 130; A. CAMUS, Chênes 3 (1954) 584.

Tree 20–40 m, up to 100 cm ø. *Branchlets* initially densely rufous tomentose by simple and stellate hairs, later subglabrescent, greyish brown, finely fissured, sparsely to densely warty lenticellate; terminal buds ovoid-ellipsoid, 3–4 by 1½–2½ mm, scales ovate to linear-acute. Stipules linear-acute, 4–5 by 0.7–1 mm, with longitudinal ribs, soon caducous. *Leaves* thin-coriaceous, (10–)13–15(–20) by (4–)5–6(–9) cm (index 2½–3), broadest at or slightly above the middle; surfaces more or less concolorous, above glabrous, dull, underneath densely greyish tomentose by adpressed stellate hairs; base rounded to acute, top bluntly acute to sharply ½–1 cm acuminate; midrib and nerves thin, impressed above; nerves 9–11 pairs, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure on both sides; petiole ½–1½ cm, *c.* 1 mm ø, terete or adaxially flat. *Inflorescence* male, androgynous or mixed, densely fulvous tomentose by short stellate hairs; bracts and bracteoles ovate-acute, ⅔–1 by ⅔ mm. *Male rachis* 10–15 cm, 1–2 mm ø; ♂ flowers in clusters of 3–7, perianth 6-lobed, stamens 12, filaments 3–4 mm, anthers 0.3–0.5 mm long, pistillode subglobose, 1½–2 mm ø. *Androgynous* or *mixed rachis* 10–15 cm, 1–2 mm ø; *female flowers* solitary, perianth 6-lobed, staminodes 12, rather well-developed but not exceeding the perianth, styles 3–4, conical, 1–1½ mm, recurved. *Ripe cupule* ½–2 cm stalked, obovoid to pear-shaped, 1½–2 cm long, 3–4 cm ø, wall 2–3 mm thick, densely pale grey stellate-hairy, lower part smooth or ridged, attenuate-rounded, top truncate set with imbricate scales or woody tubercles; covering the greater part of the fruit except for an opening of *c.* 1 cm Ø. *Ripe fruit* subhemispherical, 2 cm long, 3–3½ cm ø; wall 2–3 mm thick, for the greater part adnate to the cupule, top flat-convex.

Distr. *Malesia*: Java (mountainous country in W. Java), N. Borneo (SAN/For. Dept. 4943, from Sandakan), Philippines (Luzon, several localities).

Ecol. Forest, from sea-level (Borneo) up to 1500 m (Java). *Fl.* July-Oct., *fr.* Oct.-Febr.

11. Lithocarpus echinifer (MERR.) A. CAMUS, Bull. Soc. Bot. Fr. 80 (1934) 818 ('*echinifera*'); Chênes 3 (1954) 632, t. 372; SOEPADMO, Reinwardtia 8 (1970) 235. — *Quercus echinifera* MERR. Pl. Elm. Born. (1929) 43. — **Fig. 21.**

Tree 20–35 m, 20–80 cm ø; buttresses up to 3 m tall, 2 m out, 5 cm thick; bark greyish brown, irregularly fissured to flaky. *Branchlets* initially densely yellowish brown tomentose by woolly, simple or stellate hairs, later subglabrous, densely or sparsely warty lenticellate; terminal buds ovoid-ellipsoid, ½–1 by ⅓–½ cm, scales ovate to linear-acute, recurved. Stipules linear-acute, ½–1 by ⅓–½ cm, recurved, rather long-persistent, and sometimes crowded near the tip of a young twig. *Leaves* thick-coriaceous, (15–)18–20(–30) by (5–)7–10(–15) cm (index 2½–3), broadest at or rarely above the middle; surfaces more or less concolorous, above glabrous, dull to glossy, underneath densely greyish tomentose with adpressed stellate hairs; base rounded to cuneate, margin entire, sometimes undulate, top abruptly acute to ½–1 cm acuminate; midrib prominent on both sides; nerves (9–)11–12(–13) pairs, thinly prominent beneath, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure on both sides; petiole 1½–2½ cm, 2–4 mm ø, adaxially flat. *Inflorescence* densely fulvous stellate-hairy; bracts linear-acute, recurved, 5–6 by ½ mm, bracteoles ovate-acute, 1–1½ by ⅔ mm. *Male rachis* 10–25 cm, 1½–2 mm ø; ♂ flowers in clusters of 3–7, perianth 6–7-lobed, stamens 12, filaments 3½–5 mm, anthers 0.3–0.4 mm long, pistillode subglobose, 1–1½ mm ø. *Female rachis* not known. Young infructescence 15–20 cm, 3 mm ø; ♀ flowers (seen on a young fruit): perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1½–2 mm, recurved; young cupule obovoid, densely fulvous-tomentose, scales recurved, hook-shaped. *Ripe cupule* subsessile to 1–2 cm stalked, obconical, 2–4 cm long, 3–5 cm ø; wall up to ½ cm thick, outside densely brownish tomentose by short stellate hairs; scales spirally set, recurved, 2–5 mm long, rather woody; enclosing the greater part of the fruit except for an opening of ½–1 cm ø. *Ripe fruit* subhemispherical, 2–3 cm long, 3–4 cm ø; wall woody, 4–8 mm thick, for the greater part adnate to the cupule, base rounded, top rotundate-umbonate, densely greyish brown stellate-hairy.

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

Ecol. Forests up to 1800 m, on sandy clayey soil, usually on river-banks. *Fl.* Aug.–Nov., *fr.* Dec.–Sept.

12. Lithocarpus pulcher (KING) MARKGR. Bot. Jahrb. 49 (1925) 67 ('*pulchra*'); A. CAMUS, Chênes 3 (1954) 626, t. 370: 1–4; SOEPADMO, Reinwardtia 8 (1970) 269. — *Quercus pulchra* KING, Ann. R. Bot. Gard. Calc. 2 (1889) 85, t. 81, *p.p., excl.* BECCARI PB 3269. — *Synaedrys pulchra* (KING) KOIDZ. Bot. Mag. Tokyo 30 (1916) 189.

Tree 24–36 m, 40–60 cm ø; buttresses up to 2½ m tall, 10 cm thick; bark irregularly fissured to scaly, chocolate-brown. *Branchlets* initially densely rufous pubescent by woolly, simple or stellate hairs, later subglabrous, ridged or terete, sparsely lenticellate; terminal buds ovoid-globose, 3–5 by 2–3 mm, scales ovate to linear-acute. Stipules narrowly ovate to linear, 10 by 2–5 mm, soon caducous. *Leaves* thick-coriaceous, rigid, (10–)15–20(–22) by (4–)6–8(–12) cm (index 2–3.2), broadest at or rarely above the middle; surfaces discolorous, above glabrous except the midrib and nerves, dull to glossy, dark, chocolate-brown, beneath densely yellowish to reddish brown tomentose by adpressed stellate hairs; base acute to cuneate, rarely rounded, margin recurved, top acute to ½–1 cm acuminate; midrib and nerves strongly prominent beneath, slight-

ly so to impressed above; nerves (12–)15–18(–22) pairs, parallel, at an angle of 60–70°, arcuating but not anastomosing towards the margin; reticulation dense, fine, scalariform, distinct beneath; petiole 1–2 cm, 2–3 mm ø, adaxially flat to shallowly furrowed. *Inflorescence* male or female, densely rufous stellate-hairy; bracts and bracteoles ovate-acute, 1–2 by 0.7–1 mm. *Male rachis* 10–15 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, perianth 6-lobed, stamens 10–12, filaments 2–3 mm, anthers 0.3–0.35 mm long, pistillode subglobose, *c.* 1 mm ø. *Female rachis c.* 10 cm, 3 mm ø; ♀ flowers solitary or rarely in clusters of 2–3, perianth 6–7-lobed, staminodes 12, rather well-developed but not exceeding the perianth, styles 3–4, conical, 1–1½ mm, recurved. *Ripe cupule* sessile, obconical, 3–4 cm long, 4–6 cm ø; wall woody up to 8 mm thick; outside densely greyish brown stellate-hairy, upper half with short, thick, pointed tubercles, spirally set, lower half with irregularly set tubercles; covering the greater part of the fruit except for an opening of 1½–3 cm ø; base acute, top truncate or rotundate. *Ripe fruit* subhemispherical, 2–3 cm long, 4–5 cm ø; wall woody, 3–7 mm thick, for the greater part adnate to the cupule, base rounded, top (free part) depressed-umbonate, densely greyish brown tomentose.

Distr. *Malesia*: Borneo (Sarawak, Sabah, and Kalimantan, scattered).

Ecol. Forests, up to 1000 m. *Fr.* March–Nov.

Note. BECCARI PB 3269, on which KING based his description of the inflorescence, belongs to *L. beccarianus*.

13. Lithocarpus longispinus BARNETT, Kew Bull. (1938) 100; A. CAMUS, Chênes 3 (1954) 887, t.; SOEPADMO, Reinwardtia 8 (1970) 254. — **Fig. 22 g-i.**

Tree 8–30 m; except the buds and inflorescences all parts glabrous. *Branchlets* greyish brown, sparsely lenticellate; terminal buds ellipsoid, 5–8 by 1–2 mm, scales narrowly ovate to linear-acute. *Leaves* chartaceous, (12–)16–20(–27) by (3–) 5 –7(–8) cm (index 3–3.8), broadest at or slightly above the middle; surfaces more or less concolorous, greenish; base cuneate, top 1–1½ cm acuminate, tip oblique; midrib and nerves thinly prominent on both surfaces; nerves 12–16 pairs, subparallel, at an angle of 60–70°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform, obscure on both sides; petiole ½–1 cm, 2 mm ø, adaxially flat. *Inflorescence* male or androgynous, sparsely simple-hairy; bracts narrowly ovate, *c.* 2 by ½ mm. *Male rachis* 14-20 cm, 1–2 mm ø; ♂ flowers in clusters of 3, perianth deeply incised, lobes 5–6, stamens 10–12, filaments 4–5 mm, anthers 0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous rachis* 10–15 cm, 1–2 mm ø; *female flower* solitary, perianth 5–6-lobed, staminodes 10–12, rudimentary, styles 3, terete, 1½–5 mm, recurved. *Ripe cupule* sessile, more or less globose, 2–2½ cm through, covering the fruit almost completely except for an opening of 3–7 mm ø; wall thinner than 1 mm; scales densely but irregularly set, spine-like but soft and recurved, 1–1½ cm long. *Ripe fruit* ovoid, 1⅓–2 cm through; free part densely fulvous-tomentose; scar concave, 1 cm ø; wall *c.* 1 mm thick, for the greater part free from the cupule.

Distr. Siam (common in the Peninsula, scattered in the northern parts), in *Malesia*: Malay Peninsula (Selangor).

Ecol. Evergreen forests, up to 600 m, often on river-banks. *Fl.* Nov.–March, *fr.* April–Sept.

14. Lithocarpus wrayi (KING) A. CAMUS, Riviera Scient. 18 (1932) 42; Chênes 3 (1954) 891, t.; SOEPADMO, Reinwardtia 8 (1970) 288. — *Quercus lappacea* (*non* ROXB.) HOOK. *f.* Fl. Br. Ind. 5(1888) 607, *quoad Malaya*; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 41, t. 33; CORNER, Gard. Bull. S. S. 10 (1939) 279; Ways. Trees (1940) 303, f. 97. — *Quercus wrayii* KING, Ann. R. Bot. Gard. Calc. 2 (1889) 77, t. 104. — *Pasania wrayii* (KING) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 446. — *Pasania lappacea* (*non* OERST.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 446, *quoad Malaya*. — *Synaedrys wrayii* (KING) KOIDZ. Bot. Mag. Tokyo 30 (1916) 187. — *L. lappacea var. perakensis* A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 254; Chênes 3 (1954) 856, t. — **Fig. 22 c-d.**

Tree 12–30 m, 20–50 cm ø. *Branchlets* initially densely yellowish brown to fulvous-pubescent by erect simple hairs, later glabrescent, whitish grey, densely or sparsely lenticellate; terminal buds ellipsoid, 4–8 by 2 mm, scales linear-acute. Stipules linear-acute or broadly spathulate, 7–10 by 2–3 mm, soon caducous. *Leaves* thin-coriaceous (10–)15–20(–24) by (3–)5–7(–8) cm (index 2½–3½), broadest at or rarely above the middle; surfaces more or less concolorous, greyish green, sparsely pubescent on both surfaces, densely on the midrib and nerves; base acute to rounded, asymmetrical, margin recurved, sometimes undulate, top bluntly to sharply 1–2 cm acuminate; midrib prominent on both sides; nerves (14–)16–18(–19) pairs, parallel, at an angle of 45–70°, prominent beneath, arcuating but not anastomosing near the margin; reticulation fine, dense, scalariform, obscure on both surfaces; petiole (2–) 3–5(–10) mm, 1–2 mm ø, densely simple-hairy, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown pubescent with erect simple hairs; bracts narrowly ovate-acute, 2–3 by 0.7–1 mm, bracteoles 0.7–1 by 0.3–0.5 mm. *Male rachis* 10–20 cm, 1–2 mm ø; ♂ flowers solitary or in clusters of 3, perianth (5–)6(–7)-lobed, stamens 10–12, filaments 3–4 mm, anthers 0.25–0.30 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous rachis* 10–15 cm, 2 mm ø; *female flowers* solitary, perianth 6-lobed, staminodes 12, rather well-developed but not exceeding the perianth, styles 3, conical, 1½–2 mm. Young cupule depressed-subglobose to discoid, completely covered by imbricate, acroscopical subulate scales. *Ripe cupule* sessile, ovoid-globose to depressed-ovoid, 1½–2 cm long, 2½–3 cm ø; wall ½–1 mm thick, outside densely tomentose; scales subulate, re-

curved; covering the fruit completely; dehiscence irregular. *Ripe fruit* ovoid- to depressed ovoid-globose, 1–1½ cm long, 2–2½ cm ø; wall *c.* ½–1 mm thick, for the greater part free from the cupule; free part densely pale brown to rufous tomentose; scar flat to convex.

Distr. Peninsular Siam (Trang, BKF 2131), in *Malesia*: Sumatra (East Coast and near Palembang), Malay Peninsula (Kedah, Perak, Pahang, Trengganu).

Ecol. Forests, up to 1350 m. *Fl.* Jan.–April, *fr.* May-Nov.

15. Lithocarpus coopertus (BLANCO) REHD. J. Arn. Arb. 1 (1919) 124 ('*cooperta*'); A. CAMUS, Chênes 3 (1954) 890, t.; SOEPADMO, Reinwardtia 8 (1970) 231. — *Quercus cooperta* BLANCO, Fl. Filip. ed. 2 (1845) 503; A.DC. Prod. 16, 2 (1864) 105; MERR. Philip. J. Sc. 3 (1908) Bot. 329; Sp. Blanc. (1918) 121; En. Philip. 2 (1923) 27. — *Castanea cooperta* (BLANCO) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 379. — *Castanopsis costata* (*non* A.DC.) F.–VILL. Nov. App. (1880) 209. — *Quercus fernandesii* VIDAL, Sinopsis Atlas (1883) 41, t. 92: E. — *Quercus reflexa* KING, Ann. R. Bot. Gard. Calc. 2 (1889) 78, t. 72; MERR. Philip. J. Sc. 3 (1908) Bot. 329; ELMER, Leafl. Philip. Bot. 3 (1910) 940; *ibid.* 6 (1913) 1981; MERR. En. Philip. 2 (1923) 30. — *Quercus pruinosa* (*non* BL.) ELMER, Leafl. Philip. Bot. 3 (1910) 940. — *Synaedrys cooperta* (BLANCO) KOIDZ. Bot. Mag. Tokyo 30 (1916) 186. — *Synaedrys reflexa* (KING) KOIDZ. *l.c.* 187. — *Castanopsis reflexa* (KING) REHD. J. Arn. Arb. 1 (1919) 122. — *Quercus boholensis* MERR. Philip. J. Sc. 29 (1926) 476. — *L. boholensis* (MERR.) REHD. J. Arn. Arb. 10 (1929) 132; A. CAMUS, Chênes 3 (1954) 905, t. — *L. reflexa* (KING) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 867, t. — Fig. 22 e-f.

Tree 10–45 m, 15–70 cm ø; buttresses up to 2 m tall, 1½ m out, 10 cm thick; bark greyish brown, smooth to flaky, lenticellate. *Branchlets* initially densely yellowish brown to fulvous tomentose by stellate hairs, later subglabrescent, terete, greyish brown, sparsely lenticellate; terminal buds ovoid, 2–4 by 2–3 mm, scales ovate to linear-acute. Stipules deltoid, 4–8 by 1–3 mm, soon caducous. *Leaves* thin-coriaceous, (5–)10–14(–17) by (2–)4–6(–7) cm (index 2–4), broadest about the middle; surfaces discolorous, above glabrous, dull, greyish brown, underneath densely yellowish brown to fulvous tomentose by adpressed, stellate hairs; base rounded-acute, top acute to 1–2 cm acuminate; midrib strongly prominent on both surfaces; nerves (10–)12–14(–16) pairs, more or less prominent on both sides, subparallel, at an angle of 45–70°, arcuating but not anastomosing near the margin; reticulation fine, arched, scalariform, obscure on both surfaces; petiole 4–6 mm, 1–2 mm ø, densely stellate-hairy, adaxially flat or furrowed. *Inflorescence* male, androgynous or mixed, densely yellowish brown stellate-hairy; bracts narrowly ovate-acute, 1–1½ by ⅓–⅔ mm, bracteoles linear, ½–1 by ⅓ mm. *Male rachis* 5–15 cm, 1–1½ mm ø; ♂ flowers solitary, rarely in clusters of 2–3, perianth (5–)6(–7)-lobed, stamens 10–12, filaments 3–4 mm, anthers 0.25–0.30 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 7–10 cm, 1–2 mm ø; *female flower* solitary, perianth 6-lobed, staminodes 12, rudimentary, styles 3–4, conical, 1½–2 mm, recurved. *Ripe cupule* subsessile, ovoid-conical, 1½–2 cm long, 1½–2½ cm ø; wall thinner than 1 mm, covering the fruit completely; scales irregularly set, densely tomentose, subulate, recurved; dehiscence irregular. *Ripe fruit* ovoid-conical, *c.* 1½–2 cm through, densely yellowish brown tomentose; top acute, scar deeply concave to flat; wall thinner than 1 mm, for the greater part free from the cupule.

Distr. *Malesia*: Malay Peninsula (rare), Borneo (Sarawak, Brunei, Sabah, fairly common), Philippines (common in Mindanao, rare and scattered in Luzon, Leyte, Samar, and Surigao).

Ecol. Forests, up to 1800 m, occasionally in peat swamp and heath forest, usually on yellowish sandy soil. *Fl.* Febr.–Oct., *fr.* Nov.–May.

Uses. In Borneo the wood is used by the local people for housing construction, but serves mainly for fire-wood.

Notes. The Bornean specimens usually have smaller leaves than those from the Philippines, but the fruit and cupule are similar.

ELMER 14012 from the Philippines is chosen as the neotype of BLANCO's species.

16. Lithocarpus confragosus (KING *ex* HOOK. *f.*) A. CAMUS, Riviera Scient. 18 (1932) 40 '*confragosa*'); Chênes 3 (1954) 832, t.; SOEPADMO, Reinwardtia 8 (1970) 230. — *Quercus confragosa* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 616; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 77, t. 71. — *Pasania confragosa* (KING *ex* HOOK. *f.*) SCHOTTKY, Bot. Jahrb. 47 (1912) 662; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 446.

Tree 12–29 m, 25–100 cm ø; bark greyish brown, smooth to scaly, lenticellate. *Branchlets* initially densely greyish brown tomentose by adpressed, stellate hairs, glabrescent, densely warty lenticellate; terminal buds ovoid-globose, 3–4 by 2–3 mm, scales ovate. Stipules linear to lanceolate, 10–15 by 2–3 mm. *Leaves* thick-coriaceous, rigid, (10–)12–18(–27) by (3½–)5–7(–10) cm (index 2.2–4.5), broadest about the middle; surfaces more or less concolorous, above glabrous, glossy, underneath densely greyish brown, tomentose by adpressed, stellate hairs, glabrescent; base acute to cuneate, rarely rounded, margin recurved, top acute to 1–1½ cm acuminate; midrib prominent beneath, slightly so above; nerves (5–)6–8(–10) pairs, prominent beneath, obscure above, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation lax, subscalariform, obscure on both sides; petiole 1–2 cm, 2–4 mm ø, glabrous, adaxially flat. *Ripe cupule* sessile to 1 cm stalked, depressed-ovoid-globose, 2½–3 cm long, 3–5½ cm ø; wall 2–10 mm thick, brittle, covering the fruit almost completely except for an opening of smaller than ½ cm ø, out-

side irregularly set with rounded to pointed short tubercles; dehiscence irregular. *Ripe fruit* depressed ovoid-globose, 1½–2½ cm long, 2–4 cm ø, base truncate, scar flat to concave, 1½–2½ cm ø, top rounded and depressed umbonate at the centre; wall for the greater part free from the cupule, 2–8 mm thick, densely yellowish brown to fulvous tomentose; cotyledons flat-convex.

Distr. *Malesia*: N. Sumatra (Gajo Lands), Malay Peninsula (Perak), Borneo (Sarawak: Nyabau F. R.; Sabah, scattered; Nunukan I.).

Ecol. Forests, up to 2000 m, on yellowish brown sandy soil. *Fr.* Aug.–Febr.

Note. Inflorescence not known.

17. Lithocarpus neorobinsonii A. CAMUS, Chênes, Atlas 3 (1949) 77, t. 410: 1–6; Chênes 3 (1954) 780; SOEPADMO, Reinwardtia 8 (1970) 261. — *Quercus robinsonii* RIDL. J. Fed. Mal. St. Mus. 5 (1914) 46, *non* MERR. 1915. — *Pasania robinsonii* (RIDL.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 450. — **Fig. 22 a–b.**

Tree *c.* 15 m, 40–50 cm ø; bark smooth. *Branchlets* initially densely fulvous tomentose by stellate hairs, later glabrous, sparsely lenticellate; terminal buds ovoid-globose, *c.* 3 by 2 mm, scales broadly ovate. Stipules linear to lanceolate, 8–10 by 2–3 mm. *Leaves* thick-coriaceous, (10–)12–14 (–15½) by 4–6 cm (index 2–3), broadest at or rarely above the middle; surfaces discolorous, above glabrous, glossy, dark brown, beneath densely silvery grey-tomentose by adpressed, stellate hairs; base acute, margin sometimes undulate, top acute to ½–1½ cm acuminate; midrib more or less prominent on both sides, dark brown; nerves 13–15 pairs, prominent beneath, obscure above, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation dense, scalariform, distinct beneath; petiole ½–1½ cm long, 2 mm ø, adaxially flat. *Inflorescence* male or androgynous, densely fulvous stellate-hairy; bracts and bracteoles ovate, 1–3 by 1 mm. *Male rachis c.* 10 cm, 1–1½ mm ø; ♂ flowers solitary or in clusters of 3, perianth 6-lobed, stamens 12, filaments 2–3 mm, anthers 0.3 mm long; pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis c.* 10 cm, 1–2 mm ø; *female flowers* solitary, perianth 6-lobed, staminodes 12, rudimentary, styles 3–4, conical, 2–3 mm, recurved. *Ripe cupule* sessile to ½ cm stalked, ovoid, 2–2½ cm through; base truncate to concave, top acute; wall thinner than ½ mm, covering the fruit almost completely, densely yellowish brown to greyish tomentose; scales minute, adpressed, irregularly set; dehiscence irregular. *Ripe fruit* ovoid-conical, 1½ cm long, 2–2½ cm ø; wall bony, 1–1½ mm thick, densely yellowish brown tomentose, for the greater part free from the cupule; top acute, base rounded, scar flat to concave, *c.* 1 cm ø; cotyledons flat-convex.

Distr. *Malesia*: Malay Peninsula (Selangor, rare; Fraser Hill, Pahang).

Ecol. Forests, at 1500–1700 m. *Fl., fr.* Oct.–May.

18. Lithocarpus kostermansii SOEPADMO, Reinwardtia 8 (1970) 251. — *Quercus blumeana* (*non* KORTH.) K. & V. Bijdr. 10 (1904) 57; KOORD. Atlas 1 (1913) t. 53; BACKER & BAKH. *f.* Fl. Java, 2 (1965) 6. — *L. blumeana* (*non* REHD.) A. CAMUS Chênes 3 (1954) 773, t. 408: 1–11, *quoad Java.*

Tree 18–30 m, 30–60 cm ø; buttresses 1–4 m tall, ⅓–½ m out; bark grey. *Branchlets* initially densely fulvous tomentose by adpressed, stellate hairs, later subglabrous, greyish brown, sparsely lenticellate; terminal buds ovoid-globose, 2–4 by 1–2 mm, scales narrowly ovate to linear. Stipules linear, 3–6 by ½–1 mm. *Leaves* thick-coriaceous, (12–)16–22(–30) by (4–)6–8(–10) cm (index (1.6–)3–3½(–4)), broadest about the middle; surfaces more or less discolorous, above glabrous, dull, chocolate-brown, beneath densely greyish tomentose by adpressed, stellate hairs; base acute to cuneate, rarely rounded, top acute to 1–3 cm acuminate; midrib prominent beneath, slightly so above; nerves (8–)10–11(–13) pairs, prominent beneath, obscure above, parallel at an angle of 45–60° with the midrib, arcuating but not anastomosing towards the margin; reticulation lax, subscalariform, obscure on both sides; petiole 1–2 cm, 2–3½ mm ø, glabrous, adaxially flat. *Inflorescence* male, androgynous or mixed, densely brownish stellate-hairy; bracts linear acute, 1–2 by ⅓ mm, bracteoles narrowly ovate, ½–⅔ by ⅓–½ mm. *Male rachis* 10–20 cm, 2 mm ø; ♂ flowers in clusters of 3, perianth 6-lobed, stamens 12, filaments 4–5 mm, anthers 0.3–0.4 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 15–35 cm, 2–3 mm ø; *female flowers* solitary, rarely in clusters of 2–3, perianth 6-lobed, staminodes 12, rudimentary, styles 3–4, conical, 1½–2 mm, recurved. *Ripe cupule* subsessile, depressed ovoid-globose, 2–2½ cm long, 2¾–3 cm ø; wall thinner than ½ mm, covering the fruit completely, outside at the basal half with 3–4 thin, concentric lamellae, at the upper half set with obscure adpressed scales to almost smooth densely fulvous stellate-hairy; dehiscence irregular. *Ripe fruit* depressed ovoid-globose, *c.* 2 cm long, 2½–3 cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule, densely fulvous tomentose; base rotundate, scar concave, top abruptly acute.

Distr. *Malesia*: W. Java.

Ecol. Forests, up to 1000 m. *Fl.* July–Sept., *fr.* Oct.–Jan.

19. Lithocarpus pattaniensis BARNETT, Kew Bull. (1938) 104; A. CAMUS, Chênes 3 (1954) 770, t.; SOEPADMO, Reinwardtia 8 (1970) 266.

Small tree. *Branchlets* initially densely greyish tomentose by adpressed, stellate hairs, later glabrous, dark greyish brown, sparsely lenticellate; terminal buds ovoid, *c.* 3 by 2 mm, scales ovate-acute. Stipules deltoid, *c.* 1 by ½ mm, soon caducous. *Leaves* thick-coriaceous, (8–)14–16(–18) by (3–)6–8 (–11) cm (index 1.8–2.2), broadest at or rarely above the middle; surfaces discolorous, above glabrous, glossy, chocolate-brown, underneath densely greyish brown tomentose by

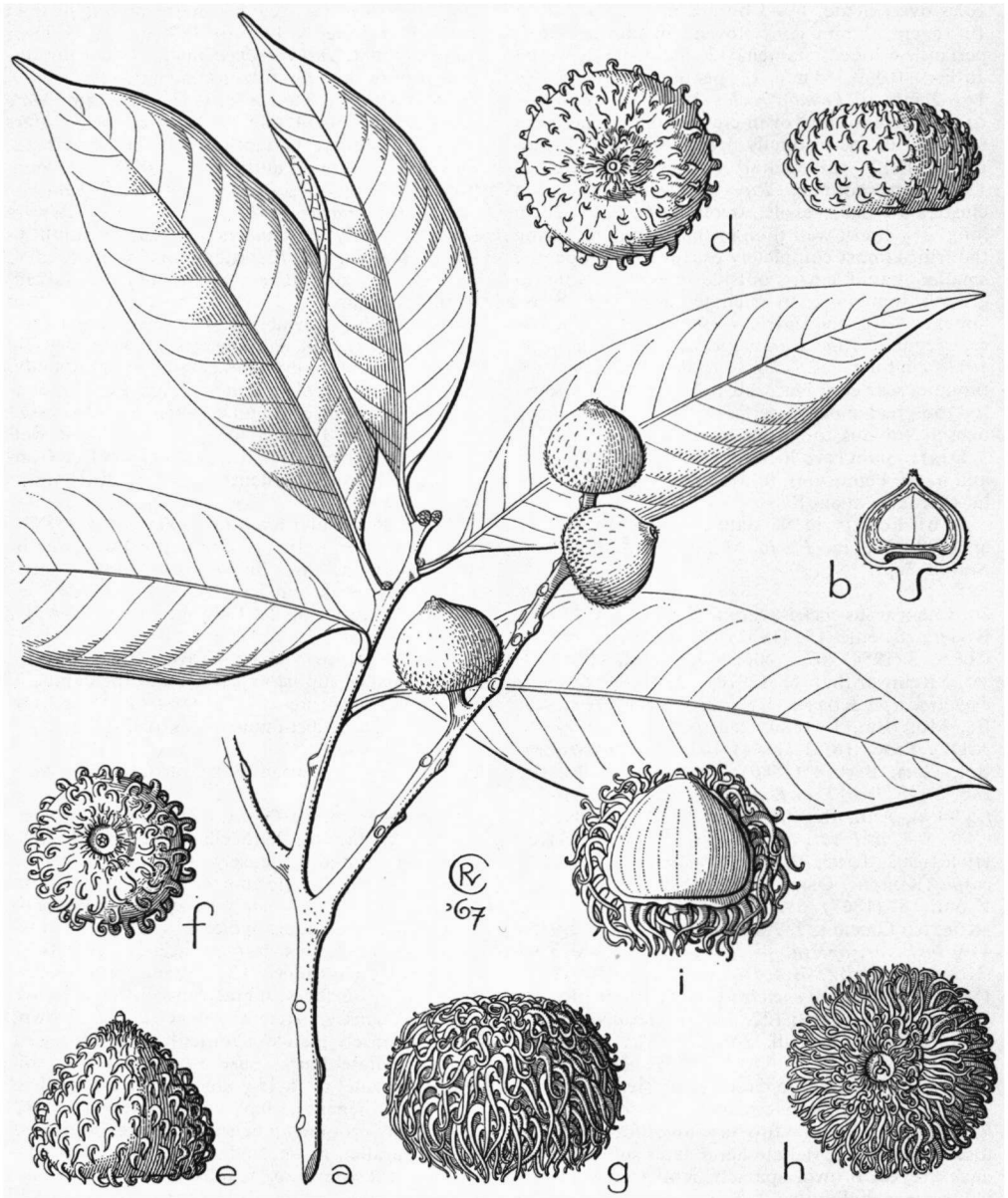

Fig. 22. *Lithocarpus neorobinsonii* A. CAMUS. *a.* Habit, *b.* longitudinal section of cupule and fruit, both ×⅔. — *L. wrayi* (KING) A. CAMUS. *c.* Cupule, side view, *d.* cupule seen from above, both nat. size. — *L. coopertus* (BLANCO) REHD. *e.* Cupule, side view, *f.* cupule seen from above, both nat. size. — *L. longispinus* BARNETT. *g.* Cupule, side view, *h.* cupule seen from above, *i.* section of cupule showing the fruit, all nat. size (*a–b* KEP 32856, *c–d* HENDERSON *s.n.*, *e–f* BECCARI PB 4057, *g–i* RAJAB 523).

adpressed, stellate hairs; base rounded, sometimes asymmetrical, margin recurved, top bluntly acute to 1 cm acuminate; midrib and nerves strongly prominent beneath, flat to impressed above; nerves 11–14 pairs, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation subscalariform, distinct beneath; petiole 1–2 cm, 2–3 mm ø, adaxially flat. *Inflorescence* male or female, densely pale yellowish brown stellate hairy; bract and brac-

eoles ovate-acute, 1½-3 by 1–2 mm. *Male rachis* 10–15 cm, 2 mm ø; ♂ flowers in clusters of 3, perianth 6-lobed, stamens 12, filaments 2–3 mm, anthers 0.3–0.35 mm ø, pistillode subglobose, 1½–2 mm ø. *Female rachis* 10–15 cm, 3–4 mm ø; ♀ flowers solitary or in clusters of 2–3, perianth 6-lobed, or occasionally irregularly lobed, staminodes 12, rudimentary, styles 4–6, conical, 1½–2 mm, connate. *Ripe cupule* solitary or in clusters of 2–3, sessile, ovoid-globose, *c.* 2 cm long, 2½ cm ø; wall thinner than 1 mm, covering the fruit almost completely except for an opening smaller than 1 cm ø, outside densely fulvous to greyish tomentose by stellate, adpressed hairs; lamellae 8–10, concentric or spiral, thin; dehiscence irregular. *Ripe fruit* depressed ovoid-globose, 1–1½ cm long, 2–2½ cm ø; top rounded, base rotundate, scar concave; wall 1–2 mm thick, woody, for the greater part free from the cupule, outside densely fulvous to rufous tomentose.

Distr. Siam (two localities, in the northern part and in the Peninsula), in *Malesia*: Malay Peninsula (Perak, Pahang).

Ecol. Forests, in N. Siam at 700 m, in Malaya at 1500–1700 m. *Fl.* in Malaya Sept.–Nov., *fr.* March–Sept.

20. Lithocarpus encleisacarpus (KORTH.) A. CAMUS Riviera Scient. 18 (1932) 40 (*'encleisocarpa'*); Chênes 3 (1954) 767, t. 406: 1–5, *incl. var.*; SOEPADMO, Reinwardtia 8 (1970) 239. — *Quercus encleisacarpa* KORTH. Kruidk. (1844) 209, t. 45; BL. Mus. Bot. 1 (1850) 288, *incl. var. divergens*; A.DC. Prod. 16, 2 (1864) 103; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 238; HOOK. *f.* Fl. Br. Ind. 5 (1888) 617, *incl. var. aperta* KING *ex* HOOK. *f.*; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 80, t. 75: 1–4, *incl. var. aperta*; CORNER, Ways. Trees (1940) 302, f. 95, 98. — *Cyclobalanus encleisacarpa* (KORTH.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Pasania encleisacarpa* (KORTH.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 449, *incl. var. aperta.* — *Synaedrys encleisacarpa* (KORTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 186. — *Castanopsis encleisacarpa* (KORTH.) REHD. J. Arn. Arb. 1 (1919) 122. — *L. encleisacarpa var. typica* A. CAMUS, Bull. Soc. Bot. Fr. 93 (1945) 84.

Tree 10–40 m, 25–75 cm ø; buttresses up to 1 m tall; bark grey, smooth to scaly, lenticellate. *Branchlets* initially densely fulvous to rufous tomentose by adpressed, stellate hairs, later subglabrous, dark greyish brown, sparsely lenticellate; terminal buds subglobose, 2–3 by ⅔–1 mm, scales broadly ovate. *Leaves* thin-coriaceous, 12–15 by 4–6 cm (index 2–3), broadest about the middle; surfaces more or less discolorous, above dark greyish brown, dull, subglabrous, beneath densely glaucous adpressed stellate-hairy; base rounded or acute, margin occasionally undulate, top acute to bluntly 1–2 cm acuminate; midrib prominent beneath, slightly so to impressed above; nerves (7–)8–10(–12) pairs, parallel, at an angle of 45–70°, more or less prominent beneath, arcuating and anastomosing near the margin; reticulation lax, subscalariform to irregular, more or less distinct beneath; petiole ½–1⅓ cm, 1–2 mm ø, terete or adaxially flat. *Inflorescence* male, female or androgynous, densely fulvous stellate-hairy; bract and bracteoles ovate-acute, 1–1½ by 1 mm. *Male rachis* 10–15 cm, 1 mm ø; ♂ flowers in clusters of 3 or solitary, perianth 6-lobed, stamens 12, filaments 3–4 mm, anthers 0.30–0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Female* or *androgynous rachis* 10–20 cm, 2 mm ø; ♀ flowers solitary, rarely in clusters of 2–3, perianth 6-lobed, staminodes 12, rudimentary, styles 3–4, conical, *c.* 1 mm. *Ripe cupule* 1–1½ cm stalked, ovoid-globose, 1½–2 cm long, 2–3 cm ø; top rounded, base truncate; wall thinner than 1 mm, covering the fruit completely, outside densely fulvous tomentose by stellate hairs, longitudinally, thinly ribbed; lamellae thin, 5–7, more or less concentric; dehiscence irregular. *Ripe fruit* depressed ovoid-globose, 1½ cm long, 2–2½ cm ø; wall thinner than 1 mm, for the greater part free from the cupule, outside densely silvery tomentose; scar concave.

Distr. Peninsular Siam (Songkla, KERR 15883), in *Malesia*: Sumatra (scattered), Malay Peninsula (common; also Singapore), Borneo (scattered in Sarawak and Sabah).

Ecol. Forests, up to 1300 m. *Fl.* Febr.–Aug., *fr.* Sept.–April.

Note. Specimens from above 900 m, usually have a smaller cupule and fruit, and the cupule is cup-shaped, covering *c.* ½ of the fruit; these have sometimes been distinguished as *var. aperta.*

21. Lithocarpus mariae SOEPADMO, Reinwardtia 8 (1970) 258.

Tree 15–33 m, 50–60 cm ø, buttresses *c.* ⅔ m tall; bark smooth, lenticellate, yellowish grey. *Branchlets* initially densely fulvous to rufous tomentose by stellate hairs, soon glabrescent, dark greyish brown, smooth or sparsely lenticellate; terminal buds ovoid, 1½–2 by 1–2 mm, scales ovate. *Leaves* thin-coriaceous, (8–)10–12 (–13) by 4–5 cm (index 2–3), broadest at or below the middle; surfaces slightly discolorous, above glabrous, glossy, greenish to chocolate-brown, beneath densely glaucous tomentose by adpressed minute stellate hairs; base rounded acute, top abruptly acute to 1–1½ cm acuminate; midrib prominent beneath, flat above; nerves 10–12 pairs, thin, prominent beneath, flat to impressed above, parallel, at an angle of 50–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, scalariform, distinct beneath; petiole 1½–2½ cm, 1–1½ mm ø, adaxially flat or shallowly furrowed. *Inflorescence* male or androgynous, simple, densely fulvous tomentose by adpressed stellate hairs; bracts and bracteoles ovate-acute, ⅔–1 by ½–⅔ mm. *Male rachis c.* 10 cm, 2 mm ø; ♂ flowers solitary or in clusters of 2–3, perianth 6-lobed, stamens 12, filaments 3–4 mm, anther 0.35 mm long, pistillode globose, 1–1½ mm ø, densely whitish tomentose, *Androgynous rachis c.* 10 cm, 2 mm ø; *female flowers* solitary, perianth 6-lobed, staminodes 12, rudi-

mentary, styles 3–5, conical, 1–1½ mm, connate. Young cupule 1–1½ cm stalked, globose, densely rufous-tomentose by adpressed stellate hairs. *Ripe cupule* on a peduncle 1–2 cm long, *c.* 1 cm ø, ovoid, rounded-acute at both ends, 2–2½ cm long, 2½–3 cm ø, enclosing the fruit except for an opening of 3 mm; wall thinner than 1 mm; inside densely fulvous-tomentose with adpressed, simple hairs, outside smooth or with obscure longitudinal streaks, densely glaucous adpressed stellate-tomentose. *Ripe fruit* ovoid, 2–2⅓ cm long, 2½–2¾ cm ø, densely fulvous-tomentose by adpressed simple hairs, top rounded-acute, base rounded, scar deeply concave, *c.* 2 cm ø, wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak, Sabah, rare).

Ecol. In forest on ridges at 300–600 m. *Fl. fr.* Oct.–Nov.

Notes. Leaves collected from a basal shoot measure 22 by 10 cm, with 14 pairs of nerves.

Near *L. encleisacarpus*, but differering in its leaves with more nerves, dense scalariform reticulation, and in its cupule without concentric rings and rounded-acute at both ends.

22. Lithocarpus macphaillii (HENDERS.) BARNETT, Trans. & Proc. Bot. Soc. Edinb. 34 (1944) 178; A. CAMUS, Chênes 3 (1954) 773, t.; SOEPADMO, Reinwardtia 8 (1970) 257. — *Pasania macphaillii* HENDERS. Gard. Bull. S. S. 5 (1930) 76, f.

Tree 10–45 m, up to 50 cm ø; bark smooth to fissured, greyish brown. *Branchlets* initially densely fulvous to rufous adpressed stellate-hairy, later glabrous, dark, greyish brown, sparsely to densely lenticellate; terminal buds ovoid-ellipsoid, 2–5 by 2–3 mm, scales narrowly to broadly ovate-acute. Stipules narrowly ovate-acute, *c.* 5 by 2 mm, soon caducous. *Leaves* thin-coriaceous, 15–22 by 6–8 cm (index 2–3), broadest at or below the middle; surfaces discolorous, above glabrous, greyish to dark brown, dull to glossy, underneath densely glaucous tomentose with adpressed, stellate hairs; base rounded or acute, top abruptly, bluntly 1–1½ cm acuminate; midrib and nerves prominent beneath, almost so above; nerves (10–)12–16(–18) pairs, subparallel, at an angle of 50–70°, arcuating but not anastomosing towards the margin; reticulation dense, fine, subscalariform, distinct beneath; petiole 1–1.7 cm, 1–2 mm ø, shallowly furrowed. *Inflorescence* male, female or androgynous, densely fulvous stellate hairy; bracts and bracteoles narrowly ovate-acute, 0.7–1½ by ½–0.7 mm. *Male rachis* 10–15 cm, 2 mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Female* or *androgynous rachis* 10–25 cm, 2 mm ø; ♀ flowers solitary or in clusters of 2–3, staminodes rudimentary, styles 3–5, conical, 1½–2 mm, connate. *Ripe cupule* sessile to ½ cm stalked, deeply cup-shaped to almost completely covering the fruit, ⅔–1½ cm long, 2–3 cm ø, wall thin, outside densely fulvous-tomentose, with 5–8 thin, more or less concentric, lamellae. *Ripe fruit* depressed ovoid-globose, 1–1½ cm long, 2–2½ cm ø, top rounded-acute, base rounded, scar flat-concave; wall woody, 1–2 mm thick, densely greyish brown to silvery tomentose by simple adpressed hairs, for the greater part free from the cupule.

Distr. Peninsular Siam, in *Malesia*: rather common in Sumatra and Malay Peninsula.

Ecol. Forests, up to 900 m, usually on river-banks. *Fl.* June–Oct., *fr.* May.

Note. Records of *Quercus* and *Pasania blumeana* from the Malay Peninsula may belong here.

23. Lithocarpus blumeanus (KORTH.) REHD. J. Arn. Arb. 10 (1929) 132; A. CAMUS, Chênes 3 (1954) 774, *excl. fig., et specim. e Java et Malaya*; SOEPADMO, Reinwardtia 8 (1970) 221. — *Quercus blumeana* KORTH. Kruidk. (1844) 208, t. 44; A.DC. Prod. 16, 2 (1864) 103. — *Cyclobalanus blumeana* (KORTH.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Synaedrys blumeana* (KORTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 186. — *Castanopsis blumeana* (KORTH.) REHD. J. Arn. Arb. 1 (1919) 122.

Tree 5–15 m, 10–25 cm ø; bark scaly, greyish brown. *Branchlets* initially densely yellowish to reddish brown tomentose by adpressed, stellate hairs, later subglabrous, greyish brown, sparsely lenticellate; terminal buds ovoid, 1–1½ by 1 mm, scales ovate-acute. Stipules deltoid, *c.* 1 by ½ mm soon caducous. *Leaves* thin-coriaceous (8–)10–15(–17) by (3½–) 4–5 (–6) cm (index 2–2.4), broadest at or slightly below the middle; surfaces more or less discolorous, above glabrous, dull to glossy, dark brown, beneath densely glaucous tomentose by adpressed stellate hairs; base acute, shortly decurrent, margin undulate, top 1–1½ cm acuminate; midrib prominent on both surfaces, stronger beneath; nerves (11–)12–14(–16) pairs, more or less prominent beneath, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, scalariform, obscure; petiole ½–1 cm long, 1 mm ø, adaxially flat or shallowly furrowed. *Inflorescence* male, female or androgynous, densely pale greyish brown stellate hairy; bract and bracteoles ovate to linear-acute, 1–2 by ⅓–½ mm. *Male rachis* 15–20 cm, 1 mm ø; ♂ flowers solitary or in clusters of 3, filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode subglobose, *c.* 1 mm ø. *Female* or *androgynous* rachis 10–15 cm, 1mm ø; ♀ flowers solitary, staminodes rudimentary, styles 3, conical, 1–1½ mm, recurved. *Ripe cupule* ½–1 cm stalked, ovoid or deeply cup-shaped, 1–1½ cm long, 2½–3 cm ø, covering the fruit for ⅔–¾ or almost completely; wall thinner than ½ mm, densely greyish brown tomentose on both surfaces; lamellae thin, concentric, denticulate; dehiscence irregular. *Ripe fruit* depressed-ovoid, *c.* 1½ cm long, 2½–3 cm ø, glabrous except for a small part at the long, acuminate top, base cordate, scar concave; wall bony, *c.* 1 mm thick, dark purplish brown, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (scattered in Sarawak, E. Kalimantan, and Sabah).

Ecol. Forests, up to 1650 m, usually on river-banks, on sandstone or basalt derived soil. *Fl.* June–Aug., *fr.* Aug.–May.

Notes. Records from Malaya, under *Quercus*, may belong to *L. macphailii*, and those from Java to *L. kostermansii*.

In SAN 16199, 16448, and 41760 from 1200–1650 m, the leaves and cupules are larger than those from the lowland forest. Several intermediates exist, however, so that they may be regarded as montane form of the species.

24. Lithocarpus platycarpus (BL.) REHD. J. Arn. Arb. 1 (1919) 130; A. CAMUS, Chênes 3 (1954) 698, t.; SOEPADMO, Reinwardtia 8 (1970) 268. — *Quercus platycarpa* BL. Fl. Jav. Cupul. (1829) 27, t. 15; A.DC. Prod. 16, 2 (1864) 92; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 234; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 70, t. 65; K. & V. Bijdr. 10 (1904) 53; BACKER & BAKH. *f.* Fl. Java 2 (1965) 7. — *Cyclobalanus platycarpa* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 80. — *Synaedrys platycarpa* (BL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192.

Tree 15–35 m, 40–50 cm ø; bark fissured, whitish grey. *Branchlets* glabrous, whitish grey, smooth to superficially fissured; terminal buds ovoid-ellipsoid, 4–5 by 2–3 mm, scales linear-acute. Stipules linear-acute, 5–7 by 1–2 mm. *Leaves* thick-coriaceous, (8–) 12–15(–20) by (4–)5–8(–9) cm (index 2–2.5), broadest at or above the middle; surfaces more or less concolorous, above glabrous, glossy, underneath densely whitish grey tomentose by adpressed stellate hairs, subglabrescent; base rounded-acute, margin recurved, top acute to bluntly 1 cm acuminate; midrib prominent on both surfaces; nerves 11–14 pairs, subparallel, at an angle of 45–60°, arcuating and anastomosing near the margin; reticulation fine, irregular to areolate, obscure; petiole ½–1½ cm, 2–3 mm ø, adaxially flat. *Inflorescence* male or female, densely stellate hairy; bracts and bracteoles linear acute, 2–4 by ½ mm. *Male rachis* 10–15 cm, 1–2 mm ø; ♂ flowers in clusters of 3–4, rarely solitary, filaments 3–4 mm, anthers 0.3 mm long, pistillode subglobose, *c.* 1 mm ø. *Female rachis c.* 10 cm, 2–3 mm ø; ♀ flowers solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3, conical, 1–1½ mm. *Ripe cupule* ½–1½ cm stalked, saucer-shaped, ½–1 cm long, 3–4 cm ø; wall woody, covering *c.* ¼ part of the fruit, outside with 5–7 strongly prominent lamellae. *Ripe fruit* depressed ovoid-globose, 1½–2 cm long, 3–4 cm ø, chocolate-brown, glabrous, glossy, top depressed-umbonate, base rounded, scar flat-convex; wall woody, 2–5 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: W. and S. Central Java (once collected in SW. Bantam, several times in Nusa Kambangan).

Ecol. Forests, at low altitude. *Fl.* April, *fr.* Aug.–Sept.

25. Lithocarpus perakensis SOEPADMO, Reinwardtia 8 (1970) 266. — *Quercus costata* (*non* BL.) HOOK. *f.* Fl. Br. Ind. 5 (1888) 617. — *Quercus costata var. convexa* (*non* BL.) KING, Ann. R. Bot. Gard. Calc. 2 (1889) 82, t. 76 A. — *Pasania costata* (BL.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 443, *quoad Malaya*. — *L. costata var. kingii* A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 254; Chênes 3 (1954) 583, t. 353: 16–19.

Tree 15–30 m, 30–90 cm ø. *Branchlets* initially densely fulvous stellate hairy, later glabrous, blackish brown, fissured; terminal buds ovoid-ellipsoid, 5–7 by 3–4 mm, scales ovate to linear-acute. Stipules linear, 5–7 by 2 mm. *Leaves* thick-coriaceous, (10–)12–16(–17) by (4–)5–6(–7) cm (index 2–2½), broadest at or above the middle; upper surface glabrous, dull or glossy, underneath sparsely greyish tomentose by adpressed stellate hairs, glabrescent; base rounded-acute to cuneate, top bluntly ½–2 cm acuminate; midrib strongly prominent beneath, flat above; nerves 11–14 pairs, thin and obscure on both sides, subparallel, at an angle of 45–60°, arcuating and anastomosing near the margin; reticulation fine, areolate, distinct beneath; petiole 1–2 cm, 1–2 mm ø, adaxially flat to shallowly furrowed. *Inflorescence* male or female, densely fulvous stellate hairy; bracts and bracteoles linear, 2–3 by ½ mm. *Male rachis* 10–20 cm, 2–3 mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Female rachis* 15–20 cm, 2–3 mm ø; ♀ flowers solitary, perianth thick-coriaceous, staminodes rudimentary, styles 3, conical, 1–1½ mm, recurved. *Ripe cupule* 1–2 cm stalked, cup-shaped, 1–1½ cm long, 3–4 cm ø; wall woody, thick, rim incurved, covering ⅓-½ part of the fruit, outside with 5–6 more or less concentric, flat or prominent lamellae. *Ripe fruit* broadly depressed ovoid-globose, 1–1½ cm long, 3–4 cm ø, glabrous, dark brown, glossy, top rounded-umbonate, base rounded, scar convex; wall woody, 3–5 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Malay Peninsula (Perak, Johore, Trengganu).

Ecol. Forests, 90–1200 m. *Fl. fr.* Sept.–March

26. Lithocarpus sericobalanus E. F. WARB. Kew Bull. (1936) 20; A. CAMUS, Chênes 3 (1954) 716, t.; SOEPADMO, Reinwardtia 8 (1970) 279.

Tree 20–50 m, 30–100 cm ø; buttresses up to 1.8 m tall, 2 m out, 10 cm thick; bark deeply fissured to scaly, pale to dark brown. *Branchlets* initially densely greyish brown tomentose by adpressed stellate hairs, later subglabrous, finely fissured; terminal buds ovoid-ellipsoid, 2½–4 by 2 mm, scales narrowly ovate. *Leaves* coriaceous, (9–)12–15(–20) by (3–)4–6 (–8) cm (index 2–3), broadest at the middle; surfaces discolorous, above glabrous, chocolate-brown, dull to glossy, underneath densely fulvous to glaucous tomentose by adpressed stellate hairs; base rounded-acute, top bluntly ½–1 cm acuminate; midrib and nerves prominent beneath; nerves 10–12 pairs, parallel, at an angle of 45–60°, arcuating but not anasto-

mosing towards the margin; reticulation fine, dense, scalariform, obscure; petiole 1–2 cm, 2 mm ø, terete or adaxially flat. *Inflorescence* male or androgynous, densely greyish brown tomentose by adpressed stellate hairs; bracts and bracteoles ovate, 3–4 by 2–3 mm. *Male rachis* 10–15 cm, 2 mm ø; ♂ flowers in clusters of 3, filaments 3–3½ mm, anthers 0.2–0.3 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous rachis* 10–15 cm, 1–2 mm ø; *female flowers* solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3–5, conical, 1–2 mm, recurved. *Ripe cupule* ½–1 cm stalked, broadly cup-shaped, ½–2 cm long, 3–4½ cm ø; wall woody, rim thick, covering ½–⅔ part of the fruit, outside with 6–10 concentric or spiral lamellae. *Ripe fruit* broadly depressed ovoid-globose to discoid, 1–2 cm long, 3–4 cm ø, top rounded-umbonate, occasionally depressed at the centre, base rounded, scar strongly convex; wall woody, 2–3 mm thick, outside densely greyish tomentose by adpressed simple hairs, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (all parts except in Brunei; also Nunukan I.).

