



A revision of the Malesian genus *Blumeodendron* (*Euphorbiaceae*)

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Key words

Blumeodendron
Euphorbiaceae
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Abstract The genus *Blumeodendron* (*Euphorbiaceae*) comprises nine species and is distributed from the Andaman Islands and Myanmar in the west through Malesia to the Bismarck Archipelago in the east. Two species are newly described, *B. gesinus*, with ridged fruits, and *B. endocarpum*, with a thickened endocarp around each seed. Three former synonyms, *B. novoguineense* (new name for *Bennettia papuanum*), *B. philippinense* and *B. subrotundifolium*, are reinstated as species. Two important characters were newly discovered, the presence of small lepidote hairs in all species and the indehiscent fruit of *B. endocarpum*.

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INTRODUCTION

Blumeodendron (Müll.Arg.) Kurz is a tree genus in the *Euphorbiaceae*, which ranges from the Andaman Islands and Myanmar in the west through Malesia to the Bismarck Archipelago in the east. *Blumeodendron* belongs to the subfamily *Acalyphoideae*, tribe *Pycnocomaeae*, subtribe *Blumeodendrinae* (Webster 1994, 2014, Radcliffe-Smith 2001) and is part of clade A1 of the core acalypoids in the molecular *Euphorbiaceae* skeleton phylogeny of Wurdack et al. (2005). Clade A1 is sister to a clade combining *Macaranga* Thouars and *Mallotus* Lour. (including *Trewia* L.). The species are common in rain forests and are small to large (up to 65 m high) trees. Other typical characters are the absence of stipules, the presence of very small lepidote hairs (termed minute stellate hairs by Radcliffe-Smith 2001), small, unisexual flowers lacking petals, the staminate ones with many stamens and disc glands forming a ruminant pattern on a convex receptacle, the fruits large, woody and probably indehiscent or late dehiscent (partly after Merrill 1920, Airy Shaw 1975).

During the last 150 years the genus was studied by various researchers, but most revisions are already quite dated, the only 21st century revision was for Thailand (Chayamarit 2005, 2007). The genus *Blumeodendron* was established by Müller in 1866 as a subgenus of *Mallotus*. In 1874 Kurz raised *Blumeodendron* to genus level when he studied *B. tokbrai* (Blume) Kurz. The description of this species was followed by several others (e.g., Merrill 1920). In 1975 Airy Shaw reduced the then known twelve species to six species after a revision of the Bornean *Euphorbiaceae*. After Airy Shaw's revision most species appeared to be present on Borneo and only two were widespread outside Borneo, *B. kurzii* (Hook.f.) J.J.Sm. and *B. tokbrai*. A revision of *Blumeodendron*, covering its complete distribution, has not yet been made. Since the last revisions much more material has been accumulated, which will allow for new insights into the variability of the various species and which will perhaps alter species boundaries.

The variation within *Blumeodendron* is very high, especially in the former circumscription of the two widespread species. It is typically a genus where it takes time to become familiar with the species before a sensible delimitation can be made. As a result, the species circumscriptions have changed dramatically. The definition of the widespread *B. kurzii* and *B. tokbrai* is much more restricted as *B. borneense* Pax & K.Hoffm. (with *B. concolor* Gage as synonym), *B. novoguineense* Ottens & Welzen and *B. subrotundifolium* (Elmer) Merr. (with the seemingly distinct *B. calophyllum* Airy Shaw as synonym) are regarded as distinct species. Thailand now contains three instead of two species (www.nationaalherbarium.nl/thaieuph). Also, two species were not recognized before, *B. gesinus* Ottens, with reddish leaves and fruits and distinct rims on the fruits, and *B. endocarpum* Ottens & Welzen, with a thick endocarp around each seed instead around all seeds. Characters used for species recognition are indumentum, leaf aestivation, thickness and colour of dried leaves, inflorescence length and fruit type.

The revision will be part of the ongoing revision of the *Euphorbiaceae* for the international Flora Malesiana Project (www.nationaalherbarium.nl/euphorbs).

The aims of this study are to revise the genus, to capture the species variability, show the distributions and to create an identification key.

MORPHOLOGICALLY AND ECOLOGICALLY IMPORTANT CHARACTERS

Nodes

In a number of *Blumeodendron* species the leaves are on the nodes of several successive short internodes, which can be extremely short and individually indistinguishable in the species with 'whorled' leaves. The short nodes alternate with much longer, leafless internodes. The nodes of the species *B. borneense*, *B. bullatum* Airy Shaw, *B. endocarpum* and *B. kurzii* are much thickened; those of the other species are less thickened. Leaves of *B. bullatum* and *B. endocarpum* are alternate to subopposite and the node is thickened at the side of the leaf attachment. The nodes of *B. kurzii* are very distinctly thickened, almost globular in shape, and carry whorls of more than three leaves. The leaves of *B. borneense* are alternate

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in semi-whorls, with globular or one-sided thickenings of the nodes, respectively. The thickened nodes at the side of the leaf attachment of *B. borneense* resemble most closely those of *B. endocarpum*, less those of *B. bullatum*. The other species have alternate to subopposite (to three whorled) leaves and less thickened nodes.

Indumentum

All species, except the hairy *B. bullatum*, appear to be glabrous, but high magnification shows that they all possess very small lepidote hairs (called minute stellate hairs by Radcliffe-Smith 2001). In many descriptions these were overlooked. Young parts of the plant are totally covered with these small, yellow to orange lepidote hairs and, as a result, may even have an orange glow. Probably, the lepidote hairs have a secretory function as some specimen labels indicate stickiness and young parts may look lacquered when dry (or seem to have a layer of glue after dehydrating with boiling water). The hairs disappear with age, but on buds, fruits and in the axils of adult leaves the hairs are more resistant, though on the bark they become obscured by the formation of secondary bark, lenticels and often by fungal infections (probably due to the sweet secretion).

Leaf morphology

- Stipules are absent. Quite often stipules are very early caducous in *Euphorbiaceae*, but then small scars remain, and neither these, nor the presence of stipules near young leaves, were observed.
- The petioles are bipulvinate and mostly transversely grooved when dry.
- The leaves are alternate (e.g., some leaves in each *B. tokbrai* collection) to subopposite (e.g., *B. subrotundifolium*) to whorled (*B. kurzii*).
- The leaves are generally elliptic to somewhat ovate or obovate. The colour of the dry leaves varies with the species and is often quite typical. Dried leaves are mostly orange in *B. gesinus*, light green in *B. borneense*, dark green in *B. novoguineense*, brown to greenish brown in *B. tokbrai* and mainly brown to dark brown in *B. endocarpum*, *B. kurzii*, *B. philippinense* Merr. & Rolfe and *B. subrotundifolium*.
- The venation is pinnate and an indistinct marginal vein is present. The secondary nerves are looped and closed near the margin, while the tertiary nerves are scalariform and the higher order nerves indistinctly reticulate to scalariform in *B. bullatum* and hardly visible in the other species.
- The leaf thickness varies from pergamentaceous (e.g., *B. borneense*) to strongly coriaceous (e.g., *B. subrotundifolium*) and varies within the species as a result of environmental conditions; for example, characteristic for *B. tokbrai* are pergamentaceous leaves, but leaves of specimens collected in swamp forests are coriaceous (this resembles *Guioa bijuga* (Hiern) Radlk., *Sapindaceae*; Van Welzen 1990). All species have smooth, flat surfaces except *B. bullatum*, which shows a very bullate surface.
- The large variation in dimensions of the leaf blade, most extreme in *B. kurzii* and the closely similar *B. subrotundifolium*, and the little variation between the species complicates the identification of the species.

Extrafloral nectaries

All species have two round (indistinct) extrafloral nectaries near the base of the leaf on the upper surface and usually also additional ones between the secondary nerves along the midrib and the margin. The number of nectaries along the midrib and margin is variable (up to 20–40) and not typical for a species.

The nectaries occur on both surfaces, but in different numbers. The basal ones are generally larger than those along the midrib and margin and are sometimes visible to the naked eye.

Inflorescences

All the inflorescences resemble racemes but are thyrses (reduced cymes racemously distributed along the inflorescence rachis). They are variable in length, while the lengths are very typical for the species (pistillate inflorescences are always shorter than staminate ones). Almost fascicle-like inflorescences of less than 2 cm length, are found in *B. borneense*, *B. bullatum*, *B. kurzii* and *B. philippinense*. Longer inflorescences, staminate ones up to 4.5 cm, pistillate ones up to 2.5 cm, are present in *B. endocarpum* and *B. subrotundifolium*. The longest inflorescences are present in *B. gesinus*, *B. novoguineense* and *B. tokbrai* (staminate ones up to 20 cm, pistillate ones up to 10 cm). The basal internodes of the longer inflorescences are longer than the more terminal internodes as can be seen in *B. tokbrai*. Pistillate flowers are single per node, staminate flowers are generally in small groups, with one flower open and the others generally present as buds.

The number of inflorescences per node also varies. Pistillate inflorescences are single except *B. kurzii* with c. 4 inflorescences per node. Staminate inflorescences are single (*B. bullatum*), paired (*B. endocarpum*, *B. gesinus* and *B. subrotundifolium*) or vary between 3 and 4 (*B. tokbrai* and *B. philippinense*) to 8 inflorescences per node in *B. kurzii*. The latter probably as a result of having mostly four whorled leaves and multiple inflorescences per leaf.

Bracts are generally absent or early caducous.

Flowers

The pedicel has a distinct abscission zone and flowerless inflorescences are often the result. In *B. novoguineense* and *B. tokbrai* the abscission zone can be halfway the pedicel giving an almost ladder-like appearance after flower drop. The buds are globose. The staminate flowers have 3–4 sepals, the pistillate flowers (3–)4–5 sepals; they lack petals.

Very typical for the staminate flowers are the disc glands which provide a ruminant appearance on the dome-shaped receptacle. The many stamens arise among the glands. The amount of stamens varies per species. The anthers are basifixed, 2-thecate, and open latrorse via lengthwise slits. A pistillode is absent.

The pistillate flowers have a circular, somewhat lobed, broad disc. The ovary is 2–3-locular with a single ovule per locule and on top 2–3 non-divided, recurved stigmas that are papillate above.

Fruits and seeds

The fruits show some key characters for identification. They are woody and globular to ovoid. Young fruits are often covered with the small lepidote hairs; on older fruits lepidote hairs are sometimes still visible. The upper part of the pedicel is thickened. Differences between the species can be found in the thickness of the wall, the thickness of the endocarp and the presence of ridges.

The wall of *B. endocarpum* is ovoid and dented in the middle of the upper margin (Fig. 3f), while the other species have very globular to ovoid fruits. *Blumeodendron endocarpum* differs in various ways from the other species; it has a thick endocarp surrounding every individual seed, while the endocarp encloses all seeds together in the other species (Fig. 3f). Another difference is that the exocarp of *B. endocarpum* separates from the meso- and endocarp during drying (Fig. 3f), while the layers remain stuck together in all the other species. Finally, there is

a difference in the manner of dehiscing. The fruits of all species dehisce tardily loculicidally, while the fruits of *B. endocarpum* do not seem to open and probably the seed will germinate after the woody endocarp decayed.

The margin of the fruits differs from possessing a much thickened rim (*B. gesinus*; Fig. 4b), to pitted (*B. tokbrai*; Fig. 9f) or slightly ridged (*B. novoguineense*; Fig. 6a).

The fruits of *B. borneense* (Fig. 1c) and *B. endocarpum* (Fig. 3c) show 3 and 6 vein ridges, respectively.

The seeds are typical, more or less bean-shaped, though the shape varies somewhat per species, and are attached in the middle (in a dent) to (less typical) more subapical.

It is unknown how the diaspores are dispersed. The fruits are woody and large, thus bird dispersal is ruled out. The seeds are covered by a thin, mainly yellow sarcotesta, which could imply that larger animals, like monkeys, might consume the seeds and disperse them. Considering the broad distributions of some of the species, then dispersal by means of water/sea is also a possibility, as the fruits generally dehisce very late, are buoyant, and relatively thick-walled.

TAXONOMY

Blumeodendron

Blumeodendron (Müll.Arg.) Kurz (1874) 245; (1877) 391; J.J.Sm. (1910) 458; Koord. (1912) 493; Pax & K.Hoffm. (1914) 47; Merr. (1920) 554; Ridl. (1924) 281; Pax & K.Hoffm. (1931) 107; Backer & Bakh.f. (1963) 479; Airy Shaw (1963) 348; (1972b) 224; Whitmore (1973) 68; L.C.Wheeler (1975) 535; Airy Shaw (1975) 57; (1980) 37; (1981) 267; (1982) 9; (1983) 10; G.L.Webster (1994) 77; Radcl.-Sm. (2001) 170; Chayam. (2005) 130; G.L.Webster (2014) 125. — *Mallotus* Lour. sect. *Blumeodendron* Müll.Arg. (1866) 956; Benth. (1880) 319; Hook.f. (1887) 427; Pax (1890) 53. — Lectotype (designated by Wheeler 1975): *Elateriospermum tokbrai* Blume (= *Blumeodendron tokbrai* (Blume) Kurz).

