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SINGAPORE

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Ridley, H. N. (1930). *The Dispersal of Plants Throughout the World,* L. Reeve; Ashford, Kent; 242-255.

For literature citations in taxonomic papers the following style is required:

Medinilla alternifolia Bl., Mus. Bot. Lugd.-Bat. I:2 (1849) 19.
Sterculia acuminatissima Merr., Philip. J. Sci. 21 (1922) 524.

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A New Account of the Genus *Horsfieldia* (Myristicaceae), *Pt 4**

W.J.J.O. de WILDE
Rijksherbarium, Leiden, The Netherlands

EFFECTIVE PUBLICATION DATE: 26 JULY 1986

Contents

71. Horsfieldia hirtiflora de Wilde, *sp. nov.* Fig. 1C(71); 27

Ramuli validi, cristati, primum pilis 0.3-0.4 mm longis obtecti. Folia disticha vel sparsa, membranacea, elliptico-oblonga usque ad oblonga, 17-30 cm longa, nervis supra prominentibus. Perianthia mascula pubescentia, breviter obovoidea, c. 2.5 mm diam., 4-valvata. Androecium indistincte triquetrum an non, antheris 7, suberectis, in parte superiore liberis. Pedicellus pubescens, basi articulatus. — Type: *Rahmat si Boeea 9257* (L; iso: MICH, *n.v.*).

Tree 10 m. Twigs subterete, in the apical portion ± angular and ridged, lower down distinctly lined or ridged, 4-6(-15) mm diam., dark brown, glabrescent, hairs 0.3-0.4 mm; bark lower down finely to coarsely striate, lenticels not very conspicuous, older bark not flaking. Leaves in 2 or sometimes in 3 rows, membranous, elliptic-oblong to oblong, broadest above the middle, 17-30 × 6-11 cm, base ± long-cuneate, top rather shortly acute-acuminate; upper surface glabrous, drying brown-olivaceous, lower surface drying brown, glabrous but midrib ± late glabrescent, without scattered larger blackish dots; midrib above raised to rather flattish, glabrescent; nerves 15-20 pairs, above slender, raised, glabrous, the lateral arches usually ± sunken, distinct; tertiary venation forming a lax network indistinct above; petioles 15-25 × 2.5-3.5 mm, late glabrescent; leaf bud 8-10 × 4-5 mm, with hairs c. 0.3-0.4 mm. Inflorescences behind the leaves, densely rusty pubescent with hairs c. 0.3-0.6 mm; in ♂: 3 or 4 times ramified, rather many-flowered, 10-12 × 5-6 cm, common peduncle 35-40 mm, the flowers in clusters of 3-5 each; bracts elliptic-oblong, acute, 5-10 mm long, densely pubescent, caducous; flowers 3- or 4-valved, perianth pubescent with hairs 0.1-0.3 mm, pedicel pubescent with hairs 0.2-0.3 mm, at base articulate; ♀ inflorescence rather few-flowered, c. 4 cm long. Male perianth subglobose-obovoid, in transverse section rounded, collapsing slightly on drying, 2.2-2.5 × 2.0-2.5 mm, top broadly rounded, base ± rounded; pedicel 1.5-2.5 mm long; perianth at anthesis cleft from c. ½ to nearly ⅔, valves 0.3-0.4 mm thick. Androecium globose to obovoid, (1.2-)1.5 mm diam., subcircular to blunt-angular in cross-section; anthers 6 or 7, acutish, 0.7-0.8 mm long, free for c. ½-way, somewhat curved towards the centre, column largely hollowed out, the basal part of the androecium consisting of a tapering androphore 0.5-0.7 mm long. Female flowers not seen. Fruits 1-3 per infructescence, broadly ellipsoid-obovoid, top broadly rounded, base narrowly rounded and short-attenuate, 5.0-5.7 × 3.8-4.5 cm, glabrous, drying dark brown, sparsely coarsely tubercled, pericarp 10(-15) mm thick; stalk 2-3 mm long, pubescent; perianth not persistent.

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*Continued from Gdns' Bull. Sing. 38 (2): 225
Received on 17 July 1984

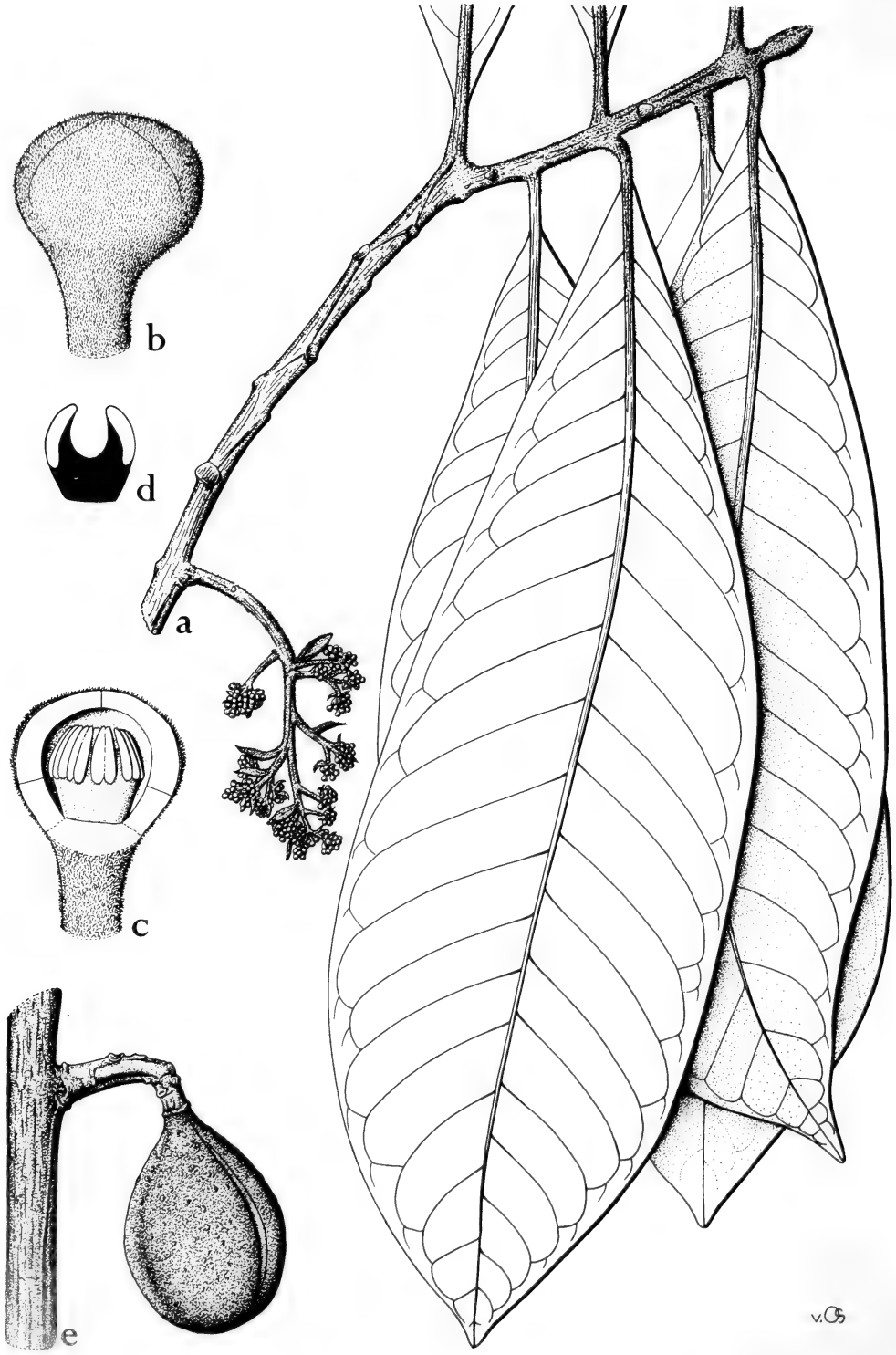

Fig. 27 *Horsfieldia hirtiflora* de Wilde.
a, leafy twig with immature male inflorescence, note lined twig, dispersed leaves and bracts present in inflorescence, × ½; *b*, submature male flower, lateral view, × 12; *c*, ditto, opened, showing androecium, × 12; *d*, immature androecium, longitudinal section, schematic, × 12; *e*, portion of twig with infructescence, fruit mature, × ½. — *a-d*, from *Rahmat si Boeea 9257; e*, from *Kostermans 22048*.

Distribution. Sumatra (Tapanuli, E. Coast).

SUMATRA. Tapanuli: *Kostermans 22048* — E. Coast: *Rahmat si Boeea 9257, 9362.*

Ecology. Forest, 100-500 m alt; on sandstone. Flowers June-July, fruits in December.

NOTES

1. Fieldnotes. Tree 10 m, diam. 12 cm. Bark rough, hard, black. Fruit yellow, subglobose, 8 cm diam.

2. Surely closely related to *H. brachiata* with which it has the distinctly ridged twigs in common, but differing by the coarser habit, larger and hairy flowers, and large fruits.

3. The leaves towards the apex of the twigs in *Kostermans 22048* and *Rahmat Si Boeea 9257* are not distichous but, rather, arranged in 3 rows.

4. Sinclair identified the specimen *Rahmat Si Boeea 9257* as *H. brachiata* var. *sumatrana, Rahmat Si Boeea 9632* as *H. brachiata* var. *brachiata.*

72. Horsfieldia brachiata (King) Warb. Fig. 1C(72).

Myristica brachiata King, Ann. Roy. Bot. Gard. Calc. 3 (1891) 311, pl. 144 — *Horsfieldia brachiata* (King) Warb., Mon. Myrist. (1897) 325; Gamble, Mat. Fl. Mal. Penins. 5, 23 (1912) 218; Ridley, Fl. Mal. Penins. 3 (1924) 59 — *H. subglobosa* (Miq.) Warb. var. *brachiata* (King) Sinclair, Gard. Bull. Sing. 16 (1958) 431, fig. 51 E. — *H. brachiata* (King) Warb. var. *brachiata:* Sinclair, Gard. Bull. Sing. 28 (1975) 9 — Type: Malaya, *Scortechini 1649* (CAL, *n.v.;* iso: K, L), *King 4704* (CAL, *n.v.;* iso: K, L; BO, PDA, *n.v.*), *6771* (CAL, *n.v.;* iso: BM, K; FI, G, *n.v.*), *Griffith 4351* (CAL, *n.v.;* iso: K, P, U; A, G, M, S, *n.v.*).

Tree 10-35 m. Twigs ± angular or subterete, or more or less flattened towards the apex, almost always distinctly lined or ridged in between the petioles, or sometimes lines evident only in a part of the material, twigs towards the apex 2-7(-18) mm diam., grey-brown to blackish, generally early glabrescent from dark brown or rusty hairs (0.1-)0.2-0.4 mm long; bark lower down finely to coarsely striate, in colour not very contrasting with lenticels; bark when older not flaking. Leaves in two rows, membranous, elliptic-oblong to oblong(-lanceolate), broadest at or slightly above the middle, 12-26(-30) × 4-9(-11) cm, base cuneate, top acute-acuminate; upper surface glabrous, drying olivaceous to brown or sometimes blackish, with the midrib glabrescent, lower surface drying light brown, early glabrescent but midrib sometimes later glabrescent; not dotted; midrib raised above, glabrous; nerves 12-20 pairs, above slender, raised, glabrous, the lateral arches usually not distinct above; tertiary venation forming a lax network usually not distinct above; petioles 8-13(-20) × 2-3 mm, glabrescent; leaf bud 8-15 × 3-4 mm, with hairs 0.2-0.4 mm long. Inflorescences sparsely to densely pubescent with dendroid hairs 0.2-0.5 mm, sometimes partly glabrescent; in ♂: 3-4 times ramified, many-flowered, 7-18(-22) × 5-16(-18) cm, common peduncle 6-18 mm long, the flowers in loose clusters of 3-6; ♀-inflorescences rather many-flowered, 3-8 × 2-6 cm; bracts oblong-lanceolate, acutish, 3-5 mm long, pubescent, caduous; perianths 3 (or 4)-valved, glabrous; pedicels in ♂ pubescent in various degree with hairs 0.1-0.2 mm, in ♀ glabrescent, at base articulate. Male perianths subglobose or

slightly depressed-globose to broadly obovoid, in transverse section usually slightly angular, sometimes rounded, 1.0-1.5 x 1.2-1.8 mm, top (broadly) rounded, base rounded to short-cuneate, glabrous; pedicel (1.0-)1.5-2.5 mm long, slightly tapering or not; perianth at anthesis cleft to ½-⅔, not or but little collapsing on drying, valves 0.2-0.4(-0.5) mm thick. Androecium depressed-globose to obovoid in outline, (0.5-)0.7-1.0 × 0.8-1.2 mm, ± rounded or usually ± 3-angular in transverse section; anthers 6-10 (12-20 thecae), 0.5-0.7 mm long, mutually free for c. ½-way, usually curved towards the centre, column largely hollowed out, at base continuing into the 0.2-0.3-mm long androphore, slightly tapering or not. Female perianth broadly ellipsoid, 2.2-2.5 × 1.8-2.0 mm, glabrous, cleft at anthesis to c. ⅓, valves c. 0.3-0.4 mm thick, pedicels 1-1.5 mm long, glabrous, ovary ovoid, 1-1.4 × 0.8-1.2 mm, glabrous, stigma 2-lobed, c. 0.2 × 0.4 mm. Fruits 4-12(-20) per infructescence, broadly ellipsoid, top narrowly rounded, base (broadly) rounded, 2.0-2.8(-4.0, see notes) × 1.8-2.2(-3.0) cm, glabrous, drying brown to dark brown, not warted nor lenticellate, pericarp 1.5-4(-7) mm thick; stalk 1.5-3 mm long; perianth not persisting.

Distribution. Peninsular Thailand, Malaya (Kedah, Kelantan, Perak, Trengganu, Pahang, Malacca, Johore), Sumatra, Borneo (Sarawak, incl. one deviating coll., see notes; Sabah; E. & NE. Kalimantan); not found in Singapore and most of Kalimantan.

THAILAND. Peninsular: (*Larsen c.s.*) Fl. of Thailand *31184,* (*Phusomsaeng 424*) *36470,* (*Sangkhachand 1132*) *36570, 52357; A.F.G. Kerr 7426, 7690, 12426, 18185; Put 1184; Shimizu et al.* (Kyoto) *8181.*

MALAYA. *FRI 0417, 4941, 5606, 10387, 11424, 11872, 13310, 13743, 15307, 15807, 17562: Griffith* (d.d. 1845; *Kew Distr. 4351*); *Kep 94517, 94688, 98501, 100129, 104313, 104996; (Kunstler* in) *King 4704, 6771; KL* (of Malaya Univ.) *3095; Ridley 4459; Shah MS. 1541,* (*& Noor*) *1751; Scortechini 1649; SFN 23869, 25991, 28707, 28963, 29466, 31617, 33753, 34569, 34708, 36791, 40772.*

SUMATRA. E. Coast: *Bartlett 7110; Rahmat si Toroes 4124, 4657; Yates 1601* — Djambi: *Roos & Franken 1653* — Palembang: *Lambach 1341.*

BORNEO. Sarawak: *S 34908* (large fr., see notes), *39162* — Sabah: *Amdjah 1088; San 21509, 48435, 69290, 74417, 74544* NE. & E. Kalimantan (incl. Tarakan, E. Kutei): *Kostermans 4988, 5078, 9018, 9171; Meÿer 2259, 2380, 2385.*

Ecology. Primary and secondary lowland rain forest; often in flatland forest, marshy forest, riverside forest, peaty forest, forest on alluvial plains, poor forest on soil with stagnant water, but also on hill sides; found on alluvial soils, brown soil, sandy soil (in *Tristania* forest, Sabah), sandstone, peaty soils, loam soil with lime; often near streams; 0-400 m alt. Flowers and fruits throughout the year.

Vernacular names. Pĕrĕdah boeroeng (Palembang), *Kajoe darodong* (Tapanoeli).

NOTES

1. Fieldnotes. Usually a slender tree, with straight bole once recorded as with buttresses to 50 cm high. Bark ± smooth, pale brown to dark brown, generally shallowly vertically fissured c. 1 cm apart, sometimes recorded as ± laminated or scaly, or cracked. Living bark 8-10 mm thick, pinkish to reddish-brown, exuding reddish sap. Wood whitish to pale brown; no heartwood. Twigs with raised lines. Flowers greenish-yellow to dark yellow, scented. Fruits yellow-green, yellow or yellow-orange.

2. The present species is largely the same as *H. subglobosa* var. *brachiata* or *H. brachiata* var. *brachiata* as delimited by Sinclair in 1958 and 1975 respectively. I also agree that it is very close to *H. polyspherula;* in fact, it stands in several respects more or less between the vars. *polyspherula* and *sumatrana* of *H. polyspherula. H. brachiata* is in most cases easily recognized by its weak to strong raised lines on the twigs on both sides from petiole to petiole. Its fruits are rather uniform in shape and size, 20-28 mm long, and thus ± intermediate between *H. polyspherula* var. *polyspherula* and var. *sumatrana* (see there). *H. brachiata* has the leaves rather like those of *H. polyspherula* var. *sumatrana, viz.* generally membranous, and drying to pale, dull olivacous above, and pale cinnamon below. Its flowers are rather uniform, mature male buds 1.2-1.8 mm diam., with a usually ± triquetrous androecium (but see note 3) consisting of 6-10 stamens, and they do not differ from those of *H. polyspherula* s.l. Sterile and flowering specimens, in which the apical and lower twig portions are not sufficiently represented may be difficult to place.

Note that *H. brachiata* generally has stouter inflorescences in contrast with *H. polyspherula.* The former occurs quite commonly in evergreen forests in Peninsular Thailand, where *H. polyspherula* is not found yet.

3. Variation. The number of anthers in the androecium is usually 6-8, only in the material from Peninsular Thailand did I find 9 or 10.

The shape of the mature male perianths in bud is generally subglobose or short-obovoid, with the transverse section faintly 3-angular, corresponding with the generally angular shape of the androecium. Only in a few specimens from Malaya (*FRI 0417, Kep 94517, 104313*) are the mature male buds rather depressed-globose and circular in section; also the androecium in these specimens is ± rounded in section, but otherwise there is no reason to exclude them from the present species.

The specimen *SFN 40772,* from Trengganu, Malaya, is a relatively glabrous plant. The twigs are almost glabrous, including the apex, and the tomentum of the leaf bud is composed of hairs only c. 0.1 mm long.

4. Some deviating and doubtful specimens. FRI 17562, from Perak, Malaya, has twig apices rather sharply 2-angled, and hence would belong to *H. brachiata.* The older wood sample, however, is not lined, the fruit is also relatively large, c. 30 × 26 mm, and the colour of the dry leaves rather blackish. Probably this specimen belongs to *H. polyspherula* var. *sumatrana.*

The Malayan specimens *King's Coll. 6771* (syntype) and *KEP 100129* are also somewhat doubtful because of the rather indistinct lines on the twigs.

S 34908 from Sarawak (Kapit, 5th Div.) is a stout specimen and in bad condition; it has ♀ flowers and at L is a single fruit measuring c. 40 × 30 mm; the pericarp is ± woody, c. 5-7 mm thick. *H. brachiata* is not common in Sarawak and this large-fruited specimen probably represents a separate taxon. It was collected in a kerangas-mossy forest at c. 800 m, the highest altitude ever collected of the species.

73. Horsfieldia pachyrachis de Wilde, *sp. nov.* Fig. 1C(73)

Ramuli validi, primum pilis c. 0.2 mm longis obtecti, deinde glabrescentes. Folia chartacea, 16-26 × 6.5-9 cm, nervis supra prominentibus. Inflorescentiae masculae validae, costa 5-8 mm diam. Perian-

thia mascula subglobosa, 1.5-2 mm diam., 3-valvata. Androecium triquetrum, antheris 5-7, erectis. Pedicellus basi articulatus. — Type: *b.b. 28128* (L; iso: K; BO, SING, n.v.).

Tree. Twigs terete, towards the apex 5-7 mm diam., blackish-brown, glabrescent, tomentum rusty to grey-brown with hairs c. 0.2 mm, bark of older twigs not seen; lenticels conspicuous. Leaves in 2 rows, thinly chartaceous, obovate-oblong to oblong, broadest at or somewhat above the middle, 16-26 × 6.5-9 cm, base (long-)attenuate, top broadly acutish; upper surface drying olivaceous brown to blackish brown, glabrous, lower surface drying dark brown, without larger blackish dots, early glabrescent but on the midrib towards the base tomentum vestigial with hairs 0.2-0.3 mm; midrib rather slender above, near the transition of the petiole 2.5-3 mm wide, raised; nerves 14-17 pairs, raised above, the marginal arches not very distinct; tertiary venation forming a lax network, flat or ± sunken, indistinct; petioles 7-11 × 3.5-4.5 mm, glabrescent; leaf bud c. 15 × 4 mm, with hairs c. 0.2 mm. Inflorescences apparently behind the leaves (see notes), densely to sparsely pubescent with dendroid hairs 0.2-0.3 mm, glabrescent, in ♂: very stout and rather compact, 4 or 5 times ramified, many-flowered, c. 14 x 10 cm (not fully expanded), the main axis stout, towards the base 5-8 mm diam., length of common peduncle not known (see notes); flowers in clusters of 4-10, perianth 3-valved, glabrous, pedicel thinly pubescent towards base with hairs 0.1-0.2 mm long, at base distinctly articulate; bracts caducous, those of uppermost ramifications ± elliptic, subacute, densely pubescent, 3-5 × 2-4 mm. Male perianth (possibly somewhat submature) broadly globose to broadly obovoid, apically slightly depressed, c. 1.5 × 2.0 mm, top broadly rounded, base ± narrowly rounded, glabrous; pedicel 1.5-2.0 mm long; perianth at anthesis cleft to nearly ½-way, hard-fleshy, not collapsing on drying, valves 0.2-0.3 mm thick at sutures, perianth towards the base 0.5-0.7 mm thick. Androecium subglobose-obovoid, c. 0.6 × 0.6 mm, rather sharp-triangular in transverse section; anthers 5-7 (i.e. 10-14 thecae), slightly curved, almost entirely connate, concealing an apical cavity in the central column reaching c. ¼-½-way; androphore slightly tapering towards the base, 0.1-0.2 mm long. Female flowers and fruits not seen.

Distribution. Borneo, W Kalimantan; only known from *b.b. 28128,* Melawi, Bukit Kelawai, 80 m alt., ♂ fl., 20 May 1939; no further ecological or fieldnotes given.

NOTES

1. The present species is described as new because it does not fit into any of the species which it resembles in general habit, i.e., the leafy twig and flowers. The separate male inflorescence is extremely stout, with the main axis (rachis) c. 5-8 mm thick and with shortish and stout lateral axes, and by this character it keys out easily. Most of the numerous flowers are submature, but the largest ones apparently are nearly full-grown. These highly resemble superficially those of the group of species with *H. polyspherula* (especially those of var. *sumatrana*) or *H. laticostata,* also in the distinctly triquetrous androecium. However, in the *H. polyspherula*-group of species the (sub)erect anthers are mutually largely free, at least for c. ½-way, whereas in our present species the anthers are (almost) completely connate. Also in general habit and the colour of the leafy twig, it agrees little with the *H. polyspherula* group. The connate anthers (and the general appearance of the leaves) point to the group of species keyed out around *H. fragillima,* and the specimen on which the present new species is based would then key out beside *H.*

borneensis (because of the distinctly articulated pedicels), a species which does not appear related at all.

2. The only collection on which the present species is based, *b.b. 28128,* consists in L of a leafy twig and, in a separately attached envelope, a part of an inflorescence, apparently broken off from the specimen in Kew. The K-specimen only consists of a stout, slightly submature inflorescence, cut-off close to its base, and there are no leaves. I have not seen the BO and SING duplicates. The collection was identified by Sinclair (1975, p. 12) as *H. brachiata* var. *laticostata* (my present *H. laticostata*), but Sinclair remarks: 'somewhat approaching robust specimens of var. *sumatrana* but probably best here'.

Unfortunately West Kalimantan is still strongly undercollected, as is also apparent from the specimen *Hallier 624* from the same area; this latter seems to represent a new species as well, as is discussed in note 3 under *H. valida.*

The collection *b.b. 28340,* sterile, from the same locality as the type (Melawi, B. Melaban Kenjit, 470 m), resembles the type and may be conspecific; this was determined by Sinclair as *H. fragillima.*

74. Horsfieldia ridleyana (King) Warb. Fig. 1C(74)

Myristica ridleyana King, Ann. Roy. Bot. Gard. Calc. 3 (1891) 311, pl. 145 — *Horsfieldia ridleyana* (King) Warb., Mon. Myrist. (1897) 331; Gamble, Mat. Fl. Mal. Pen. 5, 23 (1912) 221; Ridley, Fl. Mal. Pen. 3 (1924) 60; Burk., Dict. 1 (1935) 1199; Sinclair, Gard. Bull. Sing. 16 (1958) 432, fig. 52; 28 (1975) 108 — Type: Malaya, *Cantley 1768* (K, syntype); King's Coll. 10917 (CAL, *n.v.* iso: BM, K, L; syntype); *Scortechini (12)* (♂ fl., lectotype, annotated by King; BM, K, iso:L), *862* (♀ fls. syntype; CAL, *n.v.;* iso: K).

Horsfieldia karengasicola Sinclair, *in sched.* (Borneo material).

Tree 5-25 m. Twigs terete or somewhat angular, towards the apex 1.5-3.5(-5) mm diam., dark brown, generally early-glabrescent, tomentum rusty, with hairs c. 0.2-0.4 mm long, bark lower down finely to coarsely striate, lenticles either small and distinct, or absent; older bark not flaking. Leaves in 2 rows, thinly chartaceous to coriaceous, elliptic-oblong to lanceolate, broadest at about the middle, 5-15(-16) × 2-4.5 cm, base attenuate, top acute to acute-acuminate; upper surface glabrous, drying olivaceous to brown, lower surface glabrous, drying light brown to reddish-brown, sometimes rather contrasting with upper surface, without larger blackish dots; midrib above flat, sunken or slightly raised, and often inconspicuous, glabrous; nerves 7-15 pairs, above sunken to flattish, inconspicuous or often hardly visible; tertiary venation forming a lax network, not or hardly visible; petioles 7-15 × 1.5-2.5 mm, early glabrescent; leaf bud slender, 6-14 × 1-2 mm, densely pubescent with hairs 0.2-0.5 mm long. Inflorescences rather sparsely pubescent with hairs 0.1-0.3 mm, sometimes subglabrous or glabrescent, in ♂: c. 3 (or 4) times ramified, rather many-flowered, 2-6 × 2-4 cm, common peduncle (2-) 5-15 mm long, the flowers in loose clusters of 3-6 each; ♀-inflorescences fewer-flowered, c. 1.5-4 cm long; bracts not seen, caducous; perianths 3-or 4-(rarely 2-) valved, glabrous, pedicels slender, glabrous, at base articulated. Male perianth subglobose, or ± shortly ellipsoid, 1.0-1.2 × 0.8-1.2(-1.3) mm, top rounded, base rounded or short-attenuate, glabrous; pedicel 1.0-2.0 mm long, slender; perianth at anthesis cleft to c. ⅓- nearly ½, not or slightly collapsing on drying, valves 0.2-0.4 mm thick. Androecium (incl. androphore) broadly obovoid, 0.6-0.8 × 0.4-0.7 mm,

in transverse section generally sharply 3- or 4-angular (rarely ± ellipsoid in 2-valved flowers); anthers 4-6 (i.e., 8-12 thecae), mutually almost entirely free (Malaya, Borneo), or free only nearly for upper half (part of the material from Malaya), sub-erect, acutish, c. 0.3-0.4 mm long; androphore relatively long, ± tapering, up to nearly the length of anthers, 0.2-0.4 mm long. Female perianth ellipsoid, c. 1.5-1.8 × 1.5 mm, glabrous, cleft at anthesis to ⅓- nearly ½-way, valves 0.2-0.4(-0.5) mm thick; pedicels 1.0-2.0 mm long; ovary ellipsoid, 1.2-1.3 × 0.6-0.7 mm, ± grooved at one side, glabrous, stigma shallowly 2-lipped, c. 0.1-0.2 × 0.6 mm. Fruits 1-6 per infructescene, ellipsoid, top and base rounded, 1.5-2.0 × 1.0-1.4 cm, glabrous, drying brown, without lenticel-like tubercles, pericarp c. 1.5 mm thick; stalk 2-5 mm long; perianth not persisting.

Distribution. Malaya (Perak, Kelantan, Trengganu, Pahang, Selangor, Malacca), Borneo (Sarawak, Brunei, Sabah); apparently not in Sumatra (see notes).

MALAYA. *FRI 7404, 8334, 14321, 14729, 20023, 20626; Kep. 94376, 98171, 99117; King's Coll. 10917; Ridley 16177; Scortechini s.n. (12), 862.*

BORNEO. Sarawak: *Purseglove P. 5607; S 15925, 20925, 21540, 32200, 37632, 37681, 38438, 38579; Sinclair & Kadim 10406, 10406A.*

BRUNEI: *(Ashton) BRUN 3277; Sinclair & Kadim 10438* — Sabah (Beaufort Dist.): *San. 31427, 49267.*

Ecology. Usually in forest on poor soils: heath forest (with *Dacrydium beccarii*), kerangas forest, ridge-forest, quartzite conglomerate-ridges, exposed ridges; sandstone with very shallow soil, with *Gymnostoma, Tristania, Cotylelobium;* sandstone ridges with *Dipteris;* sandstone summits with *Dacrydium, Gymnostoma*-forest; 0-1100 m alt. Flowers throughout the year, but in Borneo most collections June to October; fruits throughout the year.

NOTES

1. Fieldnotes. Slender or crooked trees, once recorded on a hill side as having many buttresses. Bark dark brown to red brown, shallowly (rectangular) fissured, shallowly cracked, flaky, or shallowly dippled and fissured. Slash bark reddish, fibrous, laminated, once recorded as notably dense; sapwood pale, whitish, creamy pink. Flowers yellow; androecium (stamens) pink; ovary pale green. Fruits glossy, green turning yellow-green.

2. Specimens *Kep 99117* and *FRI 20023,* both from Pahang, Malaya, have proportionally many 2-valved flowers in the inflorescences. Such flowers slightly deviate by their shorter androecium, with shorter androphore, and the androecium not conspicuously triquetrous but rather subellipsoid in transverse section.

3. The material from Malaya generally has less coriaceous leaves and thicker tomentum on the leaf-bud (c. 0.4 mm) as compared with most of the material from Sarawak, Brunei, and Sabah. Specimens from Borneo generally are from heath or kerangas forest, those from Malaya from ridges and hill slopes.

4. An excluded specimen. I have to exclude the specimen *Sinclair & Kadim 10453* from Brunei, which Sinclair probably used for the description of the fruits, c. 3-4 × 2-2.8 cm, in his publication of 1975, p. 109. In my opinion *H. ridleyana* has essentially smaller fruits, c. 15-20 mm long. The specimen *Sinclair &*

Kadim 10453 differs furthermore by its much thicker pericarp (c. 8 mm), thinner leaves, the slightly raised lateral nerves on the upper leaf surface, and rather differing aspect of the bark of the older twigs; I cannot match it with any species known to me, and it is described here as a new species, *H. disticha.*

5. The only specimen seen by me from Sumatra, which may represent *H. ridleyana,* is *b.b. 6479,* a sterile specimen from W. Coast at 1000 m. This differs from the material from Malaya (which it resembles most) by the coarser tomentum on leaf bud and twig apex, and the midrib rather raised above. Possibly *H. ridleyana* does not occur in Sumatra, and the specimen *b.b. 6479* may belong instead to a new species *H. triandra* which is based on *Forbes 2465.*

6. Vegetatively *H. ridleyana* may be confused with *H. penangiana.* In Borneo *H. ridleyana* may resemble *H. oligocarpa*, but the latter has distinctly raised nerves on the upper leaf surface.

75. Horsfieldia obtusa de Wilde, *sp. nov.* Fig. 1C(75)

Gemma pilis 0.2-0.4 mm longis obtectum. Folia coriacea, oblonga, 8-10 cm longa, apice rotundata, nervis c. 10 paribus, supra planis. Perianthium masculum subglobosum, c. 1.5 mm diam., 3-valvatum. Androecium triquetrum, antheris 9 vel 10, suberectis, in parte dimidia superiore liberis. Pedicellus basi articulatus. — Type: Sarawak, *(Native Collector) Bureau of Science 821* (L).

Tree. Twigs terete or faintly angular, towards the apex 2.5-4(-6) mm diam., grey-brown, rather late glabrescent, tomentum dark rusty, with hairs 0.2-0.4 mm long, bark lower down rather coarsely striate, when older finely, longitudinally cracking; lenticels present but small and inconspicuous. Leaves in 2 rows, thinly coriaceous, oblong, broadest at about the middle, 8-10 × 3-3.5 cm, base attenuate, top rounded; upper surface glabrous (except midrib), drying dark olivaceous, lower surface glabrous (early glabrescent), drying somewhat purplish brown, provided with many paler usually pale yellowish enlarged hair-scars but not dotted; midrib above moderately raised, late glabrescent, nerves c. 10 pairs, flat or slightly raised above, well-visible, the submarginal arches rather regularly shaped and well-visible; tertiary venation forming a lax network, not or hardly visible; petioles c. 10 × 2 mm, rather late glabrescent; leaf bud c. 12 × 3 mm, densely dark rusty pubescent, hairs 0.2-0.4 mm. Inflorescences situated behind the leaves, densely pubescent, rusty hairs 0.2-0.4(-0.5) mm long, in ♂: c. 3 times ramified, many-flowered, 5-9 × 3-5 cm, common peduncle 3-10 mm long, the flowers in clusters of 3-6 each; ♀ inflorescences not seen; bracts not seen, caducous. Flowers 3(or 4)-valved, perianth glabrous, pedicel glabrous, terete, at base articulate. Male perianth subglobose, 1.3-1.5 × 1.5-1.6 mm, top and base broadly rounded; pedicel 1-1.5 mm long, slender; perianth at anthesis cleft to nearly ½-way deep, ± woody-brittle, not collapsing on drying, valves at the top c. 0.2 mm, at base c. 0.4 mm thick. Androecium (incl. androphore) broadly obovoid, c. 0.8 × 1.0 mm, in transverse section 3 (or 4)-quetrous; anthers 9 or 10 (thecae 18 or 20), c. 0.5 mm long, suberect, free in the upper half, acutish; androphore ± tapering to below, c. 0.3 mm long; apical cavity rather distinct, depth to about the base of the anthers. Female flowers and fruits not seen.

Distribution. Only known from the type from Sarawak, precise locality not indicated.

Ecology. Not known.

NOTES

1. Obviously a member of the group of species with *H. polyspherula,* because of the articulated pedicel and the angular androecium with the anthers distally free. It is distinguished by its generally flat nerves and the rather large male flowers with 9 or 10 anthers. Because of the smallish coriaceous leaves with rounded tip it is reminiscent of *H. montana,* but that species has quite different male flowers. Similar large, pale yellowish hair-scars on the leaves can be found in *H. xanthina,* a species quite different in various ways.

2. Sinclair identified the type specimen in 1959 as *H. montana,* a species which in 1975 he reduced to *H. glabra,* but the present type-collection was not included among the cited specimens.

76. Horsfieldia disticha de Wilde, *sp. nov.*

Ramuli non-angulati, primum pilis 0.2-0.3 mm longis obtecti deinde glabrescentes, deorsum cortice longitudinaliter fisso. Folia disticha, chartacea, oblongo-lanceolata, 8-13.5 cm longa, longe acuminata, nervis supra prominentibus. Fructus ovoideo-ellipsoidei, c. 3 cm longi, glabri, pericarpio (in sicco) 8-10 mm crasso. — Type: Brunei, Sinclair (& Kadim) *10453* (L; iso: BM, K; A, B, E, NY, SAR, SING, *n.v.*).

Tree 20 m. Twigs terete to faintly angular, not ridged, towards the top 2-3(-4) mm diam., in fruit-bearing portion 11-13 mm diam., dark grey-brown or dull reddish-brown, very early glabrescent, tomentum dull rusty, of hairs 0.2-0.3 mm, bark lower down coarsely longitudinally cracking, lenticels rather sparse but distinct. Leaves in 2 rows, chartaceous, oblong-lanceolate, broadest at about the middle or ± parallel-sided, 8-13.5 × 2.5-3.5 cm, base ± rounded to short-attenuate, tip long-acute-acuminate (acumen c. 15 mm); upper surface drying olivaceous-brown, glabrous, lower surface pale chocolate, glabrous, without larger scattered dots; midrib raised above, glabrous; nerves 9-13 pairs, raised above, the marginal arches indistinct; tertiary venation faint or invisible on both surfaces; petioles relatively long and slender, glabrous, 10-15 × 1-1.5 mm; leaf bud slender, c. 10 × 2 mm, densely dull rusty pubescent with hairs 0.2-0.3 mm long. Male and female flowers not seen but perianth apparently 3-valved as judged from the perianth-scars on the fruits. Fruits 3-6 in infructescences measuring 3-6 × 2-4 cm, borne on the older wood behind the leaves, glabrous (glabrescent), the fruits ovoid-ellipsoid, top narrowly rounded, base broadly rounded, 2.8-3.2 × 2.1-2.5 cm, glabrous, drying dark brown, not tubercled nor lenticellate, pericarp hard-woody when dry, 8-10 mm thick; stalk 10-15 mm long; perianth not persistent.

Distribution. Borneo: Brunei, known only from the type.

Ecology. Lowland forest, at side of new road, Andulau Forest Reserve (West); fruits in August.

NOTES

1. Fieldnotes. Bark with longitudinal, shallow furrows as in *H. wallichii.* Twigs slender, leaves distichous, dark green above, paler beneath, dull on both surfaces. Fruits unripe, pear-shaped, large.

2. According to the general habit of the specimens, and especially the leaves with the nerves raised above, this species obviously belongs to the group of *H. polyspherula.* It was, together with some other specimens, provisionally identified as *H. disticha* by Sinclair. In his posthumous publication these specimens were listed as *H. ridleyana,* and I agree, except for the collection *Sinclair & Kadim 10453* on which the present new species is based. *H. disticha* differs from *H. ridleyana* in its general habit, the raised nerves, the nature of the bark on the twigs, and the much larger fruits with a conspicuously thick pericarp. In fact, the above specimens were used by Sinclair to describe the fruits of *H. ridleyana,* but it seems to me that the fruits of that species are different, being smaller and with a much thinner pericarp.

77. Horsfieldia tenuifolia (Sinclair) de Wilde, *stat. nov.* Fig. 1C(77); 28

Horsfieldia polyspherula var. *tenuifolia* Sinclair, Gard. Bull. Sing. 28 (1975) 105. — Type: *Haji Bujang S 13686* (SING, *n.v.;* iso: K, L; S, SAR, *n.v.*).

Tree 5-15 m. Twigs terete, towards the apex 1-3(-4) mm diam., early glabrescent, tomentum greyish-rusty, hairs c. (0.1-)0.2 mm, bark of older twigs striate, lower down neither cracking nor flaking; lenticels inconspicuous or absent. Leaves in 2 rows, membranous to thinly chartaceous, elliptic to oblong-lanceolate, broadest at about the middle, 6.5-16.5 × 3-6.5 cm, base attenuate, top acute-acuminate; upper surface drying greyish olivaceous to dark greyish brown, glabrous, lower surface dull greyish brown, glabrous, without larger blackish brown dots; midrib raised above, glabrous; nerves 5-11 pairs, raised above, marginal arches regular but rather faint; tertiary venation forming a lax network, indistinct or hardly visible; petioles 8-16 × 1.5-2 mm, glabrous; leaf bud 5-8 × 1-1.5 mm, densely pubescent with hairs c. 0.2(-0.3) mm. Inflorescences moderately to sparsely pubescent with stellate hairs 0.1-0.2 mm, in ♂: rather many-flowered, c. 3 times ramified, 3-5 × 2-4 cm, common peduncle 2-10 mm; in ♀: rather slender, few-flowered, c. 2-3.5 × 1 cm; bracts elliptic to oblong, 2-3 mm, pubescent, caducous. Flowers in loose clusters of 3-8 each, perianth 3-(or 4-)valved, glabrous, pedicels glabrescent or with few scattered hairs up to 0.2 mm in the lower half, at base indistinctly or not articulate. Male perianth globose to broadly obovoid, 0.8-1.3 × 1.0-1.5 mm, top broadly rounded, base rounded to subattenuate, glabrous; pedicels 1-2 mm long, somewhat tapering; perianth at anthesis cleft to depth of c. ⅓ to nearly ½-way, valves 0.2-0.3 mm thick, at base up to 0.4 mm thick. Androecium ± obovoid to ellipsoid, 0.5-0.7 × 0.5-0.8 mm, in transverse section triquetrous; anthers 4-6, sub-erect, 0.3-0.4 mm long, mutually free for at least ½-way, central column largely hollow, towards the base continued into the somewhat tapering androphore 0.2-0.3 mm long. Female perianth ellipsoid, c. 2.0 × 1.5 mm, cleft at anthesis to c. ⅓ or slightly over, valves c. 0.3 mm thick, pedicel c. 1.5 mm long, at base ± articulate or inarticulate, glabrescent, hairs 0.2-0.3 mm; ovary ellipsoid, c. 1.3 × 0.8-0.9 mm, glabrous, stigma 2-lobed, c. 0.2 mm high. Fruits 1-3 per infructescence, ellipsoid, top rounded, base rounded or shortly tapered, 1.7-2.0 × 1.4-1.5 cm, glabrous, drying dark brown, not lenticel-like tubercled, pericarp 1-1.5 mm thick; stalk 3-5 mm long; perianth not persistent.

Distribution. Borneo: Sarawak (1st. Div.), Sabah (Beaufort Hill, Jesselton).

BORNEO. Sarawak: *S 12774, 13686, 24914, 24945, 26599, 34528; Sinclair & Kadim 10179* — Sabah: Jesselton, *Kep. 71665;* Beaufort Hill, *San. 44531.*

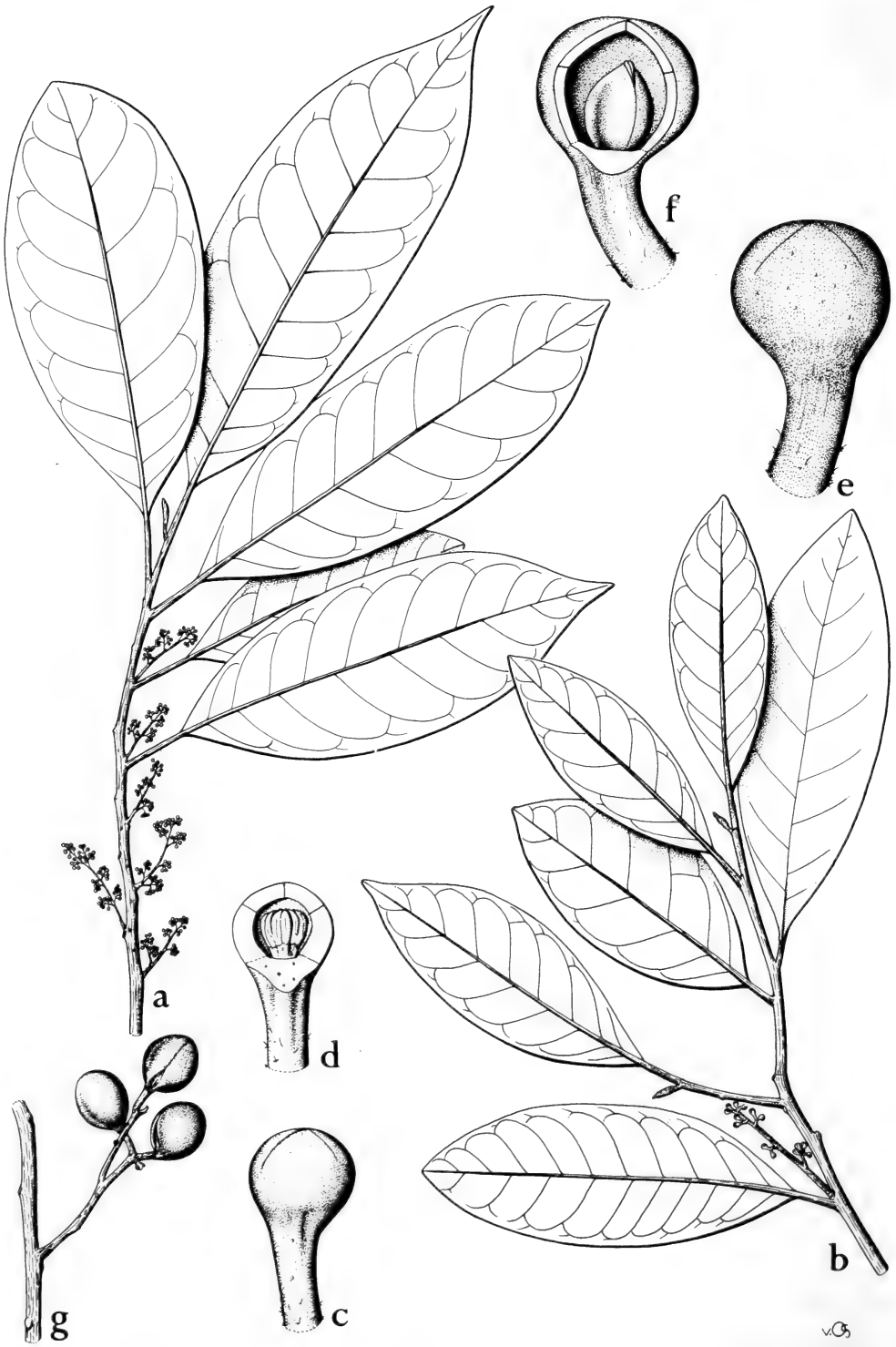

Fig. 28. *Horsfieldia tenuifolia* (Sinclair) de Wilde.
a. habit of twig with leaves and male inflorescences, × ½; *b,* ditto with female inflorescence, × ½; *c,* mature male flower, lateral view, × 12; *d,* ditto, opened, showing androecium, × 12; *e,* mature female flower, × 12; *f;* ditto, opened, showing glabrous ovary and minute 2-lipped stigma, × 12; *g,* portion of twig with infructescence, fruits mature, × ½ — *a, c, d,* from *S 24945, b, e, f,* from *S 34528; g,* from *S 24914.*

Ecology. Lowland dipterocarp forest, 0-300 m alt.; soil a yellow clay, yellow sandy clay, yellow loam, brownish soil; on ridges and slopes. Flowers and fruiits May to September.

NOTES

1. Fieldnotes. Slender tree, once recorded as buttressed. Bark dark brown to greenish brown, narrowly fissured, not flaking; inner bark dark red, with red latex; sapwood whitish. Flowers greenish yellow. Fruits yellowish.

2. Sinclair regarded the present species as a variety of *H. polyspherula,* and some specimens were included by him in the type-variety, *H. polyspherula* var. *polyspherula.*

Our present species is marked by quite a different habit; it has the twigs glabrous to the top, the leaf bud is small and slender, covered with hairs only c. 0.2 mm long; the leaves are membranous to thinly coriaceous, not brittle, drying to a greyish tinge and the colour of the upper and the lower surfaces not markedly different; the petioles are relatively long and slender; the inflorescences and flowers are comparatively small. According to the architecture of the male flowers the species is undoubtedly closely related to *H. polyspherula.* The present species is an understorey tree of the lowland dipterocarp forest on richer soils.

3. S 34528, with female flowers, has the twigs rather pale and contrasting with the darker colour of the dry leaves and petioles; by this feature, it may vegetatively key out to the group of species, incl. *H. oligocarpa,* characterized by a pale colour of the dry twigs.

A much related species is *H. macilenta,* also with thin membranous leaves, but it has much more pubescent twigs and inflorescences

78. Horsfieldia macilenta de Wilde, *sp. nov* Fig. 1C(78)

Ramuli tenues. Gemma pubescens pilis c. 0.5 mm longis. Folia membranacea, oblonga usque ad oblongo-lanceolata, 10-18 cm longa, basi attenuata, nervis lateralibus paribus 10-15, supra prominentibus. Perianthium masculum subglobosum, c. 1 mm diam., 3-valvatum. Androecium triangulare ad sectionem transversam, antheris 5-7, suberectis, in parte dimidia superiore liberis. Pedicellus basi articulatus. — Type: Sabah, *A. Gibot SAN. 37103* (L).

Tree 4-17 m. Twigs terete, towards the apex 1-3(-12) mm diam., rather late glabrescent, tomentum pale rusty, composed of stellate-dendroid hairs (0.2-)0.5 mm long, bark of older twigs rather finely striate, not cracking; lenticels small and usually inconspicuous. Leaves in 2 rows, membranous, oblong to oblong-lanceolate, broadest at about the middle, 10-18(-27) × 3-6.5 cm, base (rounded to short-)attenuate, tip acute-acuminate; upper surface drying dull olivaceous, glabrous, lower surface rather bright light brown, glabrous except midrib and the very base; without larger, dark brown dots; midrib raised above, on lower surface late glabrescent; nerves 10-15(-18) pairs, raised, the marginal arches fairly regular, distinct or not; tertiary venation forming a lax network, ± indistinct; petioles 10-15 × 1.5-2.0 mm, rather late glabrescent; leaf bud 6-8 × 1.5 mm, densely pubescent with hairs (0.2-)0.5 mm. Inflorescences rather sparsely woolly-pubescent with hairs (0.2-)0.5 mm, in ♂: many-flowered, 2 or 3(-4) times ramified, 4-9(-10) × 3-5(-7)

cm, common peduncle 3-12 mm long; ♀ inflorescences similar to the males (see notes);bracts oblong to lanceolate, 2-5 mm, pubescent, caducous. Flowers in ♂ in clusters of 5-8, perianth 3-valved, glabrous or sometimes a few minute hairs less than 0.1 mm are present towards the base of the pedicel; pedicel terete, glabrous or sparsely pubescent in the lower portion with hairs 0.1 mm or less, distinctly articulate at base. Male perianth globose to depressed globose, 0.7-1.2 × 1.0-1.2 mm, top and base (broadly) rounded; pedicels c. (0.8-) 1.0(-1.3) mm long; perianth at anthesis cleft to nearly ½-way, valves 0.2-0.3 mm thick. Androecium subglobose, (incl. androphore) 0.4-0.5 × 0.5-0.7 mm, in transverse section triangular; anthers 5-7, suberect, 0.3-0.4 mm long, at least the upper half mutually free, column largely hollow and passing into the broad ± tapering androphore c. 0.2-0.3 mm long. Female perianth (see notes) subglobose, c. 1.5 mm diam., cleft at anthesis to c. ½-way, valves c. 0.4-0.5 mm thick, pedicel c. 1.5 mm, subglabrous, only in the lower part with a few scattered hairs less than 0.1 mm long, base articulate; ovary globose, glabrous, 1.0-1.2 mm diam., stigma minutely 2-lipped, (0.1-)0.2 mm long. Fruits (in Sumatra) 2 or 3 together in a short infructescence 2-3 cm long, the fruits glabrous, ellipsoid, 2.2-2.4 × 1.5-1.6 cm, top rounded, base contracted into a 2-4-mm long narrowed portion, pericarp c. 2 mm thick, drying brown, not or sparingly tubercled; stalk c. 5 mm long; perianth not persistent.

Distribution. Sumatra, Malaya, Borneo (Sarawak, Sabah).

Cultivated Bot. Garden Bogor (orig. unknown): sub IV.H. 29 (Oct. 1912), in herb. L.

MALAYA (Kelantan, Johore): *Whitmore FRI 4415; Kadim & Noor KN. 185.*

SUMATRA (Jambi Prov.): *Roos & Franken T.F.B. 1999.*

BORNEO. Sarawak (4th Div.): *Hirano & Hotta 1206; S 39027* — Sabah: *B.N.B. For. Dept. 4204; A. Gibot SAN 37103; SAN 53268.*

Ecology. Primary lowland mixed dipterocarp forest, swamp forest; 0-200 m alt. Flowers from June to November.

NOTES

1. Fieldnotes. Outer bark whitish or green-yellow, inner bark red with latex red, cambium yellowish. Flowers greenish yellow to yellow.

2. Clearly much related to *H. polyspherula* especially to the slender specimens of var. *polyspherula,* according to the structure of the male flowers. The present species differs by many details in general habit such as its more slender and tiny build: the slender twigs, the thinly membranous leaves and the slender and tiny inflorescences.

3. I am not quite sure whether the only known female flowering specimen (*S. 39027*) belongs here. Its leaf nervation is a trifle more projecting, and the marginal arches are regular and distinct, the pubescence on the leaf bud, twig apex, and inflorescence is shorter than in the four male specimens presently known, *viz.* c. 0.2 mm long versus c. 0.5 mm in the male specimens. Remarkable are the female inflorescences which are as much-branched as the male; all flowers are mature and purely female. In the related *H. polyspherula* the female inflorescences are always noticeably smaller as compared with the males. In the fruiting specimen *T.F.B.*

(*Roos & Franken*) *1999*, from Sumatra, the infructescence is, as expected, only 2-3 cm long.

4. Specimens of the present species were included by Sinclair (1975) in *H. polyspherula;* he did not see others.

79. Horsfieldia laticostata (Sinclair) de Wilde, *stat. nov.* Fig 1C(79)

Horsfieldia brachiata (King) Warb. var. *laticostata* Sinclair, Gard. Bull. Sing. 28 (1975) 12 — Type: *Sinclair 10265* (K; iso: L; A, E, SAR, SING, *n.v.*).