Ecol. In primary, also in secondary and heath forests, on hills or low ridges, up to 1200 m, on sandy soil. *Fl.* Aug.–Dec., *fr.* Jan.–May.

27. Lithocarpus lucidus (ROXB.) REHD. J. Arn. Arb. 1 (1919) 128; A. CAMUS, Chênes 3 (1954) 690, t. 386: 1–15; SOEPADMO, Reinwardtia 8 (1970) 254. — *Quercus lucida* ROXB. Fl. Ind. ed. Carey 3 (1832) 635; HOOK. *f.* Fl. Br. Ind. 5 (1888) 614; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 69, t. 64; CORNER, Ways. Trees (1940) 304, f. 95. — *Quercus omalokos* KORTH. Kruidk. (1844) 214; A.DC. Prod. 16, 2 (1864) 92; HOOK. *f.* Fl. Br. Ind. 5 (1888) 614 ('*omalkos*'); KING, Ann. R. Bot. Gard. Calc. 2 (1889) 70, t. 23 B. — *Quercus cuneata* ROXB. *ex* A.DC. Prod. 16, 2 (1864) 108. — *Cyclobalanus omalokos* (KORTH.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 80. — *Pasania omalokos* (KORTH.) SCHOTTKY, Bot. Jahrb. 47 (1912) 676; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 439. — *Pasania lucida* (ROXB.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 440. — *Synaedrys omalkos* (KORTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192. — *L. omalokos* (KORTH.) REHD. J. Arn. Arb. 1 (1919) 129; A. CAMUS, Chênes 3 (1954) 695, t. 387: 9–20.

Tree 15–40 m, 20–120 cm ø; buttresses up to 1 m tall; bark greyish brown, shallowly fissured. *Branchlets* initially densely fulvous stellate hairy, soon glabrescent, with 3–5 sharp ribs decurrent under the leaf-insertion, pale to dark brown, sparsely lenticellate; terminal buds ovoid-ellipsoid, 4–5 by 1–2 mm, scales ovate to linear. Stipules linear-acute to subulate, 5 by 2 mm, soon caducous. *Leaves* chartaceous to coriaceous, (4–)8–15(–18) by (2–)3–5(–7) cm (index 2–3½), broadest at or more commonly above the middle; surfaces concolorous, pale to dark brown, glabrous, above glossy; base cuneate and decurrent into the petiole, top rounded, obtuse-emarginate, acute to abruptly cuspidate; midrib prominent on both sides; nerves (10–)14–16(–20) pairs, thin and obscure on both surfaces, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, areolate, obscure; petiole 2–5 mm long, 2–3 mm ø, glabrous, terete or adaxially flat. *Inflorescence* male, female or androgynous, densely fulvous stellate hairy; bracts and bracteoles ovate, *c.* 1 by ½ mm. *Male rachis* 10–20 cm, 2–3 mm ø; ♂ flowers in clusters of 3, perianth with 4–6 lobes, stamens 8–12, filaments 2–3 mm, anthers 0.2– 0.3 mm long, pistillode subglobose, *c.* 1 mm ø. *Female* or *androgynous rachis* 10–15 cm, 2–3 mm ø; ♀ flowers solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3, conical, 1–1½ mm. *Ripe cupule* sessile, cup- or saucer-shaped, ½–1 cm long, 3–3½ cm ø; wall woody, rim thick, incurved, covering the basal part of the fruit; lamellae 8–10, concentric, thick, densely greyish stellate hairy outside. *Ripe fruit* depressed ovoid, 2–2½ cm long, 3–3½ cm ø, glabrous, glossy, chocolate-brown, top rounded-acute, base truncate, scar concave, 1½–2 cm ø; wall woody, 3–5 mm thick, for the greater part free from the cupule; cotyledons flat-convex, irregularly divided by the endocarp intrusions.

Distr. *Malesia*: Sumatra (Asahan, Langkat, Indragiri, and Riouw), Malay Peninsula (common, also Singapore and Penang), Borneo (Sarawak, NE. Kalimantan, and Nunukan I.).

Ecol. Forests up to 1600 m. *Fl.*, *fr.* June-May.

Notes. Specimens from the lowland forest, attributed by most previous authors to *L. omalokos*, usually have a thin, pale greyish brown leaf with an acute or abruptly cuspidate top, and those from above 1000 m, usually credited to *L. lucidus*, have the leaves thick-coriaceous, dark brown, with rounded to obtuse-emarginate top. Recent collections from the Malay Peninsula and Borneo show that the lowland and montane forms can not be considered as separate species, as there are many intermediates.

Among the loan of *Fagaceae* received from Brussels, I found the MSS. name *Quercus cuneata*, a name originally proposed by ROXBURGH, but which he in the Calcutta Herbarium deliberately changed into *Quercus lucida* ROXB. A. DE CANDOLLE, unaware of this, validated *Quercus cuneata* ROXB. which is consequently a later, superfluous homonym of *Quercus lucida*.

28. Lithocarpus eichleri (WENZIG) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 718, t. 395; SOEPADMO, Reinwardtia 8 (1970) 236. — *Quercus eichleri* WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 236; HOOK. *f.* Fl. Br. Ind. 5 (1888) 615; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 72, t. 68. — *Pasania eichleri* (WENZIG) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 438. — *Synaedrys eichleri* (WENZIG) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191.

Tree 10–15 m, 25–60 cm ø. *Branchlets* initially densely fulvous to rufous tomentose by adpressed stellate hairs, later glabrous, whitish grey, densely warty lenticellate; terminal buds ovoid-ellipsoid, 2–3 by 1–2 mm, scales linear to narrowly

ovate-acute. Stipules narrowly ovate to linear, 3–4 by 1–1½ mm, soon caducous. *Leaves* thin-coriaceous, (14–)18–26(–30) by (4–)6–8(–12) cm (index 2½–5), broadest at or above the middle; surfaces more or less concolorous, above glabrous, dull to glossy, underneath densely greyish tomentose by adpressed stellate hairs, subglabrescent; base acute, rarely rounded, margin recurved, top bluntly to sharply 1–1½ cm acuminate; midrib prominent on both sides; nerves (7–)8–11(–15) pairs, prominent beneath, impressed above, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, lax, subscalariform, obscure; petiole 1–1½ cm, 1½–4 mm ø, adaxially flat. *Inflorescences* male, androgynous or mixed, densely pale grey stellate hairy; bracts and bracteoles ovate, *c.* 1 by ½ mm. *Male rachis* 10–15 cm, 1 mm ø; ♂ flowers solitary or in clusters of 3, perianth (5–)6(–8)-lobed, stamens (10–)12(–13), filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode subglobose, longitudinally compressed, 1–2 mm ø. *Androgynous* or *mixed rachis* 10–20 cm, 2–4 mm ø; *female flowers* solitary, staminodes well-developed and exceeding the perianth, sometimes polliniferous; styles 3, conical, *c.* 2 mm, recurved. *Ripe cupule* sessile, saucer-shaped, ½–1 cm long, 2–3½ cm ø, covering the basal part of the fruit; rim thin, entire or undulate; outside densely greyish brown stellate hairy; lamellae 5–8, concentric, thin. *Ripe fruit* depressed-ovoid, 1–1½ cm long, 2½–3 cm ø, densely fulvous short stellate-tomentose; top rounded-umbonate, base rounded, scar deeply concave, 1–2 mm ø; wall bony, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: S. Sumatra (Palembang and vicinity), Malay Peninsula (Perak, Selangor, Johore).

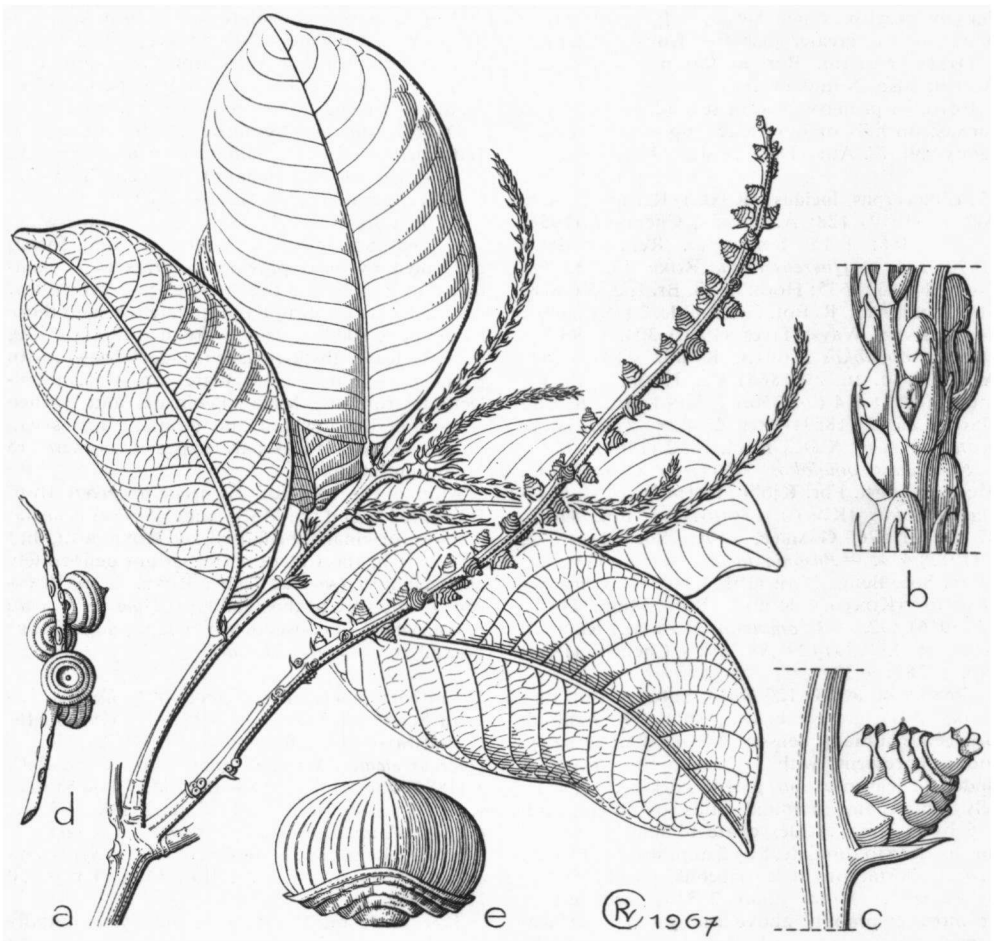

Fig. 23. *Lithocarpus korthalsii* (ENDL.) SOEPADMO. *a.* Habit with ♂ and ♀ rachis, × ⅔, *b.* part of ♂ rachis, ×4, *c.* ♀ flower, ×4, *d.* young cupules, × ⅔, *e.* ripe cupule and fruit, × ⅔ (*a–c* & *e* JACOBS 4565, *d* KORTHALS *s.n.*).

Ecol. Forests, up to 240 m, usually in swampy places. *Fl.* June–Sept., *fr.* Oct.–Febr.

29. Lithocarpus korthalsii (ENDL.) SOEPADMO, Reinwardtia 8 (1970) 251. — *Quercus korthalsii* ENDL. Gen. Pl. Suppl. 4, 2 (1847) 28, *non* BL. 1850; MIQ. Ann. Mus. Bot. Lugd. -Bat. 1 (1863) 113. — *Quercus annulata* KORTH. Kruidk. (1844) 213, t. 46: 21–22, *non* SMITH 1819. — *Quercus pseudoannulata* BL. Mus. Bot. 1 (1850) 299. — *Quercus tysmannii* BL. Mus. Bot. 1 (1850) 300; MIQ. Fl. Ind. Bat. 1, 1 (1856) 860 ('*teysmannii*'); A. DC. Prod. 16, 2 (1864) 92; OUDEM. Versl. Med. Kon. Ak. Wet. Natuurk. 12 (1861) 205; Natuurk. Verh. Kon. Akad. 11 (1865) 14, t. 8; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 235; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 71, t. 66; K. & V. Bijdr. 10 (1904) 52; KOORD. Atlas 1 (1913) t. 47; BACKER & BAKH. *f.* Fl. Java 2 (1965) 7. — *Quercus pseudomolucca var. incrassata* BL. Mus. Bot. 1 (1850) 291; A.DC. Prod. 16, 2 (1864) 86; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 9. — *Quercus laurifolia* MIQ. Pl. Jungh. 1 (1851) 11, *non* MICHX. 1801. — *Quercus hypoleuca* MIQ. Fl. Ind. Bat. 1, 1 (1858) 869. — *Cyclobalanus tysmanni* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 80; Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 375 ('*tysmanninii*'). — *Pasania teysmanni* (BL.) PRANTL in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 55. — *Quercus heliciformis* VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 15; K. & V. Bijdr. 10 (1904) 47; KOORD. Atlas 1 (1913) t. 49. — *Synaedrys heliciformis* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *Synaedrys teysmanni* (BL.) KOIDZ. *l.c.* 193. — *L. heliciformis* (VON SEEMEN) REHD. J. Arn. Arb. 1 (1919) 127; A. CAMUS, Chênes 3 (1954) 700, t. 389: 1–14. — *L. teysmannii* (BL.) REHD. J. Arn. Arb. 1 (1919) 131; A. CAMUS, Chênes 3 (1954) 692, t. 387: 1–8. — **Fig. 23–24.**

Tree 25–45 m, 100–150 cm ø; bark dark grey, lenticellate. *Branchlets* initially densely fulvous to rufous-tomentose with simple or stellate hairs, angular, later glabrous, terete, densely or sparsely lenticellate; terminal buds ovoid-ellipsoid, 5–12 by 2–3 mm, scales linear-lanceolate. Stipules linear to subulate, ½–1½ by ⅓ cm, long persistent. *Leaves* thick-coriaceous, (11–)13–16(–23) by (3–)4–7(–9) cm (index 2.3–3.3), broadest at the middle; above glabrous, glossy, pale to dark chocolate-brown, beneath densely glaucous tomentose by adpressed stellate hairs; base rounded-acute, margin recurved, top bluntly or sharply 1–1½ cm acuminate; midrib and nerves prominent beneath, flat above; nerves (13–)15–20(–25) pairs, subparallel, at an angle of 50–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure to distinct beneath; petiole ½–2 cm, 2–4 mm ø, glabrous, adaxially flat. *Inflorescence* male or androgynous, densely yellowish to greyish brown stellate hairy; bracts and bracteoles narrowly ovate to linear-acute, 1½–5 by ⅔–1½ mm. *Male rachis* 10–20 cm, 1½–3 mm ø; ♂ flowers in clusters of 3, stamens 10–12, filaments 3–4 mm, anthers 0.35 mm long, pistillode globose, 1–1½ mm ø. *Androgynous rachis* 10–20 cm, 2–3 mm ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3–4, conical, 1–3 mm. *Ripe cupule* subsessile, saucer-shaped, ⅔–2 cm long, 3½–4½ cm ø; rim thick, entire or undulate, covering ⅓–½ part of the fruit; lamellae 6–9, entire or undulate,

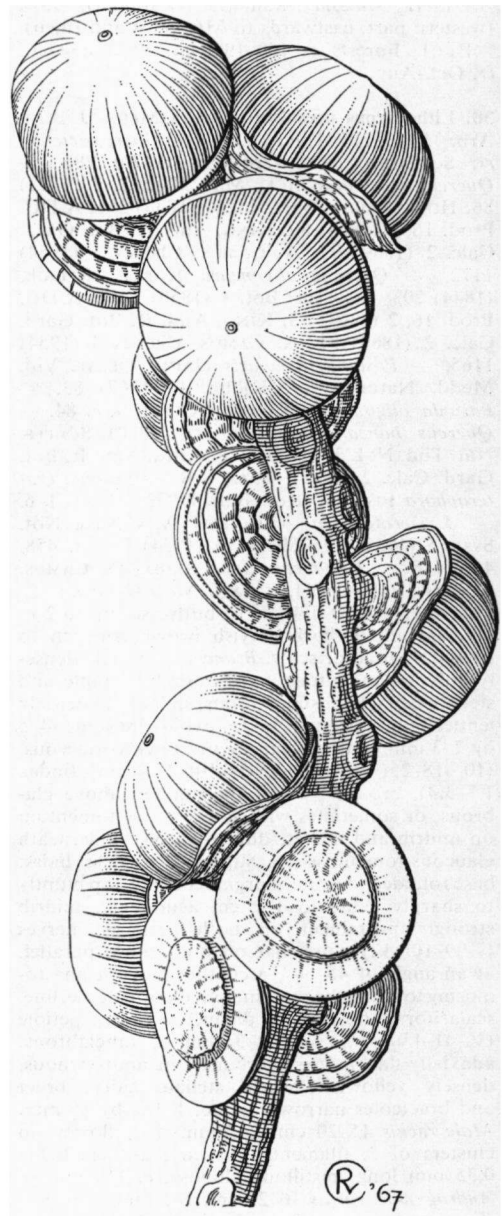

Fig. 24. *Lithocarpus korthalsii* (ENDL.) SOEPADMO. Fruiting rachis, × 2/3 (JACOBS 4565).

strongly prominent, outside densely fulvous tomentose. *Ripe fruit* depressed ovoid-globose to subhemispherical, 1½–2⅔ cm long, 3–4½ cm ø, glabrous, dark chocolate-brown, top depressed or rounded-umbonate, base truncate or rounded, scar deeply concave, rarely convex, 2½–3 cm ø; wall woody, 2–4 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Sumatra (scattered), Java (western part, eastwards to Mts Wilis and Idjen).

Ecol. Forests at 150–1900 m. *Fl.* June-Oct., *fr.* Oct.-Aug.

30. Lithocarpus urceolaris (JACK) MERR. J. Arn. Arb. 33 (1952) 241, *p.p., excl. syn. Quercus eichleri*; SOEPADMO, Reinwardtia 8 (1970) 285. — *Quercus urceolaris* JACK, Mal. Misc. 2, 7 (1822) 86; HOOK. Comp. Bot. Mag. 1 (1836) 256; A.DC. Prod. 16, 2 (1864) 89; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 92; A. CAMUS, Chênes 3 (1954) 1172. — *Quercus oligoneura* KORTH. Kruidk. (1844) 203; BL. Mus. Bot. 1 (1850) 294; A.DC. Prod. 16, 2 (1864) 88; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 91; A. CAMUS, Chênes 3 (1954) 1165. — *Pasania urceolaris* (JACK) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83. — *Pasania oligoneura* (KORTH.) OERST. *l. c.* 84. — *Quercus bancana* (*non* SCHEFF. 1870) SCHEFF. Nat. Tijd. N. I. 32 (1871) 416; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 62, t. 56 B. — *Pasania craterophora* FISCHER, Kew Bull. (1932) 319, f. 1–6. — *L. 'cratephora'* (FISCHER) A. CAMUS, Not. Syst. 5 (1935) 75; Chênes 3 (1954) 952, t. 458, 459: 1–8. — *L. bancana* (*non* REHD.) A. CAMUS, Chênes 3 (1954) 694, t., *excl. Nova Guinea.*

Tree 15–33, 20–130 cm ø; buttresses up to 2 m tall, spreading; bark greyish brown, smooth to deeply fissured or scaly. *Branchlets* initially densely fulvous to rufous tomentose by simple and stellate hairs, later subglabrous, sparsely to densely lenticellate; terminal buds ovoid-ellipsoid, 4–5 by 2–3 mm, scales linear. *Leaves* thick-coriaceous, (10–)18–25(–35) by (5–)8–10(–17) cm (index 1.7–3.4), broadest about the middle; above glabrous, or sometimes with some rufous tomentum on midrib and nerves, dull to glossy, underneath glaucous-tomentose by adpressed stellate hairs; base rounded to acute, margin recurved, top bluntly to sharply acute to 1–2 cm acuminate; midrib strongly prominent on both surfaces; nerves (7–)9–10(–12) pairs, flat on both sides, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation dense, fine, scalariform, obscure to distinct beneath; petiole (½–)1–1½(–2½) cm, 2–3 mm ø, subglabrous, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown stellate hairy; bract and bracteoles narrowly ovate, 1–1½ by ½ mm. *Male rachis* 15–20 cm, 2–3 mm ø; ♂ flowers in clusters of 3, filaments 3–5 mm, anthers 0.20–0.35 mm long, pistillode globose, *c.* 1½ mm ø. *Androgynous rachis* 10–25 cm, 2–3 mm ø; *female flowers* solitary, rarely in clusters of 3, staminodes rudimentary, styles 3–4, conical, 1–2 mm, recurved. *Ripe cupule* sessile to 1 cm stalked, deeply cup-shaped, 1⅓–2 cm long, 4–5 cm ø, rim recurved (sometimes very strongly), entire or undulate, covering ⅓–½ part of the fruit; wall woody, densely glaucous to fulvous adpressed stellate-tomentose; lamellae thin, obscure, denticulate, the scales sometimes rather distinct. *Ripe fruit* depressed subglobose or globular-cylindrical, 3–4 cm in size, top rounded to depressed-umbonate, base truncate, scar deeply concave, conical, *c.* 1½–2 cm ø; wall woody, 2–4 mm thick, outside densely greyish tomentose by adpressed simple hairs, greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Sumatra (scattered), Banka, Malay Peninsula (Pahang, Johore), Borneo (common, especially in Sabah).

Ecol. In primary, also in secondary and swamp forests, up to 1800 m, on granitic sandy or loamy soil. Fertility seems to be throughout the year, with the fruit ripe between Aug. and Febr.

31. Lithocarpus indutus (BL.) REHD. J. Arn. Arb. 1 (1919) 127; A. CAMUS, Chênes 3 (1954) 702, t. 390: 1–12; SOEPADMO, Reinwardtia 8 (1970) 247. — *Quercus induta* BL. Verh. Bat. Gen. K. & W. 9 (1823) 220; Bijdr. (1826) 522; Fl. Jav. Cupul. (1829) 23, t. 12: 1–2, *incl. var. β, l.c.* 25, t. 12: 3; A.DC. Prod. 16, 2 (1864) 96, *incl. var. microcarpa, l.c.* 97; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 13, t. 7; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 228; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 55, t. 51; K. & V. Bijdr. 10 (1904) 37; KOORD. Atlas 1 (1913) t. 60; BACKER & BAKH. *f.* Fl. Java 2 (1965) 7. — *Cyclobalanus induta* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 80. — *Synaedrys induta* (BL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 195. — *Pasania induta* (BL.) S. MOORE, J. Bot. 63 (1925) Suppl. 144.

Tree 20–45 m, 50–150 cm ø; buttresses numerous; bark dark grey, fissured, lenticellate. *Branchlets* initially densely greyish brown tomentose by adpressed simple and stellate hairs, later glabrous, smooth or sparsely warty lenticellate; terminal bud ovoid, *c.* 4 by 3 mm, scales linear to lanceolate. *Leaves* thick-coriaceous, rigid, (15–)18–20 (–26) by (5–)7–9(–11) cm (index 2½–3), broadest at or slightly below the middle; surfaces more or less discolorous, above glabrous, dull to glossy, greyish brown, underneath with a thin cover of glaucous tomentum, hairs adpressed, minute, stellate or simple; base rounded-acute, margin recurved, top bluntly acute to sharply 1–2 cm acuminate; midrib strongly prominent on both sides; nerves (11–)12–14(–15) pairs, flat on both surfaces, parallel, at an angle of 50–70°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, distinct beneath; petiole 1–2 cm, 2–4 mm ø, glabrous, terete. *Inflorescence* male, androgynous or mixed, densely greyish adpressed stellate hairy; bract and bracteoles linear, 1–2½ by ½ mm. *Male rachis* 10–20 cm, 1½–2 mm ø; ♂ flowers solitary or in clusters of 2–3, filaments 3–5 mm, anthers 0.2–0.3 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 10–25 cm, 1–2 mm

ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3, terete, 2–3 mm, recurved. *Ripe cupule* 1–1½ cm stalked, broadly cup-shaped, 1–2 cm long, 3–4 cm ø, rim thin, covering ⅓–⅔ part of the fruit; outside obscurely tuberculate, the tubercles in concentric rows or irregularly. *Ripe fruit* subhemispherical, 2–3 cm long, 3–4 cm ø, densely greyish tomentose, top flat-umbonate, base truncate, scar flat, *c.* 1½–2 cm ø; wall woody, 3–5 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Java (W. Java, rather common, eastwards to Mt Slamet, 109° 15′ E).

Ecol. In submontane forest up to 1800 m. *Fl.* mainly in March, *fr.* Aug.–Oct.

DOCTERS VAN LEEUWEN (Ned. Kruidk. Arch. 51, 1941, 134) described a leaf-gall caused by a gall-midge, and a stem-gall by a coccid.

32. Lithocarpus cyclophorus (ENDL.) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 714, t. 393; BARN. Trans. & Proc. Bot. Soc. Edinb. 33 (1942) 334; *ibid.* 34 (1944) 177; SOEPADMO, Reinwardtia 8 (1970) 233. — *Quercus depressa* ROXB. Fl. Ind. ed. Carey 3 (1832) 640, *non* HUMB. & BONPL. 1809, *nec* BL. 1826. — *Quercus cyclophora* ENDL. Gen. Pl. Suppl. 4, 2 (1847) 28; A.DC. Prod. 16, 2 (1864) 102; HOOK. *f.* Fl. Br. Ind. 5 (1888) 615; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 71, t. 67; CORNER, Ways. Trees (1940) 302, f. 97. — *Quercus penangensis* MIQ. Fl. Ind. Bat. 1, 1 (1856) 859. — *Quercus umbonata* HANCE, J. Bot. 12 (1874) 241; *ibid.* 13 (1875) 364. — *Pasania cyclophora* (ENDL.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 442. — *Synaedrys cyclophora* (ENDL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *L. pseudoplatycarpus* A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 4 (1932) 914; Chênes 3 (1954) 716, t. 394: 1–6.

Tree 18–40 m, 20–120 cm ø; buttresses up to 2 m tall and out; bark deeply fissured or scaly. *Branchlets* initially densely yellowish brown to fulvous tomentose by adpressed stellate hairs, later glabrous, lenticellate; terminal buds ovoid-ellipsoid, 3–6 by 2–3 mm, scales ovate to linear. Stipules narrowly lanceolate to linear, 10 by 3 mm. *Leaves* thick-coriaceous, rigid, (18–)20–25(–30) by (6–)7–9(–12) cm (index 2.5–3.5), broadest at or slightly below the middle; surfaces discolorous, above glabrous, dark chocolate-brown, glossy, underneath densely yellowish brown to fulvous adpressed stellate hairy; base rounded-acute, top bluntly 1–1½ cm acuminate; midrib and nerves strongly prominent beneath, slightly so to flat above; nerves (14–)15–17(–20) pairs, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation dense, scalariform, distinct beneath; petiole 1–2 cm, 2–3 cm ø, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown adpressed stellate hairy; bract and bracteoles thick-coriaceous, linear, 2½–3½ by ½ mm. *Male rachis* 10–15 cm, 2½–3 mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.25–0.3 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous rachis c.* 10 cm, 3–4 mm ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3, conical, *c.* 1 mm. *Ripe cupule* sessile, broadly obconical to cup-shaped or saucer-shaped, 1½–2½ cm long, 4–6 cm ø, rim ½–1 cm thick, incurved, covering ⅓–½ part of the fruit; wall woody, lamellae 8–10, obscure, rounded, concentric or irregular, densely fulvous stellate hairy. *Ripe fruit* broadly depressed subglobose, 1½–2½ cm long, 3½–4½ cm ø, top depressed-umbonate, base rounded, scar strongly convex; wall woody, 3–5 mm thick, outside densely yellowish brown to fulvous tomentose with adpressed simple hairs, for the greater part free from the cupule.

Distr. Peninsular Siam (Betong at 5° 45′ N), in *Malesia*: Sumatra (scattered), Malay Peninsula (Perak, Selangor, Malacca; also Penang and Singapore).

Ecol. In primary, rarely also in secondary forest, at 150-1500 m. *Fl.* Nov.-April, *fr.* Aug.-Nov.

33. Lithocarpus luteus SOEPADMO, Reinwardtia 8 (1970) 255.

Tree 18–36 m, 30–100 cm ø; buttresses up to 2 m tall and out; bark deeply fissured to scaly, reddish brown. *Branchlets* initially densely yellowish brown to fulvous tomentose by adpressed stellate hairs, later glabrous, dark greyish brown, densely warty lenticellate; terminal buds ovoid, 3 by 2 mm, scales narrowly ovate-acute. Stipules linear-acute, 4–6 by 1 mm. *Leaves* thick-coriaceous, (7–)9–12(–15) by (2½–)3½–5(–6) cm (index 2½–3), broadest at or slightly below the middle; surfaces more or less concolorous, yellowish brown, above glabrous, glossy, underneath with a thin cover of adpressed stellate hairs; base acute to cuneate, margin recurved, top acute to 1 cm acuminate; midrib and nerves yellowish, thin, prominent beneath, flat above; nerves 9–12 pairs, dense, parallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, dense, scalariform, distinct beneath; petiole 8–13 mm, 2 mm ø, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown stellate hairy; bracts and bracteoles narrowly ovate to linear, 2–2½ by 1 mm. *Male rachis* 10–15 cm, 1½ mm ø; ♂ flowers in clusters of 3–7, stamens 10–12, filaments 2½–3½ mm, anthers 0.35 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis* 5–10 cm, 2–3 mm ø; *female flowers* in clusters of 2–3 or solitary, staminodes well-developed and exceeding the perianth, styles 3, conical, *c.* 1 mm, recurved. *Cupule* sessile, solitary or more commonly in clusters of 2–3, cup-shaped, 1–1½ cm long, 2½–3 cm ø; rim thick, sometimes incurved, covering ± ⅓ part of the fruit; wall woody, dark chocolate-brown, lamellae obscure, undulate, densely stellate hairy. *Fruit* ovoid to subhemispherical, 1–1½ cm long, 2–2½ cm ø, densely fulvous to greyish tomentose, top acute to rounded-umbonate, base truncate, scar flat, *c.* 2 cm ø; wall woody, 2–3 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Mt Mulu, Mt Murut,

Kapit, Sarawak; Mt Kemul, Kalimantan; Mt Kinabalu, Sabah, very common).

Ecol. Forests, at 1100–1800 m, on brownish sandstone derived soil. *Fl.* July–Jan., *fr.* Dec.–June.

34. Lithocarpus schlechteri MARKGR. Bot. Jahrb. 59 (1924) 69, f. 2; A. CAMUS, Chênes 3 (1954) 633, t. 373: 14–17; SOEPADMO, Reinwardtia 8 (1970) 278. — *L. perclusa* MARKGR. Bot. Jahrb. 59 (1924) 68; A. CAMUS, Chênes 3 (1954) 608.

Tree 10–26 m, 10–50 cm ø; bark light grey-brown, lenticellate. *Branchlets* initially densely fulvous to rufous tomentose by adpressed stellate hairs, later glabrous, dark greyish brown, finely fissured or sparsely lenticellate; terminal buds ovoid, 1–2 by 1 mm, scales ovate. Stipules ovate, 1–1½ by 1 mm. *Leaves* thin-coriaceous, (7–)8–12 (–16) by (3–)3½–5(–6) cm (index 2.2–2.7), broadest at or rarely below the middle; surfaces discolorous, above glabrous, dark chocolate-brown, dull to glossy, underneath with a thin cover of pale greyish brown tomentum, hairs adpressed, minute, stellate; base rounded-acute to acute, top bluntly acute to ½–1 cm acuminate; midrib and nerves thinly prominent beneath, flat to impressed above; nerves (7–)8–9(–10) pairs, subparallel, at an angle of *c.* 45°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform, distinct beneath; petiole glabrous, 5–8 mm, 1–2 mm ø, adaxially flat to furrowed, dark coloured. *Inflorescence* male or androgynous, densely greyish stellate hairy; bracts and bracteoles ovate, 1–1½ by ½–1 mm. *Male rachis* 7–10 cm, 1–1½ mm ø; ♂ flowers in clusters of 2–3, filaments 2–3 mm, anthers 0.30 mm long, pistillode subglobose, *c.* 1½ mm ø. *Androgynous rachis c.* 5 cm, 2–3 mm ø; *female flowers* solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3–6, conical, 1–1½ mm. *Ripe cupule* sessile, obconical, 3–3½ cm long, 4½–5½ cm ø; rim thin, incurved over the rounded top of the fruit, covering ± ⅔ part of the fruit; wall woody, 3–5 mm thick; scales woody, thick, adpressed, with rounded edges or keeled, imbricate but set on concentric rows. *Ripe fruit* depressed-subglobose, 2½–3½ cm long, 3½–4½ cm ø, glabrous, dark chocolate-brown, top depressed-umbonate at the centre, base rounded, scar strongly convex, *c.* 2–3 cm ø; wall woody, ½–1 cm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: New Guinea (from the Vogelkop Peninsula to the eastern parts, rather common).

Ecol. Often a common and gregarious constituent of the Fagaceous forest at 800–1900 m, sporadic in the lower limit of *Nothofagus* forest at 2200 m, on sandy clayey soil. *Fl.* March–Oct., *fr.* Nov.–July.

Notes. *Quercus imperialis* VON SEEMEN in K. Sch. & Laut. Fl. Schutzgeb. (1901) 263, t. 4 F. — *Synaedrys imperialis* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 195. — *L. imperialis* (VON SEEMEN) MARKGR. Bot. Jahrb. 59 (1924) 69; A. CAMUS, Chênes 3 (1954) 632, t., may belong here, but as the author did not indicate any particular specimen, and described the species based on a single cupule (lost), and the description cannot be recognized with certainty, the later name *schlechteri* is here accepted.

L. perclusa was based on a specimen with very young cupules, while *L. schlechteri* was based on a specimen with ripe cupules. Recent collections from New Guinea show that they are conspecific.

The cupule of *L. schlechteri* is so far the largest among known species in New Guinea.

35. Lithocarpus megacarpus SOEPADMO, Reinwardtia 8 (1970) 259.

Tree 9–30 m, 10–50 cm ø. *Branchlets* glabrous, sturdy, dark greyish brown, with sparse or dense lenticels; terminal buds ovoid, 2–3 by 2 mm, scales narrowly ovate-acute, rufous tomentose. Stipules narrowly ovate, 1–1½ cm by ½–1 mm. *Leaves* thick-coriaceous, rigid, (9–)11–14(–16) by (3½–)5–6(–8) cm (index (2–)2.2–2.6(–3.2)), broadest at or rarely below the middle; surfaces concolorous, greyish brown, above glabrous, dull to glossy, underneath with a thin cover of minute, adpressed stellate hairs, soon glabrescent; base rounded-acute to attenuate-acute, margin recurved, top acute to ½–1 cm acuminate; midrib and nerves prominent beneath, flat above; nerves (7–)8–10(–11) pairs, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation coarse, lax, subscalariform, distinct beneath; petiole glabrous, 6–10 mm, 2–2½ mm ø, shallowly furrowed. *Inflorescence* male or androgynous, sparsely greyish brown stellate-tomentose; bracts and bracteoles ovate-acute, 0.7–1 by 0.7 mm. *Male rachis c.* 10 cm, 2 mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.30 mm long, pistillode globose, 1–1½ mm ø. *Androgynous rachis c.* 5 cm, 2 mm ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3, conical, *c.* 1 mm. *Ripe cupule* subsessile, broadly saucer-shaped, 1–1½ cm long, 4–5½ cm ø; rim thick, rounded, covering the basal part of the fruit; wall woody, densely greyish brown tomentose by adpressed stellate hairs; scales thick, adpressed, imbricate but concentrically set. *Ripe fruit* depressed-subglobose, rarely ovoid, glabrous, chocolate-brown, 2–3½ cm long, 4–5 cm ø, top rounded-apiculate to depressed-umbonate, base truncate, scar concave but convex at the centre, 2–4 cm ø; wall woody, 5–8 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: New Guinea (rather rare in the western part, more common in the eastern part).

Ecol. Forests, 1200–1900 m, common on steep slopes. *Fl.* Jan.–June, *fr.* July–Nov.

36. Lithocarpus revolutus HATUS. *ex* SOEPADMO, Reinwardtia 8 (1970) 273, f. 12. — Fig. 25.

Tree 12 m, 30 cm ø; bark soft, corky, creamy in colour. *Branchlets* initially densely yellowish brown, stiff, stellate-pubescent, soon glabrescent, greyish brown, sparsely lenticellate; terminal buds ovoid, 4–5 by 3–4 mm, scales narrowly ovate or linear. Stipules narrowly ovate-acute, 4–5 by 2–2½ mm. *Leaves* thick-coriaceous, rigid, 8½–14 by

3–5 cm (index 2–3), broadest at or above the middle; surfaces concolorous, greenish brown, sparsely stiff, stellate-pubescent on both sides, glabrescent; base acute, margin strongly revolute, top rounded to bluntly acute, tip emarginate; midrib and nerves strongly prominent beneath, flat to impressed above; nerves 6–8 pairs, subparallel, at an angle of 45–60°, arcuating but not anastomosing near the margin; reticulation subscalariform, fine, obscure to rather distinct beneath; petiole 5–6 mm, 3–4 mm ø, adaxially flat. *Male rachis* 10–15 cm, 3 mm ø, densely yellowish brown stiff stellate hairy; bracts narrowly ovate, 2–2½ by 1–1½ mm, bracteoles ovate, 1 by 1 mm; ♂ flowers in clusters of 3, filaments 3½–5 mm, anthers 0.3–0.35 mm long, pistillode subglobose, 1½–2 mm ø. *Female flowers* (seen as young fruit) solitary or in clusters of 2–3, staminodes well

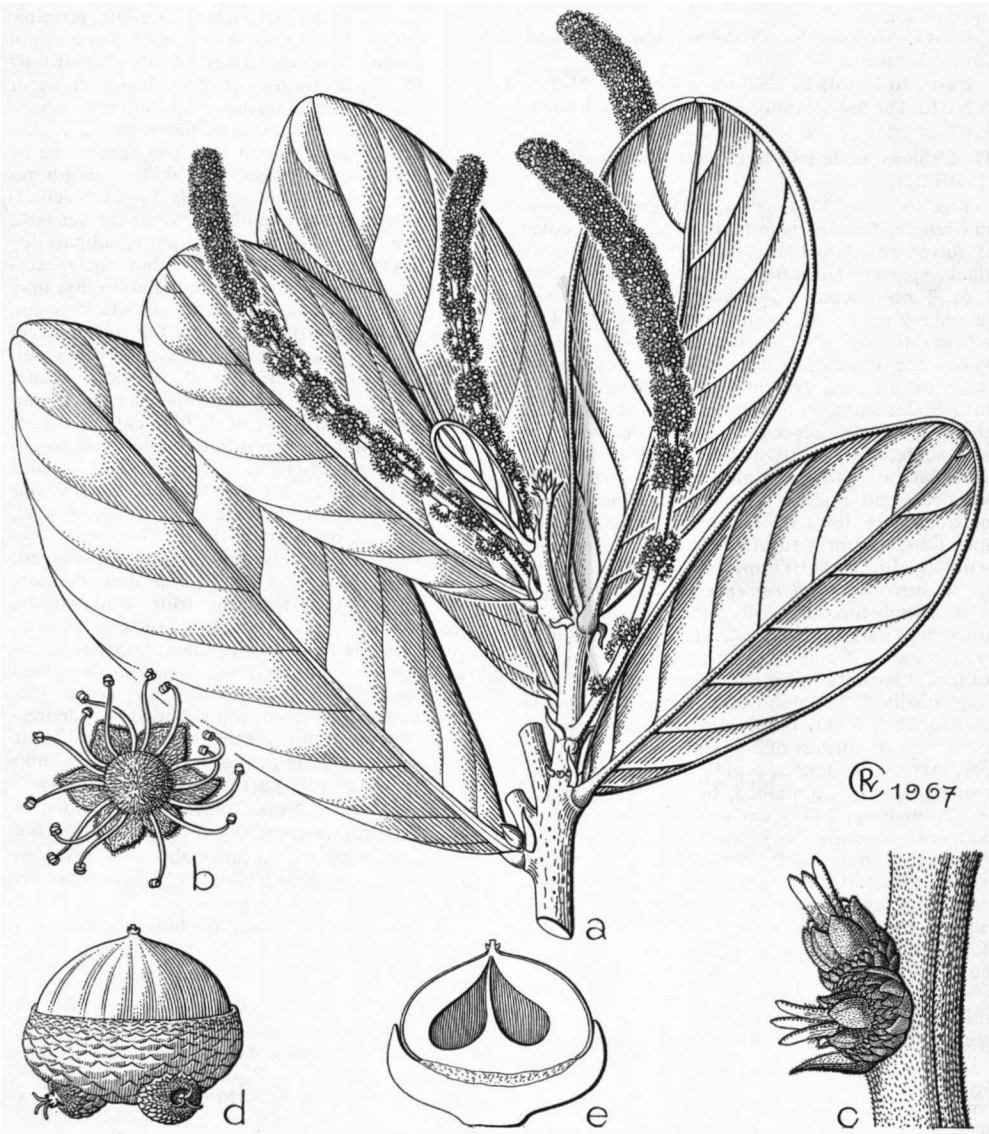

Fig. 25. *Lithocarpus revolutus* HATUS. *ex.* SOEPADMO. *a.* Habit with ♂ rachis, × ⅔, *b.* details of ♂ flower, ×4, *c.* ♀ flowers, ×4, *d.* ripe cupule and fruit, × ⅔, *e.* longitudinal section of cupule and fruit, × ⅔ (RSNB 4171).

developed and exceeding the perianth, styles 3, terete, 3–4 mm long, recurved. *Ripe cupule* sessile, woody, cup-shaped, 1½–2 cm long, 3¾–4½ cm ø; rim thin but rigid, covering ¼–⅓ part of the fruit; inside densely silvery brown simple sericeous, outside densely fulvous stellate tomentose; scales ovate, adpressed, imbricate. *Ripe fruit* depressed ovoid-conical, 2–2⅓ cm long, 3–4 cm ø, glabrous, dark chocolate-brown; top rounded-acute, base rotundate, scar concave, 2–2½ cm ø; wall woody, up to 1 cm thick, for the greater part free from the cupule.

Distr. *Malesia*: North Borneo (Mt Kinabalu; Sarawak, rare).

Ecol. In forests at 1500 m. *Fl. fr.* Jan.–May.

Note. The female inflorescence is not yet known.

37. Lithocarpus brassii SOEPADMO, Reinwardtia 8 (1970) 221.

Tree 15–35 m, 30–45 cm ø; bark greyish brown, lenticellate. *Branchlets* initially with a dense cover of fulvous stellate hairs, soon glabrous, greyish black, sparsely lenticellate; terminal buds ovoid, 3 by 2 mm, scales ovate-acute. Stipules ovate-acute, 1–2 by 1 mm. *Leaves* coriaceous, 10–14 by 4–6 cm (index 2.2–2.6), broadest at or slightly below the middle; surfaces discolorous, above glabrous, greenish grey to dark chocolate-brown, dull, underneath with a thin cover of yellowish brown to fulvous adpressed, minute stellate hairs; base acute, top bluntly acute; midrib and nerves thin, flat on both sides; nerves 8–10 pairs, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform to almost irregular, obscure; petiole glabrous, 6–10 mm, 1–2 mm ø, adaxially flat to furrowed. *Inflorescence* male or androgynous, densely fulvous woolly pubescent; bracts and bracteoles narrowly ovate-acute, 2–3 by 1 mm. *Male rachis c.* 5 cm, 1½ mm ø; ♂ flowers mostly solitary, filaments 3–4 mm, anthers 0.30–0.35 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis* 5–6 cm, 1–1½ mm ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3–4, terete, *c.* 1½ mm. *Ripe cupule* sessile to 1–1½ cm stalked, broadly cup-shaped, 1½–2 cm long, 4–4½ cm ø; rim thick, slightly incurved, covering ⅓–½ part of the fruit; wall woody, 3–5 mm thick, outside densely greyish brown tomentose by adpressed stellate hairs; scales obscure, ovate-acute, adpressed, imbricate but concentrically set. *Ripe fruit* depressed ovoid-globose, 2½–3 cm long, 3–4 cm ø, glabrous except the depressed-umbonate top, dark chocolate-brown, base rounded to conical, scar 2½–3 cm ø; wall woody, 5–7 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: East New Guinea (Highlands Districts).

Ecol. Forests at 1000–2500 m, on badly drained clayey soil. *Fl.* May–Sept., *fr.* Sept.–May.

38. Lithocarpus lauterbachii (VON SEEMEN) MARKGR. Bot. Jahrb. 59 (1924) 69; A. CAMUS, Chênes 3 (1954) 672, t.; SOEPADMO, Reinwardtia 8 (1970) 253. — *Quercus lauterbachii* VON SEEMEN, Bot. Jahrb. 23, Beibl. 57 (1897) 54; in K. Sch. & Laut. Fl. Schutzgeb. (1901) 264, t. 4: A–E. — *Synaedrys lauterbachii* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 196. — *L. solanicarpa* MARKGR. Bot. Jahrb. 59 (1924) 67; A. CAMUS, Chênes 3 (1954) 681, t.

Tree 12–36 m, 35–80 cm ø; bark grey-brown. *Branchlets* initially densely fulvous-tomentose by adpressed stellate hairs, later glabrous, dark greyish brown, smooth to sparsely lenticellate; terminal bud ovoid, 2–3 by 2 mm, scales ovate. Stipules not seen. *Leaves* thin-coriaceous, (8–)10–13(–16) by (4–)5–6(–8) cm (index 1.8–2.8), broadest at or below the middle; surfaces discolorous, above glabrous, pale to dark chocolate-brown, underneath densely glaucous to pale grey tomentose by adpressed stellate hairs; base acute, margin recurved, top bluntly and abruptly ½–1 cm acuminate; midrib and nerves thin, prominent beneath, flat above; nerves (7–)8–9(–10) pairs, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation lax, fine, subscalariform, distinct beneath; petiole ½–1 cm, 1½–2 mm ø, glabrous, adaxially flat to furrowed. *Inflorescence* male or androgynous, densely fulvous stellate hairy; bracts and bracteoles ovate, 1–1½ by ⅔–1 mm. *Male rachis* 6–15 cm, 2 mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.35 mm long, pistillode subglobose, longitudinally compressed, *c.* 1 mm ø. *Androgynous rachis* 5–7 cm, 1½–2 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, 1–1½ mm, connate at the base. *Ripe cupule* ½–1½ cm stalked, deeply and broadly cup-shaped, 1½–2½ cm long, 3–4 cm ø; rim thin, dentate, covering ⅓–½ part of the fruit; wall woody, inside densely silky tomentose, outside densely fulvous stellate hairy; scales thick, adpressed, imbricate but concentrically set. *Ripe fruit* depressed subglobose, 2½–2¾ cm long, 3–3½ cm ø, glabrous, chocolate-brown, top rounded and depressed-umbonate at the centre, base rounded, scar strongly convex, *c.* 2½ cm ø; wall woody, 5–7 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: New Guinea (locally found in NW. parts, rather common in the eastern parts).

Ecol. In primary, occasionally also in secondary forests, at 300–2400 m. *Fl.* July–Febr., *fr.* March–Oct.

Uses. Wood locally used for building construction and fencing.

39. Lithocarpus pallidus (BL.) REHD. J. Arn. Arb. 1 (1919) 129; A. CAMUS, Chênes 3 (1954) 679, t. 382: 11–21; SOEPADMO, Reinwardtia 8 (1970) 265. — *Quercus pallida* BL. Bijdr. (1826) 524; Fl. Jav. Cupul. (1829) 12, t. 4, 5; MIQ. Fl. Ind. Bat. 1, 1 (1856) 851; A.DC. Prod. 16, 2 (1864) 84; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 11, t. 6; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 225; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 57, t. 53 A; K. & V. Bijdr. 10 (1904) 35; KOORD. Atlas

1 (1913) t. 52; BACKER & BAKH. *f.* Fl. Java 2 (1965) 7. — *Quercus pseudomolucca var. rostrata* BL. Mus. Bot. 1 (1850) 291. — *Quercus pseudomolucca var. pallida* (BL.) MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 108. — *Pasania pallida* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83; S. MOORE, J. Bot. 63 (1925) Suppl. 114. — *Synaedrys pallida* (BL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 197.

Tree 10–20 m tall. *Branchlets* initially densely fulvous woolly pubescent by stellate hairs, later subglabrous, greyish brown, sparsely lenticellate; terminal buds ovoid-ellipsoid, 5–8 by 2–3 mm, scales narrowly ovate to linear, 3–5 by 1–2 mm. Stipules linear to subulate, 8–11 by 1–1½ mm, rather long persistent. *Leaves* coriaceous, (10–)12–16(–19) by (3–)4–5(–7) cm (index 2½–3½), broadest at the middle; surfaces discolorous, above pale chocolate-brown, glabrous, dull to glossy, underneath densely yellowish tomentose by adpressed stellate hairs; base rounded-acute, top abruptly acute to 1–2 cm acuminate; midrib prominent on both sides, sometimes pinkish coloured; nerves (11–)12–14(–16) pairs, prominent beneath, impressed above, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation dense, fine, scalariform, distinct beneath; petiole 6–10 mm, 1–2 mm ø, adaxially flat. *Male rachis* 5–10 cm, 1–1½ mm ø, usually much branched; bracts and bracteoles narrowly ovate-acute to linear, 3–5 by ½–1 mm; ♂ flowers solitary or in clusters of 2–3, filaments 2–3 mm, anthers 0.3 mm long, pistillode subglobose, *c.* 1 mm ø. *Young fruit*: staminodes rudimentary, styles 3, conical, 1–1½ mm, connate. *Ripe cupule* sessile, saucer-shaped, ½–1 cm long, 3½–5 cm ø; rim thick, covering the basal part of the fruit; wall woody, inside densely fulvous tomentose by simple hairs, outside densely fulvous stellate hairy; scales woody, conical, 2–3 mm long, free, imbricate. *Ripe fruit* depressed-subglobose, 1–2 cm long, 3⅓–4½ cm ø, glabrous, dark chocolate-brown, top rounded and depressed-umbonate at the centre, base rotundate, scar flat, 3–4 cm ø; wall woody, *c.* 3 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: S. Sumatra (FORBES, fr., 1881, from Mt Dempo), Java (rather common in the western parts, eastwards to Mts Slamet and Wilis).

Ecol. Forests, 1300–2100 m. *Fl.* May–June, *fr.* Aug.–Jan.

Note. Female inflorescence not known.

40. Lithocarpus conocarpus (OUDEM.) REHD. J. Arn. Arb. 1 (1919) 123; A. CAMUS, Chênes 3 (1954) 754, t. 403: 1–9; SOEPADMO, Reinwardtia 8 (1970) 231. — *Quercus conocarpa* OUDEM. Versl. Med. Kon. Ak. Wet. Natuurk. 12 (1861) 206; A.DC. Prod. 16, 2 (1864) 93; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 18, t. 10; WENZIG, Jahrb. Bot. Berl. 4 (1886) 230; HOOK. *f.* Fl. Br. Ind. 5 (1888) 612; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 61, t. 56 A; K. & V. Bijdr. 10 (1904) 50; CORNER, Ways. Trees (1940) 302, f. 96, pl. 49; BACKER & BAKH. *f.* Fl. Java 2 (1965) 8. — *Cyclobalanus conocarpa* (OUDEM.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Pasania conocarpa* (OUDEM.) SCHOTTKY, Bot. Jahrb. 49 (1913) 357, *pro auct. Oerst. citato*; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 430. — *Synaedrys conocarpa* (OUDEM.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *L. conocarpa ssp. malaccensis* A. CAMUS, Bull. Soc. Bot. Fr. 90 (1943) 200; Chênes 3 (1954) 757, t. 403: 10–19, *atque ssp. euconocarpa.*

Tree 10–45 m, 10–90 cm ø; bark greyish brown, lenticellate. *Branchlets* initially densely greyish brown tomentose with stellate hairs, later subglabrous with a few or many lenticels; terminal buds ovoid, 3–4 by 2–3 mm, scales narrowly ovate. Stipules ovate, 2–3 by 1½ mm. *Leaves* coriaceous, rigid, (6–)8–12(–14) by (2–)3–4(–5½) cm (index (2.2–)2.5–3(–4)), broadest at or above the middle; surfaces discolorous, above dark greyish to chocolate-brown, by sparse erect stellate hairs, dull to glossy, underneath with a dense cover of yellowish brown to rufous adpressed and erect stellate hairs; base acute, margin recurved, top bluntly acute to 1–1½ cm acuminate; midrib strongly prominent on both sides, densely pubescent with erect stellate hairs; nerves (9–)10–12(–15) pairs, prominent beneath, impressed above, subparallel, at an angle of 45–70°, arcuating and anastomosing near the margin, densely pubescent by erect stellate hairs; reticulation lax, coarse, subscalariform, distinct beneath; petiole densely stellate hairy, ½–1 cm long, 1–2 mm ø, terete or adaxially flat. *Inflorescence* male, androgynous or mixed, densely yellowish brown to fulvous stellate hairy; bracts and bracteoles narrowly ovate, 1½–2½ by ½–1½ mm. *Male rachis* 10–17 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.35 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 7–18 cm, 1½ mm ø; *female flowers* solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3, conical, 1–1½ mm. *Ripe cupule* 3–8 mm stalked, cup-shaped, 2–6 mm long, 1.6–2 cm ø; rim thin, covering the basal part of the fruit; lamellae 6–7, concentric, denticulate, outside densely yellowish brown to rufous stellate hairy. *Ripe fruit* ovoid-conical, 1.6–2.4 cm long, 1.7–2 cm ø, densely greyish tomentose, subglabrescent, top long-acuminate, base rounded, scar concave, 1–1.2 cm ø; wall woody, *c.* 1 mm thick, greater part free from the cupule.