Trees, dioecious; branchlets generally round in section, nodes thickened. *Indumentum* consisting of small, orange, lepidote hairs, glabrescent, few species locally with additional simple hairs. *Stipules* absent. *Leaves* alternate, subopposite or pseudo-whorled, simple; petiole apically but more so basally pulvinate, in section round but grooved transversely when dry; blade elliptic to obovate, margin entire, revolute, extrafloral nectaries 2, adaxially near base and additional smaller ones (up to 20(–40)) along midrib and margin; venation pinnate, marginal vein indistinct, primary and secondary nerves slightly raised above, secondary nerves looped and closed near the margin, tertiary nerves scalariform, higher order nerves reticulate or partly scalariform. *Inflorescences* axillary or terminally thyrses, one or more together, erect. *Flowers*: pedicel with abscission zone; flowers actinomorphic, 5-merous, buds globose; sepals elliptic, valvate, margin entire; petals absent; disc present. *Staminate flowers*: sepals 3–4; disc glands on convex receptacle, providing a ruminant surface with the stamens in between the glands; stamens 31–40, anthers basifixed, 2-thecate, opening latrorse via lengthwise slits; pistillode absent. *Pistillate flowers*: sepals (3–)4–5; disc annular, broad; ovary 2–3-locular, placenta basal, ovulum single per locule, hemitropous; styles very short; stigmas 2–3, entire, often recurved, above papillate. *Fruits* capsular, globular or ovoid, tardily completely septicidally and partly loculicidally dehiscent into bivalved cocci; pedicels thickened; wall woody, surface somewhat knobbly. *Seeds* ovoid to subglobular, with sometimes flattened sides, more or less bean-shaped; sarcotesta present.

Distribution — Nine species ranging from Burma and the Andamans via Thailand through Malesia to New Guinea and the Bismarck Archipelago.

KEY TO THE SPECIES

1. Leaves bullate, lower surface densely hairy on venation 2. *B. bullatum*
1. Leaves smooth, lower surface glabrous 2
2. All leaves in whorls of 3 or more, or leaf blades drying light green and leaves in (pseudo-)whorls or alternate. Flowers more or less fasciculate, inflorescences less than 2 cm long 3
2. Leaves drying brownish green (kind of dark green) to brown, alternate to opposite to in (pseudo-)whorls of 3. Flowers not fasciculate, inflorescences generally more than 2 cm long 4
3. Leaves alternate to in (pseudo)whorls; blades drying light green, pergamentaceous to subcoriaceous. Terminal branches often triangular or flattened in section 1. *B. borneense*
3. Leaves in whorls of 3–5 leaves; blades drying (dark green to) light brown, coriaceous. Terminal branches round to sometimes triangular in section below the nodes. . . 5. *B. kurzii*
4. Leaves drying brownish orange abaxially. Fruit wall orange-brown when dry; margin very thickened. — Borneo 4. *B. gesinus*
4. Leaves drying green to brownish green to brown abaxially, not brownish orange. Fruit wall brown when dry, margins not or only slightly thickened (New Guinea) 5
5. Blades ovate. Inflorescence rachis up to 1.3 cm long. — Philippines (Luzon: Bataan Prov.) . . . 7. *B. philippinense*
5. Blades (ovate to) elliptic (to obovate). Inflorescence rachises 2 cm or more 6
6. Plants from Thailand, Sumatra, Borneo, Java, Philippines?
6. Plants from Sulawesi, Moluccas, New Guinea 8
7. Leaf blades 6.2–46 by 3–22 cm, coriaceous (slightly bendable) to very coriaceous (breaking) when dry; petiole 2.4–18.5 cm long, diam of thinnest part 1–15 mm. Staminate inflorescences to 4.5 cm long, pistillate ones to 2.3 cm long. Fruit wall 2–4 mm thick 8. *B. subrotundifolium*
7. Leaf blades 5.3–31 by 3.1–17.3 cm, pergamentaceous to coriaceous; petiole 1.2–9.4 cm long, diam of thinnest part 1–2 mm. Staminate inflorescences to 20 cm long, pistillate ones to 10 cm long. Fruit wall 4–7 mm thick 9. *B. tokbrai*
8. Plants from Sulawesi and the Moluccas 9
8. Plants from New Guinea 10
9. Endocarp of fruit thickened around every seed. Inflorescences up to 2 cm long 3. *B. endocarpum*
9. Endocarp of fruit around all seeds. Inflorescences up to 20 cm long 9. *B. tokbrai*
10. Leaf blades 11.2–31 by 4.6–13.9 cm. Inflorescences up to 2 cm long. Fruits 3.5 (1-seeded)–6 (2-seeded) cm wide. Endocarp of fruit thickened around every seed, to c. 4 mm thick 3. *B. endocarpum*
10. Leaf blades 5.3–17.5 by 2.5–9 cm. Inflorescences up to 3 cm (pistillate) or 9.5 cm (staminate) long. Fruits 2–2.9 cm wide. Endocarp of fruit around all seeds, to 1.8 mm thick 6. *B. novoguineense*

1. *Blumeodendron borneense* Pax & K.Hoffm. — Fig. 1; Map 1

Blumeodendron borneense Pax & K.Hoffm. (1919) 14; Airy Shaw (1975) 58. — *Blumeodendron tokbrai* (Blume) Kurz var. *borneense* (Pax & K.Hoffm.) J.J.Sm. ex Airy Shaw (1981) 269. — Type: Beccari PB 2976 (FI not seen; iso K), Borneo.

Blumeodendron concolor Gage (1922) 244; Ridl. (1924) 281; Airy Shaw (1975) 59. — Type: Curtis KD 1368 (K), [Malay Peninsula,] Pangkor.

Blumeodendron sp.: Merr. (1929) 157. — pro *Elmer* 21129 (L), British North Borneo [= Sabah], Tawao.

Blumeodendron tokbrai auct. non (Blume) Kurz: Airy Shaw (1975) 60, p.p., 'form with oblong leaves'.

Trees, up to 35 m high, bole to 15 m high, dbh to 30 cm (–2 m); buttresses sometimes present, few, c. 1 m high, c. 0.3 m out, c. 20 cm thick; stem generally round, nodes notably thickened; lenticels indistinct, round; flowering branches 5–28 mm thick, terminal ones often triangular or flattened in section; distance between internodes c. 18 cm; sympodial growth via axillary buds obvious. *Outer bark* tan to reddish brown, to dark brown, whitish grey, (pale) grey to grey-brown dappled, smooth to rough to fissured and peeling off, brittle, c. 1 mm thick; inner bark white to pale yellow, orange, pale greenish, pale brown outside to yellow inside, c. 4 mm thick; sapwood white to pale yellow; heartwood reddish. *Indumentum*: simple hairs absent. *Leaves* in (pseudo-)whorls of 3 to alternate (see Notes 1, 2); petiole 0.7–10 cm long, diam of thinnest part 0.9–3 mm, shiny, basal pulvinus 1.1–3.4 mm diam; lepidote hairs present, older parts glabrous; blade ovate to elliptic (see Note 3), 6–40 by 2.7–21 cm, length/width ratio 1.7–3.2, pergamentaceous to subcoriaceous, symmetric, glabrous, smooth dark green, drying light green, base rounded to obtuse, margin recurved, apex acuminate to cuspidate, tip to 1 cm long, extrafloral nectaries c. 6–18 along midrib, c. 6–26 along margin, both sides smooth; venation slightly and partly raised above, secondary nerves 4–7 pairs, at c. 46° angle with midrib, tertiary nerves perpendicular to midrib and secondary nerves, not raised above, higher order nerves reticulate, not raised above. *Inflorescences* ramiflorous to axillary and terminal, flowers almost fasciculate when staminate buds young, pistillate inflorescences single, length unknown. *Staminate flowers* only known from one specimen, either as bud or withered: pedicel c. 19 mm long, round; sepals 3, ovate, c. 4 by 3 mm, completely reflexed; stamens many, anthers c. 0.9 by 0.9 mm. *Pistillate flowers* unknown. *Fruits* c. 3 per inflorescence, subglobose, basally slightly sulcate, capsular, 3.5–4.1 by 3.1–4.3 cm, yellow to brown, 2–3-locular, ripening from green to yellow, dry brown, surface somewhat knobbly, vein ridges c. 3; pedicels c. 2 cm long, up to c. 0.4 cm diam, abscission zone indistinct; margin slightly thickened; wall 1–2 mm thick; endocarp enclosing two or more seeds; stigmas usually persistent. *Seeds* bean-shaped, 2.1–2.3 by 1.4–2 by 1–1.1 cm, attached in middle of bean, covered by a thin sarcotesta, dirty white to yellowish, sweet, edible.

Distribution — Malay Peninsula (very rare, only type of *B. concolor*) and Borneo.

Habitat & Ecology — In mixed dipterocarp lowland forest, secondary forest, alluvial forest, mossy forest, primary upper montane forest, often along water and on very wet (but not

inundated) soil; soil on (sandy) clay, igneous derived sandy clay. Altitude: 25–700 m. Flowering: January; fruiting: February–May, July, September, October, December.

Vernacular names — Kalimantan: Kapol utan; Simpul (Bassap Dayak); Sabah: Indalus (Dusun Kinabatangan), Tampoi (Malay).

Notes — 1. Quite typical for *B. borneense* are the light coloured twigs, of which the upper ones are flattened or triangular, the leaves that dry light green, especially the lower surface, the almost fascicled flowers (one specimen in bud seen), and the thin-walled fruits (wall 2 mm at most). *Blumeodendron borneense* is mainly known from Borneo. In Borneo a group of specimens, *B. tokbrai*, dries dark green and resemble *B. borneense*, but the leaves are alternate to (sub)opposite and seldom in whorls of 3 (end of branches), the flowers are along rachises and the fruits are very thick-walled (c. 5 mm).

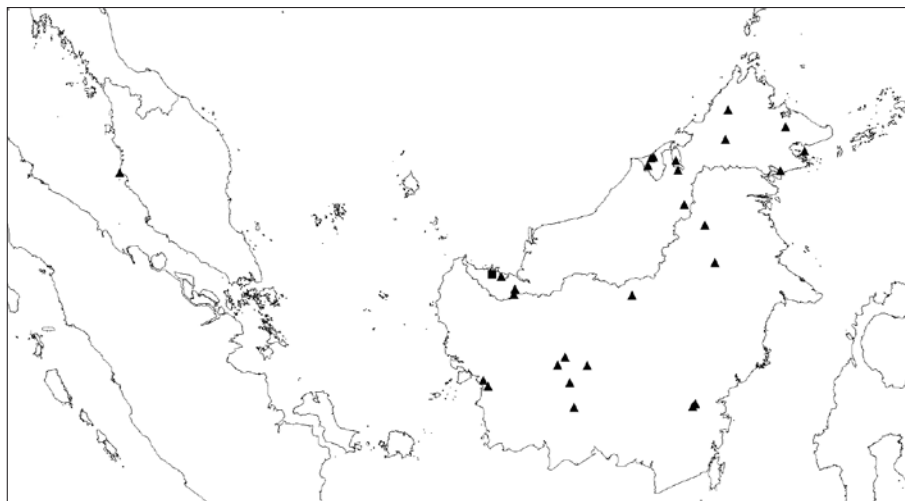
2. The type of *B. concolor*, Curtis KD 1368 (K) from the Malay Peninsula, strongly resembles *B. borneense*, as the leaves are of the same size, elliptic and also dry green, the flowers are in fascicles. However, the leaves are alternate. Another example of a specimen with leaves alternate (but close together) or in pseudo-whorls is a cultivated specimen from Borneo in the Bogor Botanical Garden, *Gravendeel, de Wilde & Hovenkamp* 521 (Kebun Raya IX.C.144). As the leaves in Bornean *B. borneense* can also be in pseudo-whorls *B. concolor* is regarded as a synonym of *B. borneense*.

3. Specimens from Sarawak, including the type, and Brunei have a tendency to show ovate leaves, those of Sabah and Kalimantan are elliptic.

2. *Blumeodendron bullatum* Airy Shaw — Fig. 2, Map 1

Blumeodendron (?) *bullatum* Airy Shaw (1965) 310; (1972a) 86; (1975) 58. — Type: Haviland & Hose 3658 (holo K; iso BM, L), Sarawak, near Kuching.

Probably trees; branchlets generally round, nodes notably thickened to side of leaf; lenticels absent or indistinct; flowering branches c. 5 mm diam. *Indumentum* of simple, white hairs and occasionally lepidote hairs on nodes. *Leaves* alternate to subopposite; petiole 0.5–1.6 cm long, diam of thinnest part 0.2–0.5 cm, round, dull, basal pulvinus 0.4–0.5 cm diam, simple hairs present; blade elliptic, 6.1–22.3 by 3.8–10.3 cm, length/width ratio 1.6–2.2, coriaceous, symmetric, strongly bullate, drying brown, base rounded, margin strongly revolute, apex rounded, extrafloral nectaries along margin c. 12, basal ones usually not obvious; venation distinct, sunken above, strongly raised below, covered with simple hairs underneath and basal part of midrib above, marginal vein distinct, nerves 5–8 pairs, at 34–41° angle with midrib, tertiary nerves perpendicular to midrib and



Map 1 Distribution of *Blumeodendron borneense* Pax & K. Hoffm. (▲) and *B. bullatum* Airy Shaw (■).

