

HAMAMELIDACEAE (W. Vink, Leyden)

Evergreen (or deciduous) shrubs or trees. Buds perulate (or naked); innovations flush-wise. *Leaves* simple, spirally arranged (rarely opposite), usually penninerved, less often 3–5-plinerved, with entire, crenate-serrate or dentate margins, often slightly oblique at the base. Indument often stellate, tufted or lepidote. Stipules usually present, very small to large. *Flowers* free or connate, in heads, spikes or racemes, ♂, polygamous or unisexual and monoecious (rarely dioecious), usually actinomorphic, usually 4–5-merous, with alternate whorls of floral parts. *Sepals* usually small or lacking. *Petals* often linear or ligulate, often rolled in bud, sometimes lacking. *Stamens* free, often in two whorls, the inner ones staminodial; anthers almost always basifix; connective often produced. *Disk* if present annular or represented by small lobes. *Ovary* consisting of 2 (exceptionally 3) carpels often free at the apex, 2-celled, usually more or less inferior; styles 2, free, long, less frequent short, often recurved, frequently persistent and hardened in fruit; stigmas small and apical or adaxially decurrent along the styles. *Ovules* 1–2 and pendent or 5–∞ and inserted on the dissepiment (or parietal), anatropous, with 2 integuments. *Capsules* 2-celled, in the lower half connate with the receptacle to various degree, rarely superior or perigynous, usually loculicidal and septicidal, hence 4-valved, endocarp often loosening from the exocarp. *Seeds* 1–∞ (in the latter case only very few fertile), sometimes winged; albumen rather thin, embryo straight, cotyledons leaf-like, radicle short.

Distr. Mainly holarctic in the Old World; temperate and warm temperate, but also in Africa and Madagascar, in South East Asia (absent in the Deccan Peninsula and Ceylon, similarly as *Fagaceae*!), throughout Malaysia, in Australia very rare in N. Queensland (*Ostrearia* and an unnamed genus), absent from the Pacific Islands, S. America, and Europe. The present centre of development in Asia, specially China.

A peculiarity of the family is the rather large number of small genera, viz monotypic 13 genera, 2 species 3 genera, 3–10 species 6 genera, and over 10 species 3 genera. Furthermore their affinities point to ancient, disjunct, relict distributional areas, for example the gondwana-land distribution of the affinity *Dicoryphe* (Madagascar), *Maingaya* (Mal. Peninsula), *Embolanthera* (Palawan), and *Ostrearia* and an unnamed genus (N. Queensland). The genus *Distylium* shows a marked Pacific disjunction, between Malaysia, East Asia and Central America.

Ecol. In Malaysia constituents of the fagaceous-lauraceous rain-forest at low and medium altitudes in the hills and mountains, just reaching into the inferior portion of the subalpine zone. In Malaysia only *Altingia* shows a rather social occurrence.

Though in more high latitudes representatives may be deciduous, in Malaysia all are evergreen and show at most a simultaneous appearance of flush and flowers from the perulate buds with accompanied rapid fall of old foliage.

Foliar dimorphism. Several genera show a marked dimorphism in the leaves, mainly due to ontogenetic development; an example is that in *Symingtonia*. Fig. 7.

Galls. Various galls have been described; they are caused by gall-mites and -midges in *Altingia*, *Distylium*, and *Sycopsis*; those in *Distylium* are frequent and conspicuous structures (fig. 4).

Pollination. No definite data have come to our knowledge; many representatives are obviously adapted to wind pollination. A marked exception is *Rhodoleia* which is clearly adapted to pollination by animals of which some observations are recorded on p. 374.

Dispersal. It is remarkable that RIDLEY in his compilation on dispersal does not mention any records of the family. The seed is winged in many species, but the wings are often small and sometimes early caducous.

There is a distinct tendency in species with many-seeded capsules to develop only one fertile seed in each cell.

In *Altingia* it has been observed that the seeds, which contain fat oil, attract a number of animals (monkeys, birds) and that seeds are also dispersed (and eaten?) by certain kinds of ants, though no obvious elaiosome is developed.

Morphology. *Distylium* and *Sycopsis* have generally been described as possessing sepals; their number would be variable (0–6) in a single inflorescence. As has already been observed by HEMSLEY

(Hook. Ic. Pl. IV, 9, 1907, t. 2835, 2836) it is difficult to draw a line between the so-called 'sepals' and bract(eole)s.

In adding the numbers of 'sepals' and bract(eole)s as found by HEMSLEY in a Chinese species it appeared that the numbers 3 and 6 were of frequent occurrence and were repeated in the androecium. This has proved a significant feature for the interpretation of the floral structure.

I have verified this regularity with the Malaysian species of *Sycopsis* and *Distylium*. A schematic diagram of the situation in both genera, as far as could be ascertained from herbarium material, is given in fig. 1, in which for convenience bracts and 'sepals' have not been drawn to the same scale. In most cases it appears that the groups of appendages are mostly opposite except in a few cases where they stand at an angle. In *Sycopsis dunnii* (fig. 1S) the number of groups of appendages is rather irregular and they are inserted both on the outer side and on top of the urceolate receptacle. In *Distylium* (fig. 1D) the most apical groups of appendages are inserted just below the superior ovary. It was observed that in several cases the central appendage of each group of 3 had a leaf-like appearance (fig. 1 Da), but the 2 lateral ones were always about lanceolate in shape.

As in both *Sycopsis* and *Distylium* stipules occur, I assume that each group of appendages represents one reduced, bract-like leaf accompanied by two stipules.

In some lateral flowers the number of appendages is less than 3; this seems to be due to lack of space.

In *Distylium stellare* (fig. 1D) the lateral ♂ flowers are sustained by one group of appendages and possess 4(-3) stamens; the distal ♂ flowers are sustained by 2 groups of appendages and contain 8 stamens, suggesting a twin flower; it was impossible to ascertain in herbarium material the precise place of insertion of these stamens. Examination of a distal flower of *D. racemosum* S. & Z. gave strong support to the assumption of the existence of twin flowers; this flower was sustained by 2 groups of appendages containing 1 fertile and 1 rudimentary ovary and 11 stamens of which 2 were inserted *between* the ovaries.

From the above observations I have concluded that both genera are *asepalous* and that in *Distylium* distal flowers are often merged in twos (twins).

In the ♀ flowers of *Altingia* many authors described the presence of a minute calyx limb accrescent in fruit. But the rudimentary stamens are, if present, always inserted *outside* the ring of these minute lobes. In my material I found one ♂ head in which the stamens were arranged in whorls surrounding the ovaries but inserted *outside* this ring of lobules, thus proving that the lobules are in fact disk lobes. In *Syningtonia populnea* there is a similar ring of lobules representing the disk, as NIEDENZU pointed out formerly (Nat. Pfl. Fam. ed. 1, 3, 2a, 1891, 117).

Bract-like lobes are in this genus also found *between* the separate flowers, equalling them in number. For that reason they cannot be accepted as sepals, but are in fact bracts, each belonging to one flower. Their undersurface is covered with the same kind of indument as is found on the axial parts between the flowers.

The remarks made above on the morphological interpretation of the flowers in some genera shows

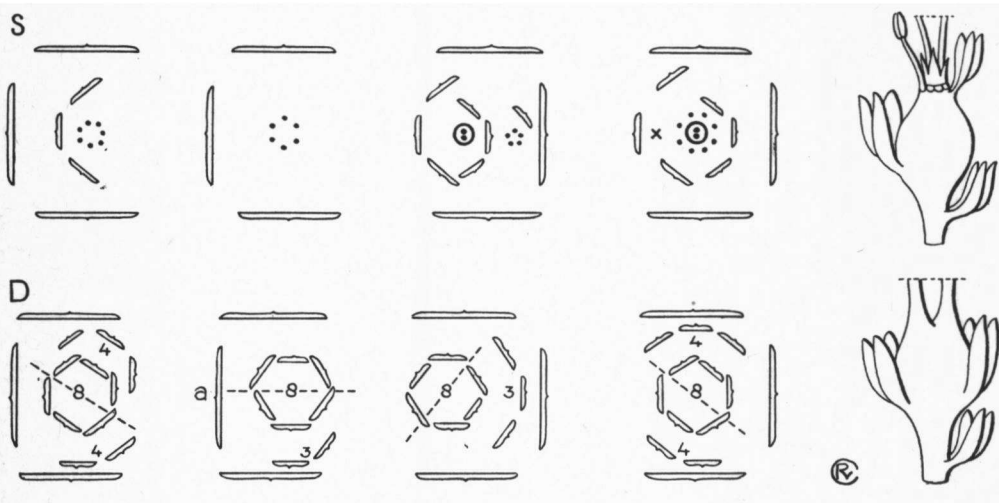


Fig. 1. Diagram of inflorescence and lateral (schematic) view of an enlarged flower of: S *Sycopsis dunnii* HEMSLEY, in which dots are stamens, double dots an ovary, a circle the receptacle, a cross an indistinct body.

D *Distylium stellare* O.K. in which 3, 4 and 8 mean the number of stamens, an interrupted line the presumed demarcation between two connate (twin) flowers, a a leaf-like bract.

For further explanation see the text.

the desirability of detail reinvestigation in other genera (specially *Sinowilsonia*). Such an examination, which is beyond the scope of the present revision may lead to a more precise interpretation of floral structures in this family, which in turn is important for its suprageneric taxonomy.