Distr. *Malesia*: Sumatra (rare, scattered), Malay Peninsula (rare, scattered), Java (W. parts, rare), Borneo (common, especially in Sabah).

Ecol. Forests, from sea-level up to 1800 m. *Fl.* July–March, *fr.* April–Oct.

DOCTERS VAN LEEUWEN (Ned. Kruidk. Arch. 51, 1941, 134) recorded a leaf gall caused by a gall-midge from Java.

41. Lithocarpus atjehensis HATUS. *ex* SOEPADMO, Reinwardtia 8 (1970) 217.

Shrub. *Branchlets* densely fulvous tomentose by adpressed stellate and erect woolly tuft-hairs, blackish brown, brittle; terminal buds ovoid-globose, 3 by 2 mm, scales ovate. Stipules narrowly ovate-acute, 2 by 1 mm. *Leaves* thick-

coriaceous, rigid, brittle, (6–)8–10(–12) by (3–)4–5(–7) cm (index 1.7–2), broadest below the middle; surfaces discolorous, above dark chocolate-brown, more or less glossy, sparsely pubescent by woolly tuft-hairs especially on midrib and nerves, beneath pale greyish brown, densely tomentose by adpressed stellate hairs interspersed with woolly tuft-hairs; base rounded to subcordate, top sharply 1–1½ cm acuminate; midrib prominent on both sides; nerves 12–14 pairs, prominent beneath, impressed above, subparallel, at an angle of 60–70°, arcuating and anastomosing near the margin; reticulation coarse, subscalariform, distinct beneath; petiole 7–10 mm, 2 mm ø, adaxially flat, densely stellate hairy. *Male rachis* 2–4 cm, 2 mm ø, densely tomentose by erect stellate hairs; bracts and bracteoles ovate, 1–1½ by ⅔–1 mm; ♂ flowers solitary, stamens 10–12, filaments 2–2½ mm, anthers 0.30 mm long, pistillode subglobose, *c.* 1 mm ø. Young infructescence 3–5 cm, 3 mm ø, carrying 5–10 obconical young cupules. *Female flowers* (seen in a young fruit) solitary or in clusters of 2–3, staminodes rudimentary, styles 3, conical, 2–2½ mm, recurved. *Young cupule* sessile, cup-shaped, *c.* 1 cm long, 2 cm ø; rim thin, covering ± 1/3 part of the fruit; wall thin, woody, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous tomentose by stellate hairs; lamellae 5–6, thin, concentric, denticulate. *Young fruit* ovoid-conical, *c.* 1½ cm long and ø, densely fulvous tomentose by adpressed simple and stellate hairs, top acute, base rotundate, scar concave, *c.* 0.7 cm ø; wall woody, *c.* ½ mm thick, for the greater part free from the cupule.

Distr. *Malesia*: N. Sumatra (Atjeh: Gajo Lands: VAN STEENIS 8419, 8563, 9143).

Ecol. Montane forest at 2500–3000 m. *Fl. fr.* Jan.–Febr.

42. Lithocarpus dasystachyus (MIQ.) REHD. J. Arn. Arb. 1 (1919) 124; A. CAMUS, Chênes 3 (1954) 798, t.; SOEPADMO, Reinwardtia 8 (1970) 234. — *Quercus dasystachya* MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1864) 221; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 53, t. 45 B. — *Pasania dasystachya* (MIQ.) SCHOTTKY, Bot. Jahrb. 49 (1913) 356. — *Pasania winkleriana* SCHOTTKY, *l.c.* 357. — *Synaedrys dasystachya* (MIQ.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 194. — *Quercus winkleriana* (SCHOTTKY) MERR. En. Born. (1921) 216. — *L. winkleriana* (SCHOTTKY) A. CAMUS, Riviera Scient. 18 (1931) 42; Chênes 3 (1954) 800.

Tree 5–18 m, 10–25 cm ø; stilt-roots occasionally present; bark smooth to flaky, lenticellate, greyish brown. *Branchlets* densely velvety tomentose by greyish to reddish brown adpressed stellate hairs and erect simple or stellate hairs; terminal bud ovoid-globose, 2–3 by 2 mm, scales ovate. Stipules ovate-acute to deltoid, 1–2 by 1½ mm. *Leaves* thick-coriaceous, rigid, (12–)15–20(–25) by (4½–)6–8(–10) cm (index 2–3), broadest about the middle; surfaces more or less discolorous, above subglabrous, dull to glossy, pale greyish brown, underneath densely yellowish to reddish brown, rarely greyish, tomentose by adpressed stellate and erect simple or stellate hairs; base rounded to acute, decurrent, margin recurved, top sharply 1–2½ cm acuminate; midrib strongly prominent on both sides, densely pubescent by erect simple hairs, glabrescent; nerves 12–14 pairs, lax, prominent on both sides or impressed above, subparallel, at an angle of 60–70°, arcuating but not anastomosing towards the margin, densely pubescent by erect simple hairs, glabrescent above; reticulation lax, subscalariform, obscure; petiole densely yellowish brown pubescent, 8–15 mm, 2–3 mm ø, adaxially flat or furrowed. *Inflorescence* male, androgynous or mixed, densely yellowish brown to rufous tomentose by erect simple and adpressed stellate hairs; bracts and bracteoles ovate or deltoid, 0.7–1 by 0.5–0.7 mm. *Male rachis* 10–25 cm, 1–2 mm ø; ♂ flowers in clusters of 3, rarely solitary, perianth 5–6-lobed, stamens 10–12, filaments 2–2½ mm, anthers 0.25 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 10–30 cm, 2 mm ø; *female flowers* solitary or rarely in clusters of 2–3, staminodes rudimentary, styles 3–6, conical, 1–2 mm. *Ripe cupule* 2–5 mm stalked, saucer- to cup-shaped, 5–7 mm long, 13–18 mm ø; rim thin, covering *c.* ¼ part of the fruit; wall thin, inside densely yellowish brown to rufous-tomentose by adpressed simple hairs, outside densely yellowish brown to fulvous-tomentose by stellate hairs and erect simple hairs; lamellae 7–8, concentric, denticulate. *Ripe fruit* ovoid-conical, 13–15 mm long, 10–13 mm ø, densely yellowish brown to fulvous tomentose by adpressed simple hairs, subglabrescent, pale chocolate-brown, top abruptly acuminate, base rotundate, scar deeply concave, *c.* ½ cm ø; wall bony, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (scattered in all parts).

Ecol. Forests up to 750 m, common in secondary peat-swamp and heath forest, or in primary lowland forest on poor sandy, badly drained podzolized soil. *Fl.* Sept.–Febr., *fr.* March–July.

Notes. Three more or less distinct forms may be recognized, *viz* one which occurs exclusively in peat-swamp forest, characterized by its large leaf with greyish brown indumentum, a form which is apparently confined to heath forest with a smaller leaf and less tomentum on the leaf and fruit, and one which occurs in forest on a better drained soil having a large leaf densely set with yellowish to reddish brown, erect simple hairs, and with strongly prominent venation. Several intermediates have, however, been collected.

Records of *L. dasystachyus* from the Philippines are referred to *L. mindanaensis*.

43. Lithocarpus caudatifolius (MERR.) REHD. J. Arn. Arb. 1 (1919) 123; A. CAMUS, Chênes 3 (1954) 796, t.; SOEPADMO, Reinwardtia 8 (1970) 226. — *Quercus caudatifolia* MERR. Philip. J. Sc. 3 (1908) Bot. 324; ELMER, Leafl. Philip. Bot. 3 (1910) 939; MERR. En. Philip. 2 (1923) 26. — *Quercus minahassae* KOORD. *ex* ELMER, Leafl. Philip. Bot. 3 (1910) 941; KOORD. in Koord.-Schum. Syst. Verz. 3 (1914) 28. — *Synaedrys caudatifolia* (MERR.) KOIDZ. Bot. Mag. Tokyo 30

(1916) 190. — *L. minahassae* (KOORD. *ex* ELMER) REHD. J. Arn. Arb. 10 (1929) 133; A. CAMUS, Chênes 3 (1954) 1162. — *Quercus bulusanensis* ELMER, Leafl. Philip. Bot. 10 (1939) 3736. — *L. bulusanensis* (ELMER) A. CAMUS, Not. Syst. 13 (1948) 265; Chênes 3 (1954) 764, t.

Tree 5–30 m, 10–80 cm ø; buttresses 0.3 m tall, 0.6 m out, 5 cm thick; bark scaly, greyish brown. *Branchlets* densely yellowish brown to fulvous velvety tomentose by soft erect simple and stellate hairs, sparsely lenticellate; terminal bud ovoid, 2–3 by 2 mm, scales ovate. Stipules ovate to linear, 2–6 by 1 mm. *Leaves* thin-coriaceous to papery, (6–)10–14(–17) by (2–)3–6(–9) cm (index (2–)2.5–3(–4)), broadest about the middle; surfaces more or less discolorous, above glabrous except the midrib and nerves, dull to glossy, pale chocolate-brown to greyish brown, underneath densely fulvous velvety tomentose by adpressed stellate and erect simple and stellate hairs; base acute to cuneate, rarely rounded-acute, occasionally asymmetrical, top bluntly to sharply 1–2½ cm caudate-acuminate, rarely acute; midrib and nerves prominent beneath slightly so above; nerves (7–)8–10(–11) pairs, lax to dense, parallel, at an angle of 40–60°, arcuating but not anastomosing towards the margin; reticulation lax, fine, subscalariform, obscure; petiole ½–1½ cm, 1–2 mm ø, terete or adaxially flat. *Inflorescence* male, androgynous or mixed, densely greyish brown to fulvous tomentose by soft adpressed and erect simple and stellate hairs; bracts and bracteoles ovate-acute, 0.7–1 by 0.7 mm. *Male rachis* 10–30 cm, 1–2 mm ø, simple and axillary or much-branched and subterminal; ♂ flowers in clusters of 3–5, rarely solitary, perianth 6–8-lobed, stamens 10–14, filaments 3–4 mm, anthers 0.25–0.35 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 6–25 cm, 1–2 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, 0.7–1 mm, recurved. *Ripe cupule* sessile to 3–5 mm stalked, cup- to saucer-shaped, 3–6 mm long, 1.2–2 cm ø; rim thin, covering the basal part of the fruit; lamellae 5–6, concentric, denticulate; densely fulvous tomentose by simple and stellate hairs. *Ripe fruit* ovoid-conical to depressed ovoid-globose, 9–17 mm long, 12–19 mm ø, densely greyish brown fulvous tomentose by adpressed stellate hairs, top rounded-acute, base truncate, scar concave to convex, 8–10 mm ø; wall bony, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (common in Sabah, rare in SE. Kalimantan), Philippines (Luzon, Mindanao, and several other islands).

Ecol. Primary and secondary forest, up to 1350 m, on ridges or in swampy places near rivers, on yellowish sandy clayey soil or basalt-derived soil. *Fl.* Sept.–June, *fr.* May–Jan.

Note. *Lithocarpus menadoensis* (KOORD.) SOEPADMO may belong here: see under the doubtful species.

44. Lithocarpus ewyckii (KORTH.) REHD. J. Arn. Arb. 10 (1929) 132; A. CAMUS, Chênes 3 (1954) 759, t. 404: 11–19; SOEPADMO, Reinwardtia 8 (1970) 240. — *Quercus ewyckii* KORTH. Kruidk. (1844) 212, t. 46: 1–20; A.DC. Prod. 16, 2 (1864) 94; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 68, t. 62 A: 1–2. — *Cyclobalanus ewyckii* (KORTH.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 80. — *Quercus ewyckii var. latifolia* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 614; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 68, t. 62 A: 3–6. — *Pasania ewyckii* (KORTH.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 431, *incl. var. latifolia*, *l.c.* 432. — *Pasania lamponga var. ewyckioides* GAMBLE, *l.c.* 425. — *Synaedrys ewyckii* (KORTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *L. pseudolamponga* A. CAMUS, Chênes, Atlas 3 (1949) 110, t. 504; Chênes 3 (1954) 1113.

Tree 10–30 m, 20–90 cm ø; buttresses 0.6–1.2 m tall, 0.9–2.4 m out, 7–10 cm thick; bark smooth to scaly, greyish brown to reddish brown. *Branchlets* initially densely fulvous tomentose by adpressed stellate hairs, later subglabrous, greyish to dark brown, sparsely lenticellate; terminal buds ovoid-ellipsoid, 3–5 by 1–2 mm, scales narrowly ovate to linear. Stipules narrowly ovate to linear, 5 by 1–2 mm, soon caducous. *Leaves* thin-coriaceous, (6–)12–15(–18) by (2–)4–6(–7) cm (index 2–3), broadest about the middle; surfaces discolorous, above glabrous, glossy, pale to dark chocolate-brown, underneath densely yellowish to greyish brown tomentose by adpressed stellate hairs; base acute, rarely rounded, top bluntly to sharply ½–2 cm acuminate; midrib and nerves prominent beneath, slightly so above; nerves (12–)13–15(–16) pairs, dense, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation dense, fine, scalariform, distinct beneath; petiole ½–1½ cm, 1–1½ mm ø, adaxially flat to furrowed. *Inflorescence* male, androgynous or mixed, densely brownish stellate hairy; bracts and bracteoles narrowly ovate-acute, 1–2 by ½–1 mm. *Male rachis* 10–15 cm, 1–2 mm ø; ♂ flowers in clusters of 3 or solitary, stamens 10–12, filaments 3–5 mm, anthers 0.30–0.50 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 7–15 cm, 1–2 mm ø; *female flowers* solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3–4, conical, 1–1½ mm long, connate. *Ripe cupule* ½–1 cm stalked, cup- to saucer-shaped, ½–1 cm long, 2–3 cm ø; rim thin, covering the basal part of the fruit; lamellae thin, 6–8, concentric, densely pale brown stellate hairy. *Ripe fruit* ovoid, 2–2½ cm through, densely greyish tomentose, glabrescent, pale brown, glossy, top abruptly acuminate, base rounded, scar deeply concave, 1–1½ cm ø; wall bony, 1–1½ cm thick, for the greater part free from the cupule.

Distr. *Malesia*: Sumatra (most parts), Malay Peninsula (Perak, Pahang, Selangor, Malacca, Johore; Singapore), Borneo (common in all parts, also Nunukan I.).

Ecol. In primary, also secondary and swamp forest up to 1800 m, on ridges or in rocky places. Fertility seems to be irregular.

Note. The flowers have been recorded as having a musty fragrance.

45. Lithocarpus cantleyanus (KING *ex* HOOK. *f.*) REHD. J. Arn. Arb. 10 (1929) 132; A. CAMUS, Chênes 3 (1954) 709, t.; SOEPADMO, Reinwardtia 8 (1970) 225. — *Quercus cantleyana* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 613; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 64, t. 59. — *Pasania cantleyana* (KING *ex* HOOK. *f.*) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 434. — *Synaedrys cantleyana* (KING *ex* HOOK. *f.*)KOIDZ. Bot. Mag. Tokyo 30 (1916) 190.

Tree 10–36 m, 10–120 cm ø; bark greyish brown, fissured to scaly, lenticellate. *Branchlets* initially strongly ribbed under the leaf-insertion, densely yellowish brown tomentose by adpressed stellate hairs, later terete, subglabrous, sparsely lenticellate; terminal buds ovoid, 2–4 by 2–3 mm, scales narrowly ovate-acute. Stipules ovate to linear-acute, 3–5 by 1–3 mm, soon caducous. *Leaves* thick-coriaceous, rigid, (10–)14–18(–24) by (4–)5–6(–8) cm (index 2–3), broadest at or above the middle; above glabrous, glossy chocolate-brown to olive-green, beneath densely yellowish brown to pale glaucous tomentose by adpressed stellate hairs; base acute to cuneate, decurrent, margin recurved, top abruptly acute to ½–1½ cm acuminate; midrib strongly prominent on both sides; nerves (12–)14–15(–16) pairs, prominent beneath, impressed above, parallel, at an angle of *c.* 60°, arcuating but not anastomosing towards the margin; reticulation lax, fine, scalariform, distinct beneath; petiole 1–1½ cm, 1–2½ mm ø, shallowly furrowed. *Inflorescence* male, female or androgynous, densely yellowish brown stellate hairy; bracts and bracteoles narrowly ovate to linear, 2–2½ by 0.7–1 mm. *Male rachis* 10–20 cm, 1½–2 mm ø; ♂ flowers in clusters of 3, perianth 5–7-lobed, stamens 10–12, filaments 3–4 mm, anthers 0.30–0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Female* or *androgynous rachis* 10–15 cm long, 2 mm ø; ♀ flowers solitary or in clusters of 3–5, staminodes rudimentary, styles 3, conical, 1–1½ mm, connate. *Ripe cupule c.* ½ cm stalked, cup-shaped, ½–1 cm long, 1½–2⅓ cm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely stellate hairy; lamellae 5–8, concentric, entire or denticulate. *Ripe fruit* depressed-ovoid, 1–1½ cm long, 1½–2 cm ø, densely pale greyish brown simple-tomentose, glabrescent, top abruptly acute, base cordate, scar concave, *c.* 1 cm ø; wall bony, thinner than 1 mm, for the greater part free from the cupule.

Distr. *Malesia*: Malay Peninsula (Perak, common, Dindings, Johore; Singapore), Borneo (Sarawak, Sabah, rare in E. Kalimantan).

Ecol. In primary forest up to 850 m, occasionally on river-bank on sandy clayey soil or ultrabasic soil. *Fl.* May–Dec., *fr.* Febr.–Nov.

46. Lithocarpus meijeri SOEPADMO, Reinwardtia 8 (1970) 260.

Tree 12–42 m, 20–100 cm ø; buttresses spreading, rounded; bark smooth to deeply fissured or scaly, greyish to reddish brown. *Branchlets* initially densely fulvous stellate hairy, later subglabrous, greyish to blackish brown, sparsely lenticellate; terminal bud ovoid, 3 by 2 mm, scales narrowly ovate-acute. Stipules linear-acute to subulate, 3–4 by ½–1 mm. *Leaves* coriaceous, (11–)13–16(–25) by (4–)5–7(–11) cm (index 2–3), broadest at or above the middle; surfaces discolorous, above glabrous, chocolate-brown, glossy, underneath densely greyish to fulvous tomentose by adpressed stellate hairs; base cuneate, decurrent, margin recurved, top bluntly acute to abruptly ½–1 cm acuminate; midrib and nerves prominent beneath, flat above, often pinkish beneath; nerves 11–13 pairs, subparallel, at an angle of *c.* 45°, arcuating but not anastomosing towards the margin; reticulation dense, fine, subscalariform, obscure; petiole subglabrous, 1–1½ cm, 1½–2½ mm ø, thickened and rugose at the base, shallowly furrowed. *Inflorescence* male, female, androgynous or mixed, densely yellowish brown to fulvous stellate hairy; bracts and bracteoles narrowly ovate-acute, 0.7–1.5 by 0.3–0.5 mm. *Male rachis* 10–25 cm, 2 mm ø; ♂ flowers in clusters of 3–7, rarely solitary, perianth 6–8-lobed, recurved, stamens 12–15, filaments 3–5 mm, anthers 0.30 mm long, pistillode globose, 1–1½ mm ø. *Female, androgynous* or *mixed rachis* 10–15 cm, 2–3 mm ø; ♀ flowers solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3, conical, 0.7–1 mm. *Ripe cupule* sessile, cup-shaped, 1–1½ cm long, 2–2½ cm ø; rim thin, covering the basal part of the fruit; wall woody, inside densely greyish brown tomentose by adpressed simple hairs, outside densely fulvous stellate hairy, lamellae 6–8, concentric, entire or undulate, sometimes obscure. *Ripe fruit* depressed ovoid, 0.6–1.5 cm long, 2–3 cm ø, densely silvery grey tomentose by adpressed simple hairs, top abruptly acuminate or depressed-apiculate, base truncate, scar deeply concave, 1½–2 cm ø; wall woody, 2 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

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

Ecol. Primary, mixed Dipterocarp forest on low ridges up to 1000 m, occasionally also in secondary forest; on yellowish brown, sandy loamy soil or blackish basalt-derived soil. *Fl.* Aug.–Dec., *fr.* March–Oct.

47. Lithocarpus daphnoideus (BL.) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 711, t. 396: 1–9; SOEPADMO, Reinwardtia 8 (1970) 234. — *Quercus daphnoidea* BL. Fl. Jav. Cupul. (1829) 28, t. 16; A.DC. Prod. 16, 2 (1864) 96; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 60, t. 54 A; K. & V. Bijdr. 10 (1904) 45; KOORD. Atlas 1 (1913) t. 56; BACKER & BAKH. *f.* Fl. Java 2 (1965) 8. — *Quercus nitida* BL. Mus. Bot. 1 (1850) 294, *non* RAFIN. 1838, *nec* MART. & GAL. 1843, *incl. var. grisea*; A.DC. Prod. 16, 2 (1864) 95; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 235; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 91; VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 11. — *Cyclobalanus daphnoidea* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Cyclobalanus nitida* (BL.) OERST. *l.c.* 81. — *Quercus poculiformis* VON SEEMEN,

Bot. Jahrb. 27, Beibl. 64 (1900) 13; K. & V. Bijdr. 10 (1904) 46; KOORD. Atlas 1 (1913) t. 61. — *Synaedrys daphnoidea* (BL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *Synaedrys poculiformis* (VON SEEMEN) KOIDZ. *l.c.* 192. — *Pasania daphnoidea* (BL.) S. MOORE, J. Bot. 63 (1925) Suppl. 114. — *L. poculiformis* (VON SEEMEN) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 763. — *L. nitida* (BL.) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 255; Chênes 3 (1954) 1116, t. — *L. sarawakensis* E. F. WARB. Kew Bull. (1936) 19; A. CAMUS, Chênes 3 (1954) 697, t.

Tree 10–24 m, 25–65 cm ø; bark smooth, grey, lenticellate. *Branchlets* initially densely fulvous-tomentose with adpressed stellate hairs, later subglabrous, greyish to blackish brown, sparsely to densely lenticellate; terminal buds ovoid, 3–4 by 2–2½ mm, scales narrowly ovate-acute to linear, 2½–3 by 0.7–1 mm. Stipules linear-acute, 3–4 by 1 mm. *Leaves* thin-coriaceous, (8–)10–13(–16) by 4–5 cm (index 2.4–3.4), broadest at the middle; surfaces discolorous, above glabrous, pale greyish green, beneath densely greyish to yellowish brown tomentose by adpressed stellate hairs; base acute, margin recurved, top bluntly acute to 1–2 cm acuminate; midrib prominent on both sides; nerves (7–)8–10(–12) pairs, more or less prominent beneath, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation lax, fine, subscalariform, distinct beneath; petiole glabrous, 1–1.2 cm, 1 mm ø, furrowed. *Inflorescence* male or androgynous, densely greyish brown stellate hairy; bracts and bracteoles narrowly ovate to linear, 1–2 by ½ mm. *Male rachis* 10–15 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, rarely solitary, perianth 5–6-lobed, stamens 10–12, filaments 2½–3 mm, anthers 0.25–0.30 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis* 10–15 cm, 1–2 mm ø; *female flowers* solitary, rarely in clusters of 3, staminodes rudimentary, styles 3–4, conical, *c.* 1 mm, connate. *Ripe cupule* sessile, obconical, cup-shaped, 1–1½ cm long, 2–2½ cm ø; rim thin, covering the basal part of the fruit; wall woody, inside densely silvery grey tomentose by adpressed simple hairs, outside densely fulvous to greyish stellate hairy; lamellae 8–10, rounded, prominent, concentric. *Ripe fruit* ovoid-conical, 2–3 cm long, 1.8–2.5 cm ø, densely fulvous tomentose by simple adpressed hairs, top abruptly acute, base rotundate, scar flat to convex, 1–1½ cm ø; wall bony, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Sumatra (scattered), Malay Peninsula (Perak, Kelantan, Pahang), W. Java (several collections from Bantam and Priangan Prov.), Borneo (scattered in Sarawak and W. Kalimantan).

Ecol. Forests, up to 1350 m. *Fl.* Dec.–April, *fr.* May–Nov.

Note. *Quercus dolichocarpa* VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 14. — *Synaedrys dolichocarpa* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *L. dolichocarpa* (VON SEEMEN) REHD. J. Arn. Arb. 1 (1919) 125, may belong here. The type and the other collections mentioned by VON SEEMEN are, however, very inadequate for a definite conclusion. The leaves and cupules are smaller and the fruit is longer than those of *L. daphnoideus*, otherwise they are very similar.

48. Lithocarpus philippinensis (A. DC.) REHD. J. Arn. Arb. 1 (1919) 129; A. CAMUS, Chênes 3 (1954) 723, t.; SOEPADMO, Reinwardtia 8 (1970) 267. — *Quercus philippinensis* A. DC. Prod. 16, 2 (1864) 97; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 230, *excl. syn.*; MERR. Philip. J. Sc. 3 (1908) Bot. 328; En. Philip. 2 (1923) 29. — *Cyclobalanus philippensis*' (A. DC.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Quercus caraballoana* F.-VILL. Nov. App. (1880) 209. — *Quercus wenzelii* MERR. Philip. J. Sc. 10 (1915) Bot. 267; En. Philip. 2 (1923) 31. — *Synaedrys philippinensis* (A. DC.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192. — *Synaedrys wenzelii* (MERR.) KOIDZ. *l.c.* 193. — *Quercus rizalensis* MERR. Philip. J. Sc. 13 (1918) Bot. 272; En. Philip. 2 (1923) 30. — *L. wenzelii* (MERR.) REHD. J. Arn. Arb. 1 (1919) 132; A. CAMUS, Chênes 3 (1954) 1111. — *L. rizalensis* (MERR.) REHD. J. Arn. Arb. 10 (1929) 133; A. CAMUS, Chênes 3 (1954) 812, t. 420: 1–9. — *L. oligocarpa* A. CAMUS, Bull. Soc. Bot. Fr. 81 (1934) 816; Chênes 3 (1954) 762, t. 405: 13–16.

Shrub or tree 4–20 m, 18–30 cm ø. *Branchlets* initially densely rufous tomentose by scurfy stellate hairs, later glabrous, whitish grey to blackish brown, sparsely to densely lenticellate; terminal buds ovoid, 3 by 1 mm, scales ovate. Stipules narrowly ovate-acute or deltoid, ½–1 by ½ mm, soon caducous. *Leaves* thin-coriaceous, rigid, (5–)7–9(–10½) by (2½–)3–4(–6) cm (index 1.6–2.5), broadest about the middle; surfaces discolorous, above glabrous, glossy, pale to dark chocolate-brown, rarely greyish green, underneath densely glaucous tomentose by adpressed stellate hairs; base acute to cuneate, decurrent, margin recurved, top bluntly ½–2½ cm acuminate-caudate; midrib prominent on both sides; nerves (7–)8–10(–12) pairs, prominent beneath, flat to impressed above, subparallel, at an angle of 45–50°, arcuating and anastomosing near the margin; reticulation dense, fine, scalariform, distinct beneath; petiole glabrous, ½–1½ cm, 1–2 mm ø, adaxially flat or furrowed. *Inflorescence* male or mixed, densely fulvous to rufous stellate hairy, simple and axillary or much-branched and subterminal; bracts and bracteoles ovate, ½–1 by ½ mm. *Male rachis* 5–15 cm, 1½ mm ø; ♂ flowers in clusters of 3, rarely solitary, stamens 10–12, filaments 2–3 mm, anthers 0.20–0.30 mm long, pistillode globose, *c.* 1 mm ø. *Mixed rachis* 5–10 cm, 1½–mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, *c.* 1 mm. *Ripe cupule* sessile to 3 mm stalked, deeply cup-shaped, 8–13 mm long, 15–25 mm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely whitish grey simple tomentose, outside densely greyish to fulvous stellate hairy; lamellae 5–6, denticulate, concentric, thin to prominent. *Ripe fruit* ovoid, 1½–2 cm in size, densely greyish tomentose by adpressed stellate hairs; top rounded-acuminate, base round-

ed, scar strongly convex to flat, 9–15 mm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, Mindanao, Samar, Leyte).

Ecol. Forests at 1000–2000 m. *Fl.* Dec.-July, *fr.* Oct.-Nov.

49. Lithocarpus apoensis (ELMER) REHD. J. Arn. Arb. 1 (1919) 123; A. CAMUS, Chênes 3 (1954) 708, t.; SOEPADMO, Reinwardtia 8 (1970) 217. — *Quercus apoensis* ELMER, Leafl. Philip. Bot. 3 (1910) 945, *incl. var. ulayan, l.c.* 946; MERR. En. Philip. 2 (1923) 25.

Tree 10–25 m, 30–130 cm ø; bark pale grey, finely fissured. *Branchlets* initially densely yellowish brown stellate hairy, later glabrous, greyish brown, densely lenticellate; terminal buds ovoid-globose, 3–4 by 2–3 mm, scale broadly ovate. Stipules ovate, 2½ by 1½ mm. *Leaves* thick-coriaceous, rigid, (12–)15–17(–22) by (5–)6–8(–10) (index 1.6–2.8), broadest at or below the middle; surfaces discolorous, above glabrous, pale to dark greyish brown, glossy, beneath densely glaucous-tomentose by adpressed-stellate hairs; base rounded-acute to cuneate, margin recurved, top bluntly acute to 1–1½ cm acuminate; midrib prominent on both sides; nerves (7–)8–9(–10) pairs, prominent beneath, flat above, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform, obscure to distinct beneath; petiole glabrous, 1–2 cm, 3–4 mm ø, terete or adaxially flat. *Inflorescence* male or mixed, densely yellowish brown stellate hairy; bracts and bracteoles ovate-acute, 1–1½ by 2/3 mm. *Male rachis* 10–25 cm, 2–3 mm ø; ♂ flowers solitary or in clusters of 2–3, filament 2½–3 mm, anthers 0.35–0.50 mm long, pistillode subglobose, 1½–2 mm ø. *Mixed rachis* 5–20 cm, 2–3 mm ø; *female flowers* solitary or in clusters of 3, staminodes rudimentary, styles 3–4, conical, *c.* 1 mm long. *Ripe cupule* subsessile, cup-shaped, 1.2–1.5 cm long, 2–2½ cm ø; rim thin, covering *c.* ¼ part of the fruit; wall woody, rather thick, outside densely greyish brown stellate hairy; lamellae 7–9, thin, entire, concentric. *Ripe fruit* ovoid, 2–2½ cm through, densely greyish tomentose by adpressed, simple hairs, top gradually rounded-apiculate, base truncate, scar flat to slightly convex, 1–2 cm ø; wall woody, 2–3 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, Mindanao, Catanduanes, Panay).

Ecol. Forests, up to 1700 m. *Fl.* March-Dec., *fr.* April-Sept.

50. Lithocarpus glutinosus (BL.) SOEPADMO, Reinwardtia 8 (1970) 243. — *Quercus glutinosa* BL. Mus. Bot. 1 (1850) 304; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 88; A. CAMUS, Chênes 3 (1954) 1158. — *Pasania glutinosa* (BL.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 379. — *Quercus koordersii* VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 16. — *Quercus zschokkei* ELMER, Leafl. Philip. Bot. 3 (1910) 944; MERR. En. Philip. 2 (1923) 31. — *Quercus copelandii* Elmer, Leafl. Philip. Bot. 6 (1913) 1984; MERR. En. Philip. 2 (1923) 27. — *L. copelandii* (ELMER) REHD. J. Arn. Arb. 1 (1919) 124; A. CAMUS, Chênes 3 (1954) 705, t. 390: 13–25. — *L. zschokkei* (ELMER) REHD. J. Arn. Arb. 1 (1919) 132; A. CAMUS, Chênes 3 (1954) 702, t. — *L. koordersii* (VON SEEMEN) MARKGR. Bot. Jahrb. 59 (1924) 66; A. CAMUS, Chênes 3 (1954) 713, t. 392: 11–19.

Tree 20 m, 60–70 cm ø; bark greyish brown. *Branchlets* initially densely yellowish brown stellate hairy, later glabrous, greyish, sparsely to densely lenticellate; terminal buds ovoid, 0.7–1 by 1½–2 mm, scale narrowly ovate. *Leaves* thin-coriaceous, (8–)12–17(–20) by (4–)5–6(–8) cm (index 2–3), broadest at or slightly above the middle; above glabrous, dull to glossy, greyish green to chocolate-brown, beneath densely greyish tomentose by adpressed stellate hairs; base acute, margin recurved, top abruptly acute to 1–3 cm acuminate; midrib strongly prominent beneath, flat above; nerves (7–)8–9(–10) pairs, prominent beneath, impressed above, subparallel, at an angle of 40–50°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform, obscure; petiole glabrous, 8–15 mm, 1–3 mm ø, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown stellate hairy; bracts and bracteoles narrowly ovate to linear, 1–2 by ⅓–½ mm. *Male rachis* 10–15 cm, 1–1½ mm ø; ♂ flowers in clusters of 3–5, filaments 3–5 mm, anthers 0.35 mm long, pistillode globose, 0.7–1 mm ø. *Androgynous rachis* 5–10 cm long, 1 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3–4, conical, *c.* 1 mm, recurved. *Ripe cupule* sessile, deeply cup-shaped, 1½–2 cm long, 2½–3 cm ø; rim thin, covering ⅓–½ part of the fruit; wall woody, densely fulvous tomentose; basal part ridged or tuberculate, upper part with 5–7 obscure lamellae. *Ripe fruit* subhemispherical, 1½–1¾ cm long, 2–2½ cm ø, densely fulvous tomentose by adpressed stellate hairs, top rounded-umbonate, base truncate, scar flat, *c.* 2 cm ø; wall woody, *c.* 2 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Mindanao), Celebes (Northern Peninsula and Central part).

Ecol. Forests, up to 900 m. Fertility mainly in the second half of the year.

Notes. *Quercus molucca* RUMPH. *ex* L. 1753 may belong here, but the original description and figure are not recognizable, the later name *glutinosa* is here accepted.

In his original description of *Quercus glutinosa*, BLUME mentioned Java as the type locality. In the Rijksherbarium (Leyden) there are 3 specimens which seem to be duplicates of one collection, bearing 2 different labels and localities. Two of these specimens (H.L.B. 901.310–309 and 310) were inscribed by BLUME as *Quercus glutinosa* and said to be from Java, and the third (901.310–380) bears REINWARDT's original green label with Tondano (N. Celebes) as the locality and is dated October 1821. As BLUME never was in Celebes, and no other

collections confirm his record of *Quercus glutinosa* from Java, it is concluded that two of REINWARDT's specimens were mislabelled and that all came from Celebes, where *L. glutinosus* has repeatedly been collected by KOORDERS, EYMA, and others.

51. Lithocarpus solerianus (VIDAL) REHD. J. Arn. Arb. 1 (1919) 131; A. CAMUS, Chênes 3 (1954) 979, t. 467: 1–15; SOEPADMO, Reinwardtia 8 (1970) 279. — *Quercus molucca* (*non* RUMPH. *ex* L.) BLANCO, Fl. Filip. (1837) 726. — *Quercus concentrica* (*non* LOUR.) BLANCO, Fl. Filip. ed. 2 (1845) 502. — *Quercus reinwardtii* (*non* KORTH.) F.-VILL. Nov. App. (1880) 207. — *Quercus costata var. convexa* (*non* BL.) NAVES in Blanco, Fl. Filip. ed. 3 (1880–83) t. 441. — *Quercus soleriana* VIDAL, Rev. Pl. Vasc. Filip. (1886) 261; MERR. Philip. J. Sc. 3 (1908) Bot. 327; ELMER, Leafl. Philip. Bot. 6 (1913) 1983; MERR. Sp. Blanc. (1918) 121; En. Philip. 2 (1923) 30. — *Quercus clementiana* (*non* KING *ex* HOOK. *f.*) MERR. Philip. J. Sc. 1 (1906) Suppl. 41. — *Synaedrys soleriana* (VIDAL) KOIDZ. Bot. Mag. Tokyo 30 (1916) 193.

Tree 10–15 m, 20–30 cm ø; bark brown. *Branchlets* initially densely greyish brown adpressed stellate hairy, later glabrous, dark blackish brown, sparsely to densely lenticellate; terminal buds ovoid, ½–1 by ½ mm, scales ovate. Stipules ovate to deltoid, ½–1 by ½ mm. *Leaves* thin-coriaceous, (5–)8–12(–16) by (3–)4–6(–7½) cm (index 1½–2½), broadest about the middle; above glabrous, dull to glossy, pale to dark chocolate-brown, underneath densely greyish to glaucous tomentose by adpressed stellate hairs; base rounded and abruptly acute to attenuate-acute, top abruptly, bluntly acuminate to sharply 1–1½ cm caudate-acuminate; midrib and nerves thin, prominent beneath, flat above; nerves (9–)10(–12) pairs, parallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation dense, fine, scalariform, distinct beneath; petiole glabrous, blackish coloured, 7–15 mm, 1–1½ mm ø, shallowly furrowed. *Inflorescence* male, androgynous, or mixed, densely greyish brown stellate hairy; bracts and bracteoles ovate-acute, 0.7–1 by ½ mm. *Male rachis* 10–15 cm, 1 mm ø, simple and axillary or more commonly much-branched and subterminal; ♂ flowers in clusters of 3, stamens 10–12, filaments 2–3 mm, anthers 0.35 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous* or *mixed rachis c.* 10 cm, 1–2 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, more or less recurved, 0.7–1 mm. *Ripe cupule* subsessile, cup-shaped, ½–1 cm long, 2–2½ cm ø; rim thin, entire, erect, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous to glaucous stellate hairy; lamellae 5–7, thin, concentric or spiral at the base, minutely denticulate. *Ripe fruit* ovoid, 1.5–2.2 cm long, 1.8–2 cm ø, glabrous, dark chocolate-brown, top gradually rounded acute, base truncate, scar flat, *c.* 1½ cm ø; wall bony, thinner than 1 mm, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, Mindanao, perhaps also Mindoro).

Ecol. Forests, at 700–1200 m. *Fl.* Aug.-May, *fr.* April-Oct.

52. Lithocarpus mindanaensis (ELMER) REHD. J. Arn. Arb. 1 (1919) 128; A. CAMUS, Chênes 3 (1954) 1110, t.; SOEPADMO, Reinwardtia 8 (1970) 261. — *Quercus philippinensis* (*non* A.DC.) MERR. Bull. Bur. For. Philip. 1 (1903) 16. — *Quercus celebica* (*non* MIQ.) VON SEEMEN in Perkins, Fragm. Fl. Philip. (1904) 41. — *Quercus acuminatissima* MERR. Philip. J. Sc. 3 (1908) Bot. 326, *non* A. DC. 1864. — *Quercus 'tasystachya'* (*non* MIQ.) ELMER, Leafl. Philip. Bot. 3 (1910) 938; MERR. En. Philip. 2 (1923) 27. — *Quercus mindanaensis* ELMER, Leafl. Philip. Bot. 3 (1910) 942, *quoad nom.*; MERR. En. Philip. 2 (1923) 28. — *Synaedrys acuminatissima* (MERR.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 190.

Small tree, *c.* 10 cm ø; bark rough, light grey. *Branchlets* initially densely yellowish to fulvous tomentose by stellate hairs, later glabrous, greyish to dark brown, with sparse minute lenticels; terminal buds ovoid, 1 by 1 mm, scales ovate-acute. (Stipules not seen.) *Leaves* chartaceous, (7½–)10–12(–14½) by (2½–)3–5(–6) cm (index (2–)2½(–3)), broadest at the middle; surfaces discolorous, above dark chocolate-brown, sparsely stellate-pubescent, glabrescent, dull or glossy, beneath densely yellowish tomentose by adpressed stellate hairs; base attenuate-acute or rounded-acute, sometimes decurrent and asymmetrical, margin sometimes undulate, top bluntly acute to sharply 1–2 cm acuminate, tip usually oblique; midrib thin but prominent on both sides; nerves (8–)9–10(–12) pairs, thin, prominent beneath, flat above, subparallel, at an angle of 50–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, scalariform, obscure, or sometimes rather distinct beneath; petiole 7–13 mm, 1–2 mm ø, sparsely pubescent, shallowly furrowed. *Inflorescence* male or androgynous, densely yellowish to fulvous stellate-hairy; bracts and bracteoles ovate-acute, *c.* 1 by 2/3 mm. *Male rachis* 10–20 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, filaments 3–3½ mm, anthers 0.3 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis* 10–20 cm, 2 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, *c.* 1 mm, recurved. *Ripe cupule* sessile, saucer-shaped, ⅓–½ cm long, 2–2½ cm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely adpresssed pubescent by simple hairs, outside densely fulvous tomentose by adpressed stellate hairs; lamellae thin, denticulate, concentric or somewhat spiral. *Ripe fruit* ovoid-conical, 2–2⅓ cm through, glabrous, pale to dark chocolate-brown, top rounded-acute to acuminate, base rotundate, scar flat, *c.* 1½ cm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Mindanao, common, Leyte, scattered).

Ecol. In forests, at 300–1200 m, common below 600 m. *Fl.* Oct.–March, *fr.* May–Sept.

Note. ELMER 11922, the only specimen cited by ELMER (1910) when he proposed the new name *Quercus mindanaensis* for *Quercus acuminatissima* MERR., *non* A. DC., belongs to *L. caudatifolius*.

53. Lithocarpus bennettii (MIQ.) REHD. J. Arn. Arb. 1 (1919) 123; A. CAMUS, Chênes 3 (1954) 742, t.; SOEPADMO, Reinwardtia 8 (1970) 220. — *Quercus bennettii* MIQ. Fl. Ind. Bat. 1, 1 (1856) 857; A. DC. Prod. 16, 2 (1864) 94; HOOK. *f.* Fl. Br. Ind. 5 (1888) 613; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 64, t. 58 A; CORNER, Ways. Trees (1940) 301. — *Quercus miqueliana* SCHEFF. Nat. Tijd. N. I. 31 (1870) 360; *ibid.* 32 (1871) 416. — *Cyclobalanus bennettii* (MIQ.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 375. — *Pasania bennettii* (MIQ.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 433. — *Synaedrys bennettii* (MIQ.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 190.

Tree 10–35 m, 20–80 cm ø; buttresses low, up to 3 m out, stilt-roots occasionally present; bark grey-brown, smooth to fissured, lenticellate. *Branchlets* initially densely yellowish brown to rufous-tomentose by adpressed stellate hairs, later glabrous, greyish to blackish brown, sparsely lenticellate; terminal buds ovoid-ellipsoid, 1½–3 by 1–1½ mm, scales ovate to linear-acute. Stipules linear-acute, 2½–3½ by 2/3–1 mm. *Leaves* thin-coriaceous, (7–)9–12(–15) by (2½–)3–5(–6) cm (index (2–)2½–3(–4)), broadest at or rarely above the middle; surfaces discolorous, above glabrous, dull to glossy, usually dark chocolate-brown, underneath densely greyish to glaucous tomentose by adpressed stellate hairs; base attenuate-acute, top bluntly or sharply ½–2 cm acuminate; midrib prominent on both sides; nerves (9–)10–12(–13) pairs, thin but prominent beneath, parallel, at an angle of 45–60°, arcuating and anastomosing towards the margin; reticulation fine, subscalariform, obscure; petiole glabrous, ½–1½ cm, 1–3 mm ø, furrowed. *Inflorescence* male or androgynous, densely greyish to yellowish brown stellate hairy; bracts and bracteoles ovate, 1–1½ by ⅓–½ mm. *Male rachis* 10–20 cm, 1–1½ mm ø, simple and axillary or much-branched and subterminal; ♂ flowers solitary or in clusters of 2–3, stamens 10–12, filaments 2–3 mm, anthers 0.35 mm, pistillode globose, *c.* 1 mm ø. *Androgynous rachis* 10–15 cm, 1–1½ mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, *c.* 1 mm. *Ripe cupule* ½ cm stalked, saucer-shaped, ⅓–½ cm long, 1–2 cm ø; rim thin, covering the basal part of the fruit; wall thin, inside densely greyish brown tomentose by adpressed simple hairs, outside densely greyish adpressed stellate hairy; lamellae 5–7, thin, concentric, minutely denticulate. *Ripe fruit* ovoid-conical, 1–1½ cm through, usually slightly longer than wide, glabrous, dark purplish brown, top gradually rounded-acute, base rotundate, scar deeply concave, *c.* 1–1⅓ cm ø; wall bony, thinner than 1 mm, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Sumatra (scattered), Banka (common), Malay Peninsula (Kelantan, Negri Sembilan, frequent in Johore; Singapore), Borneo (scattered, mainly N. of the equator).

Ecol. Primary, swampy, heath forest or mixed Dipterocarp forest, up to 1000 m, on various types of soil. *Fl.* March–Nov., *fr.* July–Febr.

Note. Philippine records of *L. bennettii* were based on specimens of *L. solerianus* or *L. sulitii*.

54. Lithocarpus confertus SOEPADMO, Reinwardtia 8 (1970) 229.

Tree 12–30 m, 20–100 cm ø; buttresses up to 0.9 m tall, 1½ m out, 10 cm thick; bark greyish brown, densely lenticellate, occasionally scaly. *Branchlets* initially densely yellowish brown to fulvous stellate hairy, later subglabrous, dark greyish brown, densely or sparsely lenticellate; terminal buds ovoid-ellipsoid, 2–3 by 1–2 mm, scales narrowly ovate. Stipules narrowly ovate-acute to lanceolate, 2–3 by 1 mm. *Leaves* thin-coriaceous, (6–)9–10(–13) by (3–)4–5(–7) cm (index (1½–)2–2½(–3)), broadest at or below the middle; surfaces more or less discolorous, above glabrous, dull to glossy, greyish green to chocolate-brown, beneath densely set with greyish to yellowish brown (rarely rufous) adpressed stellate hairs; base rounded and abruptly acute, margin recurved, top bluntly and abruptly acute to 1–1½ cm acuminate; midrib prominent on both sides; nerves (8–)9–10(–11) pairs, prominent beneath, impressed above, subparallel, at an angle of 40–50°, arcuating and anastomosing towards the margin; reticulation dense, scalariform, distinct beneath; petiole subglabrous, ½–1 cm, 1–1½ mm ø, furrowed. *Inflorescence* male, androgynous or mixed, densely greyish to yellowish brown stellate hairy; bracts and bracteoles narrowly ovate to linear, 1½–5 by ½–1 mm. *Male rachis* 10–15 cm, 1½ mm ø, in dense paniculate clusters, subterminal; ♂ flowers in clusters of 3, filaments 2–2½ mm, anthers 0.25–0.30 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 5–15 cm, 1½ mm ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3, terete, 1–2½ mm, strongly recurved. *Ripe cupule* subsessile, saucer-shaped, 2–5 mm long, 1½–1¾ cm ø; rim thin, covering the basal part of the fruit; wall thin, inside densely fulvous-tomentose by adpressed simple hairs, outside densely greyish brown to fulvous stellate hairy; lamellae 5–6, thin, concentric, minutely denticulate. *Ripe fruit* depressed-ovoid, 1–1½ cm long, 1½–2 cm ø, glabrous, chocolate-brown to purplish brown, top abruptly acuminate, base rounded, scar concave, 1–1½ cm ø; wall bony, thinner than 1 mm, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (common on Mt Kinabalu).

Ecol. Forests, at 900–1800 m, usually on ultrabasic soil. *Fl.* Sept.–April, *fr.* July–April.

55. Lithocarpus bullatus HATUS. *ex* SOEPADMO, Reinwardtia 8 (1970) 223, f. 11.

Tree 9–25 m, 15–40 cm ø; bark fissured to scaly,

dark greyish brown to reddish brown. *Branchlets* initially densely yellowish brown to rufous-tomentose by adpressed, stellate hairs, later subglabrous, pale yellowish brown to dark greyish brown, fissured, sparsely lenticellate; terminal buds ovoid, 1–1½ by 1 mm, scales narrowly ovate-acute to lanceolate. Stipules lanceolate, 1–1½ by ⅓–½ mm. *Leaves* thick-coriaceous, rigid, strongly bullate, (5–)7–9(–11) by (2½–)3–4(–5) cm (index 1.3–2.8), broadest at or slightly below the middle; above glabrous, glossy, olive-green, beneath densely pale grey-brown tomentose by adpressed stellate hairs; base acute, margin strongly recurved, top bluntly acute to ½–1 cm acuminate, rarely rounded-emarginate; midrib strongly prominent on both sides; nerves 9–10 pairs, strongly prominent beneath, impressed above, parallel, at an angle of 60–80°, arcuating but not anastomosing towards the margin; reticulation lax, subscalariform, obscure; petiole glabrous, 3–5 mm, 1–1½ mm ø, adaxially flat. *Inflorescence* male, female or mixed, densely yellowish brown stellate hairy; bracts and bracteoles ovate-acute, 1 by ½–⅔ mm. *Male rachis* 5–10 cm, 1–1½ mm ø; ♂ flowers solitary or in clusters of 3, filaments 2½–3½ mm, anthers 0.5–0.7 mm long, pistillode subglobose, *c.* 1 mm ø. *Female* or *mixed rachis* 5–10 cm, 2 mm ø; ♀ flowers solitary, staminodes rudimentary, styles 3–4, conical, 2–2½ mm, more or less connate. *Ripe cupule* subsessile, cup-shaped, ½–1 cm long, 1½–1⅔ cm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, inside densely yellowish brown to silvery tomentose by adpressed simple hairs, outside densely greyish brown stellate hairy; lamellae 5–8, concentric, minutely denticulate. *Ripe fruit* ovoid-conical, *c.* 1½ cm through, top abruptly acute, base rotundate, scar flat, 8–10 mm ø, glabrous, dark chocolate-brown; wall bony, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak, rare, Mt Kinabalu, common).

Ecol. Forests, at 800–4000 m, on sandy acid or ultra-basic soil. Fertility throughout the year.

56. Lithocarpus rigidus SOEPADMO, Reinwardtia 8 (1970) 275.

Tree 6–18 m, 30 cm ø. *Branchlets* sturdy, with short internodes and thick nodes, glabrous, dark-brown, sparsely lenticellate; terminal buds ovoid-ellipsoid, 7–10 by 3–5 mm, scales narrowly ovate, 5–7 by 2–3 mm, initially with sparse minute stellate hairs, soon glabrescent. Stipules ovate-acute to lanceolate, 6–8 by 3–4 mm. *Leaves* thick-coriaceous, rigid, (8–)14–16(–18) by (5–)6–8(–10) cm (index 1½–2), broadest at or above the middle; surfaces concolorous, pale yellowish brown, above glabrous, glossy, underneath sparsely tomentose by minute, adpressed, stellate hairs; base acute, decurrent to the base of the petiole, margin strongly recurved, top bluntly rounded-acute or rounded; midrib broad, prominent on both surfaces, nerves 8–11 pairs, prominent beneath, flat to impressed above, subparallel, at an angle of 50–80°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform to irregular, obscure on both sides; petiole 7–10 mm, 5–6 mm ø, adaxially flat, glabrous. *Male rachis* (not fully developed) *c.* 5 cm, 3–4 mm ø, sparsely stellate-tomentose; bracts linear, 5–7 by 1–2 mm, bracteoles ovate, 3–4 by 2 mm; ♂ flowers in clusters of 3. *Female flowers* (on young cupule) with perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1–2 mm, recurved and glabrous near the top. *Fruiting rachis* (not fully developed) 15–20 cm, ½–1 cm ø, sparsely fulvous stellate-tomentose; young cupule sessile, mostly in clusters of 3, densely fulvous stellate-tomentose; scales minute, adpressed, concentrically arranged. *Young fruit* ovoid, glabrous, chocolate-brown, top rounded-acuminate.

Distr. *Malesia*: Borneo (Sabah: Mts Kinabalu and Tambuyokan).

Ecol. Everwet forests, at 1500–2500 m. *Fl.* March–April, *fr.* July.

Notes. Fully developed inflorescences, cupules, and fruits not known.

Vegetatively distinct by its extremely rigid thick-coriaceous leaves, with long-decurrent base, and by its sturdy branchlets, inflorescence and infructescence.