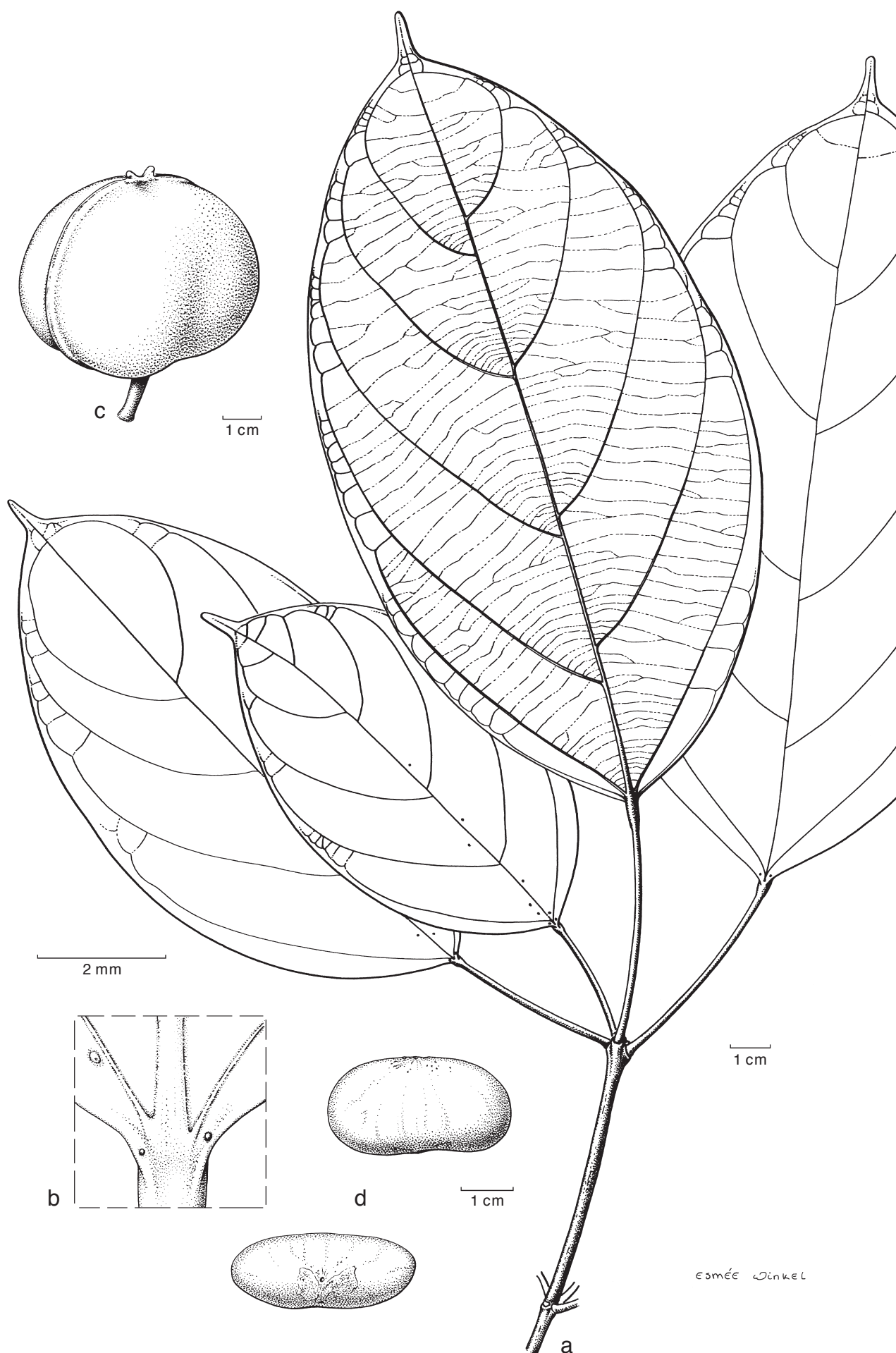
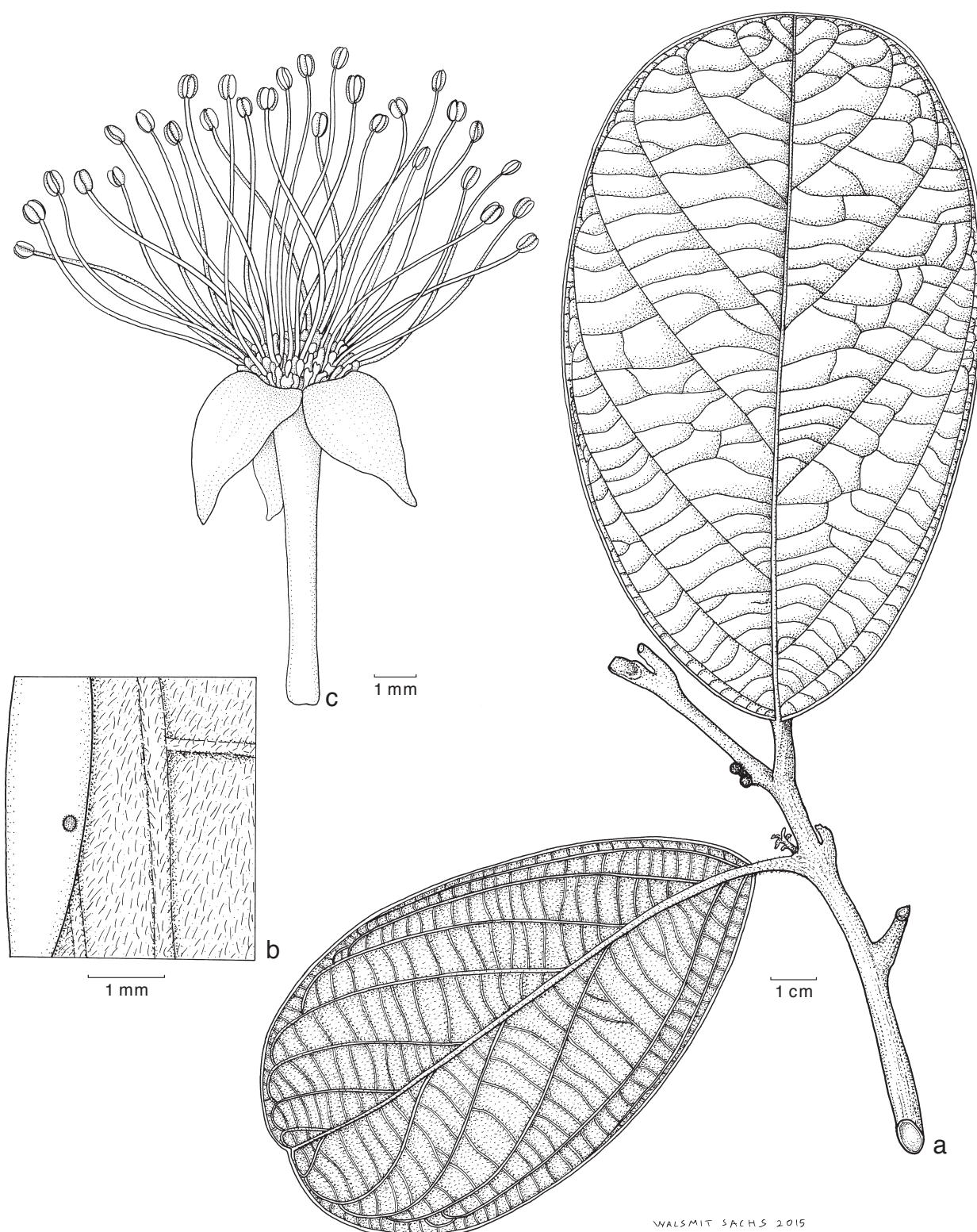


Fig. 1 *Blumeodendron borneense* Pax & K.Hoffm. a. Habit; b. extrafloral nectaries on upper surface of leaf blade; c. fruit; d. seed in lateral and ventral view (a, b: Laman, Rachman & Mirmanto TL 713; c, d: McDonald 3613; all L). — Drawing by Esmée Winkler, 2016.

secondary nerves, distance between tertiary nerves 0.3–0.6 cm; higher order nerves scalariform to reticulate. *Inflorescences* axillary, very short thyrses, single, c. 0.8 cm long, flowers seemingly fasciculate, but peduncle c. 0.2 cm long, erect; bracts not well visible, c. 0.5 cm long. *Staminate flowers* c. 8.7 mm diam; pedicel 3.5–5.5 mm long; buds c. 3.5 mm diam, covered with simple and lepidote hairs, sepals 2–3, elliptic, margin entire, c. 3.9–4.4 by 2.9–3.2 mm, valvate, free; stamens c. 33, filaments c. 4.7 mm long, anthers c. 0.6 mm long. *Pistillate flowers*, *fruits* and *seeds* unknown.

Distribution — Borneo (Sarawak; only known from the type).
Habitat & Ecology — Flowering: November.

Note — Airy Shaw (1965) was not certain if this species belonged to *Blumeodendron*, but the absence of stipules, the ruminate staminate disc glands and the presence of orange lepidote hairs on the buds are all indicative of only *Blumeodendron*.



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Fig. 2 *Blumeodendron bullatum* Airy Shaw. a. Habit; b. revolute leaf margin with extrafloral nectary on upper surface and hairs on lower surface; c. staminate flower with sepals, disc glands and stamens (all: *Haviland & Hose* 3658, L). — Drawing by Anita Walsmit Sachs, 2015.

3. *Blumeodendron endocarpum* Ottens & Welzen, sp. nov. — Fig. 3; Map 2

Resembling *B. subrotundifolium* in short inflorescences and alternate to subopposite leaves, differing in leaves chartaceous (to coriaceous), drying greenish brown, very short pistillate pedicels and most of all, a thick endocarp around every seed, not around the seeds together. — Type: *BW* (*Kalkman*) 6282 (holo L), [Indonesia, Papua,] Div. W. New Guinea, Beriat, c. 12 km S of Teminaboean.

Blumeodendron kurzii auct. non (Hook.f.) J.J.Sm.: Airy Shaw (1980) 37.

(Shrubs to) trees, to 40 m high, bole to 18 m high, dbh to 40 cm diam; buttresses sometimes present, to 1.5 m high, to 1.5 m wide, 4–10 cm thick; flowering branches 2–3 mm diam, lenticellate, generally round, flat near petioles, distance between internodes usually c. 6 cm. *Indumentum*: simple hairs absent. *Outer bark* (light) (greyish) brown to dark brown to dark grey, smooth to shallowly fissured, strongly peeling with large scales, 0.25–0.5 mm thick; *inner bark* white, creamy, yellowish brown, orange to (light) brown, 4–5 mm thick; *exudate* sometimes present, light brown; *sapwood* white, pink or light brown; *heartwood*

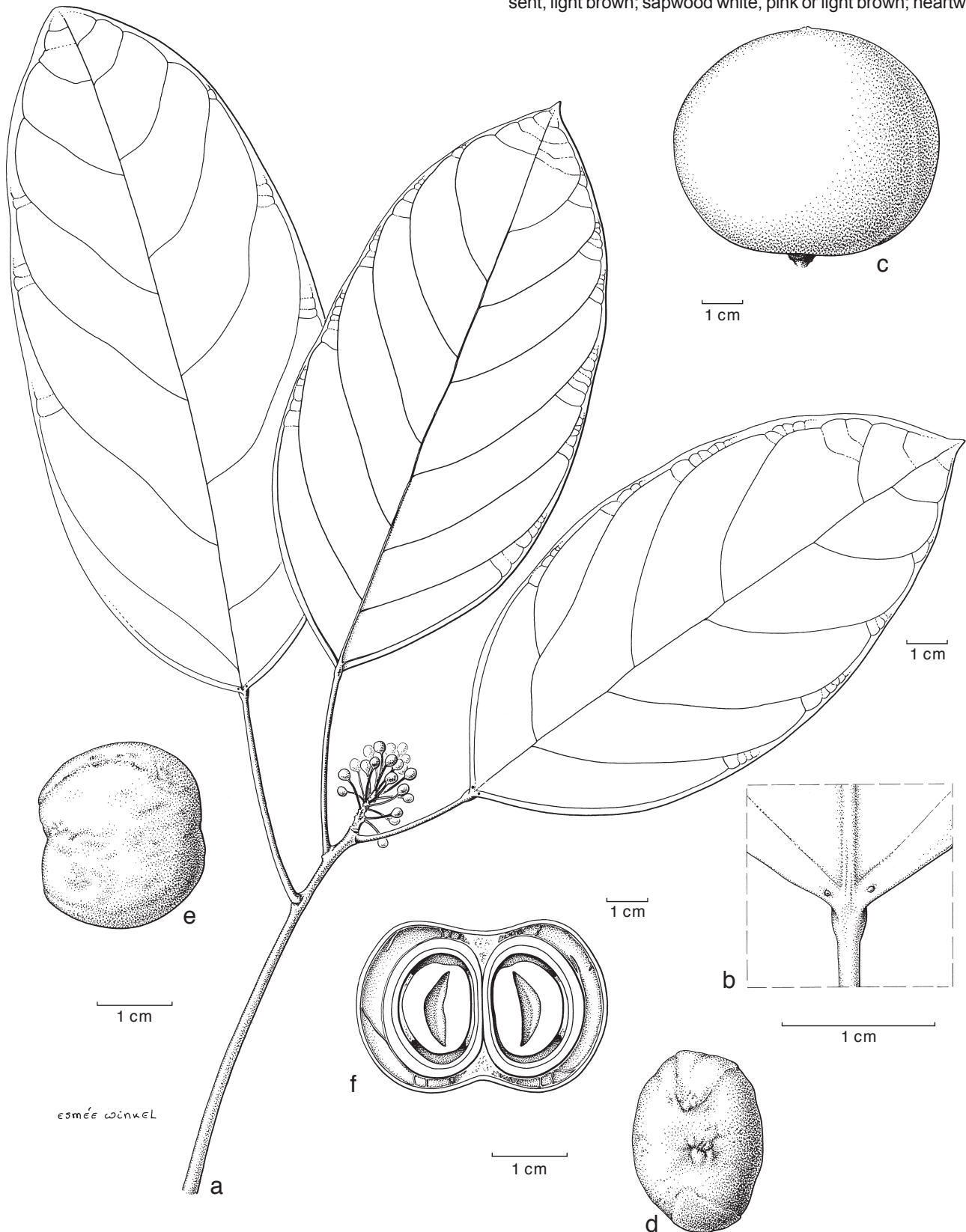
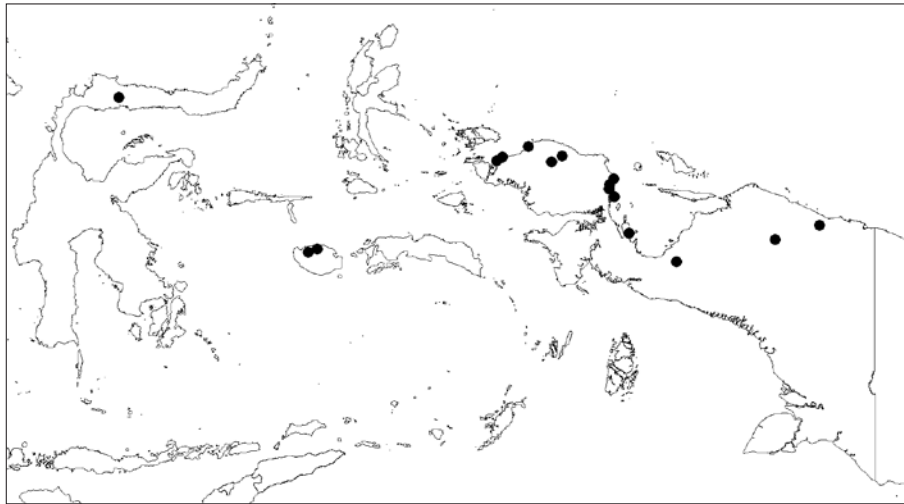


Fig. 3 *Blumeodendron endocarpum* Ottens & Welzen. a. Habit; b. upper surface of leaf with extrafloral nectaries; c. fruit; d, e. seed; f. section through fruit showing detached endocarp around seeds (a, b: *BW* (*Versteegh*) 3971; c–f: *BW* (*Kalkman*) 6282; all L). — Drawing by Esmée Winkel, 2016.