Tree 12-35 m. Twigs terete, towards the top 3-8(-15) mm diam., grey-brown to blackish, early glabrescent, tomentum grey-brown to rusty, composed of hairs 0.1-0.4 mm, bark lower down coarsely striate, when older almost flaking, lenticels usually distinct. Leaves in 2 rows, thinly to thickly coriaceous, obovate-oblong to oblong, broadest at or somewhat above the middle, (15-)20-33 × 6-12 cm, base attenuate, top (short-)acute-acuminate; upper surface drying dull olivaceous to greenish brown, glabrous, lower surface drying chocolate brown to rusty, rather contrasting with the upper surface, without blackish dots or markings, early glabrescent; midrib above raised, ± slender to broad but towards the base flattish and conspicuously broadened to 3-4(-5) mm wide at the transition to the petiole, glabrous or sometimes with some remnants of tomentum towards the base; nerves 11-20(-24) pairs, largely raised but towards the blade margin sunken, the marginal arches usually ± distinct, sunken; tertiary venation forming a lax network, flat or sunken, distinct or not; petioles stout, 6-15 × 5-8 mm, early glabrescent; leaf bud 15-23 × 3-5 mm, densely grey-brown to rusty pubescent with hairs 0.1-0.4 mm long. Inflorescences rather sparsely pubescent with hairs 0.2-0.4 mm long, in ♂: stout, 4 or 5 times ramified, many-flowered, 10-25 × 8-22 cm, main axis towards base 3-4 mm diams., common peduncle 5-35 mm long; ♀ inflorescences 3-7 cm long, 2 or 3 times ramified, rather few-flowered; bracts elliptic, acute, 2-8 × 1-4 mm, pubescent with hairs c. 0.3 mm, ± glabrescent, caducous; flowers 3-valved, in clusters of up to 10, perianth glabrous, pedicel glabrous except sometimes towards base a few hairs are present, 0.1-0.2 mm, at base distinctly articulate. Male perianth broadly obovoid to subglobose, 1.3-1.5 mm diam., top broadly rounded, base rounded or sometimes ± attenuate, glabrous; pedicel (1.0-)1.5(-2.0) mm long, slender; perianth at anthesis cleft to c. ½-way, not collapsing on drying, valves 0.2-0.3 mm, towards base of perianth c. 0.5 mm thick. Androecium including androphore broadly obovoid in outline, c. 0.7 mm diam., sharp-triangular in transverse section; anthers 6 (thecae 12), suberect, acutish, mutually largely free, c. 0.3(-0.4) mm long; androphore ± tapering, c. 0.3-(0.4) mm long. Female perianth broadly ellipsoid-globose, c. 2.5 mm diam., glabrous or with a few minute hairs c. 0.1 mm long, cleft at anthesis to c. ⅓, valves 0.3-0.4 mm thick, pedicel 0.5-1 mm long; ovary broadly ovoid, c. 1.5 mm long, glabrous, stigma c. 0.1 mm long, shallowly 2(-4)-lobed. Fruits 1-4 per infructescene, ellipsoid, top and base rounded, 2.8-4.0 × 2.2-2.5 cm, glabrous, drying brown, with or without warts or lenticels, pericarp c. 4-5 mm thick; stalk 2-4 mm long; perianth not persisting.

Distribution. Borneo: Sarawak, Sabah, N.E. Kalimantan.

BORNEO. Sarawak: *Chew Wee-Lek CWL. 637; Haviland 3074; S 13689, 17252, 18519; Sinclair 10265* — Sabah: *B.N.B. For. Dept. 2487; San A 2995, 32602 N.T. 223, 67215, 74585, 80429, 83709* — E. & NE. Kalimantan: *Kostermans 4355, 8777, 9010, 9321.*

Ecology. Primary peat swamp forest, forest on sandy acid soils, waterlogged sand soils, heath forest, karengas, poor forest; 0-400 m alt. Flowers and fruits throughout the year.

Vernacular name. Piasau piasau (Kedayan lang., Sabah).

NOTES

1. Fieldnotes. Tree to 35 m, without buttresses. Branches predominantly horizontal. Bark hard, fissured or flaky, brown to reddish-brown; inner bark reddish, laminated, sapwood whitish. Flowers yellow, smelling of Peru balsam. Fruits yellow, orange or red; once recorded as "fruiting abundantly throughout the crown along the smaller branches". Seed shining white, spotted.

2. According to Sinclair (p. 12, 13) this is a robust ecological form of *H. brachiata* var. *sumatrana* (in this treatment *H. polyspherula* var. *sumatrana*). Indeed, the present species seems closely related to *H. polyspherula,* especially to the varieties *sumatrana* and *maxima,* but I prefer it to keep it a separate species as it can usually be satisfactorily distinguished and as such it does not further complicate the still very variable *H. polyspherula-complex;* similarly I have treated *H. oligocarpa* as a separate species, which is also very close to *H. polyspherula,* but separable on various grounds, including a distinct habitat in heath forest.

The present species seems largely confined to forests on poor soils; peaty and sandy grounds. It is characterised by the stout twigs, large coriaceous leaves with the midrib very broad and flat at the transition to the petiole, the usually stout, broad petioles, the fruits of moderate size (c. 30-40 mm), and the large, stout, male inflorescences. In size and architecture of the male flowers (perianth and androecium) it is very similar to *H. polyspherula.*

80. Horsfieldia nervosa de Wilde, *sp. nov.* Fig. 1C(80)

Gemma pilis c. 0.5 mm longis obtectum. Folia tenuiter coriacea, oblonga, 16-28 cm longa, basi subrotundatis, nervis later-alibus paribus 16-19, supra prominentibus. Perianthium masculum globosum, c. 1.2 mm diam., 3-valvatum. Androecium triangulare ad sectionem transversam, antheris 5 vel 6, erectis, in parte dimidia superiore liberis. Pedicellus basi articulatus. — Type: Sarawak, *Ilias Paie & P.S. Ashton S 16652* ((L; iso: K; S, NB, A, M, B, *n.v.*).

Tree 13-16 m. Twigs terete or towards the apex subterete, 3.5-6(-8) mm diam., grey-brown, not early glabrescent, tomentum rusty, with hairs 0.3-0.6 mm long, bark lower down coarsely striate, with the lenticels rather inconspicuous, older bark slightly flaking or not. Leaves in 2 rows, thinly coriaceous, oblong, broadest ± at the middle, 16-28 × 5.5-9 cm, base short-attenuate to rounded, top acute-acuminate; upper surface drying olivaceous to greenish, largely glabrous but midrib and nerves late glabrescent, lower surface chocolate colour, conspicuously contrasting in colour with the upper surface, without larger blackish dots, glabrescent but tomentum of hairs c. 0.5 mm often partly remaining on nerves especially the midrib; midrib slender above, at transition of petiole c. 1.5 mm wide, distinctly raised, late-glabrescent; nerves 16-19 pairs, above conspicuously raised, glabrescent, the lateral arches flattish, indistinct; tertiary venation forming a lax network, indistinct or hardly visible; petioles 15-22 × 3.5-4.5 mm, (late) glabrescent; leaf bud 16-20 × 3.5-4.5 mm, densely rusty pubescent with hairs c. 0.5 mm long. Infloresc-

ences seen only on the older wood behind the leaves, densely pubescent with woolly-shaggy hairs up to 0.6 mm long, in ♂: c. 4 times ramified, many-flowered, c. 10 × 10 cm, common peduncle 10-20 mm long, the flowers in clusters of 2-6 each; ♀ inflorescences fewer-flowered, c. 4.0 × 3.5 cm; bracts pubescent, caducous; flowers 3-valved, perianth glabrous, pedicel towards base pubescent with hairs 0.1-0.2 mm, articulate at base. Male perianth globose, c. 1.2 mm diam., top and base ± rounded, glabrous; pedicel c. 1.5 mm long; perianth at anthesis cleft to nearly ½-way, not collapsing on drying, valves c. 0.2 mm thick, at base of perianth ± fleshy-coriaceous, 0.5-0.6 mm thick. Androecium incl. androphore ± broadly obovoid, c. 0.6-0.7 × 0.6 mm, triquetrous in transverse section; anthers 5 or 6, (thecae 10 or 12), at least the upper half free, ± erect, c. 0.3-0.4 mm long; column deeply hollowed; androphore ± tapering to the base, c. 0.3 mm long. Female perianth subglobose, c. 2.5 mm diam., subglabrous with some scattered hairs c. 0.1 mm towards base, cleft at anthesis to slightly over ⅓, valves c. 0.5 mm thick, pedicels c. 1.5(-2.0) mm long, ± pubescent with hairs 0.1-0.2 mm; ovary broadly ovoid, c. 1.5 mm diam., glabrous, stigma c. 0.3 ×0.6 mm, 2-lobed, the lobes very shallowly 5 or 6-lobulate. Fruits not seen.

Distribution. Borneo (Sarawak, 1st Div.); known from two collections only.

Ecology. Primary forest on yellow podsolic soil; c. 70 m alt. Flowers in November.

NOTES

1. Fieldnotes. Bark pale ochre and brown-mottled, smooth. Buttresses thin, small, to c. 35 cm tall. Flowers pale yellow.

2. This species is a close relative of *H. polyspherula;* its male flowers are practically identical. The known specimens, *S 16651* (♀), and *16652* (♂), both from Bt. Gaharu, Serian Dist., are somewhat different especially in the leaves; those of *H. polyspherula* are generally smaller, with fewer lateral nerves and generally an attenuate base. In our present species the nerves on the upper leaf surface are very strong and markedly raised and distinct, and midrib and nerves on both surfaces remain for rather a long time covered with the indumentum. Sinclair did not seem to have seen these two specimens.

81. Horsfieldia polyspherula (Hook. f. emend. King) Sinclair Fig. 1C(8l)

Myristica polyspherula Hook. f., Fl. Brit. Ind. 5 (1886) 108 (p.p., see notes by Sinclair, o.c., 1958, p. 425; 1975, p. 103); King, Ann. Roy. Bot. Gard. Calc. 3 (1891) 312, pl. 146, *emend.* — *Horsfieldia polyspherula* (Hook. f. *emend.* King) Sinclair, Gard. Bull. Sing. 16 (1958) 422, fig. 47, pl. XII B; 28 (1975) 101, p.p., for the type-variety only. — Lectotype (Sinclair, p. 103): *Griffith 4354* (K; iso: BM, P, U; C, CAL, CGE, FI, G, S, *n.v.*).

For further synonyms see under the varieties.

Tree 4-35(-40)m. Twigs terete or subterete, never distinctly lined nor ridged, 2-5(-13) mm diam., grey-brown to blackish, early to rather late glabrescent, tomentum dark rusty 'mealy', composed of dendroid hairs 0.1-0.6 mm long; bark lower down finely to coarsely striate, lenticels distinct or not, older bark neither cracking nor flaking. Leaves in 2 rows, thickly membranous to chartaceous, usually brittle,

(elliptic-)ovate-oblong to oblong-lanceolate, broadest usually at the middle, 7-28 × 2.5-9 cm, base subrounded to usually attenuate, top acute-acuminate; upper surface glabrous, drying greenish, olivaceous, or greenish-brown, the midrib glabrous (early glabrescent), lower surface drying light brown to red or chocolate-brown, usually much contrasting with the upper surface, without any larger brown or blackish dots, early glabrescent but with the midrib often late glabrescent; midrib slender; nerves 6-15 pairs, above very distinctly raised (except close to the blade margin), glabrous, the lateral arches usually indistinct above; tertiary venation forming a lax network usually not or hardly visible above; petioles 6-15 × 1.5-3.0 mm, early to rather late glabrescent; leaf bud 6-17 × 1.5-3.0 mm, pubescent by rusty dendroid hairs 0.1-0.6 mm long. Inflorescences rather sparse to densely woolly-pubescent with hairs c. 0.6 mm long, sometimes glabrescent, in ♂: 3-5 times ramified, many-flowered, 4-15 × 3-12 cm, common peduncle 3-15 mm long, the flowers usually in clusters of up to 8 each; ♀ inflorescences few- to many-flowered, generally smaller than the males, up to 8 cm long; bracts oblong to lanceolate, c. 1.5-7 mm long, densely pubescent, caducous; perianths 3-valved, glabrous or in ♀ glabrescent, pedicel glabrous or minutely pubescent towards the base which is articulate. Male perianth globose or broadly obovoid, 1.0-1.8 mm diam., top (broadly) rounded, base rounded or rarely ± tapering into the pedicel, glabrous; pedicel slender, sometimes tapering, 0.8-1.5(-2.0) mm long; perianth at anthesis cleft to ½-⅔, not collapsing on drying, valves 0.2-0.4, at base up to 0.6 mm thick. Androecium (incl. androphore) ± broadly obovoid in outline, 0.5-0.8 × 0.6-1.0 mm, usually sharp-triangular in transverse section; anthers (3 or) 4-7 (thecae 6-14, free), almost completely free, at least the upper half, ± curved or suberect, 0.3-0.5 mm long, apex acutish, at base attached to the short bowl-shaped column which continues into the relatively long ± tapering androphore (0.2-)0.3-0.4 mm long. Female perianth broadly ellipsoid-obovoid, 2.0-3.0 × 1.8-2.8 mm, glabrous or sparingly pubescent (hairs c. 0.1 mm), cleft at anthesis to ⅓-½, valves towards base c. 0.5 mm thick, pedicels 1-1.8 mm long, minutely pubescent; ovary ovoid-ellipsoid, 1.2-1.5 × 1.0-1.5 mm, glabrous, stigma shallowly 2-lobed, c. 0.2-0.3 × 0.5 mm. Fruits 1-6 per infructescence, subglobose to ellipsoid, top rounded, base rounded or slightly attenuate, 1.9-6.0 × 1.4-5.0 cm, glabrous, drying light to dark brown, not lenticel-like tuberculate, pericarp 2-15 mm thick; stalk 1-4 mm long; perianth not persisting.

Distribution. Malaya, Sumatra, Borneo, Philippines (Mindanao, only the var. *polyspherula*) 0-1100 m altitude.

NOTES

1. A very variable species. After having segregated some closely related species such as *H. oligocarpa, H. tenuifolia,* and *H. laticostata* (all 3 from Borneo), *H. brachiata* (Sumatra to Borneo), and *H. majuscula* (Malaya), I found that the remaining specimens from the same island-areas are still heterogenous. Much variability is found in the habit of the plants, i.e., the thickness of the twigs, size and texture of leaves, denseness of the indumentum on leaf bud and twig apex, and especially in fruit size and thickness of the pericarp. On the basis of mainly fruit characters, three rather heterogenous varieties are presently recognized. There are slight differences in the size of the male perianth, attributed mainly to the varying thickness of its valves; the number of anthers is possibly the same in all three varieties.

2. The anthers are composed of two rather widely separated, almost mutually free thecae, giving the impression as if there are twice as many anthers as are present. Thus, Sinclair gave the number of anthers as 9-12 for *H. polyspherula* (1958, p. 22) and 8-13 for *H. subglobosa* (sensu Sinclair, l.c. p. 426, but *H. polyspherula* as treated here).

KEY TO THE VARIETIES

1a. Fruits (when dry) (3.5-)4.0-6.0 cm long, the pericarp 5-15 mm thick. Leaves 9-20 cm long, nerves 9-15 pairs ..... **c.** var. **maxima**

b. Fruits up to 3.5 cm long, the pericarp 2-5 mm thick 2

2a. Fruits (2.5-) 2.8-3.5 cm long. Male perianth 1.2-1.8 mm diam.; anthers 6 or 7. Leaves 13-28 cm long, nerves 12-15 pairs ..... **b.** var. **sumatrana**

b. Fruits 1.9-2.5(-2.8) cm long. Male perianth 1.0-1.5 mm diam.; anthers (3 or)4-7. Leaves 7-19 cm long, nerves 6-15 pairs ..... **a.** var. **polyspherula**

a. var. **polyspherula** Fig. 1C(81)

Horsfieldia lemanniana auct. non (A. DC.) Warb: Warb., Mon. Myrist. (1897) 326 (type of basionym *Myristica lemanniana* excluded).

Myristica globularia auct. non. Bl.: Hook.f. & Th., Fl. Ind. (1855) 160; A. DC., Prod, 14, 1 (1856) 202, p.p., for the specimens from Malacca.

Twings 2-3 mm diam. towards the apex; leaf bud covered with hairs (0.2-) 0.3-0.6 mm long. Leaves 7-19 × 2.5-6 cm, lateral nerves 6-15 pairs. Male perianth 1.0-1.5 mm diam.; anthers (3 or 4)-7. Female perianth 2.0-2.5 mm long. Fruits 1.9-2.5(-2.8) × 1.4-2.0; cm, pericarp 2-4 mm thick.

Distribution. Malaya, Singapore, Sumatra, Borneo (Sarawak, rare; Sabah, E. Kalimanthan), Philippines (Mindanao, 1 collection).

MALAYA. (Kedah, Perak, Trengganu, Pahang, Selangor, Malacca, Johore): *Derry 1216; FRI 0491, 0642, 0650, 2795, 4348, 4357, 4381, 4435, 4483, 11348, 13172, 14304, 16448, 17279, 021619, 023913, 27532, 28361; Griffith 4354; Hassan Rani H. 86; Kadim & Noor KN. 185, KN. 422; KEP 21593, 38129, 71903, 83478, 85230, 85231, 98919, 99802; King's Coll. 3309, 7526, 10431; Maingay 1002, 1003A, 1003, 1286; Shah & Noor MS. 1947; Ridley 4162, 7629; Scortechini (211a) 911a; SFN, 29366, 31976, 32109, 36122, 40288.*

SINGAPORE. *Maxwell 82-226; SFN (Ngadiman) 34630, (Sinclair) 39601, 40681, 40711*

SUMATRA. Northern (Langkat): *de Wilde & de Wilde-Duyfjes 19390, 19484, 19485* — East Coast: *Bartlett 7304* — Central (Paryakumbuh): *Maradjo 285* — Riau: *Soepadmo 101* — Djambi: *Posthumus 833, Roos & Franken 1968* — Palembang; *b.b. E. 851* —Bangka: *Kostermans & Anta 593.*

BORNEO. Sarawak (1st, 4th & 7th Div.): *S 38598, 39112, 40980, 41279* — Sabah: *Puasa Angian 3918; San 17186, 17244, 21159, 21487, 30450, 31129, 32209, 32283, 37103, 49349, 53020, 62802, 73995, 76070, 80798, 80957, 82599* — Kalimantan: West (Landak), *Teysmann s.n.* — E & NE.: *Kostermans 8658, 9285; Meijer 2137, 2398; Nedi 719* — SE.: *Hubert Winkler 2526.*

PHILLIPPINES. NE. Mindanao (Agusan Prov.): *Mendoza 61-409* (= *PNH 42247*).

Ecology. Lowland forest, most often on sandy soils; also *Casuarina* forest (E. Borneo), fresh water swamp forest, ridge-top forest, kerangas forest (Sarawak, rare); 0-900 m alt. Flowers throughout the year, but most collections June to September; fruits throughout the year.

Vernacular names. Tjemanding (Palembang, Sum.), Manggoe mangkiras (Landak, West Kalimantan).

NOTES

1. Fieldnotes. Slender tree with narrow crown, the branches often almost in whorls. Bark fissured, rarely flaky; inner bark mostly yellow to reddish, fibrous. Wood whitish to ochre-brown. Flowers at first jade-green, at anthesis yellow to orange-yellow with faint sweet odour when crushed. Fruits greenish yellow to orange.

2. The type-variety var. *polyspherula* agrees with Sinclair's *H. polyspherula* as treated in Gard. Bull. Sing. 16, 1958, p. 422 and largely with *H. polyspherula* var. *polyspherula* as treated in Gard. Bull. Sing. 28, 1975, p. 102.

3. The leaves, as in var. *sumatrana* are usually brittle when dry and often fragmented in herbaria. Dry leaves are usually greenish above and contrast well with the light to chocolate-brown of the lower surface. The tomentum of the leaf bud and young twig apex is rather long, the hairs 0.2-0.6 mm, i.e., on the average slightly longer than in the other varieties.

4. As var. *polyspherula* is mainly characterized by smaller fruits, it is often difficult to tell whether specimens with fruits just over 25 mm are those of var. *sumatrana* or var. *polyspherula.*

5. Specimens from the kerangas forest of Sarawak (e.g., *S 38598*) somewhat deviate by their stouter habit and less contrasting colour of the dry leaves, being more brownish yellow rather than greenish. Var. *polyspherula* is apparently rare in Sarawak.

b. var. **sumatrana** (Miq.) de Wilde, *comb. nov.*

Myristica glabra Bl. var. *sumatrana* Miq., Ann. Mus. Bot. Lugd.-Bat. 2 (1865) 49 — *Horsfieldia brachiata* (King) Warb. var. *sumatrana* (Miq.) (Sinclair ex Whitmore, Tree Flora Malaya 1 (1972) 325, nom. inval., basionym wrongly cited and without literature ref.) Sinclair, Gard. Bull. Sing. 28 (1975) 13 (p.p., excl. syn. *H. majuscula* and *H. bartlettii*) — Type: *Korthals s.n.* (L; iso: K, U; B†; A, BP, BR, MEL. S, *n.v.*), W. Sumatra.

Myristica integra Wall., Cat. (1832) no. 6799, nom. nud.

Myristica collecttiana King, Ann. Roy. Bot. Gard. Calc. 3 (1891) 312, pl. 147 — Syntype: Malaya, *King 3620* (CAL, *n.v.*), *3899*, lecto (CAL, *n.v.;* iso: K, P: FI, G, *n.v.*), *6672* (CAL., *n.v.;* iso: PDA, SING, *n.v.*), *6737* (CAL, *n.v.;* iso: BM. K.L).

Horsfieldia subglobosa auct. non (Miq.) Warb.: Warb., Mon. Myrist. (1897) 328; Gamble, Mat. Fl. Mal. Pen. 5, 23 (1912) 220; Ridley, Fl. Mal. Pen. 3 (1924) 60 — *H. subglobosa* [*non* (Miq.) Warb.] var. *subglobosa auct.:* Sinclair, Gard. Bull. Sing. 16 (1958) 425, 426, fig. 48-50, 51A-D (p.p., excl. syn. *H. majuscula*).

Twigs 2-4 mm diam. towards apex; leaf bud covered with hairs 0.1-0.4 mm long. Leaves 13-28 × 4.5-9 cm, lateral nerves 12-15 pairs. Male perianth 1.2-1.8 mm diam., anthers 6 or 7. Female perianth c. 3 mm long. Fruits (2.5-) 2.8-3.5 x 2.2-2.7 cm, the pericarp 3-5 mm thick.

Distribution. Malaya, Singapore, Sumatra, Borneo.

MALAYA (specimens seen from Kedah, Perak, Kelantan, Pahang, Selangor, Negri Sembilan, Johore): *FRI 1138, 1690, 2637, 3026, 4012, 5776, 6900, 6959, 7851, 9353, 11610, 12339, 12498, 13823, 20400, 25263; KEP 95006, 98976, 100129, 104913, 104996, 115988; King's Coll. 3899, 6004, 6737; Shah & Kadim 362; Md Nur 34117; SFN 32064, 35779; Soepadmo c.s. F.S.C. 831.*

SINGAPORE. *SFN 39599, 39697, 39989, 40043; Wallich 6799.*

SUMATRA. W. Coast: *Korthals s.n.* — East Coast: *Bartlett 6867; Krukoff 4138; Soepadmo 15, 193* — Siberut Isl.: *Iboet 311* — Belitung: *Vorderman (50).*

BORNEO. Sarawak: *S 12751, 13987, 16956, 20888, 34059, 34813, 37289, 37881, 38576, 39574, 39761* — Brunei: *Fuchs & Muller 21168; Van Niel 4053; Sinclair & Kadim 10414* — Sabah: *Elmer 21338, 21364; San. 16284, 25045, 28152, 30403, 32932, 46674, 63866, 72321, 73228, 78219, 82022.* — Kalimantan. West: *Hallier 2141;* East: *Endert 2114, 5088, 5091; Kostermans 4448, 6093, 7721, 10176, 10696, 12613; Wiriadinata 1194;* NE. (Nunukan Isl.(: *Kostermans 8746; Meijer 2032, 2259; Payments 5.*

Ecology. Lowland mixed dipterocarp forest, ridge forest, montane forest, mossy dipterocarp forest; also in heath forest, peat swamp forest, swamp forest and kerangas; on sandy and sandy-loamy soils, 'red' soil, yellow clayey soil; 0-1100 alt. Flowers and fruits throughout the year.

Vernacular names. Kajang (Lubok Antu reg., Sarawak, 2nd. Div.); Kumpang lusoh (Sarawak, Semengoh F.R., 1st Div.; it means 'lazy kumpang' which refers to the slow combustion of wood which is not dry.

NOTES

1. Fieldnotes. Tree usually slender, bole straight, without buttresses, crown slender, branching monopodial, branches horizontal. Bark generally dark brown, rather smooth, shallowly to fairly fissured, sometimes flaky (strips 10-20 mm wide). Inner bark reddish, fibrous, laminated, kino profuse, colourless then deep red; slash wood (sap-wood) whitish to cream; cambium whitish; heartwood pinkish. Flowers yellow to waxy yellow; fruits glossy green, turning greenish yellow, yellow, or orange; aril bright orange-red to red.

2. The tomentum of the leaf-bud in specimens from Sumatra (incl. the type of var. *sumatrana*), is quite short, the hairs only c. 0.1 mm long; the tomentum in specimens from Malaya and Borneo is usually longer, and rough with hairs c. 0.4 mm long.

3. Where fruits are less than 30 mm long, leaves smallish and twigs rather slender, specimens may be difficult to distinguish from var. *polyspherula.*

4. Some specimens from East Kalimantan such as *Kostermans 7721* (Samarinda), *10696* (Central Kutai; both ♂ flowers), and *12613* (W. Kutai, fruits) slightly deviate in habit by their thinner, membranous leaves, which dry to a paler brownish colour; the flowers and fruits are not different, although Kostermans remarks that the fruits of *12613* are wine red, a colour as yet unrecorded for the other, fairly abundant, fruiting collections.

5. Deviating specimens. Two, *King's Collector* (Goping) *6004* (syntype of *H. majuscula,* not the lectotype), from Perak, Malaya, c. 200 m alt., with male flowers, and *Md, Nur 34117,* from Selangor, at low alt., also with male flowers, obviously belong to the *H. polyspherula*-complex according to the subglobose shape of the male perianth, and shape and architecture of the androecium. As regards their general habit both specimens agree with var. *sumatrana,* but differ by their larger perianth, c. 1.8-2.0 mm diam, and, accordingly, larger androecium, c. 1.0 × 0.8 mm; there are 5 or 6 anthers (10 or 12 thecae). Possibly they link up with the normal flowers of var. *sumatrana,* which is mainly characterised by fruit-size, and of which the true variation in flower size I am not certain of.

c. var. **maxima** de Wilde, *var. nov.*

Ramuli haud prominulo-lineati. Folia nervis lateralibus supra prominentibus instructa. Fructus sicco (3.5-)4-6 × 3-5 cm, pericarpio (5-)8-15 mm crasso. — Type: Sarawak, 7th Div., *Paul Chai S 36228* (L; iso: K; SAR, KEP, MO, SAN, *n.v.*).

Twigs towards apex 2-4 mm diam.; leaf bud covered with hairs 0.2-0.5 mm long. Leaves 9-20 × 3.5-7 cm, lateral nerves (6-)9-16 pairs. Flowers not seen. Fruits (3.5-)4.0-6.0 × 3.0-5.0 cm, the pericarp (5-)8-15 mm thick.

Distribution. Borneo

BORNEO. Sarawak: *S 17027, 32244, 36228, 37188, 38498* — Sabah: *San. A 1735, 25593, 48793, 66747, 86049.* — E. Kalimantan: *Kostermans 13023; Leighton 908.*

Ecology. Mixed forest, *Agathis* forest; on sandy water-logged soil, sandy loam or yellow clay-loam soil; 50-500 m alt. Fruits throughout the year.

NOTES

1. Fieldnotes. Tree recorded both as with and as without buttresses. Bark shallow boat-shaped fissured. Inner bark pinkish. Wood medium soft, whitish yellow. Fruits yellow to red.

2. The present variety differs mainly by its conspicously large and almost globose fruits with a very thick pericarp. It may be confused with *H. majuscula* from Malaya, a species which was reduced by Sinclair (l.c., p. 13) to *H. brachiata* var. *sumatrana* (the latter presently treated as *H. polyspherula* var. *sumatrana*). *H. majuscula* differs from *H. polyspherula* by the size of the male flowers (the flowers of var. *maxima* are unknown) with a differently shaped androecium, by the different leaf colour and by the slightly different fruits with a thinner pericarp.

Fruiting specimens of *H. polyspherula* var. *maxima* may also be confused with *H. punctatifolia,* which differs by its typical punctate leaves.

82. Horsfieldia oligocarpa Warb. Fig. 1C(82)

Horsfieldia oligocarpa Warb., Mon. Myrist. (1897) 354, t. 22 fig. 1-3 — *Myristica oligocarpa* (Warb.) Boerl., Handl. Fl. Ned. Ind. 3. 1 (1900) 87 — *H. polysherula* (Hook. f.) Sinclair var. *oligocarpa* (Warb.) Sinclair. Gard. Bull. Sing. 28 (1975) 104 — Syntype: *Beccari 2066* (fruits, FI acc. no. *7620,* lecto; iso: K. P), *s.n.* (♂ fl., FI acc. no. *7621, n.v.*).

Tree 4-20 m. Twigs terete, towards the apex 2-3(-4) mm diam., at the very apex dark grey-brown, early glabrescent, lower down bark striate, generally pale yellowish or whitish-brown, contrasting with the dark colour of the dry petioles, lenticels small, at first distinct, lower down inconspicuous, bark when older not flaking. Leaves in 2 rows, chartaceous, elliptic-oblong to oblong, broadest at the middle, 7-16 × 2.5-6 cm, base attenuate, top acute-acuminate, upper surface glabrous, drying usually grey-greenish, dull, lower surface generally bright rusty or chocolate-brown, contrasting much with the upper surface, glabrous including midrib, without blackish marks; midrib above raised, glabrous; nerves 8-11 pairs, above slender, raised; tertiary venation indistinct or invisible on both surfaces: petioles 6-12 × 1.5-2.5 mm, drying blackish brown; leaf bud 7-10 × 2-3 mm, covered with

dense grey-rusty tomentum of hairs c. 0.2 mm long, the tomentum early shed in the form of small crust-like pieces. Inflorescences rather sparsely pubescent with stellate hairs 0.2-0.3 mm long, sometimes glabrescent, in ♂: 2 or 3 times ramified, 3-6 × 1.5-4 cm, common peduncle 5-10 mm long, few-flowered, the flowers in clusters of 3-8 each; ♀ inflorescences not seen, according to the infructescences c. 1.5-4 cm long; bracts not seen, caducous; flowers 3-valved, perianth glabrous, pedicel glabrous, at base articulate. Male perianth globose to broadly obovoid, 1.0-1.7 mm diam., top broadly rounded, base ± rounded, glabrous; pedicel 1-1.5 mm long, slightly tapering; perianth at anthesis cleft to nearly ½-way, ± coriaceous, not collapsing on drying, valves towards base up to 0.5 mm thick. Androecium (incl. androphore) ± obovoid, c. 1.0 × 1.0 mm, in transverse section triangular; anthers 6 or 7 (thecae 12 or 14), anthers and thecae largely mutually free, c. 0.5 mm long, tip acutish, at base attached to a short column which continues into the somewhat tapering androphore c. 0.5 mm long. Female perianth not seen. Fruits 1-4 per infructescence, ellipsoid, top and base rounded, 1.8-2.7 × 1.4-1.9 cm, glabrous, drying brown to dark brown, not to hardly lenticellate, pericarp 2-3 mm thick; stalk 2-5 mm long; perianth not persisting.

Distribution. Borneo (Sarawak, Brunei)

BORNEO. Sarawak (1st, 3rd & 4th Div.): *Beccari s.n.* (FI acc. no *7621, n.v.*), *2066; Native Coll. 821; S 16219, 19470; Yacub 8255* — Brunei: (Ashton & Whitmore) *BRUN 398, 635; Brunig S 4402; Sinclair & Kadim 10414, 10430, 10452, 10503* (= *H. bicolor* Sincl. *in sched.*).

Ecology. Forest on poor soils: white sand, white podsolic sand, yellow sand, sandstone, 'terraces', sand and peat, once recorded from a ridge; heath forest; 0-50 m alt. Flowers in June, August; fruits August to October.

Vernacular name. Kumpang puteh.

NOTES

1. Fieldnotes. Shrub or tree, buttresses absent. Bark grey and dark brown, to reddish brown, fissures c. ¼-½ in. wide; c. 9 in. long; inner bark pink brown, soft, c. 1 cm thick, sap red; sapwood pink-yellow, soft. Timber firm. Leaves pale green, dull, not glaucous beneath. Fruit pale yellow to orange; pear-shaped, ± pointed at apex. Flowers light brown.

2. This species is identical with *H. polyspherula* var. *oligocarpa* as treated by Sinclair (p. 104), who regards it as a distinct ecological variety. I agree that it is extremely close to *H. polyspherula,* especially to var. *polyspherula,* as it has fruits of about the same size. Because I accept three varieties within the polymorphous *H. polyspherula,* mainly on the basis of different fruit-sizes (though some sizes overlap), the present *H. oligocarpa* could be treated as a variety based on quite different grounds. I prefer to keep it apart as a separate species because it has a strikingly different general appearance and its own distinct ecology. *H. oligocarpa* seems to be restricted to low forest and heath forest on very poor sandy and peat soils at low altitudes. The plant stands out by the overall pale colour; the older twigs are pale, whitish brown to straw; the leaves dry a dull pale green above, contrasting strongly with the bright brown, or rusty, copper, or chocolate-brown of the lower leaf surface (more contrasting than is usually the case with *H. polyspherula*); the inflorescences are rather small and not many-flowered, ± glabrescent; the flowers are markedly coriaceous (?always). Sinclair named some of the specimens

as *H. bicolor* Sincl. *in sched. H. polyspherula* grows generally on richer soils, and the twigs dry always to grey-brown to brown; the leaves are generally of a less paler green; and the perianths are not coriaceous or slightly so.

83. Horsfieldia endertii de Wilde, *sp. nov.* Fig. 1C(83)

Ramulorum apices atque gemmae pubescentes pilis scabris 0.3-0.6 mm longis. Folia coriacea. Perianthium masculum 3-valvatum, ellipsoideum, 2.5-3.5 × 2-2.5 mm. Androecium ellipsoideum, sessile, antheris 10-14, sessilibus, pedicello basi non-articulato. — Type: E. Kalimantan, *Endert 3996* (L; iso: K; A, BO, *n.v.*).

Tree 4-25 m. Twigs terete, towards the top 2.5-4(-8) mm diam., dark or blackish brown, early to rather late glabrescent, tomentum rough, deep rust, composed of hairs 0.3-0.6 mm; bark coarsely striate, with coarse and conspicuous, paler lenticels, older bark tending or not to flake. Leaves in 2 rows, coriaceous to strongly coriaceous, elliptic-oblong to oblong-lanceolate, broadest generally at the middle, 8-17(-26) × 3-6(-10) cm, base rounded to (short-)attenuate, tip rounded to subacute; upper surface glabrous but base of midrib late glabrescent, drying olivaceous or yellowish to dark-brown, lower surface drying pale brown to chocolate, not much contrasting with the upper surface, without larger blackish marks but with usually large and conspicuous, pale yellowish hair-scars (lens, × 60), glabrous but the midrib towards the base sometimes late glabrescent; midrib above relatively broad, raised, glabrous but towards base late glabrescent; nerves 8-15 pairs, above sunken, flattish, or slightly raised, the submarginal arches fairly regular-shaped and sometimes distinct; tertiary venation forming a lax network, generally indistinct or invisible on both surfaces; petioles 6-16 × 2-3.5(-4) mm, glabrescent; leaf bud 10-20 × 3-4 mm, with hairs 0.3-0.6 mm. Inflorescences densely and rather shaggy-pubescent with rusty hairs 0.5-1.0 mm long, in ♂: 2 or 3 times ramified, not very many-flowered, (1.5-) 3-10 × (1-) 2-5 cm, common peduncle 5-20 mm long, the flowers in clusters of (1-)2-6 each; ♀ inflorescences ± few-flowered, 1 or 2 times ramified, 2-4 cm long; bracts broadly ovate-ellipsoid, 3-7 mm long, densely pubescent, caducous; flowers 3-(or 4-) valved, perianth glabrous (glabrescent), pedicel minutely puberulous, hairs 0.1-0.3 mm, especially in the lower half, at base inarticulate. Male perianth ± obovoid (when immature) to ellipsoid, 2.5-3.5 × 2.0-2.5 mm, top and base rounded, glabrous; pedicel 2-3 mm long; perianth at anthesis cleft to ⅓-½-way, only slightly collapsing on drying, valves c. 0.3 mm thick. Androecium ± sessile, obovoid to truncate-ellipsoid, 2.0-2.8 × 1.4-1.6 mm, in transverse section sub-triangular; anthers (10-)12-14 (c. 24-28 thecae), almost completely sessile, 2.0-2.8 mm long, free at apex for only 0.1 mm or less, column solid except for the narrow apical hollow or slit reaching to ⅕-⅓ deep; androphore narrow, (0-)0.1-0.3 mm long, hidden by the anthers. Female perianth broadly ovoid-ellipsoid, 2.5-3 × 2-2.5 mm, glabrous, split at anthesis to ⅓-½, valves 3, at sutures 0.3-0.5 mm thick, pedicels 1.5-2.0 mm long, towards the base with hairs c. 0.2 mm, inarticulate, ovary ovoid-ellipsoid, c. 2 × 1.5 mm, glabrous, stigma c. 0.2 mm high, minutely 2-lobed. Fruits 1-4(-8) per infructescence, ellipsoid, base rounded, top rounded to acutish, 3.0-4.2 × 1.6-2.4 cm, glabrous, drying grey-brown to dark brown, without or with a few lenticel-like tubercles, pericarp 2-4 mm thick; stalk 3-5 mm long; perianth not persisting.

Distribution. Borneo: Sarawak, Sabah, E. Kalimantan.

BORNEO. Sarawak (4th & 5th Div., Baram Dist.): *Anderson 4258: Nielsen* (Mulu Exp.) *792; S 15083, 33027, 35486* — Sabah (mainly Kinabalu): *Chew, Corner & Stainton 142; Clemens 29558,*

32500, 32605, 50721; (Wyatt-Smith & Wood) Kep 80353; Nooteboom 1044; San 33940, 36778, 65314, 76815, 79585 — E. Kalimantan (W. Kutai): *Endert 3996.*

Ecology. A montane species; in ridge forest, mossy forest, mountain forest, dwarfed forest on wind-swept crests; on sandy soil, black or brownish soil; 1200-2100 m alt. Flowers and fruits throughout the year.

Vernacular name. Binarak (Murut lang., Sarawak).

NOTES

1. Fieldnotes. Tree of medium size, sometimes dwarfed. Bark cracked to finely fissured, brown-black to dark brown; inner bark reddish; cambium whitish, sapwood whitish; exudate turning reddish. Fruit orange-yellow, pink, pink-red, or orange-red, aril bright orange. Flowers yellow.

2. At first Sinclair identified most specimens (incl. the type) as *H. polyspherula* var. *montana,* or as *H. montana* Airy Shaw; later on he included *H. montana* as well as the superficially similar *H. xanthina* in his polymorphous concept of *H. glabra.* In the present revision I have kept *H. montana* and *H. xanthina* as distinct species differing from *H. glabra* and from the material here described as a new species. *H. glabra* and *H. xanthina* differ in the flowers, and vegetatively by the much shorter tomentum on the leaf bud, twig-apex and inflorescences; *H. montana* differs by the much smaller globose flowers. *H. endertii* is characterized by fairly large ellipsoid male flowers with an androecium distinctly longer than broad, the pedicels inarticulated at base, very coriaceous leaves, rough-haired leaf buds and inflorescences. On the lower leaf surface there are practically always distinct, large, pale-yellowish coloured hair-scars, well visible when magnified 60 times. *H. endertii* usually has ± rounded leaf tips, as in *H. montana,* but the leaves in the latter usually dry to a blackish colour and are generally smaller and thinner.

3. The type, *Endert 3996,* with male flowers, is from W. Kutai, the only specimen from Kalimantan. The remaining specimens from Sarawak and Sabah somewhat differ in general appearance; their twigs are often less roughly hairy towards the top, the leaves are somewhat more coriaceous with the lateral nerves ascending at a slightly sharper angle from the midrib; all male flowering specimens from Sarawak and Sabah appeared to be in a juvenile state, except the BM duplicate of *Clemens 29558* (Tenompok), of which the identity with the type is evident.

4. The collection *Chew, Corner and Stainton RSNB 142* from Kinabalu somewhat deviates by the relatively large, broad and very coriaceous leaves; it has immature male inflorescences but the lower leaf surface has typical, large, golden or whitish hair scars.

84. Horsfieldia valida (Miq.) Warb. Fig. 1C(84)

Myristica valida Miq., Fl. Ind. Bat. 1 (2), 1 (1858) 67; Suppl. 1 (1860) 156 — *Horsfieldia valida* (Miq.) Warb., Mon. Myrist. (1897) 349; Heyne, Nutt. Pl. (1927) 638. — Type: Sumatra, West Coast, Teijsmann 479 (U; iso: BO, *n.v.*) (sterile, the fruit said to be as large as a goose egg).

Tree 10-15 m. Twigs terete, towards apex 2.5-5 mm diam., at insertion of inflorescences up to 10 mm diam., brown to grey-brown, rather early glabrescent,

tomentum rusty woolly, with hairs 0.4-0.7 mm long; the bark lower down coarsely striate, rather densely set with conspicuous pustulate lenticels; older bark not flaking. Leaves in 2 rows, chartaceous, (ob)ovate-oblong, broadest at or somewhat above the middle, 20-35 × 8-13 cm, base short- to long-attenuate, tip subobtuse to acutish; upper surface glabrous, drying dark- to olivaceous-brown, lower surface drying bright brown, without blackish marks, early glabrescent but midrib rather late glabrescent; midrib above rather broad towards the base, glabrescent, slightly raised; nerves 20-25 pairs, raised above; tertiary venation forming a rather lax network, flat, indistinct or invisible on both surfaces; petioles 7-12 × 3-4.5 mm, glabrescent; leaf bud c. 15-20 × 4 mm, densely ferrugineous-pubescent with hairs c. 0.4-0.7 mm. Inflorescences situated just behind the leaves, ± woolly pubescent with hairs 0.3-0.5 mm, subglabrescent, in ♂: 2 or 3 times ramified, not very many-flowered, 5-6 × 3-4 cm, common peduncle 10-15 mm long; ♀ inflorescences not seen, according to the infructescences c. 5 cm long; bracts not seen, caducous; flowers 4-(or 3-)valved, in loose clusters of 3-6 each, perianth glabrous, pedicel glabrous and inarticulate at the base. Male perianth globose, 2.5-3 × 3-3.5 mm, top and base rounded, pedicel c. 1.5 mm long; perianth at anthesis cleft to c. ⅘, slightly collapsing on drying, valves c. 0.3-0.4 mm thick. Androecium ± depressed globose, 0.8-1.2 × 1.4-6 mm (much smaller than the perianth); in transverse section ± irregularly rounded or faintly 4-angular; anthers 12-14, curved and largely connate with the broad column, at apex free for only c. 0.2 mm; column not or hardly hollowed; androphore rather narrow, 0.1-0.2 mm long. Female flowers not seen (but see under fruits). Fruits 2-9 per infructescence, ellipsoid, top and base ± rounded, c. 8.0(-9.0) × 5.0(-6.0) cm, glabrous, drying brown with surface wrinkled and ± warted, pericarp c. 15 mm thick; stalk c. 5 mm long; perianth persistent under young fruits in *Maradjo 449,* 4-valved, c. 3 mm long.

Distribution. Sumatra (E. and W. Coast; possibly Palembang, see notes), probably W. Borneo (see note 3).

SUMATRA. West Coast: *Maradjo 449; Teijsmann 479* — East Coast: *Lörzing 5896, 15557* — Palembang: *Dumas 1649* (sterile).

BORNEO. West Kalimantan, Mt. Damoes: *H. Hallier 624* (doubtful, see notes).

Ecology. Primary forest, ravine forest; (?200m, see the notes —) 900-1100 m alt. Flowers in March and August, fruits in August.

Vernacular names. Simar mudar-mudar (Timor lang. of Sumatra), Lundang (W. Coast), Pijangoe pĕmatang (Palembang).

NOTES

1. Fieldnotes. Tree erect, branches wide-spreading and arching. Flowers tinged yellow, brown, sweet smelling.

2. The specimen *Dumas 1649,* from Pelambang, is sterile; it deviates from the other specimens (all from 900-1100 alt.) by the shorter tomentum on the leaf bud (hairs only c. 0.3 mm long) and its lower (c. 200 m.) altitude.

3. Deviating specimen from W. Borneo. Hallier 624, with ♂ fl., of Mt. Damoes, is obviously taxonomically closely related to *H. valida,* but it is markedly different in several ways. Apparently it represents a new undescribed species. It keys out

beside *H. valida* because its male perianths are cleft at anthesis to c. 4/5 or deeper, and the pedicels inarticulate at the base. It cannot be *H. fragillima* (pedicels also inarticulate, and keys out next), because that species has the perianths at anthesis cleft at most to ½-way deep, and a saucer-shaped androecium. Our specimen differs from *H. valida* by the much smaller flowers, globose perianth (which is possibly submature) measuring 1.2-1.5 × 1.5-1.6 mm; smaller androecium, 0.5-0.6 × 0.8-1.0 mm with the column at apex broadly hollowed to about ½-way deep, anthers ± completely sessile, ± incurved and concealing the hollow (in *H. valida* the column not or hardly hollow at the apex); there are fewer anthers, 9-11 (in *H. valida* 12-14). It has predominatly 4-valved perianths as in *H. valida* from Sumatra. The ♂ inflorescence is 21 cm long, those of *H. valida* only c. 6 cm. I have not found ♀-flowering or fruiting specimens which match *Hallier 624,* and I have refrained from describing it as a new species. The specimen was determined by Sinclair as *H. fragillima.*

4. Sinclair (p. 150) accepted *H. valida* in a much wider sense. As distribution he included China, most of Borneo, the Philippines, and Celebes. Most of the specimens cited by him for Sumatra have at present been included in *H. valida;* other specimens have been assigned by me to various species. The only one from Borneo (see under note 3, deviating specimen) was included by Sinclair in *H. fragillima.*

5. Warburg (p. 349) remarks that it is vegetatively very alike *H. macrothyrsa,* differing almost only in the fruits which were recorded as unusually large. I disagree as *H. macrothyrsa* differs in many ways, such as the punctate leaves and the much larger male flowers.

85. Horsfieldia borneensis de Wilde, *sp. nov.* Fig. 1C(85)

Ramulorum apices atque gemmae pubescentes pilis ferrugineis 0.2-0.4 mm longis. Folia tenuiter coriacea, subtus praedita punctis atque lineis brevibus sparsis fusco-brunneis. Perianthia mascula 3-valvata, subglobosa ad late obovoidea, 1.3-1.8 × 1.2-1.7 mm, androecio subgloboso sessili, antheris 7-10, sessilibus, pedicello glabro, basi articulato. — Type: Sarawak, *Bojang bin Sitam S 14610* (L iso: K).

Tree 10-30 m. Twigs subterete, not ridged, (1.5-)2-4(-10) mm diam. towards the apex, usually dark grey-brown, sometimes blackish, not conspicuously hollow, early to rather late glabrescent, tomentum rusty, composed of hairs 0.2-0.4 mm, bark lower down faintly finely striate, not distinctly lenticellate, when older finely cracking or not, flaking slightly or not. Leaves in 2 rows, chartaceous to thinly coriaceous, elliptic-oblong to oblong-lanceolate, broadest usually at the middle, 7-18 × 2-6 cm, base (short-) attenuate, top acute to (short-) acuminate; upper surface drying dull olivaceous to (partially) blackish-brown, glabrous, the midrib not or somewhat late glabrescent, lower surface drying pale brown to bright reddish brown or chocolate, glabrescent, tomentum of shortish, densely-branched dendroid hairs, 0.3-0.4 mm (especially on midrib), always with scattered, usually subcircular, larger, blackish dots or marks (cork warts); midrib slightly raised above, early or late glabrescent; nerves 10-16 pairs, slender above, usually flat or sunken (or only close to the midrib slightly raised) or in thinner-leaved specimens slightly raised, glabrous, the lateral arches ± regularly shaped, not very distinct; tertiary venation hardly or not visible on both surfaces; petioles relatively long, 12-25 × 1.5-2.5 mm, early to rather late glabrescent; leaf bud 10-17 × 2-4 mm, densely pubescent with hairs c. 0.3 mm long. Inflorescences behind the leaves,

densely short-woolly pubescent with rusty hairs up to 0.7 mm long, in ♂: fairly large, many-flowered, c. 4 times ramified, (8-)13-20 × (5-)10-18 cm, common peduncle 15-35 mm long; ♀ inflorescences not seen, infructescences up to 13 cm long; bracts elliptic to elliptic-oblong, pubescent as the inflorescences, 1.5-5 mm long, caducous; male flowers in loose clusters of 2-6 each; perianths glabrous, 3-valved, pedicels glabrous, distinctly articulate at base. Male perianth subglobose to broadly ellipsoid or broadly obovoid, 1.3-1.8 × 1.2-1.7 mm, top broadly rounded, base (narrowly) rounded, glabrous; pedicels 1.0-1.5 mm; perianth at anthesis cleft to c. ⅓ (to nearly ½), not collapsing on drying, valves 0.2-0.3 mm thick. Androecium broadly ellipsoid to subglobose, 0.7-1.2 × 0.6-1.3 mm, the top broadly rounded, slightly impressed in the centre, base rounded, in cross-section subcircular; anthers 7-10 (thecae 16-20), almost completely sessile and mutually closely appressed, at apex incurved over the cavity which reaches to c. ⅕-¼ (or less) deep; free apicies ± none; column broad; androphore narrow, c. 0.1 mm or less long. Female flowers not seen; as judged from remnants under very young fruits: perianth c. 2.5 mm long, ovary glabrous. Fruits 1-7 per infructescence, ovoid, somewhat laterally flattened and slightly flanged, top and base rounded, 4.0-6.0 × 3.0-4.5 cm, glabrous, drying brown and often with a glaucous tinge, rather smooth, pericarp (measured dry) 10-15 mm thick; stalk stout, 4-6 mm long; perianth not persisting.

Distribution. Borneo: Sarawak, Sabah, E. & NE. Kalimantan.

BORNEO. Sarawak (all Kuching & vicinity, 1st. Div.): *Asah Arb. no. 715; S 12771, 14610, 14759, 25241, 34706* — Sabah (Beaufort Dist.): *San 16838, 31413* — E & NE. Kalimantan (W. Kutai, Balikpapan, Nunukan Isl.): *b.b. 16516, 18180, 29301, 29315, 29373, 34325; Kostermans 7043, 8617, 9782, 9947, 13623; Schut K. 31.*

Ecology. Primary lowland dipterocarp forest; on sandy soils, flat clay soil, sandstone, sandy ridges; 0-200 m alt. Flowers in April, August and September, fruits throughout the year.

NOTES

1. Fieldnotes. Bark of trunk rough, deeply fissured, flaking in squares, usually dark brown or reddish or blackish; strips or flakes up to 5 cm wide, up to 1 cm thick. Living bark 5-10 mm thick, red-brown; sap red; sapwood c. 10 cm, reddish white to pale red, heartwood red-brown. Bark of tree c. 30 cm diam. recorded as deeply fissured, but with a smooth appearance, the strips with rounded edges. Fruits bluish green, turning green-yellow to yellow or reddish, pericarp pink inside, aril orange.

2. Sinclair included most of the specimens of the present new species in *H. wallichii,* a few were determined by him as *H. polyspherula* s.l. or *H.* aff. *ridleyana* (e.g. *Achmat b.b. 34325*). Our present species has in common with *H. wallichii* the characteristic blackish dots on the lower leaf surface, the dull upper leaf surface with largely sunken nerves, and practically similar fruits though they have a persistent perianth in *H. wallichii.* However, *H. wallichii,* which also occurs in Borneo, is generally stouter, has much larger leaves, often with a persistent tomentum. Above all, it differs in the flowers, the general appearance and shape and structure of the androecium, and the pedicel which is inarticulate at the base.

3. On account of the dotted lower leaf surface, *H. borneensis* belongs to the group of species including *H. wallichii* and *H. pulcherrima* whereas the structure of

the androecium links it up with species such as *H. pulcherrima*, *H. flocculosa*, *H. grandis* etc.

4. Variation. A few specimens (especially *San 16838*, *31413*, from Beaufort Dist., Sabah) have relatively thin leaves with the lateral nerves on the upper surface raised; the dry leaves and twigs have a relatively dark blackish colour. These specimens may be mistaken for *H. polyspherula*.