57. Lithocarpus nodosus SOEPADMO, Reinwardtia 8 (1970) 262.

Tree 10–20 m, 20 cm ø; bark brownish, smooth. *Branchlets* glabrous, with thick nodes, dark greyish brown, sparsely lenticellate; terminal bud ovoid, 1–3 by ½–1 mm, scales narrowly ovate, initially densely rufous lepidote, glabrescent. Stipules linear-acute, *c.* 2 by ½ mm. *Leaves* thick-coriaceous, rigid, (6–)8–10(–12) by (3–)4–5(–6) cm (index (1.6–)2(–3)), broadest at the middle; surfaces slightly discolorous, above glabrous, glossy, chocolate-brown, underneath densely yellowish brown tomentose by adpressed, minute, stellate hairs; base acute, top abruptly acute or 1–1½ cm acuminate; midrib broad, prominent above, flattish beneath, nerves 8–10 pairs, thinly prominent beneath, flat above, subparallel, at an angle of 30–50°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform, obscure; petiole glabrous, 8–12 mm, 2–3 mm ø, adaxially flat. *Inflorescence* male or androgynous, solitary or in dense paniculate clusters, densely or sparsely tomentose by stellate hairs; bracts narrowly ovate, 1–2 by ½–⅔ mm, bracteoles ovate, *c.* ½ by ½ mm. *Male rachis* 3–10 cm, 1–2 mm ø; ♂ flowers in clusters of 3, filaments 2–3 mm, anthers 0.25 mm long, pistillode subglobose, ⅔–1 mm ø. *Androgynous rachis c.* 5 cm, 2 mm ø; *female flowers* solitary or rarely in clusters of 2–3, staminodes rudimentary, styles 3, conical, 1–2 mm, connate. Young cupule solitary or in clusters of 2–3; scales adpressed, minute, concentrically arranged. *Ripe cupule* sessile, solitary, cup-shaped, ⅔–1 cm long, 2–2½ cm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely greyish tomentose by adpressed simple hairs, outside densely fulvous-tomentose by short stellate hairs; lamellae thin, 4–6, ob-

scure, minutely denticulate. *Ripe fruit* ovoid-globose, 1–1½ cm long, 1¾–2⅓ cm ø, glabrous, pale chocolate-brown, top rounded-acute, base rounded, scar deeply concave, *c.* 1 cm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak: Mts Mulu and Poi; Sabah: Mt Kinabalu).

Ecol. Everwet forests, at 900–2400 m; S. 4706 was recorded from a limestone hill. *Fl.* June–March, *fr.* April–Oct.

Note. Though the young cupules are sometimes in clusters of 2–3, only one is well-developed, the others being abortive.

58. Lithocarpus woodii (HANCE) A. CAMUS, Riviera Scient. 18 (1932) 42; Chênes 3 (1954) 1173; SOEPADMO, Reinwardtia 8 (1970) 287. — *Quercus woodii* HANCE, J. Bot. 12 (1874) 240; MERR. Philip. J. Sc. 3 (1908) Bot. 326; En. Philip. 2 (1923) 31. — *Synaedrys woodii* (HANCE) KOIDZ. Bot. Mag. Tokyo 30 (1916) 193. — *L. loheri* A. CAMUS, Chênes, Atlas 3 (1949) 111, t.; Chênes 3 (1954) 1112.

Tree 5–30 m, 20–90 cm ø. *Branchlets* initially densely fulvous to rufous stellate hairy, later glabrous, greyish black, sparsely to densely lenticellate; terminal buds ovoid, 1–1½ by 0.7–1 mm, scales ovate. Stipules ovate to linear, 1–3 by ½ mm. *Leaves* thick-coriaceous, (6–)9–12(–17) by (4–)5–7(–10) cm (index (1.3–)1.6–2(–2.2)), broadest at or below the middle; surfaces more or less discolorous, above glabrous, dull to glossy, pale to dark chocolate-brown, underneath densely glaucous tomentose by adpressed stellate hairs; base rounded-acute to cuneate, margin recurved, occasionally undulate, top bluntly acute to bluntly or sharply 1–1½ cm acuminate; midrib and nerves strongly prominent beneath, flat above; nerves 8–11 pairs, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, lax, subscalariform, distinct beneath; petiole glabrous, 7–15 mm, 1–3 mm ø, adaxially flat. *Inflorescence* male or androgynous, densely yellowish to greyish brown stellate hairy; bract and bracteoles ovate to linear, 1–2 by ½ mm. *Male rachis* 10–15 cm, 1–2 mm ø, much-branched, axillary or subterminal; ♂ flowers in clusters of 3 or solitary, perianth 5–6-lobed, stamens 10–12, filaments 2–3 mm, anthers 0.35 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis c.* 10 cm, 1–1½ mm ø; *female flowers* solitary or rarely in clusters of 2–3, perianth 5–6-lobed, staminodes 10–12, rudimentary, styles 3, terete, 1½–2 mm, recurved. *Ripe cupule* subsessile, cup-shaped, ⅔–1 cm long, 2½–3½ cm ø; rim thin, covering *c.* ¼ part of the fruit; wall woody, thin, inside densely pale yellowish brown tomentose by adpressed simple hairs, outside densely greyish to fulvous stellate hairy; lamellae 7–10, obscure or distinct, concentric, minutely denticulate. *Ripe fruit* subhemispherical, 1.5–2.2 cm long, 2.5–3.2 cm ø, glabrous except near the umbo, pale yellowish brown to dark chocolate-brown, top rounded-umbonate, base rotundate, scar deeply concave to flat, 1½–2 cm ø; wall woody, *c.* 2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Philippines (Luzon, Mindanao, Samar).

Ecol. Forests, at 1200–2300 m. *Fl.* Aug.–June, *fr.* April–Nov.

59. Lithocarpus hatusimae SOEPADMO, Reinwardtia 8 (1970) 244.

Tree 13–18 m, 30 cm ø; bark smooth. *Branchlets* initially densely yellowish brown tomentose by adpressed stellate hairs, later subglabrous, dark greyish brown, sparsely lenticellate; terminal buds ovoid, 2–3 by 2 mm, scales ovate-acute. Stipules thick-coriaceous, ovate, 2–3 by 1–2 mm. *Leaves* thick-coriaceous, rigid, (8–)11–14(–16) by (3–)4–6(–7) cm (index 2–3), broadest at or slightly below the middle; above glabrous, glossy, pale chocolate-brown, underneath with a thin cover of pale yellowish brown, adpressed, stellate hairs; base acute, rarely rounded, margin recurved, top acute to sharply 1–2 cm caudate; midrib strongly prominent on both sides; nerves prominent beneath, impressed above, (9–)11–12(–13) pairs, parallel, at an angle of 60–70°, arcuating but not anastomosing towards the margin; reticulation lax, subscalariform, distinct beneath; petiole glabrous, 1–1½ cm, 1–3 mm ø, furrowed. *Inflorescence* male, female, androgynous or mixed, densely yellowish brown stellate hairy; bract and bracteoles ovate, 1–1½ by ⅔ mm. *Male rachis c.* 10 cm, 1–1½ mm ø; ♂ flowers solitary or in clusters of 3, perianth 5–6-lobed, stamens 10–12, filaments 3–4 mm, anthers 0.30–0.35 mm long, pistillode subglobose, 1–1½ mm ø, densely yellowish brown pubescent. *Female, androgynous* or *mixed rachis* 5–10 cm long, 1–2 mm ø; *female flowers* solitary or in clusters of 3, perianth 6-lobed, staminodes 12, rudimentary, styles 3, conical, 1½–2 mm, connate. *Ripe cupule* subsessile, cup-shaped, *c.* ½ cm long, 1.2–1.7 cm ø; rim thin, covering *c.* ¼ part of the fruit; wall woody, thin, inside densely pale greyish brown tomentose by adpressed simple hairs, outside densely greyish brown stellate hairy; lamellae 5–8, concentric, minutely denticulate. *Ripe fruit* ovoid-conical, 1–1½ cm through, top abruptly acute, base cordate, scar concave, *c.* 1 cm ø; wall bony, thinner than 1 mm, outside glabrous, glossy, chocolate-brown, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak: Mt Mulu; Sabah: Mt Kinabalu, common).

Ecol. Primary forest, at 1200–2000 m, on ultra-basic soil. *Fl.* June–March, *fr.* March–July.

60. Lithocarpus vidalii (F.–VILL.) REHD. J. Arn. Arb. 10 (1929) 134; SOEPADMO, Reinwardtia 8 (1970) 285. — *Quercus vidalii* F.–VILL. Nov. App. (1880) 209; VIDAL, Sinopsis Atlas (1883) 41, t. 92: B; ELMER, Leafl. Philip. Bot. 6 (1913) 1981; MERR. En. Philip. 2 (1923) 31.

Tree 10–25 m, 30–40 cm ø; bark greyish brown, scaly. *Branchlets* initially densely fulvous to rufous scurfy tomentose by adpressed stellate hairs, later subglabrous, greyish to chocolate-brown, sparsely

to densely lenticellate; terminal buds ovoid-ellipsoid, 2–6 by 2–3 mm, scales ovate to lanceolate. Stipules ovate to lanceolate, 3–6 by 2–4 mm. *Leaves* coriaceous, rigid, (6–)9–12(–14) by (2½–)3–4(–5) cm (index (1.8–)2–3(–3.6)), broadest at or above the middle; above glabrous, glossy, pale to dark chocolate-brown, underneath with a thick cover of fulvous to rufous adpressed stellate hairs; base acute to cuneate, decurrent, top rounded to abruptly acute; midrib strongly prominent beneath slightly so above; nerves (9–)10–11(–13) pairs, prominent beneath, impressed above, sub parallel, at an angle of 40–45°, arcuating and anastomosing near the margin; reticulation fine, subscalariform, lax, distinct beneath; petiole subglabrous, ½–1 cm, 1½–3 mm ø, adaxially flat. *Inflorescence* male, androgynous or mixed, densely fulvous stellate hairy; bract and bracteoles ovate, 1–1½ by ⅔ mm. *Male rachis* 7–15 cm, 1–2 mm ø, usually much-branched; ♂ flowers in clusters of 3–7, filaments 2–3 mm, anthers 0.35 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 5–10 cm, 1–2 mm ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3–6, terete, 1–1½ mm, recurved. *Ripe cupule* subsessile, cup-shaped, 1 cm long, 2–2.2 cm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely dark chocolate-brown tomentose by adpressed stellate hairs, outside densely fulvous stellate hairy; lamellae 6–8, concentric, denticulate. *Ripe fruit* ovoid-conical, 1½–2 cm long, 1½–1.8 cm ø, glabrous, chocolate-brown, top abruptly acute, base truncate, scar flat, *c.* 1.1 cm ø; wall woody, thinner than 1 mm, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, Mindanao, Palawan).

Ecol. Forests, at 1100–1800 m. *Fl.* Febr.–May, *fr.* June–Nov.

61. Lithocarpus reinwardtii (KORTH.) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 726, t. 397: 1–8; SOEPADMO, Reinwardtia 8 (1970) 272. — *Quercus reinwardtii* KORTH. Kruidk. (1844) 211; OUDEM. Versl. Med. Kon. Ak. Wet. Natuurk. 12 (1861) 205; A. DC. Prod. 16, 2 (1864) 92; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 63, t. 57 A. — *Cyclobalanus reinwardtii* (KORTH.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Pasania reinwardtii* (KORTH.) PRANTL in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 55. — *Synaedrys reinwardtii* (KORTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192.

Tree of medium size; bark grey. *Branchlets* initially densely fulvous tomentose by adpressed stellate hairs, later subglabrous, dark grey, densely lenticellate; terminal buds ovoid, 1½–2 by 1–1½ mm, scales ovate-acute. Stipules ovate-acute, 2–3 by 1 mm. *Leaves* thin-coriaceous, rigid, (8–)12–14 (–16) by (2½–)3–4(–5) cm (index 2.3–3.3), broadest at or rarely slightly below the middle; surfaces discolorous, above glabrous, glossy, dark-brown, underneath densely glaucous tomentose by adpressed stellate hairs; base acute to cuneate, margin recurved, top bluntly acute to 1–1½ cm acuminate; midrib thin, prominent on both sides; nerves (10–)12–15(–17) pairs, in between with shorter ones not reaching the margin, obscure, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, areolate, obscure; petiole subglabrous, 1–2 cm, 1 mm ø, adaxially flat or furrowed. *Inflorescence* male or androgynous, densely fulvous stellate hairy; bract and bracteoles ovate, 1–1½ by ½–⅔ mm. *Male rachis c.* 10 cm, 1 mm ø; ♂ flowers in clusters of 3, stamens 10–12, filaments 1–1½ mm, anthers 0.2–0.25 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous rachis* 10–20 cm, 2–2½ mm ø; *female flowers* solitary, perianth (5–)6(–7)-lobed, staminodes rudimentary, styles 4–5, conical, *c.* 1 mm, connate. *Ripe cupule* ½–1 cm stalked, cup-shaped, 3–5 mm long, 1½–2 cm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, thin, outside densely fulvous to glaucous tomentose by adpressed stellate hairs; lamellae 6–8, thin, concentric. *Ripe fruit* ovoid-conical, 1½–2 cm long, 1–1½ cm ø, densely fulvous to glaucous tomentose by adpressed simple hairs, top abruptly acute, base rotundate, scar deeply concave, *c.* 1 cm ø; wall woody, thinner than 1 mm, for the greater part free from the cupule.

Distr. *Malesia*: Sumatra (Central part: Mt Melintang, near Pajakumbuh).

Ecol. Forests, at 600–1200 m. *Fl.* June–Sept., *fr.* Nov.–June.

Note. Records from Indo-China, Malay Peninsula and Borneo are not confirmed.

62. Lithocarpus sulitii SOEPADMO, Reinwardtia 8 (1970) 280. — *Quercus wenzigiana* (*non* KING *ex* HOOK. *f.*) MERR. Philip. J. Sc. 1 (1906) Suppl. 41. — *Quercus bennettii* (*non* MIQ.) MERR. Philip. J. Sc. 3 (1908) Bot. 328, *quoad* FB 759, 781, WHITFORD 365 *et* WILLIAMS 705; En. Philip. 2 (1923) 25, *quoad ditto et* BS 32958.

Tree 15–20 m, 25–80 cm ø. *Branchlets* initially sparsely tomentose by fulvous, adpressed stellate hairs, later glabrous, dark greyish brown, sparsely lenticellate; terminal buds ovoid, 2 by 2 mm, scales ovate. *Leaves* thin-chartaceous, (6–)9–11(–13) by (2½–)4–5(–6) cm (index (2–)2¼(–2½)), broadest about the middle; surfaces discolorous, above glabrous, dull, dark greyish brown, beneath pale chocolate-brown, densely tomentose by adpressed stellate hairs, subglabrescent; base rounded-acute, top acute or more commonly bluntly ½–1 cm acuminate; midrib and nerves thin on both sides ; nerves (8–)9–10(–13) pairs, obscure, subparallel, at an angle of 45–70°, arcuating but not anastomosing towards the margin; reticulation fine, areolate, obscure; petiole 7–12 mm, 1–1½ mm ø, glabrous, adaxially flat. *Inflorescence* male, androgynous or mixed, sparsely greyish tomentose by adpressed stellate hairs; bracts and bracteoles ovate-acute, ⅔–1 by ½ mm. *Male rachis* 8–20 cm, 1½ mm ø, simple and axillary or much-branched and subterminal; ♂ flowers in clusters of 3, filaments 2–2½ mm, anthers 0.25 –0.30 mm long, pistillode globose, ⅔–1 mm ø. *Androgynous* or *mixed rachis* 10–15 cm, 2 mm ø; *female flowers* solitary,

staminodes rudimentary, styles 3, conical, 1–1½ mm long, more or less connate. *Ripe cupule* sessile, saucer-shaped, 5–6 mm long, 2–2½ cm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely glaucous stellate hairy; lamellae 4–5, thin, spiral. *Ripe fruit* ovoid, 2.3 cm long, 2–2.2 cm ø, densely greyish tomentose by adpressed simple hairs, top rounded-acute, base rotundate, scar deeply concave, *c.* 1 cm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, common, Mindoro, rare).

Ecol. Forests, up to 600 m. *Fl.* Sept.–Jan., *fr.* Febr.–June.

Note. Other records of *Quercus bennettii* from the Philippines, partly belong to *L. solerianus*, partly to an undescribed species.

63. Lithocarpus bancanus (SCHEFF.) REHD. J. Arn. Arb. 10 (1929) 132; SOEPADMO, Reinwardtia 8 (1970) 218. — *Quercus bancana* SCHEFF. Nat. Tijd. N. I. 31 (1870) 361; KING, Ann. R. Bot. Gard.

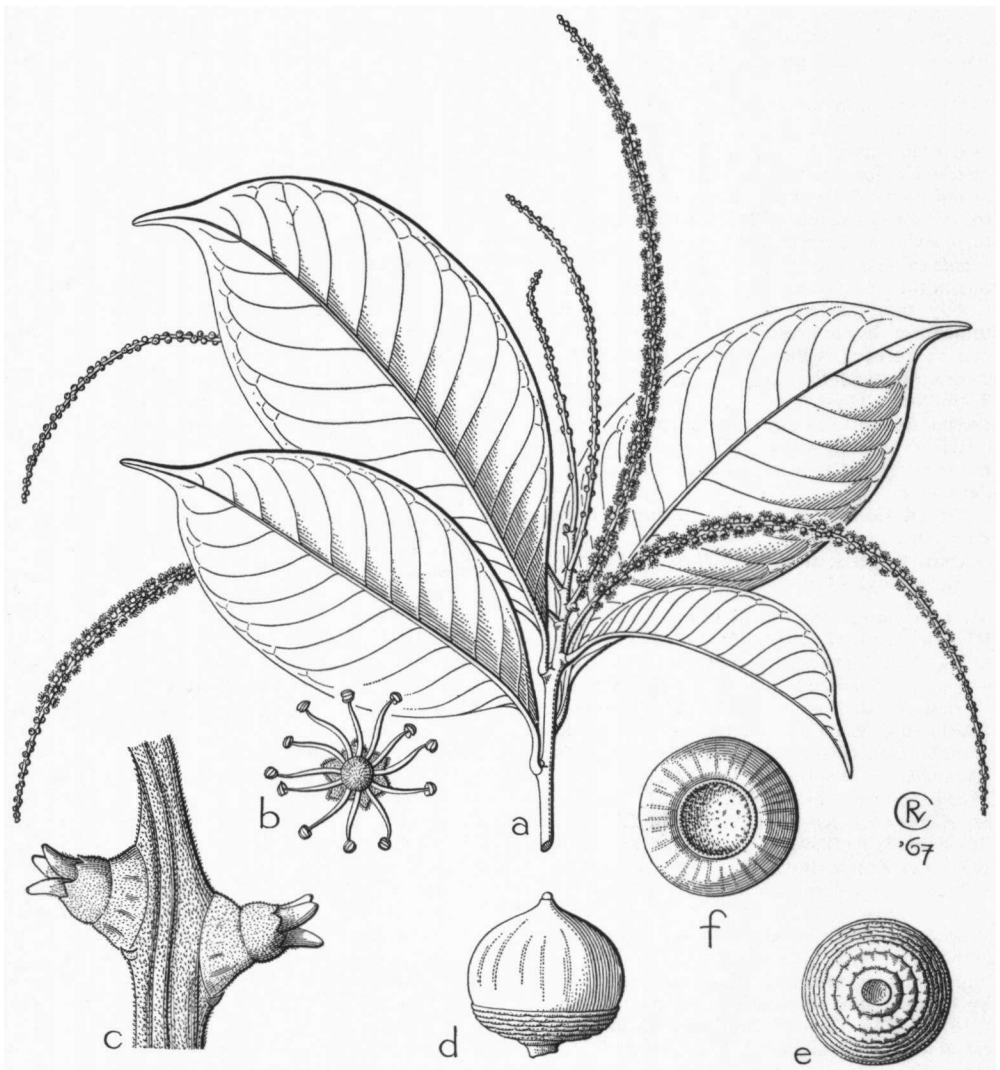

Fig. 26. *Lithocarpus bancanus* (SCHEFF.) REHD. *a.* Habit, ×⅔, *b.* ♂ flowers, ×4, *c.* ♀ flowers, ×4, *d.* fruit and cupule, *e.* basal view of the cupule, *f.* basal view of the fruit showing the deeply concave, small scar, all nat. size (*a–b* BURKILL 2509, *c* RASTINI 207, *d–f* RACHMAT SI TOROES 3357).

Calc. 2 (1889) 67. — *Quercus rajah* HANCE, J. Bot. 16 (1878) 198; KING, Ann. R. Bot. Gard. Calc 2 (1889) 67, t. 61 B. — *Quercus scyphigera var. riedelii* KING, Ann. R. Bot. Gard. Calc. 2 (1889) 39. — *Synaedrys bancana* (SCHEFF.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 190. — *Synaedrys rajah* (HANCE) KOIDZ. *l.c.* 192. — *Pasania bancana* (SCHEFF.) MARKGR. Bot. Jahrb. 59 (1924) 79, *quoad nomen.* — *Pasania rajah* (HANCE) S. MOORE, J. Bot. 63 (1925) Suppl. 115. — *L. rajah* (HANCE) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 737, t. — *L. scyphigera var. riedelii* (KING) A. CAMUS, Chênes 3 (1954) 962. — **Fig. 26.**

Tree 10–25 m, 20–60 cm ø; bark smooth to finely scaly, yellowish to greyish brown. *Branchlets* initially densely fulvous to rufous stellate hairy, later glabrous, smooth, greyish to dark chocolate-brown; terminal buds ovoid, ½–1 by 1 mm, scales ovate-acute. Stipules deltoid, ½–1 by ½ mm. *Leaves* thick-coriaceous, (9–)12–14(–17) by (4–)5–6(–7) cm (index 2–2.7), broadest about the middle; surfaces more or less discolorous, above glabrous, pale to dark chocolate-brown, glossy, beneath yellowish to greyish brown tomentose by adpressed, minute stellate hairs; base acute to cuneate, top bluntly to sharply ½–1½ cm acuminate, rarely acute; midrib strongly prominent on both sides; nerves (9–)10–12(–16) pairs, obscure on both surfaces, subparallel, at an angle of 45–60°, arcuating and anastomosing towards the margin; reticulation fine, irregular, obscure; petiole subglabrous, (½–)1(–1⅓) cm, 1–3 mm ø, adaxially flat. *Inflorescence* male, androgynous or mixed, densely fulvous to rufous adpressed stellate hairy; bracts and bracteoles ovate, ½–1 by ½ mm. *Male rachis* 5–20 cm, 1 mm ø; ♂ flowers solitary, filaments 2½–3½ mm, anthers 0.3–0.4 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 10–16 cm, 1½–2 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, 1–1½ mm, recurved. *Ripe cupule* sessile, saucer-shaped, 2–5 mm long, 15–21 mm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely silvery grey tomentose by adpressed stellate hairs, outside densely yellowish to greyish brown adpressed stellate hairy; lamellae 4–8, concentric, entire. *Ripe fruit* ovoid, 16–18 mm long, 20–22 mm ø, densely whitish grey tomentose by adpressed simple hairs, glabrescent, top abruptly rounded-acute, base rotundate, scar deeply concave, 8–10 mm ø; wall woody, thinner than 1 mm, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Sumatra (scattered in the mainland), Banka and Belitung Is., Malay Peninsula (Pahang, Johore), Borneo (scattered in Sarawak, Brunei, Kalimantan).

Ecol. Forests up to 250 m. *Fl.* April–Nov., *fr.* Dec.–March.

Notes. When SCHEFFER described *Quercus bancana* he had specimens with flowers and young cupules, and apparently also some detached, ripe cupules. A year later (1871) he stated that the detached, ripe cupules on which he based his description of *Quercus bancana*, did not belong to the species, and he replaced it with another one, based on a specimen collected by TEYSMANN (HB 7639) from Pangkal Pinang in Banka, which, however, belongs to *L. urceolaris*. HANCE, who never saw the type of *Quercus bancana* SCHEFF. (1870), described *Quercus rajah* based on specimens collected from a tree cultivated in the Bogor Botanic Gardens, the seedlings (or seeds?) of which had been brought back by TEYSMANN from Banka. These specimens are exactly the same with SCHEFFER's *Quercus bancana* (1870). Believing that SCHEFFER's identification (1871) was correct, KING (1889) and most later authors, who never checked the type of *Quercus bancana*, referred all specimens of the true *bancana* to *rajah*, and the true *urceolaris* to *bancana*. These two species are, however, perfectly different from one another by the characters of the leaf and cupule (see the key).

The material from New Guinea cited by MARKGRAF under *Pasania bancana*, belongs to *L. megacarpus*.

64. Lithocarpus ovalis (BLANCO) REHD. J. Arn. Arb. 1 (1919) 129; A. CAMUS, Chênes 3 (1954) 750, t.; SOEPADMO, Reinwardtia 8 (1970) 264. — *Quercus glabra* BLANCO, Fl. Filip. (1837) 727, *non* THUNB. 1784. — *Quercus ovalis* BLANCO, Fl. Filip. ed. 2 (1845) 502; A. DC. Prod. 16, 2 (1864) 97; F.-VILL. Nov. App. (1880) 208; MERR. Philip. J. Sc. 3 (1908) Bot. 325; Sp. Blanc. (1918) 120; En. Philip. 2 (1923) 29. — *Quercus blancoi* A. DC. Prod. 16, 2 (1864) 97; VIDAL, Sinopsis Atlas (1883) 41, t. 92: C. — *Cyclobalanus ovalis* (BLANCO) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Cyclobalanus blancoi* (A.DC.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 376. — *Synaedrys ovalis* (BLANCO) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192.

Tree 15–25 m, 30–50 cm ø. *Branchlets* glabrous, dark greyish brown, sparsely lenticellate; terminal buds globose, *c.* 1 by 1 mm, scales ovate-acute. *Leaves* thick-coriaceous, (9–)15–20(–23) by (4½–)7–8(–10) cm (index (1.6–)2.5(–3)), broadest about the middle; surfaces glabrous, above pale grey-green, glossy, beneath pale yellowish brown to glaucous; base acute to cuneate, top bluntly or sharply 1–2 cm acuminate; midrib prominent on both sides; nerves (11–)12–14(–16) pairs, obscure on both surfaces, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation irregular, obscure; petiole 1½–2½ cm, 2–3 mm ø, glabrous, adaxially flat. *Inflorescence* male or female, sparsely stellate hairy; bracts and bracteoles ovate-acute, ⅔–1 by ⅔ mm. *Male rachis* 15–30 cm, 1–2 mm ø; ♂ flowers in clusters of 2–3, filaments 3–4 mm, anthers 0.3 mm long, pistillode subglobose, 1–1½ mm ø. *Female rachis* 15–23 cm, 1½ mm ø; ♀ flowers solitary, staminodes rudimentary, styles 3–4, conical, 1–1½ mm long. *Ripe cupule* sessile, cup-shaped, 5–6 mm long, 2–2⅓ cm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely greyish tomentose by adpressed simple hairs, outside densely greyish to fulvous adpressed stellate

hairy; lamellae 5–6, thin, concentric, entire. *Ripe fruit* ovoid-conical, 2–2.4 cm long, 1.9–2.1 cm ø, densely greyish to brownish tomentose by adpressed simple hairs, top rounded-acute, base truncate, scar concave, 0.9–1 cm ø; wall woody, thinner than 1 mm, for the greater part free from the cupule.

Distr. *Malesia*: Philippines (Luzon, in various Provinces).

Ecol. Lowland forest. *Fl.* Nov.–April, *fr.* June–Aug.

65. Lithocarpus orbicularis SOEPADMO, Reinwardtia 8 (1970) 264. — **Fig. 27.**

Shrub 1–3 m. *Branchlets* initially sparsely tomentose by fulvous, adpressed stellate hairs, later glabrous, blackish brown; terminal buds ovoid, *c.* 1 by ⅔ mm, scales ovate. Stipules linear, *c.* 2 by ½ mm. *Leaves* thick-coriaceous, rigid, (2–)3–3½ (–4½) by (2–)2½(–3) cm (index 1–1½), broadest about the middle; surfaces more or less concolorous, chocolate-brown, above glabrous, glossy, with some minute glands, underneath with a thin cover of minute, adpressed stellate hairs, subglabrescent; base rounded to subcordate, top rounded-emarginate; midrib thin, prominent on both sides; nerves 8–10 pairs, obscure, parallel, at an angle of *c.* 60°, arcuating but not anastomosing towards the margin; reticulation fine, areolate, obscure; petiole *c.* 3 mm, 2 mm ø, glabrous, adaxially flat. (*Inflorescence* not known.) *Fruiting rachis* (young) *c.* 3 cm, 5 mm ø, carrying more than 10 subglobose young cupules. *Cupule* (not yet ripe) sessile, cup-shaped, *c.* 8 mm long, 2 cm ø; rim thin, covering *c.* ⅓ part of the fruit; wall thin, woody, inside densely tomentose by adpressed simple hairs, outside densely fulvous stellate hairy, hairs minute, adpressed; lamellae thin, 5–6, concentric. *Fruit* (not yet ripe) depressed-ovoid, 1 cm long, 1⅔ cm ø, glabrous, dark chocolate-brown; wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: N. Sumatra (once collected on top of Goh Lembuh, Gajo Lands, Atjeh: VAN STEENIS 8977).

Ecol. Montane forest, at 2800 m. *Fr.* 19–II–1937.

Notes. Vegetatively distinct, recognizable by its thick-coriaceous, rigid, orbicular leaf with areolate reticulation and rounded-emarginate top.

Inflorescences and ripe fruits are unknown.

66. Lithocarpus pusillus SOEPADMO, Reinwardtia 8 (1970) 270.

Tree 7–25 m, 10–80 cm ø; stilt-roots occasionally present, up to 1.2 m tall; bark finely scaly, greyish brown. *Branchlets* initially densely greyish brown adpressed stellate hairy, later subglabrous, greyish brown to greyish black, sparsely lenticellate or finely fissured; terminal buds ovoid, *c.* 1 by 1 mm, scales ovate. (Stipules not seen.) *Leaves* thin-coriaceous, rigid, (4–)6–10(–12½) by (1.7–)2½–4 (–5) cm (index (1.6–)2–3(–3.6)), broadest about the middle; above glabrous, dull to glossy, pale greyish green to chocolate-brown, underneath (except midrib and nerves) densely greyish brown tomentose by adpressed, minute, stellate hairs; base rounded-acute, top bluntly 1–3 cm acuminate -caudate; midrib thin, prominent on both sides; nerves (6–)8–10(–11) pairs, thin, obscure to distinct beneath, subparallel, at an angle of 50–60°, arcuating and faintly anastomosing near the margin; reticulation fine, irregular or areolate, obscure; petiole 5–10 mm, 1–1½ mm ø, glabrous, adaxially flat or furrowed. *Inflorescence* male, androgynous or mixed, densely greyish brown stellate hairy, subglabrescent; bracts and bracteoles ovate, ⅓–⅔ by ½–1 mm. *Male rachis* 7–20 cm, 1–1½ mm ø, mostly simple and axillary; ♂ flowers solitary, perianth 5–6-lobed, stamens 10–12, filaments 2½–3½ mm, anthers 0.25–0.3 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 8–15 cm, 1½ mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, 1–2 mm, recurved. *Ripe cupule* sessile to 2–3 mm stalked, *c.* 3 mm long, 8–12 mm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely set with adpressed simple hairs, outside densely greyish stellate hairy, hairs minute, adpressed; lamellae 4–5, thin, concentric, entire or denticulate. *Ripe fruit* ovoid-conical, 8–13 mm through, glabrous, light chocolate-brown, top rounded-acute, base rotundate, scar concave, 3–7 mm ø; wall bony, ½–1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak, Kalimantan, Sabah).

Ecol. In forests, from sea-level up to 1800 m; rather common in heath forest. *Fl.* Aug.–May, *fr.* Febr.–July.

67. Lithocarpus gracilis (KORTH.) SOEPADMO, Reinwardtia 8 (1970) 243. — *Quercus gracilis* KORTH. Kruidk. (1844) 207; A. DC. Prod. 16, 2 (1864) 93; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 88; A. CAMUS, Chênes 3 (1954) 1158. — *Quercus cyrtorhyncha* MIQ. Sumatra (1861) 350; HOOK. *f.* Fl. Br. Ind. 5 (1888) 613; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 66, t. 60 B. — *Quercus diepenhorstii* MIQ. Sumatra (1861) 349; A. DC. Prod. 16, 2 (1864) 95; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 231; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 67, t. 61 A. — *Cyclobalanus diepenhorstii* (MIQ.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 80. — *Cyclobalanus gracilis* (KORTH.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 376. — *Pasania cyrtorhyncha* (MIQ.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 432. — *Synaedrys cyrtorhyncha* (MIQ.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *Synaedrys diepenhorstii* (MIQ.) KOIDZ. *l.c.* 191. — *L. cyrtorhyncha* (MIQ.) REHD. J. Arn. Arb. 1 (1919) 124; A. CAMUS, Chênes 3 (1954) 734, t. — *L. diepenhorstii* (MIQ.) BARNETT, Trans. & Proc. Bot. Soc. Edinb. 34 (1944) 177; A. CAMUS, Chênes 3 (1954) 752, t. — *L. cyathiformis* A. CAMUS, Bull. Soc. Bot. Fr. 94 (1947) 4; Chênes 3 (1954) 802, t. 417: 1–8.

Tree 10–40 m, 20–90 cm ø; buttresses up to 1½ m tall, 1 m out, 10 cm thick; bark smooth to

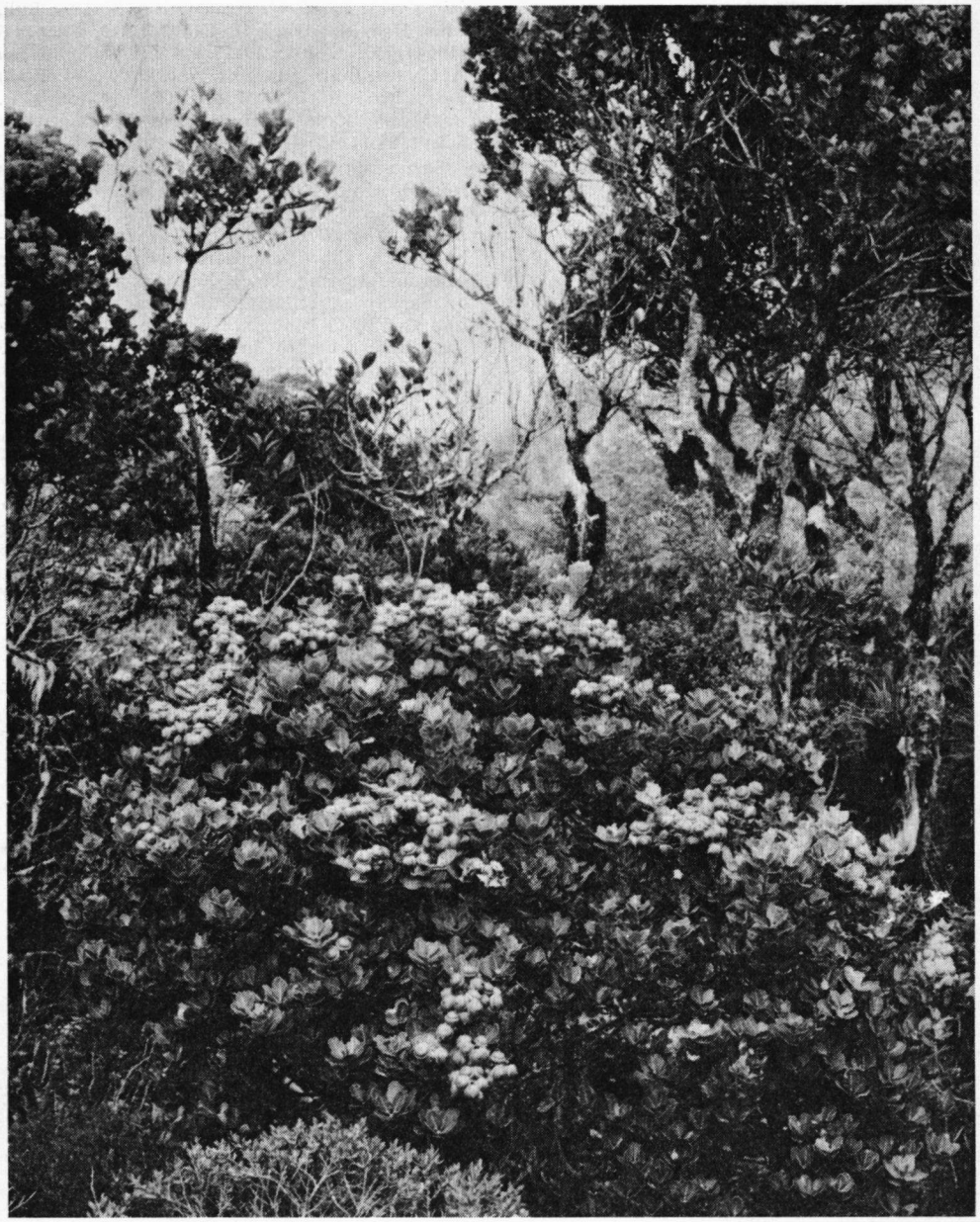

Fig. 27. *Lithocarpus orbicularis* SOEPADMO. Habit of fruiting shrub, Gajolands, N. Sumatra, *c.* 2800 m alt. (VAN STEENIS 8977; Febr. 1937).

fissured, rarely scaly, greyish brown. *Branchlets* initially angular, densely or sparsely set by silvery to greyish brown, short simple or stellate hairs, later terete, glabrous, greyish to dark brown, sparsely lenticellate; terminal buds subglobose, *c.* 1–2 by 1½ mm, scales ovate. Stipules ovate to linear-acute, 1½–4 by 0.7–1 mm. *Leaves* thin-coriaceous, (10–)15–20(–33) by (4–)5–8(–13) cm (index (2–)2½–3(–3.6)), broadest at the middle; above glabrous, dull to glossy, pale to dark brown, underneath with a thin cover of pale brown to glaucous, adpressed, minute stellate hairs; base

abruptly acute to cuneate, occasionally asymmetrical, top bluntly acute to 1–1½ cm acuminate-cuspidate; midrib strongly prominent on both sides; nerves (11–)14–16(–17) pairs, thin, prominent on both surfaces, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform to irregular, distinct beneath; petiole 7–10 mm, 2 mm ø, adaxially flat. *Inflorescence* male, androgynous or mixed, densely fulvous stellate hairy; bract and bracteoles ovate, *c.* 1 by 1/3 mm. *Male rachis* 10–20 cm, 1–2 mm ø, simple and axillary or much-branched and subterminal; ♂ flowers solitary or in clusters of 3, filaments 3–4 mm, anthers 0.35–0.4 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 10–15 cm, 1–2 mm ø; *female flowers* solitary or rarely in clusters of 2–3, staminodes rudimentary, styles 3, conical, *c.* 1½ mm, connate. *Ripe cupule* sessile to ½ cm stalked, saucer- to cup-shaped, 0.3–1 cm long, 2–2.7 cm ø; rim thin, covering the basal part of the fruit to *c.* ⅓ part of the fruit; wall thin, inside densely fulvous to silvery tomentose by adpressed simple hairs, outside densely fulvous to glaucous tomentose by minute, adpressed, stellate hairs; lamellae 6–8, thin, distantly denticulate, more or less concentric. *Ripe fruit* ovoid-conical, 1.5–1.8 cm long, 1.5–2.6 cm ø, glabrous, dark chocolate-brown to purplish black, top abruptly acuminate, base rotundate, scar flat to shallowly concave, 1.4–1.7 cm ø; wall bony, *c.* 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: S. Sumatra (Palembang and vicinity, Simalur I.), Malay Peninsula (Perak, Pahang, Selangor, Negri Sembilan; Singapore), Borneo (common in all parts; Nunukan and Laut Is.).

Ecol. Primary, sometimes also in secondary and heath forests, on ridges or hills or flat swampy lands, on sandy or rarely limestone derived soil, often on river-banks, up to 1500 m, more commonly below 800 m. Fertility throughout the year.

68. Lithocarpus rassa (MIQ.) REHD. J. Arn. Arb. 1 (1919) 130; A. CAMUS, Chênes 3 (1954) 739, t.; SOEPADMO, Reinwardtia 8 (1970) 271. — *Quercus rassa* MIQ. Sumatra (1861) 350; A. DC. Prod. 16, 2 (1864) 95; HOOK. *f.* Fl. Br. Ind. 5 (1888) 613, *incl. var. montana* KING *ex* HOOK. *f.*; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 66, t. 60 A; CORNER, Ways. Trees (1940) 304, f. 96. — *Cyclobalanus rassa* (MIQ.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 376. — *Quercus wenzigiana* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 613; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 65, t. 58 B; CORNER, Ways. Trees (1940) 305, f. 96. — *Quercus rassa var. lanuginosa* RIDL. J. Str. Br. R. As. Soc. *n.* 61 (1912) 37. — *Pasania rassa* (MIQ.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 436, *incl. var. lanuginosa*, *l.c.* 437. — *Pasania wenzigiana* (KING *ex* HOOK. *f.*) GAMBLE, *l.c.* 435. — *Synaedrys rassa* (MIQ.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192. — *Synaedrys wenzigiana* (KING *ex* HOOK. *f.*) KOIDZ. *l.c.* 193. — *L. rangeriana* A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 4 (1932) 912; Chênes 3 (1954) 791, t. 415: 9–11. — *L. ridleyana* A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 4 (1932) 913; Chênes 3 (1954) 752, t. 404: 20–27. — *L. symingtoniana* A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 4 (1932) 913; Chênes 3 (1954) 736, t. 399: 14–15. — *L. wenzigiana* (KING *ex* HOOK. *f.*) A. CAMUS, Riviera Scient. 18 (1932) 42; Chênes 3 (1954) 744, t.

Shrub or tree, 3–24 m, 15–90 cm ø; buttresses rounded, up to 0.6 m tall, 1½ m out, 5 cm thick; bark fissured to scaly, lenticellate, pale grey-brown. *Branchlets* initially densely set with yellowish brown, short, simple or stellate hairs, later glabrous, greyish to blackish brown, finely fissured or sparsely lenticellate; terminal buds ovoid-ellipsoid, 3–5 by 2–3 mm, scales ovate to linear. Stipules linear-acute to subulate, 3–4 by 1–2 mm. *Leaves* thin-coriaceous, rigid, (3½–)5–13(–17) by (1.2–)2–4(–6½) cm (index (2–)2½–3½(–4½)), broadest about the middle; above glabrous, glossy, chocolate-brown, underneath densely set with glaucous to fulvous, adpressed, minute stellate hairs, subglabrescent; base acute to cuneate, rarely rounded, margin recurved, top bluntly acute to bluntly or sharply ½–1½ cm acuminate-caudate; midrib strongly prominent on both sides; nerves thin, more or less prominent on both surfaces, (8–)10–14(–16) pairs, subparallel at an angle of 40–50°, arcuating and anastomosing near the margin; reticulation fine, areolate, obscure; petiole ½–2 cm, 1–1½ mm ø, glabrous, adaxially flat or furrowed. *Inflorescence* male, androgynous or mixed, densely yellowish brown, stellate tomentose; bracts thick-coriaceous, narrowly ovate-acute, 0.7–by 0.3 mm, bracteoles broadly ovate, 0.3 by 0.7 mm. *Male rachis* 7–20 cm, 1–3 mm ø; ♂ flowers in clusters of 3, filaments 2–3 mm, anthers 0.2–0.3 mm long, pistillode globose, 0.7–1 mm ø. *Androgynous* or *mixed rachis* 6–20 cm, 1–3 mm ø; *female flowers* solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3–5, conical, 0.7–1 mm. *Ripe cupule* sessile to 3–4 mm stalked, cup- to saucer-shaped, 5–12 mm long, 14–22 mm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, rather thick, inside densely silvery grey tomentose by adpressed simple hairs, outside densely fulvous stellate hairy, hairs minute, adpressed; lamellae 6–10, prominent, entire or denticulate. *Ripe fruit* subhemispherical, 12–15 mm long, 15–20 mm ø, pale chocolate-brown, glabrous except around the umbo, top rounded-apiculate, base rotundate, scar concave, *c.* 1 cm ø; wall bony, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Sumatra (scattered), Malay Peninsula (Perak, Pahang, Trengganu, Malacca, Johore), Borneo (Sarawak, Sabah).

Ecol. In primary forest, from sea-level up to 1800 m. *Fl.* July–June, *fr.* May–March.

Notes. The typical form of this species grows in the submontane forest at 600–1500 m, and has small, narrowly ovate to linear-lanceolate leaves, small fruits and cupules with 5–6 lamellae. Specimens from the lowland forest, recognized by KING and others as *L.* (*Quercus*) *wenzigiana*,

usually have larger leaves, cupules and fruits. In KEP 94394, SFN 10775, from Malay Peninsula, HONING *s.n.* from Sumatra, and SAN 26163, S. 5385, 18030, from Borneo, the leaves, cupules and fruits are intermediate. Specimens from 1500–1800 m, formerly recognized as *L. symingtoniana*, have much smaller leaves, cupules and fruits than those of *L. rassa*, but several intermediates also occur.

69. Lithocarpus andersonii SOEPADMO, Reinwardtia 8 (1970) 215, f. 10.

Tree 7–27 m, 20–60 cm ø; stilt-roots occasionally present, up to 1.8 m tall; bark smooth, light grey. *Branchlets* initially sparsely greyish stellate hairy, later glabrous, greyish to blackish brown, sparsely to densely lenticellate; terminal buds ovoid-ellipsoid, 3–4 by 2 mm, scales narrowly ovate-acute. Stipules narrowly ovate-acute to subulate, 3–4 by 1–2 mm. *Leaves* thin-coriaceous, rigid, (6–)7–10(–11½) by (2–)2½–3½(–5) cm (index 2–3), broadest about the middle; above glabrous, glossy, pale greyish green to yellowish brown, underneath sparsely tomentose by greyish to chocolate-brown, adpressed, minute, stellate hairs, glabrescent; base acute or rounded, margin recurved, top bluntly or sharply 1–1½ cm acuminate; midrib strongly prominent on both sides; nerves thin, obscure to rather prominent beneath, 9–11 pairs, subparallel, at an angle of 45–60°, arcuating and anastomosing near the margin; reticulation fine, areolate, obscure; petiole 5–8 mm, 1 mm ø, glabrous, furrowed. *Inflorescence* male or androgynous, densely greyish brown, stellate hairy, hairs adpressed, minute; bracts and bracteoles broadly or narrowly ovate, ⅓–1½ by ⅔ mm. *Male rachis* 5–15 cm, 1–2 mm ø; ♂ flowers in clusters of 3, perianth 5–6-lobed, stamens 10–12, filaments 2½–3½ mm, anthers 0.25 mm long, pistillode subglobose, *c.* ⅔–1 mm ø. *Androgynous rachis* 5–10 cm, 1–1½ mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, *c.* 1 mm, recurved. *Ripe cupule* sessile to 3–4 mm stalked, saucer-shaped, 2–6 mm long, 15–22 mm ø; rim thin, undulate, recurved, covering the basal part of the fruit; wall woody, thin, inside densely tomentose by adpressed, simple hairs, outside densely greyish stellate hairy; lamellae 5–6, thin, concentric, denticulate. *Ripe fruit* ovoid-conical, 1.2–2.2 cm long, 1.6–2.3 cm ø, glabrous, dark purplish brown, top rounded-acuminate, base rotundate, scar deeply concave, 9–15 mm ø; wall bony, *c.* 1.2 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Borneo (Sarawak; Sampit in S. Central Kalimantan).

Ecol. Peat swamp forest at low altitude. *Fl.* April–June, *fr.* Dec.–May.

70. Lithocarpus vinkii SOEPADMO, Reinwardtia 8 (1970) 286.

Tree 15–30 m, 15–50 cm ø; buttresses sometimes present, up to 2½ m tall and out, 10 cm thick; bark grey-brown, smooth to shallowly fissured. *Branchlets* initially densely set with a fulvous adpressed stellate tomentum, soon glabrescent, greyish brown, finely fissured, with many minute lenticels; terminal buds ovoid, *c.* 3 by 2 mm, scales ovate. Stipules ovate, 1–2 by 1 mm. *Leaves* coriaceous, (7–)8–14(–18) by (3–)4–5(–7) cm (index (1.7–)2–2½(–3½)), broadest at or rarely below the middle; surfaces more or less discolorous, above glabrous, dull or glossy, pale to dark greyish brown, beneath yellowish grey to glaucous tomentose by adpressed minute stellate hairs; base acute, rarely rounded, top abruptly acute to ½–1 cm acuminate, tip blunt or pointed, sometimes oblique; midrib and nerves thin, flattish on both sides to impressed above; nerves (8–)10–12 pairs, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, irregular, obscure on both sides; petiole 7–10 mm, 1½–2 mm ø, adaxially flat. *Inflorescence* male or androgynous, mostly simple and axillary, densely fulvous tomentose by short stellate hairs; bracts and bracteoles narrowly ovate, ⅔–1 by ½–⅔ mm. *Male rachis* 10–20 cm, 1½ mm ø; ♂ flowers in clusters of 3, filaments *c.* 2 mm, anthers 0.25 mm long, pistillode subglobose, ⅔–1 mm ø. *Androgynous rachis* 10–15 cm, 1½–2 mm ø; *female flowers* solitary or rarely in clusters of 2, staminodes rather well-developed but not exceeding the perianth, styles 3(–4), conical, *c.* 1 mm, recurved. *Ripe cupule* solitary or rarely in clusters of 2, subsessile, saucer-shaped, ⅓–½ cm long, 1½–2 cm ø, inside densely greyish tomentose by simple hairs, outside densely fulvous to glacous tomentose by adpressed stellate hairs; rim thin, incurved, covering the basal part of the fruit; lamellae 4–6, concentric, thin, denticulate. *Ripe fruit* conical, glabrous, pale chocolate-brown, 1¾–2½ cm long, 1½ cm ø, top acute, base truncate or rounded, scar concave, ¾–1 cm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: New Guinea (common in the Vogelkop Peninsula, scattered in the eastern part), also Japen I., eastward to Normanby, Misima, Sudest and Rossel Is.

Ecol. Forest, from sea-level up to 1800 m, more commonly below 700 m, on sandy to clayey soil overlying limestone. Both in the Vogelkop Peninsula and in the islands east of New Guinea, this species has been recorded as forming pure stands on low ridges. *Fl.* March–Dec., *fr.* Sept.–March.

71. Lithocarpus clementianus (KING *ex* HOOK. *f.*) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 707, t. 391: 1–8; SOEPADMO, Reinwardtia 8 (1970) 229. — *Quercus clementiana* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 614; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 69, t. 63 A; CORNER, Ways. Trees (1940) 301, f. 96. — *Pasania clementiana* (KING *ex* HOOK. *f.*) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 439. — *Synaedrys clementiana* (KING *ex* HOOK. *f.*) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191. — *Quercus teysmannii* (*non* BL.) HEINE in Fedde, Rep. 54 (1951) 225.

Tree 10–36 m, 30–70 cm ø; bark deeply fissured, brownish. *Branchlets* initially angular, sparsely stellate hairy, later terete, glabrous, blackish

brown, finely fissured; terminal buds ellipsoid, 3–5 by 1–2 mm, scales linear. *Leaves* coriaceous, (10–)12–16(–20) by (3–)4–5(–7) cm (index 3–3½), broadest at or slightly below the middle; above glossy, greyish green to pale chocolate-brown, underneath densely fulvous to pale grey tomentose by adpressed, minute, stellate hairs, subglabrescent; base acute, margin recurved, top 1–1½ cm acuminate; midrib prominent on both sides; nerves 10–14 pairs, thin, parallel at an angle of *c.* 45°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure; petiole ½–1 cm, 2 mm ø, glabrous, adaxially flat. *Inflorescence* male, androgynous or mixed, densely yellowish brown, adpressed stellate hairy, subglabrescent; bracts and bracteoles ovate to linear, ½–2 by ⅓–⅔ mm. *Male rachis* 10–15 cm, 2–3 mm ø; ♂ flowers in clusters of 3–7, filaments 2½–3½ mm, anthers 0.2–0.25 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 5–10 cm, 2–5 mm ø; *female flowers* solitary or in clusters of 2–3, staminodes rudimentary, styles 3, conical, 2–3 mm, recurved. *Ripe cupule* sessile, cup-shaped, 1–1½ cm long, 2½–3 cm ø; rim 1–2 mm thick, covering ¼–⅓ part of the fruit; wall woody, 3–4 mm thick, inside densely fulvous tomentose by adpressed simple hairs, outside sparsely stellate hairy by adpressed stellate hairs, glabrescent; lamellae 6–8, rather prominent, concentric. *Ripe fruit* depressed subglobose, 1–1½ cm long, 2–3 cm ø, glabrous, top rounded-umbonate, base truncate, scar concave, *c.* 1 cm ø; wall woody, *c.* 2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Malay Peninsula (Pahang; Penang), Borneo (Sarawak, scattered; Sabah: Mt Kinabalu, rather common).

Ecol. Forests at 600–1900 m. *Fl.* April–June, *fr.* July–Febr.

Note. Specimens from Borneo usually have thicker leaves than those from Malay Peninsula. The cupule and fruit are, however, very similar.

72. Lithocarpus suffruticosus (RIDL.) SOEPADMO, Reinwardtia 8 (1970) 280, f. 13. — *Pasania rassa var. suffruticosa* RIDL. Fl. Mal. Pen. 3 (1924) 382. — *L. rassa var. suffruticosa* (RIDL.) A. CAMUS, Chênes 3 (1954) 741.