Map 2 Distribution of *Blumeodendron endocarpum* Ottens & Welzen.

orange-brown to (light) brown, 5–12 cm diam. *Leaves* alternate to subopposite; petiole 2.3–9 cm long, diam of thinnest part 1–2 mm, basal pulvinus 1.5–4.1 mm diam; blade elliptic, 11.2–31 by 4.6–13.9 cm, length/width ratio 1.8–3, blade length/petiole length ratio 4.4–4.8, pergamentaceous (to coriaceous), often basally slightly asymmetric, glabrous, base broadly cuneate to attenuate, margin entire, revolute, apex acuminate (to cuspidate), tip round, both surfaces smooth, glabrous, green above, glossy light green to greyish green underneath; above drying greenish brown and brownish green underneath (greener than abaxially), extrafloral nectaries 2 adaxially near base, along midrib 6–15, along margin 8–36; venation: marginal nerve indistinct, secondary nerves (5–)6(–8) pairs, at c. 51.1° angle with midrib, tertiary nerves perpendicular to midrib and secondary nerves, not raised on both sides, c. 0.8 cm apart, higher order nerves reticulate, not raised on both sides. *Inflorescences* axillary and terminal, staminate ones mostly 2 per axil, thyrsoid, erect, to 2 cm long, with lepidote hairs. *Staminate flowers* 8–9 mm diam, white to (pale) yellow(-green); buds 14–30 per inflorescence; pedicel 8.5–17 mm long; sepals 3, ovate, c. 6 by 3 mm; stamens 35–43, filaments 4–5.5 mm long, anthers 0.5–1.1 mm long. *Pistillate flowers* only seen as young fruits; almost sessile, pedicel c. 2 mm long; ovary 2-locular; style c. 1 mm long; stigmas c. 5 mm long. *Fruits* flattened ellipsoid, slightly emarginate in the middle; 3.5 (1-seeded)–6 (2-seeded) cm wide by 3.6 (1-seeded)–3.9 (2-seeded) cm high, dry dull brown to whitish, vein ridges absent or indistinct; pedicel thickened up to 0.6 cm diam; exocarp woody, c. 1 mm thick; surface smooth; endocarp around every seed, thickened to c. 4 mm, not dehiscing. *Seeds* flattened ovoid, backside more flattened than front side, top emarginate, 2.1–2.3 by 2.1–2.2 by 1.6–1.8 cm; sarcotesta thin, with distinct veins, testa woody, hard.

Distribution — Sulawesi (Sulawesi Utara), Moluccas (Buru) and New Guinea (Indonesian Papua).

Habitat & Ecology — Primary forest, seldom young secondary forest, along rivers and on slopes; soil mainly clay to sandy clay to sandy loam, never inundated. Altitude: 5–730 m. Flowering: February, March, September, October, December; fruiting: April, March, June–August, October–December.

Vernacular names — New Guinea (Papua): Bobrijka, Sagogwo, Sagowgwo, Wobbrijka (Manikiong); Embaam, Embaan, M'baan (Itam); Josevakan (Tehid); Saba, Sawa (Mooi); Tiek (Kebur); Wotiet (Wandammen).

Note — Most typical of this species is a thick, woody endocarp around every seed instead around all seeds.

4. *Blumeodendron gesinus* Ottens, sp. nov. — Fig. 4; Map 3

Resembles *Blumeodendron subrotundifolium* but differs in the orange-brown dried leaves and the orange-brown fruits with a very distinct ridge (dark brown dried leaves and dark brown, non-ridged fruits in *B. subrotundifolium*). — Type: Pereira, Wong, Sugau, Madani, Tangah, Nilus & Puff 158 (holo L; iso SAN), Malaysia, Borneo, Sabah, Tambunan, Jalan Pegalan.

Trees, to 65 m high, bole to 25 m high, dbh to 70 cm; sometimes small buttresses present, c. 23 cm high, c. 30 cm out, c. 3.3 cm thick or fluted up to 1 m; crown spreading; flowering branches 2–3 mm diam, generally round, distance between internodes 2.5–5 cm, generally reddish brown and glabrous when dry, nodes slightly thickened. *Outer bark* smooth, (reddish) brown to brownish white to grey-brown to pink-brown, sometimes slightly hoop-marked, thin; inner bark chocolate brown to brownish to yellow(-green) to red(-brown) to orange-brown, c. 2.5 mm thick; sapwood white(-red) or pale yellow. *Leaves* always some alternate, but others subopposite to sometimes 3 in a pseudo-whorl; petiole 0.4–4.2 cm long, diam of thinnest part 1–1.5 mm, basal pulvinus 1.1–3.3 mm diam; blade elliptic, 4.6–15.3 by 2–7.4 cm, length/width ratio (1.3–)1.9–2.4(–3.3), coriaceous, symmetric, glabrous, base attenuate to cuneate, margin revolute, apex acuminate with rounded tip, extrafloral nectaries at base sometimes absent to 1 visible to 2 present, 2–11 along midrib, 2–8 along margin, both surfaces smooth, dark green above when fresh, bright green underneath, drying greyish brown adaxially, abaxial surface orangish brown when dry; venation: marginal vein indistinct, secondary nerves (4–)6(–8(–9) pairs, at c. 43.2° angle with midrib, tertiary nerves perpendicular to midrib, 1–3 mm apart, fourth order nerves often scalariform, higher order reticulate. *Inflorescences* axillary and terminal, thyrsoid, erect, staminate ones often 2 together, up to 11.5 cm long, flowers usually in 3-flowered cymes per node, pistillate inflorescences single, up to 3.5 cm long; bracts usually caducous, triangular, c. 0.8 by 0.2 mm, margin entire, with lepidote hairs. *Staminate flowers* 4.3–6.4 mm diam, yellow-green to yellow; buds 1.6–2.8 mm diam, often sticky with secretion; pedicel above abscission zone 3.1–3.3 mm long, c. 0.4 mm diam; sepals 3(–4), round, 4.5–5.3 by 2.5–3.8 mm long, completely recurved; stamens c. 27, filaments 2–4.5 mm long, anthers 0.4–0.7 mm long. *Pistillate flowers* 2.3–3 mm diam, pale green to yellow; sepals 5, ovate to triangular, very small, c. 0.5 by 0.5 mm, margin with few hairs; disc a c. 0.4 mm thick ring; ovary obovoid, c. 1.5–3.3 mm high by 2–3 mm wide, sutures thickened, 2(–3)-locular, style 0.3–1 mm long, stigmas 1–2.8 mm long. *Fruits* ellipsoid to obovoid, c. 2.5–3.8 by 3–3.5 cm, probably indehiscent because loculicidal sutures with a rounded thickened rim, green when

immature, orangish brown when dry; pedicel c. 4 mm long, c. 4.5 mm diam, abscission zone in the middle, upwards strongly widening; sepal remnants sometimes persistent; disc distinct, drying brownish; wall c. 2 mm thick, surface somewhat knobby; endocarp enclosing all seeds; stigma usually persistent. *Seeds* ovoid but flattened on one side, not symmetric, attached subapically, 1.9–2.5 by 1.3–2.3 by 1–1.2 cm, sarcotesta thin, veins visible.

Distribution — Borneo.

Habitat & Ecology — Lowland mixed dipterocarp forest to submontane, mossy forest, sometimes along roads in primary forest, seldom in logged over forest. Soil: yellow sandy, clay rich

to ultrabasic; bedrock often sandstone. Altitude: 25–1375 m. Flowering: February–April, June, August, September; fruiting: February, May–August, October–December.

Vernacular names — Borneo: Sabah: Tampoi (Melayu); Sarawak: Bantas (Iban), Bantas ketupong, Empungan (Iban).

Notes — 1. *Gesinus* is the first name of the first author's husband. The name is a personal name and not a latinisation, therefore ICN art. 60C.4 applies (<http://www.iapt-taxon.org/nomen/main.php?page=art60>), the name should not be changed into *gesinum*.

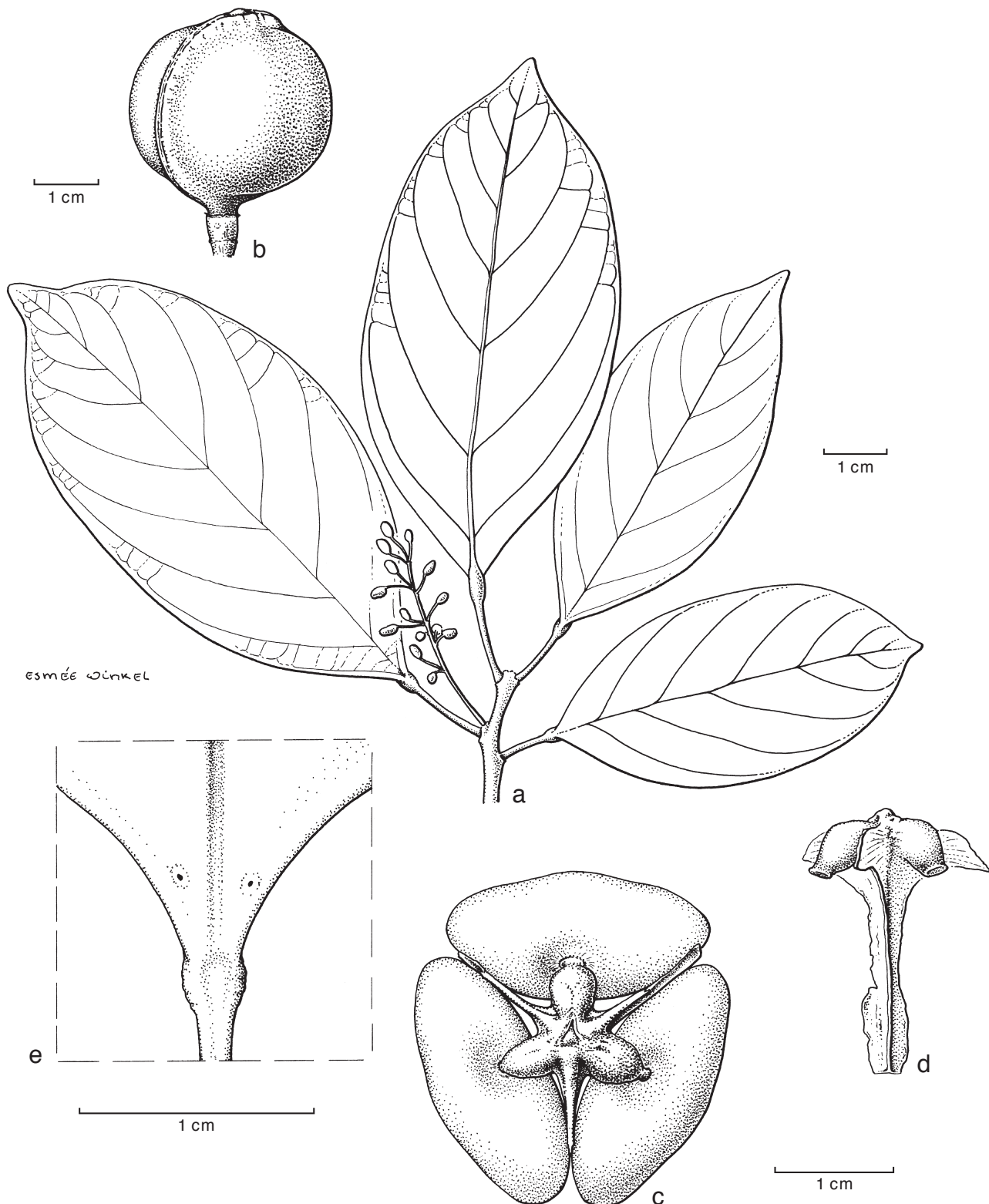
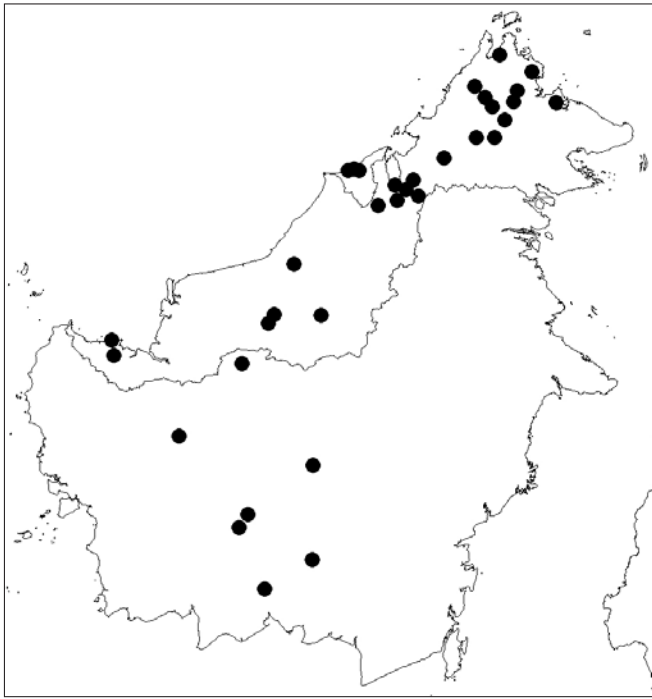


Fig. 4 *Blumeodendron gesinus* Ottens. a. Habit; b. fruit; c. seeds on columella in top view; d. columella; e. extrafloral nectaries on upper leaf surface (a, e: SAN (Ignasius B. & Clement M.) 140150; b–d: Pereira et al. 158; all L). — Drawing by Esmée Winkel, 2016.