86. Horsfieldia fragillima Airy Shaw Fig. 1C(86): 29

Horsfieldia fragillima Airy Shaw, Kew Bull. 1939, no. 10 (1940) 542 — Type: Sarawak, 4th Division, Mt. Dulit,*Richards 2602* (K; iso: A, SING, *n.v.*).

Tree 10-30 m. Twigs stoutish, terete or faintly angular, 2.5-7(-15) mm diam. towards the apex, early glabrescent, tomentum with hairs c. 0.3 mm, bark of young twigs dark brown, often with conspicuously pale lenticels, bark of older twigs usually paler brown, coarsely striate with a tendency to crack longitudinally and to flake somewhat; lenticels distinct, on older wood inconspicuous. Leaves in 2, or sometimes (partly) in 3 rows, membranous to thinly coriaceous, oblong to oblong-lanceolate, broadest at or somewhat above the middle, 20-45 × 6.5-12 cm, base narrowly rounded to short-attenuate, but blade rather tapering below the middle, base rarely long-attenuate, tip acute or acute-acuminate; upper surface drying olivaceous to brown, lower surface early glabrescent, often with some minute tomentum remaining at and near the base of the midrib; without blackish dots; midrib above raised, towards the base rather broad and flat; nerves 20-30 pairs, above raised, the marginal arches ± indistinct; tertiary venation forming a lax network, faint to nearly invisible above; petioles stout, relatively short and broad and often ± pulvinate, 4-13(-20) × 3-8 mm, glabrous; leaf bud 12-20 × 3-5 mm, densely pubescent with hairs c. 0.3 mm. Inflorescences behind the leaves, rather sparingly set with hairs (0.1-)0.2-0.4 mm, in ♂: large, very many-flowered, 4 or 5 times ramified, 15-30 × 10-20 cm, common peduncle 25-60 mm long; in ♀: 6-13 cm long, stout, rather few-flowered (known from infructescences only); bracts up to 12 × 5 mm, tomentulose, caducous. Flowers 3-(or 4-)valved, glabrous, in ♂ in clusters of 2-6; pedicels glabrous, at base inarticulate. Male perianths globose or sometwhat depressed-globose, 1.4-2.0 × 2.0-2.5 mm, top broadly rounded, base rounded; pedicels 1-1.5(-2.0) mm long; perianth at anthesis cleft nearly to ½-way, valves c. 0.2(-0.3) mm thick. Androecium strongly depressed-globose, almost saucer-shaped, much and broadly depressed in the centre, (sub-)circular in transverse section, 0.5-1.0 × 1.0-1.5 mm; anthers 7-9, almost completely sessile, incurved towards the top, free apices up to 0.1 mm; column broadly saucer-shaped, with a broad apical hollow to about ½-way deep, androphore (if present) narrow, up to 0.1 mm long. Female flowers not seen; perianth 3- or 4-valved, 4-5 × 3-4 mm according to the remnants under the fruit. Fruits up to 8 per infructescence, broadly ellipsoid, rounded at top and base, possibly slightly flattened, c. 6.0-8.0 × 4.0-6.0 cm, glabrous, drying dark brown, the surface wrinkled and usually with small and large pustules or warts, the dry valves 10-20 mm thick; perianth persistent for a long time under the fruit; stalk 2-4 mm long.

Distribution. Borneo (Sarawak, Brunei, Sabah, C. Kalimantan; possibly E. Kalimantan, see note).

BORNEO. Sarawak: *Anderson et al. 15449; Hj. Bakar 4361; Chew Wee-lek CWL. 606; Richards 2602; S 13594, 15137, 16614, 16985, 19535, 23348, 28083, 32141, 34358, 34621, 34968, 35202, 35442,*

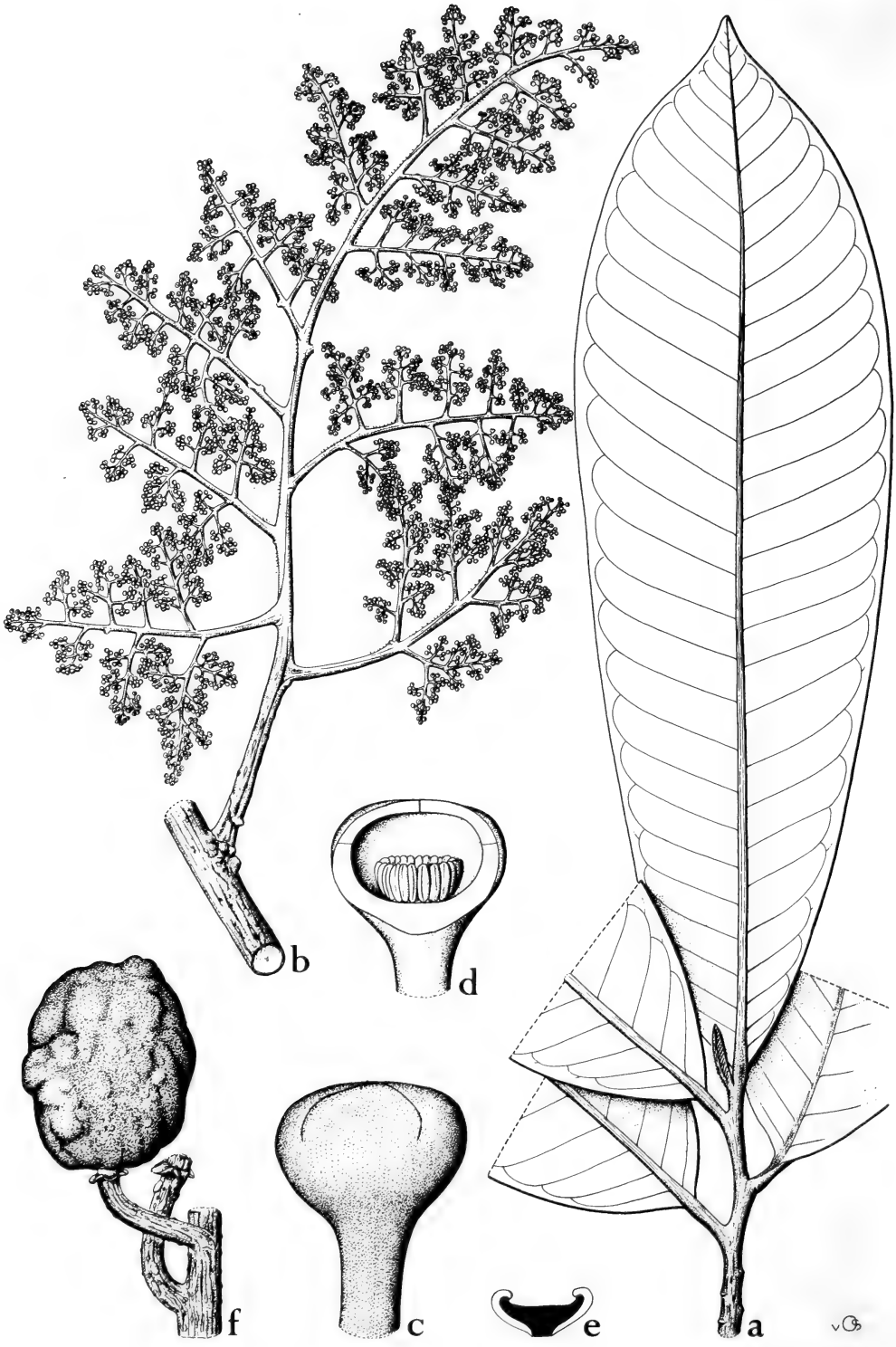

Fig. 29 *Horsfieldia fragillima* Airy Shaw
a. leafy twig apex, × ½; *b,* portion of older twig with male inflorescence axilliary to leaf scar, × ½; *c,* mature male flower, lateral view, × 12; *d,* ditto, longitudinally opened, showing androecium, × 12; *e,* androecium, longitudinal section, schematic, × 12; *f,* twig portion with infructescences, fruit mature, note persistent perianth, × ½ — *a-e,* from *S 34358; f,* from *S 16985.*

35756 — Brunei: *BRUN 137* — Sabah: *B.N.B. For. Dept. A 865; SAN A 3449, A.4211, A 4713, 16519, 16648, 27424, 39622, 50063, 66735, 73695, 74417, 75942, 78243, 83457, 83670, 92578* — Central Kalimantan: *Veldkamp 8451* — E. Kalimantan (Balikpapan): *b.b 25571* (doubtful, see notes).

Ecology. Primary lowland dipterocarp forest; hill slopes, flat land, alluvial land, once in seasonal swamp; most commonly recorded from sandy soils, leached clayey loam over sandstone, sandy clay, often along or near streams, riverine forest; 0-400 m alt. Flowers February to May, fruits collected all through the year.

Vernacular name. Kumpung Pango (Iban lang.)

Uses. Fruits recorded as edible, very acid and resinous.

NOTES

1. Fieldnotes. Trunk without buttresses, then often broadly gullied, rounded-fluted, or only with short and rounded buttresses; bark chocolate-brown, reddish-brown, or brown-blackish, recorded either as not furrowed, slightly fissured, mostly with few flakes, or scaly, or peeling into thin flakes. Inner bark c. 3 mm thick, pale pink or reddish to yellowish; sapwood soft, whitish, yellow-pink or pinkish white. Branches somewhat drooping. Flowers yellow. Fruits ramiflorous, large, up to c. 10 × 7 cm. (seed c. 3 × 2 cm), greenish yellow turning rose-pink to red; pericarp thick, to over 2 cm; aril reddish-orange.

2. On the whole a homogeneous species, only a few specimens from Sarawak (1st and 4th Div.) markedly vary, *viz. Bakar 4361* (♂), and *S 13594, 15137, 16985, 34621, 35202* (all in fruit); these deviate from the rest of the specimens by a somewhat stouter habit. The flowers in *Bakar 4361* are somewhat larger, reaching to c. 2.3(-2.5) mm. diam., whereas male perianths of the other specimens from the same localities reach only to c. 2 mm diam.

3. In the sterile state, *H. fragillima* may be confused superficially with *H. laticostata,* as the former may have a similarly broad basal part of the midrib. *H. laticostata* differs by its architecture of the male flowers, much smaller fruits, and different texture and colour of the leaves.

4. H. fragillima seems most related to *H. splendida* and *H. pulcherrima,* which have resembling androecia (though a narrower hollow), and with an inarticulate pedicel-base. The two species differ, however, strongly from *H. fragillima* in general habit, including their markedly hairy lower leaf surface.

5. In *H. fragillima* the leaves in fertile plagiotropic shoots are usually arranged in 2 rows, but in a few specimens they are distinctly in 3 rows. In most Horsfieldias the leaves of plagiotropic shoots are always distichous. The ramiflorous fruiting twigs may reach a width of 25-30 mm.

6. The present species is here accepted largely in the same sense as by Sinclair. I have to exclude *Hallier 624* which may represent a new species; that specimen is discussed in the notes under *H. valida.*

7. The collection *b.b. 25571* from E. Kalimantan is sterile and deviates by the rather coriaceous leaves; no other specimen from E. Kalimantan has been collected.

87. Horsfieldia androphora de Wilde, *sp. nov.* Fig. 1C(87); 30

Ramulorum apices atque gemmae pubescentes pilis 0.3-0.6 mm longis. Folia membranacea, subtus non punctata. Perianthia mascula 3-valvata, globosa, 1.4-2 mm diam., synandrio depresso-globoso, c. 1 mm diam., antheris 7-11, androphoro distincto, gracili, 0.3-0.8 mm longo, pedicellis basi non-articulatis. — Type: Sarawak, *Nooteboom & Chai 01710* (L).

Tree 7-20 m. Twigs terete, 2-4(-5) mm diam. towards apex, rather late glabrescent, tomentum rusty with hairs 0.3-0.6 mm, lower down the bark rather finely but distinctly striate, blackish brown, when older not flaking; lenticels small, not conspicuous. Leaves in two rows, membranous, elliptic to oblong, broadest at about the middle, 9-18 × 3.5-6.5 cm, base attenuate, tip acute-acuminate; upper surface drying dark brown or blackish brown, not minutely pustulate, glabrous, lower surface glabrescent (except midrib), without scattered larger blackish dots; midrib above raised, beneath with some vestigial tomentum or late glabrescent; nerves 9-13 pairs, raised above, the marginal arches on the lower surface not very regularly shaped and not very conspicuous; tertiary venation forming a lax network, distinct or not; petiole 10-12 × 1.5-2 mm, glabrescent; leaf bud 8-12 × 2-3 mm, rusty pubescent with hairs 0.3-0.6 mm. Inflorescences rather densely pubescent with hairs 0.2-0.6 mm, in ♂: rather many-flowered, 3 (or 4) times ramified, 6-14 × 3.5-9 cm, common peduncle 10-20 mm long; ♀-inflorescences (as seen from infructescences) 3-4 cm long; bracts densely short-pubescent, ovate-elliptic, acutish, c. 3 mm long, caducous. Flowers in ♂ in clusters of 2-6 each, 3-valved, glabrous; pedicels glabrous or with a few minute hairs 0.1 mm or less at the very base, at the base inarticulate. Male perianth globose, 1.4-2.0(-2.2) mm diam., base and apex rounded, pedicels (0.5-) 1.0-2.0 mm, slender; perianth at anthesis cleft to a depth of ⅓ to nearly ½-way, valves c. 0.2 mm thick. Synandrium (androecium minus androphore) depressed-globose, somewhat flattened or impressed at apex and/or at base, in transverse section subcircular, (0.6-)0.8-1.0 × (0.8-)1.0-1.3 mm, androphore slender, (0.3-)0.4-0.8 mm long; anthers 7-11 (thecae 14-22), almost completely sessile and interconnate, curved towards the top and concealing the apical hollow, hollow 0.2-0.3 mm deep, occupying c. ⅕-¼ of the broad column. Female flowers not seen. Fruits 2-5 per infructescence, ellipsoid, top subacute to rounded, base rounded or shortly narrowed, 2.4-3.0 × 1.4-2.0 cm, glabrous, drying dark brown, finely tubercled but without lenticels, dry valves 1.5-2 mm thick; stalk c. 2 mm long; perianth not persisting.

Distribution. Borneo: Sarawak, Sabah.

BORNEO. Sarawak (Bukit Goram, 4th Div.; Kelabit Highlands, 7th Div.): *Nooteboom & Chai 01710; (Chai) S 35443, 36146* — Sabah (Bukit Kinasaraban); *Sinclair (Kadim & Kapis) 8977.*

Ecology. Montane forest, mossy-forest, wooded sandstone ridges; 800-1200 m alt. Flowers in March and October, fruits in March, June.

Vernacular name. Li-ang (Kelabit lang., Sarawak, 4th Div.).

NOTES

1. Fieldnotes. Bark surface chocolate- to reddish-brown, bark narrowly cracked or longitudinally furrowed and cut into rectangular blocks; latex of bark watery, latex once recorded as more or less colourless (tree in flower), once as blood red (tree in fruit). Twigs chocolate brown, pubescence rusty. Flowers yellow; fruit smooth, not pubescent, orange, aril orange, outer seed coat whitish grey.

Fig. 30. *Horsfieldia androphora* de Wilde.
a, portion of branch with leafy twig and male inflorescence, × ½; *b,* mature male flower, × 12; *c,* ditto, longitudinally opened, showing androecium, × 12; *d,* androecium, longitudinal section, schematic, × 12; *e,* portion of twig with infructescence, fruits mature, aril complete, × ½ — ***a-d,*** from ***Nooteboom & Chai 01710*** (Type); *e,* from ***Sinclair, Kadim & Kapis 8977.***

2. According to the general architecture of the androecium, this species belongs to the group of *H. grandis*, but it seems closest related to *H. tomentosa* from S. Thailand and Malaya; it has the long-stalked synandrium in common with that species. *H. tomentosa* differs by the generally larger flowers, tomentose lower leaf surface, and smaller fruit which are pubescent or glabrescent. Our present species is mountainous; *H. tomentosa* is exclusively found in the lowland.

H. androphora keys out beside *H. fragillima* (also with inarticulate pedicels), but the latter differs in many characters: general habit, fruit-size, and quite a different saucer-shaped androecium.

3. Three of the known specimens of the present species were yet uncollected when Sinclair revised the genus; his own collection *Sinclair 8977* (fr.) was not recognized as a new species and was included in *H. polyspherula* var. *montana*. In this revision I consider that *H. montana*.

88. Horsfieldia amplomontana de Wilde, *sp. nov.* Fig. 1C(88)

Ramulorum apices atque gemmae tomento conspicuo pilorum 0.3-1.5 mm longorum. Folia 15-35 × 5-11 cm, subtus non punctata. Inflorescentiae masculae magnae, usque ad 20 cm longae. Perianthia mascula 3-vel 4-valvata, subglobosa, 1.5-2 mm diam.; androecio depresso-globoso, 0.6-1.0 × 1.1-1.8 mm, antheris 10-13, sessilibus, androphoro brevi atque angusto, usque ad 0.4 mm longo. Fructus sicci ellipsoidei, 7-8 cm longo, perianthio persistente. — Type: *J. & M.S. Clemens 30536* (L; iso: BM, K).

Tree 10-20 m. Twigs terete, towards the apex 3.5-6(-10) mm diam., grey-brown to dark brown, early to rather late glabrescent, tomentum brown to rusty, composed of hairs 0.3-1.0(-1.5) mm long; bark coarsely striate, lenticels small, not contrasting in colour and inconspicuous, older bark not flaking. Leaves in 2 rows, membranous to chartaceous, elliptic-oblong to oblong-lanceolate, broadest at about the middle, 15-35 × 5-11 cm, base short-attenuate to narrowly rounded, tip acute-acuminate; upper surface glabrous (i.e., glabrescent, except towards the base of the upper midrib in young leaves), drying olivaceous to brown, when dry contrasting or not with the colour of the lower surface, lower surface glabrous (glabrescent), without larger blackish or brown dots, without large pale hair-scars; midrib rather slender above, flattish to moderately raised; nerves 11-12 pairs, above flattish to raised, the submarginal arches not distinct; tertiary venation forming a lax network, ± distinct or not; petioles 8-15 × 2.5-3.5 mm, glabrescent; leaf bud 15-22 × 3-4 mm, densely brown to rusty pubescent with hairs 0.5-1.0(-1.5) mm long. Inflorescences behind the leaves, shaggy-pubescent with rusty hairs c. 0.5 mm, in ♂: 3 or 4 times ramified, many-flowered, 10-21 × 10-16 cm, common peduncle 15-40 mm long, the flowers in ♂ in loose clusters of 5-10; ♀-inflorescences not seen, in fruit c. 7-8 cm long; bracts broadly oval-ellipsoid, 2-7 mm long, finely pubescent, caducous; flowers 3-(or 4-)valved, perianth glabrous, pedicel generally glabrous, at base not articulate or ± articulate in only some flowers (see notes). Male perianth globose or slightly depressed-globose, 1.5-2.0 × 2.0-2.3 mm, top and base (broadly) rounded, glabrous; pedicel 0.8-1.5(-2.0) mm long; perianth at anthesis cleft to ½-⅔, not or only slightly collapsing on drying, valves c. 0.2 mm thick. Androecium depressed-globose, above and beneath broadly rounded, or sagged at base, 0.6-1.0 × 1.1-1-8 mm, in transverse section (sub-) circular; anthers 10-13, almost completely sessile, c. 0.8-1.2 mm long, free apices up to 0.1 mm, curved, concealing the ± 3-radiate apical slit or cavity (0.2-1)0.3-0.5 mm deep; column broad, solid; androphore rather narrow, (0.1)0.2-0.4 mm long,

completely or partly hidden by the anthers. Female perianth not seen (according to persistent perianth under the fruit 3-valved, c. 3 mm long). Fruits 1-3 per infructescence, ellipsoid, top and base rounded, c. 7.0-8.0 × 4.5-5.0 cm, glabrous, drying dark brown, finely to coarsely tubercled, pericarp c. 15 mm thick; stalk c. 3 mm long, at base inarticulate; perianth persisting under the fruit.

Distribution. Borneo (Sabah, Mt. Kinabalu).

BORNEO. Sabah: *Clemens 26971, 30536, 31579; (Mujin) San. 18843.*

Ecology. Primary and secondary forest, ridge forest; on sandstone; 1000-1500 m alt. Flowers November, December, February; fruits in November.

NOTES

1. Fieldnotes. Large tree. Bark grey, fissured; outer bark soft, c. 5 mm thick; inner bark white, soft, c. 5 mm; cambium pale; sapwood white. Exudate from bark stickly. Flowers golden. Ripe fruits orange, aril red.

2. The present species is close to *H. montana* according to the almost similar male flowers, but differs considerably by its stouter habit; stouter twigs, larger leaves, larger male inflorescences, and very much larger fruits with a thick pericarp; in *H. montana* the fruits only measure 20-27 mm in length, and the perianth on these do not persist.

3. The pedicels are generally inarticulate at the base; however, some of the flowers of *San. 18843* seem to have an articulation which may be an artifact caused by drying the specimen.

4. Sinclair identified the specimens of the present new species as *H. valida,* which was in his interpretation very variable and heterogenous, but which is presently regarded as a species confined to Sumatra.

89. Horsfieldia montana Airy Shaw. Fig. 1C(89)

Horsfieldia montana Airy Shaw, Kew Bull. 1939, no. 10 (1940) 542 — Type: Sarawak, Dulit Range, *Richards (Native Collector) 2509* (K).

Tree (3-)7-24 m. Twigs terete or faintly angular, towards the apex 1.5-4(-7) mm diam., grey brown to dark brown, early to rather late glabrescent, tomentum short- to long-shaggy, composed of hairs 0.2-1.0 mm long; bark coarsely striate, lenticels small and inconspicuous or absent, older bark with or without a tendency to flake. Leaves in 2 rows, chartaceous to coriaceous, elliptic to elliptic-oblong, broadest at or slightly above the middle, 4-14 × 2-6 cm, base (short-) attenuate, tip rounded to (sub)acute; upper surface glabrous except the midrib which is late glabrescent towards the base, drying olivaceous-brown to blackish, lower surface glabrous except the very base and midrib (late) glabrescent, drying (chocolate-) brown, not much contrasting with upper surface, without larger blackish marks and without conspicuously large yellowish hair scars; midrib raised above; nerves 6-11 pairs, flattish to raised above, submarginal arches usually not distinct; tertiary venation forming a lax network, faint or invisible on both surfaces; petioles 5-16 × 1.5-2.5 mm, rather late glabrescent; leaf bud 5-10 × 1.5-4 mm with hairs 0.2-1.0 mm

long. Inflorescences situated just behind the leaves, either rather sparsely pubescent with hairs 0.2-0.4 mm, or densely shaggy-pubescent with hairs 0.5-1.0 mm long, in ♂: 3 or 4 times ramified, moderately to many-flowered, 4-12(-16) × 3-10 cm, common peduncle 5-20 mm long, the flowers arranged in loose clusters of 3-10 each; ♀-inflorescences few-flowered, 2-6 cm long; bracts ovate to ellipsoid, pubescent, 2.5-6 mm long, caducous; flowers 3- or 4-valved, perianth glabrous, pedicel glabrous, in ♂ inarticulate at base, in ♀ more or less distinctly articulate (always?; see notes). Male perianth globose to subglobose, (1.2-)1.4-2.0 mm diam., top and base rounded, glabrous; pedicel 1-1.5 mm long; perianth at anthesis cleft to c. ⅓ to nearly ½-way, not or only slightly collapsing on drying, valves (0.2-)0.3 mm thick. Androecium globose or depressed globose, above rounded, at base rounded or ± truncate or sagged, (0.5-)0.6-1.1 × 0.8-1.1 mm, in transverse section subcircular; anthers (8-)9-13 (thecae 18-26) almost completely sessile, 0.8-1.2 mm long, ± curved, free apices up to 0.1 mm; column broad, solid except for a shallow apical cavity or slit 0.1-0.2 mm deep; androphore narrow, 0.3-0.5 mm long, completely clasped and hidden by the anthers thus making the androecium look sessile. Female perianth ellipsoid-obovoid, c. 0.2 × 1.8 mm, glabrous, cleft at anthesis to c. ⅓, valves 3, at sutures c. 0.3 mm thick, pedicel c. 1.5 mm long, glabrous, articulate at base (see notes), ovary ellipsoid, c. 1.5 × 1.3 mm, glabrous, stigma minutely 2-lobed, 0.1-0.2 mm high. Fruits 2-9 per infructescence, ellipsoid, base rounded, ± contracted toward the stalk, top rounded to acutish, 2.0-2.7 × 1.3-1.7 cm, glabrous, drying brown, with or without few small lenticel-like tubercles, pericarp 1.5-2.0 mm thick; stalk 2-4 mm long, at base ± articulate; perianth not persisting.

Distribution. Borneo: Sarawak, Brunei, Sabah.

BORNEO. Sarawak (2nd & 5th Div.): *Richards (Native Collector) 2509; S: 32858, 33025, 33057, 33591* — Brunei: *(Ashton) BRUN 1053* — Sabah (mainly Kinabalu & Pinosok Plateau): *Clemens s.n.* (9. II. 1933), *29558, 32642, 32800, 50505, 50513; Native Coll. 821; Poore 12; SAN 28914, 29239, 32283, 36190, 38257, 38294, 38425, 28957, 49301, 76424, 76458, 76803, 76939; Sinclair, Kadim & Kapis 8987.*

Ecology. Crest forest, kerangas forest on ridges, montane forest, moss forest, *Agathis* forest; on black soil or sandy soil; (800-)1300-2000 m alt. Flowers and fruits throughout the year.

NOTES

1. Fieldnotes. Low or medium-sized tree, without buttresses. Bark (slightly) longitudinally, shallowly fissured, or sometimes falky, chocolate, red-brown, dark brown or dark grey; inner bark pale yellowish, reddish, or brownish, with red watery exudate or not; sapwood pale orange or whitish. Flowers yellow; staminal disc orange; fruits yellow or red. Flowers sweet-scented.

2. Variation. All specimens from Sabah were collected on Kinabalu and its vicinity, and they differ rather markedly from those from Sarawak (2nd and 5th Div.) and from Brunei in the nature of the tomentum on the leaf bud, the apical portion of the twigs, and the inflorescences. The tomentum on the specimens from Brunei and Sarawak (including the type) is short, composed of compact dendroid hairs only c. 0.2(-0.5) mm in length; the Kinabalu specimens have the tomentum composed of hairs 0.5-1.0 mm long, sometimes with even longer emerging hairs, and the tomentum of these specimens render the Kinabalu plants much "rougher" in appearance. This character, however, seems incorrelated with any difference in flower structure, and I have refrained from recognizing it as a different variety.

3. Articulation of pedicels. Whether the pedicel at the base is articulated or not has appeared to be a reliable character for many species, and this holds for both the male and female flowers. In the present species the pedicels of male plants are always inarticulate; in the only female flowering specimen seen, *S. 32858* (Sarawak, 5th Div.) the pedicels look distinctly articulate, as is the case in several collections with immature fruit from Sabah. However, I cannot find other grounds to separate these specimens.

4. Sinclair formerly regarded *H. montana* as a variety of the variable *H. polysspherula,* but in his posthumous publication (1975, p. 36, 42) the taxon was submerged in his polymorphous *H. glabra.*

90. Horsfieldia punctata de Wilde, *sp. nov.* Fig. 1D(90)

Folia subtus dense praedita punctis nigrescentibus, ut in *Horsfieldia punctatifolia* Sinclair, differt foliis minoribus eodem tempore coriaceis, 4-12 cm longis, apice obtusis, fructibus angustioribus, c. 2 cm longis, pericarpio in sicco c. 1.5 mm crasso. Perianthia mascula 3-valvata, globosa, c. 1 mm diam., androecio globoso, ad sectionem transversam circulari, antheris c. 11, sessilibus. — Type: Malaya, *Burgess FRI 9014* (L; iso: K).

Tree 10-25 m. Twigs terete, not ridged, towards the apex 2.5-5(-8) mm diam., dark grey-brown, early to rather late glabrescent, tomentum rusty, with hairs 0.1-0.4 mm long; bark coarsely striate, lower down with a tendency to crack longitudinally and to flake; lenticels ± absent. Leaves in 2 rows, coriaceous, elliptic-oblong to oblong, broadest at about the middle, 4.5-12.0 × 2.0-5.0 cm, base (short-)attenuate, top rounded to subacute; upper surface drying olivaceous-brown, lower surface rufous-brown, glabrous, but midrib remaining pubescent for some time, with densely regularly spaced brown-black dots c. 0.1-0.4 mm diam.; midrib flat or only slightly raised above; nerves 5-12 pairs, thin and flat or only slightly raised above, late glabrescent, the marginal arches indistinct; tertiary venation invisible on both surfaces; petioles 6-12 × 1.5-2.5 mm, late glabrescent; leaf bud 7-13 × 2-3.5 mm, pubescence dense grey-brown to rusty, with hairs 0.1-0.4 mm. Inflorescences densely rusty pubescent, with hairs 0.2-0.3 mm, in ♂: c. twice ramified, not many-flowered, 2-3 × 0.5-1.0 cm, common peduncle c. 10 mm long; ♀ inflorescences only once ramified, 2-3 cm long, glabrescent in fruit; bracts elliptic-oblong, 1-3 mm, pubescent, caducous. Flowers 3-valved, in ♂ in small clusters of 3-5 each, the perianth glabrous, pedicels towards the base minutely pubescent with hairs c. 0.1 m or less long, at base inarticulate. Submature male perianths globose, c. 0.8 × 0.8-1.0 mm; pedicels c. 1.0 mm long, slender; perianth cleft (sutures) to c. (⅔-)¾, valves c. 0.2 mm thick. Androecium depressed-globose to globose, c. 0.4-0.5 × 0.5 mm, top and base broadly rounded, transverse section ± circular; anthers c. 11 (c. 22 thecae, see notes), sessile, towards the top incurved and concealing a shallow, narrow, apical cavity 0.2(-0.3) mm deep; androphore narrow, up to 0.1 mm long. Female flowers not seen. Fruits 2-4 per infructescence, ovoid, top rounded to narrowly rounded, base rounded, glabrous, 2.0-2.3 × 1.7-1.9 cm, drying dark brown, finely granulate, not tubercled; dry valves c. 1.5 mm thick; stalk c. 2 mm long; perianth not persisting.

Distribution. Malaya (Cameron Highlands; Fraser's Hill, Genting, Gunung Bunga Bua).

MALAYA: *FRI (Whitmore) 0306, 4539; (Burgess) 9014.*

Ecology. Lower montane forest on granite, ridge forest; at c. 1000 m. alt. Flowers in March, fruits in November.

NOTES

1. Fieldnotes. Bole straight, with good form, no buttresses. Bark deep-brown to mid-brown, grid-cracked with rather chunky scales or finely fissured with ridges firm, or bark thick and corky, finely longitudinally fissured; outer cut of slash bark brown, inner bark bright red, layered, separated by blade line. Slash wood white to fawn, speckled red; exudate red, blood-like. Fruits greenish-yellow, slightly glaucous.

2. The available flowers are clearly immature, and hence the anthers are difficult to count; possibly there are c. 11 thecae and in reality only 5 or 6 anthers.

3. Obviously closely related to *H. glabra* from S. Sumatra and Java, and to *H. montana, H. punctatifolia* and *H. subalpina. Horsfieldia montana* (from Borneo) is very similar in general habit as well as in the architecture of the male flowers and their fruit-shape, but lacks the characteristic blackish punctation of the leaves; *H. punctatifolia,* a species with a wider distribution in Sumatra, Malaya and Borneo differs in its membranous leaves and larger fruits with a very thick-leathery pericarp; *H. subalpina* is also related, but that species lacks the punctation of the leaves, has larger and less coriaceous leaves, and larger fruits. *H. punctatifolia* has glabrous pedicels, in *H. subalpina* the pedicels are finely puberulous in the lower part, similar as in our present species. Generally *H. glabra* has a much shorter tomentum.

4. Specimens of this species had not yet been collected when Sinclair revised the genus.

91. Horsfieldia costulata (Miq.) Warb. Fig. 1D(91)

Myristica costulata Miq., Ann. Mus. Bot. Ludg.,-Bat, 2, 1 (1865) 48 — *Horsfieldia costulata* (Miq.) Warb., Mon. Myrist. (1897) 350 — Type: Celebes, *de Vriese & Teijsmann s.n.* (L).

H. pachythyrsa Warb., Mon. Myrist. (1897) 618: Koorders, Fl. N.O. Celebes in Med. Lands. Pl. Tuin 19 (1898) 570 ("crassithyrsa") — *M. pachythyrsa* (Warb.) Boerl., Handl. Fl. Ned. Ind. 3, 1 (1900) 86; 87 *("Myristica crassithyrsa")* — *H. minahassae auct. non* (Warb.) Koord.: Koord., Fl. N.O. Celebes, etc. (1898) 70, p.p. quoad Koorders 18158 — Syntype: *Koorders 18156β* (♂, L. lecto), *18158β* (L.), *18170β* (♀, L).

H. confertiflora Merr., Ph.J. Sc. C. Bot. 13, 5 (1918) 285 — Type: *Ahern's Coll. F.B. 3183* (PNH, *n.v.;* iso: K, P; BO, NY, *n.v.*).

H. megacarpa Merr., Ph. J. Sc. C. Bot. 13, 5 (1918) 286 — Type: *Ramos B.Sc. 16527* (PNH, *n.v.;* iso: BM, K, L, P; BO, NY, SING, US, *n.v.*).

H. villamilii Elmer ex Merr., En. Phil. Fl. Pl. 2 (1923) 182, *nom. nud.*

H. vulcanica Elmer ex Merr., En. Phil. Fl. Pl. 2 (1923) 182, *nom. nud.*

Tree 9-30 m Twigs terete or subterete, not ridged, towards the apex 2.5-5.0 (-10.0) mm diam., greyish to dark brown, early glabrescent, tomentum grey-brown to light rusty, with hairs 0.1(-0.2) mm, lower down the bark finely to coarsely

striate, not flaking, lenticels small, generally inconspicuous. Leaves in 2 rows, membranous, elliptic-oblong to oblong-lanceolate, broadest at or somewhat above the middle, 15-30 × 5-13 cm, base narrowly rounded to attenuate, top acute-acuminate; upper surface drying olivaceous to dark brown, sometimes with whitish marks as in *H. irya;* lower surface early glabrescent, without regularly scattered larger, brown to blackish dots; midrib above flat or slightly raised, early glabrescent, also towards the base; nerves 14-21 pairs, above thin, flattish to usually raised, marginal arches generally indistinct; tertiary venation forming a lax network indistinct or invisible on both surfaces; petioles 7-14 × 2-4 mm; leaf bud slender, 8-14 × 2-2.5 mm, densely grey-brown to rusty pubescent with hairs 0.1(-0.2) mm. Inflorescences situated behind the leaves, rather densely to sparsely pubescent with hairs 0.1-0.2 mm, in ♂: 3 or 4 times ramified, many-flowered, 6-14 × 5-13 cm, common peduncle 10-30 mm long; ♀ inflorescences 2-6 cm long, shortly branched; bracts broadly triangular to elliptic-oblong, 2-4(-5) mm long, densely short-pubescent, caducous. Flowers 3(or 4)-valved, in ♂ in rather dense clusters of 5-10 each, in ♀ fewer, glabrous, pedicels glabrous, at base inarticulate. Male perianth globose to ± depressed-globose, glabrous, 1.5-1.8 × 1.5-2.0 mm; pedicel rather slender, short, 0.4-0.6(-0.7) mm long; perianth at anthesis cleft to c. ½-way, valves c. 0.2 mm thick. Androecium depressed-globose or broadly ovoid or subglobose, 0.5-0.8 × 0.7-1.1 mm, circular in transverse section, anthers 7-10 (thecae 14-20), completely sessile, free apices up to 0.1 mm, incurved over the rather narrow apical cavity which is c. (0.1-) 0.2 mm deep; androphore rather stout, 0.2-0.4 mm long, completely or partly hidden by the anthers. Female perianth subglobose, 2.3-2.5 mm diam., glabrous, cleft at anthesis to a depth of c. ⅓ to nearly ½-way, valves 0.3(-0.4) mm thick; pedicel 0.5-1.0 mm long; ovary ovoid, glabrous, 1.2-1.5 mm diam., stigma minutely 2-lobed, 0.1-0.2 mm. Fruits 1-3 per infructescence, subglobose to broadly ellipsoid or broadly obovoid, top and base broadly rounded, glabrous, c. 3.5-6 × 3-4 cm, surface finely granulate, drying bright brown to blackish brown, dry valves 8-10 mm thick; stalks 2-4 mm long; perianth not persisting.

Distribution. Philippines, Celebes.

PHILIPPINES (Luzon, Pinay, Leyte, Mindanao, Basilan): *BS 16527, 46059, 48080; Elmer 17045; For. B. 3183, 11885, 18893; Jacobs 7604 (Spirit Coll. 5719); PNH 2685, 10995, 42247; Santos 4246; Vidal 1676, 3563; Wenzel 920.*

CELEBES (Minahasa, North, Central): *van Balgooy 3432, 3572; b.b. 17630, 17967, 28217; Koorders 18156β, 18158β; Meijer 9718; de Vogel 2602, 5523, 5626, 6217; de Vriese & Teijsmann s.n.*

Ecology. Mixed rain forest, primary dipterocarp forest; recorded from alluvial soil and volcanic soil, with *Eucalyptus deglupta* dominant; 250-1200 m alt. Flowers and fruits throughout the year, but flowers mainly July to September.

Vernacular names. Kaya Ra (Ra=blood; C. Celebes), Kajura (C. Celebes).

NOTES

1. Fieldnotes. Tree with or without low buttresses, c. 30 × 10 cm. Bark fissured or with longitudinal grooves, often peeling off. Heartwood reddish. Sap from bark first clear, turning red to brown-red. Flowers yellow. Fruits yellow to red, on the larger branches. Jacobs, referring to no. 7604, with the fruits looking as though mature, had remarked: fruits not yet ripe, but aril orange, apparently dehiscent.

2. H. confertiflora (type from Rizal Prov., Luzon) seems a form with rather chartaceous leaves.

3. At first I had intended to describe *Jacobs 7604,* from the Sierra Madre, Luzon, as a separate variety. Its pickled fruits measure c. 7 × 5 cm, and have the pericarp (in spirit) 14-16 mm thick. When dried, however, these fruits attained the size of c. 6 × 4 cm, with the pericarp c. 10 mm thick, linking up with the only slightly smaller fruits of the other material. Its mature-looking (solid) seeds are ellipsoid, c. 4 cm long.

4. H. costulata, incl. the synonyms *H. confertiflora* and *H. megacarpa,* was reduced by Sinclair to *H. valida, sensu lato.*

92. Horsfieldia subalpina Sinclair Fig. 1D(92)

Horsfieldia subalpina Sinclair, Gard. Bull. Sing. 16 (1958) 410; 28 (1975) 131. — Type: Malaya, *Wray 467* (K; iso: L).

Tree 6-30 m. Twigs terete, not ridged, towards the apex 2.5-5(-12) mm diam., dark grey-brown, early glabrescent, tomentum greyish-brown with hairs c. 0.1 mm long or less; bark finely to coarsely striate, lower down not flaking; lenticels usually conspicuous. Leaves in 2 rows, membranous to chartaceous, elliptic-oblong to oblong, broadest at or somewhat above the middle, 15-27 × 5-10 cm, base attenuate, top acute to acute-acuminate, sometimes ± bluntish; upper surface drying olivaceous brown to dark brown, lower surface glabrous, without regularly scattered larger blackish brown dots; midrib above flat or slightly raised; nerves 9-18(-20) pairs, thin and flat or slightly raised above, marginal arches not distinct; tertiary venation forming a lax network not or slightly visible on both surfaces; petioles 5-15 × 2-3 mm, glabrous; leaf bud slender, 12-20 × 2-3 mm, with dense grey-brown to rusty tomentum of hairs c. 0.1 mm long or less. Inflorescences situated behind the leaves, sparsely (subsp. *kinabaluensis*) to rather densely pubescent with hairs c. 0.1 mm, in ♂: rather stout, c. 3 (or 4) times ramified, many-flowered, 5-14 × 3-10 cm, common peduncle (6-)10-30 mm long; ♀ inflorescences 2 (or 3) times ramified, 2-7.0 × 1.5-4 cm, fewer-flowered than in ♂; bracts ellipsoid to oblong, acutish, densely short-pubescent, 2-5 mm long, caducous. Flowers 3- (or 4-)valved, in the ♂ in loose clusters of 2-5 each, perianth glabrous, pedicels glabrous (subsp. *kinabaluensis*) or thinly pubescent entirely or only in the lower half (subsp. *subalpina*), at base inarticulate. Male perianths broad-ellipsoid or subglobose, 1.6-2.3 mm long; pedicels 1.5-2 mm, slender; perianth at anthesis cleft to c. ½-way, valves 0.2(-0.3) mm thick. Androecium globose or broadly ellipsoid, 1.0-1.5 mm long, transverse section circular; anthers 8-12, almost completely sessile, free apices c. 0.1 mm, curving towards the top and concealing the rather narrow, apical cavity, which is 0.3-0.5 mm deep, the column otherwise solid; androphore narrow, 0.2-0.3 mm long, largely hidden by the anthers; see further under the subspecies. Female perianth ellipsoid, 2.0-2.5 × 1.8-2.1 mm, glabrous (subsp. *kinabaluensis*), cleft at anthesis to a depth of c. (⅓-)½, valves c. 0.2(-0.3) mm thick; ovary subglobose to broadly ellipsoid, 1.2-1.5 mm long, glabrous, stigma minutely 2-lobed, c. 0.1 mm high; pedicel c. 1.5 mm long, at base inarticulate. Fruits 2-6 per infructescence, subglobose to broadly ellipsoid to ellipsoid-oblong, 2.5-5 cm long; perianth not persisting; stalk 3-7 mm long; see further under the subspecies.

Distribution. Two subspecies, one in mountainous Malaya, one in the Kinabalu area in Sabah.

NOTE

When working on the group of species with *H. subalpina* and *H. obscura,* there remained a number of fruiting specimens which I could not assign satisfactorily to any of the known taxa. More information on their affinities can only be obtained from such male flowering specimens which have vegetative characters matching closely those of the fruiting material. Such taxa are probably closely related to *H. subalpina* or *H. obscura.* They are enumerated and discussed from A to H under *H. obscura* (p.44).

KEY TO THE SUBSPECIES

1a. Pedicels of male flowers pubescent, at least in the lower half. Male perianth subglobose; androecium subglobose, anthers 9-12. Fruits subglobose to broadly ellipsoid, 2.5-3 cm long ..... **a.** subsp. **subalpina**

b. Pedicels of male flowers glabrous. Male perianth (broadly) ellipsoid; androecium (broadly) ellipsoid, anthers 8 or 9. Fruits ellipsoid, 3-5 cm long ..... **b.** subsp. **kinabaluensis**

a. subsp. **subalpina** Fig. 1D(92)

Inflorescences rather densely pubescent. Male pedicels, at least in the lower half thinly pubescent with hairs c. 0.1 mm. Male perianth subglobose to broadly ellipsoid, 1.6-2.3 × 1.6-2.2 mm; androecium of similar shape, 1.0-1.5 × 1.0-1.2 mm; anthers 9-12. Female flowers not seen. Fruits subglobose to broadly ellipsoid, 2.5-3.0 × 2.0-2.3 cm, top and base rounded, drying brown-blackish, without or with a few tubercles; dry valves 3-4 mm thick.

Distribution. Malaya (Perak, Pahang, Selangor; Fraser's Hill, Genting Highlands).

MALAYA: *Burkill & Holttum 8679; FRI 3884, 4539, 4565; 10972, 16161, 20485; Purseglove P. 4212; SFN 23646; Md Shah MS 1096; Wray (jr) 467.*

Ecology. Mountain forest, 800-1500 m alt. Flowers April, June; fruits Jan, August to December.

Fieldnotes. Bark smooth or with shallow distant fissures; slash reddish, with red sap; slash wood whitish. Flowers yellow, fruits greenish yellow and glaucous, or yellow; aril orange, seed white. The fruits of *Shah MS 1096* were recorded when fresh as measuring 4.5-5 cm long, dry as 3.3-4 cm long; on the Leiden specimen the dry mature fruits reach only c. 3 cm long.

b. subsp. **kinabaluensis** de Wilde, *subsp. nov.*

Gemma tomento e pilis 0.1 mm longis vel minus composito praedita. Differt a subsp. *subalpina* pedicellis florum masculorum glabris, perianthio masculo atque androecio late ellipsoideis, antheris 8 vel 9, fructibus in sicco ellipsoideis, 3-5 cm longis. — Type: Sabah, *Clemens 33136* (L; iso: BM, K; A, B, BO, M, NY, SING, UC, n.v.)

Inflorescences very sparsely pubescent. Male pedicels glabrous. Male perianth (broadly) ellipsoid, 1.7-2.0 × 1.5-1.8 mm; androecium broadly ellipsoid, 1.1-1.2 ×

0.8-1.0 mm; anthers 8 or 9. Female flowers as described under the species. Fruits ellipsoid to broadly ellipsoid, 3.0-5.1 × 1.7-2.5 cm, top ± narrowly rounded, base rounded, drying bright brown to blackish brown, without tubercles; dry valves 4-5 mm thick.

Distribution. Borneo: Sabah (Mt. Kinabalu and vicinity), one doubtful collection from E. Sarawak, see notes.

BORNEO. E. Sarawak (Kalabit Highland, 4th Div.): *Chai S 35461,* doubtful — Sabah (mainly Mt. Kinabalu and Pinosok Plateau) *Clemens 26863, 28305, 28730, 32204, 33136, 50721; Kokawa & Hotta 5477; M.E.D. Poore 0906; Chew & Corner RSNB 4116, 4209, 4530, 7000; San 26793, 28962, 38081, 49691; SFN (Carr) 27351, 27450.*

Ecology. Mountain forest, montane oak forest; clayish soil; 1400-2000 m alt. Flowers and fruits throughout the year.

NOTES

1. Fieldnotes. No buttresses. Bark slightly fissured, reddish brown; inner bark fibrous, whitish turning brown, or soft, and then yellowish; cambium pale yellow; wood white to yellowish, medium hard, heartwood not differentiated. Flowers bright yellow. Fruits yellow-red.

2. Chai S 35461 from Kalabit Highland, c. 1250 m alt., Baram Dist., 4th Div., Sarawak, with immature fruit, possibly belongs here. It deviates by having narrow leaves and small fruits which are albeit immature. The specimens also might belong to *H. xanthina.*

3. Sinclair determined specimens of the present subspecies as *H. glabra* and *H. valida.*

93. Horsfieldia obscura de Wilde, *sp. nov.* Fig. 1D(93)

Tomentum gemmae e pilis 0.1-0.2 mm longis compositum. Folia subtus non praedita punctis nigrescentibus. Androecium ad sectionem transversam circulare. Affinis *Horsfieldia subalpina* Sinclair, differt in anthesi perianthio masculo usque ad ¾ fisso, atque fructibus in sicco majoribus, 5-5.5 cm longis. — Type: E. Kalimantan, *Kostermans 13773* (L; iso: K, P; BO, A, SING, PNH. NY, *n.v.*).

Tree c. 20 m. Twigs terete, not ridged, towards the apex 2-3(-4) mm diam., dark grey-brown, early glabrescent, tomentum greyish-brown to rusty, with hairs 0.1-0.2 mm long; bark finely striate, lower down not flaking; lenticels moderately large, not much contrasting. Leaves in 2 rows, membranous, elliptic-oblong to oblong, broadest at or slightly above the middle, 10-15 × 4-7 cm, base short-attenuate, top shortly acute-acuminate; upper surface drying dark brown, lower surface pale brown to bright brown, glabrous, without scattered larger blackish dots; midrib above flat to slightly raised; nerves 10-13 pairs, very thin and flat above, marginal arches invisible; tertiary venation forming a lax network, very faint or invisible on both surfaces; petioles 11-15 × 1.5-2.5 mm, glabrous; leaf bud slender, 7-10 × 1.5-2 mm, densely grey-brown to rusty pubescent with hairs c. 0.1-0.2 mm. Inflorescences situated behind the leaves, ± sparsely minutely pubescent with hairs c. 0.1 mm, in ♂: 3(or 4) times ramified, rather many-flowered, 7-10 × 5-8 cm, common peduncle (2-)6-12 mm long; ♀ inflorescences c. 3.5 cm long (very stout, as seen in

the infructescences of *S. 36305,* (see notes); bracts caducous, not seen. Flowers 3-(or 4-) valved, in ♂ in clusters of c. 3-5, perianths glabrous, pedicels glabrous or with some minute hairs towards the base, not or sometimes faintly articulate. Male perianth subglobose, 2.0-2.2 × 2.0-2.3 mm; pedicels (1-)1.5-2 mm long, slender; perianth at anthesis cleft ⅔-¾(-⅘), valves 0.2-0.3 mm thick. Androecium subglobose to depressed globose-ovate, at the top narrowly rounded, base broadly rounded, c. 1.0 × 1.0-1.2 mm, transverse section (sub)circular; anthers c. 8, almost completely sessile, the free apices sometimes ± sterile, up to 0.1(-0.2) mm long, curving over and concealing the narrow, shallow, apical cavity, cavity c. 0.1-0.2 mm deep, the rest of the column solid; androphore narrow, up to 0.2 mm long, hidden by the anthers. Female flowers not seen. Fruits (of *S. 36305,* see note 3) 2 or 3 on a short, stout infructescence c. 3.5 cm long; fruits broadly ellipsoid, 5-5.5 × 3.5-4.0 cm, top and base rounded, glabrous, drying dark brown, with a few, small tubercles, dry valves 7-10 mm thick, perianth not persisting.

Distribution. Borneo: E. Kalimantan, possibly Sarawak, see note 3.

BORNEO. E. Kalimantan: *Kostermans 6044, 13773* — Sarawak (7th Div., Kapit): *S 36305* (doubtful).

Ecology. Ridge forest on limestone, coral limestone, yellow sandy soil in lowland dipterocarp forest; 150-730 m. alt. Flowers (E. Kalimantan) in August & November; fruits (Sarawak) in May.

NOTES

1. Fieldnotes. Trunk irregular. Bark red-brown, rough, 5 mm thick, peeling off irregularly in strips. Living bark 10 mm, red to brown-red; sap red. Wood reddish to brown-red. Flowers yellow to dark yellow, smelling of Peru-balsam. Fruits bright orange, seed (aril) red.

2. The two flowering specimens on which the present species is based, *Kostermans 6044* and *13772,* were identified by Sinclair as *Horsfieldia,* probably *glabra.* and *H. glabra* respectively.

3. The specimen *S. 36305* from Kapit, 7th Div. Sarawak is in fruit and agrees vegetatively with the two flowering specimens from E. Kalimantan. However, it being the only one in fruit, collected rather far from the limestone site in E. Kalimantan, provenance of the two male specimens, I am not completely sure whether the two lots are conspecific.

4. Horsfieldia obscura, with male flowers, keys out beside *H. subalpina,* which is accepted for Borneo as the subspecies *kinabaluensis,* restricted to the montane forest in the Kinabalu area. That differs from our present species by the more elongate male perianth, cleft at anthesis to only nearly ½-way, the short-ellipsoid androecium, the more rigid leaves, and the smaller fruits with the pericarp less thick. The present species appears to be closest to the typical *H. subalpina,* from Malaya, which differs in general habit (larger leaves, more distinct lenticels on twigs, larger inflorescences), male flowers cleft to c. ½-way deep, and by smaller fruits.

5. Some deviating specimens which are in fruit, all from Borneo, will most likely key out beside *H. subalpina* and *H. obscura.*

When I was working on the group of species included by Sinclair in his large concept of *H. glabra* and resembling species, there remained some ten sheets of fruiting material which obviously or likely belong to this alliance, but which cannot be satisfactorily matched with any of the species accepted by me. These specimens are enumerated and discussed below (in 8 groups, A to H), because I presume that if male flowers were available, they would key out on or near *H. obscura* or *H. subalpina.* They are not identical with these species, however, because of some features of general habit (twigs and leaves), and because of the characters of the leaves, fruits, and possibly flowers. As a matter of fact, the listed entities below also differ clearly one from the other. They may represent distinct species, but male flowers are needed to affirm this.

A. *Kostermans 7414, 7461.* Both were collected in July 1952 on the peak of Balikpapan (Besikan Balu), E. Kutei, E. Kalimantan, at 700 and 900 m in a mossy forest on sandstone. Vegetatively they come very close to *H. subalpina,* but they strongly deviate by the enormous fruits measuring c. 7-9 × 4.5-5.5 cm when dry, with the pericarp c. 25 mm thick. The bark on the twigs is rather pale and rather smooth, with only small inconspicuous tuberculate lenticels; the nerves are flat above. They were annotated as trees of 12-15 m, bark light brown to blackish, superficially fissured, living bark brown-red, 5-6 mm, wood white with red streaks, fruits orange-brown, aril yellow to orange. These specimens were in 1959 identified by Sinclair as *H. subalpina* and in 1975 as *H. valida.*

B. *Kostermans 4355.* This was collected in Nov. 1950 in E. Borneo, Balikpapan Bay, Muan region near Sg. Riko, at 20 m. alt. on a low ridge with sandy soil with lime. In 1954, in the herbarium at Leiden Sinclair identified it as *H. subalpina;* in 1975 as *H. valida.* It is annotated as a tree, 28 m, with buttresses 6 m high, c. 50 cm over the ground and 30 cm thick; bark rough, fissured, dark brown, containing red sap. Fruit orange. A rather rare tree. The specimens have large, broad, brittle leaves, with the midrib above being rather broad at the base, and therefore, it was perhaps the late Mr. Hildebrand who wrote the identification as probably *H. brachiata* var. *laticostata,* i.e., the present *H. laticostata.* However, the large fruits of c. 5.5 × 4.0 cm, with thick woody pericarp do not agree. The tomentum of the leaf bud is fairly coarse, with hairs c. 0.2 mm long, somewhat reminiscent of that of *H. valida,* a species presently regarded as restricted to Sumatra.