Shrub or tree, 3–15 m tall. *Branchlets* initially densely set with rufous, adpressed stellate hairs, later glabrous, greyish to blackish brown, sparsely lenticellate; terminal buds ovoid, 1–2 by 1 mm, scales ovate-acute. Stipules broadly ovate to deltoid, *c.* ⅓ by ½ mm. *Leaves* thick-coriaceous, rigid, (6–)8–10(–12) by 3–5 cm (index (1.6–)2(–3)), broadest at or below the middle; above glabrous, glossy, dark chocolate-brown, underneath densely glaucous tomentose by adpressed, minute, stellate hairs; base acute to cuneate, margin recurved, top 1–2 cm acuminate-caudate, tip blunt or sharp; midrib strongly prominent on both sides; nerves (7–)9–10(–14) pairs, obscure, subparallel at an angle of *c.* 45°, arcuating and anastomosing near the margin; reticulation fine, subscalariform, obscure; petiole (5–)10–13(–16) mm, 1–2 mm ø, glabrous, adaxially flat. *Inflorescence* male, androgynous or mixed, densely tomentose by greyish to rufous, adpressed stellate hairs; bracts and bracteoles ovate, ½–⅔ by ½ mm. *Male rachis* 10 cm, 1½ mm ø, simple and axillary or much-branched and subterminal; ♂ flowers solitary or in clusters of 2–3, perianth 5–6-lobed, stamens 10–12, filaments 2 mm, anthers 0.35 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 6 cm, 1–2 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3–4, conical, 1 mm. Fruiting rachis up to 20 cm, with numerous cupules. *Ripe cupule* 3–5 mm stalked, cup-shaped, 0.6–1 cm long, 2–2½ cm ø; rim 1½–2 mm thick, covering ¼–⅓ part of the fruit; wall woody, 2–3 mm thick, inside densely greyish brown adpressed-tomentose by simple hairs, outside densely greyish tomentose by adpressed, minute stellate hairs; lamellae 8–10, concentric, entire or distantly denticulate. *Ripe fruit* ovoid-conical, 17–25 mm long, 17–20 mm ø, glabrous, dark chocolate-brown, top acute, base rotundate, scar deeply concave, 1–1½ cm ø; wall bony, 1–2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: N. Sumatra (Mts Kemiri and Talamau), Malay Peninsula (Perak, Selangor, Pahang, Trengganu).

Ecol. Submontane to mossy montane forest at 600–3150 m. Fertility seems to be throughout the year.

Note. Though the leaves are suggestive of *L. rassa*, the cupule and fruits are different.

73. Lithocarpus elegans (BL.) HATUS. *ex* SOEPADMO Reinwardtia 8 (1970) 236. — *Quercus spicata* SM. in Rees, Cyclop. (1814) *Quercus n.* 12, *non* HUMB. & BONPL. 1809; D. DON, Prod. Fl. Nepal. (1825) 56; WALL. Pl. As. Rar. 1 (1830) 40, t. 46; MIQ. Fl. Ind. Bat. 1, 1 (1856) 848; Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 106; A. DC. Prod. 16, 2 (1864) 85; KURZ, For. Fl. Burma 2 (1877) 486; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 224; HOOK. *f.* Fl. Br. Ind. 5 (1888) 609; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 47, t. 41: 1–2; K. & V. Bijdr. 10 (1904) 39; BRANDIS, Indian Trees (1906) 629, f. 194; CRAIB, Kew Bull. (1911) 473; CORNER, Ways. Trees (1940) 304, f. 98. — *Quercus racemosa* JACK, Mal. Misc. 2 (1822) 86, *non* LAMK, 1783; in Hook. Comp. Bot. Mag. 1 (1836) 255; KORTH. Kruidk. (1844) 205; MERR. J. Arn. Arb. 33 (1952) 241. — *Quercus elegans* BL. Verh. Bat. Gen. K. & W. 9 (1823) 208; Bijdr. (1826) 518; Fl. Jav. Cupul. (1829) 21, t. 10; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 5, t. 2, 3; BACKER & BAKH. *f.* Fl. Java 2 (1965) 7. — *Quercus depressa* BL. Verh. Bat. Gen. K. & W. 9 (1823) 209, t. 1, *non* HUMB. & BONPL. 1809. — *Quercus glaberrima* BL. Verh. Bat. Gen. K. & W. 9 (1823) 210, t. 2; Bijdr. (1826) 519; Fl. Jav. Cupul. (1829) 17, t. 8. — *Quercus placentaria* BL. Bijdr. (1826) 518; Fl. Jav. Cupul. (1829) 19, t. 9; A. DC. Prod. 16, 2 (1864) 87; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 226; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 72. — *Quercus arcaula* BUCH.-HAM. *ex* SPRENG. Syst. Veg. 3 (1826) 857; BL. Mus. Bot. 1 (1850) 290,

incl. var. racemosa (JACK) BL. *et var. microcalyx* (KORTH.) BL. — *Quercus glomerata* ROXB. Fl. Ind. ed. Carey 3 (1832) 640. — *Arcaula spicata* (SM.) RAFIN. Alsog. Am. (1838) 28. — *Quercus anceps* KORTH. Kruidk. (1844) 204. — *Quercus microcalyx* KORTH. Kruidk. (1844) 206; OUDEM. Versl. Med. Kon. Ak. Wet. Natuurk. 12 (1861) 204; Natuurk. Verh. Kon. Akad. 11 (1865) 6, t. 4: 3. — *Quercus pyrifolia* BL. Mus. Bot. 1 (1850) 304. — *Quercus sphacelata* BL. *l.c.* 304. — *Quercus spicata var. glaberrima* (BL.) MIQ. Fl. Ind. Bat. 1, 1 (1856) 848; A. DC. Prod. 16, 2 (1864) 86; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 225. — *Quercus spicata var. microcalyx* (KORTH.) MIQ. Fl. Ind. Bat. 1, 1 (1856) 848; A.DC. Prod. 16, 2 (1864) 86; HOOK. *f.* Fl. Br. Ind. 5 (1888) 610; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 48, t. 43: 9–11. — *Quercus spicata var. placentaria* (BL.) MIQ. Fl. Ind. Bat. 1, 1 (1856) 849; Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 106. — *Quercus gracilipes* MIQ. Sumatra (1861) 347. — *Quercus spicata var. gracilipes* (MIQ.) MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 106; A. DC. Prod. 16, 2 (1864) 86; HOOK. *f.* Fl. Br. Ind. 5 (1888) 610; K. & V. Bijdr. 10 (1904) 42; KOORD. Atlas 1 (1913) t. 42. — *Quercus spicata var. racemosa* (JACK) MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 106; A. DC. Prod. 16, 2 (1864) 85; SCHEFF. Nat. Tijd. N. I. 31 (1870) 359. — *Pasania spicata* ('WALL.') OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83; SCHOTTKY, Bot. Jahrb. 47 (1912) 664; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 419; HICKEL & A. CAMUS, Fl. Gen. I.-C. 5 (1930) 983. — *Pasania placentaria* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83. — *Pasania glomerata* (ROXB.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 379. — *Quercus spicata var. latifolia* SCHEFF. Nat. Tijd. N. I. 31 (1870) 359. — *Quercus rhioensis* HANCE, J. Bot. 16 (1878) 198. — *Quercus leucocarpa* HOOK. *f.* & THOMS. *ex* WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 225. — *Quercus spicata var. depressa* (BL.) KING, Ann. R. Bot. Gard. Calc. 2 (1889) 48, t. 43: 8; K. & V. Bijdr. 10 (1904) 42. — *Quercus spicata var. genuina* KOORD. Exk. Fl. Java 2 (1912) 66. — *Pasania spicata var. gracilipes* (MIQ.) SCHOTTKY, Bot. Jahrb. 47 (1912) 664; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 421; RIDL. Fl. Mal. Pen. 3 (1924) 377, f. 159. — *Pasania spicata var. placentaria* (BL.) SCHOTTKY, Bot. Jahrb. 47 (1912) 664. — *Pasania spicata var. microcalyx* (KORTH.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 421. — *Synaedrys spicata* (SM.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 198. — *L. spicata* (SM.) REHD. & WILS. in Sargent, Pl. Wils. 3 (1917) 207. — *L. spicata var. gracilipes* (MIQ.) REHD. J. Arn. Arb. 1 (1919) 131. — *L. spicata var. placentaria* (BL.) REHD. *ibid.* 10 (1929) 133; A. CAMUS, Chênes 3 (1954) 1035, t. 481: 8–13. — *L. rhioensis* (HANCE) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 1026, t. 478: 8–15. — *L. microcalyx* (KORTH.) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 83; Chênes 3 (1954) 1055, t.; SMITINAND, Nat. Hist. Bull. Siam Soc. 20 (1962) 126. — *L. spicata var. elegans* (BL.) A. CAMUS, Chênes, Atlas 3 (1949) 102, t. 481: 1–7; Chênes 3 (1954) 1034. — *L. spicata var. glaberrima* (BL.) A. CAMUS, Chênes, Atlas 3 (1949) 103, t. 482: 7–15; Chênes 3 (1954) 1035.

Tree 5–30 m, 20–70 cm ø; bark greyish brown, deeply fissured, lenticellate. *Branchlets* glabrous, greyish brown, sparsely to densely lenticellate; terminal buds ovoid, 2–5 by 2–3 mm, scales narrowly ovate to linear, densely yellowish brown stellate hairy, glabrescent. Stipules narrowly ovate to linear, 3–6 by 1–2 mm. *Leaves* thick-coriaceous, rigid, (9–)12–17(–20) by (3–)4–6(–8) cm (index (1½–)2–3(–5)), broadest at or above the middle; surfaces glabrous, concolorous, glossy, pale to dark chocolate-brown; base acute, rounded to (extra-Mal.) auriculate, margin recurved, top bluntly acute to 1–2 cm acuminate; midrib strongly prominent beneath, slightly so to flat above; nerves (10–)12–15(–18) pairs, prominent beneath, obscure above, subparallel at an angle of 45–60°, arcuating and anastomosing near the margin; reticulation subscalariform to irregular, fine, obscure to distinct beneath; petiole ⅓–2½ cm, 1–2 mm ø, adaxially flat, glabrous, occasionally thickened at the base. *Inflorescence* sturdy, male, androgynous or rarely mixed, densely fulvous simple and stellate hairy; bracts and bracteoles ovate-acute, 1–2 by 1 mm. *Male rachis* 10–30 cm, 2–3 mm ø, sometimes much-branched; ♂ flowers in clusters of (3–)7–15(–24), filaments 2½–3 mm, anthers 0.3 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 15–30 cm, 2–3½ mm ø; *female flowers* in clusters of (3–)5–7(–10), staminodes rudimentary, styles 3, terete, ⅔–1 mm. Fruiting rachis up to 30 cm, carrying numerous clustered cupules. *Ripe cupule* sessile to ½ cm stalked, cup- to saucer-shaped, (¼–)½–1(–2) cm long, (1–)2–3(–3½) cm ø; rim thin to rather thick, covering ¼–⅓ part of the fruit; wall woody, inside densely yellowish brown tomentose by simple adpressed hairs, outside densely fulvous adpressed stellate hairy; scales adpressed, sometimes rather woody, distinct but not free, imbricate to more or less concentrically set. *Ripe fruit* ovoid-conical to depressed ovoid-globose, (1–)1½–2(–2½) cm long, (1–)2–2½(–3½) cm ø, glabrous, chocolate-brown, top abruptly rounded acute to rounded and depressed at the centre, base rotundate, scar flat to concave, ¾–1½ cm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. India (Bhutan, Nepal), E. Pakistan (Chittagong), Burma, Indo-China; in *Malesia*: Sumatra, Malay Peninsula, Java, Borneo (common), Celebes (rare).

Ecol. Forests, from sea-level up to 2400 m, more commonly at 1000–1600 m, on various types of soil. North of the equator *fl.* Oct.–June, *fr.* Aug.–April; south of the equator fertile throughout the year.

Notes. *L. elegans* is the most widely distributed, and narurally the most variable species, and probably the most primitive in the genus. In the past seven or more varieties have been distinguished, and some of them even had been recognized as

distinct species. After examining a vast number of collections, I came to the conclusion that none of these varieties deserves to be regarded as separate species. There are many intergrades, and the variations are mainly due to different habitats. The species as accepted here is recognizable by the glabrous, pale to dark chocolate-brown leaves, glossy on both sides, with somewhat irregular reticulation, and by the cupules which are always squamose and set in dichasial clusters of 3–10. In the flowering stage, it may be distinguished by the rigid and sturdy inflorescence with the flowers in clusters of 3–15.

Records from New Guinea relate to *L. megacarpus*; and those from China probably to *L. henryi*.

The above synonymy covers Malesia only, the complete one is given in Reinwardtia *l.c.*

74. Lithocarpus jacobsii SOEPADMO, Reinwardtia 8 (1970) 248.

Tree 9–36 m, 10–35 cm ø; stilt-roots occasionally present; bark pale brown, smooth, lenticellate. *Branchlets* initially with a sparse adpressed stellate tomentum, the hairs sometimes interspersed by minute, reddish brown tinged (scales?), later glabrous, dull greyish brown, sparsely lenticellate; terminal buds ovoid, 5–6 by 3–4 mm, scales narrowly ovate, densely rufous stellate hairy. Stipules linear, 5–10 by 1–2 mm, rather long persistent. *Leaves* thick-coriaceous, rigid, (18–)24–40 (–56) by (5–)9–11(–16) cm (index 3–4), broadest slightly above the middle; surfaces more or less discolorous, glabrous, greyish green, paler beneath; base cordate to auriculate, margin recurved, top bluntly acute to abruptly, sharply 1 cm acuminate; midrib strongly prominent beneath, flat above, nerves (13–)14–17(–19) pairs, prominent beneath, impressed above, subparallel, at an angle of *c.* 60°, arcuating and anastomosing near the margin; reticulation lax, subscalariform to irregular, distinct beneath; petiole ½–1½ cm, 3–6 mm ø, terete or adaxially flat. *Inflorescence* male or female, densely fulvous stellate hairy; bracts and bracteoles linear-acute, 2–3 by ½–1 mm. *Male rachis* (not fully developed) *c.* 5 cm, 2 mm ø; ♂ flowers in clusters of 3. *Female rachis c.* 25 cm, 2½ mm ø; ♀ flowers in clusters of 3, staminodes well-developed and exceeding the perianth, styles 3, conical, 2–3 mm. *Ripe cupule* ½–1 cm stalked, saucer-shaped, ⅓–½ cm long, 2–2½ cm ø; rim thin, covering the basal part of the fruit; wall woody, thin, dull grey-brown stellate hairy on both sides; scales obscure, set in inconspicuous concentric rows. *Ripe fruit* ovoid-globose, 1½–2 cm long, 2–2½ cm ø, glabrous, pale chocolate-brown to dark brown, top abruptly acute, base truncate, scar deeply concave, *c.* 1½ cm ø; wall bony, *c.* 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Borneo (Sarawak, Sabah, rare).

Ecol. Forests, below 500 m, usually in swampy places. *Fl.* Febr., *fr.* Sept.–Nov.

75. Lithocarpus lampadarius (GAMBLE) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 717, t. 398: 7–10; SOEPADMO, Reinwardtia 8 (1970) 253. — *Pasania lampadaria* GAMBLE, Kew Bull. (1914) 177; J. As. Soc. Beng. 75, ii (1915) 444. — *Synaedrys lampadaria* (GAMBLE) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192. — *Quercus lampadaria* (GAMBLE) BURKILL, Kew Bull. (1935) 318; Dict. 2 (1935) 1857; CORNER, Ways. Trees (1940) 303, f. 96.

Tree 15–36 m, 30–100 cm ø; buttresses up to 1.2 m tall, 1½ m out, 10 cm thick; bark dark brown, scaly. *Branchlets* initially densely fulvous to rufous stellate hairy, later glabrous, sturdy, greyish to blackish brown, sparsely lenticellate, the lenticels large; terminal buds ellipsoid, 5–10 by 2–3 mm, scales linear. Stipules linear-acute, 6–10 by 1–3 mm. *Leaves* thick-coriaceous, rigid, (15–)20–25(–30) by (6–)8–10(–15) cm (index 1.7–3), broadest about the middle; above glabrous, dull to glossy, pale greyish green, underneath densely greyish brown to glaucous tomentose by adpressed, minute stellate hairs; base acute to cuneate, rarely rounded, margin recurved, top bluntly or sharply acute to 1½–2½ cm acuminate; midrib strongly prominent on both sides; nerves (10–)12–15(–18) pairs, prominent beneath, impressed above, parallel, at an angle of *c.* 60°, arcuating but not anastomosing towards the margin; reticulation scalariform, distinct beneath; petiole 1–3 cm, 2–3 mm ø, glabrous, terete or adaxially flat. *Inflorescence* male or androgynous, densely fulvous stellate hairy; bracts linear acute, 6–8 by 1½–2 mm, bracteoles broadly ovate, 2–3 by 1½–2 mm. *Male rachis* 10–30 cm, 3–4 mm ø, much-branched; ♂ flowers in clusters of 3–7 (or more), filaments 3–4 mm, anthers 0.35 mm long, pistillode subglobose, 1–2 mm ø. *Androgynous rachis* 10–15 cm, 3–4 mm ø; *female flowers* in clusters of 3–7, very rarely solitary, staminodes rudimentary, styles 3–5, conical, 1½–2 mm, recurved. Fruiting rachis sturdy, densely warty lenticellate. *Ripe cupule* subsessile, cup-shaped, 1–1.2 cm long, 2–3 cm ø; rim thick, covering the basal part of the fruit; wall woody, rather thick, inside densely yellowish brown, silvery tomentose by adpressed simple hairs, outside densely fulvous adpressed stellate hairy; scales obscure, set in 5–6 more or less concentric rows. *Ripe fruit* depressed ovoid-globose, 2–2½ cm long, 3–3½ cm ø, densely yellowish brown tomentose by adpressed, simple hairs, top rotundate, depressed-umbonate at the centre, base rotundate, scar deeply concave, up to 2 cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Malay Peninsula (Perak, Pahang, Trengganu), Borneo (Sabah: Mt Kinabalu, common).

Ecol. Forests, at 900–2000 m. *Fl.* Sept.–April, *fr.* May–Aug.

Uses. Twigs are used by the local people as torches.

76. Lithocarpus wallichianus (LINDL. *ex* HANCE) REHD. J. Arn. Arb. 1 (1919) 132; A. CAMUS, Chênes 3 (1954) 1102, t. 503: 1–8; SOEPADMO, Reinwardtia 8 (1970) 287. — *Quercus wallichiana* LINDL. *ex* HANCE, J. Bot. 8 (1870) 4; HOOK. *f.* Fl.

Br. Ind. 5 (1888) 610; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 51, t. 46; CORNER, Ways. Trees (1940) 305, f. 96. — *Pasania wallichiana* (LINDL. *ex* HANCE) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 425. — *Quercus hystrix var. longispica* GAMBLE, *l.c.* 429. — *Synaedrys wallichiana* ('LINDL. in WALL.') KOIDZ. Bot. Mag. Tokyo 30 (1916) 199.

Tree 10–30 m, 10–90 cm ø. *Branchlets* initially densely set with fulvous erect stellate hairs, angular, later subglabrous, terete, slender, dark greyish brown, sparsely to densely lenticellate; terminal buds ovoid-globose, 2–5 by 2–3 mm, scales ovate to linear. Stipules lanceolate to linear, 2½–5 by 1–1½ mm. *Leaves* rigid, coriaceous, (10–)14–18 (–7) cm (index (2½–)3–3½(–5)), broadest at or above the middle; surfaces discolorous, above pale chocolate-brown, with erect stellate hairs especially on the midrib and nerves, underneath densely set with pale yellowish brown, adpressed and erect stellate hairs; base acute, margin recurved, top acute to 1–2 cm acuminate; midrib strongly prominent on both sides; nerves (10–)12–16 (–18) pairs, prominent beneath, impressed above, subparallel at an angle of 50–60°, arcuating and faintly anastomosing near the margin; reticulation dense, scalariform, distinct beneath; petiole (5–)10–12(–17) mm, 1–2 mm ø, densely stellate hairy, adaxially flat or furrowed. *Inflorescence* male, androgynous or mixed, densely yellowish brown to fulvous stellate hairy; bracts and bracteoles ovate, 1–1½ by ½–⅔ mm. *Male rachis* 10–15 cm, 2 mm ø; ♂ flowers in clusters of 3, filaments 3–5 mm, anthers 0.35 mm long, pistillode subglobose, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 10–20 cm, 1½–2 mm ø; *female flowers* in clusters of 3, staminodes rudimentary, styles 3, conical, 1–3 mm, recurved. *Ripe cupule* subsessile, saucer- to cup-shaped, 3–5 mm long, 1.5–1.7 cm ø; rim thin, covering the basal part of the fruit; wall woody, 1–2 mm thick, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous to rufous stellate hairy; scales set in concentric rows, adpressed. *Ripe fruit* depressed ovoid to subhemispherical, 1–1½ cm long, 1.8–2 cm ø, densely pale yellowish brown tomentose by adpressed, minute simple hairs, top depressed-umbonate, base rotundate, scar concave, 8–10 mm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. Peninsular Siam (at 6° 30′ N: KERR 15875); in *Malesia*: Sumatra (scattered in the northern half, also Singkep I.), Malay Peninsula (common in all parts; also Penang, Tioman, and Singapore Is.).

Ecol. Primary forests, from sea-level up to 1600 m, usually on poor soil. *Fl.* Dec.–May, *fr.* July–Febr.

Note. The leaves are suggestive of *L. cyclophorus*, but the cupule and fruit are much smaller and of completely different shape.

77. Lithocarpus erythrocarpus (RIDL.) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 962, t. 461: 6–12; SOEPADMO, Reinwardtia 8 (1970) 240. — *Pasania erythrocarpa* RIDL. J. Bot. 42 (1924) 301.

Tree 9–24 m, *c.* 40 cm ø; buttresses concave, 2/3 m tall; bark whitish grey, scaly, lenticellate. *Branchlets* initially densely fulvous-tomentose by adpressed, minute stellate hairs, later glabrous, sturdy, greyish brown, with numerous large lenticels; terminal buds ovoid, 2–3 by 2 mm, scales ovate. *Leaves* coriaceous, 20–26 by 6–9 cm (index 2.6–3.3), broadest at or below the middle; above glabrous greyish green, dull, underneath with a thin cover of pale green, adpressed, stellate hairs; base acute, top acute, margin recurved; midrib broad, slightly prominent on both sides; nerves 12–15 pairs, flat on both surfaces, parallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, irregular, obscure; petiole 1½–2 cm, 3–5 mm ø, terete or adaxially flat, corky. *Fruiting rachis* sturdy, *c.* 10 cm, ½–1 cm ø, densely lenticellate, carrying numerous, clustered cupules. Young cupule sessile, in clusters of 2–3, or rarely solitary, blackish brown. Young fruit: staminodes rudimentary, styles 3, terete, 2 mm, recurved. *Ripe cupule* sessile, cup-shaped, 1–1½ cm long, 2 cm ø; rim thin, covering ⅓ part of the fruit; wall woody, densely dark reddish brown tomentose on both sides; scales minute, adpressed, whitish, set in obscure concentric rows. *Ripe fruit* cylindrical, 2½ cm long, 1½–1¾ cm ø, densely dark reddish brown tomentose by adpressed simple hairs, top rounded-apiculate, base truncate, scar deeply concave, *c.* 1 cm ø; wall woody, *c.* 2 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Malay Peninsula (Selangor, Negri Sembilan, Pahang).

Ecol. Primary forests, on ridges below 900 m. *Fr.* May–Dec.

Notes. Though the young cupules are in clusters of 2–3, at maturity only one is fully developed, the others rudimentary.

Inflorescences are unknown.

78. Lithocarpus oreophilus SOEPADMO, Reinwardtia 8 (1970) 264. — *Quercus monticola* KING, Ann. R. Bot. Gard. Calc. 2 (1889) 44, t. 37, *non* PETZOLD & KIRCHNER, 1864; RIDL. J. Fed. Mal. St. Mus. 8 (1917) 86. — *Synaedrys monticola* (KING) KOIDZ. Bot. Mag. Tokyo 30 (1916) 197. — *L. monticola* (KING) REHD. J. Arn. Arb. 1 (1919) 129; A. CAMUS, Chênes 3 (1954) 1130, t. 510: 6–11.

Tree 9–20 m, *c.* 30 cm ø. *Branchlets* initially densely set with fulvous adpressed, minute stellate hairs, later glabrous, greyish to blackish brown, sparsely lenticellate; terminal buds ovoid, 1–2 by 1 mm, scales ovate. Stipules linear-acute, 3–4 by 1 mm, rather long persistent. *Leaves* thick-coriaceous, rigid, 2½–5 by 1½–4 cm (index 1–2), broadest at the middle; surfaces more or less discolorous, above glabrous, glossy, chocolate-brown to greyish green, beneath with a thick cover of greyish, adpressed, minute stellate hairs; base rounded to subcordate, margin recurved, top rounded; midrib thin, prominent on both sides; nerves 5–6 pairs, flat on both surfaces, subparallel at an angle of

45–60°, arcuating but not anastomosing towards the margin; reticulation fine, areolate, obscure; petiole 2–3 mm, 1–1½ mm ø, adaxially flat. *Inflorescence* male or female, densely stellate hairy; bract and bracteoles narrowly ovate, 1–2 by ½–1 mm. *Male rachis* 3–5 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, filaments 4–5 mm, anthers 0.3–0.4 mm long, pistillode subglobose, 1–1½ mm ø. *Female rachis* 3–4 cm, 2–3 mm ø; ♀ flowers solitary or rarely in clusters of 2–3, staminodes rather well-developed but not exceeding the perianth, styles 3, conical, 2–2½ mm, recurved. *Ripe cupule* subsessile, saucer-shaped, 2–3 mm, 2½–3 cm ø; rim thin, covering the basal part of the fruit; wall woody, inside densely yellowish brown tomentose by adpressed, simple hairs, outside densely fulvous to greyish stellate hairy; scales imbricate, distinct and free. *Ripe fruit* depressed-subglobose, 1½–2 cm long, 2–2½ cm ø, glabrous, dark chocolate-brown, glossy, top rounded-umbonate and depressed at the centre, base cordate, scar deeply concave, 1½–1⅔ cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule; cotyledons flat-convex, ruminate.

Distr. *Malesia*: Sumatra (rare).

Ecol. Montane mossy forest, at 2400–3300 m. *Fl. fr.* May–July.

Note. Records from the Philippines (ELMER, Leafl. Philip. Bot. 3, 1910, 942) and from Borneo (KING, *l.c.*) are not confirmed. ELMER had specimens of *L. submonticolus*, and according to STAPF, Trans. Linn. Soc. Lond. II, Bot. 4 (1894) 231, KING had a specimen of *Myrica*.

79. Lithocarpus obtusifolius SOEPADMO, Reinwardtia 8 (1970) 263. — *Quercus rufa* VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 4, *non* VUKOT. 1889; in Fedde, Rep. 3 (1906) 173; MERR. En. Born. (1921) 215. — *Synaedrys rufa* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 198. — *L. rufa* (VON SEEMEN) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 968, t. 463: 9–18.

Tree. *Branchlets*, petiole, undersurface of leaves, fruiting rachis, and cupules densely velvety rufous hairy by erect and adpressed stellate hairs. *Leaves* thick-coriaceous, rigid, 9–13 by 5–7½ cm (index 1½–2), broadest slightly above the middle; surfaces discolorous, above subglabrous, dark chocolate-brown; base acute, margin strongly recurved, top rounded to obtuse; midrib strongly prominent beneath, slightly so above; nerves 6–7 pairs, thin, prominent beneath, flat to impressed above, parallel, at an angle of *c.* 45°, arcuating and anastomosing near the margin; reticulation lax, subscalariform, obscure; petiole 1–1¼ cm, ⅓–½ cm ø, adaxially flat. *Ripe cupule* sessile, solitary or in clusters of 2–3, 4–5 mm long, 15–16 mm ø; rim thin, covering the basal part of the fruit, incurved; scales minute, adpressed, in more or less concentric rows. *Ripe fruit* ovoid-globose, *c.* 1½ cm in size, glabrous, dull to glossy, chocolate-brown, top abruptly rounded-acute, base truncate, scar concave, *c.* 8 mm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Mt Klam in SW. Kalimantan, HALLIER 2481, *fr.*).

Note. The inflorescences are still unknown.

80. Lithocarpus papillifer HATUS. *ex* SOEPADMO, Reinwardtia 8 (1970) 265.

Tree 15–25 m, 30–40 cm ø; bark smooth, grey-brown. *Branchlets* initially densely set with fulvous to rufous, adpressed stellate hairs, later glabrous, greyish black, densely lenticellate; terminal buds ovoid, 2 by 2 mm, scales narrowly ovate. Stipules ovate or deltoid, 1–2 by ½–1 mm. *Leaves* thick-coriaceous, (4–)6–10(–12) by (2–)3–4(–5½) cm (index 1½–2½), broadest at or below the middle; surfaces more or less discolorous, above dark chocolate-brown, dull to glossy, with some adpressed stellate hairs especially on the midrib and nerves, and blackish glandular papillae, underneath densely yellowish brown to rufous tomentose by adpressed, minute, stellate hairs; base acute, top acute or rounded-emarginate; midrib prominent beneath, slightly so above; nerves (5–)6–7(–8) pairs, prominent beneath, impressed above, parallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, dense, scalariform, obscure to rather distinct beneath; petiole ½–1 cm, 1–3 mm ø, shallowly furrowed. *Inflorescence* male or androgynous, in densely subterminal, paniculate clusters, densely yellowish brown to rufous stellate hairy; bracts and bracteoles narrowly ovate, 1–1½ by ½–1 mm. *Male rachis c.* 5 cm, 1–1½ mm ø; ♂ flowers in clusters of 2–3, rarely solitary, filaments 1½–2 mm, anthers 0.25 mm long, pistillode globose, *c.* 1 mm ø. *Androgynous rachis* 4–5 cm, 2 mm ø; *female flowers* solitary, rarely in clusters of 2, staminodes rudimentary, styles 3, conical, 1–1½ mm, recurved. *Cupule* (not fully ripe) sessile, saucer-shaped, 6 mm long, 10–15 mm ø; rim thin, covering the basal part of the fruit; wall thin, densely fulvous tomentose on both sides; scales minute, adpressed, imbricate but concentrically set. *Fruit* (not yet ripe) ovoid-conical, *c.* 1 by 1⅓ cm, glabrous, chocolate-brown, glossy, top acuminate, base rotundate, scar concave, *c.* 8 mm ø; wall bony, thinner than ½ mm, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak, rare: Mt Mulu, Mt Kalulong 3° 14′ N, 114° 41′ E; W. Kutei in Central E. Kalimantan; Sabah: Mt Kinabalu, common).

Ecol. Submontane forest, at 600–1800 m. *Fl.* June–Jan., *fr.* Febr.–June.

Note. In SAN 29006 (with female flowers) the staminodes are absent, and the styles are up to 15.

81. Lithocarpus ferrugineus SOEPADMO, Reinwardtia 8 (1970) 242. — *Quercus kunstleri* (*non* KING *ex* HOOK. *f.*) VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 4; MERR. En. Born. (1921) 214.

Tree 16–24 m, 20–30 cm ø; buttresses *c.* 0.7 m tall, 1–2 m out, 10 cm thick; bark smooth, grey. *Branchlets* initially densely yellowish brown tomentose by simple and stellate, adpressed hairs, later glabrous, greyish green, finely fissured, sparse-

ly lenticellate; terminal buds ovoid-globose, 2–4 by 2–3 mm, scale ovate. *Leaves* thin-coriaceous, (13–)17–24(–26) by (3–)4–5(–6) cm (index 3–5), broadest at or above the middle; surfaces concolorous, glabrous, pale greenish brown, above dull, beneath glossy; base acute, top abruptly acute to 1–1½ cm acuminate; midrib strongly prominent on both sides; nerves (7–)9–10 (–12) pairs, prominent beneath, impressed above, subparallel, at an angle of 30–50°, arcuating but not anastomosing towards the margin; reticulation lax, fine, subscalariform to irregular, distinct beneath; petiole (½–)1–1½(–1¾) cm, 1½–2 mm ø, adaxially flat. *Inflorescence* male, androgynous or mixed, sparsely to densely fulvous adpressed, stellate hairy; bracts and bracteoles ovate, ⅔–2 by ⅓–1 mm. *Male rachis c.* 10 cm, 1 mm ø; ♂ flowers solitary, filaments 3–4 mm, anthers 0.30 mm long, pistillode subglobose, 1½–2 mm ø. *Androgynous* or *mixed rachis* 10–15 cm, 2 mm ø; *female flowers* solitary, staminodes well-developed and exceeding the perianth, styles 3, terete, 2–3 mm, connate at the base. *Ripe cupule* subsessile, cup-shaped, ½–1 cm long, 1½–2 cm ø; rim thin, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely silvery to fulvous tomentose by adpressed, minute simple hairs, outside densely fulvous adpressed, stellate hairy; scales adpressed, imbricate. *Ripe fruit* ovoid, 1½–2 cm in size, densely covered by rufous, adpressed, simple hairs, top rounded-acute, base rotundate, scar deeply concave, *c.* 1 cm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak; SW. Kalimantan; Sabah: Beaufort Hill, rare).

Ecol. Forests, below 500 m, usually on ridges. *Fl.* April–July, *fr.* Aug.–Dec.

82. Lithocarpus falconeri (KURZ) REHD. J. Arn. Arb. 10 (1929) 133; BARNETT, Trans. & Proc. Bot. Soc. Edinb. 33 (1942) 333; A. CAMUS, Chênes 3 (1954) 955, t. 460: 1–10; SOEPADMO, Reinwardtia 8 (1970) 241.— *Quercus falconeri* KURZ, J. As. Soc. Beng. 44, ii (1875) 197; For. Fl. Burma 2 (1877) 485; HOOK. *f.* Fl. Br. Ind. 5 (1888) 608; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 42, t. 34; CORNER, Ways. Trees (1940) 303, f. 96. — *Quercus minor* RIDL. J. Str. Br. R. As. Soc. *n.* 57 (1910) 95, *non* SARGENT, 1889, *nec* GANDOGER, 1890. — *Pasania falconeri* (KURZ) SCHOTTKY, Bot. Jahrb. 47 (1912) 679; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 423. — *Synaedrys falconeri* (KURZ) KOIDZ. Bot. Mag. Tokyo 30 (1916) 195.

Tree 6–10 m. *Branchlets* initially densely set with fulvous erect simple hairs, later subglabrous, greyish to blackish brown, sparsely to densely lenticellate; terminal buds ovoid-ellipsoid, 1–2 by ½–⅔ mm, scales ovate-acute, densely silvery pubescent by simple adpressed hairs. Stipules linear-acute, 15–20 by 1–1½ mm. *Leaves* thin-coriaceous, (12–)20–30(–34) by (4–)5–8(–10) cm (index (2½–)3–4(–4½)), broadest at or rarely above the middle; surfaces more or less concolorous, glabrous, pale greyish green, above glossy, beneath dull; base acute, rarely rounded, top abruptly acute; midrib strongly prominent on both sides; nerves (12–)14–17(–20) pairs, strongly prominent beneath, impressed above, subparallel, at an angle of 45–60°, arcuating and anastomosing near the margin; reticulation lax, fine, scalariform, rather distinct beneath; petiole ¾–2 cm, 2–4 mm ø, adaxially flat. *Inflorescence* male or female, sparsely to densely fulvous stellate hairy; bracts and bracteoles ovate-acute, ⅔–3 by ⅔–1 mm. *Male rachis* 15–35 cm, 1½–2 mm ø; ♂ flowers solitary or in clusters of 2–3, filaments 3–4 mm, anthers 0.3 mm long, pistillode subglobose, compressed, ⅔–2 mm ø. *Female rachis* 10–15 cm, 3 mm ø; ♀ flowers solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3–4, conical, 1–1½ mm, recurved. *Ripe cupule* sessile, solitary, rarely in clusters of 2–3, saucer- to cup-shaped, ⅓–1 cm long, 2–2⅔ cm ø; rim thin, undulate and recurved, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous stellate hairy; scales adpressed, imbricate. *Ripe fruit* ovoid-ellipsoid, 2–2½ cm long, 1⅔–2 cm ø, glabrous, pale chocolate-brown, glossy, top gradually rounded-acute, base rotundate, scar concave, ⅔–1 cm ø; wall woody, *c.* 1 mm thick, for the greater part free from the cupule.

Distr. Burma, Peninsular Siam, in *Malesia*: Malay Peninsula (Perlis, Kedah, Perak, rather common; also Langkawi Is.).

Ecol. Primary forests, below 200 m. In Burma and Siam confined to the evergreen forest. *Fl.* Sept.–Nov., *fr.* Febr.–July.

83. Lithocarpus crassinervius (BL.) REHD. J. Arn. Arb. 1 (1919) 124; A. CAMUS, Chênes 3 (1954) 950, t. 457: 3–19; SOEPADMO, Reinwardtia 8 (1970) 232. — *Quercus crassinervia* BL. Mus. Bot. 1 (1850) 292; A. DC. Prod. 16, 2 (1864) 87 ('*dassinervia*'); KING, Ann. R. Bot. Gard. Calc. 2 (1889) 87; VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 13; K. & V. Bijdr. 10 (1904) 28; KOORD. Atlas 1 (1913) t. 63; BACKER & BAKH. *f.* Fl. Java 2 (1965) 8. — *Quercus pseudomolucca var. crassinervia* (BL.) MIQ. Fl. Ind. Bat. 1, 1 (1856) 849; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 227. — *Pasania crassinervia* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 84. — *Synaedrys crassinervia* (BL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 194.

Tree 15–20 m, 50 cm ø. *Branchlets* initially densely set with fulvous, adpressed, stellate hairs, later glabrous, greyish, sparsely lenticellate; terminal buds ovoid-ellipsoid, 2–3 by 1–1½ mm, scales narrowly ovate to linear, densely fulvous tomentose by adpressed, stellate hairs. Stipules linear-acute, 5–10 by 1–1½ mm, rather long persistent. *Leaves* thin-coriaceous, (9–)15–20(–28) by (4–)5–7(–10) cm (index (1.7–)2–3(–3.7)), broadest at or above the middle; surfaces concolorous, glabrous, greyish green, dull; base acute, rarely rounded, margin recurved, top acute; midrib and nerves strongly prominent beneath, flat to impressed above; nerves (6–)9–10(–12) pairs, parallel, at an angle of 50–60°, arcuating but not anasto-

mosing towards the margin; reticulation fine, dense subscalariform to irregular, rather distinct beneath; petiole 8–15 mm, 2–4 mm ø, corky, adaxially flat. *Male rachis* 6–10 cm, 1–2 mm ø, densely fulvous stellate hairy; bracts and bracteoles narrowly ovate 1½–2 by ⅓–⅔ mm; ♂ flowers solitary, perianth strongly recurved, filaments 3–4 mm, anthers 0.3–0.4 mm long, pistillode subglobose, 1–1½ mm ø. *Fruiting rachis* 15–35 cm, 5 mm ø, carrying a few solitary cupules. Young fruit: perianth strongly recurved, staminodes well-developed and exceeding the perianth, styles 3–4, terete, 2–2½ mm, strongly recurved. *Ripe cupule* sessile, cup-shaped, ⅔–1 cm long, 2½ cm ø; rim thin, occasionally recurved, covering the basal part of the fruit; wall woody, thin, inside densely silky, fulvous tomentose by minute, adpressed simple hairs, outside densely fulvous stellate hairy by adpressed hairs; scales thick, ovate, adpressed, imbricate. *Ripe fruit* ovoid-ellipsoid, 3–3½ cm long, 2–2½ cm ø, glabrous, chocolate-brown, top abruptly rounded-acute, base truncate, scar concave to flat, 1–1½ cm ø; wall woody, 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Java (W. and Central parts, rare).

Ecol. Primary forests, at 200–2000 m. *Fr.* Nov.–April.

Vern. *Pasang balung, p. djambé, wrakar*, J, *tangogo*, S.

84. Lithocarpus kunstleri (KING *ex* HOOK. *f.*) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 974, t. 465: 1–9; SOEPADMO, Reinwardtia 8 (1970) 252. — *Quercus kunstleri* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 606; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 40, t. 31; CORNER, Ways. Trees (1940) 303, f. 96. — *Pasania kunstleri* (KING *ex* HOOK. *f.*) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 419. — *Synaedrys kunstleri* (KING *ex* HOOK. *f.*) KOIDZ. Bot. Mag. Tokyo 30 (1916) 196.

Tree 6–15 m, 15–35 cm ø. *Branchlets* initially densely set with yellowish brown to fulvous erect, stellate hairs, later subglabrous, whitish grey to greyish brown, finely fissured or sparsely lenticellate; terminal buds ovoid-ellipsoid, 3–5 by 2–3 mm, scales narrowly ovate-acute. Stipules narrowly ovate-acute to linear, 5 by 1 mm. *Leaves* thin-coriaceous, (7½–)13–16(–20) by (3–)5–6(–7) cm (index (2–)2½(–3)), broadest at or above the middle; surfaces concolorous, sparsely stellate pubescent on both sides, dark greyish green; base rounded to subcordate, top abruptly acute to 1 cm acuminate; midrib strongly prominent on both surfaces, densely fulvous stellate hairy; nerves 10–13 pairs, strongly prominent beneath, impressed above, densely fulvous stellate hairy, subparallel, at an angle of 50–60°, arcuating and anastomosing near the margin; reticulation fine, lax, subscalariform, distinct beneath; petiole 2–5 mm, 1½–2 mm ø, terete or adaxially flat. *Inflorescence* male, androgynous or mixed, densely fulvous stellate hairy; bract and bracteoles narrowly ovate-acute, ½–1½ by ½ mm. *Male rachis* 20–30 cm, 1–2 mm ø; ♂ flowers solitary, filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode subglobose, 1 mm ø. *Androgynous* or *mixed rachis* 10–15 cm, 1 mm ø; *female flowers* solitary, staminodes well-developed and exceeding the perianth, styles 3, terete, 1½–2 mm, strongly recurved. *Ripe cupule* ⅓–½ cm stalked, cup-shaped, 5–7 mm long, 13–15 mm ø; rim thin, entire or denticulate, covering the basal part of the fruit; wall woody, thin, inside densely fulvous-tomentose by simple hairs, outside densely fulvous-tomentose by adpressed, stellate hairs; scales adpressed, distinct but not free, imbricate. *Ripe fruit* cylindrical, 2½–3 cm long, 1–1½ cm ø, glabrous, dull chocolate-brown, top rounded-acute, base truncate, scar flat, ⅔–¾ cm ø; wall woody, 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia:* Malay Peninsula (Langkawi, Perak, Selangor, Pahang, Johore).

Ecol. Primary forests, below 300 m, sometimes also in secondary forest, in swampy places or on hill-sides. *Fl.* Sept.–Nov., *fr.* Jan.–June.

85. Lithocarpus pseudokunstleri A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 10; Chênes 3 (1954) 976, t. 465: 10–17; SOEPADMO, Reinwardtia 8 (1970) 268.

Tree 10–25 m, 20–60 cm ø; buttresses ½–1 m tall, ⅓–½ m out, 6 cm thick; bark greyish brown, scaly. *Branchlets* initially densely fulvous tomentose by stellate hairs, soon glabrous, dark greyish brown or yellowish grey, sparsely to densely lenticellate; terminal buds ovoid-ellipsoid, 2–4 by 1–1½ mm, scales narrowly ovate-acute. Stipules lanceolate to subulate, 2–5 by 1–2 mm. *Leaves* thin-coriaceous, (8–)11–15(–16) by (2½–)4–6(–6½) cm (index (2–)2½–3(–3½)), broadest at or above the middle; surfaces concolorous, glabrous, glossy, pale greyish green; base attenuate-acute, top abruptly acute to 1 cm acuminate, tip blunt or sharp; midrib strongly prominent on both sides; nerves 7–8 pairs, prominent beneath, flat above, subparallel, at an angle of 45–50°, strongly arcuating but mostly not anastomosing towards the margin; reticulation fine, dense, scalariform, more or less distinct on both surfaces; petiole 4–6 mm, 1½–2 mm ø, terete or adaxially flat, glabrous. *Inflorescence* male or androgynous, densely fulvous stellate hairy, subglabrescent; bracts and bracteoles ovate-acute, ⅓–1½ by ⅓–½ mm. *Male rachis* 5–25 cm, 1 mm ø; ♂ flowers in clusters of 2–3, stamens 8–12, filaments 2–2½ mm, anthers 0.25–0.3 mm long, pistillode subglobose, 1 mm ø. *Androgynous rachis* 5–10 cm, 1 mm ø; *female flowers* solitary, staminodes rather well-developed but not exceeding the perianth, styles 3, terete, 2½–3 mm, recurved. *Ripe cupule* sessile, cup-shaped, 1–1½ cm long, 1⅔–2¼ cm ø; rim thin, entire, covering the basal part of the fruit; wall woody, thin, inside densely greyish brown tomentose by adpressed, simple hairs, outside densely fulvous stellate hairy; scales adpressed, imbricate, rather woody and corky, occasionally fused at the base to form obscure lamellae. *Ripe fruit* cylindrical, 3–4½ cm long, 1½–2 cm ø, initially densely greyish tomentose by adpressed, minute simple hairs, soon glabrous, dull chocolate-brown, top

abruptly rounded-acute, base truncate, scar flat, 1 cm ø; wall woody, 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Borneo (Sarawak, rather common; Kalimantan, rare; Sabah, rare).

Ecol. Primary forests, from sea-level up to 1500 m, occasionally also in peat-swamp forest. *Fl.* April-May, *fr.* June–March.

86. Lithocarpus havilandii (STAPF) BARNETT, Trans. & Proc. Bot. Soc. Edinb. 33 (1942) 176; A. CAMUS, Chênes 3 (1954) 677; SOEPADMO, Reinwardtia 8 (1970) 245. — *Quercus havilandii* STAPF, Trans. Linn. Soc. Lond. II, Bot. 4 (1894) 231, t. 18: A 1–4, *p.p., excl.* VIDAL 1864. — *Quercus abendanonii* VALETON, Icon. Bogor. 4 (1913) 179, t. 354. — *L. abendanonii* (VALETON) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 84; Chênes 3 (1954) 908, t. 446: 15–21. t. 447. — **Fig. 28 a–c.**

Tree or shrub, 2–25 m, 20–100 cm ø; bark grey-brown, smooth to scaly, lenticellate. *Branchlets* densely set with yellowish brown to rufous short stellate hairs and erect glandular tuft-hairs with bulbous base, later subglabrous, greyish brown, sparsely lenticellate; terminal buds ovoid, 3 by 2 mm, scales narrowly ovate-acute. Stipules linear, 3–6 by 1–2 mm. *Leaves* coriaceous, rigid, (4–)5–8 (–9) by (3–)4(–5) cm (index (1.2–)1.3–1.8(–2)), broadest at or below the middle; surfaces discolorous, above pale to dark chocolate-brown, dull to glossy, sparsely pubescent, glabrescent, beneath with a thick cover of yellowish brown to rufous, adpressed stellate hairs and erect, glandular tuft-hairs; base acute, rounded or subcordate, margin

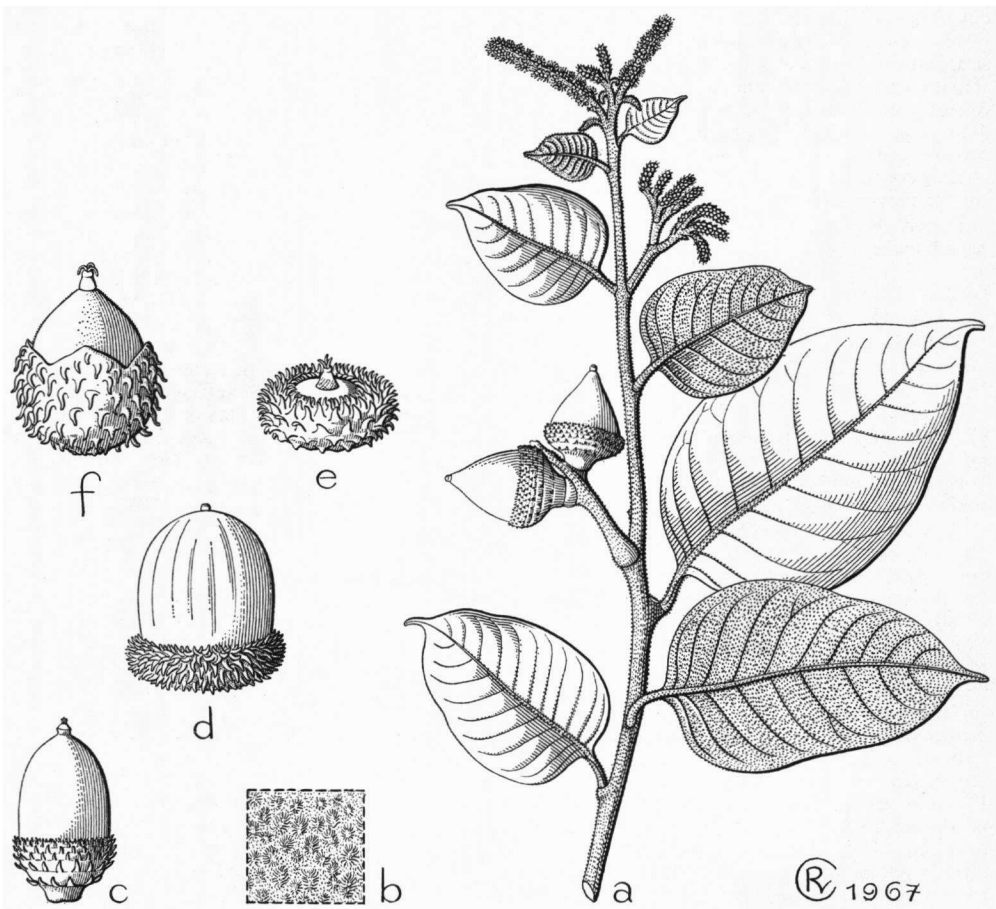

Fig. 28. *Lithocarpus havilandii* (STAPF) BARNETT. *a.* Habit with fruiting rachis and a few ♂ rachis, × ⅔, *b.* erect glandular tuft-hairs on the underside of leaf, × 12, *c.* ripe fruit and cupule, × ⅔. — *L. scortechinii* (KING *ex* HOOK. *f.*) A. CAMUS. *d.* Ripe cupule and fruit, × ⅔. — *L. kingianus* (GAMBLE) A. CAMUS. *e.* Young cupule and fruit, *f.* ripe cupule and fruit, both × ⅔ (*a–b* RSNB 5932, *c* TOXOPEUS 15, *d* KING'S Coll. 2188, *e* POORE 1282, *f* MAHMUD 606).

recurved, top bluntly acute to ½–1 cm acuminate; midrib strongly prominent beneath, slightly so above; nerves (7–)8–10(–12) pairs, prominent beneath, impressed above, subparallel, at an angle of 40–50°, arcuating but not anastomosing towards the margin; reticulation lax, subscalariform, obscure tor ather distinct beneath; petiole 6–12 mm, 1–2 mm ø, terete or adaxially flat. *Inflorescence* male or androgynous, in dense subterminal or axillary paniculate clusters, densely fulvous to rufous stellate hairy, hairs glandular; bracts and bracteoles ovate-acute, 1 by ⅔ mm. *Male rachis* 3–5 cm, 1½–2 mm ø; ♂ flowers solitary or in clusters of 2–3, filaments 2½–3 mm, anthers 0.25 mm long, pistillode globose, ⅔–1 mm ø. *Androgynous rachis* 3–4 cm, 2 mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, conical, 1–1½ mm, connate at the base. *Ripe cupule* sessile, cup-shaped, 1–1¼ cm long, 2–2¼ cm ø; rim thin, covering *c.* ¼ part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous to rufous stellate hairy; scales minute, adpressed or free, ovate, in concentric rows. *Ripe fruit* conical, 2½–3 cm long, 1½–2 cm ø, glabrous, dark chocolate-brown, top acute, base rotundate, scar flat to slightly convex, 1 cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak: twice collected from Lawas area, 5th Division; Sabah: common on Mt Kinabalu), S. and Central Celebes (scattered on Mts Lompobatang, Rante Mario, and Lumut).

Ecol. In montane mossy forests, at 1300–3000 m. *Fl. fr.* throughout the year, fruits ripe in June–July.

87. Lithocarpus sogerensis (S. MOORE) MARKGR. *ex* A. CAMUS, Chênes 3 (1954) 795, t. 415: 12–14; SOEPADMO, Reinwardtia 8 (1970) 279. — *Pasania sogerensis* S. MOORE, J. Bot. 61 (1923) Suppl. 54.

Tree 36 m, 80 cm ø; bark pale brown, finely fissured. *Branchlets* initially densely set with fulvous adpressed stellate hairs, later glabrous, greyish brown, sparsely lenticellate; terminal buds ovoid, 1–1½ by 1 mm, scales ovate-acute. Stipules ovate-acute, 1 by ⅔ mm. *Leaves* thin-coriaceous, (6–)8–10(–12) by (3–)4(–5) cm (index (2–)2.2–2.5 (–2.7)), broadest at or slightly below the middle; surfaces discolorous, above glabrous, chocolate-brown or greyish green, dull to glossy, beneath sparsely tomentose by pale greyish brown adpressed stellate hairs; base rounded-acute, top bluntly ½–1 cm acuminate; midrib thin, prominent beneath, flat above; nerves 8–10 pairs, thin, prominent beneath, flat to impressed above, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, lax, subscalariform, distinct beneath; petiole ⅔–1 cm, 1 mm ø, adaxially flat or furrowed. *Male rachis* 6–10 cm, 1–1½ mm ø, in dense paniculate clusters, densely fulvous tomentose by short stellate hairs; bracts and bracteoles ovate, 1½–2 by 1 mm; ♂ flowers in clusters of 3, perianth 5–7-lobed, recurved, stamens 10–12, filaments 2–2½ mm, anthers 0.35 mm long, pistillode subglobose, 1 mm ø. *Ripe cupule* solitary, rarely in clusters of 2–3, ⅔–1 cm stalked, cup-shaped 2 cm long, 2–3 cm ø, base gradually narrowed; rim thin, covering ¼–⅓ part of the fruit; scales mainly distinct on the upper half of the cupule, adpressed, set in concentric rows. *Ripe fruit* conical, 3 cm long, 2⅓ cm ø, glabrous, chocolate-brown, top acute, base rotundate, scar conical, 2 cm ø; wall woody, 3 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: New Guinea (scattered in the NE. parts).