Map 3 Distribution of *Blumeodendron gesinus* Ottens.

2. This new species was generally confused with *B. tokbrai*, because of the long inflorescences. Very typical are the rims on the fruits and their orangish colour when dry. The same colour can be found on the lower surface of the dried leaves.

3. The variation in inflorescence lengths seems to be large, varying between short (bud) to long (flowers), but inflorescences with buds are not yet fully grown and will largely extend during maturation of the flowers.

5. *Blumeodendron kurzii* (Hook.f.) J.J.Sm. — Fig. 5; Map 4

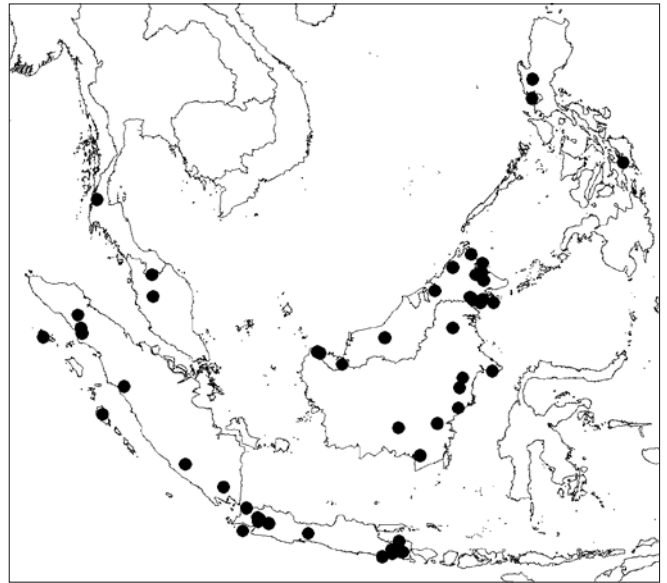
Blumeodendron kurzii (Hook.f.) J.J.Sm. (1910) 463; Koord. (1912) 493; Pax & Hoffm. (1914) 48; Ridl. (1924) 281; M.R.Hend. (1939) 69; Backer & Bakh.f. (1963) 480; Airy Shaw (1963) 348; (1972b) 224; Whitmore (1973) 70, f. 2; Airy Shaw (1975) 59; (1981) 269, f. 3B; (1983) 10; Chayam. (2005) 130; (2007) 611, f. 2. — *Mallotus kurzii* Hook.f. (1887) 427. — Lectotype (designated here): King's collector 7114 (K), [Malaysia,] Perak, Larut. (Other syntypes: Helfer KD 5010 (K), Andaman Islands; Anonymous s.n., s.d. (K), [Malaysia,] Perak.)

Blumeodendron verticillatum Merr. (1920) 557; (1923) 429; (1929) 157. — Type: FB (Meyer) 2603 (PNH lost; iso L), Philippines, Luzon, Bataan Prov., Mt Mariveles. (NY noted Elmer 20815 as type, but this is incorrect, the specimen is not cited by Merrill 1920).

Blumeodendron sumatranum S.Moore (1925) 102. — Syntypes: Forbes 1522 (BM, GH 2 sheets, L 3 sheets), Sumatra, Lampongs, Goenoeng Trang; Forbes 1563 (BM?, GH, L 2 sheets), Sumatra, Lampongs, hills NE of Goenoeng Trang; Forbes 1650a (BM, GH, L), Sumatra, Lampongs, Penang-gengan.

Blumeodendron cuneatum S.Moore (1925) 103. — Type: Forbes 2874 (holo BM; iso A, GH, L 4 sheets), Sumatra, Palembang, Ayer Kapat, foot of Kabo volcano.

Trees, to 35 m high, bole to 30 m high, dbh to 60 cm; sometimes slightly fluted at base, flutes c. 1.5 m high, out 50 cm to sometimes a short buttress; flowering branches 4–22 mm diam, round to sometimes triangular in section below the nodes, internodes up to 18 cm long; terminal bud surrounded by round or triangular axillary buds. *Outer bark* dark brown to brown-grey to greyish (black), smooth to cracked in irregular pieces to (powdery) scaly, soft to hard, 0.5–6 mm thick; inner bark beefy red outside to (pale) reddish to brown inside, 3–6 mm thick, sap absent to clear; sapwood white, yellow, reddish or brown; heartwood yellowish red to pinkish brown (to rays brown). *Leaves* always in whorls of 3–5 per node, young ones yellow-green to light green; petiole 1.3–12 cm long, diam of



Map 4 Distribution of *Blumeodendron kurzii* (Hook.f.) J.J.Sm.

thinnest part 1–4 mm, sordid green to brown, (green-brown to dark brown when dry, generally darker than stem, basal pulvinus c. 4 mm diam, upper pulvinus larger and mainly developed abaxially; blade (ovate to) elliptic to oblong to obovate, 8.8–42(–51, see Uses) by 4.4–23.7(–26.5) cm, length/width ratio 1.3–2.5, coriaceous, symmetric, glabrous, dried (dark green to) light brown on both sides, base obtuse to cuneate, margin usually light brown or yellow when dry, flat to revolute, apex acuminate (to cuspidate), extrafloral nectaries often 2, adaxially near base, at both sides along midrib 0–19 and along margin 6–36; venation: marginal vein distinct, secondary nerves (5–) 6–12 pairs, well visible, 2/3 of length of nerves parallel with others, tertiary nerves perpendicular to midrib, hardly visible above, raised beneath, 0.3–0.4 cm apart, higher order nerves reticulate, indistinct. *Inflorescences* cauliflorous, ramiflorous, axillary and terminal, thyrsoid, almost fasciculate; staminate ones more than 8 together, up to 1.7 cm long, pistillate ones c. 4 together, up to 3 cm long; bracts absent. *Flowers* yellowish, yellow-green or light green; pedicel 0.4–1 cm long; staminate buds globose, c. 35 per inflorescence, c. 3.9 mm diam. *Staminate flowers* 7–7.5 mm diam; pedicel c. 10 mm long; sepals 3, 4–5 by 2.2–3.5 mm; disk lobes yellow; stamens 20–25, filaments 2–10 mm long, yellow, anthers 0.75–1 mm long, yellow to later fulvous. *Pistillate flowers* not seen. *Fruits* capsular, subglobose, 3.3–5.8 cm wide by 2.8–4.6 cm high, 2–3-locular, dry dark brown; pedicel thickened, c. 1 cm long, c. 6 mm diam, abscission zone in the middle to subapically; sepals usually persistent; disc distinct, drying dark brown; wall 2–4 mm thick, surface knobbly; margin not or slightly thickened as very low ridges; endocarp enclosing two or more seeds; style very sturdy, at most 1 mm long; stigmas usually persistent, up to 5 mm long, spreading. *Seeds* bean-shaped, but one end smaller than other, 2.1–2.2 by 1.3–1.6 by c. 1.2 cm, dark brown, attached in middle; sarcotesta yellow.

Distribution — Peninsular Thailand, Malay Peninsula, Sumatra, Java, Borneo, Philippines (Luzon, Samar).

Habitat & Ecology — Ranging from primary and evergreen forest to logged over and secondary forest (with bamboo); soil: often rich, varying from igneous derived sandy soil to sandy clay to loamy soil to limestone; bedrock once reported as basalt. Altitude: 5–600(–1800) m. Flowering: March–August, November–January; fruiting: March–June, August–December.

Uses — Clemens 51511 is tentatively identified as *B. kurzii*. It is a single, enormous leaf, c. 51 by 26.5 cm, much larger than all other material of *B. kurzii*. The label indicates that large

leaves are used by the Dusun in N Borneo as rain shelter and to repair leaks in roofs. The seeds are eaten in the Philippines.

Vernacular names — Sumatra: Madanggadjah, Safanggeu bala, Tafanggeu, Tapanggeu delok, Tafanggeu toengo, Tampang. Java: Huru batu. Borneo: Kalimantan: Pelai, Tawiloeng; Sabah: Kulobon (Murut), Medang; Sarawak: Bantas (Iban), Ukut. Philippines: Kabarawang (Samar-Leyte Bisaya).

Note — Typical are the brown drying leaves present in pseudo-whorls: leaves in a whorl but originating at slightly different levels.

6. *Blumeodendron novoguineense* Ottens & Welzen, *nom. nov.* — Fig. 6a, b; Map 5

Blumeodendron novoguineense Ottens & Welzen (non *B. papuanum* Pax & K. Hoffm.). — *Bennettia papuana* Gilg (13 Dec. 1918) 283, f. 6 (*Flacourtiaceae*); (1925) 443, f. 205. — *Bennettiodendron papuanum* (Gilg) Merr. (1927) 10. — *Pimelodendron papuanum* auct. non Warb.: Sleumer (1954)

65; Djarwaningsih (2004) 413, p.p.: *Bennettia papuana*. — Type: *Ledermann 8945* (holo B? lost; iso K, L), [Papua] New Guinea, Etappenberg. See Note 1.

Blumeodendron papuanum Pax & K. Hoffm. (6 June 1919) 14; Airy Shaw (1963) 349. — Lectotype (designated here): *Ledermann 9517* (K), New Guinea, Kaiser Wilhelmsland, Etappenberg. Other syntypes: *Ledermann 8898, 9012, 9096* (K), New Guinea, Kaiser Wilhelmsland, Etappenberg.

Trees, to 40 m high, bole to 33 m high, dbh to 53 cm; bole sometimes fluted or with low buttresses up to 1.5 m high, out 0.6–2 m, 3–10 cm thick; flowering branches 2–3 mm diam, generally round, with orange lepidote hairs, early glabrescent, long internodes up to 8.5 cm. *Outer bark* red-brown to grey-brown to dark brown to brownish black, smooth to pustular lenticellate, not fissured nor peeling to little peeling with small to large scales, 0.25–0.5 mm thick; under bark wine-red; inner bark yellow to yellowish brown to red to light to dark brown, 3–12 mm thick; sapwood white to orange-brown to reddish brown to light brown; heartwood light brown to black. *Leaves* on hardly

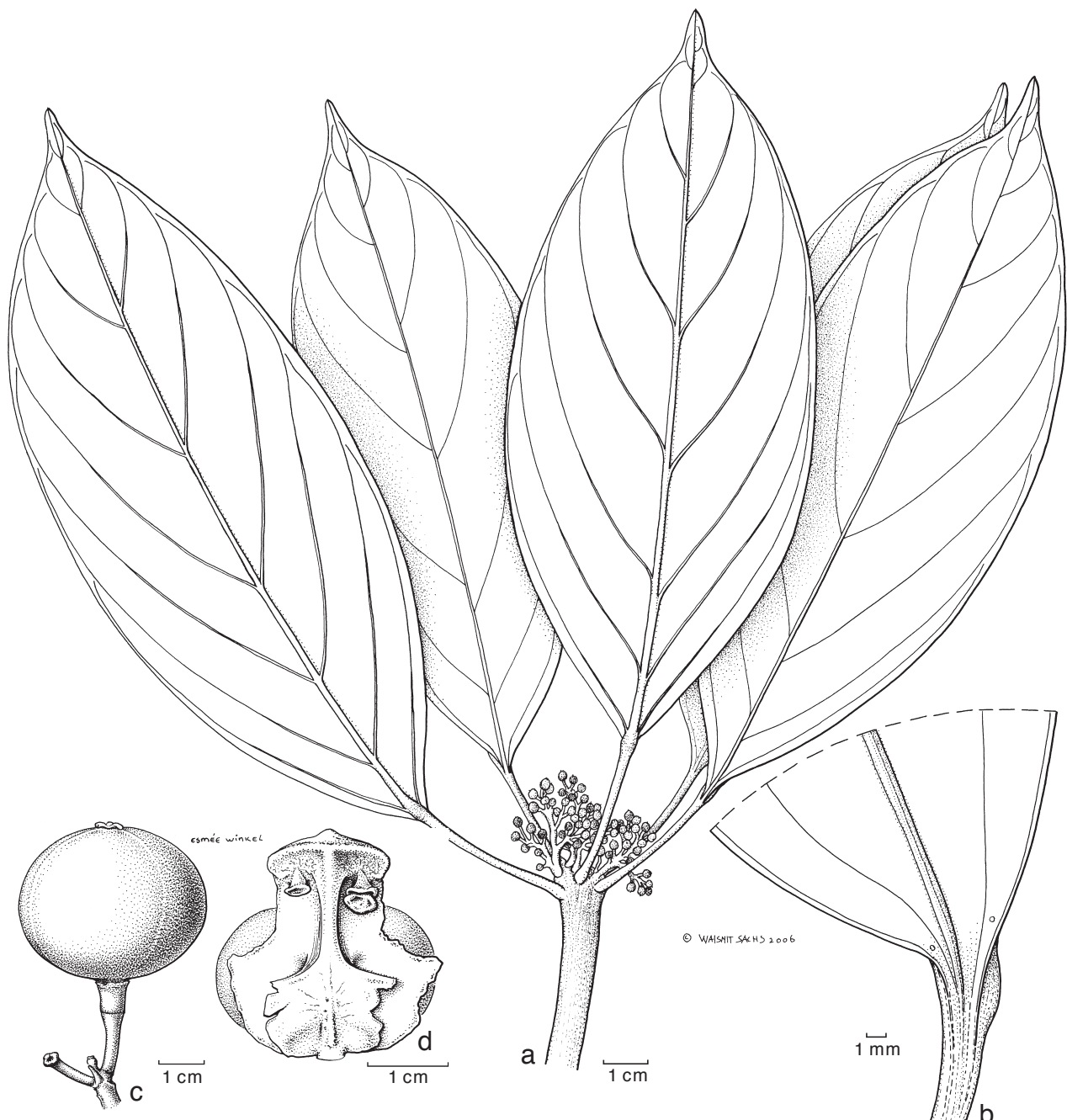


Fig. 5 *Blumeodendron kurzii* (Hook.f.) J.J.Sm. a. Habit with whorled leaves and short inflorescences; b. base of leaf blade with two small extrafloral nectaries; c. fruit; d. opened fruit with columella with apically remnants of seed attachment, and basally with parts of septa still attached, in background a single seed (a, b: Forbes 2874; c: SAN (Wood & Kilang) 16618; d: SAN (Mikil) 31599; all L). — Drawings by Anita Walsmit Sachs, 2006 (a, b) and Esmée Winkel, 2016 (c, d).