C. *Ashton BRUN 766* and *Murthy & Ashton S. 23348* are probably identical. The first was collected in Brunei in Nov. 1957 in a forest on alluvial soil at the top of a riverbank at c. 150 m altitude and the second, in Sarawak, 4th Div., March 1965, rather inland on the banks of Sg. Baloi, on clay-sand soil. Both have large fruits, long-ellipsoid, c. 6.5 cm long, blackish brown, with a rather woody pericarp 6-8 mm thick (dried), when fresh orange-red and orange-yellow respectively. The leaves dry bright dark brown, the nerves are rather raised above. The twigs of *BRUN 766* dry rather pale and lenticels are inconspicuous. Both specimens have rather large leaves, those of *S. 23348* measuring up to 34 × 12 cm. They somewhat superficially resemble *H. fragillima.*

D. *Tong and Ilias S 32763* from Sarawak, 5th Division (Ulu Sg. Pandarasan, March 1973), a kerengas forest at c. 800 m on sandy soil, has large broadly ellipsoid to subglobose fruits c. 5.5 × 4.5 cm, with apparent thick pericarp, orange when fresh. The fruit resembles somewhat but is smaller than that of species A, B, and C. Vegetatively the specimen agrees best with A in that the leaves are of about similar

size and texture, and the nerves flattish above, and in the bark of the twigs, relatively pale and lenticels inconspicuous. A, however, has very much larger fruits (see above). In Murut language it is called "Bidarak".

E. *Sinclair (& Kadim & Kapis) 9278* at Leiden is a leafy twig with the female inflorescences in an envelope. The field label states that fruits are large oblong, orange outside, 9 × 6 cm, pink inside, the aril orange, the seed 5.5 × 3 cm. It was collected in June 1957, Ranau Dist., Sabah, altitude unrecorded. Sinclair determined it as *H. punctatifolia* but its leaves are devoid of dots, and it does not belong there. These are of moderate size, up to 16 × 5.5 cm, with nerves on the upper surface flat; the bark on the twigs is rather pale.

F. *S. 28083* (*Ilias Pai'e*). I feel strongly that this represents an undescribed species. It was collected in Sarawak, Serian Dist., 1st. Div., South of Kuching, Sept. 1968, in Bukit Selabor, at c. 800 ft. alt., near a stream below Bukit Selabor; a tree. c. 15 m tall, on yellow clay soil, the fruits reddish-green. This locality is in an area with several other locally endemic *Horsfieldia* species. The L-specimen consists of a twig with several large thinly chartaceous leaves c. 33 × 14 cm, which dried light olivaceous-brown; nerves 16-18 pairs, raised above. The leaf bud is densely pubescent with hairs c. 0.2 mm long, the twig is conspicuously lenticellate and there is a ramified infructescence of c. 8 cm long with two large fruits c. 6.5 × 4.5 cm, drying dark brown, with some coarse tubercles, the dry pericarp is c. 10 mm thick. Possibly the alliance of the specimen is with species like *H. fragillima* or, less likely, with *H. grandis* or *H. reticulata* (which have the leaves pubescent beneath), rather than with the *H. subalpina* and the *H. obscura*-group.

G. *Chew Wee-lek CWL 687* from Sarawak, Kuching Dist., from limestone at c. 500 ft. has mature fruits (July 1963) which are ellipsoid, c. 3 × 2 cm, the pericarp c. 2.5 mm thick, finely pale warted-punctate. The leaves are not punctate-dotted beneath. In habit and in fruit, this specimen resembles *H. subalpina* which is a montane species in Malaya and Borneo and I have accepted the Bornean material as subsp. *kinabaluensis* which has larger fruits and which is restricted to Mt. Kinabalu at 1400-1800 m.

H. *SAN 41826 (Mikil)* from Sabah, Tambunan Dist., 6000 ft, and *S 33061 (Tong & Jugah)* from Sarawak, Lawas, 5th Div., at 4500 ft. are probably conspecific. Both are in fruit and do not agree with any known species or with the specimens A to G. The twigs have small but rather conspicuous lenticels, the tomentum of the leaf bud is composed of hairs c. 0.1 mm long, the leaves are of moderate size, up to c. 17 cm long, ± membranous, with the nerves distinctly raised above; the fruits are ellipsoid, 3.5-4 cm long, with the pericarp drying hard, 3-4 mm thick. The specimens are reminiscent of *H. xanthina,* but the nerves in the latter are not raised above, and of *H. androphora* and *H. montana,* but these have the tomentum of the leaf bud composed of remarkably longer hairs, i.e., c. 0.5 mm long, a character which has proved to be constant and valuable in the taxonomy of *Horsfieldia.* Possibly they belong to an undescribed species close to *H. androphora* or *H. montana.*

94. Horsfieldia xanthina Airy Shaw Fig. 1D(94)

Horsfieldia xanthina Airy Shaw, Kew Bull. 1939, no. 10 (1940) 541 (441) — Type: Mt. Dulit, Sarawak, *Richards 1927* (K; iso: A, SING, *n.v.*).

Tree 10-30 m. Twigs terete or faintly angular at apex, 2.5-6(-16) mm diam.,

drying dark brown, early glabrescent tomentum of hairs c. 0.1 mm, lower down bark coarsely striate and with a tendency to flake, lenticels conspicuous or not. Leaves in 2 rows, coriaceous, elliptic to oblong-lanceolate, broadest at about the middle, 8-35 × 3.5-13 cm, base attenuate to short-rounded, top subacute to acute-acuminate; upper surface drying olivaceous-brown to (dark) brown, usually with rather distinct hair-scars, lower surface drying usually with a reddish-brown tinge, without blackish dots, early glabrescent; midrib above slightly raised, glabrous; nerves 8-20 pairs, above slender, flat or slightly raised, glabrous, the lateral arches very indistinct above; tertiary venation forming a lax network, indistinct or invisible on both surfaces; petioles 7-12 × 2.5-3 mm, early glabrescent; leaf bud 8-13 × 2-3.5 mm, covered by hairs 0.1(-0.2) mm long. Inflorescences behind the leaves, rather densely pubescent by hairs c. 0.1 mm, in ♂: rather short and robust, (2-)4-20 cm long, (2 or) 3 times ramified, not many-flowered, common peduncle 5-8 or 15-20 mm (subsp. *macrophylla*) long, the flowers in loose clusters of 3-5(-8), reflexed or not; ♀ inflorescences (as seen in infructescences with young fruits) 1-1.5 or 5-7 (subsp. *macrophylla*) cm long, few-flowered; bracts not seen, caducous; flowers 3- or 4-valved, perianth glabrous, pedicels glabrescent or with a little tomentum of hairs, c. 0.1 mm towards the base, at base inarticulate. Male perianth broadly ellipsoid to ovoid-subglobose, 2.5-2.8 mm long, top rounded, base shortly rounded and somewhat tapering into the pedicel; pedicel thickish, somewhat tapering or not, straight or ± curved (flowers reflexed), 1-2.5 mm long; perianth at anthesis cleft to c. ½ (-⅔), slightly wrinkled but not collapsing on drying, valves 0.4-0.8(-1.0) mm thick. Androecium somewhat laterally flattened, ± broadly obovoid in outline, 1.0-1.3 mm long; anthers 5-8, erect, 0.9-1.1 mm long, largely sessile with free apices erect, 0.1-0.3 mm; column rather broad, solid, at apex shallowly hollowed (0.1-0.3 mm); androphore ± tapering, rather broad, (0.1-)0.2-0.3 mm long. Female inflorescences and flowers known only in subsp. *macrophylla;* ovary glabrous. Fruits 2-6 per infructescence, when immature (subsp. *xanthina*) ellipsoid-obovoid or broadly ovoid, glabrous; stalk stout, c. 3 mm long; perianth not persisting.

Distribution. Borneo: Sarawak, Sabah; two subspecies, both montane.

KEY TO THE SUBSPECIES

1a. Twigs moderate, towards the apex 2.5-4.5(-8) mm diam. Leaf blades 8-18 × 3.5-7 cm. Male inflorescences 2-5 cm long, the flowers often ± reflexed; anthers 5 or 6. ..... **a.** subsp. **xanthina**

b. Twigs stout, towards apex 3.5-6(-16) mm diam. Leaf blades 22-35 × 7-13 cm. Male inflorescences 10-20 cm, flowers erect, anthers 7 or 8 ..... **b.** subsp. **macrophylla**

a. subsp. **xanthina** Fig. 1D(94)

Tree 10-17 m. Twigs towards apex 2.5-4.5(-8) mm diam., bark with a tendency of flaking. Leaf blades 8-18 × 3.5-7 cm. Male inflorescences (2-)4-5 × 2-3.5 cm, the rhachis at base 2-3 mm diam.; flowers often ± reflexed. Male perianth subglobose or broadly ellipsoid, c. 2.5 × 2.2-2.5 mm, cleft at anthesis to c. ½-⅔; pedicels 2-2.5 mm long. Androecium slightly laterally compressed, 1.0-1.2 × 0.8-1.0 × 0.4-0.5 mm, anhers 5 or 6. Female flowers not seen. Fruits immature, ellipsoid-obvoid, c. 1.4 × 1.2 cm.

Distribution. Sarawak.

BORNEO. Sarawak (Mt. Dulit, Baram Dist.) *Richards 1927; S 19396, 30821, 34876.*

Ecology. Kerangas forest, heath forest, submontane forest; on sandy soils, yellow sandy soil, sandstone, or "on higher flanks of limestone mountain among huge limestone boulders with vegetation and organic layer entwined between boulders"; 800-1150m. Flowers in August, September; young fruits in September.

Vernacular names. Kumpang; Getah merah (Sarawak); Buah itek (Kenyah, Sarawak).

NOTES

1. Fieldnotes. Flowers yellow. Fruit glaucous green or green and shiny.

2. Male flowers known only from the type, and *S 34876.* A third specimen, *S 30821,* bears immature fruits. A fourth, *S 19396* is annotated as having fruits, but I have not seen these in the L-duplicate; this latter specimen slightly deviates by the somewhat longer hairs on the leaf buds, being c. 0.2 mm long rather than c. 0.1 mm or less as in the other specimens.

3. H. xanthina was included in *H. glabra* by Sinclair (l.c. p. 36, 41, 48). I accept it as a separate species, characterized by the flaky bark of the twigs, the coriaceous and often ± reddish-brown tinged leaves, and the coriaceous rather large male flowers with a typical androecium of only 5 or 6 anthers and a rather marked androphore. Possibly the species is confined to Kerangas at rather high altitudes.
I agree with Airy Shaw that the species is close to *H. majuscula,* from Malaya and Sumatra, which differs by the non-flaking bark of twigs, membranous leaves, 7-9 anthers, the pedicel articulate at base, and possibly by larger fruits.

b. subsp. **macrophylla** de Wilde, *subsp. nov.*

Perianthium masculinum crasse coriaceum; androecium quam latum longius. A subspec. xanthina ramulis robustioribus apicem versus 3.5-6(-16) mm diam., foliis maioribus 22-35 cm longis, 7-13 cm latis, antherisque 7 vel 8. — Type: Mt. Kinabalu, *J. & M.S. Clemens 50050* (K; iso BM, L).

Tree 25-30 m. Twigs towards the apex 3.5-6(-16) mm diam.; bark not flaking. Leaf blades 25-35 × 7-13 cm. Male inflorescences 10-20 × 7-11 cm, the rachis at base 3.5-4.5(-5.0) mm diam.; flowers erect. Male perianth broadly ellipsoid, 2.6-2.8 × 2.5-2.7 mm; valves 3, splitting the bud to nearly ½-way; pedicel 1-1.5 mm long. Androecium c. 1.3 × 0.8 mm, subtriquetrous in transverse section; anthers 7 or 8. Female inflorescences 5-8 cm long, once or twice ramified. Female perianth ovoid-ellipsoid, 4.0-4.5 × 3.0-3.5 mm, valves 3, splitting the bud to nearly ½-way, valves c. 0.8(-1.0) mm thick. Pedicel 1.5-2.0 mm, glabrous or with some minute hairs towards the base. Ovary ovoid, c. 2.2 × 2.0 mm, glabrous, stigma broadly 2-lipped, c. 0.3 × 1.0 mm. Fruits immature, broadly ovoid, c. 1 cm long.

Distribution. E. Sarawak, Sabah (Mt. Kinabalu).

BORNEO. Sarawak (East; Baram Dist., Kapit Dist.): *Anderson & Ilias bin Paie S 28523; Chai S 35442* — Sabah (Mt. Kinabalu): *J. & M.S. Clemens 50050.*

Ecology. Mountain forest, ridge forest, at 1100-1300 m; on igneous derived (andesitic) soils. Flowers July and November; young fruits in November.

Vernacular names. Kumpang lusoh, Kumpang parawan (Baram Dist.).

NOTES

1. Fieldnotes. Poorly developed low buttresses, once recorded; bark brown and grey, fissures boat-shaped; exudate light red, watery. Flowers yellow or orange; ovary pale purple. Young fruits green.

2. The type, with male flowers, was determined by Sinclair as *H. valida,* a species presently regarded as restricted to Sumatra; the other specimens of the present new subspecies were not yet collected in Sinclair's time.

3. Fruit of the iso-type, in BM, is annotated as being in the fruit collection; I have not seen them and doubt that they belong to the same species because the mounted specimen is male.

95. Horsfieldia majuscula (King) Warb. Fig. 1D(95)

Myristica majuscula King, Ann. Roy. Bot. Gard. Calc. 3 (1891) 310, pl. 143 — *Horsfieldia majuscula* (King) Warb., Mon. Myrist. (1897) 315; Gamble, Mat. Fl. Mal. Penins. 5, 23 (1912) 215; Ridley, FL. Mal. Pen. 3 (1924) 57 — Lectotype: Malaya, *King's Coll. 5039* (BM, L; see notes).

Horsfieldia bartlettii Merr., New Sumatran Plants IV, Papers Mich. Acad. Sc. Arts & Letters 24, 1 for 1938 (1939) 71 — Type: Sumatra, *Rahmat si Boeea 8772* (A, *n.v.;* iso:L).

Tree 6-25 m. Twigs terete, towards the top 2.5-5(-8) mm diam., grey-brown, early glabrescent, tomentum greyish brown, of hairs c. 0.1(-0.2) mm; bark lower down rather coarsely longitudinally striate, with smallish, sometimes rather inconspicuous, lenticels, older bark not flaking. Leaves in 2 rows, membranous to thinly chartaceous, elliptic-oblong to oblong, broadest usually at the middle, 15-27 × 5.5-9.5 cm, base attenuate, top acute-acuminate; upper surface glabrous, drying dull olivaceous brown, the midrib glabrous, lower surface drying brown, not very conspicuously contrasting in colour of the upper, without blackish larger dots, early glabrescent including midrib; midrib above slender, glabrous, raised; nerves 11-19 pairs, raised above; tertiary venation forming a lax network generally indistinct or invisible on both surfaces; petioles 10-20 × 2-2.5 mm, early glabrescent; leaf bud slender, 10-15 × 2-3 mm, pubescent with grey brown hairs c. 0.1(-0.2) mm. Inflorescences not very densely pubescent with stellate hairs c. 0.1 mm long, in ♂: 2 or 3 times ramified, not very many-flowered, c. 8 × 4-5 cm, common peduncle 10-15 mm, the flowers in clusters of 2-5; ♀-inflorescences 2-5 cm long; rather few-flowered, twice ramified; bracts ovate-oblong, c. 4 × 2 mm, densely pubescent with hairs c. 0.2 mm, caducous; flowers 3-(or 4-)valved, perianth glabrous, pedicel glabrous or sparsely pubescent, immature ones with hairs c. 0.1 mm, at base articulate. Male perianth broadly ellipsoid or obovoid, (2.0-)2.2-3 × (1.8-)2.2-2.5 mm, top rounded, base short-attenuate, pedicel 2-3 mm long, slightly tapering; perianth at anthesis cleft to ⅓ to nearly ½-way, not or slightly collapsing on drying, valves thick, c. 0.3 mm, towards the base to c. 0.8(-1.0; mm thick. Androecium (incl. the 0.2-0.5-mm long androphore) ellipsoid to ellipsoid-oblong, (1.4-) 1.7-2.0 × 0.8-1.0 mm, in transverse section subtriangular to subelliptic; anthers 7-9 (i.e., 14-18 thecae), slightly curved, (1.2) 1.3-1.8 mm long, free at apex for c. ⅓-¼, i.e., c.

(0.2-)0.3-0.5 mm, androphore rather broad, shortly tapering, 0.2-0.5 mm long. Female perianth broadly obovoid, c. 2.5 × 2.5 mm, glabrous, cleft at anthesis to c. ⅓, valves at base c. 0.6-0.8 mm thick, pedicels 2-3 mm long, glabrous, articulated, ovary ellipsoid, 1.8-2.0 × 1.3-1.5 mm, glabrous, stigma 2-lipped, c. 0.3 mm high. Fruits 1-5 per infructescence, ellipsoid, top and base rounded, 4.3-6.5 × 3.0-4.5 cm, glabrous, drying rusty-brown, finely granulate but not or inconspicuously warted or lenticellate, pericarp 4-11 mm thick; stalk 2-7 mm long; perianth not persisting.

Distribution. Malaya (Perak, Pahang, Kelantan), Sumatra (W. & E. Coast, Palembang).

MALAYA: *FRI 2885, 4506, 4767, 5656, 10835, 16511; Kadim & Noor KN. 610; KEP 104863; King's Coll. 5059; Scortechini 837.*

SUMATRA. West Coast: *Beccari 791; Meijer 6776* — East Coast: *Lörzing 15557; Rahmat si Boeea 8772, 9331* — Palembang: *van Steenis 3384.*

Ecology. Dry-land forest and freshwater swamp-forest of lowland and montane areas; rocky stream banks, river valleys; up to 1000 m alt. Flowers and fruits throughout the year.

Vernacular name. Kajoe andorodong (E. Coast Sumatra, Asahan).

NOTES

1. Fieldnotes. Trees without buttresses; bark distantly shallowly fissured or forming shallow, rectangular flakes. Slash wood whitish, red-flecked. Fruits (*Meijer 6776,* W. Sumatra) up to 5 per infructescence, when fresh up to 7 × 6 cm, pericarp c. 1.5 cm thick. Fruits yellow to bright red, aril orange. Flowers yellow.

2. H. majuscula has formerly been mixed up with what is in my present treatment *H. polyspherula* var. *sumatrana* (in Sinclair's as *H. brachiata* var. *sumatrana*) and the present new variety *H. polyspherula* var. *maxima. Horsfieldia polyspherula* var. *sumatrana* differs by the usually coarser hairs on the leaf bud, more contrasting colour of the two surfaces of dry leaves, smaller globose male perianths, an essentially different androecium, and smaller fruits, up to 35 mm long. The var. *maxima,* only known from Borneo, differs by the same characters, but has fruits of similar size as *H. majuscula,* with the pericarp up to c. 15 mm thick.

3. Lectotypification. Sinclair (1975, p. 16-18) placed *H. majuscula* entirely (i.e., including the whole of King's syntype) in the synonymy of his *H. brachiata* var. *sumatrana,* a taxon which in this treatment is accepted in a much more restricted sense as a variety of *H. polyspherula.* However, Sinclair did comment on the heterogeneity of King's syntypes.

King (p. 311) cites 7 syntype-specimens. These certainly belong to more than one species. Although King placed his *Myristica majuscula* in the section *Irya* on the characters of male flowers, and although within this section it is keyed out mainly on characters of the male flowers and the male inflorescences, I have chosen *King's Collector 5059* (in L, iso K), a fruiting specimen, as the lectotype for the following reasons.

My analysis of King's syntypes together with some information from the rest of the protologue is:

King's Coll. 5059: fine fruiting collection, seen in K and L; lectotype; identical with the present circumscription of *H. majuscula.*

King's Coll. 6004: male flowering, seen in BM and L; this is a somewhat aberrant specimen, because of its relatively large flowers, to be treated under *H. polyspherula* var. *sumatrana,* see there.

King's Coll. 7965: in submature fruit, seen in BM, K; this is possibly the present *H. majuscula.*

King's Coll. 10413: submature fruit, seen in K, P. This is possibly *H. polyspherula* var. *sumatrana.*

Wray 2218, 2705: specimens in CAL, SING, not seen; according to Sinclair both collections link up with *H. polyspherula* var. *sumatrana* in the restricted sense.

(?) Hullet (590), from Singapore: fruiting, in herb. K; the fruits are small, identical with my present *H. polyspherula* var. sumatrana.

However, the male plant figured on King's plate 143 apparently belongs to true *H. majuscula* as presently accepted by me, according to the smallish few-flowered male inflorescence, and the longer-than-broad shape of the perianth and androecium. Possibly it is drawn from *Scortechini 837,* a male collection, which was certainly in King's hands, but which is not cited among the syntype specimens of *Horsfieldia majuscula.* Thus, most likely, this collection served for the drawing, whereas King's description of the male flowers (perianth globose with rather depressed androecium) apparently was taken from *King's collector 6004,* a somewhat abberrant specimen presently treated in the notes under *H. polyspherula* var. *sumatrana.*

From the above it will be obvious that the present lectotypification prevents the proposal of a new name, and the name *H. majuscula* is retained.

4. The specimen *van Steenis 3384* (Palembang Province in Sumatra, near Lake Ranau at c. 600 m) has immature male flowers; the perianth is slightly less coriaceous and only c. 0.4 mm thick, the androphore short, only 0.1-0.2 mm, and the pedicels are sparsely pubescent towards the base. I suppose that these slight differences, if compared with the other specimens, can be attributed to the juvenile stage of the flowers.

96. Horsfieldia coriacea de Wilde, *sp. nov.* Fig. 1D(96)

Habitu atque fructibus *Horsfieldiae costulatae* (Miq.) Warb. similis, differt floribus masculis perianthio crasse coriaceo, androecio elongato, antheris 5 vel 6. — Type: *b.b. Cel. III-27* (L).

Tree 8-25 m. Twigs terete, towards the apex 2.5-4(-10) mm diam., dark grey-brown, early glabrescent, tomentum greyish brown, of hairs c. 0.1 mm; bark lower down finely striate, older bark not flaking, lenticels conspicuous or not. Leaves in 2

rows, membranous to thinly chartaceous, elliptic-oblong to oblong, broadest at or slightly above the middle, 14-27 × 5-10 cm, base attenuate, top acute-acuminate; upper surface glabrous, drying olivaceous brown to blackish brown, the midrib glabrous but towards the base in younger leaves finely pubescent, lower surface glabrous, without larger, brown or blackish dots; midrib moderately raised above; nerves 13-18 pairs, raised above, marginal arches not distinct; tertiary venation forming a lax network little or not visible on both surfaces; petioles 12-16 × 2.5-3.5 mm, early glabrescent; leaf bud slender, 12-17 × 2-3 mm, densely grey-brown to rusty pubescent with hairs c. 0.1 mm long. Inflorescences situated behind the leaves, rather sparsely pubescent with hairs c. 0.1 mm; in ♂: 2 or 3 times ramified, not many-flowered, 4-10 × 3-5 cm, common peduncle 10-20 mm long, the flowers in loose clusters of 3-5; ♀-inflorescences (according to infructescences) c. 2-5 cm long; bracts not seen, caducous. Flowers 3- or 4-valved, perianth glabrous, pedicel glabrous, at base inarticulate. Male perianth subglobose to broadly ovoid, 2.0-2.5 × 2.0-2.3 mm, top shortly rounded to subacute, base rounded; pedicel 1.5-2.0 mm long; perianth at anthesis cleft to c. ½-⅔, not or only slightly collapsing on drying, valves 0.4-0.5 mm thick, coriaceous. Androecium subellipsoid, c. 1.5-1.6 × 0.8-0.9 mm, in transverse section ± blunt-triangular; anthers 5 or 6, at the base curved, and towards the top erect or somewhat curved, c. 1.6 mm long, largely sessile, free apices 0.1-0.2(-0.3) mm, apical cavity narrow, 0.2-0.3(-0.5) mm deep, androphore narrow, 0.1-0.2 mm long, hidden by the anthers. Female flowers not seen. Fruits 1-5 per infructescence, ellipsoid, top and base rounded, 4.0-4.2 × 2.5-3.2 cm, glabrous, drying rust-brown, finely granulate and without or with a few tubercles or lenticels, pericarp rather coriaceous, 3.5-8 mm thick; stalk 2-4 mm long; perianth not persisting.

Distribution. Endemic in C. Celebes.

CELEBES. Central: *van Balgooy 3881, 4000;* b.b. *Cel/II-153, Cel./II-313, Cel./III-27; Johanson, Nybom, Riebe 133; Meijer 11248; 11278.*

Ecology. Primary and disturbed forest (with *Imperata, Gleichenia, Melastoma* and scattered *Castanopsis*) on ultrabasic soil; 100-700 m alt.. Flowers in March and November, fruits in April and July.

Vernacular name. Peroso laki (C. Celebes)

NOTES

1. Fieldnotes. Bark and leaves with aromatic scent. Branches horizontal. Cauliflorous; flowers yellow with strong scent. Perianth fleshy. Ripe fruits orange.

2. Around the insertion of the androecium in most flowers there are a few minute wart-like appendages *or* 'disc-lobes', c. 0.1 mm high.

3. Vegetatively or in fruit, the present species very much resembles *H. costulata,* which has a much larger distribution in Celebes and the Philippines. However, the latter differs generally by the thinner membranous leaves, with the upper midrib including the base glabrous, by the lateral nerves usually forming a greater angle with the midrib, less conspicuous lenticels on the twigs, leaves drying generally more olivaceous; also, the fruits are generally larger with a thicker pericarp,

8-10(-15) mm thick. Furthermore, the male flowers are quite different, in *H. costulata* arranged in rather dense clusters of 5-10 together.

4. As can be seen from the general key, the present species seems closely related to *H. xanthina* (Borneo) and *H. majuscula* (Sumatra, Malaya), both species having also a leathery perianth and an elongate androecium, the last-named species also having similar fruits. In both *H. xanthina* and *H. majuscula,* however, the androphore is broader and tapered and unhidden by the anthers; in *H. majuscula* the pedicels are articulate at the base.

5. Sinclair included specimens of the present new species in the broad concept of *H. valida.*

97. Horsfieldia penangiana Sinclair Fig. 1D(97)

Horsfieldia penangiana Sinclair, Gard. Bull. Sing. 16 (1958) 408, fig. 42; 28 (1975) 94 — Type: Penang, *Curtis 2406* (SING, *n.v.;* iso: BM, K).

Myristica griffithii auct. non. Hook. f.: King, Ann. Roy. Bot. Gard. Calc. 3 (1891) 31, p.p., quoad *Curtis 2406, 2458 — Gymnacranthera farquhariana* var. *griffithii auct. non* (Hook. f.) Warb.: Gamble, Mat. Fl. Mal. Penins. 5, 23 (1912) 226, p.p.

Tree 4-25m. Twigs terete, in the apical portion 1.5-2.0(-4.0) mm diam., grey-brown to brown, early glabrescent, tomentum grey-brown, composed of hairs up to c. 0.1 mm long, twigs lower down with the bark finely striate, not flaking, lenticels small, conspicuous or not. Leaves in 2 rows, membranous to thinly coriaceous, elliptic-oblong to oblong, broadest at about middle, 5-12 × 2-4 cm, base attenuate, top acute-acuminate or rounded (*S 23689,* see notes); upper surface drying olivaceous brown to blackish brown, lower surface early glabrescent, provided with regularly scattered dark brown to (rarely) pale brown dots (lens, × 30); midrib above flattish to raised; nerves 8-11 pairs, above thin, flat, inconspicuous or invisible, marginal arches indistinct or invisible; tertiary venation forming a lax network indistinct or invisible; petioles 8-13 × 1-2 mm, early glabrescent; leaf bud slender, 6-9 × 1-1.5 mm, densely greyish-brown pubescent with hairs up to c. 0.1 mm. Inflorescences with rather sparse tomentum, hairs c. 0.1 mm, in ♂: 3 or 4 times ramified, moderately- to many- flowered, 2-7 × 1.5-4.5 cm, common peduncle 2-20 mm long; bracts ovate-oblong, short-pubescent, 1.5-2.5 mm long, caducous; ♀ inflorescences: 2-5 cm long as judged from the infructescences. Flowers 2-, 3- or 4-valved (see notes), in ♂; in loose clusters of 2-5 together, glabrous, pedicel glabrous, at base ± articulate or not (see notes). Male perianth rather variable in shape (see notes), subglobose to ellipsoid, ± circular to faintly triangular in transverse section, 1.2-1.8 × 1.0-1.5 mm, top rounded, base rounded; pedicel c. 0.8-1.5(-2.0) mm, slender, not tapering; perianth at anthesis cleft to c. ⅓ to nearly ½-way, valves c. 0.2 mm thick. Androecium variable, either broadly ellipsoid or globose or depressed-globose (see notes), c. 0.6-0.7 × 1.0 mm, or perianth ellipsoid, 0.7-1.5 × 0.6-1.2 mm, in transverse section (sub)circular; anthers 5-9(-10), almost completely sessile, free apices (0-)0.1-0.2(-0.3) mm, erect or slightly incurved, column broad with narrow shallow hollow at apex, androphore up to 0.1 mm long. Female perianth not seen. Fruits 2-6 per infructescence, ovoid-ellipsoid, 1.1-2.0 × 0.9-1.5 cm, top (narrowly) rounded, based rounded, glabrous, without lenticel-like tubercles, drying brown with finely wrinkled or granulate structure; dry valves c. 1.5 mm thick; stalks 3-4 mm long, at base articulate; perianth not persisting.

Distribution. Malaya, Sumatra, Borneo (Sarawak, E. Kalimantan).

MALAYA. Penang Isl: *Curtis 2406* (from 2 localities, see notes) — Pahang: *Kadim & Noor KN 558; Shab & Noor MS 1984* — Selangor: *Whitmore FRI 0948.*

SUMATRA. Tapanuli: *b.b. 26117* — West: Mt. Sago, *Maradjo 435* — Jambi Prov.: *Roos & Franken 1471.*

BORNEO. Sarawak (3rd Div.): *S 23689* — E. Kalimantan (W. Kutai): *b.b. 16872, 16878.*

Ecology. Primary dryland rainforest, ridge-top forest, mountainous forest; 0-1300 m alt. Flowers in June, fruits in August.

NOTES

1. Fieldnotes. The apparently mature fruits of *S. 23689* (Sarawak) have been recorded as dark green, near mature male flower buds as green.

2. Variation. Rather much variation is shown among the few specimens presently considered under *H. penangiana,* especially in leaf shape and texture, and in the shape of the male perianth and the androecium. The leaves of specimens from Malaya and Sumatra have the tip acute-acuminate, as normally in *Horsfieldia;* the leaf tip of the specimens from Borneo (*S. 23689,* and *b.b. 16872, 16878*) are blunt or broadly rounded. The leaves of *Maradjo 453,* from Mt. Sago, West Sumatra, at c. 1000 m, are conspicuously coriaceous.

The flowers, including those of the Penang-specimens, are generally 3-(or 4-) valved. Sinclair quotes from Penang Isl. two specimens, *viz. Curtis 2458* (not seen) and *2406,* the type; of *Curtis 2406* I have not seen the holotype in SING, but I have examined two isotypes, in BM and K. Both these apparently belong to the same species, but according to the labels, and from the details of the flowers when dissected, they rather differ. The BM collection of Curtis *2406* is annotated as from between the Coolie Lines and Experimental Nursery: the male perianths in bud are rather ellipsoid, c. 1.8 × 1.5 mm, the androecium is depressed ellipsoid, c. 1.2-1.5 × 1.2 mm, and bears c. 7(-10) anthers. The K collection of *Curtis 2406* consists of two specimens, one from between the Coolie Lines and the Experimental Station, the other from Government Hill; the latter has the male perianths globose, c. 1.4 mm diam., with the mature androecium depressed globose, c. 0.6-0.7 × 1.0 mm, bearing c. 9 anthers.

The flowers of *Roos & Franken 1471* from Djambi, Sumatra, deviate from the type and West-Malesian *Horsfieldias,* by being all 2-valved. All flowers are rather immature, but apart from the remarkable deviation, the specimen obviously belongs to present species; there are only 5 or 6 anthers.

Pedicels are usually inarticulate at the base, but among the male flowers in one inflorescence quite often some more or less (not completely) articulate pedicels can be found.

3. Fruits are only known from one collection from Borneo, *S 23689,* a specimen which deviates by its blunt leaves; its fruit-stalks are distinctly articulate at the base. The pedicels of the male flowers in all specimens are either inarticulate or only partly articulate at the base.

4. Horsfieldia penangiana is recognized by its slender twigs with smallish punctate leaves, the very short tomentum of leaf buds and inflorescences, the usually ellipsoid male perianth, and ellipsoid androecium which is (sub)circular in transverse section. In general habit it resembles *Gymnacranthera eugeniifolia.* Sterile specimens may also recall *H. ridleyana.* Taxonomically it is close to *Horsfieldia glabra,* especially the var. *javanica;* see there.

5. Sinclair regarded the species as endemic to Penang Isl.

98. Horsfieldia punctatifolia Sinclair Fig. 1D(98)

Horsfieldia punctatifolia Sinclair, Gard. Bull. Sing. 16 (1958) 413, f. 44, pl. XIB: 28 (1975) 105 — Type: Singapore, fruits, *Sinclair SFN 40211* (= *Sinclair 7987*) (SING, *n.v.;* iso: K, L, P; BK, BO, DD, E, *n.v.*).

Tree 7-30 m. Twigs terete, not ridged, towards the apex 2.5-4(-10) mm diam., dark grey-brown, early glabrescent, tomentum grey-brown, of hairs up to c. 0.1 mm long; bark finely to ± coarsely striate, lower down not flaking; lenticles present but generally inconspicuous. Leaves in 2 rows, membranous, elliptic-oblong to oblong, broadest at about or slightly above the middle, 9-21 × 3.9 cm, base attenuate, top acute-acuminate; upper surface drying dull olivaceous to dark brown, lower surface glabrous, with scattered larger brown to blackish dots c. 0.05 mm diam.; midrib above flat or slightly raised; nerves 11-16 pairs, thin and flat above, marginal arches not distinctt; tertiary venation forming a lax network, not or hardly visible on both surfaces; petioles 10-17 × 1.5-3 mm, glabrous; leaf bud slender, 8-12 × 1.5-2.0 mm, with dense grey-brown tomentum, of hairs up to 0.1 mm long. Inflorescences sparsely pubescent with hairs up to 0.1 mm or glabrescent, in ♂; c. 3 times ramified, rather many-flowered, 4-10 × 2-8 cm, common peduncle 5-20 mm long; ♀ inflorescences c. 2 times ramified, 3-6 × 1.5-4 cm, fewer-flowered than in ♂: bracts ± oblong, c. 2-4 mm, short-pubescent, caducous. Flowers 3- or 4-valved, in ♂ in loose clusters of 2-5, glabrous, pedicels glabrous, at base inarticulate. Male perianths depressed-globose, 1.4-2.0 × 1.6-2.2 mm; pedicels 1.0-2.0(-2.5) mm, slender; perianth at anthesis cleft to ¾-⅘, valves 0.2-0.3 mm thick. Androecium depressed globose to depressed broadly ovoid, 0.6-0.7 × 1.0-1.5 mm, top broadly rounded, transverse section nearly circular; anthers 7-9 (14-18 thecae), completely sessile (free apices up to 0.1 mm), the apices of anthers concealing an apical, usually small, narrow, hollow up to 0.2 mm deep, in Sumatran specimens larger, up to c. 0.4 mm deep; androphore narrow, 0.1-0.2 mm long. Female perianth ellipsoid, 2.8-3.5 × 2.5-3.0 mm, glabrous, cleft at anthesis to c. ½-way, valves 0.3-0.5 mm thick; ovary broadly ovoid, 1.5-2.0 × 1.3-2.0 mm, glabrous, stigma ± irregularly 2-lipped, 0.2-0.3 mm high; pedicel 1-2 mm long. Fruits 1-3 per infructescence, ellipsoid to broadly ellipsoid, top and base rounded, glabrous, (4.5-)5.0-8.0 × (3.0-)3.5-4.5 cm, drying blackish brown, without or with a few small warts; dry valves 10-20 mm thick; stalks 4-6 mm long; perianth not persisting.

Distribution. Malaya, Singapore, Sumatra (North, E. Coast), Borneo (Sarawak, Sabah, C. & E. Kalimantan).

MALAYA (Perak, Selangor, Negri Sembilan, Malacca): *FRI 3345, 21674; KEP 76145; King's Coll. 4078; Maingay 1286; Sinclair SFN 40082.*

SINGAPORE. *Maxwell 80-157; Murton 76; Sinclair s.n., 7987, 9365, SFN 40211.*

SUMATRA. East Coast: *Bartlett 6990, 6991, 7300* — Tapanuli: *b.b. 5656* — Riouw: *b.b. 23216.*

BORNEO. Sarawak (4th, 7th Div.): *Jacob 6534; S 15917, 22673, 36580, 39341* — Brunei: *(Ashton) BRUN 317* — Sabah: *San. 26176, 26276, 30849, 32259, 32278, 66655, 72214, 88407; Sinclair (& Kadim) 9278.* — C. Kalimantan: *Mogea & de Wilde 4384; Veldkamp 8492* — E. Kalimantan: *(Kostermans) b.b. 35017; Kostermans 6713, 7414, 7461, 13623.*

Ecology. Primary forest incl. hill side forest, ridge top forest, pole forest, marshy forest, also kerangas forest; on a variety of soil types incl. grey soil, brown soil, sandy clay, tertiary sandstone, dacite hill; 0-1100 m alt. Flowers and fruits throughout the year.

NOTES.

1. Fieldnotes. Bark smooth but shallowly fissured to cracked, or brittle-scaly; inner bark pinkish to red, with reddish watery exudate; cambium white; slash wood white, yellowish, or pinkish; heartwood dark brown. Recorded as without or with low-rounded *or* steep thick buttresses. Perianths yellow to bright yellow, with a turpentine odour. Fruits yellow to red, apricot, orange or orange-brown flushed pink; pericarp pink inside; aril red.

2. The phyllotaxis in *S 15917* seems ± tristichous in the fruit-bearing twig-portion; in the leafy twig and in all other material seen the phyllotaxis is 2-stichous.

3. Sinclair records the fresh fruits (in *SFN 40211*, the type) as measuring c. 9 × 6 cm, pointed at both ends; fresh fruits collected in central Kalimantan (Mogea, Veldkamp) measured about the same size, with pericarp 20-25 thick.

4 .Sinclair regarded *H. punctatifolia* as characterized by the unique dark brown punctation of the leaves, not mentioning that several related species, including the variable *H. glabra*, have similar punctate leaves. Our present species is particularly distinguished by its deeply cleft male perianths, rather few anthers, and the large fruits with a thick pericarp.

99. Horsfieldia macrothyrsa (Miq.) Warb. Fig. 1D(99)

Myristica macrothyrsa Miq., Pl. Jungh. 1 (1852) 172; A DC., Prod. 14, 1 (1856) 203; Miq., Fl. Ind. Bat. 1(2), 1 (1858) 66; Suppl. 1 (1860) 156 — *Horsfieldia macrothyrsa* (Miq.) Warb., Mon. Myrist. (1897) 307; Heyne, Nutt. Pl. 1 (1927) 637 — Type: Sumatra, Tapanuli, Junghuhn (559) (U; iso: BM, K, L).

Tree 4-15 m. Twigs terete, not ridged, towards apex (2-)2.5-6(-8) mm diam., brown to blackish brown, early glabrescent, tomentum grey-brown to dull brown, of hairs c. 0.1 mm long, bark lower down finely striate, not flaking, lenticels usually distinct. Leaves in 2 rows, membranous, elliptic-oblong to oblong, broadest at or slightly above the middle, 12-28 × 4-12 cm, base attenuate, top acute-acuminate; upper surface drying olivaceous to dull brown; lower surface early glabrescent, with regularly spaced, pale brown to blackish, larger dots (no dashes) (lens × 30); midrib above flat or slightly raised; nerves 9-17 pairs, above thin, flat on ± raised (*Lörzing 1703*, see notes), marginal arches not distinct; tertiary venation forming a lax network, indistinct or invisible on both surfaces; petioles 12-20 × 2-4 mm, glabrous; leaf bud densely grey-brown to dull brown pubescent by hairs c. 0.1 mm, slender, 10-15 × 1.5-3 mm. Inflorescences rather sparsely pubescent by hairs c. 0.1 mm or less, in ♂: c. 3 times ramified, rather few-flowered, 7-20 × 5-12 cm,

common peduncle 5-45 mm long; ♀ inflorescences (according to the infructescences): c. 2 times ramified, 3-6 cm long; bracts elliptic-oblong, 2-4 mm long, short-pubescent, caducous. Flowers 3 (or 4)-valved, in ♂ in loose clusters of 2-4, in ♀ 1-3 together, glabrous; pedicels glabrous, at base not or but faintly articulated. Male perianth globose to (depressed-)broadly obovoid, 3-4.3 × 3-4 mm; pedicel 1-2 mm long, usually slender, well marked-off from the perianth; perianth in anthesis cleft to c. ½-way, valves 0.2-0.4 mm thick. Androecium globose, depressed globose or depressed broadly obovoid, 1.8-2.2 × 1.8-2.5 mm, in transverse section circular to bluntly 3- or 4-angled; anthers 15-22, completely sessile, free apices up to 0.1 mm long, towards apex somewhat curved into the apical cavity which is rather broad and 0.4-1.2 mm deep; androphore short and narrow, 0.1-0.4 mm long, hidden by the anthers. Female flowers not seen. Fruits 2-6 per infructescence, glabrous, ovoid-ellipsoid, 2.2-2.5 × 1.6-1.8 cm, top rounded, base (broadly) rounded, with or without a few small, lenticel-like tubercles, drying brown to blackish, dry valves 1.5-3 mm thick; stalk 2-5 mm long; perianth not persisting.

Distribution. Northern and Central Sumatra.

SUMATRA. Northern (incl. Tapanuli): *Junghuhn (559); Lörzing 11703, 17195, 17221; Nasution 67* — Central (Mt. Sago): *Jacobs 4667; Meijer 3474, 3680, 4029, 4572*

Ecology. Lower and mid-mountainous forest, riverine forest; 400-1600 m alt. Flowers and fruits throughout the year.

NOTES

1. Fieldnotes. A small tree, only 4 to 15 m tall. Bark fissured or peeling somewhat; sap dark red-brown. Wood white to yellowish with red veins. Flowers greenish to yellow, aromatic. Fruits 2.5-3.5 cm long when fresh, ellipsoid, greenish to light yellow, valves light yellow inside, aril green (almost mature, as in *Lörzing 11703*), seed pale yellow.

2. The present species is closely related to *H. glabra* which has similar fruits, and flowers of a similar architecture. *H. macrothyrsa*, however, has markedly larger male flowers, and about twice as many anthers as compared with *H. glabra*. Apparently *H. macrothyrsa* also has a different distributional area; *H. glabra* is up to now not found in Central and North Sumatra.

3. Variation. The specimens presently brought together under the name *H. macrothyrsa* rather differ from each other in various aspects. The plants from Mt. Sago (= Mt. Malintang), C. Sumatra, are relatively weaker in general habit; leaves and inflorescences are smaller, the male perianths c. 3-3.5 mm diam. The plants from the Sibolangit Botanic Garden jungle (see note 4) are stout, with the leaves large (to 28 cm long), have large male perianths (c. 4.3 × 4.0 mm), and deviate furthermore by the rather raised nerves on the upper leaf surface (*Lörzing 11703*, and others, see note 4). The type-specimen (from Tapanuli) and a collection from Pematang Siantar (*Lörzing 17195*, ♂ fls.) are rather intermediate in habit, but have smaller male perianths (c. 3-3.5 diam.) as are the collections from Mt. Sago. *Lörzing 17195* deviates by short male pedicels which are only c. 1 mm long.

4. The specimens from the Sibolangit Botanic Garden jungle *(Lörzing 11703, 17221, Nasution 67)* are from specimens collected in 1926 (with fruits) and in 1937 and 1962 (fruits, ♂ flowers), and annotated as growing wild in large numbers. As

remarked under note 3, these specimens differ from the rest of the material and possibly represent a separate taxon.

5. Warburg (l.c. p. 308) describes the perianths of *H. macrothyrsa* as of c. 2 mm diam., although the type, seen by Warburg, clearly has the strikingly large globose perianths of c. 3.5 mm diam.

6. Sinclair included the present species in *H. glabra,* which was accepted by him as a very large and variable species.

100. Horsfieldia glabra (Bl.) Warb. Fig. 1D(100,100 b)

Myristica glabra Bl., Bijdr. 2, 11 (1826) 576; Rumphia 1 (1837) 191, t. 64 fig. 1; Miq., Pl. Jungh. (1852) 172; Fl. Ind. Bat. 1(2), 1 (1858) 65 (excl. *M. integra* Wall.); Ann. Mus. Bot. Lugd.-Bat. 2, 1 (1865) 49 (excl. var. *sumatrana*) — *Pyrrhosa glabra* (Bl.) Hasskarl, Cat. Pl. Hort. Bog. (1844) 174 — *Horsfieldia glabra* (Bl.) Warb., Mon. Myrist. (1897) 313, t. 21 fig. 1-2 (p.p.); Sinclair, Gard. Bull. Sing. 16 (1958) 411 (p.p., for the basionym only); 28 (1975) 35 (p.p.); Backer & Bakh. f., Fl. Java 1 (1963) 138 — Syntype: Java, *Blume* (several sheets, L).

Myristica glabra var. *grandifolia* Miq., Fl. Ind. Bat. 1(2), 1 (1858) 65; Suppl. 1 (1860) 156 — Type: W. Coast Sumatra, *Teijsmann s.n.* (U).

Tree 6-25 m. Twigs terete, towards apex 2-4(-8) mm diam., brown to blackish brown, not ridged, early glabrescent, tomentum from grey-brown to rusty, of hairs up to 0.2 mm long, lower down bark usually finely striate, not flaking, lenticels usually conspicuous, especially towards the apex. Leaves in 2 or 3 rows, membranous to thinly coriaceous (and very brittle when dry), elliptic or obovate to oblong-lanceolate, broadest at or usually above the middle, 8-27 × 3-10.5 cm, base short- to usually long-attenuate or gradually tapering from about the middle to the petiole, top acute to acute-acuminate; upper surface drying olivaceous-brown to dark-brown; lower surface early glabrescent, with regularly scattered brown to blackish-brown or rarely pale brown, larger dots (not dashes) (lens, × 30); midrib above flat; nerves 8-16 pairs, above thin, flat or sunken, or in var. *glabra* sometimes faintly raised especially towards the base, marginal arches not distinct; tertiary venation forming a lax network, indistinct or invisible on both surfaces; petioles 10-15 × 1.5-2.5 mm, glabrous (early glabrescent); leaf bud densely grey-brown to rusty pubescent with hairs 0.1-0.2 mm, slender, 7-12 × 1.5- 2.5 mm, on 3-stichous twigs slightly thicker. Inflorescences densely to sparsely pubescent with hairs up to c. 0.1 mm long, sometimes glabrescent, in ♂: (2 or) 3 (or 4) times ramified, rather many-flowered, 5-10 × 4-7 cm, common peduncle 4-15 mm long; ♀ inflorescences 1 or 2 times ramified, 2-4 × 1-3 cm; bracts elliptic-lanceolate, c. 2-5 mm long, short-pubescent, caducous. Flowers (2-) 3- or 4-valved, in ♂ (2-)3-5 in loose clusters, in ♀ solitary or 2 or 3 together, glabrous; pedicels glabrous, at base either not or more or less distinctly articulate, usually mixed in one inflorescence. Male perianth globose (var. *glabra*) or broadly ellipsoid or obovoid (vars. *javanica* & *oviflora*), 1.5-2.5 mm long (see further under the varieties); pedicel slender (vars. *glabra & javanica*) or thickish (var. *oviflora*,; perianth at anthesis cleft to c. ½-⅔, valves 0.2-0.3 mm thick. Androecium (depressed-)globose (var. *glabra*) or ellipsoid or short-obovoid (vars. *javanica* & *oviflora*), anthers 9-15, almost completely sessile; androphore short and narrow, (0-)0.1-0.2 mm long; see further under the varieties. Female perianth ellipsoid, 2.5-3 × 2.2-2.5 mm, glabrous, cleft at anthesis to c. ⅓ to nearly ½-way, valves 0.4-0.5 mm thick; pedicel 0.5-1.5 mm long; ovary ovoid, 1.5-2 × 1.2-1.5 mm, glabrous, stigma minutely 2-lobed, c. 0.1 mm high (var.

glabra) or if broad-lipped then 0.2(-0.3) mm high (var. *oviflora*). Fruits 2-6 per infructescence, ovoid-ellipsoid, top rounded, base rounded to broadly rounded, glabrous, 1.8-2.4 × 1.4-1.9 cm, drying blackish brown, without lenticel-like tubercles; dry valves 1-2.5 mm thick; stalk 1-2.5 mm long; perianth not persisting.

Distribution. S. Sumatra, Mentawai Isl. north to Simeuluë (Simaloer Isl.), Java; in Java three varieties.

NOTE. In *H. glabra* the lower leaf surface is always coarsely punctate with dark brown non-traumatic cork warts, a character which was regarded by Sinclair as exclusive for the related *H. punctatifolia* and which it resembles vegetatively.

KEY TO THE VARIETIES

1a. Male perianth globose or subglose, 1.7-2.5 mm diam., at anthesis cleft to c. ½-⅔; androecium globose or depressed-globose, circular or faintly 3-angular in transverse section; pedicel ± slender. Leaves membranous to chartaceous, nerves flat or slightly raised above. Fruit 18-24 mm long. Area as the species; 0-600 m. alt. ..... **a.** var. **glabra**

b. Male perianth broadly ellipsoid to broadly obovoid, at anthesis cleft to c. ½-way; androecium ellipsoid to obovoid, blunt-triangular in section 2

2a. Male perianth ellipsoid, c. 1.5 mm long; androecium ellipsoid; pedicel slender. Leaves membranous, nerves flat. Fruit not seen. E. Java ..... **b.** var. **javanica**

b. Male perianth broadly ellipsoid-obovoid, 20-2.5 mm long; androecium broadly ellipsoid-obovoid; pedicel rather short and thickish. Leaves chartaceous to subcoriaceous, nerves flat or sunken above. Fruit 18-20 mm long. W. & C. Java, 500-1500 m alt. ..... **c.** var. **oviflora**

a. var. **glabra** Fig. 1D(100)

Leaves membranous to chartaceous, up to 27 cm long; nerves above flat or slightly raised. Male perianth globose, 1.7-2.5 mm diam., at anthesis cleft to c. ½-⅔; valves 3 or 4, c. 0.2-0.3 mm thick; pedicel relatively slender, well marked-off from the perianth. Androecium globose or depressed-globose, 0.8-1.3(-1.5) × 1.3-1.6 mm, circular or faintly 3-angular in transverse section; anthers 10-15, almost completely sessile, free apices up to 0.1 mm, curved over towards apex and ± into the apical cavity which is rather broad, 0.3-0.5 mm deep; column broad and solid; androphore short, narrow, up to 0.2 mm long. Female flowers: stigma minutely 2-lobed, c. 0.1 mm long. Fruits 1.8-2.4 cm long.

Distribution. As the species.

SUMATRA (Central & South): *Jacobs 8375; Korthals s.n.* — Simaloer (Simeuluë) & Enggano Isl.: *Achmad 205, 1342; Lütjeharms 4259, 4420, 4422.*

JAVA (mainly W. & C.): *Backer 1163; Bakhuizen v.d. Brink 5444, 5516, 6780; b.b. Ja. 2585, 2617; Blume 2206 (a/b), 2160 (B); van Borssum Waalkes 799* (Pulau Panaitan); *Sinclair 10047, 10048; H.L.B. 565; Hochreutiner 2290;* Herb. Legd. Bat./*Houtsoorten Gedeh 243, 362, 378, 644; Junghuhn s.n., 230; Koorders* (ß) *5198, 5200, 5208, 5284, 13145, 14615, 20173, 20242, 22690, 23711, 24292, 25585, 25595, 26937, 30471, 34030; Kostermans 11133, 23017, 23889; Loos s.n.; Teijsmann s.n.* (1867); *Warburg 11007; Wirawan 95.*

Ecology. Primary and secondary forest, also in coastal forest on limestone; 0-800 m alt. Flowers and fruits throughout the year.

Vernacular names. Java: Ki-mokla lentik (Djasilin Sund.); Ki-lalakina, Ki-minjak, Ki-sareni (Gedeh); Kelapa tjioen, Kelapa, tjiung, Kelapa tjún — Sumatra:

Bonauw falah, Soemaralah silai delok (Simaloer Isl.); Prianggoe Epoekha (Enggano Isl.).