Ecol. Forests, at 900–1600 m. *Fl.* March, *fr.* July-Oct.

88. Lithocarpus celebicus (MIQ.) REHD. J. Arn. Arb. 1 (1919) 123; A. CAMUS, Chênes 3 (1954) 903, t.; SOEPADMO, Reinwardtia 8 (1970) 227. — *Quercus celebica* MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 110; A. DC. Prod. 16, 2 (1864) 95; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 50, t. 45 A; ELMER, Leafl. Philip. Bot. 3 (1910) 938; MERR. En. Philip. 2 (1923) 26. — *Quercus llanosii* A. DC. Prod. 16, 2 (1864) 97; MERR. Philip. J. Sc. 3 (1908) Bot. 323; En. Philip. 2 (1923) 28. — *Cyclobalanus celebica* (MIQ.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Cyclobalanus llanosii* (A. DC.) OERST. *l.c.* 80; Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 375 ('*lanosii*'). — *Quercus companoana* VIDAL, Sinopsis Atlas (1883) 41, t. 92: D. — *Quercus dalbertisii* F. v. M. Vict. Natural. 1 (1884) 124, *ibid.* 1 (1885) 167. — *Quercus gulliveri* F. v. M. *l.c.* 167. — *Quercus pseudomolucca var. papuana* O. WARB. Bot. Jahrb. 13 (1891) 286; K. SCH. & LAUT. Fl. Schutzgeb. (1901) 263. — *Quercus brachyclada* VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 7. — *Quercus lipacon* ELMER, Leafl. Philip. Bot. 6 (1913) 1983; MERR. En. Philip. 2 (1923) 27. — *Synaedrys brachyclada* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 194. — *Synaedrys celebica* (MIQ.) KOIDZ. *l.c.* 194. — *Synaedrys d'albertisii* (F. v. M.) KOIDZ. *l.c.* 194. — *Synaedrys gulliveri* (F. v. M.) KOIDZ. *l.c.* 189. — *Synaedrys llanosii* (A. DC.) KOIDZ. *l.c.* 196. — *Quercus mabesae* MERR. Philip. J. Sc. 3 (1908) Bot. 7; En. Philip. 2 (1923) 28. — *L. lipacon* (ELMER) REHD. J. Arn. Arb. 1 (1919) 128; A. CAMUS, Chênes 3 (1954) 1114, t. — *L. llanosii* (A. DC.) REHD. J. Arn. Arb. 1 (1919) 128; A. CAMUS, Chênes 3 (1954) 757, t. — *Pasania aculeata* MARKGR. Bot. Jahrb. 59 (1924) 73, *excl.* SCHLECHTER 19296. — *Pasania d'albertisii* (F. v. M.) MARKGR. *l.c.* 74. — *Pasania companoana* (VIDAL) MARKGR. *l.c.* 78. — *Pasania papuana* (O. WARB.) MARKGR. *l.c.* 74. — *L. aculeata* (MARKGR.) REHD. J. Arn. Arb. 10 (1929) 132; A. CAMUS, Chênes 3 (1954) 914, t. — *L. d'albertisii* (F. v. M.) REHD. J. Arn. Arb. 10 (1929) 132; A. CAMUS, Chênes 3 (1954) 1154. — *L. papuana* (O. WARB.) REHD. J. Arn. Arb. 10 (1929) 133; A. CAMUS, Chênes 3 (1954) 1115, t. — *L. brachyclada* (VON SEEMEN) A. CAMUS, Bull. Soc. Bot. Fr. 90 (1943) 201; Chênes 3 (1954) 792, t. 413: 1–8. — *L. mabesae*

(MERR.) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 84; Chênes 3 (1954) 904, t.

Tree 10–33 m, 30–100 cm ø; buttresses up to 1 m tall and out; bark grey-brown, fissured to scaly. *Branchlets* initially densely yellowish brown to rufous short stellate hairy, later glabrous, grey-brown, finely fissured, sparsely lenticellate; terminal buds ovoid, 3–5 by 2–3 mm, scales narrowly ovate-acute, densely tomentose by adpressed stellate hairs. Stipules linear-acute, 3–4 by ½–1 mm. *Leaves* thin-coriaceous, (8–)12–16(–20) by (3–)4–6(–8) cm (index (2–)2½–3(–3½)), broadest at or below the middle; surfaces discolorous, above greyish brown, dull to glossy, sparsely pubescent, glabrescent, beneath with a thin cover of yellowish brown to greyish adpressed, minute, stellate hairs, on the midrib and nerves sometimes also with some erect stellate hairs; base rounded-acute to cuneate, decurrent, occasionally asymmetrical, top abruptly or gradually ½–2 cm acuminate, tip blunt or sharp; midrib thin, prominent on both sides; nerves (6–)8–10(–12) pairs, flat on both surfaces, subparallel, at an angle of 40–50°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform, lax, obscure; petiole subglabrous, ½–1 cm, 2 mm ø, adaxially flat or furrowed. *Inflorescence* male, androgynous or mixed, densely fulvous stellate hairy; bracts and bracteoles ovate-acute, 1–1½ by ⅔–1 mm. *Male rachis* 10–20 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode globose, 1 mm ø. *Androgynous* or *mixed rachis* 10–15 cm, 1–2 mm ø; *female flowers* solitary, very rarely in clusters of 2–3, staminodes rudimentary, styles 3, terete, 1½–2 mm, recurved. *Ripe cupule* sessile to ½ cm stalked, cup-shaped, ⅔–1 cm long, 2–3 cm ø; rim thin, covering *c.* ¼ part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely yellowish brown stellate hairy; scales ovate, adpressed, rather distinct but not free, in concentric rows or imbricate. *Ripe fruit* ovoid-conical, 2–2½ cm long, 1⅔–2⅓ cm ø, glabrous, chocolate-brown, top rounded-acute, rarely rotundate-apiculate, base rotundate, scar deeply concave, 1–1½ cm ø; wall woody, 2 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines, Celebes (scattered), Moluccas, New Guinea (also including Goodenough and Fergusson Is.).

Ecol. Forests, at 20–1200 m, commonly below 800 m, on clayey soil. *Fl.* Sept.–May, *fr.* June–April. In New Guinea usually as co-dominant forming an association with species of *Anisoptera* (*Dipt.*) and *Eugenia* (*Myrt.*).

89. Lithocarpus sundaicus (BL.) REHD. J. Arn. Arb. 1 (1919) 131; A. CAMUS, Chênes 3 (1954) 910, t. 448: 1–24; SOEPADMO, Reinwardtia 8 (1970) 282. — *Quercus sundaica* BL. Verh. Bat. Gen. K. & W. 9 (1823) 216; Bijdr. (1826) 520; Fl. Jav. Cupul. (1829) 11, t. 2, 3; MIQ. Fl. Ind. Bat. 1, 1 (1856) 850; A. DC. Prod. 16, 2 (1864) 89; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 11; HOOK. *f.* Fl. Br. Ind. 5 (1888) 611; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 51, t. 47, 48; K. & V. Bijdr. 10 (1904) 31; ELMER, Leafl. Philip. Bot. 3 (1910) 941; KOORD. Atlas 1 (1913) t. 51; MERR. En. Philip. 2 (1923) 31; CORNER, Ways. Trees (1940) 305; BACKER & BAKH. *f.* Fl. Java 2 (1965) 8. — *Quercus pruinosa* BL. Verh. Bat. Gen. K. & W. 9 (1823) 217, t. 5; Bijdr. (1826) 521; Fl. Jav. Cupul. (1829) 9, t. 1, *incl. var. β, l.c.* 10; ENDL. Gen. Pl. Suppl. 4, 2 (1847) 28; MIQ. Fl. Ind. Bat. 1, 1 (1856) 850; Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 107; A. DC. Prod. 16, 2 (1864) 87; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 56, t. 53B; K. & V. Bijdr. 10 (1904) 33. — *Castanea latifolia* BL. Bijdr. (1826) 526. — *Quercus muricata* ROXB. Fl. Ind. ed. Carey 3 (1832) 635. — *Quercus mappacea* KORTH. Kruidk. (1844) 202; MIQ. Fl. Ind. Bat. 1, 1 (1856) 850. — *Quercus korthalsii* BL. Mus. Bot. 1 (1850) 292, *non* ENDL. 1847; A. DC. Prod. 16, 2 (1864) 89; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 11. — *Quercus korthalsii* BL. *var. kajan* BL. Mus. Bot. 1 (1850) 293; A. DC. Prod. 16, 2 (1864) 89. — *Quercus korthalsii* BL. *var. mappacea* (KORTH.) BL. Mus. Bot. 1 (1850) 293; A. DC. Prod. 16, 2 (1864) 90. — *Quercus korthalsii* BL. *var. pachyphylla* BL. Mus. Bot. 1 (1850) 293; MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 107; A. DC. Prod. 16, 2 (1864) 90. — *Quercus pruinosa var. alpina* JUNGH. Java ed. 2, 1 (1853) 496. — *Quercus lamponga* MIQ. Sumatra (1861) 348; A. DC. Prod. 16, 2 (1864) 95; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 229; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 53, t. 49; CORNER, Ways. Trees (1940) 303, f. 96. — *Cyclobalanus lamponga* (MIQ.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Pasania pruinosa* (BL.) OERST. *l.c.* 83; S. MOORE, J. Bot. 63 (1925) Suppl. 114. — *Pasania sundaica* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 426; S. MOORE, J. Bot. 63 (1925) Suppl. 114. — *Pasania korthalsii* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83. — *Cyclobalanopsis muricata* (ROXB.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 379. — *Quercus pseudomolucca var. korthalsii* (BL.) WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 227. — *Quercus pseudomolucca var. pruinosa* (BL.) WENZIG, *l.c.* 227. — *Quercus pseudomolucca var. sundaica* (BL.) WENZIG, *l.c.* 227. — *Quercus grandifrons* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 610; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 49, t. 35 B; CORNER, Ways. Trees (1940) 303. — *Pasania lamponga* (MIQ.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 423, *excl. var.* — *Pasania grandifrons* (KING *ex* HOOK. *f.*) GAMBLE, *l.c.* 421. — *Synaedrys grandifrons* (KING *ex* HOOK. *f.*) KOIDZ. Bot. Mag. Tokyo 30 (1916) 195. — *Synaedrys lamponga* (MIQ.) KOIDZ. *l.c.* 196. — *Synaedrys pruinosa* (BL.) KOIDZ. *l.c.* 197. — *Synaedrys sundaica* (BL.) KOIDZ. *l.c.* 198. — *L. lamponga* (MIQ.) REHD. J. Arn. Arb. 1 (1919) 128; A. CAMUS, Chênes 3 (1954) 1107, t. 504: 9–20. — *L. pruinosa* (BL.) REHD. J. Arn. Arb. 1 (1919) 130; A. CAMUS, Chênes 3 (1954) 673, t. 383, 384: 1–16.

— *Quercus hystrix var. mappacea* (KORTH.) MERR. En. Born. (1921) 213. — *L. grandifrons* (KING *ex* HOOK. *f.*) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 1122, t. 507: 7–18.

Tree 10–36 m, 20–90 cm ø; bark grey-brown, fissured to scaly. *Branchlets* initially densely yellowish brown to fulvous tomentose by adpressed stellate hairs and woolly or erect tuft-hairs, later subglabrous, dark greyish brown, with numerous minute lenticels; terminal buds ovoid, 3–5 by 2–3 mm, scales narrowly ovate. Stipules narrowly ovate to linear, 5–10 by 2–3 mm. *Leaves* coriaceous (10–)12–16(–24) by (4–)5–6(–10) cm (index (2–) 2½–(–3)), broadest at or below the middle; surfaces discolorous, above greyish brown to dark chocolate-brown, initially with some woolly or erect tuft-hairs especially on the midrib and nerves, soon glabrescent, beneath densely yellowish brown to fulvous tomentose by adpressed stellate hairs interspersed with woolly or erect tuft-hairs; base rounded-acute, rarely acute, top acute to ½–2 cm acuminate, tip blunt or sharp; midrib strongly prominent on both sides; nerves (10–)12–14(–16) pairs, prominent beneath, flat above, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, lax, scalariform, obscure to distinct beneath; petiole 5–12 mm, 1½–3 mm ø, initially densely stellate hairy, glabrescent, adaxially flat or furrowed. *Inflorescence* male, androgynous or mixed, in dense, subterminal paniculate clusters, densely yellowish brown to fulvous stellate hairy; bracts and bracteoles narrowly ovate-acute, 1–1½ by ½–⅔ mm. *Male rachis* 10–15 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, stamens 10–12, filaments 2½–3 mm, anthers 0.25–0.3 mm long, pistillode globose, 1 mm ø. *Androgynous* or *mixed rachis* 10–15 cm, 1½–2 mm ø; *female flowers* solitary or rarely in clusters of 2–3, staminodes rudimentary, styles 3–4, terete, 1–2 mm, recurved. *Ripe cupule* sessile to ½–1 cm stalked, saucer-shaped, 3–6 mm long, (2–)2½(–3) cm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely fulvous-tomentose by adpressed, simple hairs, outside densely fulvous stellate hairy; scales adpressed, ovate, imbricate but concentrically set. *Ripe fruit* depressed-ovoid, 1⅓–2 cm long, (2–)2⅓ –2½(–3) cm ø, glabrous, dark chocolate-brown to purplish brown, top rounded-acute, base rotundate, scar concave to flat, 1½–2 cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. Peninsular Siam (rare), in *Malesia*: Sumatra (scattered), Malay Peninsula (common; also in Penang and Singapore), Java (common in the western part, scattered in the central and eastern parts, eastwards to Mts Ardjuno, Kawi, Tengger and Idjen), Borneo (scattered in Sarawak, Kalimantan, and Sabah), Philippines (Luzon, Mindoro, rare).

Ecol. Primary forests, from sea-level up to 2600 m, more commonly between 500–1500 m. In Central and E. Java confined to pockets of everwet forest at higher altitude. *Fl.* Sept.–July, *fr.* Aug.–March.

Notes. The typical form of this species occurs at 1000–1500 m, and is characterized by the relatively thin leaves with a thin indumentum. Specimens from higher localities (*Quercus pruinosa*) usually have a somewhat smaller but thicker leaf with a thicker indumentum, and larger cupule and fruit than those of the typical form.

Specimens from below 500 m, formerly included in *Quercus mappacea* and *Quercus grandifrons*, have larger leaves with less indumentum, smaller cupule and fruit than those of *L. sundaicus*. The nervation, reticulation, the type of indumentum, fruit and cupule are, however, very similar in the whole series of specimens.

The Sumatran specimens, formerly recognized as *Quercus lamponga*, have smaller, almost glabrous leaves, but again the type of the cupule and fruit is the same.

90. Lithocarpus pseudomoluccus (BL.) REHD. J. Arn. Arb. 1 (1919) 130; A. CAMUS, Chênes 3 (1954) 947, t. 456: 8–24; SOEPADMO, Reinwardtia 8 (1970) 269. — *Quercus pseudomolucca* BL. Verh. Bat. Gen. K. & W. 9 (1823) 214, t. 4; Bijdr. (1826) 519; Fl. Jav. Cupul. (1829) 14, t. 6; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 8, t. 5; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 43, t. 36; K. & V. Bijdr. 10 (1904) 26; KOORD. Atlas 1 (1913) t. 57; BACKER & BAKH. *f.* Fl. Java 2 (1965) 8. — *Quercus angustata* BL. Verh. Bat. Gen. K. & W. 9 (1823) 212, t. 3; Bijdr. (1826) 520; Fl. Jav. Cupul. (1829) 15, t. 7. — *Quercus pseudomolucca var. angustata* (BL.) BL. Mus. Bot. 1 (1850) 292; MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 108; A. DC. Prod. 16, 2 (1864) 86; OUDEM. Natuurk. Verh. Kon. Akad. 11 (1865) 9. — *Quercus thelecarpa* MIQ. Pl. Jungh. (1851) 9; Fl. Ind. Bat. 1, 1 (1856) 851. — *Quercus thelecarpa var. angustata* (BL.) MIQ. Pl. Jungh. (1851) 9; MIQ. Fl. Ind. Bat. 1, 1 (1856) 852. — *Quercus neurophylla* MIQ. Sumatra (1861) 351. — *Pasania pseudomolucca* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 83. — *Pasania neurophylla* (MIQ.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 379. — *Synaedrys pseudomolucca* (BL.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 197.

Tree 15–25 m, 60 cm ø; bark grey, fissured; stilt-roots and aerial roots occasionally present. *Branchlets* initially densely fulvous stellate hairy, later glabrous, greyish to blackish brown, with many large lenticels; terminal buds ovoid, 3–5 by 3–4 mm, scales ovate to linear. Stipules linear-acute, 4–8 by 1–1½ mm. *Leaves* coriaceous, (8–)13–17(–22) by (2½–) 5–6 (–8) cm (index 2–3), broadest about the middle; surfaces more or less discolorous, above glabrous, pale greyish green, glossy, underneath densely greyish to glaucous tomentose by adpressed stellate hairs; base rounded-acute to acute, margin recurved, top bluntly acute to sharply 1–2 cm acuminate; midrib strongly prominent on both sides; nerves 10–12 pairs, prominent beneath, flat above, subparallel, at an angle of 45–60°, arcuating

faintly anastomosing near the margin; reticulation subscalariform to irregular, distinct beneath; petiole ⅔–2 cm, 1–2 mm ø, adaxially flat or furrowed. *Inflorescence* male, female or mixed, densely fulvous stellate hairy; bracts and bracteoles narrowly ovate, 1–4 by ⅔–1 mm. *Male rachis* 10–20 cm, 1½–2 mm ø; ♂ flowers in clusters of 3, or solitary, filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Female* or *mixed rachis* 10–20 cm, 2 mm ø; ♀ flowers solitary or rarely in clusters of 3, staminodes rudimentary, styles 3, conical, 1½–2 mm. *Ripe cupule* sessile, saucer-shaped, 3–8 mm long, (2–)2½–3 (–3½) cm ø; rim thin, covering the basal part of fruit; wall woody, thin, inside densely greyish brown tomentose by adpressed, simple hairs, outside densely fulvous stellate hairy; scales distinct, imbricate or occasionally in more or less concentric rows. *Ripe fruit* depressed-subglobose or ovoid, 1½–2 cm long, 2–3 cm ø, glabrous except around the umbo, top acute or rounded and depressed at the centre, base cordate, scar flat, 1½–2½ cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Sumatra (rare), Java (mainly in the western part, eastwards to Mt Jang at 113° 30′ E).

Ecol. Forests, at 600–1700 m. *Fl.* April–June, *fr.* July–Dec.

Note. Records from the Malay Peninsula relate to *L. rassa*, and from New Guinea to *L. megacarpus*.

91. Lithocarpus submonticolus (ELMER) REHD. J. Arn. Arb. 1 (1919) 131; A. CAMUS, Chênes 3 (1954) 972; SOEPADMO, Reinwardtia 8 (1970) 280. — *Quercus submonticola* ELMER, Leafl. Philip. Bot. 3 (1910) 943; MERR. En. Philip. 2 (1923) 31. — *Quercus monticola* (*non* KING, *nec* PETZ. & KIRCHN.) ELMER, Leafl. Philip. Bot. 3 (1910) 942; *ibid.* 6 (1913) 1982; MERR. En. Philip. 2 (1923) 29.

Tree 7–13 m, 10–15 cm ø; bark grey, smooth. *Branchlets* initially densely tomentose by adpressed stellate hairs, later glabrous, greyish to blackish brown, densely lenticellate; terminal buds ovoid-ellipsoid, 2–4 by 1–2 mm, scales narrowly ovate-acute. Stipules linear-acute, 4–5 by 1 mm. *Leaves* thin-coriaceous, (3–)6–8(–10) by (2–)3–3½(–4) cm (index (2–)2½(–3)), broadest at or below the middle; above glabrous, greyish green to chocolate-brown, dull to glossy, beneath with a thin cover of adpressed, minute stellate hairs, sometimes interspersed with some erect stellate hairs especially on the midrib and nerves, dull pale brown to greyish brown; base rounded-acute to acute, top rounded-acute to 1 cm acuminate, tip usually oblique; midrib prominent on both sides; nerves 6–8 pairs, thin, flat on both surfaces to impressed above, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation subscalariform to irregular, obscure; petiole 5–8 mm, 1–1½ mm ø, adaxially flat or furrowed. *Inflorescence* male or androgynous, simple and axillary or much-branched and subterminal, densely fulvous stellate hairy; bract and bracteoles narrowly ovate-acute, 2–3 by ⅔–1 mm. *Male rachis* 5–10 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, filaments 3–3½ mm, anthers 0.3 mm long, pistillode globose, ⅔–1 mm ø. *Androgynous rachis* 3–8 cm, 1½ mm ø; *female flowers* solitary, staminodes rather well-developed but not exceeding the perianth, styles 3, conical, 1–1½ mm, recurved. *Ripe cupule* ½–⅔ cm stalked, cup-shaped, ⅔–1 cm long, 1½–2 cm ø; rim thick, covering ¼–⅓ part of the fruit; wall woody, 1–2 mm thick, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous tomentose to adpressed, minute, rather distinct on the upper half of the cupule, imbricate but set in concentric rows. *Ripe fruit* cylindrical to depressed subglobose, 1½–2¼ cm long, 1½–1¾ cm ø, densely fulvous tomentose by adpressed simple hairs, top acute or rounded-umbonate, base truncate, scar flat, 1–1⅓ cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Philippines (Luzon, common; Mindoro, rare).

Ecol. Forests, at 1000–1300 m. *Fl.* Sept.–May, *fr.* June–Dec.

92. Lithocarpus castellarnauianus (VIDAL) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 84; Rev. Bot. Appl. Trop. 25 (1945) 32; Chênes 3 (1954) 817; SOEPADMO, Reinwardtia 8 (1970) 226. — *Quercus castellarnauiana* VIDAL, Rev. Pl. Vasc. Filip. (1886) 264; MERR. Philip. J. Sc. 3 (1908) Bot. 326; En. Philip. 2 (1923) 26. — *Quercus merrittii* MERR. Philip. J. Sc. 3 (1908) Bot. 325; En. Philip. 2 (1923) 28. — *Quercus obliquinervia* MERR. Philip. J. Sc. 4 (1909) Bot. 250; En. Philip. 2 (1923) 29. — *Synaedrys castellarnauiana* (VIDAL) KOIDZ. Bot. Mag. Tokyo 30 (1916) 190. — *Synaedrys merrittii* (MERR.) KOIDZ. *l.c.* 192. — *Quercus cagayanensis* MERR. Philip. J. Sc. 13 (1918) Bot. 6; En. Philip. 2 (1923) 26. — *L. merrittii* (MERR.) REHD. J. Arn. Arb. 1 (1919) 128; A. CAMUS, Chênes 3 (1954) 818. — *L. obliquinervia* (MERR.) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 818. — *Quercus pinatubensis* ELMER, Leafl. Philip. Bot. 9 (1934) 3188. — *L. cagayanensis* (MERR.) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 256; Chênes 3 (1954) 819. — *L. pinatubensis* (ELMER) A. CAMUS, Chênes, Atlas 3 (1949) 117, t. 518: 15–18; Chênes 3 (1954) 804.

Tree 10–20 m, 20–30 cm ø. *Branchlets* initially densely fulvous to rufous tomentose by adpressed stellate hairs, later glabrous, greyish, sparsely to densely lenticellate; terminal buds ovoid, 3–4 by 2–3 mm, scales narrowly ovate-acute. Stipules ovate to lanceolate, 3–5 by 1–3 mm. *Leaves* thin-coriaceous, (9½–)13–17(–21) by (3½–)4½–6 (7½) cm (index 2.3–3), broadest at or rarely above the middle; above glabrous, dull to glossy, greyish green to chocolate-brown, beneath with a thin cover of greyish to glaucous adpressed, minute stellate hairs, subglabrescent; base rounded-acute to attenuate-acute, top 1–2½ cm acuminate, tip sharp, oblique; midrib prominent beneath, slightly so above, rather broad especially near the base; nerves (9–)10(–11) pairs, thin, prominent beneath,

Fig. 29. *Lithocarpus leptogyne* (KORTH.) SOEPADMO. A stilt-rooted tree locally common in Johore, S. Malaya (CORNER SF 28959; 1935).

flat above, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation dense, subscalariform, obscure to distinct beneath; petiole 7–11 mm, 1–3 mm ø, adaxially flat. *Inflorescence* male or androgynous, densely yellowish brown to fulvous stellate hairy; bracts and bracteoles ovate-acute, ½–1 by ½ mm. *Male rachis* 10–20 cm, 2 mm ø; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.3 mm long, pistillode globose, 1 mm ø. *Androgynous rachis* 10 cm, 1½–2 mm ø; *female flowers* solitary, rarely in clusters of 2, staminodes well-developed but not exceeding the perianth, styles 3, conical, 1 mm, strongly recurved. *Ripe cupule* 1 cm stalked, cup-shaped, ⅔–1 cm long, 2–2⅓ cm ø; rim thin, covering ¼–⅓ part of the fruit; scales ovate, minute, adpressed, in more or less concentric rows, distinct on the upper half of the cupule only. *Ripe fruit* cylindrical or ovoid, 2–2⅔ cm long, 1⅔–2 cm ø, densely fulvous tomentose by adpressed, simple hairs, top rounded-acute, base rounded, scar strongly convex, 1–1½ cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, common; Mindoro, Marinduque, Samar, Leyte, rare).

Ecol. Forests, at 200–2200 m. *Fl.* Jan.–May, *fr.* June–Dec.

93. Lithocarpus leptogyne (KORTH.) SOEPADMO, Reinwardtia 8 (1970) 254. — *Quercus leptogyne* KORTH. Kruidk. (1844) 206; A. DC. Prod. 16, 2 (1864) 93; A. CAMUS, Chênes 3 (1954) 1160. — *Cyclobalanus leptogyne* (KORTH.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 376. — *Quercus lamponga* (*non* MIQ.) HOOK. *f.* Fl. Br. Ind. 5 (1888) 611. — *Quercus conocarpa* (*non* OUDEM.) MERR. Pl. Elm. Born. (1929) 43. — **Fig. 29.**

Tree 10–40 m, 10–90 cm ø; buttresses up to 1½ m tall, 1⅓ m out, 10 cm thick; bark pale grey-brown, lenticellate. *Branchlets* initially densely fulvous tomentose by stellate hairs, later subglabrous, sparsely lenticellate; terminal buds ovoid-ellipsoid, 3–5 by 2–3 mm, scales narrowly ovate-acute. Stipules linear, 4–5 by ⅔–1 mm. *Leaves* thin-coriaceous, (8–)12–15(–18) by (3–)3½–5 (–5½) cm (index (2½–)2.7–3.3 (–3.6)), broadest at or above the middle; surfaces more or less discolorous, above dull, greyish green to pale chocolate-brown, sparsely stellate hairy especially on the midrib and nerves, underneath with a thin cover of pale yellowish brown to pale greyish green, adpressed, minute stellate hairs; base acute to rarely rounded, usually asymmetrical, top abruptly 1–1½ cm acuminate; midrib prominent on both sides; nerves 11–14 pairs, flat beneath, impressed above, subparallel at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, lax, subscalariform, obscure to rather distinct beneath; petiole 3–6 mm, 1–2 mm ø, densely tomentose by stellate hairs, shallowly furrowed. *Inflorescence* male, androgynous or mixed, densely greyish brown stellate hairy; bracts and bracteoles ovate, 1–1½ by ⅔–1 mm. *Male rachis* 10–15 cm, 1 mm ø, usually much-branched; ♂ flowers in clusters of 3, filaments 3–4 mm, anthers 0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 5–10 cm, 1 mm ø; *female flowers* solitary, staminodes rudimentary or well-developed and exceeding the perianth, styles 3, terete, 1–1½ mm, recurved. *Ripe cupule* ⅓ cm stalked, saucer-shaped, 3–6 mm long, 1.3–2 cm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely fulvous-tomentose by adpressed simple hairs, outside densely fulvous stellate hairy; scales adpressed, in 6–10 concentric rows. *Ripe fruit* depressed ovoid, 1.2–1.7 cm long, 1½–2 cm ø, densely fulvous tomentose by adpressed simple hairs, soon glabrescent, top rounded-acute, base rounded, scar deeply concave to rarely flat, 1 cm ø; wall woody, 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Sumatra (rare), Malay Peninsula (scattered), Borneo (rather common in Sarawak and Sabah).

Ecol. Forests, from sea-level up to 1500 m. *Fl.* Aug.–July, *fr.* Sept.–May.

94. Lithocarpus nieuwenhuisii (VON SEEMEN) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 255; Chênes 3 (1954) 732, t.; SOEPADMO, Reinwardtia 8 (1970) 262. — *Quercus nieuwenhuisii* VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 6. — *Quercus clementis* MERR. Philip. J. Sc. 3 (1908) Bot. 321; En. Philip. 2 (1923) 26. — *Pasania clementis* (MERR.) SCHOTTKY, Bot. Jahrb. 49 (1913) 358. — *Pasania ochracea* SCHOTTKY, *l.c.* 357. — *Synaedrys 'clementi'* (MERR.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 194. — *Synaedrys 'nieawenhuisii'* (VON SEEMEN) KOIDZ. *l.c.* 197. — *Quercus ochracea* (SCHOTTKY) MERR. En. Born. (1921) 214. — *Quercus borneensis* MERR. Philip. J. Sc. 21 (1922) 516; Pl. Elm. Born. (1929) 42. — *L. borneensis* (MERR.) REHD. J. Arn. Arb. 10 (1929) 132; A. CAMUS, Chênes 3 (1954) 956, t. 460: 11–19. — *L. clementis* (MERR.) A. CAMUS, Riviera Scient. 18 (1932) 39; Chênes 3 (1954) 983, t. 467: 16–22. — *L. ochracea* (SCHOTTKY) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 985. — *L. crateriformis* MERR. *ex* A. CAMUS, Chênes, Atlas 3 (1949) 97, t.; Chênes 3 (1954) 967.

Tree 5–25 m, 15–70 cm ø; buttresses and stilt-roots sometimes present; bark greyish brown, scaly, lenticellate. *Branchlets* initially densely yellowish brown to fulvous or rufous tomentose by long, erect simple hairs and adpressed stellate hairs, later subglabrous, greyish to blackish brown, sparsely lenticellate; terminal buds ovoid, 3–5 by 2–3 mm, scales narrowly ovate to linear. Stipules ovate to lanceolate, 5–6 by 2–3 mm. *Leaves* chartaceous to coriaceous, (9–)14–20(–23) by (3–)4–6 (–8) cm (index (2.6–)3–3½(–4)), broadest about the middle; surfaces discolorous, above glabrous, except the midrib and nerves, dull greyish green, rarely glossy, underneath dull chocolate-brown, rarely glossy, densely yellowish brown to rufous hairy by erect simple hairs and adpressed stellate hairs, glabrescent except the midrib and nerves; base attenuate-acute to rounded-acute, occasionally asymmetrical, top bluntly acute with emargin-

ate tip to sharply or bluntly 1–2 cm acuminate; midrib strongly prominent beneath, slightly so above; nerves (9–)10(–14) pairs, strongly prominent beneath, impressed above, subparallel, at an angle of 45–60°, arcuating and anastomosing near the margin; reticulation lax, subscalariform, distinct beneath; petiole densely fulvous to rufous stellate hairy, (3–)5–10(–12) mm, 1–3 mm ø, terete or adaxially flat. *Inflorescence* male, androgynous or mixed, densely fulvous to rufous stellate hairy; bracts and bracteoles ovate, 1–2 by ½–1 mm. *Male rachis* 10–15 cm, 1–1½ mm ø; ♂ flowers solitary, filaments 3–4 mm, anthers 0.3–0.35 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous* or *mixed rachis* 10–20 cm, 1½–2 mm ø; *female flowers* solitary, staminodes rather well-developed but not exceeding the perianth, styles 3, terete, 2–3 mm, strongly recurved. *Ripe cupule* subsessile, cup-shaped, 1⅓–2 cm long, 2–2⅔ cm ø; rim thin, erect and entire or undulate and recurved, covering ¼–⅓ part of the fruit; wall woody, thin, inside densely fulvous to rufous tomentose by adpressed stellate hairs, outside densely fulvous to rufous-tomentose by adpressed stellate hairs; scales minute, adpressed, imbricate or occasionally in more or less concentric rows. *Ripe fruit* ovoid-globose to cylindrical, 2–3 cm long, 1½–2 cm ø, densely greyish brown tomentose by adpressed simple hairs, subglabrescent, top rounded-acute to rotundate-apiculate, base truncate, scar deeply concave to flat, ½–1 cm ø; wall woody, 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (Sarawak, Kalimantan, Sabah, Brunei), also Nunukan Is.; Philippines (Mindanao, Basilan, rare).

Ecol. Forests, at low altitude, sometimes also in peat-swamp or heath forest, on sandy clayey to ultra-basic soil; usually along stream. *Fl. fr.* throughout the year.

95. Lithocarpus curtisii (KING *ex* HOOK. *f.*) A. CAMUS, Riviera Scient. 18 (1932) 40; Chênes 3 (1954) 1104, t. 503: 9–12; BARN. Trans. & Proc. Bot. Soc. Edinb. 33 (1942) 333; SOEPADMO, Reinwardtia 8 (1970) 233. — *Quercus curtisii* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 612; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 56, t. 52. — *Pasania curtisii* (KING *ex* HOOK. *f.*) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 429. — *Synaedrys curtisii* (KING *ex* HOOK. *f.*) KOIDZ. Bot. Mag. Tokyo 30 (1916) 194.

Tree 6–27 m, 25–60 cm ø; bark pale grey, lenticellate. *Branchlets* initially densely fulvous to rufous tomentose by adpressed stellate hairs, later glabrous, greyish brown, sparsely lenticellate; terminal buds ovoid, 1–1½ by ⅔ mm, scales narrowly ovate. *Leaves* thick-coriaceous, (12–)15–22 (–24) by (4–)5–7(–10) cm (index (2½–)3–3½(–4)), broadest at or below the middle; surfaces more or less concolorous, above glabrous, dull to glossy, pale greyish brown, underneath densely tomentose by adpressed minute, stellate hairs, glabrescent; base acute, rarely rounded, top bluntly or sharply 1–2 cm acuminate; midrib strongly prominent on both sides; nerves 9–11 pairs, prominent beneath, impressed above, subparallel, at an angle of 45–60°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform to irregular, obscure; petiole ½–1 cm, 1½–2½ mm ø, adaxially flat. *Inflorescence* male, androgynous or mixed, densely fulvous stellate hairy; bracts and bracteoles ovate-acute, ⅔–1 by ½ mm. *Male rachis* 5–15 cm, 1–1½ mm ø; ♂ flowers solitary, or rarely in clusters of 2–3, perianth 5–6-lobed, stamens 10–12, filaments 2½–3 mm, anthers 0.3 mm long, pistillode subglobose, 1 mm ø. *Androgynous* or *mixed rachis* 15–25 cm, 1½–2 mm ø; *female flowers* solitary, staminodes well-developed and exceeding the perianth, occasionally pollniferous, styles 3, conical, 1–1½ mm, recurved. *Ripe cupule* sessile, saucer-shaped, 3–5 mm long, 2–2⅔ cm ø; rim thin, undulate and recurved, covering the basal part of the fruit; wall woody, thin, inside densely greyish tomentose by adpressed simple hairs, outside densely fulvous stellate hairy; scales adpressed, obscure. *Ripe fruit* ovoid-globose, 1⅔–2½ cm long, 1⅓–2 cm ø, densely greyish tomentose by adpressed simple hairs, subglabrescent, top rounded-acute, base cordate, scar deeply concave, 1 cm ø; wall bony, thinner than 1 mm, for the greater part free from the cupule.

Distr. *Malesia*: Malay Peninsula (Perak, Selangor, Pahang, Trengganu, Kelantan, also Penang I.).

Ecol. Forests, below 300 m, on clayey soil. *Fl. fr.* June–Nov.

96. Lithocarpus scortechinii (KING *ex* HOOK. *f.*) A. CAMUS, Riviera Scient. 18 (1932) 42; Chênes 3 (1954) 894, t. 442: 5–10; BARN. Trans. & Proc. Bot. Soc. Edinb. 33 (1942) 333; SOEPADMO, Reinwardtia 8 (1970) 278. — *Quercus scortechinii* KING *ex* HOOK. *f.* Fl. Br. Ind. 5 (1888) 608; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 43, t. 35A; CORNER, Ways. Trees (1940) 304, f. 96. — *Pasania scortechinii* (KING *ex* HOOK. *f.*) SCHOTTKY, Bot. Jahrb. 47 (1912) 676; GAMBLE, J. As. Soc. Beng. 75, ii (1915) 418.— *Synaedrys scortechinii* (KING *ex* HOOK. *f.*) KOIDZ. Bot. Mag. Tokyo 30 (1916) 198. — *L. eriolepis* A. CAMUS, Bull. Soc. Bot. Fr. 84 (1937) 176; Chênes 3 (1954) 888, t. 448: 25–27. — *L. smitinandiana* A. CAMUS, Not. Syst. 14 (1952) 257; Chênes 3 (1954) 1270, f. 28: 5–8. — **Fig. 28d.**

Tree 15–20 m, 30–90 cm ø. *Branchlets* initially densely yellowish brown to fulvous tomentose by woolly stellate hairs, later glabrous, greyish brown, sparsely to densely lenticellate; terminal buds ellipsoid, 5–8 by 2–3 mm, scales linear-acute to lanceolate, densely yellowish brown erect stellate hairy. Stipules linear-acute, 5–6 by 1–2 mm. *Leaves* thick-coriaceous, rigid, (10–)14–16(–20) by 3–6 cm (index (2½–)3(–5)), broadest at or rarely below the middle; surfaces concolorous, glabrous, pale greyish green, dull beneath, glossy above; base acute, top bluntly acute to rounded, rarely 1–2 cm acuminate; midrib strongly prominent on both sides; nerves 8–10 pairs, thin, prominent beneath, impressed above, subparallel, at an angle of 45–50°, arcuating but not anastomosing to-

wards the margin; reticulation fine, subscalariform to irregular, obscure; petiole 10–13 mm, 2 mm ø, adaxially flat, towards the base gradually thickened and corky. *Inflorescence* male, androgynous or mixed, densely yellowish brown tomentose by adpressed stellate hairs; bracts and bracteoles ovate, 2–3 by 1 mm. *Male rachis* 10–25 cm, 1–1½ mm ø; ♂ flowers in clusters of 2–3, filaments 3–5 mm, anthers 0.3 mm long, pistillode subglobose, occasionally compressed, *c.* 1 mm ø. *Androgynous* or *mixed rachis* 10–20 cm, 2 mm ø; *female flowers* solitary or rarely in clusters of 2, staminodes rudimentary, styles 3, conical, 2 mm, recurved. *Ripe cupule* sessile, saucer-shaped, ½–1 cm long, 2½–3 cm ø; rim thin, incurved, covering the basal part of the fruit; wall woody, 1–2 mm thick, inside densely greyish brown tomentose by adpressed simple hairs, outside densely fulvous stellate hairy; scales subulate, 3–4 mm long, free, recurved or patent, densely but irregular set. *Ripe fruit* subglobose to cylindrical, 2½–4 cm long, 2–2¾ cm ø, glabrous, dark chocolate-brown, top rounded umbonate or rounded-acute, base rotundate or cordate, scar deeply concave, 1–1½ cm ø; wall woody, 2 mm thick, for the greater part free from the cupule.

Distr. Indo-China (Annam), Peninsular Siam (Pattani), in *Malesia*: Malay Peninsula (Perak, Kelantan, Pahang).

Ecol. Evergreen forests, at 700–1200 m. *Fl.* Dec., *fr.* April–Nov.

97. Lithocarpus kingianus (GAMBLE) A. CAMUS, Riviera Scient. 18 (1932) 41; Chênes 3 (1954) 678, t.; SOEPADMO, Reinwardtia 8 (1970) 250. — *Pasania kingiana* GAMBLE, Kew Bull. (1914) 117; J. As. Soc. Beng. 75, ii (1915) 417. — *Synaedrys kingiana* (GAMBLE) KOIDZ. Bot. Mag. Tokyo 30 (1916) 196. — Fig. 28 e–f.

Tree 12–20 m, 20–30 cm ø. *Branchlets* initially densely fulvous to rufous tomentose by woolly stellate hairs, later glabrous, greyish brown, sparsely lenticellate; terminal buds ovoid-globose, 2–4 by 1–2 mm, scales broadly ovate. *Leaves* coriaceous, 7–13 by 4–7 cm (index 1.7–2½), broadest at the middle; surfaces more or less concolorous, glabrous, dark greyish green, above glossy, beneath dull; base rounded-acute, top abruptly acute; midrib thin, prominent on both sides; nerves (4–)6–7(–8) pairs, prominent beneath, flat above, subparallel, at an angle of *c.* 45°, arcuating but usually not anastomosing towards the margin; reticulation fine, subscalariform to irregular, rather distinct beneath; petiole 4–8 mm, 1½–2 mm, glabrous, adaxially flat. *Inflorescence* male or androgynous, densely fulvous stellate hairy; bracts and bracteoles ovate-acute, ⅔–2 by ⅔–1 mm. *Male rachis* 10–20 cm, 2 mm ø; ♂ flowers solitary or in clusters of 2–3, stamens 8–12, filaments 2½–4 mm, anthers 0.3–0.4 mm long, pistillode subglobose, 1–1½ mm ø. *Androgynous rachis* 5–15 cm, 1½–2 mm ø; *female flowers* solitary, staminodes well-developed and exceeding the perianth, styles 3, terete, 2½–3½ mm, recurved. *Ripe cupule* sessile, cup-shaped, 2 cm long, 2½ cm ø; rim thin, covering ½–⅔ part of the fruit; wall woody, thin, inside and outside densely fulvous-tomentose; scales subulate, 4–5 mm long, free, recurved, spirally set. *Ripe fruit* ovoid, 2½ cm long, 2 cm ø, densely fulvous-tomentose by adpressed simple hairs, top rounded-acute, base truncate, scar flat, 1½ cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Malay Peninsula (Pahang).

Ecol. Forests, at 1350–2100 m. *Fl.* March–April, *fr.* May.

98. Lithocarpus luzoniensis (MERR.) REHD. J. Arn. Arb. 10 (1929) 133; A. CAMUS, Chênes 3 (1954) 1111, t.; SOEPADMO, Reinwardtia 8 (1970) 256. — *Quercus luzoniensis* MERR. Philip. J. Sc. 3 (1908) Bot. 323; En. Philip. 2 (1923) 28. — *Synaedrys 'luzonensis'* (MERR.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 197.

Tree 5–12 m, 20–30 cm ø. *Branchlets* initially angular, densely stellate hairy, later terete, glabrous, greyish black, densely lenticellate; terminal buds ovoid-ellipsoid, 3–5 by 2–3 mm, scales narrowly ovate to linear. Stipules linear-acute, 6–8 by 1 mm. *Leaves* thin-coriaceous, (3½–)5–6(–8) by (1½–)2½–3(–3½) cm (index 2–2.7), broadest at or below the middle; surfaces concolorous, greenish, above glabrous, dull to glossy, beneath with a thin cover of adpressed, minute, stellate hairs; base acute to rarely rounded-acute, margin recurved, top bluntly acute to 1–2 cm acuminate; midrib prominent beneath, slightly so above; nerves (6–)7–8(–10) pairs, thin, flat beneath, impressed above, parallel, at an angle of 40–50°, arcuating but not anastomosing towards the margin; reticulation fine, subscalariform to irregular, obscure; petiole 4–6 mm, 1 mm ø, adaxially flat. *Inflorescence* male or androgynous, simple and axillary or much-branched and subterminal, densely fulvous stellate hairy; bracts and bracteoles linear, 2–3 by ½–1 mm. *Male rachis* 3–5 cm, 1–1½ mm ø; ♂ flowers solitary or in clusters of 3, filaments 2–2½ mm, anthers 0.25–0.3 mm long, pistillode subglobose, 1 mm ø. *Androgynous rachis* 3–5 cm, 1–1½ mm ø; *female flowers* solitary, staminodes rather well-developed but not exceeding the perianth, styles 3, conical, 1 mm. *Cupule* (not fully developed) sessile, cup-shaped, ½–1 cm long, 1⅓–1½ cm ø; rim thin, covering *c.* ⅓ part of the fruit; wall woody, thin, inside densely silky tomentose by adpressed simple hairs, outside densely fulvous stellate hairy; scales distinct, narrowly ovate, 1 mm long, imbricate but concentrically set. *Ripe fruit* ovoid, 1½ cm long, 1 cm ø, glabrous, chocolate-brown, top acute, base rotundate, scar flat to concave, 7 mm ø; wall woody 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Philippines (Luzon, rather common on Mts Pulog, Pauai, Data, and Nangaoto).

Ecol. Forests, at 1500–2700 m. *Fl.* Jan.–June, *fr.* July–March.

99. Lithocarpus echinulatus SOEPADMO, Reinwardtia 8 (1970) 235.

Tree 25–40 m, 50–80 cm ø; buttresses 1–2 m tall and out, concave; bark smooth, pale greyish brown. *Branchlets* initially densely tomentose by adpressed stellate hairs, later subglabrous, dull grey-brown, sparsely lenticellate; terminal buds ovoid, 3–4 by 2–3 mm, scales narrowly ovate. *Leaves* thin-coriaceous, (9–)13–18(–21) by (3–)4–6(–7) cm (index 3–3½), broadest at the middle; surfaces concolorous, dull greyish green, above glabrous, beneath densely tomentose by adpressed, minute stellate hairs; base attenuate-acute, top sharply 1–1½ cm acuminate; midrib prominent beneath, flat above; nerves 7–9 pairs, prominent beneath, impressed above, subparallel, at an angle of 30–45°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure; petiole ¾–1½ cm, 1–2 mm ø, adaxially flat. *Ripe cupule* sessile, saucer-shaped, ⅓–½ cm long, 2–2½ cm ø; rim thin, undulate, covering the basal part of the fruit; wall woody, thin, insides densely silky tomentose by adpressed simple hairs, outside densely fulvous tomentose by adpressed stellate hairs; scales subulate, 1–2 mm long, free, patent, densely but irregular set. *Ripe fruit* depressed ovoid-globose, 1–1½ cm long, 1½–2⅓ cm ø, densely greyish tomentose by adpressed simple hairs, glabrescent, top abruptly rounded-apiculate, base rounded, scar flat, 1½ cm ø; wall woody, 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Borneo (scattered in SE. Kalimantan and Sabah).

Ecol. Forests, below 300 m, on sandy loamy soil. *Fr.* April–Aug.

Note. Inflorescences as yet unknown.

100. Lithocarpus jordanae (LAGUNA) REHD. J. Arn. Arb. 1 (1919) 127; A. CAMUS, Chênes 3 (1954) 981, t.; SOEPADMO, Reinwardtia 8 (1970) 250. — *Quercus jordanae* LAGUNA, Apuntes Roble Filip. (1875) 7, t.; VIDAL, Rev. Pl. Vasc. Filip. (1886) 265; MERR. Philip. J. Sc. 3 (1908) Bot. 322, *excl. syn.*; En. Philip. 2 (1923) 27, *excl. syn.* — *Quercus sundaica* (*non* BL.) MERR. Philip. J. Sc. 1 (1906) Suppl. 41. — *Synaedrys jordanae* (LAGUNA) KOIDZ. Bot. Mag. Tokyo 30 (1916) 196.

Tree 5–12 m, 20–30 cm ø; bark greyish brown, smooth, lenticellate. *Branchlets* initially densely set with yellowish brown to fulvous velvety, simple and adpressed stellate hairs, later glabrous, dark greyish brown, finely fissured and densely lenticellate; terminal buds ovoid, 3–5 by 2–3 mm, scales broadly ovate. Stipules ovate-acute, 4–5 by 2–3 mm, longitudinally ribbed and rather long persistent. *Leaves* thick-coriaceous, rigid, (4–)6–8(–10) by (3–)4–5(–6) cm (index (1.3–)1.7(–2)), broadest at or below the middle; surfaces discolorous, above dark chocolate-brown, dull to glossy, sparsely stellate pubescent especially on the midrib and nerves, beneath densely set with yellowish brown, adpressed stellate and erect simple or stellate hairs; base acute to rounded-acute, sometimes asymmetrical, margin strongly recurved, sometimes undulate, top bluntly acute to abruptly ½–1 cm acuminate; midrib and nerves strongly prominent beneath, flat to impressed above; nerves 8–10 pairs, dense, parallel, at an angle of 40–60°, arcuating but not anastomosing towards the margin; reticulation fine, dense, scalariform, obscure to distinct beneath; petiole 5–7 mm, 2–3 mm ø, densely stellate pubescent, glabrescent, adaxially flat. *Inflorescence* male or androgynous, densely yellowish to fulvous stellate hairy; bracts and bracteoles narrowly ovate-acute, 1–4 by ½–1 mm. *Male rachis* 5 cm, 1–1½ mm ø; ♂ flowers in clusters of 3, filaments 2½–3 mm, anthers 0.3–0.35 mm long, pistillode globose, 1 mm ø. *Androgynous rachis* 3–4 cm, 1–1½ mm ø; *female flowers* solitary, staminodes rudimentary, styles 3, terete, 1–1½ mm, recurved. *Ripe cupule* subsessile, cup-shaped, ½–1 cm long, 2–2½ cm ø; rim thin, covering *c.* ⅓ part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous adpressed stellate hairy; scales linear, 5 mm long, free, irregularly set or in obscure concentric rows. *Ripe fruit* ovoid-conical, 2–2½ cm long, 1½–2 cm ø, glabrous, chocolate-brown, top rounded-acute, base rotundate, scar flat, 1 cm ø; wall woody, 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, rather common).

Ecol. Forests, at 1200–2400 m. *Fl.* Jan.–July, *fr.* Aug.–April.

Note. VIDAL 1814, placed by STAPF (1894) under his *Quercus havilandii*, belongs here.

101. Lithocarpus aspericupula (MARKGR.) REHD. J. Arn. Arb. 10 (1929) 123; A. CAMUS, Chênes 3 (1954) 903, t.; SOEPADMO, Reinwardtia 8 (1970) 217. — *Pasania aspericupula* MARKGR. Bot. Jahrb. 59 (1924) 78, f. 1 E.

Tree, *c.* 10 m tall. *Branchlets* initially densely fulvous tomentose by adpressed stellate hairs, later subglabrous, dark brown, densely lenticellate; terminal buds ovoid, 3 by 3 mm, scales ovate. Stipules ovate, 3 by 2 mm. *Leaves* coriaceous, elliptic-oblong, 8–14 by 4–6 cm; surfaces discolorous, above glabrous except the midrib, glossy, chocolate-brown, beneath densely yellowish tomentose by adpressed stellate hairs interspersed by erect, brownish tuft-hairs; base rounded-acute, top rounded and abruptly, sharply ½–1 cm acuminate; midrib prominent on both sides; nerves 8–10 pairs, prominent beneath, impressed above, subparallel, at an angle of *c.* 50°, arcuating but not anastomosing towards the margin; reticulation lax, arched, subscalariform, distinct beneath; petiole 7–10 mm, 2 mm ø, densely stellate pubescent, glabrescent, adaxially flat. *Cupule* (? ripe) ½ cm stalked, saucer-shaped, ½ cm long, 1½–1⅔ cm ø, rim thin, covering the basal part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely yellowish tomentose by adpressed stellate hairs; scales ovate to subulate with pointed tips, recurved, 2–4 mm long, irregular set. *Fruit* ovoid, 1½–1⅔ cm

long, 1½ cm ø, glabrous, chocolate-brown, top rounded-acute, base rounded, scar concave, 7 mm ø; wall woody, 1 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: New Guinea (Vogelkop Peninsula and Sepik area).

Ecol. Forests, up to 250 m, on sandy clayey soil overlying limestone. *Fl.* Sept., *fr.* March.

Notes. The male inflorescence in LEDERMANN's specimens is too badly preserved for description.

The fruiting specimen BW 15331 agrees very well with MARKGRAF's drawing of the cupule and fruit of LEDERMANN 11523 (†) but for the smaller size, which was cited by MARKGRAF (nuts up to 3 by 2½ cm); the leaves perfectly agree with those of LEDERMANN 8729 (WRSL).

102. Lithocarpus buddii (MERR.) A. CAMUS, Bull. Soc. Bot. Fr. 90 (1943) 85; Chênes 3 (1954) 846, t. 428; SOEPADMO, Reinwardtia 8 (1970) 222. — *Quercus robinsonii* MERR. Philip. J. Sc. 10 (1915) Bot. 287; En. Philip. 2 (1923) 30, *non* RIDL. 1914. — *Synaedrys robinsonii* (MERR.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192. — *L. robinsonii* MERR. J. Arn. Arb. 1 (1919) 130. — *Quercus buddii* MERR. Philip. J. Sc. 35 (1928) 6.