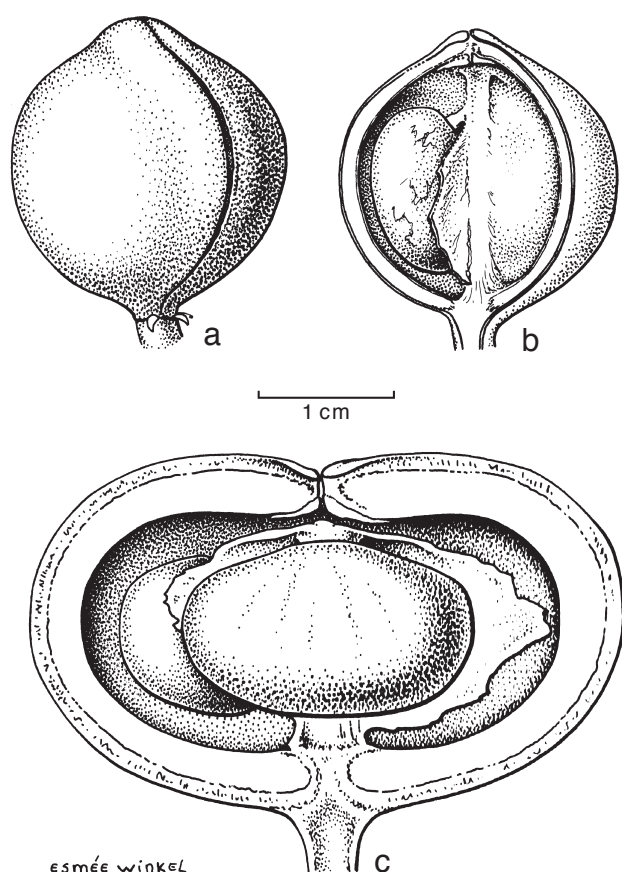


Fig. 6 Fruits of: a, b. *Blumeodendron novoguineense* Ottens & Welzen: a. Fruit; b. section through fruit showing columella and a septum (right) and a seed (left), notice the thin fruit wall. — c. *Blumeodendron tokbrai* (Blume) Kurz: Transverse section through fruit, with two seeds and part of two septa (not attaching to fruit wall), notice the thick fruit wall and larger fruit (a, b: Takeuchi, Ama & Morris 17041; c: Burley, Tukirin et al. 1404; all L). — Drawing by Esmée Winkel, 2016.

widened nodes at end of short nodes, alternate to subopposite to in pseudo-whorls of 3; petiole 1–4.1 cm long, diam of thinnest part 0.8–1.2 mm, round, basal pulvinus 1.3–2 mm diam, fast fading orange lepidote hairs; blade (ovate to) elliptic, 5.3–17.5 by 2.5–9 cm, length/width ratio 1.5–2.6, pergamentaceous to coriaceous, symmetric, glabrous, base (broadly) cuneate, margin recurved, apex acuminate, tip rounded, extrafloral nectaries on both surfaces along midrib, 2 to many, along margin several, both surfaces smooth, mid to dark green when fresh, dull and

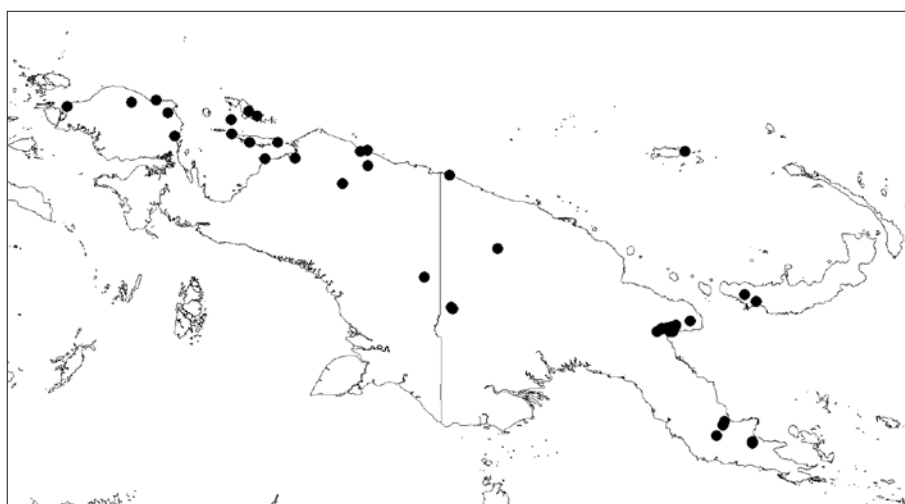
lighter beneath, drying brownish green, slightly darker brown underneath; venation slightly raised on both sides, marginal vein indistinct, secondary nerves pinnate, 5–8 pairs, sometimes very parallel, at c. 52° angle with midrib, tertiary nerves more or less scalariform, perpendicular to midrib, higher order nerves indistinct, reticulate. *Inflorescences* axillary, mostly single, staminate rachises up to 9.5 cm long, 1–1.3 mm diam, pistillate ones up to 3 cm long in flower, up to 9 cm when in fruit, 1–1.5 mm diam, thickening during fruit set to c. 2 mm; bracts vestigial; flowers single per node (young additional buds can be present when staminate). *Staminate flowers* c. 7.5 mm diam, white, sweet scented; pedicel 2–5 mm long, 0.8–1 mm diam; sepals 3–4, ovate, 3.8–5 by 2.5–3.5 mm, green to yellow; disc lobes yellow; stamens c. 40, filaments 3–8.3 mm long, white, anthers 0.4–0.6 mm long. *Pistillate flowers* 3.8–6 mm diam, green; pedicel c. 3.3 mm long; sepals 3–5, triangular, 1.6–3.1 by 1.4–2 mm, recurved; ovary 2(–3)-locular, ellipsoid, c. 3 by 3 mm; style c. 0.8 mm long, sturdy, stigmas 2–5 mm long, recurved. *Fruits* capsular, flattened obovoid, angular (perhaps not ripe yet) with often slightly raised suture, 2–2.9 cm wide by 2–2.9 cm high; pedicel c. 3 mm long, abscission zone subbasally; wall 1–1.8 mm thick, brown when dry, surface somewhat rugose; endocarp enclosing all seeds; stigma mostly persistent. *Seeds* bean-like to flattened at one side, c. 1.9 by 1.3 by 1 cm, attached in middle, black.

Distribution — New Guinea.

Habitat & Ecology — Lowland rain forest to *Araucaria-Anisoptera* forest at higher altitudes; soil: clayey, sandy clay, loam, broken lava, can be inundated in the wet season. Altitude: 8–800 m. Flowering: March–June, August, September, November; fruiting: January, March, July–September, November, December.

Vernacular names — New Guinea: *Papua*: New Guinea: Arom (Hattam); Kem (Mooi); Lowkwa (Manikiong); Manaper/Manapper/Manapir (Biak); Moe-e (Tor); Moentawiempi, Moentawinakpopi (Roberbai, Japen dialect); Moëre (Wain); Mwer (Berik); Sehoi/Sohoi (Manikiong); Tabet (Moejoe); Tajapmoetop (Mandobo); Wobbrijka (Manikiong); Wonsoka (Arfak, Sidai dialect); *Papua New Guinea*: Akop; He-arahai (Mangalese, Bariji dialect).

Wood — Sapwood not defined from heartwood, white to straw-coloured, close grained, medium hard to hard, medium heavy to heavy. Pores few, small, visible to naked eye, short radial chains. Rays fine, barely visible to the naked eye. Parenchyma in numerous fine bands. (NGF (Mair) 547; NGF (Havel & Kairo) 17205).



Map 5 Distribution of *Blumeodendron novoguineense* Ottens & Welzen.

Notes — 1. The epithet *papuana* by Gilg is the oldest one on species level, however, within *Blumeodendron* the combination already existed (*B. papuanum* Pax & K. Hoffm; Pax & Hoffmann 1919). Therefore, Gilg's name has to receive a new name within *Blumeodendron* even in spite of the fact that *B. papuanum* Pax & K. Hoffm. is the same species.

2. This species closely resemblances *B. tokbrai*, but differs in the size and form of the fruits, smaller (2–2.9 by 2–2.9 cm vs 2.3–4.8 by 2.3–4.1 cm) and often angular and with slightly thickened sutures (vs round, without thickened sutures), the thickness of the fruit wall is thinner (1–1.8 mm vs 4–7 mm) and the presence of broader sepals in the pistillate (1.4–2 mm vs 0.5–1.1 mm) and staminate flowers (2.5–3.5 by 1–2 mm). Moreover, the leaves of *B. novoguineense* usually dry brownish green, which also occurs in *B. tokbrai*, but most dry leaves of *B. tokbrai* are dark brown.

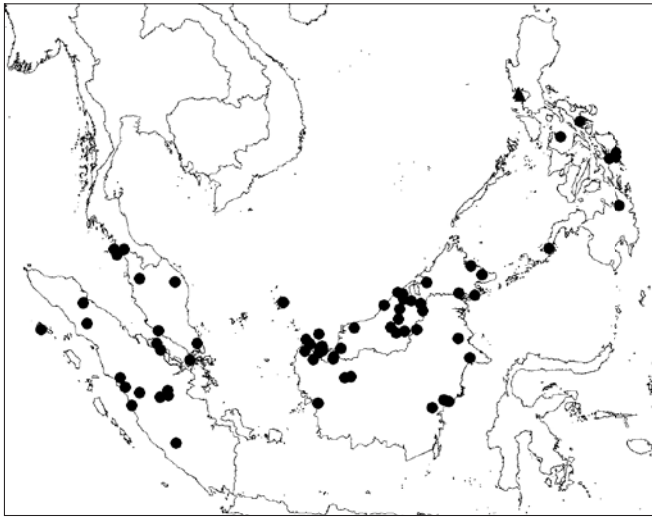
7. *Blumeodendron philippinense* Merr. & Rolfe — Fig. 7; Map 6

Blumeodendron philippinense Merr. & Rolfe (in Merr. 1920) 555; Merr. (1923) 429. — Type: *FB (Topacio) 20054* (holo PNH lost; iso L), Philippines, Luzon, Bataan Prov., Mount Mariveles.

Trees, to 15 m high, dbh to 45 cm; flowering branches c. 5 mm diam, generally round, with fast fading orange lepidote hairs, internodes c. 4 cm long. *Leaves* alternate; petiole 3.9–8.9 cm long, diam of thinnest part 1.5–2 mm, round with groove above, basal pulvinus c. 3 mm diam, with lepidote hairs, orange, early caducous; blade ovate, 7.8–21 by 3.7–10.2 cm, length/width ratio 2–2.3, coriaceous, symmetric, glabrous, base broadly cuneate to attenuate, margin recurved, apex acuminate, both surfaces smooth, glossy, upper dark green, lower pale green, adaxial surface browner than abaxial surface when dry, extra-



Fig. 7 *Blumeodendron philippinense* Merr. & Rolfe. Habit (*FB (Topacio) 20054*, L). — Drawing by Esmée Winkel, 2016.



Map 6 Distribution of *Blumeodendron philippinense* Merr. & Rolfe (▲) and *B. subrotundifolium* (Elmer) Merr. (●).

floral nectaries along margin 6–7; venation: marginal vein indistinct, secondary nerves 5–6 pairs, usually parallel, at c. 33° angle with midrib, tertiary nerves perpendicular to midrib and/or only to secondary nerves, higher order nerves indistinct. *Inflorescences* terminal and axillary, only consisting of an up to 1.3 cm long rachis, staminate ones 3–4 together, pistillate ones single or 2 per node; latter inflorescences thickening after fertilization, to 2.5 mm diam; lepidote hairs present, orange. *Staminate flowers* seen in bud: pedicel c. 3 mm long; buds c. 4 mm diam, c. 6 per inflorescence; rest unknown. *Pistillate flowers* seen in fruiting stage; upper part of pedicel above abscission zone c. 3 mm long; sepals 5, ovate, c. 2 by 2 mm; disc very c. 1 mm high; ovary 2–3-locular, style c. 0.8 mm long, stigmas c. 3 mm long. *Fruits* subglobose, c. 2 per inflorescence, up to 3 cm in width when immature, green (probably unripe), surface knobby; pedicel c. 6 mm long, to c. 3.5 mm diam, abscission zone basally; wall c. 1 mm thick, drying brown; endocarp enclosing two or more seeds; stigma mostly persistent. *Seeds* not seen mature.