Wood anatomy. BEEKMAN, Med. Proefstat. Boschw. 5 (1920) 94; DEN BERGER & ENDERT, *ibid.* 11 (1925) 60; DEN BERGER, Determinatietabel Malesië, Veenman, Wageningen (1949) 24, 30, 31, 32; DESCH, Mal. For. Rec. 15¹ (1941) 224 (hand lens). JANSSONUS, Blumea 6 (1950) 425, Key to Jav. woods, Brill, Leiden (1952) 9; METCALFE & CHALK, 1 (1950) 589 (*Distylium*, *Sycopsis*, *Rhodoleia*, *Symingtonia* (*Bucklandia*), *Altingia*); MOLL & JANS. Mikr. 3 (1918) 301 (*Altingia*, *Distylium*); TIPPO, Bot. Gaz. 100 (1938) 45 & 66 considers the family to be a derivative of the *Magnoliales*. JANSSONUS (1950) *l.c.* mentions structural similarity with *Daphniphyllum* and *Theaceae*. The *Casuarinaceae* are higher than the *Hamamelidaceae* in every wood anatomical character (TIPPO, *l.c.* 71) and so support HUTCHINSON's derivation of the *Casuarinaceae* from the *Hamamelidaceae*.—C.A.R.—G.

Uses. In Malaysia most representatives do not attain large sizes and do not occur in such quantity to be important as timber trees. An exception is *Altingia* which by its good timber, obtainable in large sizes and quantities, is one of the most estimated trees of the West Javanese mountain forest.

The Sundanese people in West Java use its flush as a vegetable (lalab).

The aromatic resin of *Altingia*, obviously produced secondarily after injury of the bark and sapwood, is collected for local use.

For reforestation purposes and for timber *Altingia* has been employed by the Indonesian Forest Service on a large scale both in its native area and outside it; *Distylium* and *Symingtonia* have occasionally been used for the same purpose.

Rhodoleia is a beautiful tree for parks and along waysides in the hill areas by its attractive foliage, pretty flowers, and moderate size.

Notes. In the new edition of the 'Pflanzenfamilien' (1930) HARMS recognized the following sub-families¹:

(1) *Disanthoideae* (only *Disanthus*, Japan).

(2) *Hamamelidoideae* (5 tribes):

Tribe: *Hamamelideae* (*Maingaya*, *Embolanthera*, *Loropetalum*, *Dicoryphe*, *Ostrearia*, etc.).

Tribe: *Distyliaceae* (*Distylium*, *Sycopsis*, *Sinowilsonia*).

(3) *Rhodoleioideae* (*Rhodoleia*).

(4) *Bucklandioideae* (*Symingtonia*, *Chunia*).

(5) *Liquidambaroideae* (*Liquidambar*, *Altingia*).

Hamamelidaceae show several characters in common with *Euphorbiaceae*: mostly stipules, often stellate (or lepidote) indument, and in the capsules endo- and exocarp often separating, but the latter is persistent. These characters apparently do not reflect taxonomic relationship with this family.

About the taxonomic position of the family opinions vary. R. BROWN, LINDLEY, and NIEDENZU compare the *Hamamelidaceae* with the *Bruniaceae*. The latter were inserted in the *Rosales* by VON WETTSTEIN, but referred to the *Hamamelidaceae* by GARDNER.

BAILLON merged *Hamamelidaceae* with *Saxifragaceae* arranging *Hamamelidaceae* and *Liquidambaraceae* as tribes in the *Saxifragaceae*. HOOKER *f.* admitted that he could hardly separate the *Hamamelidaceae* from the *Saxifragaceae*.

HALLIER *f.* made a very wide definition of the *Hamamelidaceae* uniting them with *Buxaceae*, *Casuarinaceae*, *Daphniphyllaceae*, and others. He derived them from the *Betulaceae*.

Most recent authors accept the arrangement of VON WETTSTEIN of the *Hamamelidaceae* with the *Platanaceae* and some other small families in the *Hamamelidales* with relationships to *Rosales*.

For wood-anatomical characters see above.

The structure of the pollen shows similarity with that found in *Platanaceae*, *Eucommiaceae* (both inserted by HUTCHINSON in *Hamamelidales*), *Trochodendraceae*, and *Cercidiphyllaceae*.

The subfamily of the *Liquidambaroideae* (*Liquidambar* and *Altingia*) has a somewhat isolated position in the *Hamamelidaceae* by the following characters: the flowers are unisexual and apetalous; there occur medullary secretory canals which otherwise are only present in *Mytilaria*; the pollen grains are polyporate, in contrast to the remaining part of the family where they are usually 3-colpate or 3-colporoidate.

Some authors have considered the *Liquidambaroidae* to represent a distinct family, but there is a very close connection with the other subfamilies through *Symingtonia*.

(1) *Mytilaria* is insufficiently known and not yet placed.

KEY TO THE GENERA

(based on fertile material)

1. Flowers in distinctly peduncled heads, heads rarely (in ♂ *Altingia* always) in racemes.
2. Heads rayed with a large involucre 5. *Rhodoleia*
2. Heads not rayed. Involucre absent or small.
3. Stipules very large, cohering 6. *Symingtonia*
3. Stipules small, not cohering.
4. Leaves crenate-serrate. Stipular scars punctiform or absent. Heads unisexual 7. *Altingia*
4. Leaves entire. Stipular scars annular. Flowers bisexual 1. *Maingaya*
1. Flowers in (sometimes short) spikes or racemes.
5. Petals long, 2-lobed at the base. Connective horn-like. Indument of simple hairs. 2. *Embolanthera*
5. Petals absent. Connective apiculate.
6. Ovary setose-pilose, enveloped by a persistent, lepidote receptacle. Indument lepidote. 4. *Sycopsis*
6. Ovary stellate-hairy, not enveloped by a receptacle. Indument lepidote and stellate-hairy. 3. *Distylium*

KEY TO THE GENERA

(based on vegetative characters)

1. Stipules leaving annular scars.
2. Stipules large, cohering. Leaves 3-plinerved 6. *Symingtonia*
2. Stipules small, not cohering. Leaves penninerved 1. *Maingaya*
1. Leaf scars not annular, small or absent.
3. Leaf margin glandular-crenate-serrate (fig. 8) 7. *Altingia*
3. Leaf margin entire or spiny-dentate.
4. Stipules absent 5. *Rhodoleia*
4. Stipules present, caducous.
5. Stipules at least in part capitate-glandular pectinate at the base 2. *Embolanthera*
5. Stipules entire 3. *Distylium* & 4. *Sycopsis*

1. MAINGAYA

OLIVER, Trans. Linn. Soc. 28 (1873) 517, t. 44.—Fig. 2.

Evergreen tree with bisexual flowers. *Leaves* entire, penninerved. Stipules small, early caducous, leaving annular scars. *Flowers* in dense, globose heads, free, sessile. *Calyx* closed in bud, before anthesis circumscissile, caducous, leaving a narrow annulus. *Petals* 5, linear-spathulate. *Stamens* 5, alternipetalous; filaments very short, stout; anthers basifix, ellipsoid-obovoid, laterally flattened, with 4 pollen sacs, 2-celled, dehiscing laterally with 4 valves; connective produced into a curved adaxial horn and two abaxial teeth. *Staminodes* 5, epipetalous, adaxially horned as stamens. *Disk* 10-lobed. *Ovary* half-inferior, 2-celled, each cell with 1 pendent ovule; styles 2, very short, slender, stigma apical, minute. *Fruits* shortly and stoutly pedicelled, free, ovoid, 2-celled, 4-valved, woody, to about halfway enveloped by the receptacle. *Seed* 1 in each cell, wingless.

Distr. Monotypic, *Malaysia*: Malay Peninsula.

Note. *Maingaya* differs mainly from both *Loropetalum* R.Br. and *Embolanthera* MERR. in its different calyx and the presence of well developed staminodes, and moreover, from *Embolanthera* by capitate inflorescences and entire petals.

1. *Maingaya malayana* OLIVER, Trans. Linn. Soc. 28 (1873) 517, t. 44; CLARKE, Fl. Br. Ind. 2 (1878) 428; BOERL. Handl. Fl. Ned. Ind. 1, 2 (1890) 454; KING, J. As. Soc. Beng. 66, ii (1897) 307; RIDL. Fl. Mal. Pen. 1 (1922) 691; HARMS, E. & P. Pfl. Fam. ed. 2, 18a (1930) 323.—Fig. 2.

Tree, 6–20 m high, 45–60 cm in diam. or less. Ultimate twigs minutely stellate-pubescent, quickly glabrescent. *Leaves* elliptic to lanceolate oblong or lanceolate, (7–)10–25 by (2–)3–11 cm, acuminate at the apex, slightly oblique, rounded or obtuse

(or sometimes slightly peltate, KING, *l.c.*) at the base, glabrous on either side, firmly chartaceous; midrib prominent above; nerves 7–10 pairs; petioles 12–25 mm, slightly thickened at base and apex, glabrous. Stipules tomentose. *Flowerheads* c. 15-flowered, 2–2½ cm in diam.; peduncle 1 cm or less. *Calyx* puberulous. *Petals* 8–12 by 1½–2 mm. *Filaments* glabrous, ⅓–½ mm long; anthers ⅔–1 mm long; horn ½–⅔ mm long, provided with an adaxial tooth. *Staminodes* slender, laterally flattened, nearly as long as the stamens. *Disk* lobes

free, oblong, small. Free part of ovary grey-hirsute; styles less than 1 mm long. Fruits 10–15 by 8–12 mm; pedicels c. $\frac{1}{2}$ cm long, inserted on the thickened apex of the peduncle; endocarp separating from the exocarp. Seeds narrowly ellipsoid, tapering much to the apex, white.