NOTES

1. Fieldnotes. Bark smooth to roughish, shallowly longitudinally fissured. Flowers yellow, smelling of Peru-balsam. Fruits glossy greenish-orange, fresh valves to c. 4 mm thick; aril bright orange.

2. Phyllotaxis is 2- or 3-stichous, sometimes mixed in one collection in specimens from Java; all specimens from Sumatra are distichous.

3. The male perianths of the Sumatra specimens are faintly ellipsoid, rather than strictly globose as in Java.

b. var. **javanica** de Wilde, *var. nov.* Fig. 1D(100b).

Gemmae foliorum tomento pilis 0.1-0.2 mm longis composito obtectae. Folia membranacea, subtus punctis nigrescentibus obsita, nervis supra planis. A var. *glabra* perianthio masculino ellipsoideo ca. 1.5 mm longo atque androecio ellipsoideo differt. — Type: Java, *Koorders 5210ß* (L).

Leaves membranous, 9-12 cm long, nerves above flat. Male perianth ellipsoid, c. 1.5 × 1.2-1.3 mm, in anthesis cleft to c. ½-way; valves c. 0.1-0.2 mm thick; pedicel slender. Androecium ellipsoid, above subtruncate, 1.0-1.2 × 0.7-0.8 mm, blunt-triangular in transverse section; anthers 9-15, completely sessile, free apices 0-0.1 mm, at apex not or only slightly incurved; apical cavity small and narrow, c. 0.1-0.2 mm deep; column solid; androphore very short, narrow, up to 0.1 mm long. Female flowers and fruits not seen.

Distribution. Java, possibly only in E. Java; the two known collections are from Java without further locality (*Koorders 5210ß*, the type) and from E. Java (Besoeki, *Koorders 21635),* without notes on altitude or habitat.

NOTES

According to the flowers this variety seems very related to *H. penangiana,* also with dotted leaves and with the perianth of similar size and shape (partly), but with the androecium round in transverse section and with fewer anthers, 5-9(-10); also, in *H. penangiana* the habit of the twigs is more slender, the leaves generally smaller. However, *H. penangiana* as accepted by me is variable (especially in flower shape) and might include the present *H. glabra* var. *javanica* when more material of both taxa becomes available.

The specimens of the present variety were determined by Sinclair as *H. glabra.*

c. var. **oviflora** de Wilde, *var. nov.*

Gemmae foliorum tomento pilis 0.1-0.2 mm longis composito obtectae. Folia subcoriacea, subtus punctis sparsis obsita, nervis supra planis vel immersis. A var. *glabra* perianthio masculino ellipsoideo-obovoideo 2-2.5 mm longo atque androecio ellipsoideo-obovoideo differt — Type: C. Java, *b.b. Ja, 3827* (L).

Leaves chartaceous to subcoriaceous, 8-15 cm long; nerves above flat or sunken. Male perianth broadly obovate-ellipsoid, 2.0-2.5 × 1.7-2.3 mm, in anthesis cleft to

c. ½-way; valves 0.2-0.3 mm thick; pedicel c. 1 mm long thickish. Andoecium ellipsoid-obovoid, top subtruncate, 1.2-1.8 × 0.8-1.0 mm, blunt-triangular in transverse section; anthers 10-15, ± completely sessile, free apices 0.1-0.2 mm, at apex little in-curved; apical cavity narrow to rather broad and deep, reaching to nearly half-way the central column, 0.4-1.0 mm deep; androphore narrow, short, (0-)0.1(--0.2) mm long. Female flowers: stigma broadly 2-lipped, 0.2-0.3 mm high. Fruits rather small, 1.8-2.0 × 1.4-1.6 cm.

Distribution: W. and C. Java.

JAVA, b.b: *Ja. 3837; Koorders 5197β, 5204, 27874β; Kostermans s.n.* (May 1968), *s.n.* (Jan. 1971).

Ecology. Forest at 600-1500 m. Flowers throughout the year, fruits in June.

Vernacular names. Kalak katjoeng, Woeroe timah.

NOTES

1. Fieldnotes. Bark smooth. Flowers yellow, smelling of Peru-balsam.

2. I have the impression that the phyllotaxis of all 6 specimens seen is 3-stichous.

3. Sinclair included specimens of the present variety in *H. glabra* s.l. Possibly the new variety represents a separate species, mainly because of the essentially different shape of perianth and androecium, but because of the rather poor material at hand I have kept it under *H. glabra.*

Excluded

As explained under the description and redefinition of the genus *Horsfieldia* I have excluded the species of the *Horsfieldia macrocoma*-complex as published by Sinclair (1958) for Malaya and as the specimens enumerated by Sinclair (1975) for its whole area. The species of this *H. macrocoma*-complex have been removed into a new genus *Endocomia,* published in *Blumea* (1984). Under the genus *Endocomia* go over 20 names (mostly combinations in *Horsfieldia*) formerly treated in relation to *Horsfieldia.* These names have presently all been included in the Index and are referred to as 'excl.' (excluded). Their identity can be found through the index with the article on *Endocomia* in *Blumea.*

Further excluded are:

Horsfieldia Bl. *ex* A. DC., Prod. 4 (1830) 87, *non* Willd., 1805 = Harmsiopanax Warb. (Aral.).

Horsfieldia aculeata BL. *ex* DC. = *Harmsiopanax aculeatus* (Bl. *ex* DC.) Warb. *ex* Boerl. (Aral.).

Horsfieldia peltata Benth. in Benth. & Hook. f., Gen. Pl. 1 (1862) 937 = *Harmsiopanax aculeatus* (Bl. *ex* DC.) Warb. *ex* Boerl. (Aral.).

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Errata

Horsfieldia Pt	Gdns' Bull. yr; vol.: pg	Corrections
1	1984; 37: 124	In 'Table 1', column 1, transpose the symbol '+' for 1. *H. iryaghedi* to line 2 for *H. kingii.*
2	1985; 38: 87	In '2. Variation and resembling species', *H. salicifolia* is an error for *Myristica salicifolia.*

Bibliography

Armstrong, J.E. & T.K. Wilson, (1978). Floral morphology of *Horsfieldia* (Myristicaceae). *Amer. J. Bot.* 65: 441-449.

———. (1980). Wood anatomy of *Horsfieldia* (Myristicaceae). *IAWA Bulletin* n.s., Vol. 1(3): 121-129.

King, G., (1891). The species of *Myristica* of British India. *Ann. Roy. Bot. Gard. Calc.* III: 275-331, Plates 106-174.

Koster, J. & P. Baas, (1981). Comparative leaf anatomy of the Asiatic Myristicaceae. *Blumea* 27, 1: 115-173.

Sinclair, J., (1958). A revision of the Malayan Myristicaceae. *Gard. Bull. Sing.* 16: 205-472.

———. (1974). The genus *Horsfieldia* (Myristicaceae) in and outside Malesia I: *H. sabulosa* and *H. whitmorei* J. Sinclair spp. nov. *Gard. Bull. Sing.* 27: 133-141.

———. (1975). The genus *Horsfieldia* (Myristicaceae) in and outside Malesia II. *Gard. Bull. Sing.* 28: 1-181.

Warburg, 0., (1897), Monographie der Myristicaceen. *Nova Acta Acad. Leop.-Carol.* 68: 1-680.

Wilde, W.J.J.O. de, (1979). New account of the genus *Knema* (Myristicaceae). *Blumea* 25, 2: 321-478.

———. (1981). Supplementary data on Malesian *Knema* (Myristicaceae), including three new taxa. *Blumea* 27, 1: 223-234.

———. (1983). *Horsfieldia* inside and outside Malesia. *Acta Bot. Neerl.* 32: 117.

———. (1984). *Endocomia,* a new genus of Myristicaceae. *Blumea* 30:173-196.

Index of Names

Names that are new are printed in bold, those accepted by the author are in roman, and synonyms are in italics. Numbers in bold are ordinal numbers of descriptions in this work whereas those in roman are page numbers, and these refer to the Gardens' Bulletin vol. 37(2).

labillardieri Warb. = **6**
laevigata (Bl.) Warb. = **35**
var. laevigata = **35a**
var. **novobritannica** (Sinclair) de Wilde = **35b**
lancifolia de Wilde = **37**
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laticostata (Sinclair) de Wilde = **79**
lemanniana auct. = **81a**
lemanniana (A. DC.) Warb. = **6**
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leptosperma, nom. = excl.
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macrobotrys Merr. = **60**
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var. *macrocoma* = excl.
var. *rufirachis* Sinclair = excl.
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var. **pubescencs** de Wilde = **9d**
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"*kitjil*" Rumph. = **10**
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quinta Rumph = **10**
tertia Rumph. **10**
tingens Rumph. = **10**
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Annotated List of Seed Plants of Singapore (X)*

HSUAN KENG

Department of Botany, National University of Singapore

Index to Families

II. Angiospermae-Dicotyledons (cont'd)

131. CONVOLVULACEAE

Key to the genera

A. Parasitic, leafless, twining plants, yellow or pinkish ..... *Cuscuta*
A. Autotrophic, leafy twining or trailing plants, green
  B. Style(s) absent; stigma solitary, conical, usually 5-10-rayed; corolla-lobes 2-fid; ovary 1-loculate; berry 1-seeded ..... *Erycibe*
  B. Style(s) present
    C. All sepals much enlarged in fruit, deciduous ..... *Porana*
    C. Sepals enlarged in fruit or not, persistent
      D. Pollen grains spiny
        E. Fruit a thin-walled capsule, dehiscent; mostly herbaceous twiners; corolla mostly glabrous outside ..... *Ipomoea*
        E. Fruit indehiscent or leathery; woody twiners; corolla mostly with hairy bands outside ..... *Argyreia*
      D. Pollen grains not spiny
        F. Styles 2, free or united near the base
          G. Styles 2, united below ..... *Bonamia*
          G. Styles 2, free
            H. Each style forked with 2 filiform stigmas; small herbs, not twining *Evolvulus*
            H. Each style with a kidney-shaped lobed stigma, long woody twiners ..... *Neuropeltis*
        F. Style 1, entire or with 2 minute branches
          I. Outer sepals acute or acuminate, much longer and broader than the inner ones ..... *Aniseia*
          I. Outer sepals not both distinctly longer and broader than the inner ones *Merremia*

Aniseia martinicensis (Jacq.) Choisy

Twining herb, the basal parts rooting, to 1.5 m long; leaves narrowly oblong, 3.5-7 cm long; flowers in clusters of 2-3; corolla funnel-shaped, white, 2-3 cm long; capsule ovoid, 4-valved. Collected once at Kampong Ayer, Bajau *(Sinclair 38917)*.

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* Continued from *Gdns' Bull. Sing.* 38: 174, 1985.
The author is indebted to Dr. Richard T. Corlett for going through the manuscript and for his suggestions.

Argyreia ridleyi Prain ex Coststr. (= *Lettsomia ridleyi* Prain)
Woody twiner, densely hairy; leaves elliptic or ovate, 7-16 cm long; flowers funnel-shaped, 3 cm long, white or purplish, 8-10 together in a head-like cyme. In damp forests, Bukit Mandai, Chua Chu Kang, Nee Soon *(Sinclair SF 40369)*.

Bonamia semidigyna (Roxb.) Hall.f.
Twiner, to 15 m long; leaves ovate or heart-shaped, 5-16 cm long; cymes 2-5-flowered; corolla funnel-shaped, 3-4 cm long, white. Collected once at Pulau Merlimau *(Sinclair 5926)*.

Cuscuta australis R. Br. (= *C. hygrophilae* Pears.)
Twining parasitic plant; stems slender, filiform, yellow or reddish, with haustoria; leaves reduced to tiny scales; flowers small, in clusters. In waste ground, formerly found in Paya Lebar and Victoria Street *(Ridley 12124)*, parasitic on *Hygrophila quadrivalvis* Nees (Acanthaceae); now extinct.

Erycibe festiva Prain
Creeper, to 20 m long; leaves oblong, 7-14 cm long; flowers greenish white, 5-lobed, less than 1 cm across, in axillary clusters. In forest, formerly found in Gardens' Jungle *(Ridley 6043)*.

Eryc. griffithii Clarke
Scandent shrub; leaves elliptic to oblong, 7-14 cm long, leathery; flowers white. In hedges and woods, Gardens' Jungle, Bukit Timah Road, Changi *(Goodenough 3846)*.

Eryc. leucoxyloides King ex Prain
Slender climber; leaves lanceolate to ovate, 1.6-5.5 cm long; flowers white, solitary, axillary. In open thickets, Changi, Jurong, Gardens' Jungle, (Bukit Timah, *Ridley 6897*, type).

Eryc. maingayi Clarke
Slender woody climber; leaves oblong or ovate, 6-10 cm long; flowers creamy white. On hedges, and edges of forests, Jurong, Bukit Timah, Tanglin, MacRitchie *(Sinclair SF 40215)*.

Eryc. malaccensis Clarke
Creeper or scandent shrub; leaves elliptic to ovate, 5-16 cm long; flowers white, in axillary cymes. In forests, Chua Chu Kang *(Hullett 845)*, Changi.

Evolvulus alsinoides L.
Creeping or prostrate small herb, hairy; leaves lanceolate, to 2.5 cm long; flowers 1-3 in leaf-axils, light blue to white; capsule round, splitting into 4 1-seeded parts. On sandy shores at Changi (*Ridley s.n.* in 1890).

Ipomoea alba L. (= *I. bona-nox* L.)
Twining herb; leaves ovate-rounded, entire or 3-lobed, 6-20 cm long; corolla trumpet-shaped, 7-15 cm long, greenish white, fragrant, opening at dusk (thus called 'the moon flower'). Native to tropical America, sometimes cultivated.

Ipom. aquatica Forsk. (= *I. reptans* Poir.)
Herb, trailing on moist soil or on mud in shallow ponds; leaves varying from

linear to ovate, 3-15 cm long, the base cordate or sagittate; flowers funnel-shaped, 2.5-5 cm long, pink or pale lilac. Pantropical, young shoots and leaves used as a vegetable. Geylang *(Teruja 2945)*. Vern. Kangkong. 甕菜.

Ipom. batatas (L.) Lamk.
Herb, prostrate and ascending, with large tuberous roots; leaves broadly ovate to orbicular, 4-14 cm long; flowers bell-shaped, 3-4 cm long, white or pale violet. Native to the New World, the edible tubers can be found in the market. Vern. Keledek. 番薯.

Ipom. cairica (L.) Sweet (= *I. pulchella* auct. non Roth.)
Twining herb; leaves ovate or rounded in outline, 3-10 cm long and wide, palmately divided into 5 lanceolate to ovate segments, the basal segments often lobed again; flowers funnel-shaped, white with purplish red tinge, 4-6 cm long. Native to tropical Africa and Asia, cultivated and naturalized in waste places and thickets.

Ipom. digitata L.
Large perennial twiner; stems terete, glabrous; leaves broadly orbicular in outline, 6-14 cm long, palmately deeply divided into 5-7 pointed lobes; flowers funnel-shaped, 5-6 cm long, pale reddish purple. In waste ground and seashores, sometimes cultivated. Ang Mo Kio (*Ridley s.n.* in 1894), Bukit Timah Road, Changi.

Ipom. gracilis R. Br. (= *I. littoralis* Bl.)
Slender prostrate or twining herb; leaves ovate-cordate, variable in size (1-10 cm long); flowers funnel-shaped, 3-4 cm long, pink or purple, inside darker near the base. On sandy beaches and in thickets. Changi, Sungei Morai, Raffles Lighthouse (Pulau Satumu) *(Burkill & Kiah, HMB 467)*. Vern. Tarpak kuda.

Ipom. horsfalliae Hook.
Woody climber; leaves orbicular in outline, 5-20 cm long and wide, deeply palmately lobed almost to the base into 3-5 segments, the mid-segment usually much larger than the lateral ones; flowers salver-shaped, about 4 cm long, red or reddish purple. Native of the West Indies, sometimes cultivated.

Ipom. illustris (Clarke) Prain
Woody twiner; stems glabrous or pubescent; leaves ovate to orbicular, sometimes ovate-oblong, 6-16 cm long; cymes axillary; corolla tubular, reddish purple with a dark centre, rarely white, 10 cm long. Seashore of Tanjong Gul (*Sinclair s.n.* in 1950).

Ipom. pes-caprae (L.) Sweet ssp. **braziliensis** (L.) Ooststr.
Herb, stems long-trailing and rooting at the nodes; leaves varying, ovate, quandrangular to rounded, the apex rounded, truncate or shallowly 2-lobed; flowers funnel-shaped, 3-5 cm long, reddish purple or rarely white. Common on the sandy coast, Jurong (*Ridley s.n.* in 1894), Changi.

Ipom. quamoclit L. (= *Quamoclit pinnata* Bojer)
Twining annual; stems very slender; leaves oblong in outline, 2-10 cm long, deeply pinnately lobed, the lobes linear, in 8-20 pairs; flowers 1-4, axillary; corolla trumpet-shaped, deeply red (rarely white), 2-3 cm long, 5-lobed near the top. Native to tropical America, sometimes cultivated. 鳶蘿.

Ipom. triloba L.
Twining herb, 1-3 m long; leaves broadly ovate to orbicular in outline, 3-8 cm long, often 3-lobed; corolla funnel-shaped, pink or pale red-purple, 1.8-2 cm long. Native of tropical America, found on reclaimed land and waste places.

Ipom. tuba (Schlecht.) G. Don
Glabrous twiner; stems woody; leaves orbicular or ovate, 5-6 cm long, deeply cordate; flowers axillary, 1 or few together; corolla white, salver-shaped, 9-12 cm long. Pulau Samulun, near seashore *(Sinclair 38844)*.

Merremia hederacea (Burm. f.) Hallier (= *M. convolvulacea* Dennst.)
Twining or prostrate herb; stems slender, mostly glabrous; leaves ovate in outline, 2-5 cm long, the base cordate; flowers cymose, bell-shaped, 0.5-1 cm long, yellow. In thickets and open grassland, Jurong, Kranji, Bukit Timah (*Ridley s.n.* in 1894).

Merr. hirta (L.) Merr. (= *M. caespitosa* Hallier)
Twining or prostrate herb; stems slender, mostly hairy; leaves variable in form (linear, oblong to ovate), 3-6 cm long, the base rounded, cordate or hastate; flowers in cymes; corolla funnel-shaped, 1.5-2 cm long, pale yellow or white. In open grassland, Chua Chu Kang *(Ridley 2686)*, Kranji, Tanglin.

Merr. tridentata (L.) Hallier f.
Prostrate herb; stems angular, glabrous; leaves varying from linear to oblong, or spathulate, 4-20 cm long, the apex mostly obtuse or emarginate (a variety, var. *hastata* with acute apex), the base often 2-lobed and the lobes toothed; corolla funnel-shaped, 1-1.2 cm long, yellow or white, with a pink eye. On sandy shores, Changi (*Ridley s.n.* in 1891).

Merr. umbellata (L.) Hallier f.
Twining or prostrate herb; stems slender, soft pubescent or glabrous; leaves ovate or oblong, variable, 4-12 cm long, the base rounded, truncate or lobed; flowers in umbellate cymes; corolla funnel-shaped, 2-3 cm long, white or orange-yellow. In thickets or grasslands, Sepoy Lines *(Ridley 11956)*.

Porana volubilis Berum f.
Large woody twiner; leaves ovate, 3-9 cm long; flowers in large panicles; corolla bell-shaped, deeply 5-lobed, less than 1 cm long, white fragrant. Native to the neighbouring countries (Burma to Indo-China and Indonesia) but not to Malaya and Singapore, occasionally planted in gardens.

132. Hydrophyllaceae

Hydrolea zeylanica (L.) Vahl
Creeping herb with erect branches; leaves lanceolate or oblong, 2-10 cm long; flowers solitary or in panicles; corolla wheel-shaped, 5-7 mm long, blue. According to Ridley, it was formerly found in Geylang, beneath coconut trees in ditches (no specimens available), now extinct.

133. Boraginaceae

Key to the genera

A. Erect shrubs or trees
  B. Shrubs or small trees
    C. Shrubs or small trees; flowers in unbranched spike-like inflorescences, or in branched cymes ..... *Cordia*
    C. Shrubs; flowers solitary or in small cymes, axillary ..... *Carmona (Ehretia)*
  B. Herbs; inflorescences scorpioid, usually not branched ..... *Heliotropium*
A. Scandent shrubs; inflorescence spike-like, 2-3 times branched ..... *Tournefortia*

Carmona retusa (Vahl) Masam. (= *Ehretia buxifolia* Roxb., *E. microphylla* Lam.)
Erect shrub; leaves spirally arranged, leathery, oblong-ovate, 3-5-tipped, coarsely dentate, 1-6 cm long, dark green and hairy above; flowers axillary, solitary or in small cymes; corolla white, 7.5 mm across; drupe light red, globose. Native to Malaya, sometimes cultivated for training as bonsai or miniature plants and naturalized.

Cordia cylindristachys R. & S.
A bushy shrub, 1-1.5 m tall; leaves elliptic or ovate, 5-10 cm long, rough and toothed; flowers small, crowded in terminal spike-like inflorescence; corolla bell-shaped, 4-6 mm long, white. Native to tropical America, introduced to Singapore as a hedge plant at the end of the last century, became very common in 1940s to 60s; gradually disappearing since the introduction of a beetle *(Schematiza cordiae)*.

Cord. dichotoma Forster f. (= *C. obliqua* Willd.)
Tree, 10-15 m tall; Leaves ovate, 5-8 cm long, thin leathery; flowers in branched cymes; corolla white, bell-shaped, 1-1.5 cm long. A native of tropical Asia, formerly planted in kampongs at Ponggol, Changi, Chua Chu Kang *(Ridley 8059)*.

Cord. subcordata Lamk.
Tree, 3-10 m tall; leaves elliptic-ovate or heart-shaped, 7-20 cm long; petiole 2-8 cm long; cymes 3- to many-flowered; corolla orange-red, 2-4 cm long. Once collected at Pulau Busing *(Sinclair 39128)*.

Heliotropium indicum L.
Erect hairy herb, 10-20 cm tall; leaves ovate-cordate, 3-5 cm long; flowers in terminal scorpioid cymes; corolla bell-shaped, pale violet with a yellow eye, very small (2-4 mm long). A weed in waste ground, Kranji (*Ridley s.n.* in 1894).

Tournefortia tetrandra Bl. (= *T. wallichii* DC.)
Scandent herbaceous shrub; leaves fleshy, ovate, 5-8 cm long; flowers in terminal and axillary branched scorpioid cymes; corolla green, tubular, 1 cm long, 4-toothed. In damp shady places, Water Catchment area, Changi (*Ridley s.n.* in 1890), Jurong.

134. SOLANACEAE

Key to the genera

A. Cultivated ornamentals or vegetables, usually not producing fruits under local conditions
  B. Herbs
    C. Corolla funnel-shaped; stamens 5 ..... *Petunia*
    C. Corolla tubular, with spreading lobed limb; stamens 4 ..... *Browallia*
  B. Shrubs
    D Thorny, locally not flowering; leafy branchlets sold as a vegetable ..... *Lycium*
    D. Not thorny; corolla long-tubular, curved near apex ..... *Brunfelsia*
A. Cultivated or native plants, normally producing fruit
  E. Fruit capsular
    F. Flowers solitary, terminal, large (to 25 cm long) capsule spiny ..... *Datura*
    F. Flowers in panicles or corymbose racemes; fruit unarmed ..... *Nicotiana*
  E. Fruit baccate
    G. Anthers forming a cone surrounding the style
      H. Leaves 2-3 times pinnate; anthers with narrow sterile tip, opening by slits *Lycopersicum*
      H. Leaves entire, lobed or pinnatifid; anthers without narrow sterile tip, opening at tip by slit or pore ..... *Solanum*
    G. Anthers free
      I. Herbs or shrubs; corolla wheel-shaped; stamens exposed ..... *Capsicum*
      I. Shrubs; corolla salver-shaped, with stamens hidden within ..... *Cestrum*

Browallia speciosa Hook.

Shrubby, usually less than 1 m tall; leaves ovate, alternate or opposite, 4-5 cm long; flowers axillary, white, blue or violet; corolla salver-shaped, about 2.5 cm long. Native to tropical America, sometimes cultivated.

Brunfelsia americana L.

Shrub, 1-2 m tall; leaves oval or ovate, 8-10 cm long; flowers solitary or several together; corolla salver-shaped, about 5 cm long, opening white and changing to yellowish, fragrant at night (thus called 'Lady of the Night'); the calyx less than ⅕ of the corolla tube. Native to tropical America, sometimes cultivated.

Brunf. calycina Benth.

Like the above species, but the calyx about half as long as the corolla which is whitish or violet in colour. Native to the West Indies, sometimes cultivated.

Capsicum annuum L.

Shrub or shrubby, up to 1 m tall; leaves ovate, 2-10 cm long; flowers white or tinged purple, axillary, solitary or several together; fruits various, including: (1) the long pepper (var. *acuminatum*) (e.g., the chilli), with red fruits 7-15 or more cm long, often pendulous; (2) the bell or sweet pepper (var. *grossum*) with slightly inflated, globose, ovate or oblong, green or red fruits, 7-10 cm long; (3) the cherry pepper (var. *cerasiforme*), with red, yellow or purplish, cherry-shaped fruits, 1-2.5 cm across. Native to tropical America, widely cultivated. 辣椒.

Cestrum nocturnum L.

Shrub, 3-4 m tall, the branches drooping; leaves ovate-lanceolate, 2-6 cm long; flowers slender, 2-2.5 cm long, clustered at the leaf-axils, more fragrant at night than day (thus called 'Night Jasmine'). Native to the West Indies, sometimes cultivated in gardens.

Datura candida (Pers.) Pasq.

Shrub; leaves short-hairy, ovate or oblong, 20-30 cm long with entire margins; flowers pendent, white, to 25 cm long (thus called 'Angel's Trumpet'), with 5

long-pointed lobes; fruit smooth, ovoid. Native to tropical America; flowers, seeds and leaves poisonous; occasionally planted.

Datura metel L.
Glabrous herb, 1-1.5 cm long; leaves smooth, narrowly ovate, 15-20 cm long with wavy margins; flowers erect, pale yellow, white or reddish, single or double, 14-18 cm long; fruit a spiny capsule, globose, 2-2.5 cm across. Native of India, sometimes planted. 曼陀羅.

Lycium chinensis Mill.
Thorny shrub, 1-2 m tall; leaves alternate or sometimes fascicled at the nodes, lanceolate-oblong, 2-7 cm long. Native to E. Asia. Fresh leafy branches are found in local markets and dried red berries can be obtained from Chinese medicine shops. Vern. Chinese box-thorn. 枸杞.

Lycopersicum esculentum Mill.
Weak-stemmed herb, to 1 m tall; leaves 15-35 cm long, divided into 5-9-toothed leaflets; flowers yellow, 3-7 in a cluster; berry ('tomato') varies in shape and dimensions, yellow or red, edible. Native to S. America, often cultivated for the edible fruits. One variety, the cherry tomato, (var. *cerasiforme* Alef), with smaller (1-1.5 cm across) globose, red or yellow fruit, is sometimes grown in pots as an ornamental. The egg-shaped fruit of the 'Tree-tomato' (*Cyphomandra betacea* Sendtn.), another native to S. America, sometimes found in the markets, is also edible and flavoured like the tomato. It can only grow in mountain stations. 番茄.

Nicotiana tabacum L.
Herb, to 2.5 m tall, sticky-hairy; leaves oblong-ovate, acute, hairy on both surfaces; larger blades 30-60 cm long; flowers in panicled racemes; corolla-tube 3.5-6 cm long, widened in upper part, limb 2-3.5 cm across, pale red. The leaves are the source of commercial tobacco. Native to tropical America, the tobacco plant was at one time extensively grown in Mandai, Pulau Tekong and elsewhere. 烟草.

Petunia hybrida Vitmor
Erect or ascending hairy herb; leaves ovate or lanceolate, 1-10 cm long, thick; flowers axillary, solitary; corolla funnel-shaped, 2-5 cm long, varying in colour, sometimes variegated. It is a hybrid between two S. American species, *P. axillaris* B.S. and *P. interifolia* S. & T.

Physalis minima L.
Annual herb, 30-50 cm high, soft hairy; leaves opposite, ovate or heart-shaped, 1-9 cm long; flowers solitary, nodding, bell-shaped, pale yellow with brown spots; berry 1.2 cm across, enclosed in an inflated, reticulate urn-shaped calyx. A weed, found in grassland and waste places, Pulau Ubin *(Ridley 367)*. 小燈籠果.

Solanum ferox L.
Herb, stellate hairy and prickly, to 1 m tall; leaves broadly ovate with a cordate base, 5-30 cm long, shallowly pinnately lobed, prickly on the veins on both sides; corolla white or purple, as long as or shorter than the calyx, divided; berry with stellate hairs. Ridley mentioned that this plant is "said by Malays to have been brought from Java".

Sol. mammosum L.
Shrubby, to 1 m high, pubescent and spiny; leaves ovate, 8-12 cm long, velvety, nerves with spines, flowers in short racemes, densely hairy; corolla blue, 1.2-1.5 cm across; fruit inverted pear-shaped, 6-8 cm high, orange, with about 5 short mamilla-like protrusions from the base. A native to S. America, wild, occasionally planted for its decorative fruits.

Sol. melongena L.
A large stellately hairy herb, sometimes shrubby, to 1 m high, spiny or not; leaves oblong to oval, 10-30 cm long, often lobed; flowers solitary or a few together, opposite the leaves; corolla white or purple, 1-1.5 cm long; berry globose or ovoid, greenish white, purple or black, 10-30 cm long. Native of tropical Asia, cultivated for the edible fruits. Vern. Egg Plant. 茄.

Sol. nigrum L.
Herb, 30-80 cm high; leaves ovate, 1.5-10 cm long, with wavy margins; flowers 2 to many in an extra-axillary cluster; corolla white, 0.5-1 cm across; ripe berry black, about 0.5 cm across. A weed in gardens and waste places, variable; Geylang *(Ridley 8084)*. Vern. Ranti.

Sol. torvum Sw.
Shrubby, to 1.5 m high; stems prickled; leaves ovate, 5-10 cm long, lobed, hairy; flowers in cymes; corolla white, 1-1.2 cm across; ripe berry yellow. A weed in waste ground, Tanglin *(Ridley 12383)*. 水茄.

Sol. tuberosum L.
The potato is a native of tropical America, now widely cultivated in many parts of the world. The starchy underground tubers are imported for food. 馬鈴薯.

Sol. wrightii Benth.
An ornamental tree, 5-10 m tall; twigs smooth or sparsely prickly; leaves ovate, 9-20 cm long, shallowly or deeply lobed, unequal at base; flowers in cymes; corolla blue or purple, 3-5 cm across; ripe berry globose, 3-5 cm across. Native to Peru, sometimes cultivated.

135. SCROPHULARIACEAE

Key to the genera

A. Slender herbs, tiny, parasitic on grass-roots ..... *Striga*
A. Autotrophic herbs, not parasitic
  B. Corolla not or less clearly 2-lipped
    C. Flowers axillary, solitary or in pairs; corolla wheel-shaped, 4-lobed ..... *Scoparia*
    C. Flowers in terminal spikes; corolla cylindric, 5-lobed ..... *Centranthera*
  B. Corolla cylindric or campanulate, distinctly 2-lipped
    D. Calyx-lobes very unequal
      E. Stamens 4, 2 or all with one reduced anther-locule ..... *Adenosma*
      E. Stamens 4, all anther-locules perfect ..... *Bacopa*
    D. Calyx-lobes ± equal
      F. Fertile stamens 2
        G. Calyx 5-lobed, the lobes narrow ..... *Lindernia* (p.p)
        G. Calyx 5-toothed ..... *Microcarpaea*

F. Fertile stamens 4
H. Anther-locules separate ..... *Limnophila*
H. Anther-locules contiguous
I. Corolla with a 2-lobed palate in the throat ..... *Mazus*
I. Corolla without appendages in the throat ..... *Lindernia* (p.p.)

Adenosma indicum (Lour.) Merr. (= *A. capitatum* Benth.)
Aromatic herb, 30-60 cm tall; leaves ovate, 3-5 cm long; flowers in dense terminal heads with many leafy bracts at the base; corolla 6-7 mm long, blue, 2-lipped. In sandy fields by roadsides, Tanglin, Chua Chu Kang, Jurong *(Ridley 1826),* Serangoon.

Aden. inopinatum Prain
Erect herb; stems hairy; leaves ovate, 2.5-4 cm long; flowers solitary, axillary; corolla white or purplish. In grassy spots, Tanglin, Bukit Timah *(Nur 25986).*

Aden. javanicum (Bl.) Koord. (= *A. ovatum* Benth.)
Pubescent low creeping herb, 15-50 cm tall; leaves ovate, 1.5-2 cm long; flowers axillary, sessile; corolla pale blue. On roadsides, Tanglin, Chua Chu Kang, Bukit Timah Road *(Ridley 6894).*

Angelonia salicariaefolia Humb. & Bonpl.
Perennial herb, 60-70 cm tall; leaves in a spiral above, opposite and verticillate below, narrow lanceolate, 4-5 cm long; flowers in narrow terminal clusters; corolla short and swollen, 2-lipped, 1-1.2 cm long, blue. A cultivated ornamental from tropical America.

Bacopa monnieri (L.) Pennel (= *Herpestis monnieri* (L.) Rothm.)
Small glabrous herb, 10-15 cm tall; leaves obovate-spathulate, 1-2 cm long; flowers solitary, axillary; corolla 2-lipped, 1 cm long, white. In wet places. Bukit Timah, Tampinis, Rochore, Serangoon (*Ridley s.n.* in 1891).

Centranthera tranquebarica (Spreng.) Merr. (= *C. humifusa* Wall. ex Benth.)
Erect annual herb, 10-15 cm tall, glabrous; leaves linear, 1-1.5 cm long; flowers axillary; corolla tubular, curved, 5-lobed; stamens 4, in 2 pairs. In grassy banks and roadsides, Bukit Timah Road (*Ridley s.n.* in 1898).

Limnophila laxa Benth.
Small annual herb; stamens about 30 cm long, ascending; leaves opposite, linear or elliptic; flowers axillary, solitary or few in a cluster; corolla 2-lipped, less than 1 cm long. In damp places, Seletar (*Hullett 588,* not seen).

Limn. sessiliflora Bl. (= *Ambullia sessiliflora* Baill. ex Wettst.)
Aquatic slender herb; leaves of two forms, the submerged ones 3-6 in a whorl, finely pinnatisect, the aerial ones opposite, narrowly spathulate, toothed, 2-2.5 cm long; flowers solitary, axillary, on aerial branches; corolla pink, 1-1.2 mm long, 2-lipped; stamens 4, in 2 pairs. Introduced water plant; common in aquaria, native to northern Malaya and S. Asia.

Limn. villosa Bl.
Small aromatic herb, pubescent, 10-15 cm long; leaves lanceolate to elliptic, crenate, 1-1.5 cm long, sessile; flowers solitary, axillary; corolla violet, 5 mm long. In ditches and damp spots, Tanglin, Chua Chu Kang, Bukit Timah (*Goodenough s.n.* in 1891).

Lindernia anagallis (Burm.f.) Penn. (= *Vandellia pedunculata* Benth.)
Annual herb, suberect to prostrate, 30-50 cm tall, rooting at the nodes; leaves shortly petioled or subsessile, varying from linear to broadly ovate; flowers solitary, axillary; corolla 2-lipped, 7-10 mm long, white to purple; stamens 4, in 2 pairs; capsule cylindric, to 1.3 cm long. In grasslands; Geylang (*Ridley s.n.* in 1896).

Lind. antipoda (L.) Alston (= *Bonnaya veronicaefolia* Spreng.)
Slender herb, 10-25 cm tall, tufted, sometimes creeping; leaves ovate, 1.5 cm long; flowers axillary, solitary; corolla 2-lipped, 5-10 mm long, violet or white, with yellow spots. In wet places, Ang Mo Kio, Chua Chu Kang *(Ridley 3948)*.

Lind. ciliata Penn. (= *Bonnaya brachiata* L. & O.)
Slender erect herb, 5-15 cm tall; leaves ablong, 1-2 cm long, deeply serrate, sessile; flowers in elongate racemes; corolla 2-lipped, white, 1 cm long; stamens in 2 pairs, only the upper pair functional. In damp spots by the stream, Tanjong Katong (*Ridley s.n.* in 1906).

Lind. crustacea (L) F.v.M. (= *Vandellia crustacea* Benth.)
Small herb, erect or decumbent and rooting at the nodes; leaves lanceolate or ovate, 1-2 cm long; flowers axillary; corolla 2-lipped, violet with dark purple blotches. In waste ground, often a garden weed; Tanglin, Bukit Timah *(Ridley 2700)*. Vern. Kerak nasi.

Lind. ruellioides Penn. (= *Bonnaya reptans* Spreng.)
Stoloniferous herb, tufted, 1 cm high; leaves oblong-obovate, 1-1.5 cm long, serrate; flowers in racemes; corolla 1.5 cm long, violet-white. In damp grassy spots by streams; Chua Chu Kang *(Ridley 2940)*, Bukit Panjang, Tanglin.

Lind. sessiliflora (Bth.) Wettst. (= *Vandellia sessiliflora* Bth.)
Annual herb, to 10 cm tall; stem creeping and rooting at the nodes; leaves broadly ovate to suborbicular, 1.5-2.5 cm long, subsessile; flowers axillary, solitary or in pairs; corolla white; capsule cylindric, 1.2 cm long. A weed sometimes found in gardens and wasteground.

Lind. viscosa (Hornem.) Merr. (= *Vandellia hirsuta* Bth.)
Small herb, 8-10 cm high, hairy; leaves oblong to ovate, 2-5 cm long, crenate; flowers small, in a lax terminal raceme; corolla 2-lipped, 3-4 mm long, pale lilac. In sandy spots, Tanglin, Botanic Gardens *(Purseglove 4029)*.

Mazus rugosus Lour.
Small creeping herb; Leaves obovate, 1.5-2 cm long, crenate; flowers in a terminal raceme; corolla 2-lipped, 4-5 mm long, pale violet, white with yellow spots in the centre of the lip. A weed on waste ground, Botanic Gardens (*Ridley s.n.* in 1889).

Microcarpaea minima (Koen.) Meer. (= *M. muscosa* R. Br.)
Very slender herb, 3-10 cm tall, tufted; leaves opposite, oblong, 2-3 mm long; flowers solitary, axillary; corolla cylindric, 5-lobed (1 linear oblong, 4 short, acute, all fringed with white hairs); fertile stamens 4. Edge of damp spots or ponds, 'Reservoir' *(Ridley 12513)*.

Russelia equisetiformis Champ. & Schlecht. (= *R. juncea* Zucc.)
Shrubby, 30 cm to 1 m tall; branches 4-angled, green, drooping; leaves often reduced if present, linear-lanceolate or ovate; flowers in a simple terminal panicle, nodding; corolla tubular, 2-2.5 cm long, 5-lobed, bright red, A native of Mexico, planted for its red fire-cracker-like flowers. Vern. Coral Plant.

Scoparia dulcis L.
Herb, 30-60 cm tall; leaves opposite or verticillate, lanceolate, 3-5 cm long, serrate; flowers axillary, solitary or in pairs; corolla pale purple, 4-lobed, with long white hairs in the throat; stamens 4. Native to tropical America, naturalized in wasteland.

Striga asiatica (L.) O. Ktze. (*S. hirsuta* Benth.)
Tiny stiff erect herb, semi-parasitic on grass roots, 8-15 cm high; leaves linear, opposite below and alternate above, 1-1.5 cm long; flowers axillary, solitary; corolla 2-lipped, 1-1.2 cm long, yellow or pink. In grassy places and on roadsides, Kranji, (*Ridley s.n.* in 1894). Vern. Rumput siku-siku.

Torenia polygonoides Benth.
Small creeping herb, 10-30 cm long; leaves ovate 1-1.2 cm long, serrate; flowers axillary; calyx tubular, 3-winged; corolla 2-lipped, upper lip reddish brown, the lower white. Common in grassland and on banks, Tanglin (*Ridley s.n.* in 1980).

136. LENTIBULARIACEAE

Utricularia bifida Linn.
Terrestrial slender herb; stolons few; leaves linear-spathulate, 1-1.5 cm long, on the stolons; flowering stalk 5-15 cm high; flowers yellow, 6-8 mm long. In damp sandy spots and marshes; MacRitchie Reservoir, Chua Chu Kang (*Ridley s.n.* 1894), Bukit Timah.

Utric. caerulea L. (= *U. albina* Ridl.)
Terrestrial slender herb; flowering stems 8-15 cm tall; leaves rosulate, linear-spathulate, to 7 mm long; flowering stalk to 30 cm long; flowers white or pink, subcapitate; corolla 0.4-1 cm long. In grassy sandy spots, Changi *(Ridley 1474)*, MacRitchie Reservoir, Telok Kurau.

Utric. exoleta R. Br.
Floating plant; stolon filiform; leaves slender, capillary, with bladders; traps obliquely ovoid, 1-1.5 mm long; flowering stalks 5-15 cm tall; flowers yellow, 4-8 mm long. In ponds and ditches; Botanic Gardens' lake, Ang Mo Kio (*Ridley s.n.* in 1889).

Utric. punctata Wall. ex A.DC. (= *U. fluitans* Ridl.)
Aquatic; stolons filiform, to 20 cm long; leaves finely dissected, 2-6 cm long; flowering stalks 8-30 cm long; flowers violet or white; corolla 6-10 mm long. In swamps, Changi Road *(Ridley 5642)*.

Utric. uliginosa Vahl (= *U. griffithii* Wight)
Terrestrial slender herb; stolons 30-40 cm long; leaves linear or linear-spathulate, 1.5-2(-4) cm long; flowering stalks to 30 cm long; flowers bright purplish blue;

corolla 3-18 mm long. In wet sandy places or in shallow water; Changi (*Ridley s.n.* in 1889), Bedok, Tampines.

137. Gesneriaceae

Key to the genera

A. Native plants
  B. Creeping epiphytes; fertile stamens 4; fruit linear ..... *Aeschynanthus*
  B. Erect herbs or shrubby; fertile stamens 2
    C. Fruit ovoid, fleshy, indehiscent ..... *Cyrtandra*
    C. Fruit linear, dry, dehiscent ..... *Didymocarpus*
A. Cultivated pot plants
  D. Fertile stamens 2; corolla-tube short ..... *Saintpaulia*
  D. Fertile stamens 4
    E. Herbs with stoloniferous stems; corolla-tube trumpet-shaped ..... *Episcia*
    E. Herbs with very short stems; corolla bell-shaped ..... *Sinningia*

Aeschynanthus parviflora R. Br.
Creeping epiphyte on trees; leaves leathery, lanceolate-ovate, 4-5 cm long; flowers 5 cm long, curved, deep red. In mangroves; Kranji, Sungei Tengah, Tuas (*Goodenough s.n.* in 1890).

Aeschy. purpurascens Hassk.
Slender epiphyte, on trees or branches; leaves fleshy, lanceolate to ovate, 8-10 cm long; flowers light green, tipped purplish brown, 2-3.5 cm long. In forests, Chua Chu Kang (*Ridley s.n.* in 1892).

Aeschy. radicans Jack
Creeping on rocks and epiphytic on tree trunks; leaves ovate, 1.5-3 cm long, hairy; flowers axillary, solitary or in pairs, bright red. In forests, Bukit Timah *(Md Nur 24637)*.

Aeschy. wallichii R. Br.
Shrubby, slender and glabrous; leaves lanceolate or elliptic, 5-7 cm long; flowers axillary, several together, 1.5-2.5 cm long, dark red. In dense forests; Bukit Mandai (*Goodenough s.n.* in 1890), Kranji.

Cyrtandra pendula Bl.
Herb; stems creeping and ascending; leaves alternate, ovate, 10-20 cm long, reddish hairy beneath; cymes axillary; corolla funnel-shaped, creamy white or pale yellow, 3-4 cm long, with purple spots. In forests, Bukit Timah (*Ridley s.n.* in 1890).

Didymocarpus perdita Ridl.
Shrubby, 10 m long; leaves elliptic, peltate, 6-7 cm long, crenulate; peduncles slender, hairy. Endemic to Singapore, only 2 specimens were collected, in ravines, Seletar (*Ridley s.n.* in 1889, type).

Didym. platypus Clarke
Shrubby; stem woody; leaves oblanceolate, 20-30 cm long, sessile, serrate, sparsely hairy; flowers in axillary cymes; flowers white with a yellow mouth, 2-3 cm long. In forests, Bukit Timah *(Hullett 454)*, Seletar.

Episcia fulgida (Lind.) Hook. f.
Perennial herb; stems stoloniferous; leaves opposite, elliptic or ovate, greenish with brown lines and blotches, 5-7 cm long; flowers solitary, axillary, corolla salver-shaped, bright red, lobes 5, rounded. Native to Colombia, cultivated commonly as a pot plant. Another species, *E. cupreata* (Hook.) Hanst., a native of Nicaragua, with hairy reddish green leaves and green veins and red flowers, is also planted.

Saintpaulia ionantha Wendl.
Perennial herb, hairy; leaves succulent, oblong or rounded, 3-4 cm long, long-stalked; flowers 1-6 on a long peduncle; corolla short-tubed, 2-lipped, 2-2.5 cm across, violet or in various other colours. Native to tropical Africa ('African Violet'); many forms, some with double flowers.非洲堇.

Sinningia speciosa (Lodd.) Hiern.
Hairy herb; stems short or creeping underground; leaves oblong or ovate, hairy, 8-15 cm long, long-stalked; flowers bell-shaped, 10-15 cm long, variously coloured (violet, purple, red or white), with 5 round lobes. Native to Brazil, sometimes cultivated as a pot plant, horticulturally known as 'Gloxinia'.大岩桐.

138. Bignoniaceae

Key to the genera

A. Woody climber or twiners
  B. Leaves simple or 2-foliate with a long tendril; flowers reddish violet ..... *Saritaea*
  B. Leaves pinnate, leaflets 3-15; flowers creamy white ..... *Pandorea*
A. Erect shrubs or trees
  C. Leaves simple, in whorls or 3-4 each; flowers bright yellow ..... *Deplanchea*
  C. Leaves compound
    D. Leaves palmately compound, leaflets 1-5; flowers yellow or pinkish ..... *Tabebuia*
    D. Leaves pinnately compound
      E. Leaves once pinnately compound
        F. Shrubs, rarely small trees
          G. Native shrubs (or small trees) by tidal rivers; corolla trumpet-shaped, white ..... *Dolichandrone*
          G. Introduced shrubs, cultivated in gardens
            H. Corolla bell-shaped, bright yellow ..... *Tecoma*
            H. Corolla narrow trumpet-shaped, orange red ..... *Tecomaria*
        F. Tall trees
          I. Capsules long-linear, twisted or curved; corolla pinkish or dull yellow, fringed ..... *Stereospermum*
          I. Capsules oblong, not twisted
            J. Calyx campanulate, 5-lobed; corolla pale yellow ..... *Pajanelia*
            J. Calyx spathe-like; corolla orange-red ..... *Spathodea*
      E. Leaves 2-3 times pinnate
        K. Leaflets large (4-12 cm long) and few; corolla trumpet-shaped, pinkish white, capsule linear ..... *Radermachera*
        K. Leaflets small (0.5-1 cm long) and numerous; corolla bell-shaped, violet, capsule ovate ..... *Jacaranda*

Deplanchea bancana (Scheff.) Steen.
Tree, about 30 m tall; leaves simple, 3-4 in a whorl, obovate to elliptic, 9-30 cm long, glandulate at base; flowers in terminal panicles; corolla tubular, 3-3.5 cm long, bright yellow; stamens 4, in 2 pairs; capsule elliptic, 10-14 cm long. In forest, very rare; Kranji (*Goodenough s.n.* in 1889), Bukit Timah, Seletar.

Dolichandrone spathacea (Linn. f.) K. Schum.
Shrub or tree; leaves pinnate; leaflets 3-11, lanceolate or ovate, 6-20 cm long; flowers 2-10 in terminal raceme, opening in the early morning and closing at noon; corolla white, trumpet-shaped, 16-20 cm long; stamens 4; capsule linear, curved and compressed, 25-60 cm long. Formerly common along tidal rivers, Ponggol, Bajau, Pulau Ubin, P. Tekong, Tanjong Gul *(Burkill HMB 2791)*.

Jacaranda filicifolia (Anders.) D. Don
Small tree; leaves opposite, bipinnate; leaflets numerous, elliptic, oblique, 0.5-1 cm long; flowers in terminal panicle; corolla bell-shaped, violet with white-blotched throat; stamens 4, with a long hairy staminode; fruit ovate, 4-7 cm long. A native of S. America, sometimes planted.

Pajanelia longifolia (Willd.) K. Schum. (= *P. multijuga* DC.)
Tree, little branched, 20-25 m tall; leaves pinnate, 40-120 cm long; leaflets 8-12 pairs, obliquely ovate, 10-12 cm long; flowers in terminal thyrses; corolla pale yellowish, dark purple inside, bell-shaped, 5-7.5 cm long, thick and hairy; capsule flat, obovate, 30-45 cm long. Formerly recorded from the coast of Kranji (?*Cantley s.n.* in 1782), now extinct.

Pandorea pandorana (Andr.) Steen.
Climber; leaves opposite, pinnate; leaflets 3-13, varying from linear to orbicular, 2-8 cm long; flowers in cymes; corolla funnel-shaped, white or creamy, 2.5 cm long. Native to E. Malesia, sometimes cultivated.

Radermachera gigantea (Bl.) Miq. (= *R. lobbii* Miq.)
Shrub or tree, leaves mostly twicely pinnate, 12-35 cm long; leaflets often elliptic, 4-12 cm long; flowers in terminal panicles; corolla trumpet-shaped, 5-6 cm long, white tinted pink, with yellow streaks in the throat; capsule linear, 15-60 cm long. Tanglin, Bukit Timah, Bukit Mandai and Reservoir Jungle.

Saritaea magnifica (Steen.) Dugand (= *Arrabidaea magnifica* Steenis)
Climbing shrub; leaves opposite; lower leaves simple, obovate, 8-12 cm long; higher ones 2-foliate with a long terminal tendril; flowers bell-shaped, 6-8 cm long, reddish violet. Native of Colombia, cultivated or escaped.

Spathodea campanulata Beauv.
Tree; leaves opposite or in whorls of three, pinnate; leaflets 7-17, ovate-oblong, 4-12 cm long; flowers in terminal racemes; calyx closed in bud, spathe-like in flowers, containing watery fluid inside, corolla orange-red, obliquely bell-shaped (thus 'African Tulip Tree'), 11-13 cm long, broadly 5-lobed; stamens 4; capsule erect, oblong-lanceolate, 15-20 cm long. Native of tropical Africa, more or less naturalized. 火焰木.

Stereospermum fimbriatum (Wall. ex G. Don) DC.
Deciduous tall tree; leaves pinnate, opposite, 30-75 cm long; leaflets usually 7, rarely 5 or 9, ovate-oblong, 8-16 cm long; flowers in large spreading clusters on the bare twigs; corolla pale pinkish, narrowly funnel-shaped, 6-7 cm long, the lobes finely long-fringed; capsule 4-angled, 35-60 cm long, twisted (thus 'Snake Tree'). Native of Burma and Malaya, sometimes planted by roadsides.

Ster. personatum (Hassk.) Chatterjee (= *Ster. chelonoides* A.P. DC.)
Deciduous tree; leaves pinnate, opposite, 20-50 cm long; leaflets 7-13, elliptic-oblong, 5-15 cm long; flowers in terminal panicles; corolla dull yellow, trumpet-

shaped, 2-3 cm long, with dark red stripes inside; capsule long-linear, to 45 cm long, 4-ribbed, curved. Rare. Tanglin, Bukit Timah *(Ridley 3642)*.

Tabebuia chrysantha Nichols
Small spreading tree; leaves opposite, palmate; leaflets 5, elliptic pointed. Central one the largest (6-25 cm long); flowers in cymes, on old branches, yellow, funnel-shaped, 9-12 cm long. Native to Brazil, recently cultivated as a roadside tree; other species including the pinkish flowered *T. pallida* Miers (leaflets obtuse, capsules smaller, less than 15 cm long from the West Indies) and *T. rosea* DC. (leaflets acute, capsules larger, over 22 cm long, from Central America).

Tecoma stans (L.) HBK. (= *Stenolobium stans* Seem.)
Erect shrub, 2-5 m tall; leaves opposite, pinnate; leaflets 7-11, ovate-lanceolate, 4-12 cm long; flowers in terminal racemes; corolla bell-shaped, bright yellow (thus 'Yellow Bell'), 3-4 cm long; capsule linear, 10-18 cm long. Native to South America, planted as ornamental in gardens. 黃鐘花.

Tecomaria capensis (Thunb.) Spach
Straggling shrub; leaves opposite, pinnate, leaflets 5-9, ovate, acute, 1-3.5 cm long; flowers in terminal racemes; corolla orange-red, narrowly funnel-shaped, 3-4 cm long; capsule linear, 6-8 cm long. Native of S. Africa, often planted in gardens.

139. Pedaliaceae

Sesamum orientale L. (= *S. indicum* L.)
Erect herb, covered with long and short (mucilaginous) hairs; lower leaves opposite, upper ones spirally alternate, oblong-lanceolate, 4-10 cm long; flowers axillary, solitary; corolla white (pale-seeded form) or violet (black-seeded form), obliquely and narrowly bell-shaped, 2.5-3 cm long; capsule erect, 4-angled. Native of Africa; formerly cultivated for its seeds (the 'Sesame seeds'), now an escape occasionally found on wasteland. 胡麻，脂麻.