Distribution — Philippines, endemic on Luzon in Bataan Prov.

Habitat & Ecology — Secondary forest on a slope with brown soil. Altitude: c. 650 m. Flowering: January, October; fruiting: May, December.

Note — Distinctive for this species are the alternate, coriaceous leaves and the very short inflorescences. The short inflorescences are reminiscent of *B. kurzii* (leaves in whorls) and alternate leaves are found in various species, but all with longer inflorescences except for *B. borneense* from the Malay Peninsula, but the latter form has light green dried leaves instead of brown dry leaves.

8. *Blumeodendron subrotundifolium* (Elmer) Merr. — Fig. 8; Map 6

Blumeodendron subrotundifolium (Elmer) Merr. (1912) 384; Pax & K. Hoffm. (1914) 49; Merr. (1920) 558; (1923) 429; Whitmore (1973) 70, f. 2. — *Sapium subrotundifolium* Elmer (1910) 930 ('*subrotundifolia*'). — Type: Elmer 12349 (holo PNH lost; iso A, BISH, G, GH, HBG, K, L, NY, US), Philippines, Sibuyan, Capiz Prov., Magallanes (Mt Giting-Giting).

Blumeodendron calophyllum Airy Shaw (1965) 309; (1971) 518; Whitmore (1973) 70, f. 2; Airy Shaw (1975) 58. — Type: S (*Brunig*) 8867 (holo K; iso L), Sarawak, Bintulu Dist., Niah-Jelalong primary forest.

Blumeodendron subcaudatum Merr. (1920) 557; (1923) 429. — Lectotype (designated here): FB (Sherfese, Cenabre & Cortes) 21075 (holo K; iso A, US), [Philippines,] Samar.

Trees, to 50 m high, bole to 25 m high, dbh to 91 cm; bole sometimes fluted or with low buttresses up to 1.5 m, out c. 1.5 m, c. 2.5

cm thick; flowering branches 3 (staminate)–28 (pistillate) mm diam, generally round, with orange lepidote hairs, early glabrescent, internodes up to c. 5 cm. *Outer bark* brown to yellow-brown to grey-brown to yellow-grey to grey (to greyish green), fissured to scaly to flaky, soft, lenticellate, 1–3 mm thick; inner bark red, light or reddish brown or dark brown with yellow and light brown spots (laminated), hard; 8–10 mm thick; sometimes exudate reported, red, watery; sapwood cream to white (with pinkish tinge radially), yellow or light reddish brown, very hard; heartwood brown. *Leaves* alternate to subopposite to in pseudo-whorls; petiole 2.4–18.5 cm long, diam of thinnest part 1–15 mm, round, basal pulvinus 2–20 mm diam, fast fading orange lepidote hairs; blade elliptic, 6.2–46 by 3–22 cm, length/width ratio 1.2–3.1, coriaceous (slightly bendable) to very coriaceous (breaking), symmetric, glabrous, base emarginate to rounded to cuneate, margin recurved, apex acuminate (to cuspidate), both surfaces smooth, extrafloral nectaries on both surfaces along midrib c. 2–26, along margin c. 8–20, adaxial surface usually drying shiny brown, abaxial surface lighter dull brown; venation: marginal vein indistinct, secondary nerves pinnate, 3–4(–11) pairs, sometimes very parallel, at c. 52° angle with midrib, tertiary nerves raised below, perpendicular to midrib and/or only to secondary nerves, higher order nerves indistinct. *Inflorescences* cauliflorous, ramiflorous to axillary, c. 0.1 cm diam, staminate ones often paired, up to 4.5 cm long, pistillate ones single, up to 2.3 cm long, rachis thickening during fruit set to c. 4 mm, peduncle c. 1.3 cm long, brown; bracteoles triangular, c. 0.5 by 0.2 cm, margin undulate; lepidote hairs orange. *Flowers* pale yellow to yellow-green to yellowish tinged pink to (greenish) red. *Staminate flowers* 5–6 mm diam; pedicel 3–25 mm long, brown; buds 1.5–5 mm diam; sepals 2–3, ovate, 4–5.5 by 3–5 mm; disc lobes yellow; stamens 25–40, yellow, filaments 1.5–3 mm long, anthers 0.4–0.5 mm long. *Pistillate flowers* not seen; sepals 4–5, c. 1.5 by 2.2 mm; ovary 2–3-locular, dull sordidly purple; style c. 1 mm long, sturdy, stigmas c. 2.5 mm long, recurved, greenish. *Fruits* capsular, subglobose (smaller) to ovoid (larger), 3.5–6 cm wide by 2.9–4.5 cm high, green (unripe) to yellow to orange-yellow (or red); pedicel c. 1.5 cm long, to c. 0.8 cm diam, abscission zone in the middle; wall 2–4 mm thick, dark brown when dry, margin slightly thickened, but without ridges, surface knobby; endocarp enclosing two or more seeds; stigma mostly persistent. *Seeds* bean-like to flattened at one side, 2.3–3.4 by 1.6–2.4 by 1.1–1.3 cm, attached in middle; sarcotesta cream to purple.

Distribution — Peninsular Thailand, Malay Peninsula, Sumatra, Borneo, Philippines.

Habitat & Ecology — Mixed lowland dipterocarp forest, evergreen forest, gallery (Emperan) forest, peat swamp forest, to mossy submontane forest, along logging roads; soil sandy loam, sandy clay, clayey loam, alluvial soil, bedrock: sandstone. Altitude: sea level to 1200 m. Flowering: March–November; fruiting: January, April–November. Fallen seeds/fruits are eaten by birds and animals (e.g., pigs).

Vernacular names — Malay Peninsula: Gaham badak; Kaum Bada. Sumatra: Babak; Basi; Madang soenting; Makoera; Mamboeloh; Medang koenik; Oendal; Sikoe kaloeang; Tendal (Malay); Toetoen sijeureuh, Toetoen sijeureuh etem, Toetoen sijeureuh pajo. Borneo: *Anambas* & *Natuna Islands*: Medang keladi; *Kalimantan*: Duhat (Malay); Kahingai; Sibau; *Sarawak*: Bantas, Bantas belulang (Iban); Belulang; Berti-an (Kenyah); Empungan (Malay Sarikei); Marahbulan; Ngisigi (Land Dayak); Teku (Malay). Philippines: Halilimokon (Samar); Mangamit.

Notes — 1. *Blumeodendron subrotundifolium* resembles *B. kurzii* in leaf-shape, colour of dried leaves and leaf texture. However, the leaves do not arise in whorls from thickened nodes. Also, the inflorescences are generally longer than the almost fasciculate ones of *B. kurzii*.

2. *Blumeodendron calophyllum* is added here as a synonym of *B. subrotundifolium*. Most specimens can easily be divided over both species as they look spectacularly different. Small, coriaceous leaves with slender petioles and more axillary smaller fruits are present in typical *B. subrotundifolium*, while much larger, very coriaceous (not bendable) leaves with thick petioles and cauliflorous large fruits are found in *B. calophyllum*. However, quite a number of specimens bridge the gap between both typical forms (see Table 1). Both forms are generally high trees with (very) coriaceous leaves on relatively long petioles, which are dry dark shiny brown above and dull brown underneath. Leaf sizes also vary strongly in *B. kurzii*, a species with which *B. subrotundifolium* was often confused.

9. *Blumeodendron tokbrai* (Blume) Kurz — Fig. 6c, 9; Map 7

Blumeodendron tokbrai (Blume) Kurz (1874) 245; (1877) 391 (pro *Mallotus tokbrai* (Blume) Müll.Arg.); emend. J.J.Sm. (1910) 460; Koord. (1912) 493; Pax & K.Hoffm. (1914) 48; (1919) 14; Merr. (1921) 340; Backer & Bakh.f. (1963) 479; Whitmore (1973) 71, f. 3; Airy Shaw (1975) 60; (1980) 38; (1981) 269, f. 3A; (1982) 9; (1983) 10; Chayam. (2005) 131; (2007) 612, f. 3. — *Elatiospermum tokbrai* Blume (1826) 621; Hassk. (1848) 251; Miq. (1859) 412. — *Mallotus tokbrai* (Blume) Müll.Arg. (1866) 956; Pax (1910) 18. — *Rottlera tokbrai* (Blume) Scheff. (1869) 122. — *Blumeodendron elatiospermum* J.J.Sm. (1912) 56, nom. illeg., superfl. — Lectotype (designated here): Blume 1531 (L), Java, Mt Salak. *Mallotus ?vernicosus* Hook.f. (1887) 443. — *Blumeodendron vernicosum* (Hook.f.) Gage (1922) 244; Ridl. (1924) 282. — Type: Cantley 9 (K), Singapore, Botanical Garden.

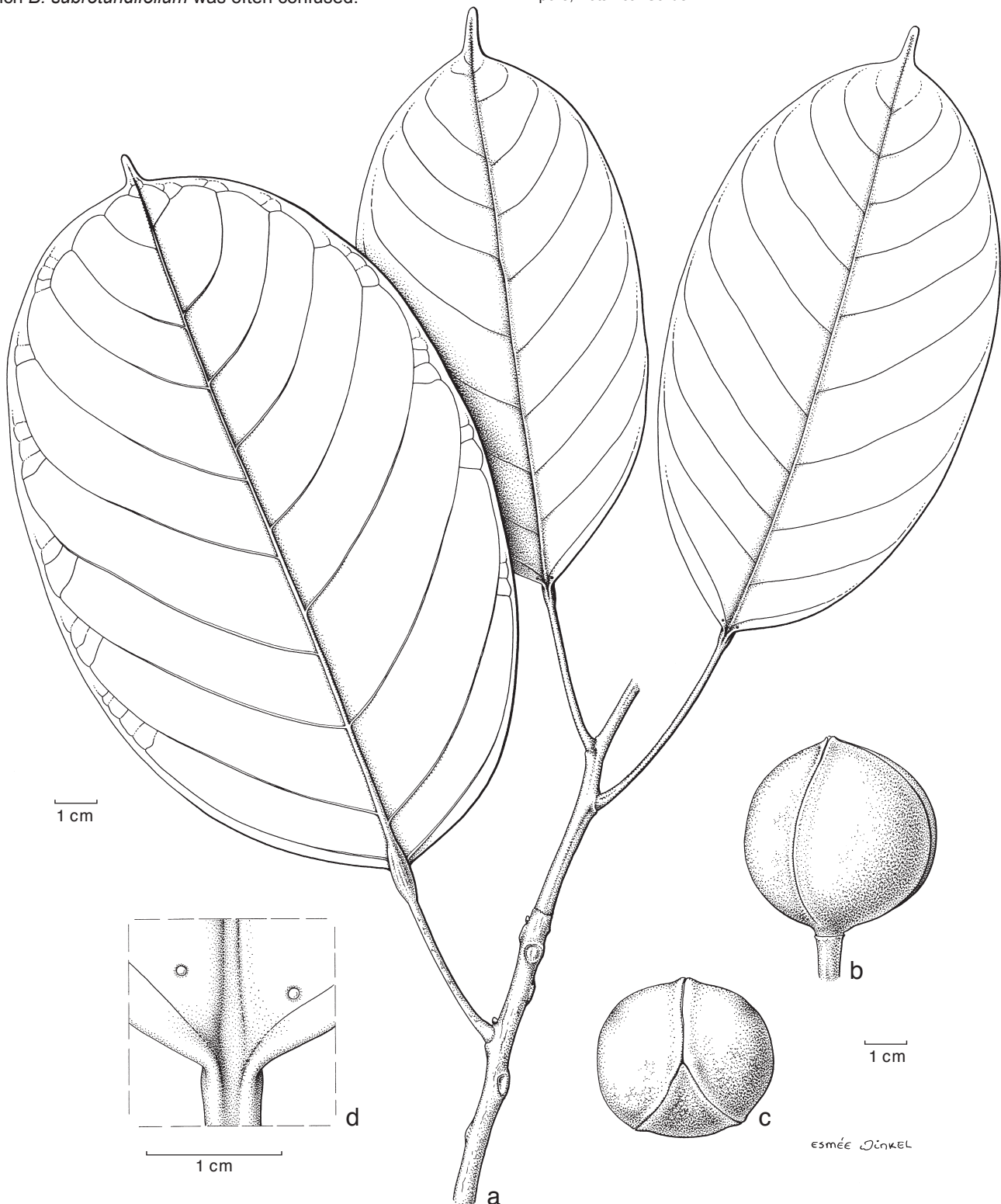


Fig. 8 *Blumeodendron subrotundifolium* (Elmer) Merr. a. Habit; b. fruit in lateral view; c. fruit in top view; d. base of upper leaf surface with extrafloral nectaries (a, b: Kessler et al. Berau 763; c, d: Nootboom & Chai 2317; all L). — Drawing by Esmée Winkel, 2016.

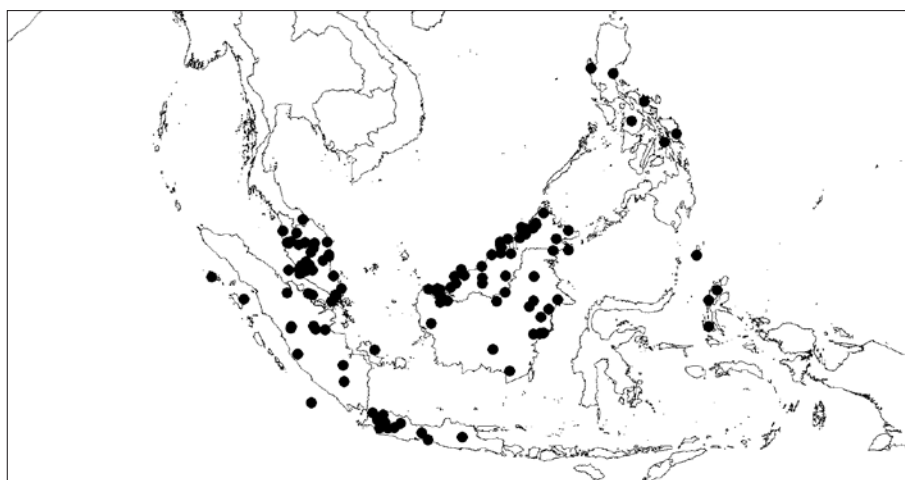
Table 1 Division of *B. subrotundifolium* forms over the smaller *B. subrotundifolium* form and the much larger *B. calophyllum* with all intermediates. Intermediate specimens are assigned to three columns to stress the gradualness in character changes.