Distr. *Malaysia*: Malay Peninsula (Penang, Perak).

Ecol. In primary forests, 300–1000 m.

Notes. About ten specimens are now known, 2 from Perak, the others from Penang.

In the specimens at my disposition the flowers possess only 5 staminodes as described by OLIVER; KING (copied by RIDLEY) erroneously recorded to have observed 10 staminodes.



Fig. 2. *Maingaya malayana* OLIVER. a. Flowering twig, $\times \frac{2}{3}$, b. flowerbud with ruptured calyx, $\times \frac{2}{3}$, c. flower in anthesis, $\times 4$, d. ditto, petals removed, $\times 5$, e. staminode, lateral view, $\times 10$, f. fertile stamen, dorsal and lateral views, $\times 14$, g. section of flower (petals & androecium removed) showing the calyx rim, disk lobes, 2 styles, and ovary cells, h. head with 2 dehiscent fruits, nat. size.

2. EMBOLANTHERA

MERRILL, Philip. J. Sc. 4 (1909) Bot. 263.—Fig. 3.

Evergreen trees with bisexual flowers. *Leaves* entire to spiny-denticulate, penninerved. Stipules small, usually glandular-pectinate at the base, early caducous, leaving small scars. *Flowers* in dense, many-flowered, axillary spikes, free. *Calyx* connate, closed in bud, splitting into 2–4 unequal rather irregular lobes, persistent in anthesis. *Petals* 5, linear-spathulate, with two lateral lobes at the base. *Stamens* (4–)5, alternipetalous, filaments very short, stout, anthers basifix, obovoid, laterally flattened, with 4 pollen sacs, 2-celled, dehiscing laterally with 4 valves; connective produced into an adaxial, subulate awn. *Staminodes* lacking. *Disk* lacking. *Ovary* inferior, 2-celled, each cell with 1 pendent ovule; styles 2, slender, very short, with slightly adaxially, decurrent, papillose stigmas. *Fruits* unknown.



Fig. 3. *Embolanthera spicata* MERR. a. Habit and a' separate entire leaf, $\times \frac{2}{3}$, b. calyx, $\times 4$, c. petal, $\times 4$, d. stamen, $\times 10$, e. longitudinal section of ovary, $\times 10$, f. bract, $\times 7$, g. stipule (pectinate type), $\times 7$ (a–g after PNH 12292, a' after BS 739).

Distr. Monotypic, *Malaysia*: SW. Philippines (Palawan).

Notes. This genus is closely related to *Maingaya* OLIV. from the Malay Peninsula and *Loropetalum* R.Br. from Assam and China, differing from both in its spicate inflorescence, in its basally lobed petals, and in the absence of staminodes, from *Maingaya* in addition in its different calyx and from *Loropetalum* in its \pm 5-merous flowers.

1. *Embolanthera spicata* MERR. Philip. J. Sc. 4 (1909) Bot. 263; En. Philip. 2 (1923) 225; HARMS, E. & P. Pfl. Fam. ed. 2, 18a (1930) 324.—Fig. 3.

Tree, 7–10 m high, 15–20 cm in diam. Twigs minutely pubescent or glabrous. *Leaves* ovate, ovate-oblong, or oblong, acute to acuminate, sometimes obtuse to rounded, margin entire and slightly recurved to spiny-denticulate, base slightly oblique, acute, obtuse, or rounded, 7–14 by 3–6 cm, glabrous on either side, firmly chartaceous; midrib impressed above, nerves 7–12 pairs. Petioles $\frac{1}{2}$ –1 cm, minutely pubescent or glabrous. Stipules ovate-lanceolate to linear, very acute 4–5 by $\frac{4}{5}$ – $1\frac{1}{3}$ mm. *Spikes* 3–8 cm long, 1– $1\frac{1}{2}$ cm peduncled, rhachis, peduncle, and calyces minutely whitish stellate-pubescent. *Flowers* white. *Calyx* lobes ovate, 3–5 mm long, acute to acuminate, with a tufted-hairy apiculus. *Petals* 11–20 by $1\frac{1}{2}$ –2 mm, with c. $2\frac{1}{2}$ mm long, basal lobes, just above

these lobes with a sharp inward curve. Filaments $\frac{3}{5}$ –1 mm long, dorsally and ventrally blackish pubescent, curved outward, at the base connate with the base of the petals and falling off with these; anthers $\frac{4}{5}$ –1 mm long, awn $1\frac{1}{3}$ –2 mm. Top of ovary light yellowish short-villous; styles less than 1 mm; stigmas minute.

Distr. *Malaysia*: S. Philippines (Palawan: Mt Victoria).

Ecol. Along rocky river-banks and in forest, 50–250 m.

Notes. This remarkable plant has been found twice only.

MERRILL *l.c.* stated that the calyx is finally circumscissile and caducous, but my material did not allow to verify this statement. The second collection (SULTR PNH 12292) differs from the type specimen by its larger, spiny-denticulate leaves and pubescent twigs and petioles.

3. DISTYLIUM

SIEB. & ZUCC. Fl. Japon. 1 (1835) 178, t. 94; WALKER, J. Arn. Arb. 25 (1944) 322.—Fig. 1D, 4.

Evergreen polygamous-monoecious trees or shrubs. *Leaves* entire or denticulate above the middle, penninerved. Stipules small, caducous, leaving small scars. *Flowers* in headlike spikes or racemes, free, sustained by 0–2 groups of 3(–2) lanceolate small bracts. *Calyx* and *petals* lacking. *Stamens* in ♀ flowers lacking, in ♂ or ♂ flowers 1–8; filaments of varying length, subulate; anthers basifix, ellipsoid, with 4 pollen sacs, 2-celled, dehiscing laterally with 2 longitudinal slits; connective apiculate. Staminodes lacking. Disk lacking. *Ovary* in ♂ flowers lacking, in ♀ and ♀ flowers superior, 2-celled, each cell with 1 pendent ovule; styles 2, subulate, divergent; adaxially with decurrent papillose stigmas. *Fruits* free, 2-celled, 2- or 4-valved, woody; endocarp loosening from the exocarp. *Seeds* 1 in each cell, oblong to ovoid, wingless; albumen present.

Distr. Two species in Central America, ten species from Assam, S. China to Korea and Japan, and in *Malaysia*: S. Sumatra, Malay Peninsula, Java, and Flores.

Notes. *Distylium* differs from *Sycopsis* OLIV. mainly in the absence of a persistent receptacle in ♂ and ♀ flowers, the ovary being exposed and lepidote or stellate-pubescent, never densely setose-pilose.

As is shown on p. 364 the calyx is lacking and the organs described as representing sepals have appeared to be bracts.

1. *Distylium stellare* O. KUNTZE, Rev. Gen. Pl. 1 (1891) 233; KOORDERS, Versl. Kon. Ak. Wet. A'dam sect. B (1909) 948; BACK. Schoolf. Java (1911) 475; KOORD. Exk. Fl. Java 2 (1912) 313; J. J. SMITH, K. & V. Bijdr. 13 (1914) 80; HALLIER *f. Med. Rijksherb. no 37* (1918) 15; DOCT. v. LEEUWEN, Zooecidia (1926) 215, f. 341–342 and Ned. Kruidk. Arch. 51 (1941) 159; HARMS, E. & P. Pfl. Fam. ed. 2, 18a (1930) 331; STEEN. Bull. Jard. Bot. Btzg III, 13 (1934) 219; WALKER, J. Arn. Arb. 25 (1944) 330; BACKER, Brittonia 3 (1938) 79;

Bekn. Fl. Java (em. ed.) 6 (1948) fam. 121, p. 3.—Fig. 1D, 4.

Tree, 12–45 m high, 30–150 cm in diam., bole rather straight to columnar, without buttresses; bark grey. Innovations densely stellate-hairy and stellate-lepidote, glabrescent. *Leaves* ovate, ovate-oblong, oblong or ovate-lanceolate, sometimes obovate or roundish, 4–18 by 2– $6\frac{1}{2}$ cm, acute, acuminate or caudate at the apex, often slightly oblique, rounded, obtuse or acute at the base, margin entire and recurved or (in saplings and

young trees) above the middle of the leaf with 1-3 sharp, glandlike tipped, thickened teeth, when mature glabrous or tardily glabrescent beneath, thin- to firmly coriaceous; midrib impressed above; nerves (3-4-6 pairs; petiole $1\frac{1}{3}$ -10 cm. Stipules lanceolate to linear, 3-7 by $1\frac{1}{4}$ - $3\frac{1}{4}$ mm, very acute at the apex, thinly stellate and stellate-lepidote. ♂ *Spikes* or racemes $1\frac{1}{2}$ - $2\frac{1}{2}$ cm long, rather densely 3-6-flowered, ♀ and ♂ *spikes* or (often branched) racemes $1\frac{1}{2}$ -3 cm long, rather laxly 4-12-flowered, with the axial parts stellate-hairy and stellate-lepidote. Bracts lanceolate, 2-3 by $1\frac{1}{2}$ -1 mm. *Filaments* $1\frac{1}{2}$ -2 mm long, glabrous; anthers $1\frac{1}{2}$ -2 mm long, red. *Ovary* ovoid, $1\frac{3}{4}$ - $2\frac{1}{2}$

by 2- $2\frac{1}{2}$ mm, densely dark-brown stellate-tomentose; styles 4-5 mm. *Fruits* ellipsoid to ovoid, 10-14 by 8-11 mm, subacute, apiculate by short remains of the styles, brown stellate-tomentose. *Seeds* ellipsoid to ovoid, c. 6-7 mm long, whitish, turning brown and shining; hilum apical, slightly impressed, descending shortly on one lateral side.