Tree 10–25 m, 25–40 cm ø. *Branchlets* initially densely rufous pubescent with adpressed and erect, stellate and simple hairs, later glabrous, dark greyish brown, finely fissured, sparsely lenticellate; terminal buds ovoid, 3–5 by 2–4 mm, scales linear-acute. Stipules linear-acute, 5–10 by 1–1½ mm. *Leaves* thin-coriaceous, (6–)10–14(–17) by (2½–)3½–5(–7) cm (index (2–)2.3–2.8(–3)), broadest at or below the middle; surfaces discolorous, above dull to glossy, greyish brown, initially densely rufous pubescent by stellate hairs, soon glabrescent, beneath densely rufous tomentose by adpressed and erect stellate hairs, later subglabrous; base acute, top bluntly 1–1½ cm acuminate; midrib strongly prominent beneath, slightly so to flat above; nerves (6–)7–8(–9) pairs, thin, prominent beneath, flat above, subparallel, at an angle of 45–50°, arcuating but not anastomosing towards the margin; reticulation fine, dense, subscalariform, obscure; petiole ½–1 cm, 1–1½ mm ø, adaxially flat. *Inflorescence* male or androgynous, simple and axillary or much-branched and subterminal, densely rufous stellate hairy; bracts and bracteoles linear-acute, 2–5 by ½–1 mm. *Male rachis* 8–15 cm, 1–1½ mm ø; ♂ flowers solitary or in clusters of 2–3, stamens 10–12, filaments 2–3 mm, anthers 0.25–0.3 mm long, pistillode globose, 1 mm ø. *Androgynous rachis* 6–17 cm, 1½ mm ø; *female flowers* solitary or very rarely in clusters of 2–3, staminodes rudimentary, styles 3–4, terete, 2–3 mm, recurved. *Ripe cupule* subsessile, cup-shaped, ½–1 cm long, 1½–2 cm ø; rim thin, covering the basal part of the fruit; wall woody, thin, inside densely fulvous tomentose by adpressed simple hairs, outside densely rufous tomentose by adpressed stellate hairs; scales subulate, recurved, 2–4 mm long, free, in 4–6 concentric rows. *Ripe fruit* depressed ovoid, 1½–1⅔ cm long, 1½–2 cm ø, glabrous, chocolate-brown, top rounded-acute, base rotundate, scar flat to concave, 1 cm ø; wall woody, 1 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: Philippines (Luzon, common on Mt Maquiling; Samar, rare; Leyte, rare).

Ecol. Forests, at 200–900 m. *Fl.* Oct.–June, *fr.* June–Dec.

103. Lithocarpus rufovillosus (MARKGR.) REHD. J. Arn. Arb. 10 (1929) 133; A. CAMUS, Chênes 3 (1954) 807, t.; SOEPADMO, Reinwardtia 8 (1970) 276. — *Pasania rufovillosa* MARKGR. Bot. Jahrb. 59 (1924) 74, f. 3, 4: B–C.

Tree 15–40 m, 20–60 cm ø; bark pale to dark grey-brown, fissured to scaly. *Branchlets* initially densely fulvous to rufous-tomentose by adpressed stellate hairs and woolly tuft-hairs, later subglabrous, dark grey-brown, sparsely lenticellate; terminal buds ovoid, 3–5 by 2–3 mm, scales ovate. Stipules ovate to lanceolate, 3–5 by 2 mm. *Leaves* coriaceous, (6–)10–15(–18) by (3–)4–6(–8) cm (index (2–)2½(–3½)), broadest at or below the middle; surfaces more or less discolorous, above greyish brown to dark chocolate-brown, dull to rarely glossy, initially sparsely pubescent by erect, woolly tuft-hairs especially on the midrib and nerves, soon glabrescent, beneath densely set with a thick cover of fulvous to rufous, adpressed stellate hairs and woolly tuft-hairs, the latter subglabrescent; base rounded-acute, very often asymmetrical, margin occasionally strongly recurved, top rounded and abruptly acute to more commonly ½–1½ cm acuminate, tips sharp, often oblique; midrib strongly prominent on both sides; nerves 9–11 pairs, prominent beneath, flat to impressed above, subparallel, at an angle of (45–)60–70°, arcuating but not anastomosing towards the margin; reticulation lax, subscalariform, rather distinct beneath; petiole ½–1 cm, 1½–3 mm ø, terete, densely rufous pubescent. *Inflorescence* male or androgynous, in densely subterminal paniculate clusters, densely rufous stellate hairy; bracts and bracteoles ovate-acute, 1–2½ by ⅔–1 mm. *Male rachis* 7–15 cm, 2 mm ø; ♂ flowers in clusters of 3, stamens 10–12, filaments 2½–3 mm, anthers 0.3–0.4 mm long, pistillode subglobose, 1 mm ø. *Androgynous rachis* 5–10 cm, 2 mm ø; *female flowers* solitary, very rarely in clusters of 2–3, staminodes rather well-developed but not exceeding the perianth, styles 3–4, terete, 1½–2 mm, recurved. *Ripe cupule* sessile, cup-shaped, 1–2½ cm long, 2–3(–3½) cm ø; rim 1 mm thick, covering the basal part of the fruit; wall woody, 1–2 mm thick, inside densely fulvous tomentose by adpressed simple hairs, outside densely fulvous to rufous tomentose by adpressed stellate hairs; scales ovate with pointed, subulate tips, 1–3 mm long, alternate but concentrically set. *Ripe fruit* ovoid-conical, 2–3 cm long, 2–2½ cm ø, glabrous, chocolate-brown, top rounded, base rotundate, scar concave, 1½ cm ø; wall bony, 2–3 mm thick, for the greater part free from the cupule; cotyledons flat-convex.

Distr. *Malesia*: New Guinea (common in all parts), also Japen and Misool Is.

Ecol. Forests, from sea-level up to 2300 m, more commonly above 700 m, on sandy or clayey soils. *Fl.* Sept.–June, *fr.* July–April.

Note. Specimens from above 1000 m usually have a thicker and darker indumentum and a larger cupule and fruit than those from the lowlands.

104. Lithocarpus hystrix (KORTH.) REHD. J. Arn. Arb. 1 (1919) 127; A. CAMUS, Chênes 3 (1954) 856, t. 432: 5–22; SOEPADMO, Reinwardtia 8 (1970) 246. — *Quercus hystrix* KORTH. Kruidk. (1844) 201, t. 43; MIQ. Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 108; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 223; HOOK. *f.* Fl. Br. Ind. 5 (1888) 611; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 54, t. 50; CORNER, Ways. Trees (1940) 303, f. 96. — *Quercus korthalsii* BL. *var. hystrix* (KORTH.) BL. Mus. Bot. 1 (1850) 293; A. DC. Prod. 16, 2 (1864) 90. — *Quercus mappacea var. hystrix* (KORTH.) MIQ. Fl. Ind. Bat. 1, 1 (1856) 851. — *Quercus cyrtopoda* MIQ. *ibid.* 1, 1 (1858) 869; A. DC. Prod. 16, 2 (1864) 97; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 86. — *Castanea furfurella* MIQ. Sumatra (1861) 352. — *Cyclobalanus hystrix* (KORTH.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81. — *Cyclobalanus cyrtopoda* (MIQ.) OERST. *l.c.* 80. — *Quercus brevipetiolata* SCHEFF. Nat. Tijd. N. I. 31 (1870) 359. — *Pasania hystrix* (KORTH.) GAMBLE, J. As. Soc. Beng. 75, ii (1915) 428. — *Synaedrys hystrix* (KORTH.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 195. — *L. cyrtopoda* (MIQ.) A. CAMUS, Chênes, Atlas 3 (1949) 74, t.; Chênes 3 (1954) 753.

Tree 10–30 m, 20–90 cm ø; bark pale-brown. *Branchlets* densely set with fulvous to rufous erect tuft-hairs with 2-many arms, later subglabrous, dark greyish brown, finely fissured, sparsely to densely lenticellate; terminal buds ovoid, 3–5 by 2–3 mm, scales ovate. Stipules broadly ovate to lanceolate, 3–10 by 2–5 mm, rather long persistent. *Leaves* thin-coriaceous, (12–)14–18(–20) by (5–)6–7(–8) cm (index 2–3), broadest at the middle; surfaces discolorous, above dark brown, densely pubescent especially on the midrib and nerves, subglabrescent, dull to glossy, beneath densely set with fulvous to rufous, adpressed stellate hairs and erect tuft-hairs; base rounded, margin occasionally strongly recurved, top rounded and abruptly acute to ½–1 cm acuminate; midrib strongly prominent on both sides; nerves 12–16 pairs, strongly prominent beneath, flat to impressed above, parallel, at an angle of 50–60°, arcuating and anastomosing near the margin; reticulation dense, scalariform, distinct beneath; petiole ½–1 cm, 2 mm ø, terete or adaxially flat, densely fulvous to rufous pubescent. *Inflorescence* male, androgynous or mixed, in densely subterminal paniculate clusters, densely fulvous to rufous pubescent; bracts and bracteoles narrowly ovate, 1–1½ by ½–⅔ mm. *Male rachis* 5–15 cm, 1–2 mm ø; ♂ flowers solitary or in clusters of 2–3, filaments 2–3 mm, anthers 0.25–0.3 mm long, pistillode globose, 1 mm ø. *Androgynous* or *mixed rachis* 10–20 cm, 2 mm ø; *female flowers* solitary, rarely in clusters of 2–3, staminodes rudimentary, styles 3–4, conical, 1–1½ mm, recurved. *Ripe cupule* sessile to ½ cm stalked, saucer- to cup-shaped, ½–1 cm long, 2–3 cm ø; rim thin, covering the basal part of the fruit; wall woody, 2–3 mm thick, inside densely fulvous tomentose by adpressed, simple hairs, outside densely fulvous to rufous tomentose by adpressed stellate hairs; scales subulate, 3–5 mm long, patent or recurved, more or less concentrically set. Young fruit with a long acuminate top. *Ripe fruit* depressed-ovoid, 1½–2 cm long, 2–3 cm ø, glabrous, dark purplish brown, top rounded-acute to rounded-acuminate, base rotundate, scar flat to concave, 1½–2 cm ø; wall woody, 1–2 mm thick, for the greater part free from the cupule.

Distr. *Malesia*: Sumatra (common; also in Simalur, Riouw, and Karimun Is.), Malay Peninsula (Perak, Selangor, Negri Sembilan, Pahang, Malacca, Johore; also in Penang and Singapore), Borneo (scattered in SE. Kalimantan).

Ecol. Forests, from sea-level up to 1800 m, mostly below 800 m. *Fl.* Sept.–July, *fr.* Aug.–June.

Doubtful

Lithocarpus argyrocarpa A. CAMUS, Bull. Soc. Bot. Fr. 94 (1947) 4; Chênes 3 (1954) 806, t. 417: 9–15.

KEP 21712 (type, K!) with young cupules and fruits, was collected in the border area between Kedah (Malay Peninsula) and Siam. Except for the smaller size, the cupules, fruits and leaves, it very closely resembles specimens of *L. sootepensis* (CRAIB) A. CAMUS from Doi Angka in Siam. More material of both species is, however, needed to draw a definite conclusion.

Lithocarpus debaryana (O. WARB.) MARKGR. Bot. Jahrb. 59 (1924) 69; A. CAMUS, Chênes 3 (1954) 608. — *Quercus debaryana* O. WARB. Bot. Jahrb. 13 (1891) 286; VON SEEMEN in K. Sch. & Laut. Fl. Schutzgeb. (1901) 263. — *Synaedrys debaryana* (O. WARB.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 189.

When WARBURG described this species from E. New Guinea, he did not indicate any particular specimen on which he based his new species. He described the leaves as 18 by 9 cm, and the cupule 4 cm long, 3½ cm ø, narrowed at the base and covering the fruit almost completely. MARKGRAF mentioned WARBURG 20584 (consisting of one leaf and one fruit) from Sattelberg in the NE. part of New Guinea as the type, and added HELLWIG 515, also from Sattelberg. Both specimens were lost during the World War II. Among the later collections from the same area, CLEMENS 11360 (Eot-Wonimbu, Morobe Distr.) is the only specimen of which the cupules and fruits agree with WARBURG's description. The cupule and nut show some resemblance in size to those of 38. *L. lauterbachii* (VON SEEMEN) MARKGR. but

are clearly different. It seems a good species but more material is needed for its proper definition of the inflorescence and foliage. The leaves (collected from a basal shoot) are, however, much smaller than those described by WARBURG, the largest being 12 by 5 cm.

Lithocarpus dolichocarpa (VON SEEMEN) REHD. J. Arn. Arb. 1 (1919) 125; A. CAMUS, Chênes 3 (1954) 801. — *Quercus dolichocarpa* VON SEEMEN, Bot. Jahrb. 27, Beibl. 64 (1900) 14; K. & V. Bijdr. 10 (1904) 44; KOORD. Atlas 1 (1913) t. 50; BACKER & BAKH. *f.* Fl. Java 2 (1965) 8. — *Synaedrys dolichocarpa* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 191.

Except for the smaller size of the cupule, fruit and leaf, the species which is based on Javanese specimens is suggestive of 47. *L. daphnoideus* (BL.) A. CAMUS. The specimens which I have seen are, however, far too incomplete for a final decision.

Lithocarpus menadoensis (KOORD.) SOEPADMO, Reinwardtia 8 (1970) 290. — *Quercus menadoensis* KOORD. in Koord.-Schum. Syst. Verz. 3 (1914) 28, *nomen.*

KOORDERS 16632 from Minahassa (NE. Celebes), the type, now preserved in the Rijksherbarium, Leyden, has glabrous leaves, 10–12 by 3–4½ cm, with 6–7 pairs of nerves, irregular reticulation, and a cupule 1 cm long and 1.7 cm ø, with 5–6 obscure denticulate lamellae. The fruit is ovoid, *c.* 1½ cm through, glabrous and chocolate-brown. There are, at Leyden, several other collections mainly from the vicinity of Malili, Central Celebes, which resemble KOORDERS 16632, but unfortunately most of them are sterile. The species is suggestive of 43. *L. caudatifolius* (MERR.) REHD. from Borneo and the Philippines, but in the latter the leaves and branchlets are densely velvety tomentose.

Lithocarpus moluccus (RUMPH. *ex* L.) SOEPADMO, Reinwardtia 8 (1970) 290. — *Quercus molucca* [RUMPH. Herb. Amb. 3 (1743) 85, t. 56 *ex*] LINNÉ, Sp. Pl. (1753) 1199; WILLD. Sp. Pl. 4, 1 (1809) 427; BL. Mus. Bot. 1 (1850) 291; MIQ. Fl. Ind. Bat. 1, 1 (1856) 849; A. DC. Prod. 16, 2 (1864) 86; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 90; MERR. Int. Rumph. (1917) 186; A. CAMUS, Chênes 3 (1954) 1163. — *Balanaulax molucca* (RUMPH. *ex* L.) RAFIN. Alsog. Am. (1838) 25. — *Pasania molucca* (RUMPH. *ex* L.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 373.

See notes under 50. *L. glutinosus* (BL.) SOEPADMO.

Lithocarpus 'nymanniana' (MARKGR.) REHD. J. Arn. Arb. 10 (1929) 133; A. CAMUS, Chênes 3 (1954) 1164. — *Pasania nymaniana* MARKGR. Bot. Jahrb. 59 (1924) 77.

The species was described from a specimen (NYMAN 692, New Guinea, *n.v.*) with a very young cupule and fruit. As the type seems to be lost, and the description is not recognizable, the species is treated as doubtful.

Lithocarpus oogyne (MIQ.) A. CAMUS, Bull. Soc. Bot. Fr. 92 (1945) 255; Chênes 3 (1954) 781. — *Quercus oogyne* MIQ. Sumatra (1861) 351; A. DC. Prod. 16, 2 (1864) 95; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 92. — *Cyclobalanus oogyne* (MIQ.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 81.

DIEPENHORST HB 1315 (type, U!) from Priaman, NW. Sumatra, has very young cupules and fruits which are suggestive of 89. *L. sundaicus* REHD., though the leaves (badly preserved) are much smaller and less pubescent. MIQUEL compared his species with *Quercus blumeana* KORTH. and *Quercus encleisacarpa* KORTH., which are, however, two completely different species.

Lithocarpus plumbea (BL.) SOEPADMO, Reinwardtia 8 (1970) 291. — *Quercus plumbea* BL. Mus. Bot. 1 (1850) 293; A. DC. Prod. 16, 2 (1864) 88; A. CAMUS, Chênes 3 (1954) 1166. — *Pasania plumbea* (BL.) OERST. Vid. Medd. Naturh. For. Kjöbn. 8 (1867) 84.

The type (? KORTHALS *s.n.*, Sumatra) now preserved at Leyden, has very young cupules and fruits which resemble those of 89. *L. sundaicus* REHD. The leaves are, however, smaller and less pubescent than those of *L. sundaicus.*

4. QUERCUS[1]

LINNÉ, Gen. Pl. ed. 5 (1754) 431; A.DC. Prod. 16, 2 (1864) 2, *p.p., excl. sect. Androgyne, Chlamydobalanus, Cyclobalanus, Lithocarpus et Pasania*; B. & H. Gen. Pl. 3 (1880) 407, *p.p., excl. ditto et sect. Synaedrys*; HOOK. *f.* Fl. Br. Ind. 5 (1888) 600, *p.p., excl. ditto*; PRANTL in E. & P. Nat. Pfl. Fam. 3, 1 (1889) 55; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 19, *p.p., excl. ditto*; A. CAMUS, Chênes 1 (1938) 7; BARNETT, Trans. & Proc. Bot. Soc. Edinb. 33 (1942) 329; HUTCHINSON, Gen. Fl. Pl. 2 (1967) 13; SOEPADMO, Gard. Bull. Sing. 22 (1968) 355. — *Cyclobalanopsis* OERST. Vid. Medd. Nat. For. Kjöbn. 8 (1867) 77. — **Fig. 32–34.**

(1) This generic description covers only the Malesian species.

Trees, sometimes buttressed, rarely with small stilt-roots. Branchlets initially densely tomentose by simple or stellate hairs, or densely brownish, stiff pubescent, glabrescent; terminal buds ovoid-globose or ovoid-conical, rarely ovoid-ellipsoid, usually conferted, scales densely fulvous-tomentose, with a tendency to orthostichy. Stipules extrapetiolar, linear-acute, densely tomentose or woolly pubescent, caducous. *Leaves* spirally arranged, crowded near the top of the branchlets, or rarely pseudo-whorled; midrib and nerves flattened or impressed or slightly raised above, prominent beneath; margin entire or remotely minutely serrate in the apical half; glabrous to densely pubescent or tomentose (sometimes by stellate hairs) at least on the lower surface; petiole thickened at base. *Inflorescence* male or female. *Male rachis* solitary in the axil of a lower leaf or in paniculate clusters on the lateral or subterminal new shoots, flexuous, pendent, compound or simple; bracts ovate-linear, acute, densely tomentose, caducous; ♂ flowers in clusters of 3–4; perianth (4–)6-lobed, the lobes connate at base, densely tomentose; stamens (4–)6(–9), filaments slender, filiform, glabrous or tomentose at base, anthers ½–1 mm long, basifixed; pistillode normally absent, sometimes replaced by a tuft of stiff simple hairs. *Female rachis* solitary in the axil of a higher leaf, erect, densely woolly pubescent, few- to many-flowered; bracts linear-acute, densely pubescent, caducous; ♀ flowers always solitary; perianth (4–)6(–9)-lobed; staminodes 0 or 5–7; styles 3–4(–6), cylindrical, free and recurved or connate at base; stigmas broadly capitate, glabrous; ovary cells as many as styles. *Cupule* cup- or saucer-shaped, obconical or obovoid-globose, lamellate, hairy both inside and outside; lamellae *c.* 5–12, denticulate and free at the rim or more or less smooth and connate, thin or thick. *Fruit* ovoid-conical, ovoid-globose or ovoid-cylindrical; apex rounded, attenuate-acute or abruptly depressed, umbonate; perianthodium (umbo) provided with many rings, well-developed; glabrous and shining or densely tomentose. Cotyledons flat-convex; radicle vertical. Germination hypogeal.

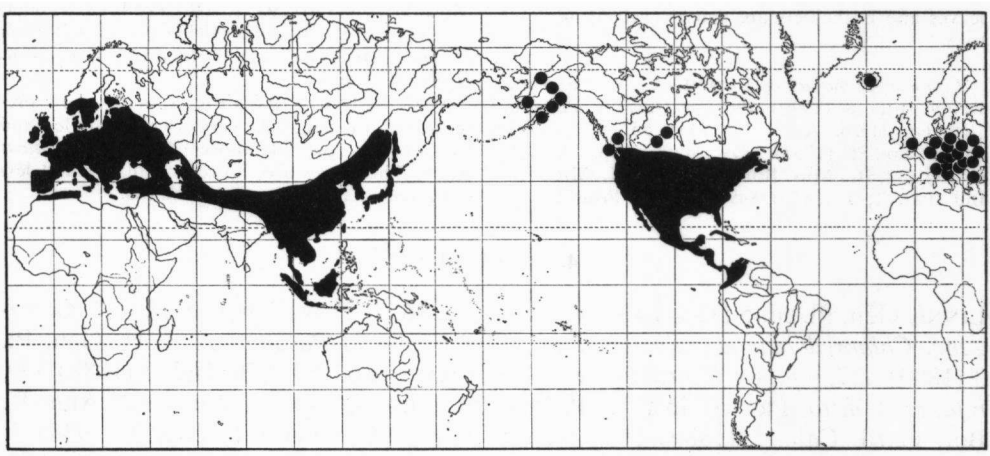

Fig. 30. Distribution of the genus *Quercus*, the fossil records indicated by dots.

Distr. *Quercus* has most of its *c.* 600 *spp.* in the northern temperate zone, with an extension into the subtropics and tropics into W. Malesia (to 8° S) and the NE. corner of S. America (see map in Gard. Bull. Sing. 22, 1968, 419). In Malesia occurs only *Quercus subg. Cyclobalanopsis*, which is confined to

E. and SE. Asia, *viz* Japan (Kanto Prov., Honshu), Korea, China, Hainan, Formosa, Indo-China (with a centre of speciation), NE. India, Burma, Thailand; in *Malesia* it is found in Sumatra, the Malay Peninsula, Banka, Billiton, Anambas Is., W. and Central Java, Borneo, and Palawan. The wider spread species are rather equally spread over the Malay Peninsula, Sumatra, and Borneo, but few in Java. In Borneo occur 9 endemic *spp.*, in N. Sumatra 1. Fig. 30–31.

Fossil records. LA MOTTE (Mem. Am. Geol. Soc. 51, 1952, 285–301) listed not less than 200 fossil "species" recorded from various localities in America and Greenland of different geological ages (Upper Cretaceous to Pleistocene).

Most fossil records which have been discovered in Europe refer to fossils younger than Late Tertiary. According to TRALAU (Kongl. Svensk. Vet. Akad. Handl. IV, 9, 1963, 18–21), all these records might belong to one species.

From the Tertiary of Asia, FLORIN (Kongl. Svensk. Vet. Akad. Handl. 63, 1920, 1–71), OGURA (Jap. J. Bot. 6, 1932, 173–181), and WATARI (Jap. J. Bot. 11, 1938, 385–438) reported several fossils from Japan, Korea and Manchuria, and RAO (Paleaeobot, 4, 1955, 37–89) from India.

In Australia and Tasmania, ETTINGSHAUSEN (Mem. Geol. Surv. N.S.W., Palaeont. 2, 1888) and JOHNSTON (Pap. & Proc. R. Soc. Tasmania 1885, 322–325) described 21 species from various Tertiary deposits. According to DUIGAN (Proc. R. Soc. Victoria n.s. 63, 1951, 46–47) and COUPER (Proc. R. Soc. London, Sect. B, 152, 1960, 491–500) the identification of most of these Australasian records is rather doubtful.

Ecol. In Malesia, *Quercus* is confined to everwet conditions. Therefore it is very scarce in Central and East Java. The genus occurs from sea-level to 3350 m, with a preference for the region between 600 and 1500 m, in various sorts of primary forest, *viz* lowland mixed Dipterocarp forest, swamp forest (with fluctuating water-level), low or hill kerangas or heath forest, ridge forest. Types of soil recorded are sandy clay, sandy loam, and ultrabasic soil overlying sandstone or granite.

Notes. The distribution of Malesian species of *Quercus* outside Malesia has but partially been investigated.

O. SCHWARZ (Notizbl. Berl. Dahl. 13, 1936, 7–8) distinguished besides *Cyclobalanopsis* also *Erythrobalanus* and *Macrobalanus* as distinct genera; they are both New World taxa which, in my opinion, should not be segregated from *Quercus*.

KEY TO THE SPECIES[1]

(based on flowering and fruiting specimens)

1. Rim of the cupule thinner than ½ mm, lamellae with more or less free margin. ♀ Inflorescences usually many-flowered.
2. Cupule deeply cup-shaped, covering ⅓—¾ part of the fruit, (1–)2–3(–3½) cm high, 2–4 cm ø.
3. Cupule 2–3½ cm high, 2½–4 cm ø. Fruit 3–5 by 2–3 cm. Leaves pseudo-whorled, base cordate to auriculate; petiole ½–1 cm . . . . . **1. Q. pseudoverticillata**
3. Cupule (1–)1½–2(–2½) cm high, (1–)1½–2(–2½) cm ø. Fruit 2–3(–3½) by 1½–2(–3) cm. Leaves not pseudo-whorled, base not cordate nor auriculate; petiole 1½–5 cm.
4. Cupule tapering towards the base. Leaves densely stellate-tomentellous, glaucous or silvery beneath, entire.
5. Fruit elongate conical or ovoid-globose. Styles free and recurved. Staminodes 0. Leaves silvery beneath; petiole not sulcate on the adaxial side. . . . . **2. Q. argentata**
5. Fruit obovoid-globose. Styles connate, not recurved. Staminodes 5–7. Leaves glaucous beneath; petiole deeply sulcate on the adaxial side . . . . . **3. Q. nivea**
4. Cupule rounded or truncate at base. Leaves glabrous or densely brownish stiff-pubescent or sparsely stellate-tomentose, neither glaucous nor silvery beneath; margin remotely minutely serrate in the apical half.
6. Cupule 2–2½ by 2–2½ cm; lamellae 6–8. Fruit ovoid-conical, 2–3 by *c.* 2 cm; base convex. **4. Q. gaharuensis**
6. Cupule 3–3½ by 3–3½ cm; lamellae 9–11. Fruit ovoid-globose or ovoid-cylindrical, 2½–3½ by 2–3 cm; base flat or convex . . . . . **5. Q. oidocarpa**
2. Cupule shallowly cup-shaped or saucer-shaped, covering ⅛–½ part of the fruit, ½–1.2 cm high, (0.7–)1–1.8(–2½) cm ø.
7. Leaves elliptic-lanceolate or ovate-lanceolate, (3–)10–15(–24) by (1–)3–5(–9) cm; petiole 1–3 cm.
8. Leaves elliptic-lanceolate, chartaceous, base attenuate-acute.
9. Cupule covering ⅛–⅕ part of the fruit; base of the fruit concave. Petiole terete or flattened on the adaxial side . . . . . **6. Q. sumatrana**

(1) The term 'tomentose' is used for any indument which is continuous interwoven and does not show the parenchyma beneath, *irrespective* of its thickness and the size of the hairs; the latter may be of microscopical dimension and the tomentum very thin.

9. Cupule covering ¼–½ part of the fruit; base of the fruit convex. Petiole sulcate on the adaxial side. . . . . **7. Q. subsericea**
8. Leaves ovate-elliptic or ovate-lanceolate, thick-coriaceous; base rounded or cordate.
10. Cupule covering ¼–⅓ part of the ovoid-cylindrical fruit. Leaves (3–)5–10(–14) by 2–5½ cm, underneath not glaucous; nerves 5–8 pairs . . . . . **8. Q. lowii**
10. Cupule covering ⅙–1/5 part of the ovoid-globose fruit. Leaves (10–)15–18(–20) by 5–9 cm, glaucous beneath; nerves 8–10 pairs . . . . . **9. Q. percoriacea**
7. Leaves obovate or elliptic-obovate, 1½–5½ by ¾–3½ cm; petiole 1–6 mm.
11. Leaves glabrous or sparsely pubescent beneath, upper surface glossy, margin entire, apex rounded or truncate-emarginate; nerves 4–5 pairs . . . . . **10. Q. chrysotricha**
11. Leaves densely pubescent on both surfaces, upper surface dull, margin remotely serrulate in the apical half, apex bluntly acute; nerves 5–8 pairs. . . . . **11. Q. merrillii**
1. Rim of the cupule ½–4 mm thick, lamellae more or less connate at the rim. ♀ Inflorescences normally few-flowered.
12. Cupule 0.7–1.2 cm high, *c.* 1–2 cm ø; lamellae 5–8. Fruit 1–2(–3) by 1.2–1.5 cm. Leaves entire.
13. Leaves elliptic-lanceolate, glabrous, glaucous beneath, base attenuate-acute. **12. Q. kerangasensis**
13. Leaves ovate-elliptic, densely yellowish brown pubescent, base rounded or acute. **13. Q. kinabaluensis**
12. Cupule 1½–2 cm high, (1–)2–2½ cm ø; lamellae (5–)8–10(–12). Fruit 2–5½ by 1–2 cm. Leaves remotely serrulate in the apical half.
14. Old leaves glabrous. Fruit 2–5½ cm long.
15. Leaves with strong and dense reticulation; nerves 10–15 pairs. Stamens 5–9. Styles connate at base; staminodes 0 . . . . . **14. Q. valdinervosa**
15. Leaves with obscure and lax reticulation; nerves 7–10 pairs. Stamens 3–6. Styles free and recurved; staminodes 6–0 . . . . . **15. Q. gemelliflora**
14. Old leaves densely pubescent beneath. Fruit 1–3 cm long.
16. Leaves with strong and dense reticulation.
17. Cupule deeply cup-shaped, obconical, 1–1.2 cm high, 2–2½ cm ø; lamellae 8–10. Fruit cylindrical-conical, 2–3 by 1–2 cm . . . . . **16. Q. lineata**
17. Cupule flattened cup-shaped or saucer-shaped, 0.7–1 cm high and 1.2–2.5 cm ø; lamellae 7–8. Fruit globose or ovoid, 1–2 by 1–2 . . . . . **17. Q. steenisii**
16. Leaves with obscure and lax reticulation.
18. Cupule cup-shaped, base rounded, 1½–2 cm high, 1½–2 cm ø; lamellae 10–12. Fruit with convex base. Leaves linear-lanceolate . . . . . **18. Q. treubiana**
18. Cupule saucer-shaped, base flat, 0.5–0.7 cm high, 2–2½ cm ø; lamellae 5–7. Fruit with flat base. Leaves elliptic-oblong . . . . . **19. Q. elmeri**

KEY TO THE SPECIES
(based on sterile specimens)

1. Petiole (0.1–)0.3–0.5(–1) cm. Leaves with rounded or bluntly acute apex.
2. Leaves 6–17 by 3–6½ cm, base rounded, subcordate or auriculate.
3. Leaves elliptic-oblong or oblanceolate-oblong, 7–17 by 3–6½ cm, entire; beneath with sparse minute simple hairs; reticulation fine, obscure, scalariform. . . . . **1. Q. pseudoverticillata**
3. Leaves ovate-elliptic or ovate-orbicular, 3–8 by 2–5 cm, remotely serrulate in the apical half, underneath with a dense cover of brownish woolly tomentum; reticulation coarse, prominent beneath, subscalariform. . . . . **17. Q. steenisii**
2. Leaves 1½–5 by ¾–3½ cm, base attenuate-acute or attenuate-rounded.
4. Leaves glabrous, entire, apex rounded or truncate; nerves 4–5 pairs . . . . . **10. Q. chrysotricha**
4. Leaves densely pubescent, at least on the midrib and nerves, remotely serrulate in the apical half, apex bluntly acute, rarely rounded; nerves 5–8 pairs . . . . . **11. Q. merrillii**
1. Petiole (1–)2–3(–4½) cm. Leaves with acute, acuminate or caudate apex.
5. Leaves (5–)10–17(–24) by (2–)3–5(–9) cm, elliptic-lanceolate, lanceolate-oblong or ovate-elliptic.
6. Leaf margin entire, recurved, reticulation obscure on both surfaces.
7. Leaves underneath glaucous. Branchlets sparsely stellate-tomentose, shallowly fissured. **3. Q. nivea**
7. Leaves beneath silvery. Branchlets glabrous, densely and prominently lenticellate. **2. Q. argentata**
6. Leaves remotely serrulate in the apical half, reticulation distinct beneath.
8. Old leaves glabrous.
9. Leaves elliptic-oblong, nerves 10–15 pairs; reticulation coarse and dense . **14. Q. valdinervosa**
9. Leaves elliptic-lanceolate, nerves 7–10 pairs; reticulation obscure, lax . . . **15. Q. gemelliflora**
8. Old leaves variously pubescent.

10. Leaves ovate-elliptic, elliptic-oblong or oblong-lanceolate, (5–(10–20)–22) by (2½–)5–7(–9)cm.
11. Leaves ovate-elliptic, glaucous beneath. . . . . **9. Q. percoriacea**
11. Leaves elliptic-oblong or oblong-lanceolate, not glaucous beneath.
12. Leaves densely brownish stiff-pubescent beneath; petiole and midrib not sulcate on the adaxial side. . . . . **4. Q. gaharuensis**
12. Leaves sparsely stellate-tomentose; petiole and midrib deeply sulcate on the adaxial side. **5. Q. oidocarpa**

10. Leaves elliptic-lanceolate, (1½–)5–13(–24) by 2½–5 cm.
13. Leaves glaucous beneath, reticulation fine, obscure. . . . . **6. Q. sumatrana**
13. Leaves not glaucous beneath; reticulation coarse, distinct beneath.
14. Leaves densely glaucous, adpressed-pubescent beneath; nerves 10–20 pairs, dense; reticulation dense, distinct beneath . . . . . **16. Q. lineata**
14. Leaves densely rufous, woolly-pubescent beneath; nerves 5–12 pairs, lax; reticulation obscure, lax. . . . . **19. Q. elmeri**

5. Leaves linear-lanceolate or ovate-elliptic, 5–10 by 2–4 cm.
15. Leaves linear-lanceolate, with a dense cover of simple pubescence beneath . . . **18. Q. treubiana**
15. Leaves ovate-elliptic, densely or sparsely stellate-tomentose beneath, or glabrous.
16. Leaves with attenuate-acute or attenuate-rounded base, glabrous or sparsely stellate-tomentose beneath.
17. Leaves glabrous, glaucous beneath; petiole 0.8–1.2 cm . . . . . **12. Q. kerangasensis**
17. Leaves sparsely stellate-tomentose beneath, not glaucous; petiole 1–2½ cm. **7. Q. subsericea**
16. Leaves with rounded or cordate base, with densely stellate-tomentose by simple hairs beneath.
18. Leaves remotely serrulate in the apical half, beneath densely stellate-tomentose or glabrous; reticulation more or less areolate . . . . . **8. Q. lowii**
18. Leaves entire, beneath densely yellowish pubescent; reticulation scalariform. **13. Q. kinabaluensis**

1. Quercus pseudoverticillata SOEPADMO, Gard. Bull. Sing. 21 (1966) 380, f. 1; *ibid.* 22 (1968) 384, map 3.

Tree, *c.* 30 m, *c.* 90 cm ø; buttresses up to 2 m tall; bark scaly, peeling off profusely into small, rectangular pieces. Branchlets glabrous, lenticellate; terminal buds ovoid-globose, 2–3 by 2 mm. *Leaves* pseudo-whorled, thick-coriaceous, elliptic-lanceolate or oblanceolate-oblong, 7–17 by 3–6½ cm, entire, base cordate to auriculate, apex rounded or bluntly acute; above glabrous, beneath sparsely minute-pubescent; midrib and nerves strongly prominent beneath, flattened to slightly impressed above, especially in the apical half; nerves 8–15 pairs, at an angle of 30–45° with the midrib, parallel arcuating; reticulation obscure, scalariform, dense; petiole ½–1 cm by 0.2 cm, tomentose, glabrescent, adaxially flat. *Cupule* cup-shaped, obconical-globose, pointed at base, covering ⅓–½ part of the fruit, 2–3½ cm high, 2½–4 cm ø; outside brownish sericeous, glabrescent; inside densely brownish stiff-pubescent; lamellae 10–12, thin, rims free, dentate, especially the lower ones. *Fruit* cylindrical-globose, 3–5 by 2–3 cm, sericeous, apex rounded or depressed, base convex or flat; umbo conical.

Distr. *Malesia*: North Borneo (Mt Kinabalu).

Ecol. Rain-forest, *c.* 1650 m. *Fr.* Oct.–Febr.

Note. Stipules and inflorescences are as yet unknown.

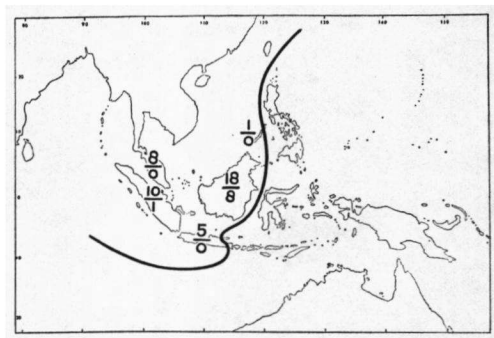

Fig. 31. Species density of *Quercus* in Malesia, above the hyphen the number of non-endemic species, below the hyphen the number of endemic species in the island or island group.

2. Quercus argentata KORTH. Kruidk. (1844) 215, t. 47: 1–17; A. DC. Prod. 16, 2 (1864) 91; SCHEFF. Nat. Tijd. N. I. 32 (1871) 417; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 230; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 30, t. 24A; A. CAMUS, Chênes 1 (1938) 311, t. 23: 1–9; SOEPADMO, Gard. Bull. Sing. 22 (1968) 384, f. 6, map 4. — *Q. argentata var. concolor* BL. Mus. Bot. 1 (1850) 299. — *Q. pinanga* BL. *l.c.* 303; A. DC. Prod. 16, 2 (1864) 107; MIQ. Fl. Ind. Bat. 1, 1 (1856) 864; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 92; K. & V. Bijdr. 10 (1904) 65. — *Cyclobalanopsis argentata* (KORTH.) OERST. Vid. Medd. Nat. For. Kjöbn. 8 (1867) 79, t. 1–2 f. 5–8. — *Q. wilhelminae* VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 9, *excl. fr.* — *Synaedrys wilhelmianae* (VON SEEMEN) KOIDZ. Bot. Mag. Tokyo 30 (1916) 193. — *Lithocarpus argentata* (KORTH.) MERR. Contr. Arn. Arb. 8 (1934) 42, *excl.* BANGHAM 1117 which is *L. ewyckii.* — Fig. 32.

Fig. 32. *Quercus argentata* KORTH. Tree base, Bembangan R., Mt Kinabalu, Sabah, *c.* 1500 m alt. (RSNB 4427; CORNER, 1964).

Tree, 7–37 m, 20–100 cm ø; buttresses up to 1.2 m tall; bark smooth, lenticellate, pale grey, sometimes with horizontal cracks; inner bark *c.* 2 cm thick, pale brown, brittle. Branchlets glabrous, densely lenticellate, greyish brown; terminal buds ovoid-globose, 2–3 by 2–2½ mm, tomentose by stellate or simple hairs, glabrescent. Stipules linear-acute, densely stiff-pubescent, 3–5 by 1–1½ mm. *Leaves* coriaceous, elliptic- or lanceolate-oblong, 8–22 by 3–7 cm; beneath with dense, silvery, stellate tomentum, above glossy, glabrous; base attenuate-rounded or attenuate-acute, slightly asymmetrical, top ½–1 cm acuminate, entire and slightly undulate; midrib and nerves strongly prominent beneath, impressed above, glabrous; nerves 10–17 pairs at an angle of 60–75°, parallel, arcuating near the margin; reticulation fine, obscure; petiole 1½–3 cm by 1–1½ mm, adaxially flat, glabrous. *Male rachis* 5–10 cm, in a paniculate cluster of 3 or 4 on a lateral new shoot; bracts ovate-acute, densely tomentose by simple hairs, 1–1½ by ½ cm; ♂ flowers: perianth lobes connate at base; stamens normally 6, filaments hairy at base. *Female rachis* many-flowered, slender, 2–3 cm, densely tomentose by simple hairs; bracts linear-acute, ½–1 mm; ♀ perianth densely tomentose outside; staminodes absent; styles hairy at base, free and slightly recurved. *Young cupule* turbinate or ovoid-conical, flattened or rounded at the top, attenuate at base; lamellae 8–10, thin, dentate, with dense brownish tomentum, covering the fruit except for the umbo. *Mature cupule* cup-shaped, obconical or obovoid, 1½–2 cm high, 1–1½ cm ø, densely pubescent; lamellae 8–10, free and denticulate at the rim. *Fruit* elongated conical or ovoid-globose, attenuate towards the acute top and rounded base, 3–3½ by 1½ cm.

Distr. *Malesia*: Sumatra (scattered), also Banka, Malay Peninsula (Malacca, Selangor, Johore, Trengganu, and Singapore), Anambas Is., Borneo (all parts except Brunei; also P. Laut), West Java.

Ecol. Forests up to 2700 m. *Fl.* July–Sept., *fr.* Oct.–May.

3. Quercus nivea KING, Ann. R. Bot. Gard. Calc. 2 (1889) 31, t. 24B; A. CAMUS, Chênes 1 (1938) 313, t. 23: 10–16; SOEPADMO, Gard. Bull. Sing. 22 (1968) 387, f. 7, map 3.

Tree, *c.* 25 m, *c.* 40 cm ø; buttresses *c.* 2 m tall, 10–15 cm thick; bark pale grey, rough; inner bark chocolate-brown, fibrous. Branchlets with a dense brownish, stellate tomentum, glabrescent; lenticels sparse, splitting longitudinally into shallow furrows; terminal bud ovoid-ellipsoid, 3–4 by 2–3 mm, scales ovate, glabrous. Stipules linear-acute, stellate-tomentose, 2–3 by ½–1 mm. *Leaves* thick-coriaceous, elliptic-oblong or lanceolate-oblong, 6–15 by 2½–5½ cm; above glossy, glabrous, beneath glaucous, with dense stellate tomentum; entire, slightly undulate in upper part; base rounded or abruptly acute, sometimes asymmetrical, top ½–1 cm acuminate or caudate; midrib and nerves prominent beneath, impressed or flattened above; nerves 6–12 pairs, parallel, arcuating near the margin, at an angle of 60–70°, petiole densely stellate-tomentose when young, soon glabrous, 2–4½ cm, deeply sulcate especially near the top. *Male rachis* in a paniculate cluster on the lateral new shoot, *c.* 5–20 cm, densely stellate-tomentose; ♂ flowers: perianth lobes rather thick-coriaceous; filaments slender, hairy at base. *Female rachis* solitary in the axil of a higher leaf; bracts ovate-acute; ♀ flowers: perianth densely stellate-tomentose, staminodes well-developed, styles short, connate at base. *Young cupule* obconical-turbinate, base attenuate, lamellae thin, densely stellate-tomentose. *Ripe cupule* cup-shaped, obconical, tapering towards the base, 1–1.7 cm high and 1½–2 cm ø; lamellae *c.* 7. *Fruit* obovoid-globose, *c.* 2 by 2 cm, top depressed, base convex.

Distr. *Malesia*: Malay Peninsula (Pahang, Trengganu), Borneo (Sarawak, Mts Gaharu and Pueh).

Ecol. In Malaya it is found in hill Dipterocarp forest at *c.* 1000 m, and in Borneo in heath forest, also at *c.* 1000 m. *Fl.* Jan.–Febr., *fr.* June–July.

4. Quercus gaharuensis SOEPADMO, Gard. Bull. Sing. 21 (1966) 384, f. 3; *ibid.* 22 (1968) 389, map 5.

Tree, 10–30 m, 0.3–1 m ø; buttresses short, spreading, up to 0.7 m tall; bark smooth, mottled hooped, lenticels scattered in longitudinal rows. Branchlets densely stellate-tomentose, glabrescent, lenticellate; terminal bud ovoid-globose, *c.* 2 by 2 mm. Stipules linear-acute, *c.* 5 by 1 mm. *Leaves* thin-coriaceous, elliptic-lanceolate or elliptic-oblong, 5–23 by 2–9 cm, entire or remotely serrulate in the apical part, base attenuate-acute or rounded, slightly asymmetrical, top rounded or bluntly acute; above glabrous, beneath densely stellate-pubescent, glabrescent; midrib and nerves prominent beneath, slightly so above; nerves 8–15 pairs, parallel, arcuating towards the margin, at an angle of 45–60°, reticulation distinct beneath; petiole 1–3½ cm, slender, terete or adaxially flat, densely stellate-tomentose, glabrescent. *Male rachis* 1½–3½ cm; bracts ovate-acute, 1–1½ by 1 mm; ♂ flowers: filaments hairy at base, 1–2 mm; anthers *c.* ½ by ½ mm; pistillode replaced by a tuft of stiff hairs. *Female rachis* 1–1½ cm; bracts ovate-linear, 1–2 by ½–1 mm; ♀ flower: staminodes absent, styles slender, cylindrical, hairy at base, 1–2 mm. *Young cupule* ovoid-globose, 1½–2 cm through, top rounded or truncate, base attenuate-rounded, densely sericeous outside and densely brownish stiff-pubescent inside. *Mature cupule* deeply cup-shaped, 2–2½ cm through; base rounded, enclosing ½–⅔ part of the fruit; lamellae 6–8, rims thin, slightly recurved and denticulate. *Fruit* ovoid-conical, 2–3 by 2 cm, top acute or rounded, convex at base.

Distr. *Malesia*: Sumatra (East Coast Res. and SE. of Padang), Malay Peninsula (Perak, P. Penang), Borneo (Sarawak and adjoining Sipitang in Sabah).

Ecol. Forest, 100–1400 m. *Fr.* Sept.–Febr.

Note. Specimens from Malaya reckoned by HOOK. *f.* Fl. Br. Ind. 5 (1888) 603 and by later authors to *Q. oidocarpa*, belong here.

5. Quercus oidocarpa KORTH. Kruidk. (1844) 216, t. 47: 18; BL. Mus. Bot. 1 (1850) 302; MIQ. Fl. Ind. Bat. 1, 1 (1856) 856; Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 115; A. DC. Prod. 16, 2 (1864) 99; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 233; HOOK. *f.* Fl. Br. Ind. 5 (1888) 603; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 28; HICKEL & A. CAMUS, Fl. Gén. I.-C. 5 (1930) 952; A. CAMUS, Chênes 1 (1938) 213, t. 7: 10–15; SOEPADMO, Gard. Bull. Sing. 22 (1968) 390, map 6. — *Cyclobalanopsis oidocarpa* (KORTH.) OERST. Vid. Medd. Nat. For. Kjöbn. 8 (1867) 78. — *Q. brevistyla* A. CAMUS, Bull. Soc. Bot. Fr. 80 (1933) 353; Chênes 1 (1938) 276, t. 17. — **Fig. 33.**

Tree, 25–30 m, *c.* 50 cm ø; bark grey, scaly and peeling off profusely into rectangular pieces. Branchlets initially with dense stiff pubescence, glabrescent, lenticellate; terminal bud ovoid-globose, 3–5 by 2–3 mm. Stipules linear-acute, 3–4 by ½–1 mm, densely fulvous-tomentose by simple hairs. *Leaves* oblong-lanceolate or elliptic-oblong, 7–17 by 3–7 cm, remotely serrulate in the apical half; base acute or rounded or subcordate, top acute or ½–1½ cm acuminate; above glabrous, beneath sparsely stellate-tomentose; midrib and nerves prominent beneath, impressed above; nerves *c.* 9–13 pairs, parallel, at an angle of *c.* 45°; reticulation distinct beneath, scalariform, dense; petiole

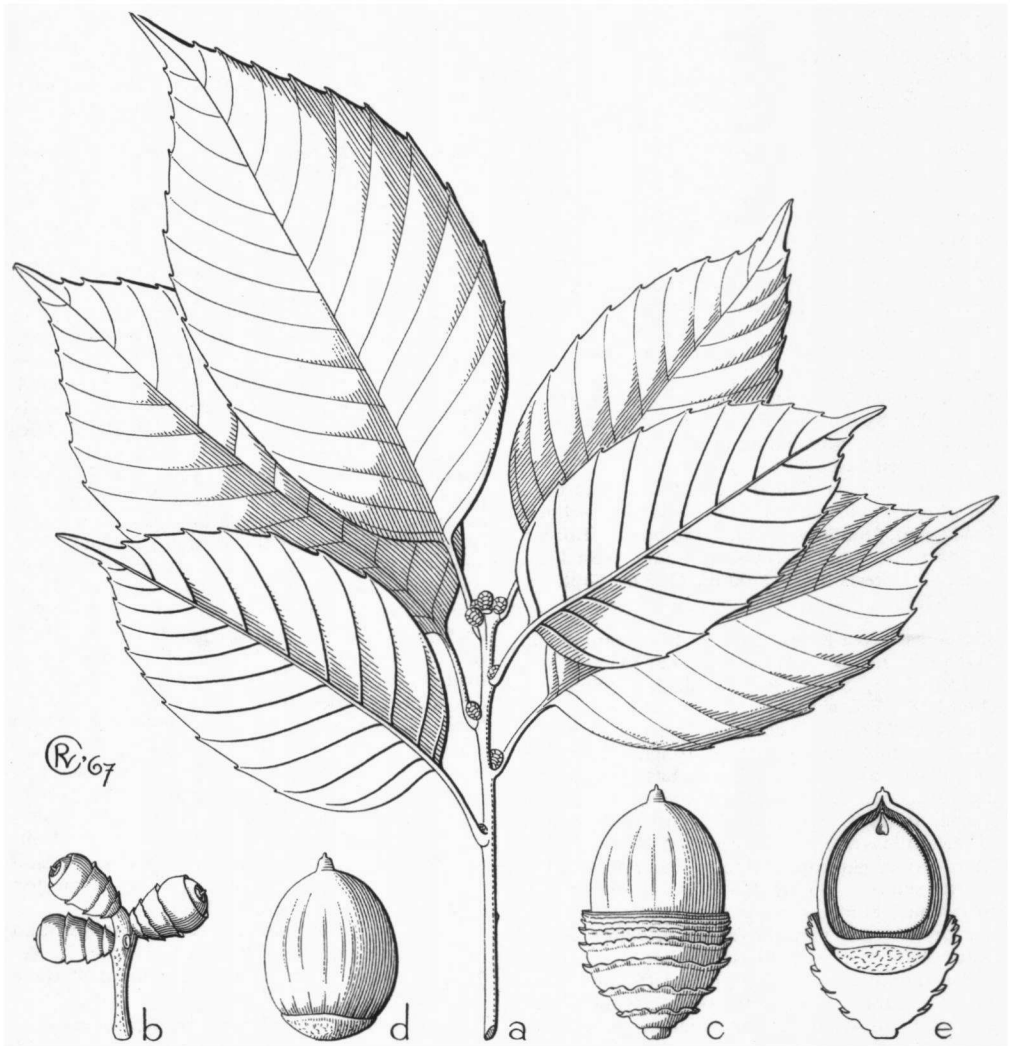

Fig. 33. *Quercus oidocarpa* KORTH. *a.* Habit, *b.* young cupules, *c.* ripe cupule and fruit, *d.* ripe fruit, *e.* longitudinal section of cupule and fruit, all ×⅔ (*a* BACKER 25956, *b* Ja. 4784, *c–e* ICHLAS 115).

1½–3½ cm, shallowly furrowed, glabrous. *Male rachis* 5–7 cm, densely stiff pubescent; bracts ovate-acute, 1½–2 by 1–1½ mm, glabrous; ♂ flowers: perianth membranous, glabrous; filaments slender, glabrous, *c.* 2 mm; anthers *c.* 0.7 mm long, *Female rachis* 3–7 cm, subglabrous, carrying *c.* 3–7 flowers, bracts ovate-acute; ♀ flowers: staminodes absent, styles free, recurved, *c.* 2 mm, hairy at base. *Cupule* deeply cup-shaped, 3–3½ cm through; base attenuate-rounded; lamellae thin, 9–11, lower ones denticulate, the others entire, yellowish brown tomentose. *Fruit* ovoid-globose or ovoid-cylindrical, 2½–3½ by 2–3 cm, top rounded or abruptly depressed, base rounded or flat.

Distr. *Malesia*: Sumatra (western central part), Malay Peninsula (Pahang, Selangor), Java (eastwards to Banjumas, Pringombo).

Ecol. Forests, 150–1500 m. *Fl.* March–April, *fr.* April–Febr.