140. Acanthaceae

I. Synoptic key to the genera

1. Subshrubs, in mangroves or on muddy shores; corolla 2-lipped, with the upper lip obsolete, lower 3-lobed ..... *Acanthus*
1. Not as above
   2. Scandent herbs or shrubs, rarely erect; calyx small, ring-shaped or 10-15-toothed ..... *Thunbergia*
   2. Otherwise
      3. Corolla-lobes in bud twisted to the left
         4. Ovules 3-12 in each locule; capsule usually 6- or more-seeded
            5. Corolla subequally 5-lobed ..... *Hemigraphis, Ruellia*
            5. Corolla distinctly 2-lipped ..... *Hygrophila*
         4. Ovules 2 in each locule; capsule 4- or fewer-seeded ..... *Strobilanthes*
      3. Corolla-lobes in bud imbricate
         6. Ovules 3-10 in each locule; capsule usually 6- or more-seeded ..... *Andrographis*
         6. Ovules 2 or 1 in each locule; capsule 4- or fewer-seeded
            7. Corolla nearly regular subequally 5-lobed ..... *Asystasia, Barleria, Crossandra, Eranthemum*
            7. Corolla distinctly 2-lipped ..... *Graptophyllum, Justicia, Peristrophe*

*II. Key to some ornamental genera and species**

1. Corolla nearly regular, limb subsequently 5-lobed
   2. Leaves variegated or coloured
      3. Creeping herb; leaves ovate or heart-shaped, purplish, veins sunken; flowers white, in spikes ..... *Hemigraphis alternata*
      3. Shrubs; leaves often mottled with coloured veins
         4. Flowers yellow, 4-5 cm long; bracts red, broad ..... *Sanchezia*
         4. Flowers white with purplish dots smaller bracts green, narrow ..... *Pseuderanthemum*
   2. Leaves generally green above
      5. Bracts of flowers very conspicuous, often colourful,
         6. Bracts red, corolla yellow ..... *Sanchezia*
         6. Bracts whitish with green veins; corolla blue ..... *Eranthemum nervosum*
      5. Bracts of flowers inconspicuous or less so, usually green,
         7. Corolla ± cylindric
            8. Herbs or small shrubs; flowers variously coloured; stamens 4 ..... *Ruellia*
            8. Shrubs; flowers white, purplish-spotted; fertile stamens 2 ..... *Pseuderanthemum*
         7. Corolla funnel- or bell-shaped.
            9. Bracts edged with long-pointed teeth or thorns; small shrubs; flowers violet-blue, white or yellow ..... *Barleria*
            9. Bracts not as above
               10. Woody or herbaceous climbers, rarely erect shrub; calyx ring-shaped or 10-15-toothed; bracts fairly large; capsule rounded ..... *Thunbergia*
               10. Herbaceous climbers; calyx 5-toothed; bracts small; capsule pointed-topped .... *Asystasia*

1. Corolla distinctly 2-lipped
   11. Leaves variegated
      12. Creeping herbs; leaves green with red or white veins; flowers yellowish ..... *Fittonia*
      12. Shrubs; leaves green or red-purple, mottled with yellow; flowers red-purple *Graptophyllum*
   11. Leaves generally green
      13. Bracts of flowers very conspicuous, often colourful
         14. Spikes erect
            15. Bracts orange-red; corolla light to purple-red ..... *Aphelandra sinclairiana*
            15. Bracts white with green veins; corolla white and lilac ..... *Justicia betonica*
         14. Spikes curving; bracts brick-red ..... *Beloperone guttata*
      13. Bracts of flowers inconspicuous; flowers in compact clusters ..... *Jacobinia*

Acanthus ebracteatus Vahl

Undershrub, 50-80 cm tall; leaves stiff, oblong, toothed, lobed and spiny, 10-16 cm long; flowers in terminal spikes, 8-10 cm long; bract ovate, 5-6 mm long, without bracteoles; calyx-lobes ovate, free near to base; corolla 2-lipped, upper lip obsolete, lower lip elliptic, 3-lobed, 2-2.5 cm long, white, often with bluish tip and yellow central keel; stamens 4, pinkish. Common in tidal rivers; Jurong, Geylang; used in local medicine. Vern. Jerujuh.

Acan. volubilis Wall.

Shrubby, twining with long internodes, unarmed; leaves lanceolate to elliptic, 7-15 cm long; spikes 6-12 cm long, narrow; bracts ovate, 5-6 cm long; corolla white, 2-2.5 cm long. In tidal mud among grass; Kranji, Tampines.

Andrographis paniculata (Burm. f.) Nees

Herb, 40-90 cm tall, very bitter; flowers in terminal and axillary racemes, paniculate; bracts small; calyx small, 5-lobed; corolla tube straight and narrow, 5-6 mm long, limb 2-lipped, upper lip 7-8 mm long, white with a yellow top, lower lip 6 mm long, broad, 3-lobed, white with violet blotches; stamens 2. Native to India and northern Malaya, cultivated as a medicinal plant, locally naturalized.

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* Based on M.C Neal, In *Gardens of Hawaii* pp. 777-779, (1965); rewritten.

Asystasia gangetica (L.) T. Anders. (= *A. coromandeliana* Nees)
Ascending or trailing herb, sometimes climbing, to 1 m long; leaves ovate or heart-shaped, 3-7.5 cm long; flowers 6-10 in spike-like inflorescence, often arranged on one side; bracts small; calyx deeply 5-lobed, 7-9 mm long; corolla 3-3.5 cm long, light violet or white, bell-shaped, narrow at base, widened in the upper half and at the top, segments 5, ovate, subequal; stamens 4. Native to India and Sri Lanka, cultivated and more or less naturalized.

Asyst. nemorum Nees (= *A. intrusa* Bl.)
Ascending or trailing herb; leaves oblong or ovate, 3.5-10 cm long; flowers mostly solitary; calyx (4.5-7 mm long) and corolla (2-3 cm long) smaller than the above species. In hedges and open places, Tanglin, Fort Canning.

Barleria cristata L.
Shrub, 1-1.5 m tall; branches downy; leaves elliptic, pointed at both ends, 4-8 cm long, hairy; flowers sessile, axillary, 1-3 together, each subtended by 2 ovate, spiny-edged green (or white) bracts; calyx 4-lobed; corolla trumpet-shaped, 3-4.5 cm long, 5-lobed, light violet (or white); stamens 4. Native of India, sometimes planted.

Barleria lupulina Lind.
Shrub, like the above species, but with 2 sharp spines in leaf axils; leaves linear-lanceolate, 5-10 cm long; flowers yellow, 4-5 cm long. Native of Mauritius, occasionally planted.

Beloperone guttata Brand. (altern. name: *Calliaspidia guttata* (Brand.) Bremek.)
Small shrub, to 3 m tall; leaves ovate, tip shortly pointed, 2-6 cm long, margin entire; flowers in terminal and axillary spikes, 5-15 cm long, often slightly curved; bracts 4-ranked, ovate-cordate, pubescent, reddish purple, 1.5-2 cm long; calyx small, 5-lobed; corolla 2-lipped, 1.5-2.5 cm long, white, with 2 rows of purplish spots on the 3-lobed lower lip; stamens 2. Native of Mexico, planted in gardens.

Calophanoides quadrifaria Ridl. (= *Justicia quadrifaria* Wall.)
Shrubby, branched, 60-70 cm tall, glabrous; leaves narrowly lanceolate to elliptic, 4-10 cm long; flowers in dense, axillary clusters; bracts small; calyx 5-lobed; corolla small, 5-7 mm long; stamens 2. In sandy spots, Changi (*Ridley s.n.* in 1889).

Crossandra infundibuliformis (L.) Nees (= *C. undulaefolia* Salisb.)
Shrubby to 1 m tall; leaves 4 in a false whorl, oblong-ovate, 3-12 cm long, with wavy margins; flowers in terminal, peduncled, dense spikes (later pushed aside by new branches), 4-angled; bracts ovate oblong, 1.5 cm long; calyx 5-lobed; corolla tube 1.5-2 cm long, limb 5-lobed, 2.5-4 cm wide, bright orange. Stamens 4. Native to India and Sri Lanka, cultivated.

Endopogon ridleyi Clarke
Branched herb, 30 cm tall; leaves opposite, elliptic, unequal-sided, tip acuminate, 8-15 cm long; flowers in pairs or spikes; bracts elliptic, 1.5 cm long, green; corolla 5-7 mm long, white. According to Ridley, it was abundant along the stream at Stagmount (*Ridley 11255*), but entirely destroyed in 1910. Chua Chu Kang, Pulau Damar.

Eranthemum nervosum (Vahl) R. Br. (= *E. pulchellum* Andr.)
Shrub, 1-2 m high, glabrous; leaves broadly ovate, pointed at both ends, 10-15 cm long; side veins oblique and sunken, shallowly toothed; flowers in spikes, 3-8 cm long; bracts elliptic to broadly ovate, 1.5-2.5 cm long, whitish with conspicuous green venation; corolla narrowly tubular, 2-2.5 cm long, limb 5-lobed, lobes subequal; fertile stamens 2. Native to SE. Asia, cultivated.

Fittonia verschaffeltii Coem.
Creeping herb, rooting at the nodes; leaves subsessile, oval or rounded, base heart-shaped, 5-12.5 cm long, dark green above with a reticulation of red veins; flowers small, 2-lipped, yellow, in a spike of 6-12 cm long. One variety, var. *argyroneura* Nichols (or according to other authors, a separate species), has smaller leaves with a network of white veins. Native of Peru, planted in pots.

Gendarussa vulgaris Nees (= *Justicia gendarussa* Burm. f.)
Erect shrub, branches thickened at the nodes; flowers nearly sessile, in terminal and axillary spikes; 3-12 cm long; bracts narrow; calyx small, 5-8 mm long, narrowly 5-lobed; corolla 2-lipped, 1.5-2 cm long, white, the lips violet-blotched or dotted; stamens 2. Native home unknown, formerly commonly cultivated in kampongs.

Graptophyllum pictum (L.) Griff.
Shrub, 2-3 m high; leaves broadly ovate, pointed at both ends, 10-15 cm long, green or red-purplish with irregular yellowish blotches along the midrib; flowers in cymes forming a terminal panicle, 3-12 cm long; bracts small; calyx 5-lobed; corolla funnel-shaped, 2-3 cm long, 2-lipped, crimson purple; stamens 4, only 2 fertile. Native of eastern Malesia, cultivated.

Hemigraphis alternata (Burm. f.) T. Anders. (= *H. colorata* (Bl.) Hall. (f.)
Creeping herb, purplish, rooting at the nodes; leaves ovate to heart-shaped, 2.5-8 cm long, purplish, veins sunken, blunt-toothed; flowers in narrow spikes, 2-10 cm long, pedunculate; bracts dark purple, 1-1.5 cm long, slightly exceeding the calyx; corolla funnel-shaped, 1.5-2 cm long, white, purple-lined, limb 5-lobed, subequal. Native to eastern Malesia, cultivated for ornament and for medicine.

Hygrophila erecta (Burm. f.) Hochr. (= *H. quadrivalvis* Nees)
Herb, 1-1.2 m tall; stem 4-angled; leaves oblong-obovate, tip round, 3-5 cm long; flowers few, in axillary clusters; calyx shallowly 5-lobed; corolla funnel-shaped, 1-1.2 cm long, 2-lipped, the tube and the upper lip white, lower lip violet edged and purple-dotted; stamens 4. In wet spots; Bukit Timah, Ang Mo Kio.

Hygr. meianthos Clarke
Ascending herb, 30 cm tall; leaves obovate, tip obtuse, 1.5-3 cm long; flowers few, in axillary clusters; calyx white hairy; corolla 1 cm long, white, edged violet. In wet grassland, rare; Botanic Gardens. (Probably merely a variety of the above species).

Hygr. phlomoides Nees
Herb, 1 m tall; branches soft hairy; leaves obovate, tip blunt, 2.5-10 cm long; flowers many, in axillary clusters, bract lanceolate; corolla violet, lower lip darker. In wet places, edge of Garden's lake, Changi (*Ridley s.n.* in 1891), Water Catchment Areas.

Hygr. spinosa T. Anders.
Herb, 0.5-.15 m tall, with axillary spines (2.5 cm long) leaves linear to lanceolate, 7-14 cm long, sessile; flowers in large clusters; bracts lanceolate; calyx lobed nearly to the base; corolla 2 cm long, pale purple. Native to India, an accidental weed.

Jacobinia carnea (Lindl.) Nichols (altern. name, *Cyrtanthera carnea* Bremek.)
Shrub, 0.5-2 m tall; leaves ovate-oblong, 12-25 cm long; panicles subsessile, erect, 12-20 cm long; bracts narrow, 1-2.5 cm long; calyx deeply 5-lobed; corolla tubular, deeply 2-lipped, 6-7 cm long, pink. Native of Brazil, cultivated.

Jacob. coccinea (Aubl.) Hiern. (altern. name, *Pachystachys coccinea* Nees)
Shrub, 1-2 m tall; leaves oblong or elliptic, 12-27 cm long, glabrous; flowers in dense terminal spikes; bracts ovate, green, hairy, 2-3 cm long; corolla tubulate, laterally compressed, 2-3.5 cm long; 2-lipped, bright red, pubescent. Native to French Guyana, cultivated and escaped.

Justicia betonica L. (= *Nicoteba betonica* (L.) Lindau)
Shrubby, 1-2 m tall; leaves narrowly ovate, pointed, 5-7 cm long; flowers in terminal spikes, 8-10 cm long, often branched; bracts conspicuous, ovate, white with green nerves, 3 bracts subtending one flower; corolla 1-1.5 cm long, white or lilac. Native of Mexico, planted.

Justicia vasculosa Wall.
Straggling herb, 20-30 cm tall; leaves opposite; subequal or very unequal, lanceolate to ovate, 10-12 cm long; flowers in terminal and axillary spikes, 5-10 cm long, bracts not larger than calyx; calyx deeply 5-lobed, lobes lanceolate, hairy; corolla 1.5 cm long, yellow, spotted with pink in the mouth, pubescent. In forests; Bukit Panjang, Bukit Mandai (*Ridley s.n.* in 1889), Chua Chu Kang.

Peristrophe acuminata Nees
Herb, 1 m tall; leaves lanceolate, 6-7 cm long, narrowed at both ends; flowers in terminal and axillary short cymes, briefly peduncled; bracts linear, 1-1.5 cm long; corolla tubular, 1.5 cm long; tube white, limb 2-lipped, purple with a creamy blotch and many purple spots in the mouth. In waste ground and roadsides; Tanglin, Chua Chu Kang, Botanic Gardens *(Purseglove 4041)*.

Peris. roxburghiana (Schult.) Bremek. (= *P. tinctoria* Nees)
Herb, 1-1.2 m tall; leaves elliptic-ovate, 5-8 cm long, narrowed at both ends; peduncles 2-3 cm long, pubescent; bracts ovate, 2-4 cm long; corolla 3-4 cm long, tube white, limb bright purple with a curved creamy blotch in the mouth. In shade spots, usually near cultivated land; Changi, Blakang Mati *(Ridley s.n.* in 1892).

Pseuderanthemum kingii (Clarke) Ridl.
Shrubby, slender, 30-40 cm tall; leaves elliptic, 5-7 cm long, acuminate; flowers in pairs on terminal spikes, 6-7 cm long, bracts linear, small; calyx-lobes linear, nearly free to the base; corolla cylindric, 5-lobed, 2-3.5 cm long, white, not 2-lipped. In forests; Changi, Seletar *(Ridley 3776)*.

Pseud. reticulatum Radlk.
Shrub, 1 m tall; leaves leathery, ovate or rounded, 3-10 cm long, yellow and pale green with or without yellow bands and blotches; corolla 2-3.5 cm long, the lobes acute, white with purple spots. native of Melanesia, planted as an ornamental.

Ruellia amoena Nees (Altern. name, *Stephanophysum longifolium* Poir.)
Erect herb; leaves opposite, ovate-oblong, 6-15 cm long, acute, shallowly toothed; flowers in axillary long-peduncled (2-10 cm long) cymes; calyx small, 0.7-1 cm long; corolla 3-3.5 cm long, bright red, round-lobed. Native of Brazil, cultivated as an ornamental.

Ruel. repens L. (altern. name, *Dipteracanthus repens* Hassk.)
Herb, erect or ascending, 20-70 cm tall; leaves narrowly lanceolate, 3-10 cm long; flower solitary, axillary, bracteoles leaf-like, ovate, 1-2 cm long; corolla bell-shaped, violet, with 5 rounded lobes. In grassland, Botanic Gardens (*Hullett s.n.* in 1884).

Ruel. tuberosa L.
Spreading or ascending herb, roots tuberous; leaves opposite, oblong or ovate, 6-18 cm long; flowers in axillary cymes, 1-many-flowered; bracts narrow; calyx 2-3 cm long; narrowly 5-lobed; corolla trumpet-shaped, 4-6 cm long; limb violet, sometimes pink or white, 3-5 cm across. Native to W. Indies, planted.

Sanchezia nobilis Hook. f.
Shrub, 1-2 m tall; branches 4-angled, glabrous; leaves oblong, 10-25 cm long (one variety often with a white midrib), petioles winged; flowers in terminal spikes, often branched, bracts ovate, reddish, 3-5 cm long; corolla 4-5 cm long, bright yellow. Native of tropical America, cultivated.

Staurogyne griffithiana O. Ktze.
Creeping or ascending herb, 10-20 cm long; leaves ovate or broadly elliptic, both ends rounded; flowers in terminal, simple or branched racemes, 5-12 cm long; bracts broader than calyx; calyx-lobes linear, one larger than the others; corolla cylindric, 1-1.5 cm long, white. In forests; Bukit Timah *(Hullett 613),* Kranji, Sungei Buluh.

Staur. setigera O. Ktze.
Ascending herb, 1-25 cm long, pubescent; leaves lanceolate to ovate, 4-6 cm long; flowers in terminal dense racemes, 5-10 cm long; corolla 1.5 cm long, white with pink spots in the mouth. In forests; Bukit Timah (*Ridley s.n.* in 1890), Chua Chu Kang, Jurong.

Strobilanthes dyerianus Mast. (altern. name, *Perilepta dyeriana* Bremek.)
Herb, to 1 m tall; leaves opposite, of the same pair very unequal, larger ones 10-20 cm long, smaller ones much reduced; flowers in terminal and axillary spikes; bracts about the same size as calyx; calyx 2-lipped; corolla bluish violet, 2.5-3 cm long. Native of Burma, formerly planted.

Thunbergia affinis S. Moore
Erect shrub, 1-2 m tall; leaves ovate or rhomboid, 4-11 cm long; flowers axillary, solitary or in pairs; bracteoles persistent; corolla dark violet, tube 4-5 cm long, limb 5-6 cm across. Native to tropical E. Africa, sometimes cultivated.

Thunb. alata Boj. ex Sims
Slender climber; leaves ovate or cordate, 3-5 or more cm long; petioles winged; flowers axillary, solitary; calyx with 11-14 teeth; corolla 3.5-5 cm across, orange-yellow, with (or without) a dark purple mouth, (thus called 'Black-eyed-susan'), rarely white. Native of tropical Africa; in waste places.

Thunb. erecta T. Anders
Erect shrub, 1-2 m tall; leaves ovate-rhomboid, narrowed above, 2-9 cm long; flowers axillary, solitary or in pairs; bracteoles deciduous; corolla dark violet or white, tube 0.5 cm long; limb 3.5-5 cm across. Native of tropical W. Africa; sometimes cultivated.

Thunb. fragrans Roxb.
Slender climber, glabrous; leaves oblong or elliptic, 5-7 cm long; base rounded or hastate; flowers axillary, solitary or in pairs; calyx with 12 teeth; corolla 4-5 cm across, white. Native to India, Java and Australia; an escape from gardens.

Thunb. grandiflora Roxb.
Woody climber, pubescent; leaves cordate, 5-7 nerved at base, 7-18 cm long, shallowly to deeply palmate-lobed; flowers raceme-like, terminal; corolla-tube 3-5 cm long; limb blue-violet or rarely white. Native to SE. Asia; planted as an ornamental, sometimes on overhead bridges, more or less naturalized here.

Thunb. laurifolia Lindl.
Woody climber, glabrous; leaves ovate, lower leaves broad at base and often toothed, upper ones narrower and entire, 3-5 nerved at base, 7-12 cm long; flowers in terminal racemes; calyx a mere rim; corolla-tube 3-4 cm long; limb dark blue. Native to SE. Asia, sometimes cultivated.

141. Verbenaceae

Key to the genera

1. Inflorescences ± head-like
   2. Woody
      3. Shrubs, erect or scrambling; inflorescence flat-topped, not surrounded by large bracts ..... *Lantana*
      3. Woody climbers; inflorescence surrounded by large, colourful bracts
         4. Bracts 3-4; corolla 2-lipped ..... *Congea*
         4. Bracts 6; corolla cylindric, 5-6 lobed ..... *Sphenodesma*
   2. Herbaceous
      5. Erect, garden plants ..... *Verbena*
      5. Prostrate, sea-shore plants ..... *Phyla*
1. Inflorescence not head-like
   6. Inflorescence spike- or raceme-like
      7. Inflorescence spike-like, simple or branched; flowers sessile or nearly so
         8. Trees, on muddy shores or in mangroves, with peg-like breathing roots *Avicennia*
         8. Not as above
            9. Shrubs, cultivated ..... *Citharexylum*
            9. Herbs, escaped weeds ..... *Stachytarpheta*
      7. Inflorescence raceme-like; flowers stalked; creeping or climbing shrubs
         10. Leaves thin and smooth; calyx of 5 green teeth; fruit a yellow berry ..... *Duranta*
         10. Leaves thick and downy, sandpaper-like; calyx of 5 large, star-shaped, colourful lobes; fruit dry, small ..... *Petrea*

6. Inflorescence cymose-paniculate
   11. Corolla regular or nearly so, not 2-lipped; stamens exerted
      12. Trees; leaves large, 30-60 cm long ..... *Tectona*
      12. Shrubs
         13. Cymes axillary, shorter than the leaves; calyx tubular, small; flowers 4-merous ..... *Callicarpa*
         13. Cymes axillary and terminal, often in terminal panicles; flowers 5-merous
            14. Calyx of flower bell-shaped ..... *Clerodendrum*
            14. Calyx of flower saucer-shaped ..... *Holmskioldia*
   11. Corolla distinctly 2-lipped; stamens included
      15. Leaves simple, entire or toothed
         16. Flowers large, corolla 2-2.5 cm long ..... *Gmelina*
         16. Flowers smaller, corolla less than 0.5 cm long ..... *Premna*
      15. Leaves palmately compound, with 3-5 leaflets (or sometimes reduced to one leaflet in *V. trifolia*)
         17. Petioles and petiolules strongly swollen towards the apex ..... *Teijsmanniodendron*
         17. Not as above ..... *Vitex*

Avicennia alba Bl.

Tree, to 20 m tall; leaves simple, opposite, lanceolate, 8-12 cm long, pointed, lower surface greyish white; flowers small, in branched spikes; corolla tubular, orange, 4-5 mm long, 4-lobed; fruit lanceolate-elliptic, leathery, 1-1.5 cm long, pointed; seedlings semi-viviparous (i.e., fruit dehiscing by 2 valves, the emerging seedling consisting of (1) 2 large, green, subequal cotyledons conduplicately arranged, (2) a fully developed plumule and (3) a stout radicle with tangling hairs). Common in mangrove and along tidal river. Tuas *(Ridley 6312)*. Vern. Api api.

Avic. lanata Ridley

Young branches and lower leaf-surfaces densely covered with brown hairs; leaves ovate or elliptic, 8-10 cm long; fruit broadly ovoid, 1.5-1.8 cm long. In mangroves on sandy soils, Pandan Nature Reserve *(Ismail 54)*. Vern. Api api.

Avic. officinalis Bl.

Leaves oblong-elliptic, 8-10 cm long, round-tipped; flowers in clusters; fruit ovoid, slightly beaked, 3-3.5 cm long, velvety. Common in mangrove and along tidal rivers. Changi, River Valley Road *(Burkill 3792)*, Pulau Ubin. A fourth species, called *A. intermedia* Griff. [? = *A. marina* (Forsk.) Vierch.] is somewhat intermediate between *A. alba* (with the lower leaf surface glaucous) and *A. officinalis* (with round-tipped elliptic leaves) but differing from both in its 4-angled stem. Tuas, Pulau Sudong *(Womersley 61)*.

Callicarpa longifolia Lam.

Straggling shrub; 2-3 m tall; leaves lanceolate, 7-15 cm long, stellately hairy beneath; flowers many in cymes; corolla tubular, liliac. Formerly common in hedges in Tanglin, Bukit Timah *(Ridley 2786)* and Changi, now rare.

Citharexylum spinosum L. (= *C. quadrangulare* Jacq.)

A shrub (in country of origin, a small tree); branches 4-angled; leaves opposite or in 3s, oblong or oval, 15-20 cm long, smooth, pointed; flowers in narrow clustered spikes, 10-20 cm long; corolla tubular, white 5-lobed, curved, less than 1 cm long. Native to the West Indies, known as 'Fiddlewood', sometimes cultivated in gardens.

Clerodendrum deflexum Wall.
Small shrub, 1 m tall; leaves opposite, lanceolate or elliptic, 15-30 cm long; flowers in nodding heads, with red bracts; corolla tubular, white, 2-2.5 cm long; drupe purple to black. Common in woods; Gardens' Jungle, Tanglin, Chua Chu Kang *(Goodenough 2796)*, Tampinis.

Cler. indicum (L.) Ktze (= *C. siphonanthus* R. Br.)
Shrub; leaves narrowly oblong, 10-12 cm long, in whorls; corolla white, night-blooming, fragrant; fruit purplish with red calyx. Native of SE. Asia, cultivated for its fragrant flowers.

Cler. inerme (L.) Gaertn.
Small shrub, about 1 m tall; leaves elliptic, narrowed at both ends; 4-8 cm long; flowers in axillary small cymes; corolla cylindric, white, 2-2.5 cm long; stamens exsert, dark purple. Common near the sea in tidal mud; Rochore, Changi *(Hullett 625)*, Seletar, Pulau Ubin.

Cler. laevifolium Bl. (= *C. disparifolium* Bl.)
Shrub or small slender tree, 5-7 m tall; leaves oblong or lanceolate-elliptic, 5-15 cm long; flowers in slender cymes; corolla pale yellow; fruit black with red calyx. Common in woods; Tanglin, Gardens' Jungle, Bukit Timah, Changi. Vern. Guriam padang.

Cler. nutans Jack (= *C. penduliflorum* Wall.)
Shrub, less than 1 m tall; leaves ovate-lanceolate, pointed, 12-20 cm long; panicles pendent; corolla funnel-shaped, white, 1-1.5 cm long. Native of N. Malaya, occasionally cultivated.

Cler. paniculatum L.
Shrub, 3-4 m tall; leaves heart-shaped, shallowly 3-5 lobed, 15-20 cm long; flowers in large terminal panicles; corolla scarlet, 2-3 cm long. Native of Continental Asia, cultivated for the showy inflorescences.

Cler. philippinum Schauer. (= *C. fragrans* Willd.)
Erect shrub, with root-suckers; leaves broadly ovate, hairy, 8-20 cm long; flowers in dense corymbs; corolla white, 2-3 cm long. Native to Java, cultivated as ornamental. There is a double-flowered variety, var. *pleniflorum* Schauer.

Cler. phyllomega Steud. var. **myrmecophilum** (Ridl.) Moldenke (= *C. myrmecophilum* Ridl.)
Slender shrub, usually unbranched; stem and petioles hollow and tenanted by ants; leaves oblong or lanceolate, 15-30 cm long; panicles large, terminal; corolla cylindric, 1-1.5 cm long, 5-lobed, orange-red; stamens long exsert, dark pink. In muddy wet spots in forests, formerly found at Chua Chu Kang *(Ridley 6700)* and on Pulau Damar.

Cler. thomsonae Balf.f.
Climber; leaves ovate to heart-shaped, 8-12 cm long; calyx white; corolla red (thus 'Bleeding Heart'). Native of W. Africa, often cultivated.

Cler. villosum Bl.
Shrubs, 2-3 m tall, hairy; leaves ovate-cordate, 10-20 cm long; flowers in terminal panicles; corolla white, the tube less than 1 cm long; fruit black, with enlarged white calyx. In waste land, Chua Chu Kang *(Goodenough 2795)*.

Congea velutina Wight
A climber, all parts covered with greyish woolly hairs; leaves ovate-elliptic, thick, shortly pointed, 3-15 cm long; panicles much branched, formed by 5-7-small-flowered heads; flowers pink, inconspicuous, the 3-4 bracts subtending the flower-heads spathula-shaped, 2-3.5 cm long, lilac. Native to India and Malaya, cultivated as ornamental.

Duranta repens L.
Creeping shrub with slender, drooping branches; leaves opposite or in whorls, ovate, 3-8 cm long; racemes terminal and axillary, forming panicles; corolla tubular, light blue or white, less than 1 cm long; globose, drupe bright (thus 'Golden Dewdrop'), less than 1 cm across. Native of tropical America, cultivated or escaped. 金露花.

Gmelina asiatica L.
Small bushy tree or climber, with axillary spines; leaves simple, opposite, obovate or rhomboid, 2-4 cm long, often 3-lobed, glaucous beneath; flowers in cymose-racemes on a terminal panicle; corolla obliquely funnel-shaped, yellow, 3-4 cm long; drupe pear-shaped, 2-3 cm across. On waste grounds; Geylang.

Gmel. elliptica. J. E. Sm. (= *G. villosa* Roxb.)
Spiny shrub: leaves ovate, acute, 2.5-7 cm long, densely hairy underneath; corolla yellow; drupe subglobose, 2-2.5 cm across, yellow. Formerly collected at Chua Chu Kang and Geylang. Vern. Bulang.

Gmel. philippinensis Cham. (= *G. hystrix* Schultes)
Scandent shrub, spiny; leaves elliptic, blunt, 8-10 cm long; flowers in pendent clusters, 6-8 cm long, with dark red, ovate bracts; corolla yellow. Tanglin, Gardens' Jungle. Fruit used in local medicine.

Holmskioldia sanguinea Retz.
Shrub, less than 3 m tall; leaves opposite, ovate, pointed, 2.5-8 cm long; flowers in small clusters, both axillary and on branch tips; calyx red or orange, saucer-shaped; corolla funnel-shaped, curved, 5-lobed, 2-2.5 cm long, red (thus 'Cup-and-saucer Plant'). Native of Himalayan region, occasionally planted.

Lantana camara L. (incl. *L. aculeata* L.)
A shrub, branches prickly (var. *aculeata* Mold.) or unarmed; leaves opposite, rarely 3 in a whorl, ovate, 5-12 cm long, pungent-scented; flowers in head-like dense spikes; corolla salver-shaped, curved, 1-1.2 cm long, orange, pink, red, or variegated; drupe bluish. Native to tropical America, originally a garden plant, later growing wild in waste places, several cultivated varieties with an array of flower colours. 馬櫻丹.

Peronema canescens Jack
Small tree, to 14 m tall, with 4-angled branches; leaves opposite, pinnate, 30-90 cm long; leaflets 4-10 pairs, with or without a terminal leaflet, sessile, 10-30 cm

long; terminal panicles 30-60 cm long; corolla small (0.3 cm wide), 2-lipped, greenish white; capsule round, 3 mm broad. In secondary forests, formerly found in Bukit Mandai, now occasionally cultivated.

Petrea volubilis L.
Woody climber; leaves opposite, oval, pointed, 5-15 cm long, thick and downy; racemes hanging from branch tips; calyx 5-lobed, accrescent and persistent, spreading, reaching 3-4 cm across, bluish; corolla funnel-shaped, violet. Native to tropical America often planted in gardens.

Phyla nodiflora (L) Greene (= *Lippia nodiflora* A. Rich.)
Creeping perennial herb, rooting from the nodes, densely covered with greyish soft hairs; leaves opposite, obovate, 2-5 cm long; dense spikes erect, axillary, with prominent bracts; corolla small (2-3 mm long), white and then lilac with a dark eye. In dry sandy waste places.

Premna corymbosa Rottl. & Willd. (= *P. angustior* Ridl., *P. integrifolia* L.)
Low shrub, sometimes creeping; leaves simple, oblong-ovate, 3-10 cm long; panicles corymbose, terminal; corolla small (2-3 mm wide), white, 2-lipped; drupe ovoid, black. On sandy places near the sea. Changi *(Ridley 2785)*, Loyang, Chua Chu Kang.

Prem. foetida Reinw. ex Bl.
Large shrub, to 6 m tall, hairy; leaves ovate, acute, 8-15 cm long; corymbs 8-12 cm long and wide; corolla greenish white. In damp low-lying ground, leaves served as a pot herb; Tanglin, Thomson Road *(Hullett 395)*.

Prem. parasitica Bl. (= *P. trichostoma* Miq.)
Large climbing shrub, glabrous; leaves oblong-obovate to nearly orbicular, nerves 5-6 pairs; corymbs 10-12 cm across. In woods; Chua Chu Kang *(Ridley 6828)*.

Prem. punctulata Clarke
Scandent shrub; leaves elliptic or broadly oblong, rigid, nerves 4-5 pairs, sparsely hairy, 10-15 cm long; corymbs pubescent, branched. Once found in the former Economic Gardens in 1915 (Ridley) where it has since disappeared.

Prem. ridleyi K. & G.
Climbing shrub; leaves ovate, or oblong, blunt, subleathery, 4-8 cm long; corymbs 5-12 cm across. Climbing on trees in woods, only one plant was found in the Gardens' Jungle in 1896 (*Ridley 6826,* photo).

Sphenodesma pentandra Jack
Climbing shrub, pubescent; leaves lanceolate or ovate, acute, 5-15 cm long; raceme-like inflorescences consisting of many pairs of heads; heads small, 5-7-flowered, surrounded by 6 large, oblong, 2-3 cm long bracts; corolla bluish. On edge of woods; Seletar, Changi. Vern. Akar sulang.

Stachytarpheta indica (L.) Vahl
Erect herb, to 1 m tall; leaves opposite, bright green, elliptic oblong, 4-11 cm long, margin toothed, the teeth of very different sizes, secondary veins inconspi-

cuous beneath; spikes 15-40 cm long; corolla bright violet, sometimes pale violet or white. Common on seashores.

Stachy. jamaicensis (L.) Vahl
Herb or shrubby, 2 m tall, glabrous; leaves dark green, ovate or oval, 3-8 cm long, toothed, the teeth more or less of same size, secondary veins prominent beneath; terminal spikes 10-20 cm long; corolla tubular, blue, less than 1 cm long. Native to tropical America, a common weed on waste ground.

Stachy. mutabilis (Jack.) Vahl
Differs from *S. jamaicensis* in being hairy throughout, in having a thicker spike, and larger, crimson to pink flowers. Also from tropical America; an ornamental and a garden escape.

Tectona grandis L.f.
Large deciduous tree to 50 m tall; leaves opposite or in threes, oval, 30-60 cm long; panicles large, terminal, 30-90 cm long; flowers small; calyx bell-shaped, much enlarged in fruit; corolla funnel-shaped, white or reddish, 1 cm across; drupe globose, 1-1.5 cm across. Native of monsoon forests of E. India to Thailand and Java, valued for its durable wood (teak), occasionally planted.

Teijsmanniodendron coriaceum (Clarke) Kosterm. (= *Vitex coriacea* Clarke)
Tree; leaves 3-foliate; leaflets leathery, oblong to elliptic, 7-12 cm long, stalks swollen at the base; flowers in paniculate cymes; corolla violet, 2-lipped; drupe globose to oblong, 1-seeded. In forests; Bukit Timah, Gardens' Jungle.

Teijsm. pteropodum (Miq.) Bakh. (= *Vitex pteropoda* Miq.)
Small tree; leaves palmately compound, petiole 10-15 cm long, broadly winged; leaflets 5-7, elliptic to oblong, 10-50 cm long; panicles terminal; corolla purplish; drupe ovoid. In swampy forests; formerly found at Chua Chu Kang, Pulau Damar.

Verbena hybrida Voss.
Annual herb; leaves oblong, blunt-toothed, 4-8 cm long; flowers in broad heads; corolla red, pink or yellow or variegated, often with a white eye. A hybrid of *V. peruviana* Druce with other S. American species, sometimes cultivated.

Verb. tenuisecta Briq. (= *V. tenera* Spreng.)
Perennial herb; stems creeping; leaves 1.5-2.5 cm long, twice pinnatifid, segments linear; flowers in dense heads; corolla violet, blue or white. An ornamental, native to S. America.

Vitex negundo L.
Shrub; leaves palmate; leaflets 3-5, elliptic, the mid-leaflet distinctly stalked; flowers in terminal panicles; corolla pale to deep blue, with a yellow curved mark on lower lip. A medicinal plant for various ailments; in wasteland, probably introduced. 黃荊.

Vit. pinnata L. (= *V. pubescens* Vahl)
Hairy tree to 10 m tall; leaves palmately compound; leaflets usually 5, almost sessile, the mid-leaflet the largest, about 7.5-20 cm long; panicles terminal;

corolla violet blue; fruit globose, black, flattened. Common in open wasteland and in secondary forests.

Vitex trifolia L.
White hairy shrub; branches drooping; leaves 3-foliate, rarely simple (var. *repens*); leaflets 3-7.5 cm long, mid-leaflet almost sessile; corolla pale blue; fruit oblong. In gardens and villages near the sea; Pasir Panjang, Pulau Ubin.

Vit. vestita Wall. ex Schau.
Small tree; branches pubescent; leaves 3-foliate; leaflets elliptic, long-acuminate, 8-18 cm long, mid-leaflet the largest; corolla cylindric, 1-1.5 cm long, 2-lipped, yellow. In inland forests; Bukit Timah, Jurong.

142. Labiatae

Key to the genera

1. Flowers mostly in dense axillary (sometimes also terminal) clusters
   2. Leaves finely dissected into lobes and narrow segments ..... *Leonurus*
   2. Leaves entire or toothed, not dissected
      3. Calyx 6-10-toothed
         4. Corolla 2-2.5 cm long, orange or red ..... *Leonotis*
         4. Corolla less than 1.5 cm long, white or bluish ..... *Leucas*
      3. Calyx 4-5-toothed
         5. Flowers in dense ball-like heads or in clusters; corolla 2-lipped, the upper lip bent downwards; weeds ..... *Hyptis*
         5. Flowers in axillary clusters; corolla subequally 4-lobed; cultivated ..... *Mentha*
1. Flowers generally in terminal spike- or raceme-like inflorescences, simple or branched
   6. Spike-like inflorescence densely packed with very tiny (less than 3 mm long), bluish flowers ..... *Pogostemon*
   6. Spike- or raceme-like inflorescence clearly in whorls; flowers larger (over 5 mm long, usually much longer)
      7. Calyx nearly regular, 5-lobed; weeds ..... *Anisomeles*
      7. Calyx irregular, generally 2-lipped; generally cultivated
         8. Stamens 2, anther-cells widely separated on a long slender connective ..... *Salvia*
         8. Stamens 4, anther-cells parallel, not separated,
            9. Stamens coiled in bud, projecting 1.5-2 cm beyond the corolla ..... *Orthosiphon*
            9. Stamens not as above
               10. Lower corolla-lip nearly flat; plants strongly aromatic ..... *Ocimum*
               10. Lower corolla-lip boat-shaped; plant not or only faintly aromatic *Plectranthus* (incl. *Coleus*)

Anisomeles indica (L.) OK. (= A. ovata R. Br.)
Herb or shrubby, to 1.5 m high, more or less hairy; leaves ovate, 4.5-6 cm long; flowers in dense false whorls in a spurious spike; corolla tubular, 2-lipped, 7-8 mm long, white or violet. In open and waste places, formerly found at Tanglin *(Ridley 2692)*, now probably extinct.

Hyptis brevipes Poit.
Erect herb, to 1 m high; leaves narrowly lanceolate to oblong-ovate, 4-8 cm long; flowers in spurious heads, 1-1.2 cm across in fruit; corolla white, 4-5 mm long, 2-lipped. Native to S. America, more or less established.

Hypt. capitata Jacq.
Annual herb, 1-1.5 cm high; leaves lanceolate or rhomboid elliptic, 6-12 cm long; flowers in axillary globular spurious heads, 1.5-2 cm across in fruit; corolla 5-6

mm long, white. Native to S. America, a weed in waste places.

Hypt. suaveolens (L.) Poit.
Branched herb, to 1.5 m high, strongly aromatic; leaves ovate to broadly obovate, 3-5 cm long, pubescent; flowers in 2-5 flowered cymes, on one side of a spurious raceme; corolla blue, tubular, 6-8 mm long. Introduced from S. America, one time very common in waste grounds.

Leonotis nepetaefolia (L.) R. Br.
Erect herb, to 2 m tall; leaves oblong to ovate, 4-12 cm long, toothed; flowers in dense axillary spurious whorls; corolla bright orange or red, 2-2.5 cm long. Native of tropical Africa, occasionally escaped from cultivation, a weed.

Leonurus sibiricus L.
Herb, to 1.5 m tall, leaves linear to ovate, palmate-pinnately dissected, 4-7 cm long, flowers in dense axillary spurious whorls; corolla white, about 1 cm long, 2 lipped. A native of E. Asia; cultivated as an ornamental or for medicinal purposes, occasionally found in wasteland. Vern. Seranting, 益母草.

Leucas lavandulifolia J. E. Sm. (= *L linifolia* Spreng.)
Annual herb, less than 1 m tall; leaves linear, to lanceolate, 4-6 cm long; flowers in terminal and axillary leafy false whorls, often congested towards apex and forming clusters; calxy oblique, 10-toothed; corolla tubular, 1 cm long. 2-lipped. In open places, rare. Mt Faber *(Ridley 3888)*.

Leucas zeylanica (L.) R. Br.
Annual, to 60 cm high, hairy; leaves lanceolate, 4-5.5 cm long; flowers in terminal spurious whorls, usually 6-8 whorls forming a globular head, 1.5-2 cm across; corolla white, tubular, 8-10 mm long, 2-lipped. In open grassland. Pasir Panjang (*Mat. s.n.* in 1894). Vern. Ketumbit.

Mentha arvensis L.
Aromatic perennial, often prostrate, variously pubescent; leaves ovate, 2-4.5 cm long, weakly toothed. A native of the northern hemisphere, a small-leaved form sometimes cultivated in pots, no flowers have been observed. Another related species, *M. spicata* L., an erect or ascending herb of 0.5-1 m tall, with dense axillary clusters of small pinkish flowers, of the northern temperate countries, is occasionally planted. Vern. Pokok kepari, 薄荷.

Ocimum americanum L. (= O. canum Sims)
Aromatic herb, erect, 30-50 cm high; leaves lanceolate to elliptic, 2.5-5 cm long; false whorls in spurious racemes, usually branched, 7-15 cm long; pedicels much shorter than calyx, 2 lower calyx-teeth slightly longer than the upper one; corolla white, 4-6 mm long. In settled areas, sometimes cultivated.

Ocim. basilicum L.
Like *O. americanum,* except flowers are larger (corolla 7-12 mm long, white or pinkish). Often cultivated. Vern, Basil, Selaseh.

Ocim. tenuiflorum L.
Like *O. americanum,* except the two lower calyx-teeth equalling the upper tooth and less aromatic. A pantropical weed occasionally found in waste places or in settled areas.

Orthosiphon aristatus (Bl.) Miq. (= *O. stamineus* Benth.)
Slender ascending herb, 30-60 cm high; leaves ovate or rhomboid, 3-9 cm long; terminal spurious racemes 10-15 cm long; corolla pinkish or white, tubular, 10-12 mm long, 2-lipped; stamens coiled in bud, projecting about 2 cm beyond the corolla throat. Native to SE. Asia, sometimes cultivated as an ornamental or medicinal plant. Vern. Kumis kuching 猫鬚草.

Plectranthus scutellarioides (L.) R. Br. (= *Coleus atropurpureus* Benth., *C. blumei* Benth.)
Branched herb, erect or ascending; leaves very variable in size, shape and colouring, generally ovate in outline, 4-7 cm long, toothed; usually in 6-flowered cymes, forming spurious racemes or panicles; corolla boat-shaped, 8-13 mm long, bright purple. Formerly occurred in open places (Jurong, *Ridley s.n.* in 1890), now in cultivation only.

Plectr. rotundifolius (Poir.) Spreng. (= *Coleus tuberosus* Benth., *C. parviflorus* Benth.)
Herb, pubescent; lower stem creeping; older roots often swollen into dark brown tubers, 2-4 cm long; leaves thick, juicy, ovate or suborbicular, 2-5 cm long. Native of India, sometimes cultivated for the edible roots.

Pogostemon auricularius (L.) Hassk. (= *Dysophylla auricularia* (L.) Benth.)
Annual herb, 30-70 cm high, pubescent; leaves narrowly ovate, 4-6 cm long; flowers in dense spurious terminal spikes, hairy; corolla very small, 2-2.5 mm long. Formerly common in open wet spots, Tanglin, Changi (*Hullett 375*); now probably extinct. Vern. Ekor kuching.

Salvia coccinea Juss. ex Murr.
Slender herb, to 1 m high, hairy or not; leaves ovate or deltoid-ovate, 2.5-3.5 cm long; false racemes terminal, branched or not; flowers 6-10 in a false whorl; corolla bright scarlet, 2-2.5 cm long, the tube straight, 2-lipped. Native of tropical America, sometimes cultivated from imported seeds. 一串紅.

The Evaluation of the Effectiveness of Water Absorbent Polymers in Reducing the Irrigation Needs of Potted Plants

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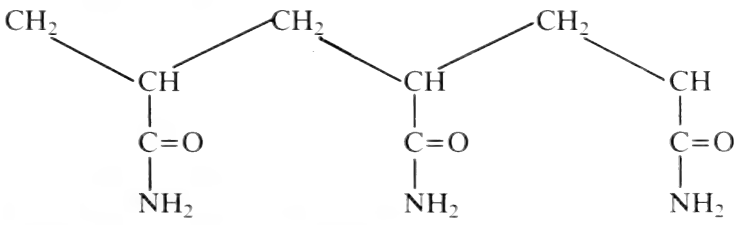
Abstract

The available-water-enhancing effects of the water-absorbent polymers, Agrosoke, Soiltex G1 and Terra-Sorb, on a typical local sandy-clay topsoil were evaluated, using *Mussaenda* Dona Luz, *Tecomaria capensis*, and *Hibiscus rosa-chinensis* as indicator plants. Results did not indicate significant beneficial effects at the three rates of polymers used. Instead, the practicability of using sludge to augment the water-holding capacity of the topsoil was validated.

Introduction

Synthetic polymeric soil conditioners are increasingly being used as modifiers of physical soil attributes such as water-holding capacity and permeability, with promising results (Azzam, 1985; Callebaut et al, 1979; De Boodt., 1979 and Gunn, 1984). Many of the synthetic soil conditioners are polyacrylamide-based, having the following basic structure.



An interesting property of these polymeric soil conditioners is their ability to hold many times their own weight in plant available water (Flannery & Busscher, 1982; Gehring & Lewis III, 1980 and Hamilton & Lowe, 1982). Moreover, rehydration of spent conditioners is possible after the available water is depleted by plant uptake and evaporation. Consequently, they have been used in potting media, especially those of open and sandy nature, to enhance their water-holding capacity thereby reducing the watering frequency (Flannery & Busscher, 1982 and Gehring & Lewis III, 1980).

In the Republic of Singapore, watering is a horticultural operation which is not yet fully mechanized. In some cases, watering of potted plants in the nurseries is accomplished by manual labour. Therefore, if plant growth media could be physically altered by polymeric additives to hold more water, labour expended on watering and water itself, a scarce resource, can be saved.

Materials And Methods

The effects of three polyacrylamide-based polymeric conditioners viz: Agrosoke (Chemical Discoveries (UK) Limited), Soiltex G1 (Interlates Limited, UK) and Terra-Sorb (Industrial Services International, Inc.), on the water-holding capacities of a local topsoil (a sandy clay loam of composition 53% sand, 24% silt and 23% clay; pH 5.5) were investigated.

The indicator plants selected were *Mussaenda* Dona Luz, *Tecomaria capensis* and *Hibiscus rosa-sinensis,* all known to be susceptible to water stress. Uniform plants, especially in terms of leaf coverage, of the above species were chosen and inplanted into a standard amount of topsoil alone, topsoil with treated and pulverized sludge in the ratio 3:1 v/v (standard departmental mix for planting holes), topsoil with 3 rates of each conditioner (Table 1) or a synthetic topsoil of formulation 1/3 Rengam subsoil: 1/3 treated and pulverized sludge: 1/3 granite dust (v/v/v; pH 6.2) (Teoh & Chua, 1975; Wells, 1977). Clay pots of dimensions 23 cm (top internal diameter) × 16 cm (height) × 18 cm (bottom internal diameter) were used and each was packed with 4.5 kg of substrate. The treatments are summarized in Table 1.

Table 1

Summary of treatments

Treatment	Specification
A	Control: topsoil without additive
B	Topsoil: Agrosoke (2000:1/w/w)
C	Topsoil: Agrosoke (1000:1 w/w) (Recommended rate)
D	Topsoil: Agrosoke (1000:2 w/w)
E	Topsoil: Soiltex G 1 (2000:1 w/w)
F	Topsoil: Soiltex G 1 (1000:1 w/w) (Recommended rate)
G	Topsoil: Soiltex G 1 (1000:2 w/w)
H	Topsoil: Treated sludge (3:1 v/v)
I	1/3 Rengam subsoil: 1/3 Treated sludge: 1/3 granite dust (v/v/v; synthetic topsoil)
J	Topsoil: Terra-sorb (2000:1 w/w)
K	Topsoil: Terra-sorb (1000:1 w/w) (Recommended rate)
L	Topsoil: Terra-sorb (1000:2 w/w)

The conditioners were mixed with the topsoil in the deactivated state and later activated by repeated flooding after the plants were established in the mixes.

All treatments and control were replicated 6 times for each plant species used, giving a total of 72 pots per plant species. After implantation, plants were arranged in randomized complete blocks and allowed to establish for a week under a shed of transparent polythene cover. This provided shelter from the rain while leaving ample room for air circulation and heat transmission.

To initiate the trial, pots were soaked thoroughly and allowed to drain for half an hour to achieve field capacity. Immediately, a 10 g sample of substrate was collected from a depth of 8 cm from each pot for the determination of moisture content at field capacity by drying to constant weight at 105°C. For the first 4 days, sampling was done twice daily, once at 10 a.m. and the other at 4 p.m. Thereafter, sampling was carried out once daily in the afternoon for moisture determination until the permanent wilting point was reached. The number of days taken to reach the permanent wilting point was recorded (DTW). The difference between the moisture content at field capacity and that at the permanent wilting point yielded the index for plant-available water.

Results And Discussions

Results on total water contents, available water contents and days-to-wilting (DTW) are presented in Tables 2, 3, 4 and 5. Data were analysed with the Duncan Multiple Range Test for significance.

Data in Table 2 indicated that the departmental planting mix comprising 3 volumes of topsoil to 1 volume of treated sludge was significantly superior to all other treatments in terms of total water-holding capacity. Total water-holding capacity was similar with or without adding polymers to topsoil (cf. Control (A) and treatments with conditioners in Table 2). Increasing the rate of conditioner in certain cases did not result in a higher total water-holding capacity (cf. Treatments (B) and (C), and Treatments (E), (F) and (G) in Table 2). It appeared that the three rates of conditioners applied did not augment significantly the water-holding capacity of the topsoil, a sandy clay loam. Also, according to Flannery & Buscher (1982), the full capacity of polymeric soil conditioners could only be effected after long periods of saturation.

In the case with *Tecomaria capensis* as the indicator plant (Table 3), DTW was not affected by treatments. The available water contents did not relate to the rates of the soil conditioners added. In fact, the highest rate of soiltex Gl appeared to be the poorest in maintaining available water for the trial plant. In terms of available water, Treatments H (the departmental planting mix) and A (Control) yielded results better than Treatment G but comparable to those of other treatments.

In the case with *Hisbiscus rosa-sinensis* (Table 4), no significant treatment-difference on available water was detected. However, the effect of Treatment H on DTW was significantly better than a majority of other treatments. DTW was similar in the absence (A, control) and presence (Treatments B, C, D, E, F, G, J, K and L, Table 4) of polymers in the topsoil.

Table 2

Effects of various treatments on the total water-holding capacities

Treatment	A	B	C	D	E	F	G	H	I	J	K	L
Total water (%)	21.58 bg	22.55 be	21.04 cdefg	22.07 bf	24.33 b	23.19 bd	18.73 cg	27.19 a	18.55 cg	18.26 c	19.04 cfg	20.03 cefg

Treatments A-L have reference in Table 1.
Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P<0.01$.

Table 3

Effects of various treatments on the number of days taken to reach the permanent wilting point (DTW) of *Tecomaria capensis* and the available water contents

Treatment	A	B	C	D	E	F	G	H	I	J	K	L
DTW	16.0a	14.7a	14.5a	15.0a	15.5a	16.0a	16.0a	16.8a	13.8a	14.0a	12.5a	15.8a
Available water (%)	18.4 ad	20.4 a	16.3 bcd	16.0 bd	18.9 ad	20.3 ac	12.0 b	16.9 ad	18.0 ad	16.2 bd	16.7 ad	19.1 ad

Treatments A-L have reference in Table 1.
Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P<0.01$.
DTW = Days to Wilting.