Distr. *Malaysia*: Malay Peninsula (Pahang: Cameron Highl.), S. Sumatra, Java (Gedeh to Jang), and Lesser Sunda Islands (Flores).

Ecol. Scattered on slopes and ridges in evergreen, mixed rain-forest, locally common, 1000-2700 m; fl. April-Nov., fr. June-Oct.

There are several kinds of galls occurring on this species:

(a) ellipsoid to globose, dark grey-brown or brown, $1\frac{1}{2}$ -3 cm in diam., *in vivo* light green with a peach-coloured hue, caused by an aphid: *Schizoneuraphis gallarum* VAN DER GOOT.

(b) obovoid, about rounded at the apex, acute at the base, yellowish brown stellate-hairy, c. $2\frac{1}{2}$ cm in diam., *in vivo* apparently light-orange coloured, probably caused by another aphid.

(c) long and narrow terete, striate, yellowish brown stellate-hairy, 3-7 by $1\frac{1}{2}$ -1 cm, often curved, with small to rather large, leaf-like wing below the base.

(d) globose, prominent on both sides of the leaf, 5-11 mm in diam.; the young galls are light green with a pink hue, the mature ones are darker or brownish green; caused by an aphid: *Schizoneuraphis distyllii* VAN DER GOOT.

(e) circular to oblong, densely light-brown stellate-hairy patches on the lower side of the leaf, 1-3 by 1-2 mm.

(f) domatia: pitted, glandlike axils of the lateral nerves with the midrib, often bearing small hair-tufts.

USES. In the mountains used for purposes of reforestation, sometimes as a wayside tree (Diëng).

Vern. *Ki tambaga*, *srom*, *ki sirum*, *pangsor*, S, *sêrut* (Slamet), *pitjis* (Diëng), *sientok* (Ungaran), J, none of them apparently well stabilized.



Fig. 4. *Distylium stellare* O.K. Habit of flowering and fruiting twig and a gall, $\times 2\frac{1}{3}$.

4. SYCOPSIS

OLIVER, Trans. Linn. Soc. 23 (1860) 83, t. 8; WALKER, J. Arn. Arb. 25 (1944) 335.—Fig. 1S.

Evergreen polygamous-monoecious trees or shrubs. *Leaves* entire or denticulate above the middle, penninerved. Stipules small, caducous, leaving small scars. Racemes or headlike spikes, initially sometimes involucre-like enclosed by large lower bracts. *Flowers* free, sustained by 0-2 groups of 3(-2) lanceolate small bracts, which occur also on the sides and the top of the urceolate *receptacle*, which envelops the ovary in ♀ and ♂ flowers and bears in the latter also stamens on its top. *Calyx* and *petals* lacking. *Stamens* in ♀ flowers lacking, in ♂ or ♂ flowers 4-10; filaments of varying length, subulate; anthers basifix, ellipsoid, with 4 pollen sacs, 2-celled, dehiscing laterally with 2 longitudinal slits, connective often apiculate. *Staminodes* lacking or, occasionally, a few to numerous stamens, sterile and

slightly smaller. Disk lacking. *Ovary* in ♂ flowers very rudimentary or lacking, in ♀ and ♀ flowers enveloped by the receptacle, free, 2-celled, each cell with 1 pendent ovule; styles 2, subulate, slender, divergent, adaxially with decurrent, papillose stigmas. *Fruits* free, 2-celled, 2- or 4-valved, woody, at the base surrounded by the split receptacle or wholly enclosed by it. *Seeds* 1 in each cell, ovate-oblong, wingless; hilum apical, impressed; albumen thin.

Distr. Seven species from Assam, Central and S. China to Hainan and *Malaysia*: North to Central Sumatra, Malay Peninsula, Philippines (Luzon), Central to S. Celebes, and New Guinea.

Notes. *Sycopsis* differs from *Distylium* SIEB. & ZUCC. mainly in the presence of a persistent receptacle in ♂ and ♀ flowers enveloping the setose-pilose ovary and bearing the stamens on its top.

As is shown in fig. 1 S the calyx is lacking and the parts described as sepals have appeared to be bracts.

1. *Sycopsis dunni* HEMSLEY, Hook. Ic. Pl. 29 (1907) t. 2836; HARMS, E. & P. Pfl. Fam. ed. 2, 18a (1930) 333; CHUN, Sunyatsenia 1 (1934) 245; WALKER, J. Arn. Arb. 25 (1944) 338; STEEN. Nova Guinea 6 (1955) 33, f. 1.—*S. philippinensis* HEMSLEY, l.c. p. 2; MERR. En. Philip. Fl. Pl. 2 (1923) 225; HARMS, l.c.—*Croton curviflorus* ELMER, Leaf. Philip. Bot. 1 (1908) 310.—Fig. 1 S.

Shrub or tree up to 16 m high; bark grey. Innovations yellowish-grey (twigs) or reddish (leaves) stellate-lepidote, glabrescent. *Leaves* broadly elliptic or ovate to oblong or lanceolate, 5–12 by 2–5 cm, coriaceous, acute to acuminate at the apex, nearly rounded, obtuse or acute and shortly decurrent at the base, margin entire, often recurved; midrib impressed, at the leaf-base more or less prominent above; nerves 5–9 pairs; petiole $\frac{1}{3}$ – $\frac{1}{5}$ cm. Stipules lanceolate, acute at the apex, 2–5 by 1–2 mm, yellowish-grey lepidote, glabrescent. *Racemes* or *spikes* 3–6-flowered, 1–2½ cm long, the ♂ inflorescences being the shorter ones, the axial parts densely stellate-lepidote and with ovate, oblong or lanceolate bracts 2–4½ by ½–2 mm, not enclosed initially by involucre bracts. *Receptacle* 2–4 by 2–3 mm, outside densely stellate-lepidote, inside sericeous, with 2–6 scattered bracts on its surface and minute, membranous, irregular, connate lobes up to 1½ mm long on its top inserted inside of the androecium. *Filaments* 2–5½ mm, glabrous or with a few stellate scales; anthers 1½–3 mm long. *Ovary* ovoid to conical, 2–3 by 1½–2 mm, brown setose-pilose; styles 8–13 mm; stigmas red. *Fruits* ellipsoid to ovoid, 11–13 by 6–8 mm, acute and with or without short remains of the styles, light greyish-brown setose-pilose; receptacle spathaceous. *Seeds* ovoid, c.

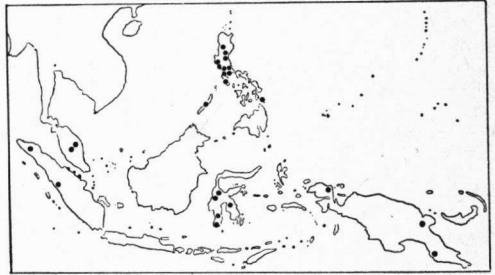


Fig. 5. Malaysian localities of *Sycopsis dunni* HEMSL.

$\frac{3}{4}$ – $\frac{4}{5}$ cm long, dark-brown and very shining; hilum descending shortly on both lateral sides.

Distr. S. China (Yunnan to Fukien) and *Malaysia*: North to Central Sumatra, Malay Peninsula, Philippines (Palawan, Mindoro, Luzon, Dinagat), Central to S. Celebes, and New Guinea.—Fig. 5.

Ecol. Mixed mountain forests, 1100–2200 m, fl. Jan.–June, fr. April, Dec.

Vern. Marapujan, kalek beringin, Sum. West Coast, parukápok, Neg.

Note. WALKER (l.c. 340) reported some minor differences between Chinese and Malaysian specimens, the latter having more often obtuse to nearly rounded leaf-bases.

The lower side of the leaves is frequently provided with domatia: pitted, glandlike nerve axils often bearing small hair-tufts. Sometimes additional pitted glands occur alongside the midrib on the intervenium.

5. RHODOLEIA

CHAMPION ex HOOK. f. Bot. Mag. III, 6 (1850) t. 4509; EXELL, Sunyatsenia 1 (1933) 95.—Fig. 6.