Area	Typical <i>B. subrotundifolium</i>	Intermediates			Typical <i>B. calophyllum</i>
Sumatra	bb 3045 bb 5215 bb 5369 bb 27645 Béguin 491 Béguin 501	Achmad 1270 Achmad 1325 Achmad 1448 bb 5791 Béguin 288	bb 2823 bb 3137 bb 29523 bb 30093 Béguin 328 De Wilde & De Wilde-Duyfjes 19486	bb 2431 bb 9078 bb 19621 bb 25204	
Borneo	bb 13778 BRUN 15 Haviland 1648 Kostermans 13629 S 9568 S 36664 S 39134 S 41635 S 41880 SAN 16283 SAN 24987	bb 27027 bb 28140 bb 34388 Fuchs 31372 Jacobs 5367 Kostermans 7629 S 5228 S 34695 S 38587 S 44010 SAN 30133 SAN 84144 SAN 100029 Sidiyasa et al. 3387 Suzuki 5354 Suzuki 10048	bb 18259 Nooteboom & Chan 2317 SAN 40893 Suzuki 10058 Van Balgooy & Van Setten 5475	bb 18324 Kostermans 7652 S 15684 SAN 85404	Ambriansyah & Arifin AA77 Endert 4603 S 24932 S 46498 S 49954 S 68702 S 81221 Van Steenis 1372
Philippines	BS 16549 FB 10598 PNH 14450 PNH 117735	PNH 42439 PNH 117385		FB 18906 PPI 4276 Santos 4541	

?*Elateriospermum paucinervia* Elmer (1908) 484. — *Blumeodendron paucinervium* (Elmer) Merr. (1920) 555; (1923) 428. — Type: *Elmer* 7416 (holo PNH lost; iso L), Philippines, Luzon, Tayabas Prov., Lucban.

Trees, to 40 m high, bole to 25 m high, dbh to 100 cm; stilt roots or buttresses up to 3 m high, out to 3 m; flowering branches 2–5.5 mm diam, often somewhat angular, with internodes 3–7 cm long; nodes hardly thickened. *Outer bark* red-, greenish- or light brown to (dark) grey to red to orange(-brown), smooth, pustular or fissured, lenticels round, c. 0.5 mm thick; inner bark wine- or orange red to yellow-brown, brown, (ochre-)orange, white, purple, yellow-pink and sometimes mottled, 5–10 mm thick; exudate indistinct, but plants becoming sticky; sapwood straw to pale yellow to cream to greyish white; heartwood straw. *Leaves* usually always a few alternate, but also subopposite to 3 leaves whorled; petiole 1.2–9.4 cm long, diam of thinnest part 1–2 mm, basal pulvinus 1–3.6 mm diam, hairs present (see Note 2); blade (ovate to) elliptic (to obovate), 5.3–31 by 3.1–17.3 cm, length/width ratio 1.4–2.4(–3.3), ratio leaf length/petiole length 4.4–4.8, pergamentaceous to coriaceous, asymmetric, with simple and lepidote hairs when young, base attenuate to cuneate, margin slightly recurved, apex acuminate

to cuspidate, tip rounded to mucronulate, extrafloral nectaries sometimes adaxially along midrib, c. 10, young leaves resinous, covered with orange lepidote hairs, surfaces drying brown to brown-green to dark green, smooth, abaxial surface browner than adaxial surface when dry; venation slightly raised above, marginal vein indistinct, secondary nerves 5–9 pairs, at c. 45.6° angle with midrib, tertiary nerves perpendicular to midrib, c. 2 mm apart, distinct, raised beneath, higher order nerves reticulate, indistinct. *Inflorescences* axillary and terminal, staminate ones 1–3 together, to 20 cm long, c. 1.4 mm diam, pistillate ones single, to 10 cm long, c. 1 mm diam; lepidote hairs orange, simple hairs white. *Buds* c. 3 mm diam. *Staminate flowers* 4–7.7 mm diam, white to pale green, sweet scented; pedicel 5.8–8.4 mm long, 0.3–0.7 mm diam; sepals 3–4, ovate to elliptic, 2.5–4 by 1–2 mm, inside red; stamens 31–36, filaments c. 4 mm long, white, anthers c. 0.5 mm long, yellow. *Pistillate flowers* 0.9–2.3 mm diam, light green; pedicel c. 2.5 mm long, c. 0.8 mm diam; sepals 5, triangular to ovate, 1.5–3 by 0.5–1.1 mm, inside red; ovary 2–3(–4)-locular, ellipsoid, 1.7–2.3 mm high, 1.4–2.3 mm diam; style indistinct, 0.3–0.5 mm long, stigma 1.3–4 mm long, recurved. *Fruits* ellipsoid to flattened-globular,

**Map 7** Distribution of *Blumeodendron tokbrai* (Blume) Kurz.

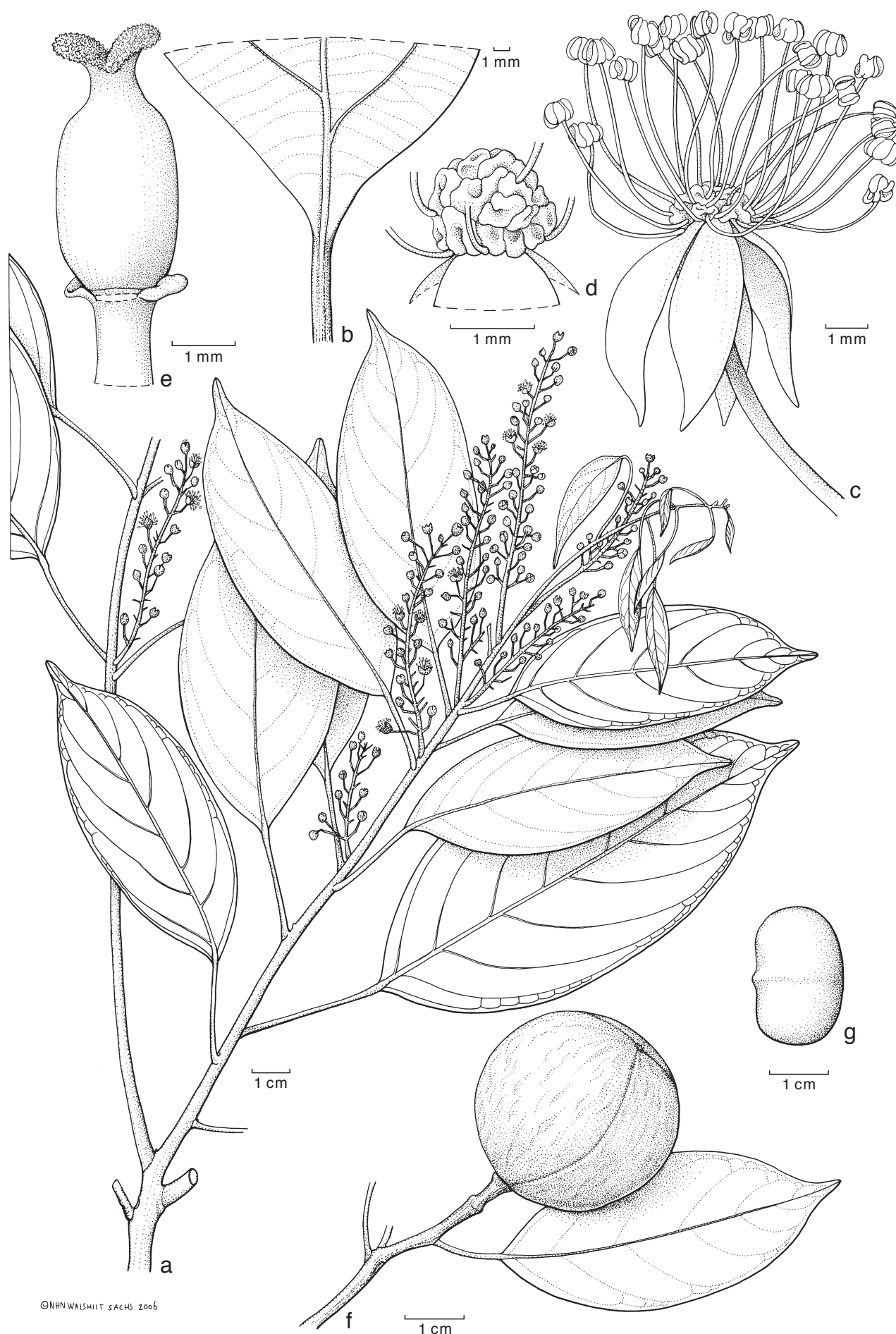


Fig. 9 *Blumeodendron tokbrai* (Blume) Kurz. a. Habit with alternate leaves and long inflorescences; b. base of leaf blade; c. staminate flower; d. idem with disc glands in detail; e. pistillate flower; f. fruit; g. seed (a, b: KEP (Ismail) 104883; c, d: Niyomdham et al. 1009; e: KEP FRI (Cockburn) 7696; f: KEP FRI (Ng) 1966; g: SF (Sinclair) 39693; all L). — Drawing by Anita Walsmit Sachs, 2006.

3.3–4.8 cm broad by 2.3–4.1 cm high, green to red-brown when dry; pedicel to 1 cm long, up to 3 mm diam, abscission zone basally; sepals not persistent; disc distinct; wall 4–7 mm thick, meso- and endocarp thickened, mesocarp sometimes with cavities when dry (see Note 3), surface knobby; margin mostly pitted when dry; endocarp enclosing 2 or more seeds; stigma usually long persistent. *Seeds* bean-shaped, 2–3.8 by 1.1–2.2 by 0.9–1.3 cm; sarcotesta yellow.

Distribution — Thailand, Malay Peninsula, Sumatra, Java, Borneo, Philippines, Sulawesi, Moluccas.

Habitat & Ecology — Primary dipterocarp lowland forest, peat swamp forest, mangrove, kerangas forest, riverine forest, secondary forest; soil: white sand, sandy clay, clay, sandstone. Altitude: sea level to 1400 m. Flowering and fruiting throughout the year.

Uses — Sarawak (Borneo): Wood used for canoes and planks; fruits edible.

Vernacular names — Malay Peninsula: Gaham badak; Kaum bada; Marahbulan. Sumatra: Awa sijeureuh; Batin-batin oeding; Belanti; Beroewa babi; Kalek kasih; Kemili oétan (Malay-Palembang); Keroeng; Lala lalar oeding; Matakeroeng; Niho (Enggano); Lala lalar oeding; Matakeroeng; Oekih datan; Panai-panai; Sijeureuh etem; Sijeureuh-pajo; Sijeureuh silai; Sijeroeh alafai; Tekeroeng; Tekeroeng keroeng; Tijeureuh silai; Toe-toen ramboetan dotan. Java: Boerahol; Kendoeng leuweung; Ki tokbraay; Tokbray. Sangi and Talaud Isles: Aluwatu. Borneo: *Brunei*: Antangon (Iban); *Kalimantan*: Sibau; *Sabah*: Gangu-lang; Gulang gulang; Tombuakat; *Sarawak*: Bantas (Iban); Buan (Kayan); Empungan (Milanau); Marahbulan; Merbulan; Merahbulan; Oendal; Pelapi (Kayan); Selunsor merah; Takok (Milanau); Teku. Sulawesi: *Talaud*: Aluwatu.

Notes — 1. *Blumeodendron novoguineense* and *B. tokbrai* resemble each other closely, see Note 2 under former.

2. Simple hairs are usually visible in Sumatran collections.

3. Some specimens in Borneo dry with green leaves and the fruits are very thick, not only the endocarp is thick also the mesocarp. The mesocarp then contains cavities of which is unclear if these were formed during drying of the fruits. Examples are: *A (Wood) 4815*, *S (Paie) 16992*, *S (Au) 23937*, *SAN (Gansau) 47750*. Probably *S (Anderson & Paie) 28338*, with staminate buds, and *Ambrianyah & Arifin W 807*, with young fruits, also belong to this form. *Endert 4029*, from SE Kalimantan, dried brownish green and also has fruits – still young – with a thickened mesoderm, but without cavities (see also Note 1 under *B. borneense*).

4. Formerly, no distinction was made between *B. tokbrai* and *B. novoguineense*. The geographical border between both species is between the Moluccas (*B. tokbrai*; fruits larger and thick-walled) and New Guinea (*B. novoguineense*; fruits smaller and thin-walled). This may be due to clinal variation in the fruits of *B. tokbrai*, which show a geocline, they are larger in the west (Malay Peninsula and Sumatra) and smaller towards the east (Philippines, Moluccas). Thus it seems that the small fruits of *B. novoguineense* are a continuation of this trend, but this is actually not the case.

EXCLUDED TAXA

Blumeodendron muelleri Kurz (1874) 245, nom. superfl. (presented as new name for *Paracroton pendulus*) = *Paracroton pendulus* (Hassk.) Miq.

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IDENTIFICATION LIST OF BLUMEODENDRON SPECIMENS

1 = <i>B. borneense</i>	4 = <i>B. gesinus</i>	7 = <i>B. philippinense</i>
2 = <i>B. bullatum</i>	5 = <i>B. kurzii</i>	8 = <i>B. subrotundifolium</i>
3 = <i>B. endocarpum</i>	6 = <i>B. novoguineense</i>	9 = <i>B. tokbrai</i>

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