Table 4

Effects of various treatments on the number of days taken to reach the permanent wilting point (DTW) of *Hibiscus rosa-sinensis* and the available water contents

Treatment	A	B	C	D	E	F	G	H	I	J	K	L
DTW	10.0 abc	9.7 abc	10.7 abc	11.5 cd	10.2 abc	10.8 cd	14.2 bd	15.5 d	9.0 abc	7.50 ac	9.7 abc	8.0 ac
Available water (%)	18.2 a	17.1 a	18.3 a	20.2 a	19.9 a	19.3 a	21.0 a	22.4 a	14.9 a	16.5 a	17.5 a	16.3 a

Treatments A-L have reference in Table 1.
Values in each row if not followed by the same letter are significantly different as judged by the DMR testt at $P<0.01$.
DTW = Days to Wilting.

Table 5

Effects of various treatments on the number of days taken to reach the permanent wilting point (DTW) of *Mussaenda* Dona Luz and the available water contents

Treatment	A	B	C	D	E	F	G	H	I	J	K	L
DTW	5.7a	5.8a	5.5a	5.5a	5.8a	5.2a	5.0a	5.5a	4.3a	5.0a	5.3a	5.3a
Available water (%)	15.9 a	17.6 a	15.5 a	15.5 ac	20.1 a	17.1 a	10.3 bc	16.3 a	16.7 a	14.9 ac	16.7 a	18.1 a

Treatments A-L have reference in Table 1.
Values in each row if not followed by the same letter are significantly different as judged by the DMR test at $P<0.01$.
DTW = Days to Wilting.

Mussaenda Dona Luz appeared to be the most susceptible to water stress among the three indicator plants selected. It reacted to water stress by shedding its leaves. The first sign of leaf drop was therefore construed to be the permanent wilting point. Results obtained with this trial plant showed no significant treatment effect on DTW (Table 5) and only marginal effects on available water. As with *Tecomaria capensis*, there was no significant correspondence between the rate of conditioner applied and the water-holding capacity. Treatments H and A were significantly different from Treatment G but similar to all other treatments in terms of available water.

Conclusion

The present trial did not show any significant enhancing effect of polymers on the water-holding capacity of a typical topsoil. Control A, irrespective of the indicator plant used, showed similar effects in total water-holding capacity, available water and DTW to those of treatments with conditioners. Our results indicated that the standard planting mix of the Parks and Recreation Department compared more than favourably to topsoil treated with various rates of the polymeric soil conditioners, in the three attributes measured.

However, our results do not rule out the possible usefulness of these polymers in sand or more sandy soils, for which such products are more intended for, and in

planting where a larger volume of substrate is involved. In fact, Gehring & Lewis III (1980) have found significant relationships between the wilting time and the container size used in their study of a polymeric soil conditioner.

References

Azzam, R.A.I. (1985). Tailoring polymeric gels for soil reclamation and hydroponics. Commun. In *Soil Sci. Plant Anal.*, 16, 1123-1128.

Callebaut, F., Gabriels, D. & M. De Boodt (1979). The effect of polymer structure on soil physico-chemical properties and soil water evaporation. *Journal of Chemical Technology & Biotechnology*, 29, 723-729.

De Boodt, M. (1979). Soil conditioning for better soil management. *Outlook on Agriculture*, 10, 63-70.

Flannery, R.L. & W.J. Busscher (1982). Use of a synthetic polymer in potting soils to improve water-holding capacity. Commun. *In Soil Sci. & Plant Anal.* 13, 103-111.

Gehring, J.M. & A.J. Lewis III (1980). Effect of hydrogel on wilting and moisture stress of bedding plants. *J. Amer. Soc. Hort. Sci.* 105, 511-513.

Gunn, S. (1984). Like a sponge. *GC & HTJ*, August 10, 19, 21 & 24.

Hamilton, J.L. & R.H. Lowe (1982). Use of a water-absorbent polymer in tobacco seedling production and transplanting. *Tobacco Science,* XXXVI, 17-20.

Page, E.R. (1982). Soil conditioners. *Scientific Horticulture*, 33, 1-13.

Teoh, T.S. & S.E. Chua (1975). The performance of several ornamental shrubs in different potting mixtures of subsoil, sludge and granite dust. *Singapore J. Pri. Ind.*, 3, 21-34.

Wells, N. (1977). The role of soils in the utilization of sludge in Singapore. *N.Z. Soil Bureau Scientific Report 30.* Department of Scientific & Industrial Research, New Zealand.

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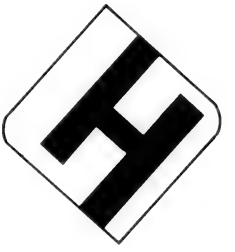

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The Agaric Genus *Panellus* Karst. (including *Dictyopanus* Pat.) in Malaysia

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91 Hinton Way, Great Shelford, Cambridge CB2 5AH, England

EFFECTIVE PUBLICATION DATE: 24 JAN. 1987

Abstract

Panellus, with *Dictyopanus* as a synonym, has 27 species in Malesia; 11 species (all new) are lamellate; 13 species (8 new) are poroid. Two new subgenera are made for species with more or less centric pileus and well-developed stem, namely *Megalopanellus* (1 species) and *Mesopanellus* (2 species). *P. longinquus* (Berk.) Singer is recorded tentatively for Queensland.

New taxa in subgen. *Panellus* — lamellate species, *P. alutaceus*, *P. ambiguus*, *P. bambusarum*, *P. brunneomaculatus*, *P. dichotomus* and var. *pinnatus*, *P. exiguus*, *P. fuscatus*, *P. intermedius* and var. *stenosporus*, *P. parvulus*, *P. pendens*, and *P. sublevatus;* as poroid species, *P. albifavolus*, *P. bambusifavolus*, *P. brunneifavolus*, *P. hispidifavolus*, *P. megalosporus*, *P. microsporus*, *P. pauciporus*, and *P. sublamelliformis;* subgen. *Megalopanellus*, *P. magnus;* subgen. *Mesopanellus*, *P. glutinosus*, *P pyruliferus*.

Contents

Introduction

Some twenty years ago, I studied in detail the collections of this genus which I had made in the Malay Peninsula, Borneo, New Guinea, and the Solomon Islands. I offer these notes and drawings for others to pursue the quest. The Malacca fungus flora enlarges the concept of the genus very considerably, and there are certainly more species to be found. In a few cases I have introduced drawings of exotic material because they convey better the construction than such as I have of the Malesian.

Received on 9 October 1985

Panellus is like *Pleurotus* but with more or less amyloid spores, commonly with acerose basidioles in the hymenium (as a marasmioid feature), and commonly with granular-encrusted dichophysial hyphae on the edges of gills or pores, and on the pileus and stem. In consequence of this last feature, the pileus is usually opaque, not striate. The fruit- bodies are generally rather small to minute, rather tough or in parts gelatinous, and on the whole without bright colours. They are white to dull ochraceous, brownish, or somewhat rufous, but there is an exception in the golden yellow *P. aureofactus* Horak of India.

The best introduction is to study illustrations of the north temperate *P. stypticus,* which is the type-species and has much in common with the Malesian *P. dichotomus.* They have the opaque incrustation which renders almost impossible the microscopic study of the fruit-body until sections are treated with dilute potash which fortunately, dissolves all or most of the granular matter fairly quickly. With this picture in mind and with the amyloid test for the spores, it is easy to recognise most lamellate collections. The species grow on dead wood and various plant-remains, and are not terricolous. A chalky white edge to the gill may be a sure sign. However, I have added from the Malesian flora two new subgenera, *Megalopanellus* and *Mesopanellus,* in which the stem is not lateral or the pileus sessile, as usual in *Pleurotus,* but central or excentric so that one begins to think of an ordinary agaric as *Collybia, Marasmius,* or *Tricholoma.* The decurrent gills, amyloid spores, acerose basidioles, dichophysial processes from the superficial hyphae, and the pallid colour of the pileus become diagnostic. In fact, *Megalopanellus* begins to disclose with its large fruit-bodies the ancestry of the genus.

Dictyopanus Pat.

In the course of collecting, one will find that the underside of the fruit-body, with obvious resemblance to *Panellus,* is not lamellate but closely poroid with the characteristic chalky opacity (Fig. 2). These polyporoid species were the object of the genus *Dictyopanus,* for which it would serve a useful purpose if generic names were taken as ideas and not, as now, for type-species. It has been realised for some time that no sharp line can be drawn between the lamellate and the poroid species; there are intermediates partly poroid and partly lamellate or with the gills closely connected by poroid reticulations in the interstices. It happens that the type-species of *Dictyopanus,* namely *D. pusillus,* has just such an intermediate variety in the American tropics; it is var. *pseudorhipidium* Singer, of which var. *sublamellatus* Corner may be a synonym (Fig. 3). Accordingly, *Dictyopanus* has been reduced to *Panellus* by Burdsall and Miller (1975) and referred to subgen. *Panellus.* Presumably all species of *Dictyopanus* must be transferred to *Panellus* whether or not they have lamellate indication; otherwise, they are without a genus unless it is *Favolaschia.*

Favolaschia (Pat.) P. Henn.

This genus of long uncertainty, dating from 1895, has been revised by Singer (1945, 1975) and by Dennis (1952, 1970). The extraordinary fact that emerges is that their definitions reveal no distinction from *Dictyopanus.* Perusal of the species now attributed to *Favolaschia* shows that some are panelloid as *Dictyopanus* and others are mycenoid, including the type-species. Singer (1969) made the new family Favolaschiaceae to be allied with the thelephoraceous Aleurodiscaceae, in which he is followed by Jülich (1981). Alliance with Panellaceae was ruled out; yet, there is no fundamental difference between the descriptions of the two families; they read almost exactly alike. Clearly, there is still some misunderstanding. Thus, *D. gloeocystidiatus* Corner (1954), which I here transfer to *Panellus,* was left out of

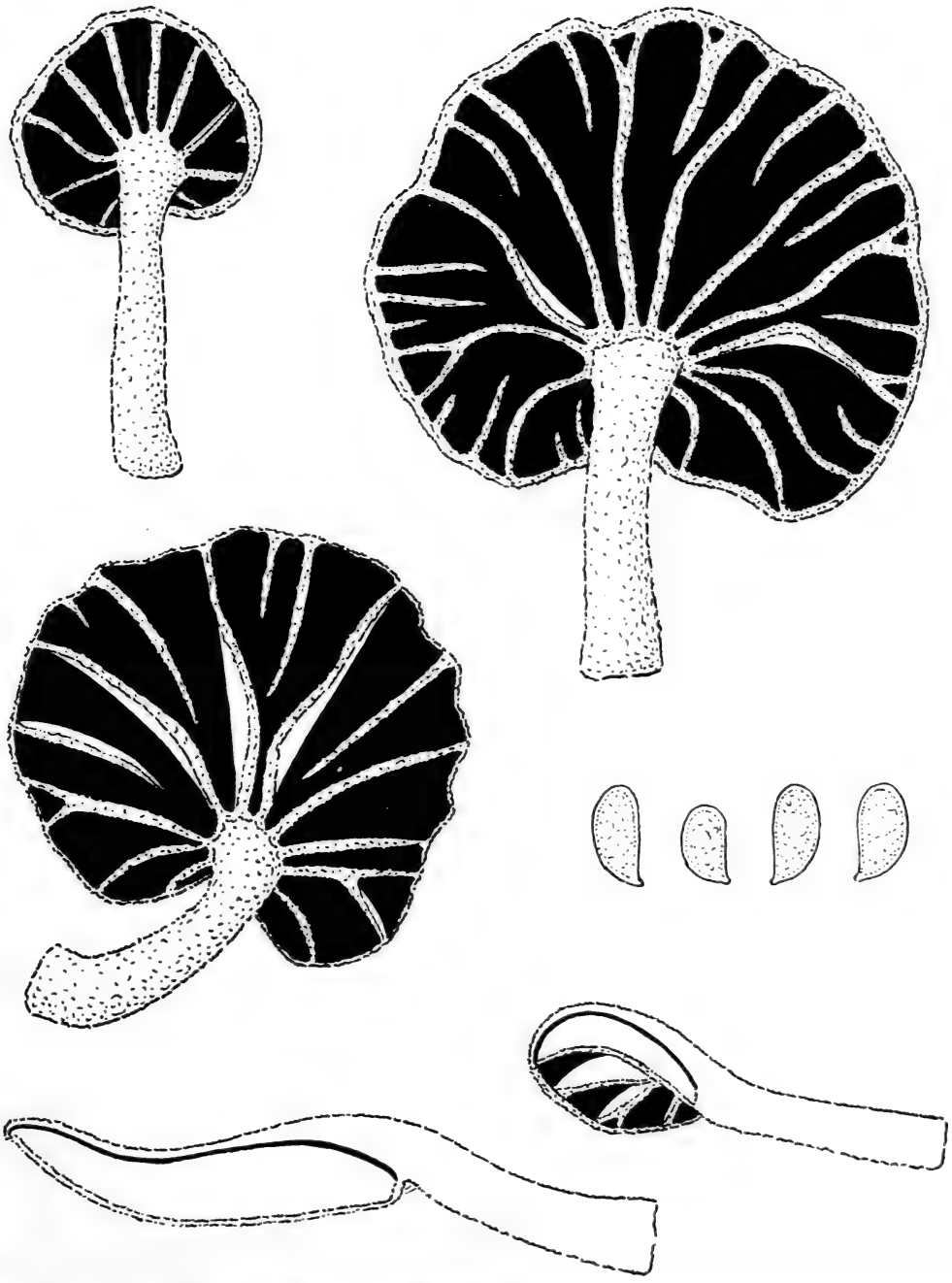

Fig. 1. *Panellus sp.* (aff. *P. pteridophytorum* Singer) from Brazil, to show the lamellate form with distant gills; × 12, the spores × 1200.

consideration because it upset any supposed distinction. I do not regard *Favolaschia* as a suitable deposit for poroid *Panellus*.

Lamellate and poroid species of *Panellus* in Malesia

Dictyopanus having been lost, I refer to the many species with gills, not pores, as the lamellate, and to the many with pores, not gills, as the poroid. The question arises whether the species of one group can be related to any of the other. The

more or less lamellate variety of *P. pusillus* has not been found in Malesia, but there is the new species *P. intermedius* of Borneo with deeply poroid-reticulate gills as an intermediate (Fig. 14), and I add the poroid *P. sublamelliformis* of the Solomon Islands, the pores of which become lamelliform peripherally. I have searched for instances and found only the close relation between the lamellate *P. parvulus* and the poroid *P. sublamelliformis,* both growing on bamboo remains in the Solomon Islands. I listed the species of both categories according to spore-size as the most immediate means of assessing affinity, and found four other possible pairs of lamellate and poroid species. When, however, other details of construction were taken into account, it became obvious that the pairs could not be closely related in spite of their similarity in spore. These points of construction showed that there were remarkable anatomical parallels between the lamellate and the poroid. Thus, for the species with acerose basidioles, there are three sets of parallels, as follows:

1. Cheilocystidia and pileocystidia absent.
   Lamellate — *P. brunneomaculatus, P. sublevatus*
   Poroid — *P. copelandii, P. pauciporus*
1. Cheilocystidia present.
   2. Cheilocystidia and/or pileocystidia gloeocystidial, subcylindric
      Lamellate — *P. dichotomus, P. parvulus*
      Poroid — *P. bambusifavolus, P. gloeocystidiatus, P. megalosporus, P. orientalis*
   2. Cheilocystidia not gloeocystidial, more or less clavate.
      Lamellate — *P. bambusarum, P. exiguus, P. intermedius*
      Poroid — *P. brunneifavolus, P. luminescens, P. microsporus, P. pusillus, P. sublamellatus.*

It looks, therefore, as if the poroid may have arisen along three separate lines of evolution, and that *Dictyopanus* must be regarded merely as an unnatural form-genus.

I have recorded 8 species as growing on bamboo remains, one from Borneo and the others from the Solomon Islands, thus:

Lamellate — *P. ambiguus, P. bambusarum, P. parvulus, P. sublevatus* (Borneo).
Poroid — *P. bambusifavolus, P. brunneifavolus, P. pauciporus, P. sublamelliformis.*

Of these, one could associate on spore-size the lamellate *P. parvulus with poroid P. sublamelliformis,* and the lamellate *P. ambiguus* with the graminicolous and poroid *P. copelandii.* Singer has described several bambusicolous species from South America none of which seems to fit with the oriental.

Surface structure of the fruit-body

In subgen. *Panellus,* to which most Malesian species belong, the general construction of the surface of the pileus, stem, and gill-edge is shown in Figs. 4 and 5. Cystidia protrude into a superficial felt of narrow hyphae the ends of which ramify into lobules, spicules, or diverticula, and the ends are more or less heavily encrusted with the granular matter that dissolves in dilute potash. The construction seems to be a perfection of Singer's *Rameales*-structure. The narrow, ramified, and diverticulate hyphae have been called acanthophyses, dendrophyses, dichophyses, and astereostromelloid according to the appearance of one or other of these branching hyphal ends with die-away growth. The branchings and lobings, however, are generally so varied and intricate that there are many transitions, even in the same species, from one ideal form to another. I prefer to call them simply

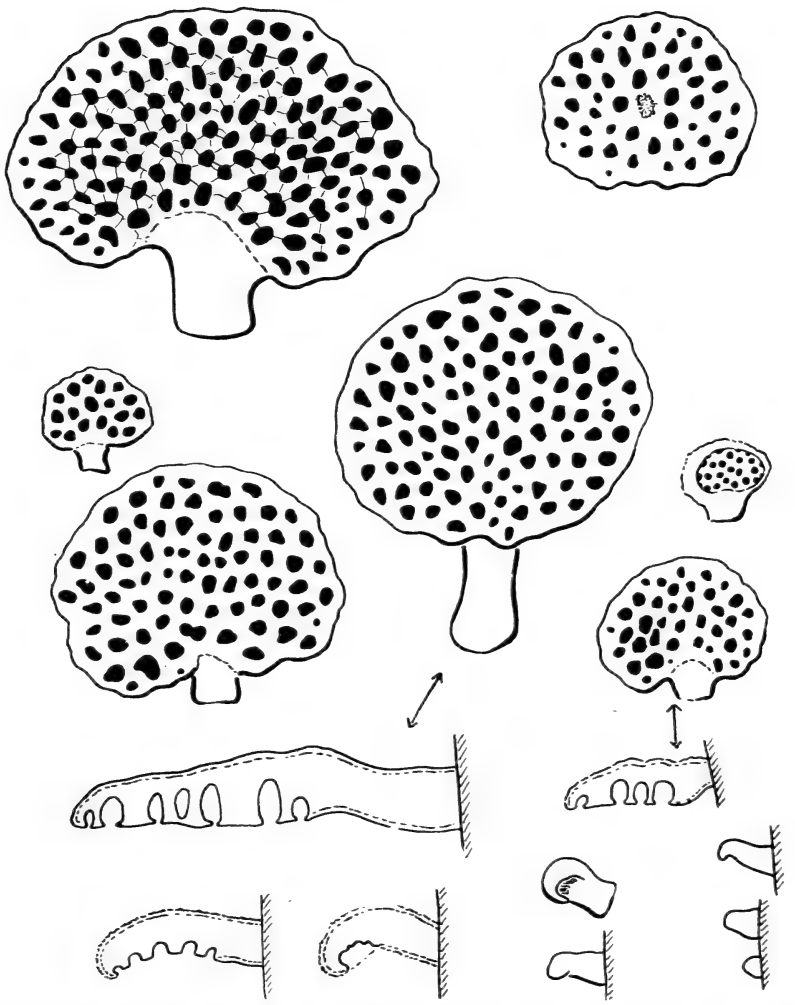

Fig. 2. *Panellus luminescens*, showing the poroid form of the genus, previously called *Dictyopanus;* × 15. (from *Mycologia* 42, 1950, 424).

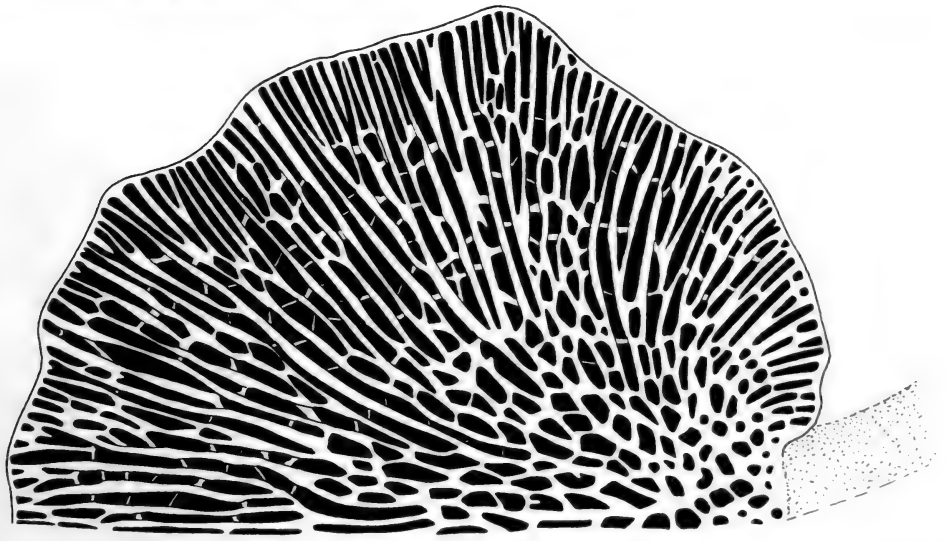

Fig. 3. The sublamellate variety of *Panellus pusillus;* × 10. (from *Trans. Brit. Mycol. Soc., 37, 1954, 260).*

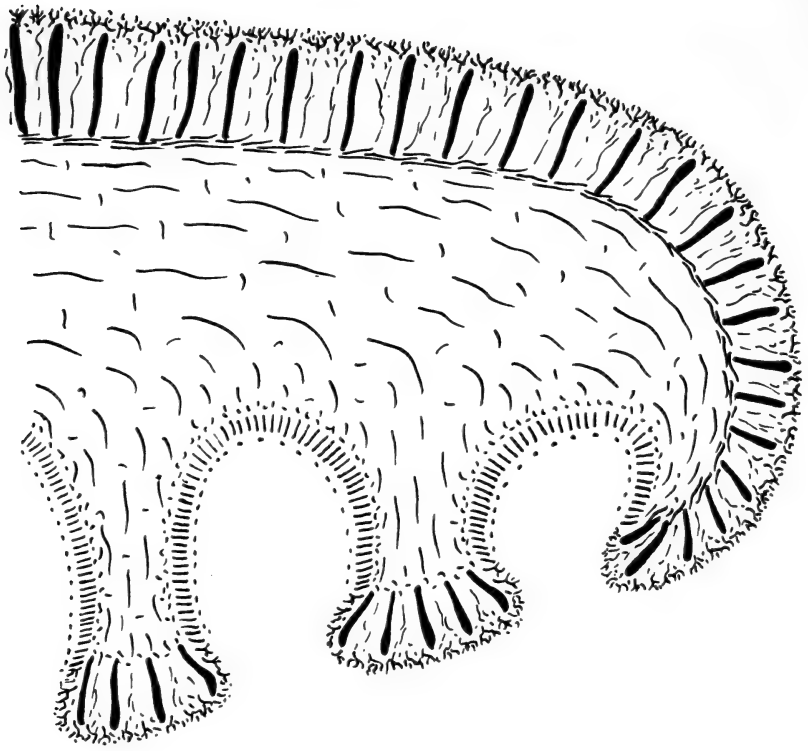

Fig. 4. *Panellus gloeocystidiatus*. Diagram of the structure of the pileus, with the gloeocystidia shown in black. (from *Trans. Brit. Mycol. Soc.* 37, 1954, 257).

dichophysial hyphae. They appear as sterile hymenial hyphae given over to excessive branching with decreasing width until mere lobules or spicules are produced. They do not occur in the fertile hymenium except occasionally as an invasion from the edge of gill, pore, or pileus.

This surface structure develops as a palisade of cystidia on the primordial parts. The palisade becomes disrupted as the internal tissues expand and the dichophysial hyphae grow out between the cystidia to overtop them; they may extend up to 150 μ before developing the terminal mat of encrusted diverticula. In some cases, especially when the cystidia are gloeocystidial and subcylindric, they lengthen into the intricate felt of hyphae, even exceeding themselves and becoming septate (without clamps) at the apex as the cytoplasm is withdrawn. In other cases, especially with more clavate ones, they may themselves produce an intricate tangle of coralloid and spiculiform dichophysial hyphae.

There are the following variations in surface structure:

1, The cystidia may have dense oleaginous contents and can be called gloeocystidia. In some cases the contents become vacuolate and the original gloeocystidial nature is not evident in the mature tissue.

2, As mentioned, the cystidia may themselves produce dichophysial hyphae and, in so doing, may also become unrecognisable in the mature tissue.

3, The mat of dichophysial hyphae may not develop, particularly on the pileus or the edge of gill or pore. Examples are the lamellate *P. alutaceus, P. fuscatus, P. pendens,* and the poroid *P. albifavolus, P. hispidifavolus,* and *P. microsporus.*

4, The surface of the pileus may be more or less gelatinous. Examples are the lamellate *P. exiguus* and *P. longinquus* and the poroid *P. bambusifavolus.* Singer gives several examples from tropical America.

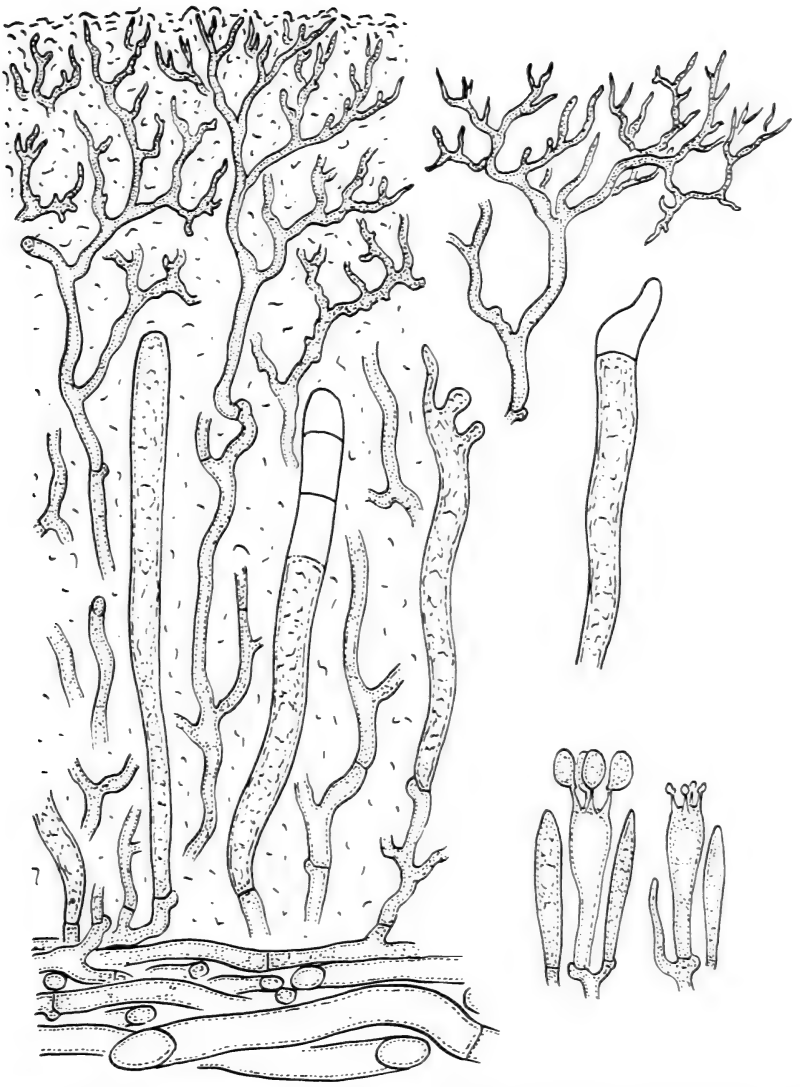

Fig. 5. *Panellus gloeocystidiatus*. Details of the surface of the pileus with gloeocystidia and dichophysial hyphae (simplified), with basidia and acerose basidioles, × 1000. (from *Trans. Brit. Mycol. Soc.* 37, 1954, 257).

This is a degradation series in which the original and detailed construction disappears. As in other cases with a hymeniiderm, or palisade of clavate cells, such as *Amauroderma, Boletus, Entoloma,* or *pluteus,* it presupposes a trichoderm or cortical pile of inflated and septate ends. The extensive hymeniiderm is shown by subgen. *Mesopanellus* (Figs. 24, 25) and the primitive trichoderm by subgen. *Megalopanellus* (Fig. 28). Both subgenera have the more primitive characters of centric pileus and inflating hyphae.

Hyphae of the fruit-body

The hyphae are monomitic, clamped, inamyloid, and usually colourless, and have short cells up to 250 μ long, in a few cases longer but not of exceptional length. There are, however, such differences in the degree of inflation, the thickening of the hyphal walls, and their tendency to become gelatinous that more precise characterisation is impossible (Fig. 6). In subgen. *Panellus* the greatest inflation

occurs in *P. parvulus* with thin-walled hyphae -20 μ wide. *P. intermedius* and *P. sublevatus* have some hyphae -16 μ wide. In others, the hyphae have slightly inflated cells 8-14 μ wide in the stem and base of the pileus; commonly these cells are inflated unequally in different parts, perhaps because of the lateral pressure from the hyphae. Failure to support the rather dense fruit-body by turgidity is compensated by thickening of the hyphal walls, even up to 5 μ thick, with correspondingly reduced lumen. As a variation, the whole tissue becomes toughly gelatinous with agglutinated and uninflated hyphae, for instance *P. dichotomus*.

The gradual loss of inflation implies the derivation of *Panellus* from some typical agaric ancestry which is presented by *P. magnus* of subgen. *Megalopanus*. This species shows the tendency to dichophysial hyphae arising almost like binding hyphae in the inner tissue (Fig. 29). In contrast, the poroid species have more or less uninflated hyphae in the pileus in accordance with their subcircular pores.

Basidioles — pleurocystidia

The hymenium of most species carries, as well as basidia, narrow fusiform cells 3-5 μ wide, often with acute, or even, mucronate tip. They are regarded as sterile cells or basidioles though it seems that it has still to be shown that they are not merely immature basidia which, on charging, would become clavate (Fig. 7). Acerose basidioles occur in several genera of agarics, such as *Collybia* and *Marasmius*, but it is not clear if they have generic distinction. In some species which agree in other respects with *Panellus*, basidioles seem not to occur. It is impossible to prove a negative, in this case their total absence, and I have not used the feature as a primary character.

Pleurocystidia differ from basidioles in their larger size which follows from their early differentiation in the developing hymenium; they are usually the first mature cells to be formed and have, in consequence, a deeper origin in the subhymenium, even from the first out-turned branches of the tramal hyphae. Basidioles are the last formed cells and appear in numbers as branches from the more superficial subhymenial hyphae. Pleurocystidia have been described for some South American species, as *P. cystidiosus* Singer and *P. dumontii* Singer, but seem to be lacking from other species of subgen. *Panellus* unless, perhaps, in the Malesian *P. bambusarum*. The structures called pleurocystidia by Burdsall and Miller (1975) seem to be basidioles, but the temperate *P. serotinus*, in their subgen. *Mitellus* has abundant pleurocystidia. Species of this subgenus, the distinction of which is not clear, have not been found in Malesia.

Spores and basidia

The impression, gathered from the literature, is that *Panellus* (including *Dictyopanus*) has rather small, often cylindric to allantoid, spores. This contrasts with the rather large, ellipsoid to subglobose, spores in many species of *Favolaschia*. Any such distinction does not hold, however, in the eastern tropics. In 1963 Kobayasi described *D. orientalis* with subglobose spores 8 × 7 μ. I add several lamellate and poroid species with moderately large ellipsoid or subglobose spores, among which the poroid *P. megalosporus* is outstanding with subglobose spores up to 18 × 16 μ, produced by enormous basidia averaging 90 × 17.5 μ. In contrast, the smallest spores in Malesian species are the minute allantoid spores, averaging 3.5 × 0.8 μ, of the poroid *P. microsporus* (Fig. 8). *Panellus* is revealed as a genus with great latitude in spores and basidia and one that must have come from an agaric source with large spores on large basidia which qualify for Singer's *Hygrophorus* kind; that is with basidium-length at least 5-6 times the width of the spore. No

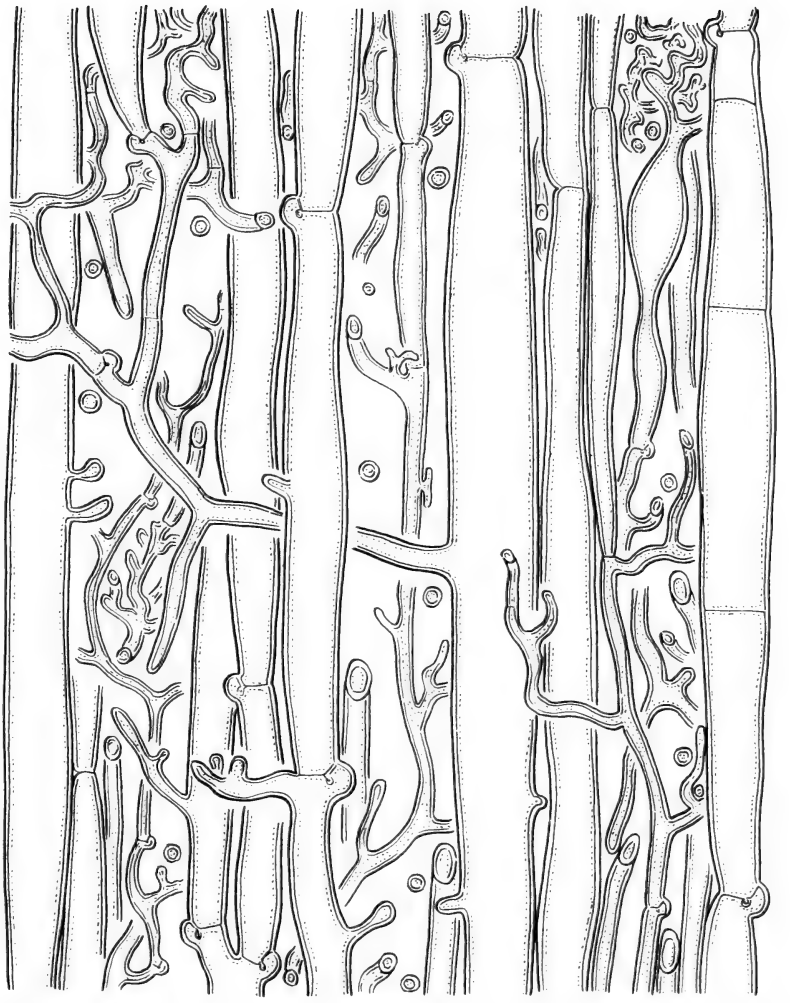

Fig. 6. *Panellus sp.* (aff. *P. pteridophytorum* Singer), showing the variation in inflation of the hyphae of the fruit-body and in the thickening of the walls; × 500.

lamellate *Panellus* is known with spores as large as those of *P. megalosporus*, though such a one may be found. I note that the minute allantoid spores of *P. microsporus* should place it in subgen. *Mitellus* but, in all other respects it belongs in subgen. *Panellus*. I note, too, that the spores of the Malesian *P. albifavolus*, *P. ambiguus*, and *P. brunneomaculatus* are hardly amyloid, if at all.

With this range in size of spore and basidium I constructed sporographs and basidiographs but found, as with *Polyporus* (Corner 1981), that no clear locus was obtainable. The reason seemed to be that the variation in size shown mainly by the poroid species, was effected by compression of the basidium-unit in the tubes. Thus, the ratio of spore-width to basidium-width varied from 0.21 in the highly compressed and allantoid spores of *P. microsporus* through all gradations to 0.8 in *P. megalosporus* and 0.87 in *P. orientalis*. However, the usual trends were clear, as follows:

1, Spore-volume increased in direct proportion to basidium-volume.
2, Spore-width increased with spore-length.
3, Basidium-width increased with basidium-length, the smallest structures being the basidioles.

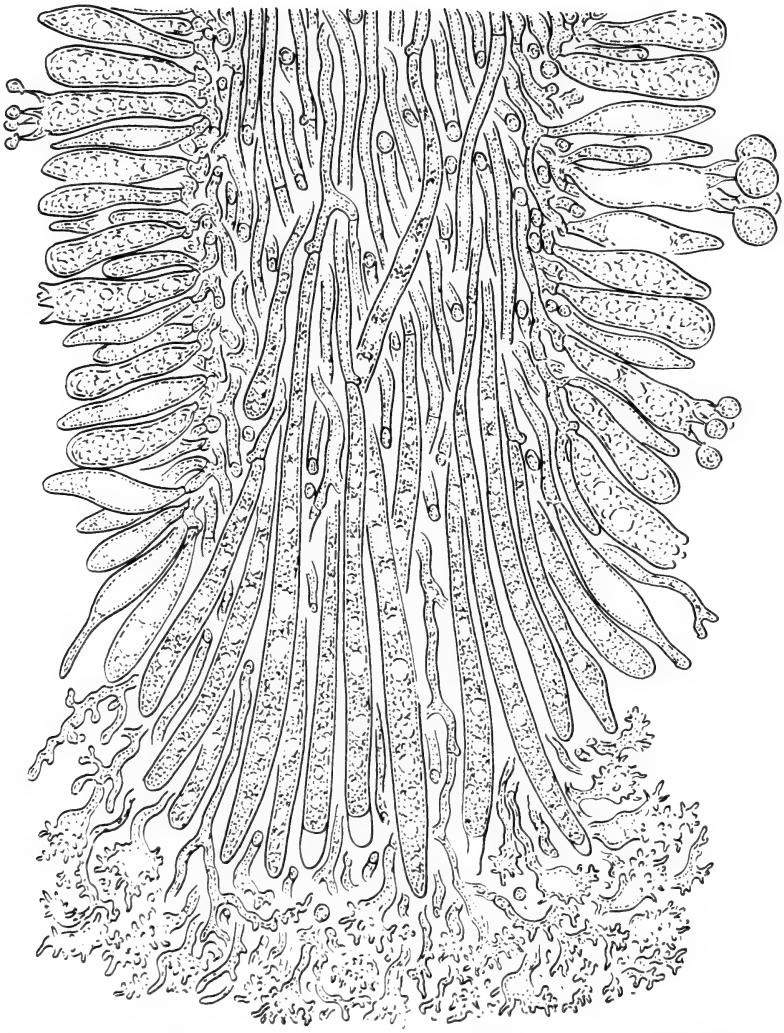

Fig. 7. *Panellus orientalis*, showing the pore-edge with gloeocystidia and dichophysial hyphae; × 600.

4, The large spores and large basidia of *P. megalosporus* were consistent with an average sporograph-locus and an average basidium-locus, the value of which, for the basidium-locus, was $l/w = 2.9 \times 0.025l$, where l is the basidium-length and w its width.

Taking figures that I have given for other genera with large spores and basidia (Corner 1983), l/w varies as $0.069l$ in *Heimiella*, $0.02l$ in *Oudemansiella*, and $0.013l$ in *Amauroderma* and *Ganoderma*. These values contrast with $0.08l$ for the narrow clavarioid basidium.

Phosphorescence

Several species of subgen. *Panellus* are known to be phosphorescent with a greenish light emitted from the gills or pores and the mycelium; others are not phosphorescent, but the majority remains to be tested. The phosphorescent are *P. stypticus* (in North America), *P. luminescens*, *P. gloeocystidiatus*, and the Japanese *Dictyopanus foliicolus* Kobayasi. *P. orientalis*, according to Kobayasi, and *P. megalosporus* are not phosphorescent. In the case of *P. stypticus*, North American

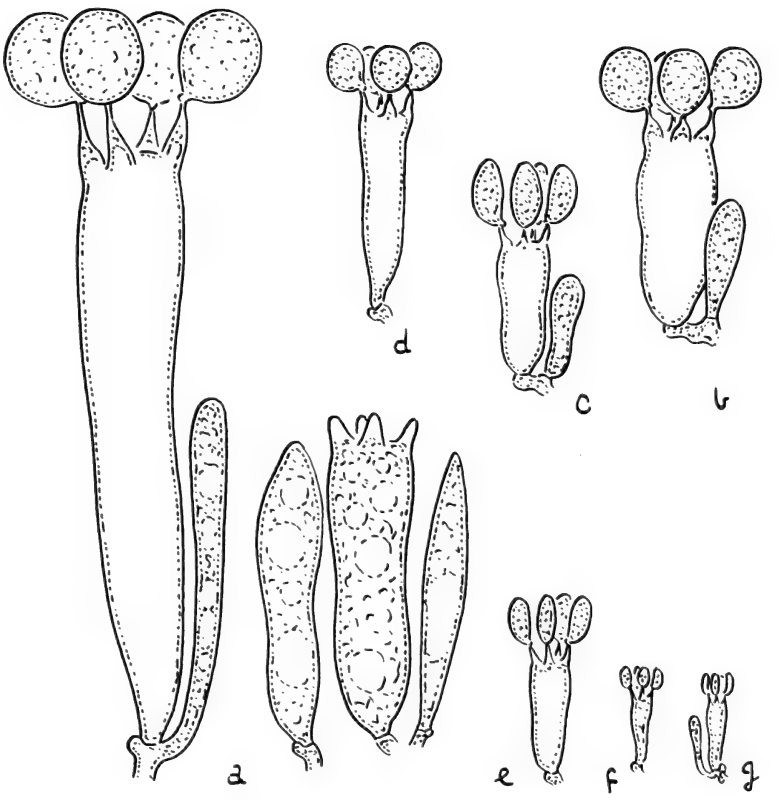

Fig. 8. Basidia and spores of *Panellus*, to show the variation in size and shape; × c. 700. *a, P. megalosporus; b, P. brunneifavolus; c, P. luminescens* (large spores); *d, P. orientalis; e, P. luminescens* (small spores); *f, P. gloeocystidiatus; g, P. microsporus.*

specimens are phosphorescent but not the European. When the mycelia of the two forms were mated, it was found that phosphorescence appeared as a dominant character (Macrae 1937).

Possibly the origin of *Panellus* is to be related with that of the phosphorescent species of *Pleurotus* with large spores (Corner 1981).

Panellus Karst.

Hattsv, Bidr, Finl. Nat. Folk 32 (1879) xiv; Singer, Agaricales Mod. Tax. (1975) 339.
Dictyopanus Pat., Ess. Tax. Hym (1900) 137; Singer. Agaricales Mod. Tax. (1975) 338.

Pileus mesopodal, pleuropodal, or sessile, medium-sized to very small, mostly *white, bistre, ochraceous, to cinnamon and rufous brown* but golden yellow, olive green, or violaceous in exotic species, mostly *opaque*, gymnocarpic with incurved margin. Gills adnate to decurrent, or with small to minute pores; *edges of gills or pores usually chalky pruinose.* Flesh thin, soft, tough or more or less gelatinous.

Spores *white, smooth, more or less amyloid,* subglobose to ellipsoid, cylindric or allantoid, large to minute. Basidia mostly 4-spored; *basidioles subacerose, but lacking in some species;* subhymenium usually narrow, with interwoven hyphae; hymenium not thickening. Cheilocystidia *usually present,* thin-walled, with or without oleaginous contents, in some species emitting diverticula, forming a sterile edge to gill or pore, *generally becoming overgrown with encrusted dichophysial hyphae.* Pleurocystidia generally absent except in some exotic species. Hyphae *monomitic, usually clamped,* inflating or not, with thin or thickened walls, in some

species more or less gelatinous, rather short-celled, not sarcodimitic, not amyloid. Surface of pileus and stem *usually with a palisade of cystidia becoming disrupted and overgrown by dichophysial hyphae encrusted with granular matter* soluble in dilute potash in some cases practically smooth, with or without a thin gelatinous pellicle.

On dead wood, stems, and leaves, Cosmopolitan, c. 55 species, 27 species in Malesia and the Solomon Islands.

This is the best that I can do to extract a generic character. The genus has what are called pleurotoid and marasmioid fruit-bodies distinguished by the amyloid spores and, usually, by the excrescent and encrusted dichophysial hyphae. No poroid forms are mesopodal.

1. Pileus mesopodal or excentric, with well developed stem. Gills not reticulately veined. Hyphae generally not granular encrusted, inflating
   2. Pileus 2-9 cm wide, fuscous fuliginous furfuraceous squamulose. Basidioles lacking. Pileus with a disrupted trichoderm without dichophysial hyphae. Flesh rather tough, not gelatinous ..... subgen. *Megalopanellus* p. 143
   2. Pileus 1-2 cm wide, not furfuraceous squamulose. Basidioles acerose, copious. Cheilocystidia clavate, with oleaginous contents. Surface of pileus hymeniiform and with dichophysial hyphae ..... subgen. *Mesopanellus* p. 139
1. Pileus lateral, dorsifixed, or sessile, usually with short stem. Pileus 1-40 mm wide. Basidioles present or not. Hyphae often granular encrusted, in some cases more or less gelatinous. Surface of pileus without a trichoderm, generally with dichophysial hyphae ..... subgen. *Panellus* p. 114
   3. Lamellate, with or without poroid reticulate interstices ..... Lamellate species p. 114
   3. Poroid ..... Poroid species p. 128

Subgen. **Panellus**

Singer, Agaricales Mod. Tax. (1975); Burdsall and Miller (1975). 24 species in Malesia and the Solomon Islands (11 lamellate, 13 poroid).

Key to the lamellate species of subgen. *Panellus* in Malesia and the Solomon Islands

1. Hymenium without acerose basidioles. Surface of pileus and gill-edge not granular encrusted ..... Group A
1. With acerose basidioles. Surfaces generally granular encrusted ..... Group B

GROUP A

1. Pileus sessile, dorsifixed, -15 mm wide. Gills distant, 1 mm wide. Spores 4.3-5 × 3.5-4 μ, deeply amyloid. Surface of pileus with appressed oleaginous hyphae in a single layer. Cystidia none. Borneo ..... *P. pendens* p. 126
1. Pleuropodal, Spores larger, pale amyloid. Pileus -30 mm wide, surface with different structure.
   2. Spores 7.5-10 × 3.3-4 μ m. Cystidia none. Hyphae -21 μ wide. Surface of pileus with a thin gelatinous layer, pale bistre ochraceous. Gills -5 mm wide. Queensland ..... *P. longinquus* p. 124
   2. Spores 5-6 × 4.7-5.7 μ, subglobose. Cheilocystidia clavate to ventricose. Hyphae -13 μ wide. Surface of pileus dry, with a disrupted palisade of clavate cells with pale fuscous sap, buff-white and fuscous brownish scurfy. Borneo ..... *P. fuscatus* p. 121

GROUP B

1. Pileus 1-3 mm wide. Gill-primaries 3-5, often pore-like if without short secondaries
   2. Dorsifixed, pale fawn. Spores 8.5-10.7 × 3.7-4.5 μ. Cheilocystidia cylindric to clavate. Surface of pileus subgelatinous. On fern petioles. Malaya ..... *P. exiguus* p. 120
   2. Pleuropodal, white, scurfy-pruinose. Spores 7-8 × 5-6 μ. Gill-edge and surface of pileus with dichophysial hyphae. On dead bamboo. Borneo ..... *P. sublevatus* p. 127
   (Spores 4.5-6 × 3-3.7 μ ..... *P. bambusarum* p. 117)

1. Larger, with more gills
   3. Gills with deeply poroid-reticulate interstices. Pileus-10 mm wide, white to pale fawn. Flesh not gelatinous. Cheilocystidia clavate with a few apical processes. Pileocystidia none. On sticks. Borneo
      4. Spores 8-10 × 4.5-5.7 μ Cheilocystidia 5-11 μ wide. Hyphae -16 μ wide .. *P. intermedius* p. 123
      4. Spores 7-9 × 3.5-4.5 μ. Cheilocystidia -14 μ wide. Hyphae -9 μ wide ... var. *stenosporus* p. 124
   3. Gills not conspicuously reticulate in the interstices, mostly smooth.
      5. Surface of pileus and gill-edge not granular encrusted, without dichophysial hyphae. Cheilocystidia involved in brown resinous matter. Spores 4-6 × 2.5-3 μ. Pileus -10 mm wide, sessile, pale alutaceous. Borneo ..... *P. alutaceus* p. 115
      5. Surface of pileus and gill-edge granular encrusted, with dichophysial hyphae
         6. Without distinct cheilocystidia or pileocystidia. Pileus -4 cm wide, pleuropodal or excentric, with stem 3-12 x 2-4 mm. Gills very crowded. Spores 5-6.5 × 2-2.5 μ. On wood, Solomon Islands ..... *P. brunneomaculatus* p. 118
         6. With cystidia
            7. Cystidia clavate, not gloeocystidial. Spores 4.5-6 × 3-3.7 μ. Pileus -6 mm wide, subsessile, white to brownish. On dead bamboo. Solomon Islands ..... *P. bambusarum* p. 117
            7. Cheilocystidia and pileocystidia gloecystidial
               8. Cystidia 3-7 μ wide, subcylindric. Flesh subgelatinous. Pileus -3 cm wide, brownish ochraceous to subrufous. Spores 2.7-3 × 1.7-2 μ. On wood ..... *P. dichotomus* p. 118
                  9. Gills repeatedly dichotomous ..... var. *dichotomus* p. 118
                  9. Gills pinnate ..... var. *pinnatus* p. 120
               8. Cystidia clavate, especially the pileocystidia. Flesh not gelatinous. Pileus -10 mm wide, white to pale ochraceous. Spores 6-8 × 4-5.5 μ. On dead bamboo. Solomon Islands.
                  10. Cheilocystidia 5-8 μ wide. Pileocystidia 12-15 μ wide, with copious dichophysial hyphae at the base of the pileus ..... *P. parvulus* p. 125
                  10. Cheilocystidia -16 μ wide, mixed narrow branched hyphae set with short processes. Surface of pileus set with narrow, simple or sparingly branched, excrescent hyphae, not dichophysial. Spores not or scarcely amyloid ..... *P. ambiguus* p. 116

Panellus alutaceus *sp. nov.* Fig. 9

Ex integro alutaceus, sessilis, horizontalis. Pileus -10 mm in radio, siccus, basim versus subvillosus. Lamellae confertae. Caro subcoriacea, haud gelatinosa.

Sporae 4-6 × 2.5-3 μ, amyloideae. Basidiola acerosa inconspicua. Cheilocystidia 20-35 × 4-7 μ, lanceolata vel subventricosa, saepe breviter appendiculata vel capitata, haud incrustata, in resina brunnea immersa. Pleurocystidia nulla. Hyphae -18 μ irregulariter inflatae, fibulatae, tunicis 1-2 μ crassis, haud incrustatae. Superficies pilei hyphis angustis 2-5 μ latis appressis ut in lamina c. 20 μ crassa instructa.

Ad lignum emortuum in silva. Borneo, mt. Kinabalu, 20 Jul. 1961, *Corner s.n.* typus, in herb. Corner.

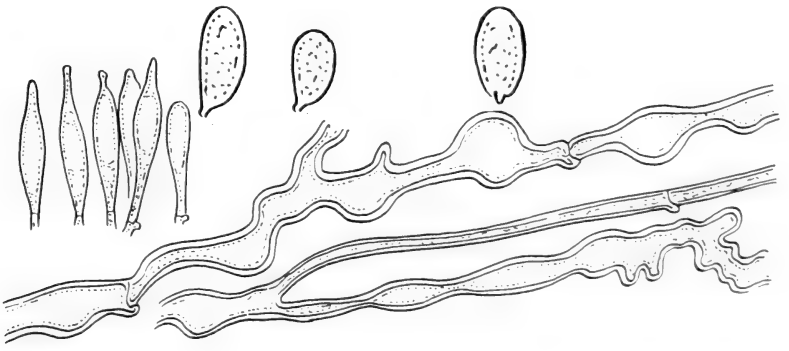

Fig. 9. *Panellus alutaceus*. Spores, × 2000; cheilocystidia and hyphae of the pileus, × 500.

Sessile, horizontal, pale biscuit colour. Pileus 1 cm radius, subvillous towards the base, dry. Gills arising from the base, c. 14 primaries 1 mm wide, 3-4 ranks, not dichotomous, somewhat crowded, the edge entire and darker. Flesh thin, floccoso-firm to subcoriaceous, no gelatinous layer.

Spores 4-6 × 2.5-3 μ, white, smooth, pip-shaped, amyloid. Basidia 18-25 × 4 μ; sterigmata 4; acerose basidioles present but inconspicuous. Cheilocystidia 20-35 × 4-7 μ, lanceolate to subventricose, often with a short cylindric appendage, capitate or not, thin-walled, not encrusted but involved in resinous brown matter, forming a sterile gill-edge. Pleurocystidia none. Hyphae monomitic, clamped, irregularly inflating -18 μ wide, often of different widths in different parts of a cell, the walls eventually thickening 1-2 μ closely interwoven and longitudinal in the pileus descending and subparallel in the gills; not granular encrusted. Surface of pileus covered by a thin layer c. 20 μ thick of narrow, radiating, mostly thin-walled hyphae 2-5 μ wide, without pileocystidia but with some excrescent hyphal ends at the base of the pileus.