Evergreen trees with bisexual flowers. *Leaves* entire, penninerved, occasionally 3-plinerved. Stipules lacking. *Flowers* connate, 5–10 in peduncled heads. Bracts 12–20, the lower ones small, the higher ones large, broadly rounded at the apex, forming an involucre, caducous after anthesis. *Sepals* connate, minute, forming a slightly lobed calyx limb. *Petals* 0–4, spatulate to obovate, unguiculate, exerted beyond the involucre, only those along the outer margin of the head well developed,

the head hence rayed and resembling a 'flower'. *Stamens* 7–11; filaments long, slender; anthers basifix, oblong, with 4 pollen sacs, 2-celled, dehiscing laterally with 2 septicial slits producing 4 narrow valves; connective apiculate. Disk absent. *Ovary* half-inferior, 2-celled, less frequently imperfectly 2-celled or 1-celled; ovules ∞, inserted on the dissepiment; styles 2, long, very slender, only slightly divergent, apically with minute stigmas, caducous in fruit. *Fruits* 6–10 in heads, only basally connate, woody, ovoid, 2-celled, 4-valved; the receptacle only very slightly enlarged. *Seeds* 10–20 in each cell, most of them sterile, wingless, 0–1 fertile, about triangular in cross-section or flattened, laterally narrowly winged; cotyledons ovate, flat, fleshy; radicles cylindrical, *c.* $\frac{1}{3}$ as long as the cotyledons; albumen rather copious.

Distr. Monotypic; Yunnan to Hongkong and *Malaysia*: Sumatra, Malay Peninsula.

Notes. EXELL (*l.c.*) distinguished 7 species in his revision. In my opinion, however, only one Linnean species can be accepted for this polymorphous population. As I will show below the distinguishing characters everywhere overlap and are, even in a small geographic area, subject to a considerable range of variability. Moreover, they mostly concern sizes and not structural differences.

Extreme specimens may look very different but are linked by a number of intermediates prohibiting to fix sound demarcations even for the distinction of races.

This appears from the following analysis:

a) The length of the capitules is the smallest in *R. teysmanni* (1½–2½ cm) and *R. ovalifolia* (1½–3 cm), somewhat larger in *R. parvipetala* (2–3 cm) and the largest in *R. championi* (3–4¼ cm) and *R. forrestii* (3–4 cm);

b) The length of the anthers varies in the same way (from *R. ovalifolia* with 1½–3 mm to *R. championi* with 3–5 mm);

c) The petals are the narrowest in *R. ovalifolia* (1–3½ mm) and broader in *R. teysmanni* (2–4(–6) mm), *R. forrestii* (3–6 mm), *R. parvipetala* (3–9 mm), and *R. championi* (4–10 mm);

d) The stamens are (in the dried state) 1–3 mm longer than the petals in *R. ovalifolia* and 0–1 mm in *R. teysmanni*; generally the stamens are shorter in the other species, but there are exceptions: 0–2 mm shorter in *R. forrestii*, 1 mm longer to 6 mm shorter in *R. championi* and 1 mm longer to 7 mm shorter in *R. parvipetala*;

e) The leaf-base is very variable. In *R. teysmanni* it is acute, obtuse or rounded, just as in *R. championi sensu stricto*, but in the latter the rounded leaf-base is more prevailing. In *R. subcordata* the leaf-base is subcordate, in a paratype specimen even cordate, but in an isotype specimen there occur also rounded leaf-bases; therefore, there is no sharp delimitation in this character against other species.

f) *R. subcordata* is said to be characterized by a tomentose ovary and fruit. S.F. 28830 should be referred to it according to shape, dimensions, and texture of the leaf, the prominence of the nerves, and the subcordate to rounded leaf-base, but it has, however, glabrous fruits.

g) The degree of persistence of the indument on the undersurface of the leaves varies considerably in both *R. subcordata* and *R. forrestii* and this character appears to have no taxonomical value.

h) Even in one specimen the 3-plinerved leafbase may be present or absent; the distinctness of the basal nerves is a matter of degree.

The single character in which there are no transitions is the indument of the ovary (and fruit), but as explained *sub f* this cannot be accepted as of value.

I have not seen any material of *R. henryi*, but it appears very probable that its characters will fall within the range of variability of *R. championi sens. lat.*

As no good delimiting characters or combinations of characters could be found, I feel obliged to unite all species described into *R. championi*.

1. *Rhodoleia championi* HOOK. *f. Bot. Mag.* III, 6 (1850) t. 4509; VAN HOUTTE, *Fl. Serres* 6 (1850–1851) 87, t. 561, copied from *Bot. Mag.*; LUBBOCK, *Seedl.* 1 (1892) 519, f. 334; EXELL, *Sunyatsenia* 1 (1933) 96.—*R. teysmanni* MIQ. *Versl. Med. Kon. Ak. Wet.* 6 (1857) 123, *incl. f. minor* MIQ. and *f. major* MIQ.; MIQ. *Fl. Ind. Bat.* 1, 2 (1859) 669; *Suppl.* (1860) 532; KING, *J. As. Soc. Beng.* 66, ii (1897) 309; BACK, *Schooffl. Java* (1911) 475; KOORD. *Exk. Fl. Java* 2 (1912) 312; RIDL, *Fl. Mal. Pen.* 1 (1922) 690; PORSCH, *Oest. Bot. Z.* 72 (1923) 147; DOCTERS VAN LEEUWEN, *Trop. Natuur* 16

(1927) 2, f. 1–4; HARMS, E. & P. Pfl. *Fam. ed.* 2, 18a (1930) 336; EXELL, *l.c.* 90.—*R. ovalifolia* RIDL, *J. Str. Br. R. As. Soc. no 75* (1917) 33; *Fl. Mal. Pen.* 1 (1922) 690; HARMS, *l.c.* 336; EXELL, *l.c.* 100.—*R. henryi* TONG, *Bull. Dep. Biol. Yatsen Un.* 2 (1930) 35.—*R. parvipetala* TONG, *l.c.*—*R. forrestii* CHUN *ex* EXELL, *l.c.* 97.—*R. subcordata* EXELL, *l.c.* 101.—*Fig. 6.*

Large shrub or tree, up to 25 m high, bole up to 45 cm in diam. *Leaves* broadly ovate to (ob)ovate-oblong to lanceolate or oblanceolate, 5–13 by 2–6 cm, rounded, obtuse, acute or acuminate

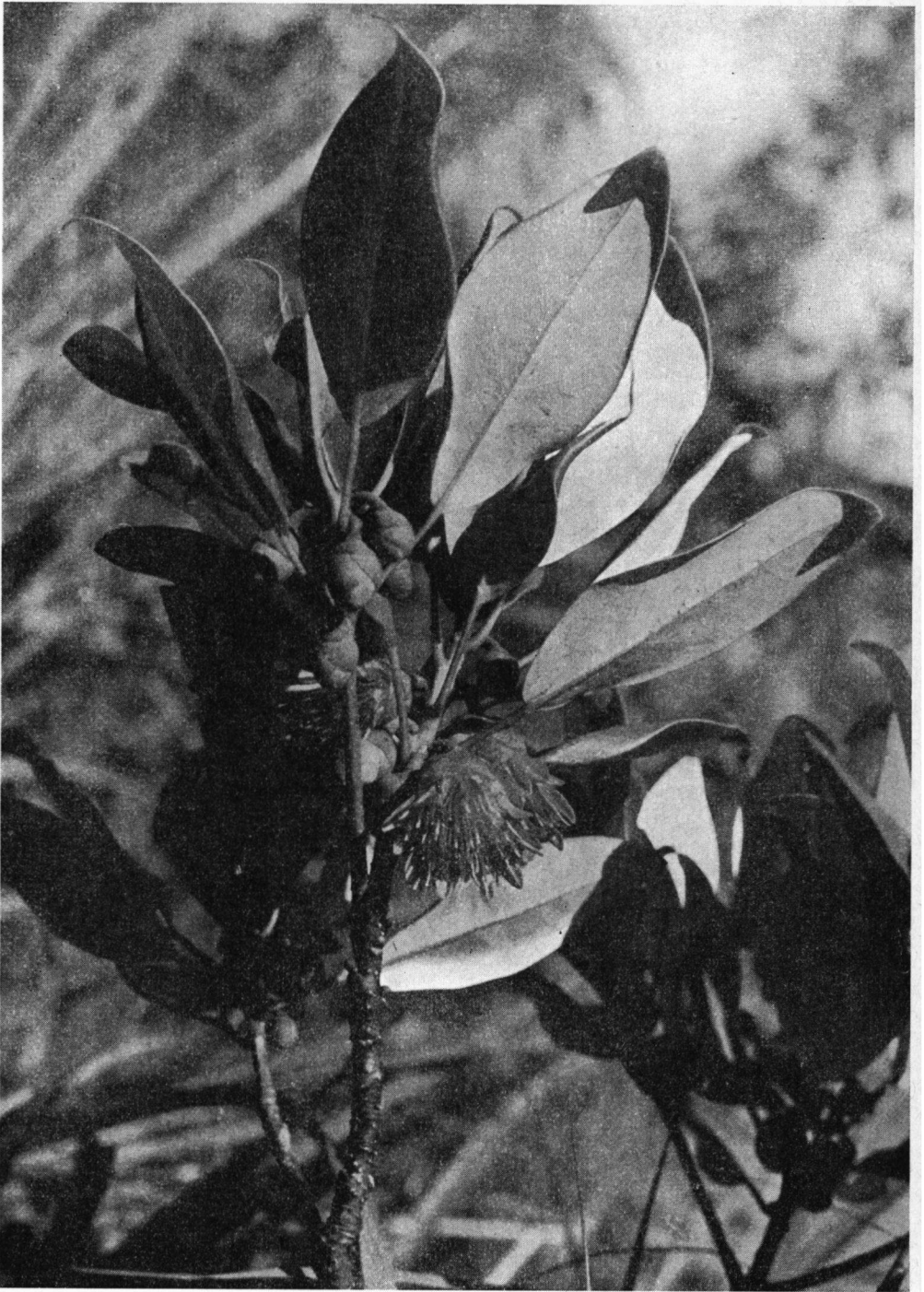


Fig. 6. *Rhodoleia championi* Hook. f. from Mt Bungso near Pajakumbuh, c. 1000 m, Central Sumatra (Photogr. W. MEIJER).