6. Quercus sumatrana SOEPADMO, Gard. Bull. Sing. 21 (1966) 387, f. 4; *ibid.* 22 (1968) 392, map 7.

Tree, *c.* 35 m, 130 cm ø; buttresses 1–2½ m tall; bark rough, grey. Branchlets initially densely brownish, stiff-pubescent, late glabrescent, smooth lenticellate; terminal buds ovoid-globose, 2–3 by 1½–2 mm. Stipules linear-acute membranous, 7 by 1 mm, densely fulvous-tomentose by simple hairs. *Leaves* chartaceous, elliptic-lanceolate, 8–24 by 2–8 cm, entire and undulate or remotely serrulate in the upper part, base attenuate-acute, top sharply ½–1½ cm acuminate; above glabrous, underneath sparsely set with stiff, simple hairs, glaucous; midrib and nerves prominent beneath, slightly so above; nerves 8–13 pairs, rarely opposite, at an angle of 45–60°, parallel, arcuating near the margin; reticulation scalariform, obscure on both surfaces; petiole slender, 1–2½ cm, terete or adaxially flat, sparsely pubescent. *Ripe cupule* shallowly cup-shaped, 0.7–1 cm high, 2–2½ cm ø, covering ⅙–⅕ part of the fruit, base attenuate-rounded, densely tomentose on both faces; lamellae free at the rim. *Ripe fruit* ovoid-conical, 1.8–2 by 1½–2 cm, densely sericeous, top acute, base concave.

Distr. *Malesia*: Sumatra (Bencoolen, also Simalur), Borneo (northern Sarawak; western Sabah; in Kalimantan near Balikpapan and Samarinda).

Ecol. Forests, up to 1300 m, on sandy loam or basalt-derived soil. *Fr.* April–Dec.

Note. Inflorescences are as yet unknown.

7. Quercus subsericea A. CAMUS, Bull. Soc. Bot. Fr. 80 (1933) 354; Chênes 1 (1938) 367, t. 33: 21–26; SOEPADMO, Gard. Bull. Sing. 22 (1968) 392, f. 9, map 8. — *Q. sericea* SCHEFF. Nat. Tijd. N. I. 31 (1870) 361; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 63, t. 57B, *non* WILLD. (1805). — *Cyclobalanopsis sericea* (SCHEFF.) SCHOTTKY, Bot. Jahrb. 47 (1912) 656. — *Synaedrys sericea* (SCHEFF.) KOIDZ. Bot. Mag. Tokyo 30 (1916) 192. — *Q. lineata* (*non* BL.) S. MOORE, J. Bot. 63 (1925) Suppl. 114, *p.p.*, *quoad specim.* FORBES 572. — *Q. oidocarpa* (*non* KORTH.) MERR. En. Born. (1921) 214, *p.p.*, *quoad specim.* BECCARI 2919.

Tree, 6–15 m, 10–40 cm ø; bark finely fissured or scaly, thin, greyish brown; inner bark fibrous, brownish, *c.* 2½ cm thick. Branchlets initially densely set with stiff simple hairs or adpressed stellate hairs, glabrescent, later lenticellate; terminal buds ovoid-globose, 3–4 by 2–3 mm, scales narrowly ovate, densely simple sericeous. Stipules linear-acute, 7 by 1–2 mm. *Leaves* thin-coriaceous, elliptic-lanceolate, rarely ovate, 5–16 by 1–5 cm, base acute or roundish, margin entire or remotely serrulate near the sharply acute or ½–1½ cm acuminate apex; beneath with a sparse stellate tomentum, above glossy, glabrous; midrib and nerves prominent beneath, impressed above; nerves 6–12 pairs, at an angle of 45–60°, parallel, arcuating towards the margin; reticulation obscure; petiole slender, 1–2½ cm, adaxially furrowed. *Male rachis* 2–5 cm; bracts ovate-acute, tomentose outside, 1–2 by 1 mm; ♂ flowers 1–3; perianth tomentose, filaments slender, 1–2 mm, anthers *c.* 1 by 1 mm. *Female rachis* ½–1½ cm, carrying 2–5 flowers; bracts ovate-acute, 0.5–0.7 by 0.3–0.5 mm; ♀ flowers: ovary ovoid-cylindrical, *c.* ½ mm long, rounded-triangular, staminodes 0, styles *c.* 1 mm, tomentose at base. *Young cupule* ovoid-globose or obconical, lamellae 4–5, the 2–3 lower ones denticulate, the others entire. *Ripe cupule* cup-shaped, obconical, covering ¼–½ part of the fruit, 0.5–1.2 cm high, 0.7–1 cm ø, base rounded or attenuate, lamellae densely tomentose. *Fruit* ovoid-conical or ovoid-globose, 1–2½ by 1–1½ cm, densely sericeous, base obtuse or convex, apex acute or abruptly depressed-umbonate.

Distr. *Malesia*: Sumatra (scattered), Malay Peninsula (Kelantan, Negri Sembilan, Pahang, Malacca), Banka (common), Borneo (scattered), W. Java (Pasir Orai: FORBES 572).

Ecol. Forests, mostly at low altitude, in Java found at 850 m, on Mt Kinabalu at 1500 m; on sandy clay, sandy loam or granitic soil. Fertility seems irregular.

8. Quercus lowii KING, Ann. R. Bot. Gard. Calc. 2 (1889) 28, t. 21B; A. CAMUS, Chênes 1 (1938) 366, t. 33: 27–29; SOEPADMO, Gard. Bull. Sing. 22 (1968) 394, f. 10, map 9. — *Cyclobalanopsis lowii* (KING) SCHOTTKY, Bot. Jahrb. 47 (1912) 653.

Tree, 10–20 m, 30–40 cm ø. Branchlets initially densely set with brownish stellate hairs, late glabrescent, dark grey, shallowly fissured; older branchlets lenticellate, glabrous; terminal buds ovoid-globose, densely tomentose. Stipules linear-acute, 2–4 by ¼–½ mm. *Leaves* thick-coriaceous, ovate-elliptic or ovate-lanceolate, (3–)5–10(–14) by 2–5½ cm; base rounded or cordate, slightly asymmetrical, top sharply acute or ½–2 cm acuminate; margin entire or remotely serrulate in the apical half; beneath densely brownish stellate tomentose or almost glabrous, above glabrous and glossy or dull and with sparse stellate tomentum (especially on the midrib); midrib and nerves impressed above, prominent or flattened beneath; nerves 5–8 pairs, at an angle of 50–60°, parallel, arcuating towards

the margin; reticulation fine, more or less areolate, distinct beneath; petiole 1–2½ cm, sulcate, densely tomentose by simple or stellate hairs. *Male rachis* slender, 5–10 cm, simple or rarely much-branched; bracts ovate-acute, 1–2 by ½ mm, densely stellate-tomentose, glabrescent; ♂ flowers 1–3; perianth densely tomentose by simple or stellate hairs, glabrescent, anthers 1 by ½–1 mm, filaments 1 mm, pistillode replaced by a cluster of woolly, simple hairs. *Female rachis* 1–2 cm, with 2–5 ♀ flowers, staminodes none, styles *c.* 1 mm, recurved. *Young cupule* obconical, 0.8–1 cm high, 0.7–1.2 cm ø; lamellae thin, 5–7, the lower ones denticulate, the rest entire, densely stellate-tomentose. *Ripe cupule* cup-shaped, 0.8–1 cm high, 1.3–1.8 cm ø, base rounded, covering ¼–⅓ part of the fruit. *Fruit* ovoid-cylindrical, 1½–2 by 1.3–1.5 cm, top rounded or acute, base convex; densely stellate-tomentose, glabrescent.

Distr. *Malesia*: Borneo (Sabah, various places, common on Mt Kinabalu; HALLIER 2950 from Mt Liang Gagang in western Kalimantan).

Ecol. Forests, up to 2500 m, mostly in the montane zone on blackish ultra-basic soil. *Fr.* July–March.

Note. In the lowland specimens the leaves are glabrous, in mountain specimens they are mostly tomentose beneath; intermediates exist, see SOEPADMO (1968).

9. Quercus percoriacea SOEPADMO, Gard. Bull. Bull. Sing. 21 (1966) 382, f. 2; *ibid.* 22 (1968) 396, map 6.

Tree, trunk *c.* 50 cm ø; buttresses up to 1 m tall; bark smooth, grey, hoop-marked. Branchlets grey, glabrous, lenticellate; terminal buds ovoid-globose, *c.* 3 by 2 mm, densely tomentose. *Leaves* thick-coriaceous, ovate-elliptic, (10–)15–18(–20) by 5–9 cm; base rounded, top acute or 1–1½ cm acuminate; margin incurved, remotely serrulate in the apical half, sparsely set with stellate hairs, glaucous, above glossy, glabrous; midrib and nerves prominent beneath, impressed and obscure above; nerves 8–10 pairs, at an angle of 45–60°, parallel, arcuating towards the margin; reticulation subscalariform, distinct beneath; petiole 2–3½ cm, glabrous, terete or adaxially ± flat. *Young infructescence* 2–3 cm, rachis lenticellate, with 1–4 solitary young fruits. *Young cupule* obovoid, sericeous, 0.7–1 cm high, 0.8–1 cm ø, base attenuate; lamellae 4–8, the lower ones denticulate, the others entire; young fruits ovoid-globose, attenuate towards the conical, ringed umbo, sericeous; styles recurved, sericeous. *Ripe cupule* flattened cup-shaped, 0.7–1 cm high, 2 cm ø, covering ⅙–⅛ part of the fruit, base rounded; lamellae 6–8, thin, more or less free at the rim, densely tomentose. *Fruit* ovoid-globose, *c.* 2 by 2 cm, densely tomentose, top rounded, umbonate, base convex.

Distr. *Malesia*: Borneo (northern Sarawak: Ulu Baram).

Ecol. Primary heath forest on terrace sand, with *Agathis*, 1100–1200 m. *Fr.* June-July.

Note. The inflorescence is as yet unknown.

10. Quercus chrysotricha A. CAMUS, Chênes, Atlas 3 (1949) 50, t. 347: 7–14; Chênes 3 (1954) 1212; SOEPADMO, Gard. Bull. Sing. 22 (1968) 397, f. 11: 1a–c, map 10.

Tree, *c.* 19 m, *c.* 30 cm ø; bark smooth or finely fissured. Branchlets initially densely brownish pubescent, late glabrescent, lenticellate; terminal buds ovoid-globose, *c.* 3 by 2 mm, scales ovate, glabrous. Stipules linear-acute, 8–10 by 1 mm, densely woolly rufous-tomentose by simple hairs. *Leaves* thin-coriaceous, obovate-elliptic, 1–5½ by 1½–3½ cm; base attenuate-rounded or attenuate-acute, slightly asymmetrical, margin entire, apex rounded or truncate-emarginate; above glabrous, underneath sparsely pubescent, glabrescent; midrib and nerves slightly prominent beneath, flattened or impressed above; nerves 4–5 pairs, at an angle of 60–70°, parallel, arcuating towards the margin; reticulation obscure on both surfaces; petiole 1–5 mm, adaxially flat. *Cupule* cup-shaped, obconical, 1–1½ cm through, base attenuate-acute, covering ¼–⅓ part of the fruit; lamellae thin, 6–7, densely tomentose, denticulate. *Fruit* ovoid-conical, 1½–2 by 1–1½ cm, densely tomentose, glabrescent; top attenuate-acute, base convex.

Distr. *Malesia*: Borneo (northern Sarawak, Dulit Ridge).

Ecol. Mossy forest, 1200–1300 m. *Fr.* Sept.

Notes. RICHARDS 1885, the type, was referred to *Q. arbutifolia* HICKEL & A. CAMUS by E. F. WARBURG (Kew Bull. 1936, 19).

The inflorescence is as yet unknown.

11. Quercus merrillii VON SEEMEN in Fedde, Rep. 5 (1908) 21; MERR. Philip. J. Sc. 3 (1908) Bot. 329; En. Philip. 2 (1923) 28; A. CAMUS, Chênes 1 (1938) 210, t. 7: 6–9; SOEPADMO, Gard. Bull. Sing. 22 (1968) 397, f. 11: 2a–c, map 10. — *Cyclobalanopsis merrillii* (VON SEEMEN) SCHOTTKY, Bot. Jahrb. 47 (1912) 649.

Small tree. Branchlets initially densely set with brownish, stiff hairs, glabrescent, lenticellate; terminal buds ovoid-conical, *c.* 3 by 2 mm, scales ovate, glabrous. Stipules linear-acute, densely pubescent outside, 5–10 by 1 mm. *Leaves* thin-coriaceous, obovate or elliptic-ovate, 1½–5 by 0.7–2½ cm, base attenuate-acute, top bluntly acute; margin remotely serrulate in the apical half; densely pubescent on both surfaces, late glabrescent; midrib and nerves prominent beneath, flattened or impressed above; nerves 5–8 pairs, parallel, at an angle of 50–60°, arcuating towards the margin; reticulation obscure on both surfaces; petiole 3–6 mm, densely pubescent, glabrescent, adaxially flat. *Young infructescence* 1–2 cm, rachis densely tomentose, glabrescent, lenticellate, with 1–2 solitary young fruits. *Young cupule* obovoid or obconical, *c.* ½ cm through, densely tomentose; styles 1–2 mm. *Ripe cupule* cup-shaped, obconical, covering ¼–⅓ part of the fruit; 1 cm high, 1–1½ cm ø; lamellae 7–8, thin, denticulate, densely tomentose. *Fruit* ovoid or ovoid-cylindrical, 2–2½ by 1–1½ cm, glabrous, glossy, top acute, base convex.

Distr. *Malesia*: Borneo (scattered in Sarawak and Sabah, also Nunukan I.), Philippines (Palawan only).

Ecol. Forest, 100–500 m. *Fr.* April–Aug.

Note. Inflorescences are as yet unknown.

12. Quercus kerangasensis SOEPADMO, Gard. Bull. Sing. 22 (1968) 399, f. 12, map 11.

Tree, 20–30 m, 25–50 cm ø; buttresses small, fluted; bark smooth or rough, lenticellate, grey. Branchlets initially densely stiff-pubescent, late glabrescent, greyish brown, densely warty lenticellate; terminal buds ovoid-globose, 3–6 by 3–4 mm. Stipules linear-acute, 2–3 by ½–1 mm. *Leaves* elliptic-lanceolate, coriaceous, 4–11 by 2–4 cm, above glossy, glabrous, underneath pale glaucous, glabrous except on the midrib, entire; base attenuate-acute, top acute or ½–1 cm acuminate; midrib and nerves prominent beneath, slightly so above; nerves 7–10 pairs, ascending, subparallel, arcuating towards the margin, at an angle of 60–70°; reticulation obscure on both surfaces; petiole 8–12 by ½–1 mm, densely pubescent, glabrescent, adaxially flat or shallowly furrowed. *Male rachis* 1–2 cm; bracts membranous, ovate-acute, densely stiff-pubescent outside, 1 by 1 mm; ♂ flowers with membranous perianth, filaments 1–2 mm. *Ripe cupule* cup-shaped, obconical, 8–12 mm high, 1½–2 cm ø, base attenuate, rim 1–1½ mm thick, densely brownish tomentose on both surfaces; lamellae 5–7, entire or denticulate. *Ripe fruit* ovoid-conical or ovoid-cylindrical, 2–3 cm by 12–15 mm, densely sericeous, glabrescent, top rounded or acute, base convex.

Distr. *Malesia*: Borneo (Sarawak; Brunei; in Kalimantan: Central Kutei near Long Bleh).

Ecol. Primary heath ('kerangas') forests, to 100 m. *Fl.* June, *fr.* Sept.

Note. The female rachis is still unknown.

13. Quercus kinabaluensis SOEPADMO, Gard. Bull. Sing. 22 (1968) 401, f. 13, map 11.

Tree, 10–40 m, 20–30 cm ø; bark smooth, brownish with white patches. Branchlets initially densely brownish, stiff-pubescent, glabrescent, later with sparse lenticels; terminal bud ovoid-globose or ovoid-conical, 4–10 by 3–4 mm. Stipules linear-acute, 5–10 by ½–1 mm. *Leaves* thick-coriaceous, ovate-elliptic, 5–10 by 2–5 cm; surfaces densely yellowish brown pubescent, glabrescent; base asymmetrical, rounded or acute, top acute or ½–1½ cm acuminate; margin entire; midrib and nerves slightly prominent beneath, flattened or impressed above; nerves 6–8 pairs, ascending, arcuating towards the margin at an angle of 45–60°; reticulation obscure on both surfaces; petiole 1–1½ cm by 1–1½ mm, adaxially flat. *Male rachis* 5–11 cm, 1 mm ø; bracts ovate-acute, membranous, densely pubescent outside, 2–3 by 1–2 mm; ♂ flowers 3, filaments 2 mm, anthers *c.* 1 by 1 mm. *Female rachis* 1–3 cm by 2–3 mm, carrying 1–3 flowers; perianth thick-coriaceous, staminodes none, styles recurved, 2–3 by ½–1 mm. *Young cupule* cup-shaped, obconical, 0.7–1 cm high, 1–1½ cm ø, rim thick, base attenuate; lamellae 6–8, denticulate or entire, with some brownish pubescence on both surfaces. *Fruit* ovoid-conical, densely brownish tomentose, glabrescent, 1–1.2 by 0.8–1 cm; top rounded or attenuate-acute, base convex.

Distr. *Malesia*: Borneo (Sabah: Mt Kinabalu and Bk. Ampuon).

Ecol. Forests, 500–2600 m, on ultra-basic soil. *Fl.* Febr., *fr.* March–May.

14. Quercus valdinervosa SOEPADMO, Gard. Bull. Sing. 22 (1968) 404, f. 14, map 12. — *Q. mespilifolia var. borneensis* HEINE in Fedde, Rep. 54 (1951) 225.

Tree, 20–35 m, 30–60 cm ø; bark smooth, grey. Branchlets initially densely brownish pubescent, hairs stiff, simple or stellate, glabrous, lenticellate; terminal buds ovoid-globose, ½–1 by ½ cm, the scales in four vertical rows. Stipules linear-acute, tomentose, 10–15 by 1–2 mm. *Leaves* thick-coriaceous, elliptic or obovate-oblong, 8–15 by 3–6 cm; above glabrous, beneath densely pubescent, soon glabrescent; base acute or attenuate-rounded, top ½–1 cm acuminate; margin remotely serrulate in the apical half; midrib and nerves prominent beneath, flattened or impressed above; nerves 10–15 pairs, dense, parallel and straight, arcuating near the margin at an angle of *c.* 60°; reticulation dense, scalariform, prominent beneath; petiole 1–2½ cm, glabrous, adaxially flat. *Male rachis* 5–10 cm; bracts lanceolate or linear-acute, membranous, 3–5 by 2–3 mm; ♂ flowers: perianth densely tomentose, filaments 3–4 mm, anthers *c.* 1 by 1 mm. *Female rachis* 1–1½ cm, carrying 4–6 flowers; bracts ovate or linear, 2–3 by 1 mm; staminodes none, styles 1–2 mm. *Ripe cupule* cup-shaped, obconical, base attenuate, 1.5–1.7 cm high, 1–2½ cm ø, covering ⅓–⅙ part of the fruit; lamellae 7–8, densely tomentose rim crenate and thick. *Fruit* cylindrical-conical or ellipsoid, 3–3.7 by 1.3–1.7 cm, tomentose, top acute, base convex.

Distr. *Malesia*: Borneo (Sarawak: Kalabit Highland and Mt Mulu; Brunei: Mt Pagon Periuk; Sabah: Mt Kinabalu; Kalimantan: Mt Kemul in W. Kutei).

Ecol. Forests, 1200–2300 m, on brownish soil. *Fl.* Jan.–Febr. and June, *fr.* Febr.–April and July.

15. Quercus gemelliflora BL. Verh. Bat. Gen. K. & W. 9 (1823) 222, t. 6, *excl. fr.*; Bijdr. (1826) 523; Fl. Jav. Cupul. (1829) 30, t. 17; A. DC. Prod. 16, 2 (1864) 88; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 88; K. & V. Bijdr. 10 (1904) 24; A. CAMUS, Chênes 1 (1938) 363, t. 23: 15–25; BACKER & BAKH. *f.* Fl. Java 2 (1965) 5; SOEPADMO, Gard. Bull. Sing. 22 (1968) 406, f. 15, map 13. — *Q. turbinata* BL. Bijdr. (1826) 523, *non* ROXB. (1832); Fl. Jav. Cupul. (1829) 31, t. 18; K. & V. Bijdr. 10 (1904) 22; RIDL. Fl. Mal. Pen. 5 (1925) 336; HICKEL & A. CAMUS, Fl. Gén. I.–C. 5 (1930) 949; A. CAMUS, Chênes 1 (1938) 204, t. 6: 9–16. — *Q. merkusii* ENDL. Gen. Pl. Suppl. 4, 2 (1847) 28; A. DC. Prod. 16, 2 (1864) 98. — *Q. horsfieldii* MIQ. Fl. Ind.

Bat. 1, 1 (1856) 856; A. DC. Prod. 16, 2 (1864) 99. — *Q. horsfieldii var. longifolia* MIQ. Fl. Ind. Bat. 1, 1 (1858) 869. — *Cyclobalanopsis horsfieldii* (MIQ.) OERST. Vid. Medd. Nat. For. Kjöbn. 8 (1867) 78. — *Cyclobalanopsis merkusii* (ENDL.) OERST. *l.c.* 79. — *Q. lineata var. merkusii* (ENDL.) WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 232; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 33, t. 26: 2. — *Q. semiserrata* (*non* ROXB.) HOOK. *f.* Fl. Br. Ind. 5 (1888) 604; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 28, *quoad specim. e Sumatra et Banka*; K. & V. Bijdr. 10 (1904) 25, *p.p.* — *Cyclobalanopsis turbinata* (BL.) SCHOTTKY, Bot. Jahrb. 47 (1912) 648. — *Q. turbinata var. crassilamellata* GAMBLE, J. As. Soc. Beng. 75, ii (1915) 410. — *Q. crassilamellata* (GAMBLE) A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 3 (1931) 689; Chênes 1 (1938) 226, t. 10: 1–7.

Tree, 20–30 m, 20–60 cm ø; buttresses up to 1 m tall; bark smooth or finely fissured, greyish brown. Branchlets initially densely brownish hairy, late glabrescent, lenticellate; terminal buds ovoid, 3–5 by 2–3 mm, scales broadly ovate, densely fulvous tomentose, by simple hairs, glabrescent. Stipules linear-acute, 5–10 by 1–2 mm. *Leaves* thin-coriaceous, elliptic-lanceolate or elliptic-oblong, 5–15 by 2–5½ cm; base attenuate-acute, asymmetrical, top shortly acuminate; margin remotely serrulate in the apical half; above glabrous, beneath densely pubescent, soon glabrescent; midrib and nerves prominent beneath, flattened or slightly raised above, especially the midrib; nerves 8–10 pairs, parallel, straight, arcuating towards the margin, at an angle of *c.* 60°; reticulation obscure on both surfaces; petiole 1–3 cm by 1–2 mm. *Male rachis* *c.* 6 cm; ♂ flowers: filaments *c.* 2 mm, anthers ½–1 mm long. *Female rachis* carrying 2–7 flowers; bracts ovate-acute, 1–2 by 1 mm; staminodes 0–6, styles recurved, 1–2 mm. *Young cupule* turbinate-obconical or cylindrical-globose, covering the greater part of the fruit, base attenuate; lamellae 5–7, rim thick, entire or denticulate, densely tomentose. *Ripe cupule* cup-shaped, 1½–2 cm high, 1½–2½ cm ø, covering ½–⅓ part of the fruit, rim *c.* 2 mm thick; lamellae 7–8, densely tomentose. *Ripe fruit* conical cylindrical, 2–5½ by 1–2 cm; top acute, base rounded; densely tomentose, glabrescent.

Distr. *Malesia*: Sumatra (common), Malay Peninsula (most provinces, also P. Penang), Banka, Borneo (scattered, in Sarawak, Sabah and eastern Kalimantan), Java (West Java, eastwards only on Mts Lawu, Wilis and Ardjuno).

Ecol. Forests in lowland and montane zone, in E. Java up to 2160 m, usually near streams on red sandy clay or ultra-basic soil overlying sandstone or granitic formations. Fertility seems to be irregular.

DOCTERS VAN LEEUWEN, Zoocecidia (1926) 105 and 107, described some galls from Java and Sumatra, and BACKER & BAKHUIZEN *f.* hold it, that the large, globose, brown-pilose galls often borne by the twigs of this species, are unknown from other *Quercus* species in Java.

16. Quercus lineata BL. Bijdr. (1826) 523; Fl. Jav. Cupul. (1829) 32, t. 19; MIQ. Fl. Ind. Bat. 1, 1 (1856) 855; A. DC. Prod. 16, 2 (1864) 98; WENZIG, Jahrb. Bot. Gart. Berl. 4 (1886) 232; K. & V. Bijdr. 10 (1904) 20, *et* KOORD. Atlas 1 (1913) t. 58, *quoad Java*; A. CAMUS, Chênes 1 (1938) 207, t. 6: 1–5; BACKER & BAKH. *f.* Fl. Java 2 (1965) 5; SOEPADMO, Gard. Bull. Sing. 22 (1968) 408, f. 16, map 14. — *Q. polyneura* MIQ. Pl. Jungh. (1851) 11. — *Q. lineata var. heterochroa* MIQ. Fl. Ind. Bat. 1, 1 (1856) 855. — *Q. oxyrhyncha* MIQ. Sumatra (1861) 347. — *Cyclobalanopsis lineata* (BL.) OERST. Vid. Medd. Nat. For. Kjöbn. 8 (1867) 78. — *Q. lineata var.* '*typical lineata*' KING, Ann. R. Bot. Gard. Calc. 2 (1889) 33, t. 26: 1. — *Q. lineata var. oxyrhyncha* (MIQ.) VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 4. — *Q. hendersoniana* A. CAMUS, Bull. Mus. Hist. Nat. Paris II, 4 (1932) 123; Chênes 1 (1938) 210, t. 6: 6–8. — **Fig. 34.**

Tree, 20–30 m, 20–60 cm ø; bark smooth grey; inner bark fibrous, reddish brown. Branchlets initially densely pubescent, late glabrescent, dark grey, lenticellate; terminal buds globose or ovoid-conical, densely puberulous, glabrescent. Stipules linear-acute, 10–15 by 1–2 mm. *Leaves* thin-coriaceous, ovate-elliptic or ovate-lanceolate, 5–16 by 2–6 cm; base attenuate-acute, sometimes asymmetrical, top acute to ½–1½ cm acuminate-caudate; margin remotely serrulate in the apical half, above with some pubescence, especially on midrib and nerves, beneath densely adpressed-pubescent; midrib and nerves prominent beneath, slightly so above; nerves 10–20 pairs, straight, parallel, dense, arcuating near the margin but not anastomosing, at an angle of 45–60°; petiole 1–2 cm, shallowly furrowed. *Male rachis* 5–10 cm; bracts ovate-acute, 2–3 by 2 mm, membranous; ♂ flowers: filaments ½–1 mm, anthers *c.* ½ by ½ mm, pistillode replaced by a tuft of stiff, simple hairs. *Female rachis* 1½–2 cm, carrying 5–6 flowers; bracts ovate-acute, 1–2 mm; staminodes none, styles recurved, 1–3 mm. *Young cupule* ovoid-globose, densely sericeous, lamellae 3–4, thick, the 2 lower ones denticulate, the others entire. *Ripe cupule* cup-shaped, obconical, 1–1.2 cm high, 2–2½ cm ø, attenuating towards the base, densely tomentose, rim thick; lamellae 8–10, free. *Ripe fruit* conical-cylindrical, 2–3 by 1–2 cm, densely tomentose; apex attenuate-rounded, base convex.

Distr. *Malesia*: Sumatra (scattered in the N. and central part), Malay Peninsula (Pahang, Trengganu), Java (scattered in W., in Central Java: Mt Telemojo and Mt Wilis), Borneo (Sarawak: Mts Pueh and Berumput; Sabah: Mt Kinabalu).

Ecol. Forests, 1000–2000 m, on yellow sandy or ultra-basic soil. *Fl.* April–May, *fr.* Aug. –April.

Note. Non-Malesian records of *Q. lineata* relate to different species.

17. Quercus steenisii SOEPADMO, Gard. Bull. Sing. 21 (1966) 389, f. 4; *ibid.* 22 (1968) 411, map 3.

Tree, *c.* 15 m, *c.* 60 cm ø. Branchlets initially densely brownish stiff-pubescent, late glabrescent, lenticellate; terminal buds ovoid-ellipsoid, 1–1½

Fig. 34. *Quercus lineata* BL. *a.* Habit with ♂ rachis, ×⅔, *b.* ♂ flower, ×4, *c.* ♂ flower seen from above, ×4, *d.* stamen, ×8, *e.* habit with ♀ rachis, ×⅔, *f.* ♀ flower, ×4, *g.* style, ×8, *h.* longitudinal section of a ♀ flower, ×4, *i.* ripe cupule and fruit, ×⅔ (*a* HOLTTUM SF 31253, *b–d* RSNB 4927, *e–h* MEIJER SAN 38069, *i* RAJAB 607).

by ½ cm. Stipules linear, 5–10 by 1–2 mm. *Leaves* thick-coriaceous, ovate-elliptic or ovate-orbicular, 3–8 by 2–5 cm; base rounded, obtuse, or cordate, top rounded, emarginate or bluntly acute; margin entire or remotely serrulate in the apical half; above with some brownish, stiff simple hairs, glabrescent, beneath brownish, woolly tomentose, soon glabrescent; midrib and nerves prominent beneath, keeled or flattened above; nerves 6–10 pairs, straight, parallel, arcuating towards the margin, at an angle of 45–60°; reticulation scalariform, prominent beneath, dense; petiole 2–5 mm long, adaxially flat. *Male rachis* 5 cm; bracts ovate-obtuse, *c.* 2 by 1 mm, densely pubescent; ♂ flowers: filaments 1–1.3 mm long, anthers *c.* 1 by ½ mm, pistillode replaced by a tuft of stiff, simple hairs. *Young infructescence* 1½–3 cm, sparsely lenticellate, carrying 2–7 young fruits; bracts ovate-acute; perianth thick-coriaceous, staminodes 0–6, rudimentary, styles recurved, 1–2 mm long. *Young cupule* ovoid-globose, densely pubescent; lamellae thick, 3–4, the 2 lower ones denticulate, the others

entire. *Ripe cupule* cup-shaped, obconical, or patelliform, 0.7–1 cm high, 1.2–2½ cm ø, enclosing ⅓–¼ part of the fruit; lamellae 7–8, ± recurved, densely brownish pubescent. *Fruit* globose or ovoid, densely brownish tomentose, glabrescent, 1–2 cm through; top rounded- or depressed-umbonate, base convex or flat.

Distr. *Malesia*: N. Sumatra (Gajo Lands).

Ecol. Mossy forest on ridges, 2000–3350 m. *Fl.* Jan., *fr.* Febr.

Note. The female rachis and flowers are as yet unknown.

18. Quercus treubiana VON SEEMEN, Bull. Dép. Agr. Ind. Néerl. 1 (1906) 3; A. CAMUS, Chênes 1 (1938) 368, t. 33: 15–17; SOEPADMO, Gard. Bull. Sing. 22 (1968) 412, f. 17, map 15. — *Cyclobalanopsis treubiana* (VON SEEMEN) SCHOTTKY, Bot. Jahrb. 47 (1912) 648.

Tree, *c.* 30 m, *c.* 60 cm ø, bole irregular; buttresses up to 1 m tall; bark rough, peeling off profusely into rectangular pieces, rusty; inner bark *c.* 1½ cm thick, ridged. Branchlets initially densely brownish pubescent, later glabrous, lenticellate; terminal buds ovoid-ellipsoid, scales linear-acute. Stipules linear-acute, 5–10 mm, densely pubescent. *Leaves* thin-chartaceous, linear-lanceolate or elliptic-lanceolate, 3–10 by 1–3 cm; base attenuate-acute, sometimes asymmetrical, top sharply acute or ½–1 cm acuminate; margin remotely serrulate in the apical half; beneath densely pubescent, glabrescent, above glabrous except the midrib and nerves; midrib and nerves more or less prominent on both surfaces; nerves *c.* 5–10 pairs, straight, parallel, arcuating towards the margin, at an angle of 45–60°; reticulation obscure on both surfaces; petiole ½–1½ cm, adaxially flat. *Male flowers*: perianth densely sericeous outside, filament *c.* 2 mm, anther ½–1 mm through, pistillode reduced to a tuft of stiff, simple hairs. *Young infructescence*: rachis 1–2 cm by 1–2 mm, densely woolly pubescent, glabrescent, carrying 2–5 young fruits; bracts ovate-acute, 1–1½ by ½–1 mm, densely tomentose; perianth (in young fruit): styles recurved, *c.* 2 mm. *Young cupule* ovoid-globose or obconical, lamellae *c.* 6, densely tomentose. *Ripe cupule* cup-shaped, base attenuate-rounded, 1½–2 cm high, 1–2 cm ø, covering ⅓–½ part of the fruit; lamellae 10–12, thick, densely sericeous. *Ripe fruit* cylindrical-globose, 2–3 by 1½–2 cm; top depressed-umbonate, base convex.

Distr. *Malesia*: Sumatra (near Palembang), Borneo (Sabah: Mts Kinabalu and Tambuyokan; Kalimantan: scattered).

Ecol. Forests, 600–2100 m, on sandy waterlogged soil. *Fr.* July–Aug.

Note. The female rachis is not yet known.

19. Quercus elmeri MERR. Pl. Elm. Born. (1929) 43; A. CAMUS, Chênes 1 (1938) 194, t. 4: 9–12; SOEPADMO, Gard. Bull. Sing. 22 (1968) 414, f. 18, map 16.

Tree, 18–40 m, 25–60 cm ø; bark greyish brown, cankered with longitudinal rows of lenticels or scaly, inner bark ½–1½ cm thick, fibrous, reddish brown; buttresses narrow, up to 1.3–3 m tall. Branchlets initially densely rufous-tomentose, later glabrous, lenticellate; terminal buds subglobose, 3–5 by 4–5 mm. Stipules linear-acute, 5–7 by 1 mm. *Leaves* thin-coriaceous, elliptic-lanceolate or elliptic-oblong, 5–14 by 1–5 cm; above glabrous, glossy, beneath densely rufous-tomentose, glabrescent; base attenuate-acute, usually asymmetrical, margin remotely serrulate near the acute or sharply acuminate apex; midrib and nerves strongly prominent beneath, flattened or slightly raised above; nerves 5–12 pairs, parallel, arcuating towards the margin, at an angle of 60–70°; reticulation fine, subscalariform, obscure on both surfaces; petiole 1–3 cm, terete or adaxially flat. *Young infructescence* 1–2 cm, carrying 1–5 young fruits; bracts linear-acute, 1–2 mm long, densely tomentose; perianth of the ♀ flower (in young fruit): staminodes 0, styles 2–3 mm, recurved. *Young cupule* ovoid-conical; lamellae 3–4. *Ripe cupule* shallowly cup-shaped, or patelliform, 5–7 mm high, 2–2½ cm ø, covering ⅓–¼ part of the fruit; lamellae 5–7, thick; rim denticulate; base truncate or rounded. *Ripe fruit* ovoid-conical or conical-cylindrical, 2–3 by 1½–2 cm, densely sericeous, glabrescent; base truncate or convex, top rounded- or depressed-umbonate.

Distr. *Malesia*: Central Sumatra, Malay Peninsula (Pahang), Borneo (N. Sarawak; Sabah; W. of Samarinda in Kalimantan).

Ecol. Forests, up to 1400 m, on sandy loam or ultra-basic soil. *Fr.* Sept. –April.

Note. Inflorescences not known.

Excluded

Quercus litoralis BL. Mus. Bot. 1 (1850) 303; MIQ. Fl. Ind. Bat. 1, 1 (1856) 864; A. DC. Prod. 16, 2 (1864) 106; KING, Ann. R. Bot. Gard. Calc. 2 (1889) 90; A. CAMUS, Chênes 3 (1954) 1161. — *Pasania litoralis* (BL.) OERST. Kong. Danske Vid. Selsk. Skrift. V, 9 (1871) 379.

The type (BLUME *s.n.*) now preserved in Leyden, has been identified by Dr. A. J. G. H. KOSTERMANS as *Cyclandrophora scabra* HASSK. (*Rosaceae*).

5. TRIGONOBALANUS

FORMAN, Taxon 11 (1962) 140; Kew Bull. 17 (1964) 381; *ibid.* 21 (1967) 331.— **Fig. 35–38.**

Trees. Innovations densely set with fulvous to rufous adpressed and erect, simple

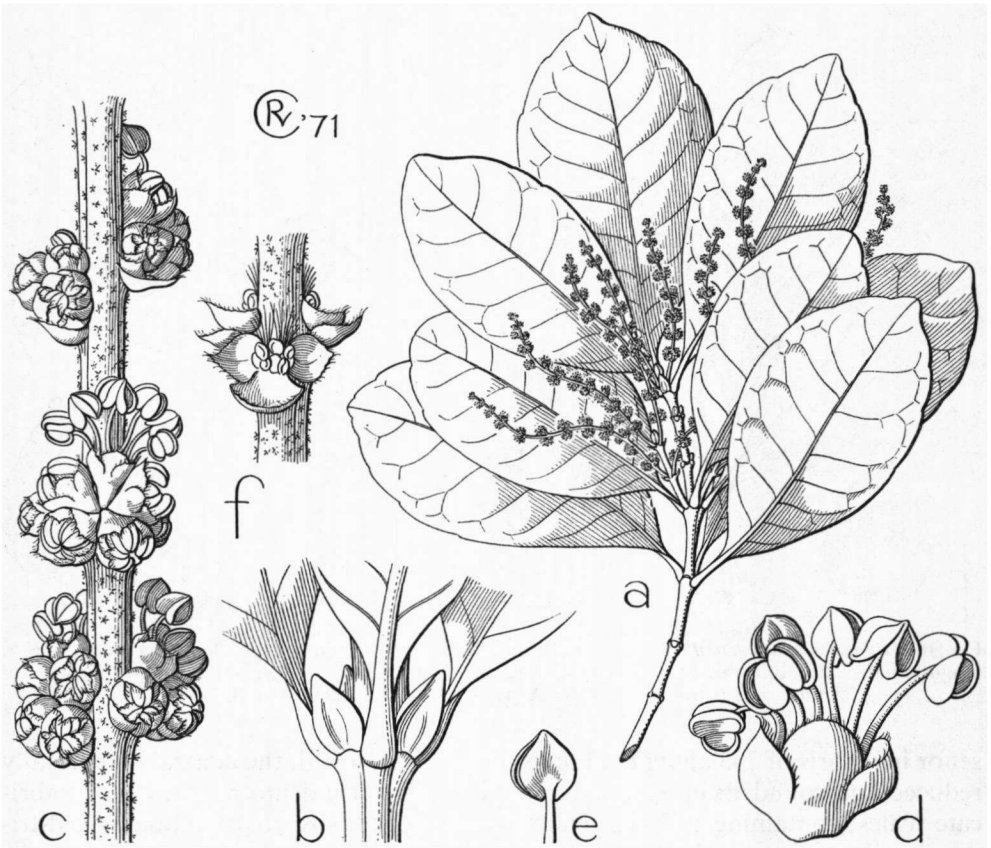

Fig. 35. *Trigonobalanus verticillata* FORMAN. Male. *a.* Habit, ×⅔, *b.* node, showing stipules, ×5, *c.* ♂ rachis, ×6, *d.* ♂ flower, ×12, *e.* stamen, ×8, *f.* bract and bracteoles, ×8 (*a* POORE 1337, *b–c* CORNER RSNB 2732, *d–f* WHITMORE FRI 8631, *e* from Kew Bull. 17, 1964, 382, *f.* 1, 5).

and stellate hairs. Terminal buds ovoid, scales imbricate. Stipules extra- or interpetiolar. *Leaves* spirally arranged or in whorls of 3. *Inflorescence* catkin-like, male, female, androgynous or mixed. *Male rachis* slender, erect or pendent, simple or with some lateral branches, arising from the axil of a lower, normal leaf or in the axil of reduced leaves and crowded together in a lateral or subterminal paniculate cluster. *Male flowers* in dichasial clusters of (1–)3–7(–12), subtended by a bract and bracteoles; perianth membranous, campanulate, 6-lobed, the lobes imbricate; stamens 6, filaments free, exserted, anthers ovoid, ½–1 mm long, cordate at the base, basifixed, 2-loculed, longitudinally dehiscent; pistillode replaced by a cluster of erect simple hairs. *Female, androgynous* or *mixed rachis* slender, erect, not branched, arising from the axil of al higher leaf. *Female flowers* in dichasial clusters of (1–)3–7(–15), subtended by a bract and bracteoles; perianth with 6 imbricate lobes, the lower parts adnate to the ovary; staminodes 6, well-developed and exceeding the perianth or remaining shorter than the perianth, sometimes polliniferous; ovary 3-celled, ovules 2 per cell, axillary and apical; styles 3, recurved or connate at the base, stigmas capitate. *Cupule* sessile or ⅓–½ cm stalked, spirally

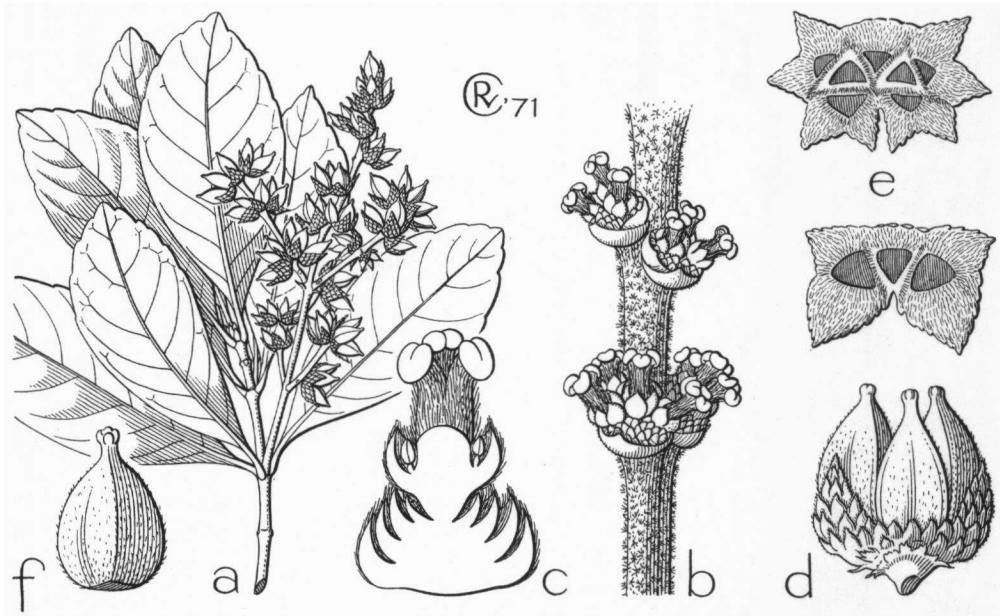

Fig. 36. *Trigonobalanus verticillata* FORMAN. Female. *a.* Habit, in fruit, ×⅔, *b.* flowering rachis, ×6, *c.* longitudinal section of ♀ flower, and cupule, ×12, *d.* fruiting cupule, ×6, *e.* cupules showing scars of nuts, ×6, *f.* nut, ×6 (*a*, *d–f* ASHTON 19624, *b–c* ILIAS PAIE S 26547).

set or in whorls of 2–3 along the rachis, open, 3–12-lobed, the adaxial lobe usually reduced and rounded; outside covered with transverse dentate lamellae or imbricate scales; containing 1–7(–12) fruits. *Fruit* trigonous in cross-section, ovoid-triangular in outline; wall thinner than ½ mm, for the greater part free from the cupule. Germination epigeal.

Distr. Two species, one in N. Siam (Mts Doi Chang and Doi Nang Ka, in Chieng Mai Prov., ±19° N, 99°E) and one in *Malesia*: Malay Peninsula, Borneo, and Central Celebes. Fig. 39.

Ecol. Confined to everwet, montane forest at 850–1765 m; in Malesia *fl.* Aug.–June, *fr.* April–Nov., in Siam *fl.* Nov. - Jan., *fr.* March.

1. Trigobalanus verticillata FORMAN, Taxon 11 (1962) 140; Kew Bull. 17 (1964) 383, f. 1 & 2. — **Fig. 35–38.**

Tree 10–36 m, 20–70 cm ø, sometimes fluted, producing many sucker-shoots at the base; bark smooth, shallowly fissured to scaly, pale grey-brown. *Branchlets* initially rather densely fulvous to rufous stellate-hairy, trigonous, later glabrous, terete, dark greyish brown, densely lenticellate or verrucose, lenticels minute; terminal buds ovoid, 3–5 by 2–4 mm, scales narrowly ovate. Stipules interpetiolar, ovate-lanceolate, 4–5 by 2–3 mm, sparsely stellate-hairy, soon caducous, leaving prominent scars. *Leaves* in whorls of 3, coriaceous, rigid, (4–)6–8(–12) by (2–)3–4(–5½) cm (index 1.8–2.5), broadest at or slightly above the middle; above glabrous, dull to glossy, beneath sparsely puberulous by stellate hairs, especially on midrib and nerves; base acute to cuneate, decurrent, margin crenate in the apical half, or entire and recurved, top bluntly acute to rounded emarginate; midrib prominent beneath, slightly so above; nerves (6–)7–8(–10) pairs, prominent beneath, slightly so above, subparallel, at an angle of 50–70°, arcuating but not anastomosing towards the margin; reticulation irregular to areolate, obscure to rather distinct beneath; petiole (3–)5–8(–10) mm, 1–2 mm ø, adaxially flat, thickened and rugose at the base. *Inflorescence* male, androgynous or mixed, sparsely pubescent by stellate hairs; bracts and bracteoles membranous, broadly to narrowly ovate-acute, ciliate, ½–1 by 1–1½ mm. *Male rachis* 5–10 cm, 1 mm ø, erect, simple or much-branched, arising from the axils of normal, lower leaves or in the axils of reduced leaves and crowded together in lateral or subterminal paniculate clusters; ♂ flowers in clusters of 3–12, perianth usually 6-lobed, filaments *c.* 1 mm, an-

Fig. 37. *Trigonobalanus verticillata* FORMAN. Tree habit showing the basal suckers, Mt. Kinabalu, Sabah (CORNER, 1964).

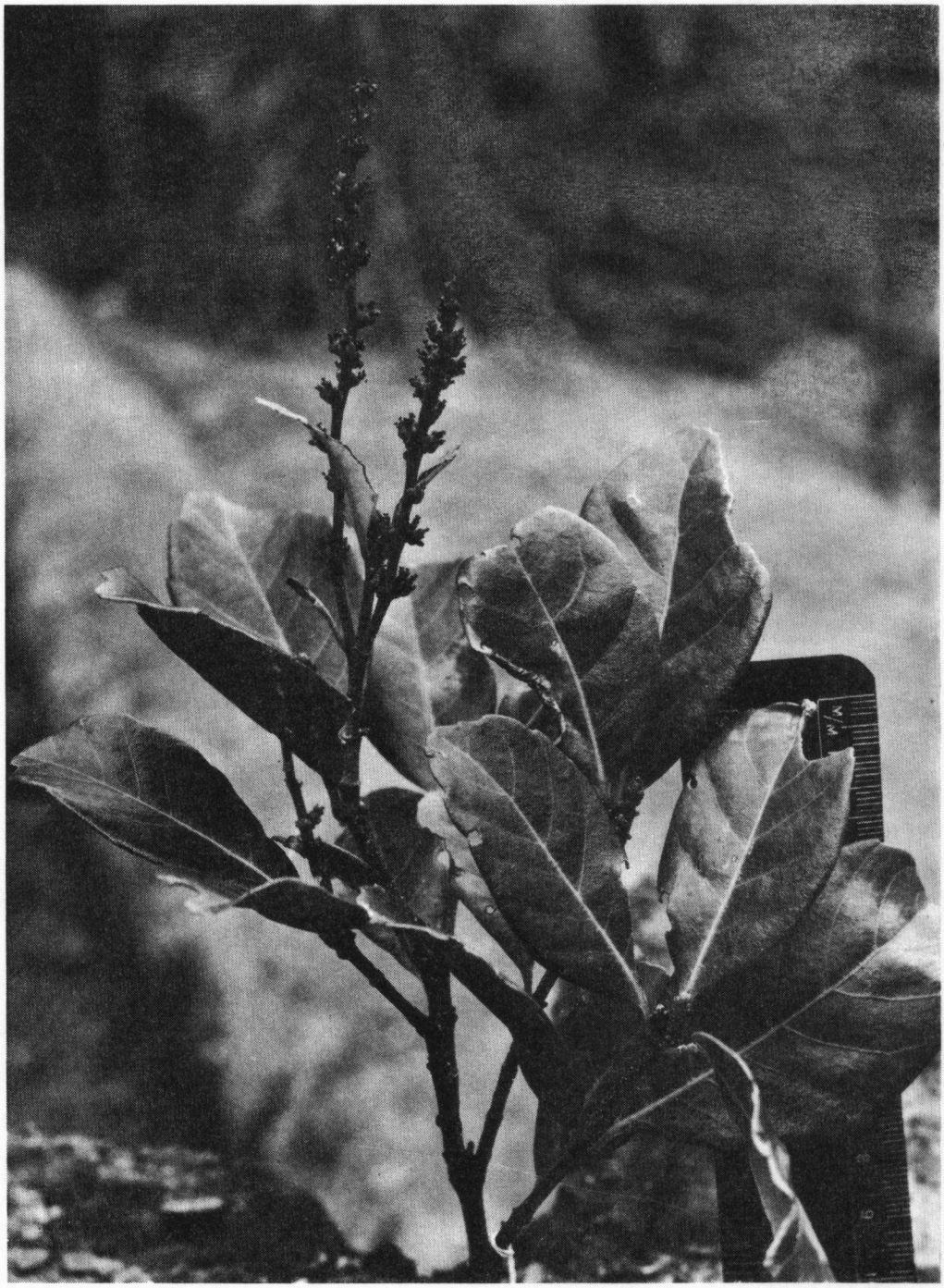

Fig. 38. *Trigonobalanus verticillata* FORMAN. Branchlets with two ♀ rachis, Mt Kinabalu, Sabah (CORNER, 1964).

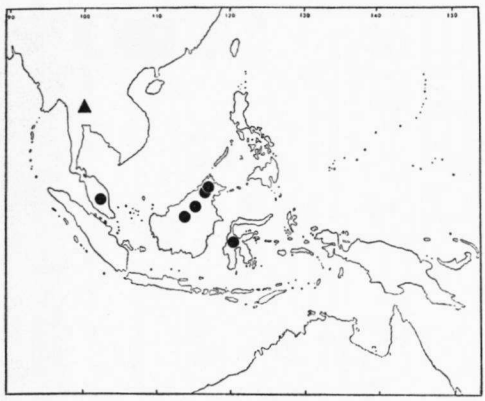

Fig. 39. Distribution of the genus *Trigonobalanus*, *viz T. verticillata* FORMAN (dots) and *T. doichangensis* (A. CAMUS) FORMAN (triangle).

thers ½–1 mm long. *Androgynous* or *mixed rachis* 5–10 cm, 1½–2 mm ø; *female flowers* in clusters of 3–7(–15), rarely solitary, staminodes 6, rather well-developed but not exceeding the perianth, styles terete, *c.* 1 mm, connate but at the distal part. *Infructescence* 5–10 cm, 2–3 mm ø, carrying numerous cupules arranged in whorls of 2–3, rachis more or less triangular. *Ripe cupule* sessile, enclosing (1–)3–7(–10) fruits, 4–6 mm long, width 8–15 by 5–10 mm, open, 3–12-lobed, the lobes acute, 3–4 mm long, inside densely fulvous tomentose by adpressed simple hairs, outside densely yellowish brown to fulvous stellate hairy and with 4–7 transverse rows of acutely denticulate lamellae. *Ripe fruit* sharply trigonous but not winged, 5–7 mm long, near the base 3–5 mm wide, outside sparsely stellate hairy; base truncate, scar flat, triangular, *c.* 2 mm ø, top acute.

Distr. *Malesia*: Malay Peninsula (common on Fraser Hill), Borneo (Sarawak: Mt Hose, Carapa Pila, Balleh, Ulu Baram; Sabah, common on Mt Kinabalu), Central Celebes (twice collected from Pena, above Binuang, Mamasa, at 3° S, 119° 3′ E). Fig. 39.

Ecol. Forests at 850–1500 m, usually on ridges, on blackish ultra-basic or loamy soil overlying Tertiary sandstones. *Fl.* Sept.–Febr., *fr.* April–Nov.

Both in Malaya and Borneo, the species grows gregariously in association with *Dacrydium elatum*, *Podocarpus imbricatus*, and *Agathis alba*.

Vern. Borneo: *bĕrangan bĕluyan*, Iban, *salad rettan* Kelabit; Celebes: *mĕrang*, Toradja.

Note. Leaves collected from a basal shoot and also from the seedling measured 12–18 by 4–6 cm, with a long acuminate top, and are either alternate or decussate; the stipules are linear, up to 6 by 2 mm. Both in Malaya and in Borneo, the main trunk has been reported after dying off to be replaced by several subsidiary boles arising from the sucker-shoots. Fig. 37.

Dr. D. H. MAI (Jb. Geol. 3 für 1967, 1970, 381–409, t. 1–4) has attributed fossil remains of *Dryophyllum* from Europe to *Trigonobalanus*, which would enormously extend its former range. Mr. FORMAN rejects this reduction.