at the apex, cuneate, obtuse, rounded or occasionally (sub)cordate at the base, with a flat or recurved margin, thin or rather firmly coriaceous, often glaucous beneath, glabrous or sometimes with remains of a brown stellate-lepidote or stellate indument, especially beneath; midrib minutely impressed, flat or prominent above; nerves 5-13 pairs. Petioles 2-4½ cm, glabrous or sometimes stellate-tomentose. *Flower heads in sicco* 1½-2½ cm long, hanging or recurved. Lower bracts ferrugineously stellate-lepidote and stellate-hairy, glabrescent, the higher ones densely ferrugineous-tomentose by bundles of basally connate hairs. *Sepals* very thin, glabrous, apically sparsely to densely ferrugineous-ciliate. *Petals* red, 10-20 by 1-4(-6) mm, sometimes with irregular, lateral lobes at or above the middle. *Filaments* 10-18 mm long, glabrous; anthers 1½-3 mm long. *Ovary* glabrous, occasionally ferrugineous-hairy; styles 15-22 mm, glabrous. *Fruit heads* subglobose, 1-1¾ by 1-2½ cm. *Fruits* glabrous, occasionally ferrugineous-hairy, 6-10 mm long. *Seeds* 3½-5½ by 2½-3½ mm, the fertile seeds being the larger ones.

Distr. Yunnan, NE. Upper Burma, Kwangsi, Kwangtung, Tonkin, Hongkong, and *Malaysia*: North to Central Sumatra, Malay Peninsula. Occasionally planted in parks or along waysides in the Javanese mountains.

Ecol. Primary rain-forest, rarely in secondary growths, 330-2000 m, fl. June-Jan., fr. probably Dec.-July.

DOCTERS VAN LEEUWEN has made observations on flower visitors of cultivated trees in the mountain garden Tjibodas, W. Java (Trop. Natuur 16, 1927, 2-4, f. 1-4). He found the pollen not powdery but sticky and flowers to contain abundant nectar obviously produced by small glands surrounding the insertion of the filaments. Several birds are regular flower visitors there, notably *Zosteropidae* (*Zosterops*) and *Nectariniidae* (*Aethopyga*, *Arachnothera*). More occasional visitors are *Pycnonotus analis* and squirrels but these are possibly not regular pollinators and cause damage to the flowers. *Bombus rufipes* has also been observed as a flower visitor.

Uses. Timber is moderately durable and fit for constructions under roof.

Vern. *Sialagundi*, Tapanuli, *kasi bĕranak*, Sidjungdung, *sidukung anah*, Suliki, *santur, mail*, Pajakumbuh, *madang (modang) galundi*, Fort v. d. Capellen, *kasjiebranh, katji barana, kaju barana, santu*, Sumatra.

Note. The specific description has been drawn after Malaysian materials. Specimens from the northern part of the disjunct distributional area (Burma-S. China) generally have somewhat larger floral parts.

6. SYMINGTONIA

VAN STEENIS, Act. Bot. Neerl. 1 (1952) 443.—*Bucklandia* [R.BR. in Wall. Cat. (1832) no 7414 *nom. nud.*] R.BR. ex GRIFF. in As. Res. 19, 1 (1836) 94, t. 13-14 and Ann. Sc. Nat. II, 9 Bot. (1838) 176, *non* PRESL in Sternb. Tent. Fl. Primord. (1825) p. xxxiii, *nec* BRONGN. Prod. Hist. Veg. Foss. (1828) 128.—*Exbucklandia* R. W. BROWN, J. Wash. Ac. Sc. 36 (1946) 348, *nom. nud. invalid.*; STEEN. *Blumea* 7 (1954) 595.—Fig. 7.

Polygamous-monoecious evergreen trees. Twigs thickened at the nodes. *Leaves* entire (or in saplings and young shoots palmately 3-5-lobed), 3-5-plinerved. Stipules large, cohering, caducous, leaving annular scars. *Flowers* connate to the base of the petals, 7-20 in peduncled ♂ and ♀ heads not sustained by bracts, initially enclosed by a pair of stipules.—♂ *Flowers*: each flower subtended by a minute bract; calyx lacking; petals 2-7, linear (-spathulate); stamens 10-14, filament of varying length, subulate, anthers basifix or basidorsifix, oblong, with 2 pollen sacs, 1-celled, dehiscing introrsely with two valves, connective apiculate; disk 5-10-lobed, dorsoventrally flattened; ovary half-inferior, 2-celled, ovules 6-8 in each cell, inserted on the dissipation; styles 2, subulate, divergent, adaxially with decurrent papillose stigmas, caducous in fruit.—♀ *Flowers*: as in ♂, but: petals 4, rudimentary or lacking; stamens lacking. *Fruits* in globose to subglobose, woody heads, obovoid, 2-celled, 4-valved, surrounded by a ring of minute black, glandlike appendages representing the disk. *Seeds* 6-8 in each cell, the 4-5 upper ones sterile, not winged, 1 or 2 lower ones fertile, with a long wing; albumen scant.

Distr. Two species in SE. Asia (from Sikkim and Martaban to Kweichou and Tonkin) and *Malaysia*: Sumatra, Malay Peninsula.

Notes. As PRESL employed the name *Bucklandia* for a fossil cycadoid genus in 1825, it was preoccupied when *Bucklandia* R.BR. ex WALLICH (*nom. nud.*, 1832) and *Bucklandia* R.BR. ex GRIFF. (1836)

were published. In 1946 R. W. BROWN attempted to propose the new name *Exbucklandia* for '*Bucklandia* R.Br.'. He failed, however, to fulfill the conditions for its valid publication as required by art. 42 of the then (and now) prevailing rules of botanic nomenclature.

The second species described, *S. tonkinensis* (LECOMTE) STEEN., differs apparently mainly by its much larger fruiting heads and fruits. I have not examined whether it deserves specific rank.

There is an astonishing vegetative similarity with the monotypic genus *Chunia* CHANG (*Sunyatsenia* 7, 1948, 63, f. 11-12) from Hainan. Its flowers are said to differ from those of *Symingtonia* by stamens with 4 pollen sacs, very short styles, and absence of petals in both ♂ and ♀ flowers.

1. *Symingtonia populnea* (R.Br. ex GRIFF.) STEEN. Act. Bot. Neerl. 1 (1952) 444.—*Bucklandia populnea* R.Br. ex GRIFF. l.c. 95; MIQ. Fl. Ind. Bat. 1, 1 (1856) 837; KURZ, Fl. Burma 1 (1877) 445; CLARKE, Fl. Br. Ind. 2 (1878) 429; GAMBLE, Man. Ind. Timber Trees (1881) 174; KING, J. As. Soc. Beng. 66, ii (1897) 308; BRANDIS, Ind. Trees (1906) 301; RIDLEY, Fl. Mal. Pen. 1 (1922) 691; HARMS, E. & P. Pfl. Fam. ed. 2, 18a (1930) 336, f. 117; STEEN. Bull. Jard. Bot. Btzg III, 13 (1933) 18, f. 5; REHDER, J. Agr. Arb. 17 (1936) 333; CORNER, Ways. Trees (1940) 321, f. 113.—*Liquidambar tricuspis* MIQ. Fl. Ind. Bat. 1, 1 (1858) 1097; Suppl. (1860) 346, t. 4.—*Bucklandia populifolia* HOOK. f. & THOMS. J. Linn. Soc. Bot. 2 (1858) 86.—*Bucklandia tricuspis* HALL. f. Med. Rijksherb. no 37 (1918) 14.—*Exbucklandia popul-*

nea R. W. BROWN, J. Wash. Ac. Sc. 36 (1946) 348.—Fig. 7.

Tree, 15-33 m high, 30-40 cm or more in diam.; bark dark-brown, fissured and flaky. *Leaves* broadly ovate, acute or acuminate at the apex, rounded, obtuse or subcordate at the base, 5-15½ by 3½-12½ cm, ferruginous-tomentose on either side when very young, quickly glabrescent, thin-coriaceous, withering apricot-pink or pinkish-orange; midrib (sometimes minutely) impressed above; petiole 2-6½ cm, with a red tinge. Stipules obovate to oblong, often asymmetrical, flat, coriaceous, 1½-4½ by 2½-4½ cm, rounded at the apex, brown-tomentose, glabrescent. Peduncles of flower heads ferruginous-hirsute, 1-1½ cm.—♂ *Heads* globose, c. 1½ cm in diam.; petals linear, 2-3 by ½-1½ mm; filaments 2-4 mm, anthers 1-1½ mm



Fig. 7. *Symingtonia populnea* (R.Br. ex GRIFF.) STEEN. showing dimorphous leaves and the remarkably large coherent stipules on flowering twigs. Mt Kerintji, c. 2100 m altitude (Photogr. W. MEIJER).

long; disk glabrous; free part of the ovary conical, ferruginous-hirsute; styles $2\frac{1}{2}$ –3 mm, glabrous.—♀ *Heads* globose, $2\frac{1}{2}$ –6 mm in diam. *Fruitheads* 2– $2\frac{1}{2}$ by 2– $2\frac{1}{2}$ cm, $1\frac{1}{2}$ – $2\frac{1}{2}$ cm peduncled, glabrous. *Fruits* glabrous, 7–11 per head, 6–10 mm long, their free part 4–6 mm. *Seeds* narrowly ovoid, flattened, 3–5 by $\frac{2}{3}$ – $1\frac{1}{2}$ mm, wing narrowly oblong, 9–10 by 2– $2\frac{1}{2}$ mm; upper, wingless seeds irregularly prismatical, sterile.

Distr. SE. Asia (Sikkim, Bhotan, Assam, Manipur, Martaban, and S. China: Kweichow) and *Malaysia*: N.–S. Sumatra & Malay Peninsula.

Ecol. Everwet, mixed hill and mountain forests, mainly primary, (800–)1000–3000 m, apparently seldom flowering, but found *fl.* & *fr.* throughout the year.

Uses. The timber is not unimportant, the wood is white and soft, splits good and straight and is classified by ENDERT in durability class iii; it is,

however, soon attacked by xylophages. In Assam it is in great demand for planking and door and window frames. In the Toba District (N. Sumatra) it is planted for reforestation and local timber demands.

Vern. *Malayan aspen* (the leaves quiver on their long stalks like those of aspens, CORNER, *l.c.*), E. *tiga sagi*, *drok* or *groh*, Sakai (Mal. Pen.), *tampu litjin*, Gajo Alas, *sikadundung*, *sigëdundung*, Talang, *maëndung*, Merapi, *hapas hapas* or *kapas kapas*, Toba-Batak, *sigadunduëng*, Minangk., *dul-parangan*, Karo, *tapatapa lëman*, Sum. Westcoast.

Note. Specimens from continental Asia possess in general somewhat larger leaves and stipules.

KURZ (Nat. Tijd. Ned. Ind. 27, 1864, 170) reported with doubt the species to occur in Banka, but this record must be based on an erroneous identification of an apparently juvenile plant belonging to some other family.

7. ALTINGIA

NOROÑA, Verh. Bat. Gen. K. W. ed. 1, 5 (1790) art. 2, p. 9, *non vidi*; ditto, ed. 2 (1827) art. 2, p. 41.—*Sedgwickia* GRIFFITH, As. Res. 19 (1836) 98, t. 15; Ann. Sc. Nat. II, 9 Bot. (1838) 179.—Fig. 8–9.

Monogamous-monoecious evergreen trees. *Leaves* glandular-crenate-serrate or entire, penninerved. Stipules very small, caducous and leaving minute scars or connate with the petiole and about persistent. *Flowers* in peduncled ♂ and ♀ heads initially enveloped by 4 bracts.—♂ *Heads* in racemes, consisting of masses of stamens, intermingled with some minute ?bracts; *sepals*, *petals*, disk and *ovary* lacking; *filaments* short, thick; anthers basifix, obpyramidal, with 4 pollen sacs, 2-celled; dehiscing with longitudinal slits.—♀ *Heads* solitary, in racemes or in the lower part of ♂ racemes; flowers connate. *Sepals* and *petals* lacking. *Stamens* rudimentary or absent; disk consisting of a variable number of minute lobes. *Ovary* half-inferior to inferior, 2-celled; ovules ∞, in each cell inserted on the dissepiment; styles 2, subulate, divergent, often strongly recurved, adaxially with decurrent, papillose stigmas, caducous (or the basal parts persistents) in fruit. *Fruits* in globose to subglobose, woody heads, obovoid to obpyramidal, 2-celled, 4-valved, surrounded by a ring of enlarged, hardened disk lobes. *Seeds* ∞ in each cell, the upper ones sterile, wingless, 1 or a few lower ones fertile, flattened, narrowly winged along the margin or only apically; albumen scant.

Distr. Seven species from Assam, Yunnan and Fokien to *Malaysia*: Sumatra, Malay Peninsula and W. Java.

Notes. As is explained on p. 364 the disk has often been described as a calyx limb.

1. *Altingia excelsa* NOROÑA, Verh. Bat. Gen. K. W. ed. 1, 5 (1790) art. 2, p. 9; ditto, ed. 2 (1827) 41; JUNGHUHN, Java, ed. 2 (*neerl.*) 1 (1853) 441; KURZ, Fl. Burma 1 (1877) 445; CLARKE, Fl. Br. India 2 (1878) 429; K. & V. Bijdr. 2 (1895) 204, *incl. var. velutina* K. & V.; BRANDIS, Ind. Trees (1906) 302; BACK, Schoolfl. (1911) 476; LÖRZING, Tectona 4 (1911) 490; KOORD. Exk. Fl. Java 2 (1912) 312, f. 62; KERBERT, Tectona 8 (1915) 185–219; KORTZ, Tectona 13 (1920) 715; RIDL, Fl. Mal. Pen. 1 (1922) 692; KOORD. Fl. Tjib. 2 (1923) 98; KRAMER, Med. Proefst. Boschw. 14

(1926) 49; HEYNE, Nutt. Pl. (1927) 690; HARMS, E. & P. Fl. Fam. ed. 2, 18a (1930) 344, f. 164j, 180; OCHSE & BAKH. v. D. BRINK, Ind. Groent. (1931) 348, f. 219; BURK. Dict. 1 (1935) 116; SARTJO MARTOSOEDIRO, Het Bosch 3 (1935) 123; FERGUSON, Tectona 30 (1937) 235–280; *ibid.* 31 (1938) 34–36; HILDEBRAND, Het Bosch 8 (1941) 268–269; BEEKMAN, Houtteelt Indon. (1949) 246.—*Liquidambar altingiana* BL. Bijdr. Fl. Ned. Ind. 10 (1825) 527.—*Liquidambar altingia* BL. Fl. Javae, 8. Balsamifluae (1829) 2, t. 1, 2 (*Liquidambar altingiana* in tab.); MIQ. Fl. Ind. Bat. 1, 1 (1855)

836.—*Sedgwickia cerasifolia* GRIFF. As. Res. 19 (1836) 99, t. 15; Ann. Sc. Nat. II, 9 Bot. (1838) 179.—Fig. 8-9.

Tree, 40–50(–60) m high, clear bole 20–35 m, 80–110(–200) cm in diam.; bark rather smooth, light grey to yellowish- or brownish-grey, with narrow longitudinal fissures, slightly peeling with thin, long, irregular flakes. Ultimate twigs glabrous to yellowish-brown puberulous. *Leaves* elliptic to oblong or ovate to ovate-lanceolate, 6–12(–16) by $2\frac{1}{2}$ – $5\frac{1}{2}$ (– $6\frac{1}{2}$) cm, acute, acuminate or sometimes caudate at the apex, obtuse, rounded or very slightly cordate, gland-like thickened at the base, with glandular-crenate-serrate margins, glabrous above, glabrous to yellowish-brown puberulous below, very rarely velutinous, thin-coriaceous; midrib about flat above; nerves 5–10 pairs; petiole 13–32 mm, glabrous to yellowish-brown puberulous, apically usually (on the upper side often) with sessile to shortly stalked gland-like appendages. *Stipules* subulate, 1–6 by $\frac{1}{4}$ – $\frac{4}{5}$ mm. *♂ Heads* 6–14, in racemes, ellipsoid, 6–10 by 3–6 mm. *Filaments* glabrous, $\frac{4}{5}$ –1 mm long; anthers 1– $1\frac{2}{5}$ mm long. ?*Bracts* linear, $\frac{4}{5}$ –1 mm long, minutely puberulous.—♀ *Heads* 4–18-flowered, globose to subglobose, 6–9 by 5–8 mm, 2– $3\frac{1}{2}$ cm peduncled, all parts puberulous. *Stamens* rudimentary or lacking. *Disk* $\frac{1}{3}$ – $\frac{1}{2}$ mm high. *Ovary* $\frac{3}{4}$ -inferior; styles adaxially sulcate, 3–4 mm. *Fruit heads* $1\frac{1}{5}$ – $2\frac{1}{2}$ by $1\frac{1}{5}$ –2 cm, 2– $3\frac{1}{2}$ cm peduncled, nearly glabrous. *Fruits* light brown-puberulous at the apex, 4–18 per head, 8–10 mm long. Fertile *seeds* 0–1 in each cell, dorso-ventrally flattened, obovate, 5– $6\frac{1}{2}$ by $2\frac{1}{2}$ – $3\frac{1}{2}$ mm, surrounded by a narrow wing; hilum central on the dorsal side; sterile seeds 15–25 in each cell, small, irregularly prismatical.

Distr. SE. Asia (Bhotan, Assam, Pegu, Mergui) and *Malaysia*: Sumatra, Malay Peninsula (Pahang) and Java (eastwards to Garut), planted for reforestation purposes elsewhere.

Ecol. Everwet, mixed hill and mountain forests, often gregarious and forming the frame of the mountain forest, 550–1700 m, *fl.* mainly March–May and Oct.–Nov., apparently at the change of the seasons, but occasionally in other months of the year, *fr.* according to KRAMER *l.c.* throughout the year but mainly in the middle of both seasons.

Flowers and flush appear simultaneously with rapid change of old foliage; the flush is light-green tinged reddish giving, seen from a distance, a bronze hue to the crowns.

Leaves when crushed possess an agreeable aromatic odor.

Sociology. Many data have been assembled on the 'king of the mountain forest' of Java and Sumatra as JUNGHUHN characterized the 'rasamala'. Its social occurrence, its majestic, high-branched, columnar bole and imposing size of the crown give it a predominant place in the mountain forest. Large, old specimens are the emergent trees here, approached in size and stature only by *Podocarpus neriifolia* and *Podocarpus imbricata*. JUNGHUHN characterized the middle mountain zone as that of the rasamala.

According to KERBERT *l.c.* and KRAMER *l.c.* the occurrence is more or less colony-wise, but this is difficult to judge as mature rasamala, of old being recognized as the most valuable timber tree, has been removed in many places by selective cutting. In good, primitive forest 10–35 mature specimens may be encountered per hectare, containing, by



Fig. 8. *Altingia excelsa* Nor. a. Twig with a young fruit head, b. young ♂ inflorescence.

their colossal size, (50–)75–85% of the total timber mass, ranging up to 150 m³ per ha. In Sumatra similar conditions seem to prevail in the Barisan Range from South to North Sumatra.

Following in abundance, its associates are, besides the *Podocarpus spp.*, representatives of *Quercus*, and further a number of other constituents of this type of mountain forest: *Schima*, *Castanopsis*, *Eugenia*, *Sloanea*, *Dysoxylum*, *Engelhardtia*, *Magnolia*, *Michelia*, *Elaeocarpus*, etc. After selective cutting these elements rapidly fill the gaps, specially *Quercus* and *Castanopsis*.

The unbranched, columnar bole may reach dimensions between 20 and 35 m, bearing on top an irregularly globular crown; juvenile specimens show a typically acute, conical crown, similar to that in *Schima* and *Dryobalanops*.

Trees grown in the open assume a low, globular shape and a very poor development of the trunk (cf. vol. 4, 1948, p. xxxviii, f. 31).

Planting rasamala for reforestation or for obtaining commercial timber has already started in 1851 (cf. FERGUSON, Tectona 31, 1938, 34–36). This was originally managed with seedlings obtained from natural regeneration in the forest, but later done with seed on seed beds. The collecting of seed presents several difficulties, besides those of the picking of the fruits from the large trees.

Germination follows rapidly after sowing (about

one week) but growth of the early seedling is slow for the initial few years, after which follows a period of rapid access; FERGUSON *l.c.* has found that the most rapid growth is found at levels of 600–700 m in cultivated specimens; whether this timber will finally have the same good quality as that of the slower growing specimens at higher altitude is not known.

Rasamala has been used for reafforestation with valuable timber in Central Java and elsewhere outside its natural area, which does not extend E of Garut in Priangan. Though rainfall is there (Mts Slamet, Merbabu) decidedly less, growth appeared satisfactory. The driest month of the year should have apparently at least 100 mm precipitation.

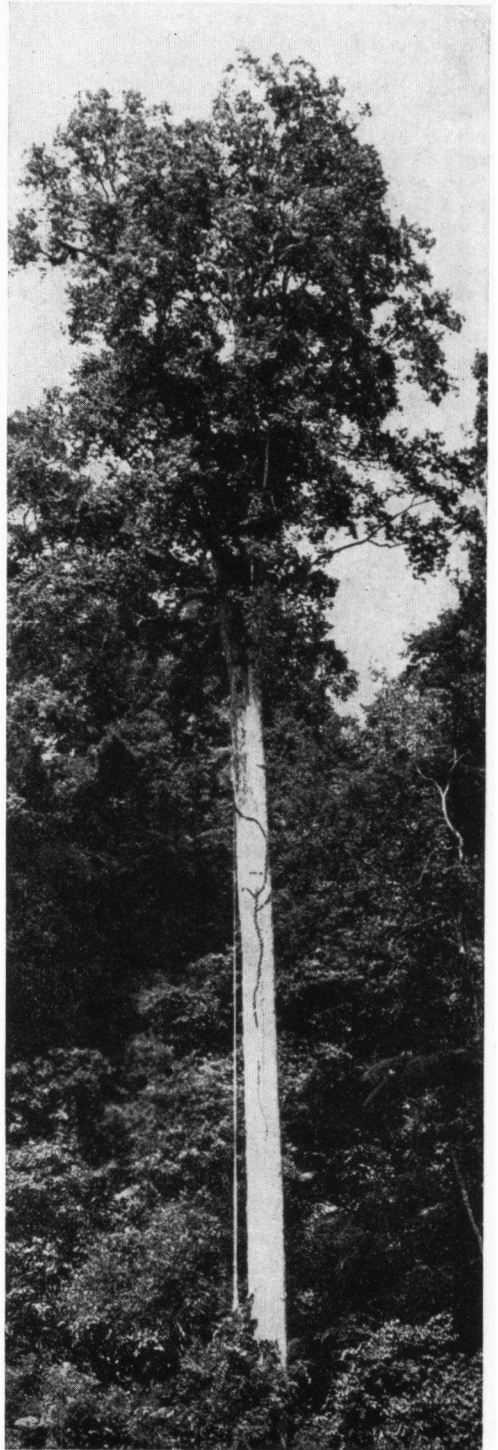
Seed and seed dispersal. The capsules contain up to 35 prismatic seeds; the majority of these is much reduced in size and entirely sterile, only a few are developed and among the latter averagely only one is fully developed and viable. The best method to collect seed is to pick nearly ripe heads and dry them in the open. As is usual among tropical rain-forest timbers germination power is retained only for a short time.

Animals seem very fond of the seeds which, according to SARTJO *l.c.*, have a sweet scent. KALSHOVEN in his essay on pests of rasamala (Tectona 30, 1937, 165) records that monkeys feed on the seed and that birds are observed to pick seeds from the fruit on the tree. The reason for this is, according to KALSHOVEN, that the seeds contain oil. This agrees precisely with the practical experience that the seed on seed beds must be carefully protected from red ants which otherwise remove the seed in no time. *Aliingia* is apparently distinctly myrmecochorous, though obviously lacking an elaiosome structure.

Occasionally caterpillars may defoliate individual rasamala trees, giving it the appearance of being deciduous; new flush is soon developing after such an attack.

Galls. Two kinds of leaf galls have been described by DOCTERS VAN LEEUWEN (Ned. Kruidk. Arch. 51, 1941, 159), one caused by a gall midge, the other by a gall mite. Hairy domatia are sometimes found in the nerve axils on the underside of the leaves. Gall-like thickenings of twigs are caused by the loranthaceous parasite *Korthalsella opuntia* (THUNB.) MERR. These were found first by DOCTERS VAN LEEUWEN (Trop. Natuur 21, 1932, 53–56, fig. 1–4); thus far they are only recorded from Mt Gedeh (W. Java). An other viscoideous parasite, *Viscum liquidambaricum* HAYATA is in Java confined to *Aliingia*, according to DANSER (Bull. Jard. Bot. Btzg III, 16, 1938, 57); in Formosa it parasitizes on *Liquidambar*.

Fig. 9. Mature tree of *Aliingia excelsa* NOR. on forest border along Tjibodas Mountain Garden at c. 1450 m altitude. Tree c. 45 m tall (Photogr. DOCTERS VAN LEEUWEN). →



Uses. In West Java one of the most valuable timber trees from the mountain rain-forest, classified in class ii for strength and durability. It is obtained in large dimensions and used for frames of bridges and buildings; old heart-wood is only slowly attacked by termites. A disadvantage of the timber is its slow drying, and further its tendency to warping and cleaving.

Altingia excelsa produces an aromatic resin (*gĕtah malai, g. kandai*); LÖRZING *l.c.* and others maintain that this is produced only after injuries (similarly to resin formation in *Styrax*); small bees collect the resin and use it for their combs, concentrating it in this way (*cf.* ALMEROOD, *Tijd. Land- Tuinb. & Boschkultuur* 4, p. 138); it is only locally used and not a product collected in great quantity (*cf.* FERGUSON *l.c.*).

The flush of *Altingia* is eaten as a vegetable (*lalab*) in West Java (OCHSE, *l.c.*).

Vern. *Rasamala, r. mĕnjan, (ki) mala, m. gadog, m. bodas, m. beureum, m. taribih, m. kapas, m. tanduk*, S; Sumatra: *tjĕmara abang, tj. itam*, Palembang, *rasamalo, sĕludang*, M (Redjang), *sĕmalo*, Lebong, *pulasan*, Karo, *tulasan*, Toba,

lamin, mandung, m. djati, sigĕdung, ma(ā)ndung, Minangk.

Notes. Sterile material is easily confused with *Ehretia acuminata* (Borr.) on which an erroneous record is based from Timor (*cf.* DE VOOGD, *Trop. Natuur* 27, 1938, 61).

RUMPHIUS (Herb. Amb. 2, p. 58) mentioned some scented woods from the Moluccas and New Guinea indicated as '*Caju rasamala*', comparing their leaves with 'ironwood' (*i.e.* *Intsia*); this unidentifiable mixture is the source of the erroneous record of *Altingia* from E. Malaysia (*cf.* MERRILL, *Int. Rumph.* 1917, 245). In New Guinea the name *rasamala* seems to be used for *Flindersia* which possesses scented wood (FERGUSON, *Tectona* 30, 1937, 239).

Mountain people in W. Java distinguish two 'varieties', based on the structure and colour of the timber, white and red; they can not be recognized in botanical specimens.

The var. *velutina* K. & V., characterized by a conspicuously hairy undersurface of the leaves, has only once been collected.