On dead wood in the forest. Borneo.

Mt. Kinabalu, east ridge 3200 m alt., 20 July 1961, *Corner s.n.*

Panellus ambiguus *sp. nov.*

Albus, dein in centro pilei pallide ochraceus, sessilis vel subpleuropodalis. Pileus −10 mm latus, convexus dein planus, striatus. Stipes ut pulvinula lateralis vel nullus. Lamellae adnatae, subdistantes, primariis 6-12, haud reticulatae, acie pruinosula. Caro mollis, haud gelatinosa.

Sporae 6-8.5 × 4-5.7 μ, haud vel vix amyloideae, Basidiola acerosa. Cheilocystidia trimorpha; 35-50 × 11-16 μ, clavata, intus oleaginosa, copiosa sed aliis superantibus; -55 × 7-12 μ, subclavata vel subfusiformia obtusa, intus oleaginosa; -50 × 3-5 μ, subcylindrica ramosa, diverticulis copiosis, simplicibus spiciformibus vel furcatis, -11 μ longis praedita, leniter incrustata. Pileocystidia ut cheilocystidia clavata, hyphis 1-1.8 μ latis sparsim vel vix ramosis superantibus, haud dichophysialibus. Hyphae 3-14 μ latae, fibulatae, nec gelatinosae nec incrustatae.

Ad folia caulesque bambusarum in silva. Insulae Solomonenses, Guadalcanal *RSS 566* typus, in herb. Corner.

White, the pileus pale cream ochraceous in the centre, sessile or subpleuropodal. Pileus -10 mm wide, convex then plane, reniform, smooth, striate; margin subpruinose. Stem as a slight lateral cushion or none. Gills adnate, subdistant, thin, dry, 6-12 primaries -1 mm wide, 3-4 ranks, not poroid or veined, the edge minutely pruinoso-scurfy. Flesh thin, soft, not gelatinous.

Spores 6-8.5 × 4-5.7 μ, white, smooth, pip-shaped, with rather oleaginous contents, not or slightly amyloid. Basidia 24-33 × 6-6.5 μ; sterigmata 4, 4-5 μ long; acerose basidioles numerous; subhymenium narrow, not corticate. Cheilocystidia of three kinds, thin-walled, not amyloid or dextrinoid; 1, 35-50 × 11-16 μ, clavate, with oleaginous-vacuolate contents, very abundant as a sterile edge but overgrown by the others, smooth; 2, -55 × 7-12 μ, narrowly clavate to subfusiform with obtuse apex, with oleaginous-vacuolate contents, scattered, generally projecting beyond the first kind; 3, as emergent hyphal ends -50 × 3-5 μ, branched and more or less copiously set along their length with simple or forked, often spicate, processes 2-11 μ long, (not clavate with apical processes), often thinly encrusted, very abundant along the gill-edge and more or less covering the other cystidia. Pleurocystidia none, but occasionally the acerose basidioles somewhat enlarged. Hyphae monomitic, clamped, more or less inflating in stem, pileus and gills with cells 40-200 × 3-14 μ and mostly tapered at the ends, not gelatinous, not granular encrusted, more or less longitudinal, rather compact. Surface of pileus covered with filiform, simple or sparingly branched, more or less erect hyphae 1-1.8 μ wide, not gelatinous, with scattered and more or less decumbent pileocystidia like the larger

clavate cheilocystidia (of first kind), with abundant spores embedded in the finely villous surface.

On dead bamboo in the forest, Solomon Islands.

Guadalcanal, Gallego, Hidden Valley, 5 July 1965, *RSS 566.*

This was collected as *Marasmius,* which the practically inamyloid spores suggest, but it is difficult to see any satisfactory distinction from *Panellus* in view of the variety in the genus, and it is certainly close to *P. parvulus.*

Panellus bambusarum *sp. nov.* Fig. 10

Albus, dein pallide brunneus. Pileus -6 mm latus, lateralis subsessilis conchiformis dein planus. Stipes -1 × 0.3-0.5 mm. Lamellae adnatae subdistantes, primariae 4-6, vel subconfertae primariae 6-11, acie pruinosa. Caro mollis, haud gelatinosa, in pileo c. 100 μ crassa.

Sporae 4.5-6 × 3-3.7 μ, ellipsoideae amyloideae. Basidiola acerosa. Cheilocystidia -28 × 4-7 μ, subclavata, hyphis dichophysialibus incrustatis superantibus. Pleurocystidia -18 × 4-6 μ, ventricosa, in apicem gracilem prolongata, sparsa. Pileosystidia -50 × 4-7 μ, copiosa. Hyphae fibulatae (ut videtur), vix inflatae 1.5-11 μ latae. Superficies pilei stipitisque hyphis dichophysialibus superantibus, tenuiter incrustatis.

Ad caules emortuos bambusarum. Insulae Solomonenses, Guadalcanal, *RSS 1653* typus, in herb. Corner.

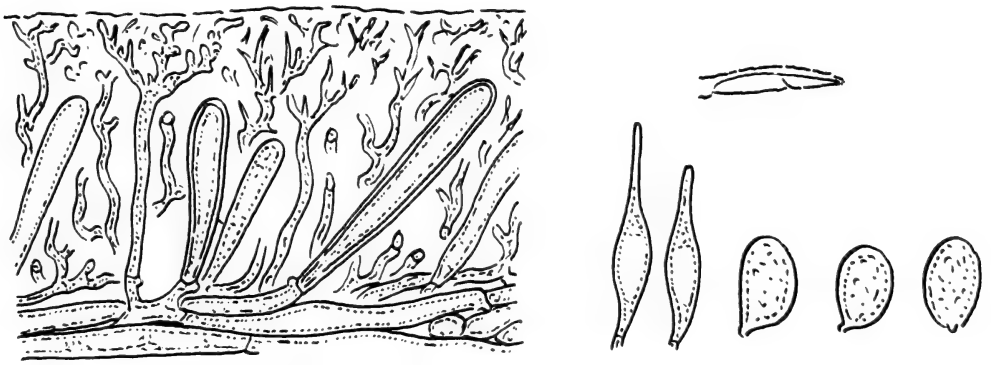

Fig. 10. *Panellus bambusarum.* Fruit-body, × 3; spores, × 2000; pleurocystidia and surface of pileus.

Pileus 3-6 mm wide, lateral, subsessile, conchate then flattened, *white then pale brownish drab-white,* substriate. Stem 0.3-1 × 0.3-0.5 mm, lateral, relatively thick. Gills adnate, subdistant, 4-6 primaries 0.5 mm wide, 2 ranks, but rather crowded with 6-11 primaries and 3-4 ranks in *RSS 1654,* not veined or poroid, white then pale fawn drab, edge whitish pruinose. Flesh c. 100 μ thick at the base of the pileus, soft, not gelatinous.

Spores 4.5-6 × 3-3.7 μ, white, smooth, ellipsoid, pale bluish amyloid. Basidia 18-22 × 5 μ; sterigmata 4; subacerose basidioles present. Cheilocystidia -28 × 4.5-7 μ, subclavate, with thin or firm walls, overgrown by a mass of profusely diverticulate hyphal ends, with bodies 2-4 μ wide, -50 μ long overall, with thin incrustation soluble in potash. Pleurocystidia -38 × 4-6 μ, ventricose with a slender subacute appendage, thin-walled, not encrusted, scattered. Hyphae monomitic, clamped (apparently, but difficult to be sure), scarcely inflating, thin-walled: in the stem longitudinal with cells 25-200 × 1.5-11 μ; in the pileus 1.5-8 μ wide, radiating; in the gill-trama 1.5-6 μ wide, descending, thin-walled. Surface of stem and pileus as the gill-edge but with more copious subclavate thin-walled cells -50 × 4-7 μ, (not gloeocystidial), thinly encrusted.

On dead bamboo stems, rather scattered, Solomon Islands.

Guadalcanal. Popomanasiu, 1800 m alt., *RSS 1653 & RSS 1654.*

Panellus brunneomaculatus *sp. nov.*

Albus, dein stipite pileoque rufobrunneo-maculatus. Pileus -4 cm latus, convexus dein planus, villosulus opacus. Stipes 3-12 × 2-4 mm, excentricus vel lateralis, villosulus. Lamellae adnexae angustae confertissimae, acie albofurfuracea. Caro firma, haud gelatinosa.

Sporae 5-6.5 × 2-2.5 μ, cylindricae, amyloideae vel vix. Basidiola acerosa copiosa. Cheilocystidia vix evoluta, lamellae acie hyphis dichophysialibus incrustatis copiosis. Pleurocystidia, caulocystidia et pileocystidia nulla. Hyphae fibulatae, 2-13 μ latae, ad basim stipitis crasse tunicatae. Superficies stipitis hyphis 2-5 μ latis excrescentibus, tunicis tenuibus, plus minus incrustatis praedita, Superficies pilei hyphis dichophysialibus 1-2.5 μ latis copiosis incrustatis praedita.

Ad truncum emortuum in silva. Insulae Solomonenses, Kolombangara, *RSS 1106* typus, in herb. Corner.

White, then the stem and pileus suffused and spotted dull rufous brown. Pileus -4 cm wide, convex then plane, smooth, opaque, drying finely subvillous. Stem 3-12 × 2-4 mm, *excentric to lateral, short,* subcylindric, solid, finely subvillous. Gills adnexed, *very crowded, narrow,* 26-31 primaries -1.3 mm wide, 4-5 ranks edge minutely chalky pruinose. Flesh 2-3 mm thick in the centre of the pileus, firm but watery. Smell none.

Spores 5-6.5 × 2-2.5 μ, white, smooth, rod-like, very pale bluish amyloid or not at all. Basidia 19-24 × 4 μ; sterigmata 4; acerose basidioles 3-4 μ wide, copious; subhymenium very narrow. Cheilocystidia none, or as scattered enlarged basidioles -40 × 6 μ, the gill-edge becoming overgrown with narrow, thin-walled, lobulating dichophysial hyphae 1-2 μ wide, thinly encrusted. Pleurocystidia none. Hyphae monomitic, clamped, subcylindric, rather short-celled, the cells 40-250 × 2-13 μ, with firm walls (subdiffluent in potash); towards the base of the stem the hyphal walls 1-2 μ thick; in the pileus longitudinal and compact; in the gill-trama more or less descending. Surface of stem with excrescent devious hyphae 2-5 μ wide, thin-walled, septate, more or less thinly encrusted in places with granules and short acicular crystals insoluble in dilute potash, forming a thin villous layer 100-200 μ thick, not as a regular pile and without caulocystidia. Surface of pileus with appressed radiating hyphae becoming covered with a subvillous layer of narrow, branching and lobulating, dichophysial hyphae 1-2.5 μ wide, granular encrusted as on the stem but more profusely branched, without pileocystidia.

On a dead standing trunk in the forest. Solomon Islands.

Kolombangara, low alt., 27 Aug. 1965, *RSS 1106.*

This has the appearance of a less reduced lamellate *Panellus* but is peculiar in the non-dichophysial covering of the stem, in contrast with the pileus and gill-edges, and the insoluble incrustation. In the almost inamyloid spores, it might be considered a species of *Marasmius,* under which name it was collected. Nevertheless, the species appears to be very close to that described from Argentina with practically no stem and with shorter spores as *P. stenocystis* Singer (Sydowia Beih, 7, 1973, 32).

Panellus dichotomus *sp. nov.* Fig. 11

Pileus -32 mm latus, pleuropodalis, convexus dein applanatus reniformis, minute rimosus, subfurfuraceus, cremeo-albus dein cervino-ochraceus vel subrufus. Stipes 1-3 × 2-5 mm, crassus lateralis brunneolus. Lamellae confertae, angustae, dichotomae ter quinquiens, cremeo-albae, acie cretaceopruinosa. Caro tenax, subgelatinosa, albida, sicco cornea.

Sporae 2.7-3 × 1.7-2 μ, ellipsoideae, amyloideae. Basidiola subacerosa, copiosa. Cheilocystidia 20-60 × 3-7 μ, ut gloeocystidia, cylindrica vel subfusiformia, saepe ex apice diverticulata, hyphis dichophysialibus incrustatis superantibus. Hyphae fibulatae, vix inflatae, tunicis tenuiter subgelatinosis. Superficies pilei stipitisque ut lamellae acie, gloeocystidiis numerosis, hyphis dichophysialibus superantibus.

Ad truncos ramulosque delapsos in silva. Peninsula Malayana, Borneo, New Guinea; *RSNB 5362* typus, in herb. Corner.

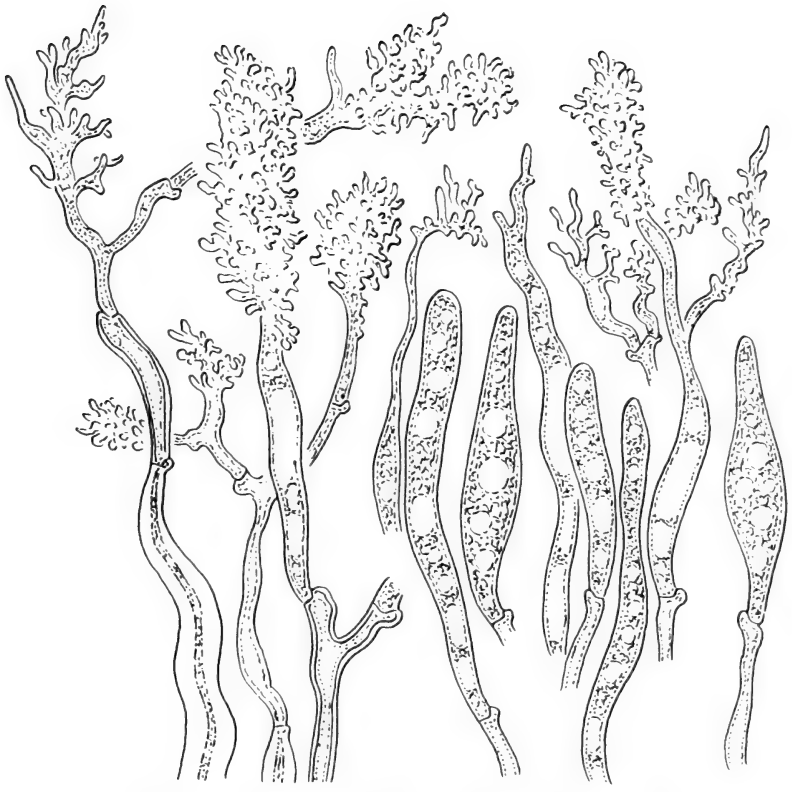

Fig. 11. *Panellus dichotomus*. Cheilocystidia, × 1000.

Pileus -21 mm radius, 32 mm wide, pleuropodal, convex then more or less flattened and reniform, *finely cracked* and rather scurfy, *cream-white then light fawn, fawn ochraceous, or subrufous;* margin incurved at first, white. Stem 1-3 × 2-5 mm, short, thick, lateral, cracked and scurfy, brownish. Gills *narrow, crowded,* 30-50 primaries -1 mm wide, *dichotomous* 3-5 times, sometimes with a free short gill near the margin of pileus, *white to pale cream with chalky edge.* Flesh -2.5 mm thick at the base of the pileus, *tough,* pliant, *subgelatinous,* drying very hard and horny, pallid white.

Spores 2.7-3 × 1.7-2 μ, white, smooth, ellipsoid, faintly amyloid. Basidia 14-17 × 3.5-4.5 μ; sterigmata 4; basidioles subacerose, abundant; with more or less amyloid mucilage round the basidia. Cheilocystidia 20-60 × 3-7 μ, subcylindric to subfusiform with oleaginous gloeocystidial contents, often developing one or more apical processes with short lobes -7 × 1.5 μ, investing the cystidia, and with excrescent hyphae 1-2.5 μ wide, with short intricate branches and lobings, even coralloid, little incrusted with granular matter soluble in potash, as sterile gill-edge. Pleurocystidia none. Hyphae monomitic, clamped, scarcely inflated, with toughly subgelatinous walls, inseparable, more or less radiating, descending in the gills. Surface of pileus and stem developed as the gill-edge as a more or less continuous, but loose, layer -100 μ thick of cystidia like the cheilocystidia with gloeocystidial contents, sending out processes 2-4 μ wide, mainly apical, developing into the lobed and spicate dendrophyses or dichophyses, accompanied by similar processes excrescent from the narrow superficial longitudinal hyphae, not mucilaginous but encrusted with brownish granular matter soluble in potash.

On wood, sticks, and fallen branches in the forest. Malay Peninsula, Borneo, New Guinea; lowland and montane.

MALAY PENINSULA. Pahang, Cameron Highlands 1300 m alt., 1 Oct. 1966, *Corner s.n.* — BORNEO. Mt. Kinabalu 1300 m alt., Liwagu River, 3 Sept. 1961, *RSNB 2715;* Bembangan River 1700 m alt., 19 Feb. 1964, *RSNB 5362;* Mesilau 1700 m alt., 11 Feb. 1964, *RSNB 5315.* — NEW GUINEA. Papua, Woitapi c. 2000 m. alt., 23 Aug. 1960, *Corner s.n.*

Superficially this closely resembles the temperate *P. stypticus* but differs in the dichotomous gills with chalky-encrusted edge and not poroid-reticulate, the smaller spores, the subgelatinous tissue, and the very intricate lobing of the dichophysial hyphae on stem and pileus. The following var. *pinnatus* has pinnate gills and, though intermediates have not been found, it does not seem that it can be separated specifically from var. *dichotomus.*

var. **pinnatus** *var. nov.*

Differt lamellis haud dichotomis sed ordinibus 3-4(-5) instructis, cinnamomeocervinis, acie flavidula. Peninsula Malayana, Pahang, Tembeling, 8 Nov. 1930, *Corner s.n.* typus, in herb. Corner.

Pileus -20 mm wide, 15 mm radius, pleuropodal, reniform, spathulate or flabelliform, wholly cinnamon fawn, drying paler and closely rugulose and minutely cracked. Stem lateral, concolorous. Gills not dichotomous but *pinnate with 3-4(-5) ranks, cinnamon fawn with light yellowish cinnamon scurfy edge,* drying dark brown. Flesh subgelatinous, tough.

Spores 2.7-3 × 1.8 μ, ellipsoid, aguttate, very pale amyloid. Microscopically as var. *dichotomus* but the gill-edge and surface of pileus and stem with abundant microscopic brown resinous masses dissolving in Melzer's iodine into brown oily masses, giving the dark colour to the dried gill-edge.

On dead fallen branches in the forest. Malay Peninsula.

Pahang, Tembeling, 8 and 10 Nov. 1930, *Corner s.n.*

Panellus exiguus *sp. nov.* Figure 12

Pileus -2 mm latus, dorsifixus cupulatus dein fere planus, laevis, sublobatus, pallide cervinus. Stipes -1.5 × 0.5 mm, dorso-lateralis, in pileo subito expansus, concolor, ad basim disco membranaceo affixus. Lamellae 3-5 alveoliformes, haud reticulatae, concolores. Caro superficie tenuiter gelatinosa.

Sporae 8.5-10.7 × 3.7-4.5 μ, subcylindricae amyloideae. Basidiola acerosa copiosa. Cheilocystidia -30 × 5-8 μ, cylindrica vel clavata, hyphis dichophysialibus superantibus. Pileocystidia 20-38 × 5-7 μ, in pellicula gelatinosa immersa. Caulocystidia nulla? Hyphae fibulatae, vix inflatae, 1.5-8 μ latae, tunicis -2 μ crassis.

Ad petiolos filicium in silva. Peninsula Malayana, Pahang, Cameron Highlands, 4 Oct. 1966, *Corner s.n.* typus, in herb. Corner.

Very small, pale fawn. Pileus -2 mm wide, dorsifixed, *cupular then almost plane* and horizontal, slightly lobate at the margin, smooth. Stem 0.5-1.5 × 0.5 mm, subcylindric, enlarged suddenly into the pileus, with a small membranous disc at the base. Gills 3-5 primaries -0.4 mm wide, meeting more or less centrally under the pileus, mostly with a small secondary gill, interstices smooth, the underside of the pileus appearing alveolate. Flesh 0.2-0.4 mm thick at the base of the pileus, firm, with a *thin gelatinous layer* (30-40 μ thick) on stem and pileus.

Spores 8.5-10.7 × 3.7-4.5 μ, white, smooth, subcylindric, obtuse, thin-walled, pale violaceous amyloid, very abundant. Basidia 23-30 × 7-7.5 μ; sterigmata 4, 5-7 μ long; basidioles acerose to mucronate, abundant; subhymenium narrow, not corticate. Cheilocystidia -30 × 5-8 μ, cylindric to clavate, thin-walled, smooth, contents hyaline to vacuolate (not gloeocystidial), eventually with some excrescent, sparsely branched or lobulate hyphae 1-2 μ wide inserted among them. Pleurocystidia none. Hyphae monomitic, clamped, scarcely inflated, the cells -230 × 1.5-8 μ the walls 0.5-2 μ thick, firm, often shortly lobulate, very closely interwoven. Surface of pileus and stem with a thin gelatinous layer 30-40 μ thick on the pileus,

thinner on the stem, composed of 1-1.5 μ hyphae laxly branched, not or scarcely lobulate, with gelatinous walls. Pileocystidia 20-38 × 5-7 μ, as sterile basidia with somewhat gloeocystidial contents, more or less divergent into the gelatinous layer from the firm tissue of the flesh, not lobulate, developing from the margin of the pileus. Caulocystidia apparently none.

On dead fern petioles in the forest. Malay Peninsula.

Pahang, Cameron Highlands 1600 m alt., 4 Oct. 1966, *Corner s.n.*

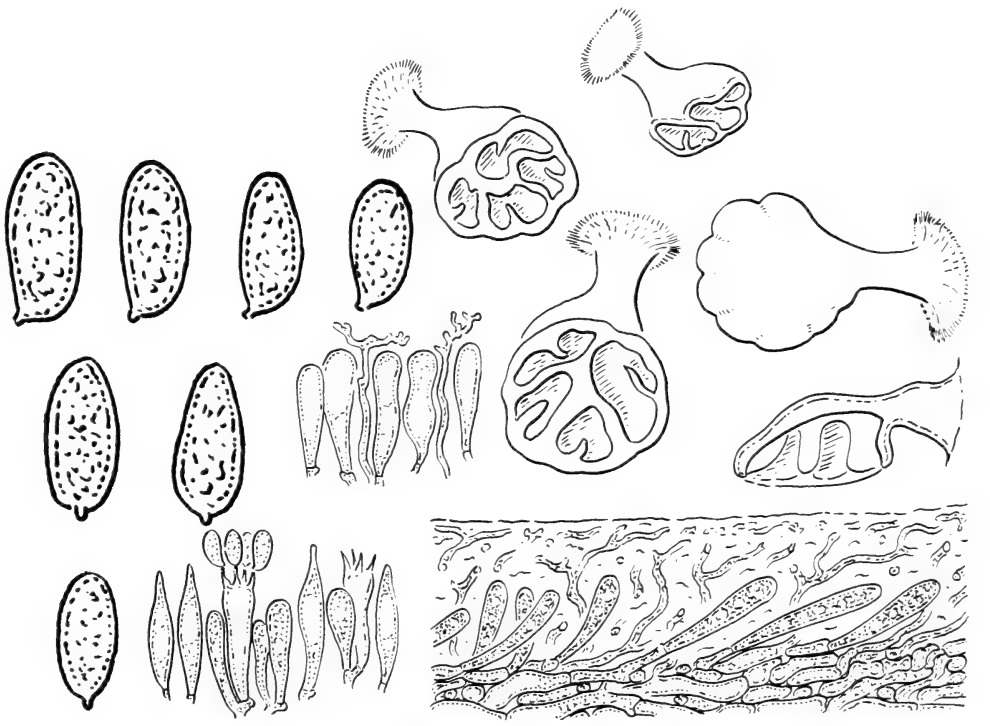

Fig. 12. *Panellus exiguus*. Fruit-body, × 10; spores × 2000; basidia, cheilocystidia, and surface of pileus, × 500.

Panellus fuscatus *sp. nov.* Fig. 13

Pileus -3 cm latus, pleuropodalis, reniformis vel flabelliformis, pallide albido-alutaceus, ultimo fuscibrunneo-pruinosus. Stipes -25 × 3 mm, albus, basi abruptus, pruinoso-furfuraceus. Lamellae decurrentes confertae angustae albidae, acie obtusa pruinosa, Caro tenax.

Sporae 5-6(-6.5) × 4.7-5.7 μ, subglobosae amyloideae. Basidiola acerosa nulla. Cheilocystidia 23-55 × 5-20 μ, clavata vel ventricosa, etiam subcylindrica, tenuiter tunicata, haud incrustata. Pleurocystidia nulla. Pileocystidia 20-80 × 5-20 μ, clavata vel ventricosa, succo fuscidulo intus. Caulocystidia similia sed incolorata, haud incrustata. Hyphae fibulatae, inflatae; in stipite -13 μ latae, tunicis tenuibus vel crassiusculis; in pileo -20 μ latae.

Ad lignum in silva. Borneo, mt. Kinabalu, *RSNB 5479* typus, in herb. Corner.

Pileus -3 cm wide, pleuropodal, reniform to flabelliform, horizontal, *pallid buff white, finely fuscous brownish scurfy pruinose,* not striate. Stem -25 × 3 mm, lateral, with slightly dilated apex, solid, fibrous, *white and white scurfy pruinose upwards,* base abrupt. Gills decurrent, *crowded, narrow,* c. 40 primaries -2 mm wide, 2-3 ranks, some dichotomous, *white, the obtuse edge pruinose.* Flesh 1.5 mm thick at the base of the pileus, rather tough, especially in the stem, white. Smell none.

Spores 5-6(-6.5) × 4.7-5.7 μ, white, smooth, ovoid-subglobose, thin-walled, guttulate opalescent, rather pale bluish amyloid, (bluish black in the mass). Basidia

27-30 × 6.5-7 μ, guttulate-opalescent, brown in Melzer's iodine; sterigmata 4, 4 μ long; acerose basidioles none; subhymenium 12-16 μ thick, composed of subagglutinated hyphae 1.5-3 μ wide, interwoven. Cheilocystidia 23-55 × 5-20 μ, clavate to ventricose or waisted, varying subcylindric, obtuse, thin-walled, colourless, not encrusted, as a broad sterile edge to the gill. Pleurocystidia none. Hyphae monomitic, clamped, inflating, not encrusted, not amyloid; in the *stem* parallel, longitudinal, cylindric, the cells 45-600 × 2-13 μ, with broad septa and often slightly thickened walls, mainly fibrillose but subagglutinated in places; in the *pileus* with shorter and more inflated cells especially over the gills, the cells 20-120 × 3-20 μ, longitudinal interwoven, fairly compact, thin-walled, often unequally inflated or with undulate walls; in the gill-trama, as in the pileus, descending; oleiferous hyphae none. Surface of stem with 3-5 μ subagglutinated hyphae and scattered tufts of cystidia similar to those on the pileus but mostly smaller and colourless, not encrusted. Surface of pileus with a disrupted palisade or short pile of more or less clavate to subventricose, obtuse cells 20-80 × 5-20 μ, or with 1-3 celled hyphal ends with similarly inflated cells, with thin or slightly thickened walls, smooth, *with pale fuscous sap*, arising from appressed longitudinal hyphae, 3-8 μ wide, at the surface of the flesh.

On fallen wood in the forest. Borneo.

Mt. Kinabalu, Bembangan River 1800 m alt., 26 Feb. 1964, *RSNB 5479*.

This species lacks the acerose basidioles, the dichophysial hyphae, and the granular incrustation of the hyphal walls, but the spores are rather intensely

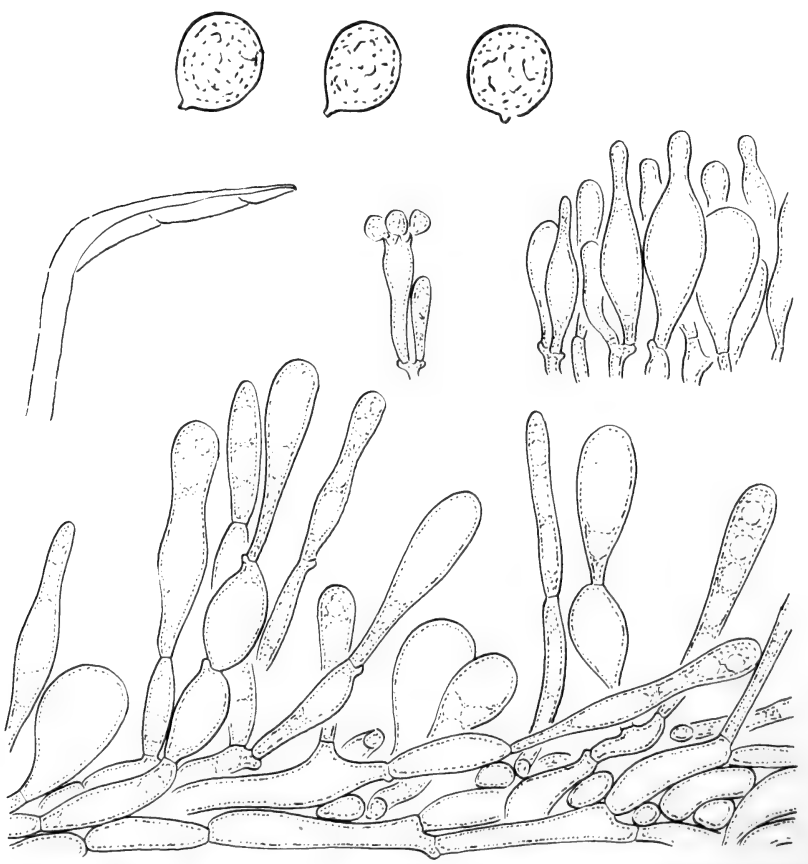

Fig. 13. *Panellus fuscatus*. Fruit-body, × 1; spores, × 2000; basidia, cheilocystidia, surface of pileus near the base, × 500.

amyloid. Compare *P. magnus* (p. 143) with more or less centric pilei, narrow spores, and brown colour in the hyphal walls; both occur in the same forest on mt. Kinabalu.

Panellus intermedius *sp. nov.* Fig. 14

Ex integro pallide cervinus, pleuropodalis, lamellato-poroideus. Pileus -15 mm latus, reniformis vel flabelliformis, opacus, siccus. Stipes -3 × 1-1.5 mm. Lamellae adnatae vel decurrentes, poroideo-reticulatae, acie albida furfuracea. Caro tenax, haud gelatinosa.

Sporae 8-10 × 4.5-5.7 μ, lacrymiformes, vix amyloideae. Basidiola subacerosa. Cheilocystidia 22-40 × 5-11 μ, clavata, diverticulis 1-2 lobulatis evolventia, hyphis dichophysialibus incrustatis superantibus. Pleurocystidia, pileocystidia et caulocystidia nulla. Hyphae fibulatae, plus minus inflatae, latiores cellulis subfusiformibus -300 × 16 μ, tunicis 1-5 μ crassis sed superficiem pilei versus tenuibus -1.5 μ crassis. Superficies pilei hyphis appressis sublobulatis leniter incrustatis, haud gelatinosis, praedita.

Ad ramulos dejectos in silva. Borneo, mt. Kinabalu, *RSNB 5474* typus, in herb Corner.

Entirely pale fawn, pleuropodal, lamellate-poroid. Pileus -10 mm radius, 15 mm wide, reniform-flabelliform, smooth or minutely cottony, opaque, dry. Stem 1-3 × 1-1.5 mm, lateral, cottony fibrillose to subfurfuraceous. Gills adnate to decurrent, 7-15 primaries 0.8-1 mm wide, 3(-4) ranks, poroid-reticulate with transverse septa almost as deep as the primary gills, not venulose in the smooth interstices, pale fawn with *thin chalky white edge*. Flesh 0.8-1 mm thick at the base of the pileus, tough, not gelatinous. Smell none.

Spores 8-10 × 4.5-5.7 μ, white, smooth, pip-shaped, varying pale violet-brown amyloid to almost inamyloid. Basidia 23-28 × 5.5-6.5 μ; sterigmata 4, 3-3.5 μ long; basidioles subacerose, frequent; many lobulate ramifying hyphae 1-2 μ wide investing the basidia in the mature hymenium; subhymenium narrow, with 1.5-2.5 μ interwoven hyphae, not corticate. Cheilocystidia 22-40 × 5-11 μ, more or less clavate, thin-walled, vacuolate, developing from the distal end 1-2 lobulating

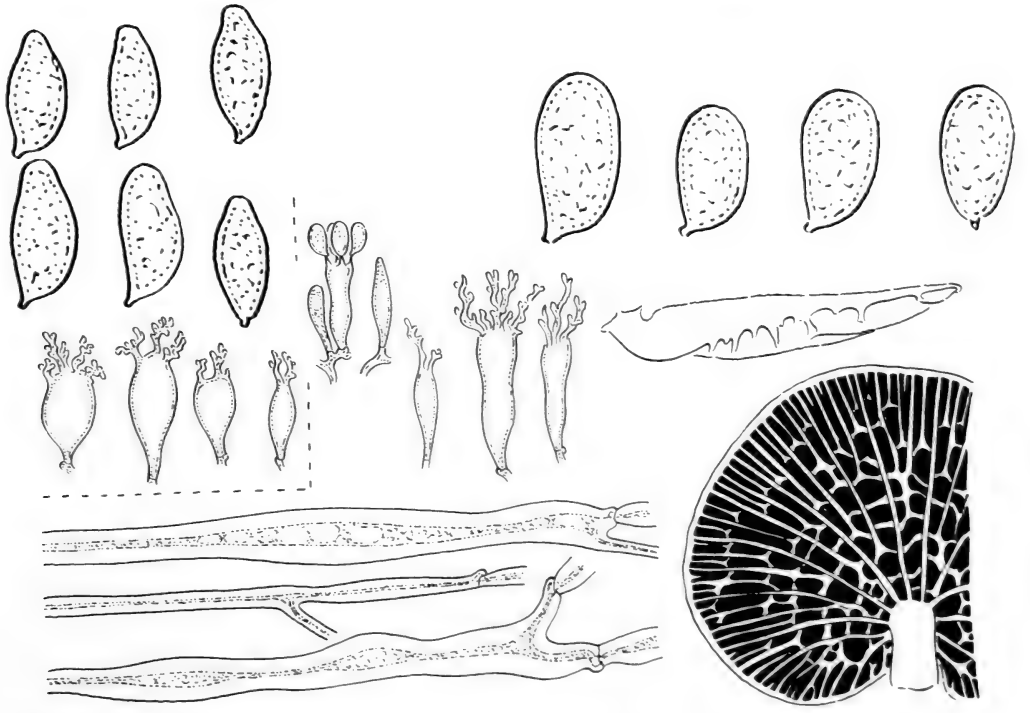

Fig. 14. *Panellus intermedius*. Fruit-body, × 4; spores, × 2250; basidia, cheilocystidia, and hyphae, × 500. Inset (*upper left*), var. *stenosporus*.

processes -15 μ long, also invested with lobulating hyphae as the basidia; thinly encrusted. Pleurocystidia none. Hyphae monomitic, clamped, more or less inflating, appearing spuriously trimitic, the wider hyphae with somewhat fusiform cells -300 × 16 μ with firm hyaline walls 1-5 μ thick and narrow fuscous lumen appearing as skeletals, the narrower hyphae appearing as binding hyphae (but clamped); in the stem longitudinal, compactly fibrillar; in the pileus longitudinal as in the stem but in the upper part of the pileus laxly interwoven with thinner walls -1.5 μ thick and wide lumen; in the gill-trama as in the stem, more or less descending, with many narrow interweaving hyphae. Surface of pileus and stem without cystidia but with 1-2 μ processes becoming somewhat lobulate and ramified though not in a dense layer, thinly encrusted or scarcely at all, not gelatinous.

On sticks in the forest. Borneo.

Mt. Kinabalu 1700-1800 m alt.: 6 Feb. 1964, *RSNB 5243* (immature); 26 Feb. 1964, *RSNB 5474;* 28 Feb. 1964, *RSNB 5539.*

This species is exactly intermediate between *Dictyopanus* and *Panellus.* It seems not to begin sporing until the fruit-bodies are nearly fully grown. Compare the poroid *P. luminescens* on dead palm-leaves.

var. **stenosporus** *var. nov.* Fig. 14 (inset)

Sporae 7-9 × 3.5-4.5 μ, amygdaliformes. Cheilocystidia 20-38 × 8-14 μ, clavata vel subglobosa. Hyphae in stipite 2-6 μ latae, in pileo -9 μ.

Ad ramos dejectos in silva. Borneo, mt. Kinabalu, 20 April 1964, *Corner s.n.* typus, in herb. Corner.

Pileus -10 mm in radius, white to fawn-brown. Stem -1.5 × 1 mm, lateral, slight. Gills whitish. Flesh -1 mm thick at the base of the pileus, not gelatinous.

Spores 7-9 × 3.5-4.5 μ, amygdaliform or mango-shaped. Cheilocystidia 20-38 × 8-14 μ, widely clavate to subglobose. Hyphae narrower and less thick-walled; 2-6 μ wide in the stem, with walls -2.5 thick, without stout skeletal-like cells; in the pileus 2-9 μ wide. Surface of pileus with appressed interwoven hyphae without external processes, not specially modified.

On sticks in the forest. Borneo.

Mt. Kinabalu, Mesilau 1700 m alt., 20 April 1964, *Corner s.n.*

With narrow hyphae, this variety shows the approach to the poroid state of *Dictyopanus,* but the difference in the spores shows that they are not a guide to specific affinity between the lamellate and the poroid species of *Panellus.*

Panellus longinquus (Berk.) Singer

Singer et Digilio, Lilloa 25 (1952) 121; Libonati-Barnes and Redhead, Mycotaxon 20 (1984) 205-212.
? Panellus diversipes (Berk.) Pegler, Austral. J. Bot. 13 (1965) 329.

Pileus -3 cm wide, horizontal, flabelliform, smooth, subviscid, *pale bistre subochraceous,* drying finely villous at the base. Stem lateral, very short, white villous. Gills subdecurrent, subdistant, c. 15 primaries -5 mm wide, 4 ranks, *pale bistre cream,* edge entire. Flesh firm dry, white. Smell none.

Spores 7.5-10 × 3.3-4 μ, white, smooth, subcylindric, thin-walled, aguttate, pale blue-black amyloid. Basidia 30-38 × 5.5-6 μ; sterigmata 4; racemose basidioles none; subhymenium composed of 2-3 μ interwoven hyphae, not corticate. Cystidia none, gill-edge fertile. Hyphae monomitic, inflating, clamped, the cells 50-500 × 3-20 μ, flexuous, very variable, mostly with broad septa, not tapered, the walls slightly thickened and firm in the older tissue. Surface of pileus with a very thin superficial gelatinous layer 20-30 μ thick, composed of hyphae 1.5-2.5 μ wide, mostly appressed and radiating, with scattered processes to the exterior or amassed

here and there into patches of rudimentary hymenium, the processes subcylindric to subclavate -20 × 1.5-3 μ, simple or with a few short lobes, extending at the base of the pileus -70 μ as the villous layer. Hyphae of gill-trama -10 μ wide, descending, with slightly thickened subgelatinous walls near the subhymenium.

On a dead trunk in forest. Queensland.

Mt. Lamington, 21 June 1964, *Corner s.n.*

This is my description of an Australian collection, which I include here because the species may well be widely distributed in the Western Pacific. It was described from South America and recently recorded from North America. The Australian collection agrees with the descriptions of the American except that the gills are wider and the pileus lacks a pinkish colour. Acerose basidioles were not mentioned for the American collections.

Panellus parvulus *sp. nov.* Fig. 15

Pileus -7 mm latus, pleuropodalis vel sessilis, opacus albus. Stipes -0.5 mm longus et latus, vel nullus. Lamellae e basi pilei radiantes, 7-12 primariae, haud dichotomae, albae, acie pruinosula. Caro haud gelatinosa.

Sporae 6-7.5 × 4-5 μ, late ellipsoideae, amyloideae. Basidiola subacerosa. Cheilocystidia 25-50 × 5-8 μ, subclavata vel subventricosa, intus oleaginosa, hyphis dichophysialibus superantibus. Pleurocystidia nulla. Pileocystidia 28-58 × 12-15 μ, clavata, intus oleaginosa, vix in strato hymeniiformi, basim pilei versus hyphis dichophysialibus superantibus, leniter incrustata. Hyphae fibulatae, in stipite basique pilei -20 μ latae, in lamellis 1.5-6 μ latae.

Ad folia emortua bambusarum in silva. Insulae Solomonenses, Guadalcanal, *RSS 688* typus, in herb. Corner.

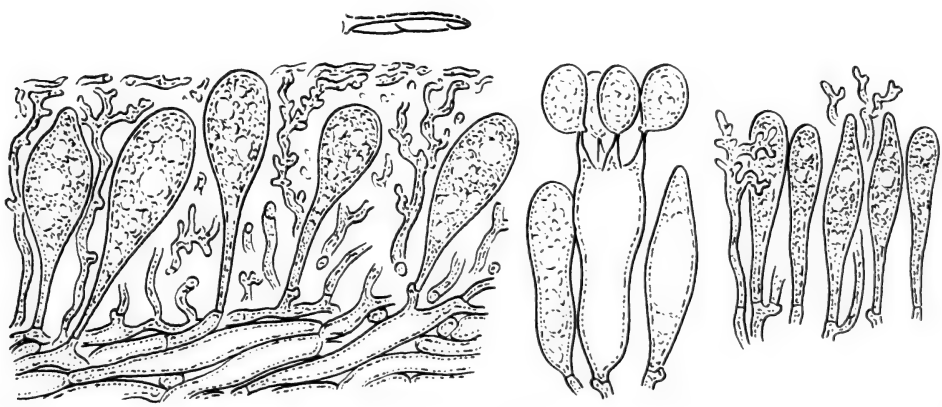

Fig. 15. *Panellus parvulus*. Fruit-body, × 3; spores, × 1500; cheilocystidia and surface of pileus, × 600.

Pileus -7 mm wide, lateral, sessile, or with a very short stem -0.5 mm long and wide, *white,* opaque to substriate: margin minutely pruinose. Gills 7-12 primaries, 2-3 ranks, radiating from the base of the pileus, not dichotomous or veined at the base, *white,* edge pruinulose. Flesh 0.2-0.3 mm thick at the base of the pileus, not gelatinous.

Spores 6-7.5 × 4-5 μ, white, smooth, broadly ellipsoid, pale bluish amyloid. Basidia 18-25 × 6.5-7.5 μ, with oleaginous contents; sterigmata 4, 4-5 μ long; subacerose basidioles numerous, not conspicuous; subhymenium very narrow, with 1.5-2.5 μ interwoven hyphae. Cheilocystidia 25-50 × 5-8 μ, subclavate, obtuse, varying subventricose, thin-walled, smooth or thinly encrusted, with oleaginous cloudy contents, as a conspicuous sterile edge to the gill, becoming overgrown with dichophysial hyphal ends with stalks 1-3 μ wide and fine short processes. Pleurocy-

stidia none. Hyphae monomitic, clamped, inflating in the stem and base of pileus with cells 30-160 × 1.5-20 μ, thin-walled, longitudinal interwoven, narrower towards the margin of pileus; in the *gill-trama* 1.5-6 μ wide, not inflated, more or less descending. Pileocystidia 28-58 × 12-15 μ, clavate, rarely with narrowed apex, with slender stalk 1-2 μ wide, thin-walled, smooth or thinly encrusted, containing dense smeary-oleaginous cytoplasm, erect or appressed, abundant and conspicuous but not in a compact palisade, becoming overgrown at the base of the pileus with dichophysial hyphae, their long, sparingly branched, filiform arms c. 1 μ wide. All the more superficial hyphae of pileus and gill-edge with granular incrustation soluble in potash. Hyphae and contents of basidia and cystidia merely yellow-brown in Melzer's iodine.

On dead bamboo-leaves in forest. Solomon Islands.

Guadalcanal, Gallego, 11 July 1965, *RSS 688*.

This is easily known from the conspicuous pileocystidia which, if immersed, would be gloeocystidia. It seems close to the South American *P. nubigenus* Singer (1969), also on bamboo remains, but with the pileus becoming brownish, the spores slightly larger, and the pileus with a thin gelatinous layer below the superficial mat of dichophysial hyphae.

Panellus pendens *sp. nov.*

Pileus sessilis dorsifixatus, cyphelliformis, -15 mm latus, laevis substriatus, albidulus dein subochraceus et subroseolus. Lamellae distantes angustae, haud venosoreticulatae. Caro hygrophana, haud gelatinosa.

Sporae 4.3-5 × 3.5-4 μ, subglobosae, intense amyloideae. Basidiola acerosa nulla. Cystidia nulla. Hyphae fibulatae, 2-5 (-6) μ latae, plus minus crasse tunicatae, haud incrustatae; in lamellis saepe oleiferae ut gloeocystidia, subagglutinatae. Superficies pilei hyphis oleiferis 5-9 μ latis, haud dextrinoideis, in strato tenui in crassitudine hyphae unae constructa.

Ad ramos delapsos in silva. Borneo, mt. Kinabalu, *RSNB 5448* typus, in herb. Corner.

Sessile, cyphelloid, dorsifixed, pendent, pallid white becoming pale dingy buff, the upperside drying pale pinkish tan. Pileus -15 mm wide, smooth, substriate. Stem none. Gills radiating from a centre below the attachment of the pileus, *distant, narrow*, 9-16 primaries 0.5-1 mm wide, 2(-3) ranks, not veined. Flesh 0.5-0.8 mm thick in the centre of pileus, 0.1-0.2 mm thick at the margin, firm, rather tough, hygrophanous, not gelatinous. Smell none.

Spores 4.3-5 × 3.5-4 μ, white, smooth, ovoid or subglobose, thin-walled, indigo-black amyloid. Basidia 13-15 × 5-5.5 μ, short, squat, somewhat waisted; sterigmata 4; no acerose basidioles; subhymenium very narrow, 5-8 μ thick, with hyphae 1.5-2.5 μ wide. Cystidia none, or with sterile basidia on the apparently sterile gill-edge. Hyphae monomitic, clamped, *not inflating*, 2-5(-6) μ wide, more or less thick-walled, not amyloid; in the pileus densely interwoven and impossible to tease apart, many thin-walled but others with walls 1-1.5 μ thick, the cells 70-400 μ long, flexuous, often kinked resembling bits of skeletal hyphae but with distant clamps and occasionally branched, also with scattered more or less radiating oleiferous hyphae 3-7 μ wide with dense contents not staining with Melzer's iodine; in a thin layer, c. 30 μ thick, above the gills, with thin-walled radiating hyphae and oleiferous hyphae descending into the gills; in the *gill trama* with thin-walled hyphae descending obliquely towards the margin of the pileus and with many subparallel oleiferous hyphae (as gloeocystidia) reaching almost to the gill-edge with tips tapered to 2-3 μ wide, the tissue of the *gill-trama subagglutinated* (not gelatinous). Surface of pileus with a layer (one hypha thick) of appressed radiating oleiferous hyphae 5-9 μ wide with dense contents (not staining with Melzer's iodine), with agglutinated walls, as a tough layer with many affixed spores; round the basal

attachment of the pileus, with many excrescent hyphae 1.5-3 μ wide, clamped, with slightly thickened brownish cells.

On a rotten fallen branch in the forest. Borneo.

Mt. Kinabalu, Bembangan River 1700 m alt., 25 Feb. 1964, *RSNB 5448*.

The spores seem too intensely amyloid for *Panellus*. The agglutinated oleiferous hyphae on the pileus and the absence of incrustation are also differences. Intensely amyloid spores are recorded for the South American *P. mirabilis* Singer.

Panellus sublevatus *sp. nov.* Fig. 16

Albus exiguus. Pileus -3 mm latus, pleuropodalis vel subsessilis, cyphelliformis dein reniformis. Lamellae 3-5, haud reticulatae, acie pruinosofurfuracea. Caro mollis, haud gelatinosa.

Sporae 7-8(-9) × 5-6 μ, ellipsoideae amyloideas. Basidiola subacerosa sparsa. Cheilocystidia et pileocystidia vix evoluta, ut hyphae dichophysiales incrustatae. Pleurocystidia nulla. Hyphae fibulatae 1.5-5 μ latae, sed ad basim pilei cellulis hypodermatis 16-30 × 80-16 μ.

Ad caudices bambusarum in silva. Borneo, mt. Kinabalu, *RSNB 8407A* typus, in herb. Corner.

White, very small. Pileus -3 mm wide, lateral, more or less sessile, at first semi-cupular and cyphelloid, then more or less reniform, sinuato-sulcate, slightly scurfy pruinose. Gills distant, 3-5 primaries 0.3-0.5 mm wide, 1-2 ranks, interstices smooth, edge scurfy pruinose. Flesh c. 100 μ thick in the pileus (excluding the scurfy villous layer 50-80 μ thick), soft, not gelatinous.

Spores 7-8(-9) × 5-6 μ, white, smooth, ellipsoid, obtuse, pale indigo amyloid. Basidia 20-27 × 6.5-8 μ; sterigmata 4, 5-7 μ long; subacerose basidioles rather sparse; subhymenium slight, with 1.5-2.5 μ interwoven hyphae, not gelatinous. Cheilocystidia as dendritic hyphal ends -50 μ long, the stalk 1.5-3(-4) μ wide, granular-encrusted, forming a broad sterile edge to the gill with a few sterile basidia. Pleurocystidia none. Hyphae monomitic, clamped, thin-walled, 1.5-5 μ wide, short-celled, but with inflated cells 16-30 × 8-16 μ in a hypodermal layer near the base of the pileus (? as a vestige of the stem). Surface of pileus composed of masses of granular-encrusted dendritic hyphae 50-80 μ long, as the cheilocystidia, with a few scattered sterile basidia 20-40 × 6-7 μ or cylindric hyphal ends -50 × 4-5 μ; no definite pileocystidia.

Fruit-bodies begin to spore when c. 1 mm wide.

On dead stems of a climbing bamboo in the forest. Borneo.

Mt. Kinabalu, Mesilau 1700 m alt., 22 April 1974, *RSNB 8407A*.

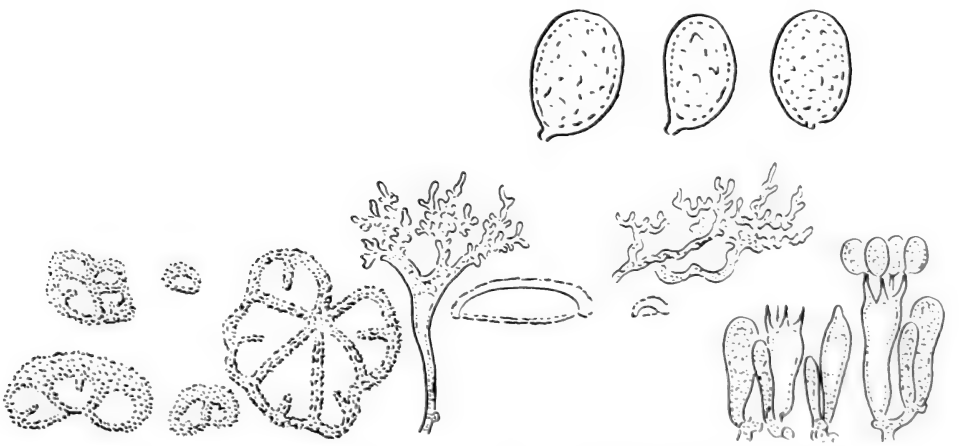

Fig. 16. *Panellus sublevatus*. Fruit-body, × 10; spores, × 2000; basidia and cheilocystidia, × 600.

Key to the poroid species of subgen. *Panellus* in Malesia

1. Spores subglobose, more than 6 μ wide.
   2. Spores 13-18 × 12-16 μ. Pileus -22 mm wide, sessile, white. Pores reaching 1 mm wide. Gloeocystidia on pore-edges and pileus. On fallen branches. Borneo ..... *P. megalosporus* p. 133
   2. Spores smaller. Pileus white to pale fawn. Pores 0.2 mm wide.
      3. Spores 6.5-9.5 × 6-8.5 μ. Pileus -17 mm wide. Gloeocystidia on pore-edges and pileus. On wood ..... *P. orientalis* p. 135
      3. Spores 9-12.5 × 8-11 μ. Pileus-3 mm wide. Gloeocystidia none. On dead bamboo. Solomon Isl. ..... *P. brunneifavolus* p. 130
1. Spores ellipsoid to allantoid, generally less than 6 μ wide.
   4. Spores generally more than 6 μ long. Pileus 1-5 mm wide. On grasses, bamboo or palms.
      5. Cheilocystidia clavate, not gloeocystidial. Pileus -4 mm wide.
         6. Flesh entirely subgelatinous. Acerose basidioles absent. Cheilocystidia developing lobulate processes. Spores 7-8.5 × 4.5-6 μ, scarcely amyloid. Pileus subsessile *P. albifavolus* p. 128
         6. Flesh dry. Acerose basidioles present. Cheilocystidia not developing processes.
            7. Spores 6-7.5 × 4.5-5.5 μ. Cheilocystidia 22-35 × 7-18 μ. Pileus subsessile, white to pale fawn and pinkish. On bamboo ..... *P. sublamelliformis* p. 137
            7. Spores 7.5-9 × 4-4.5 μ to 9-13 × 4-6 μ, ellipsoid. Cheilocystidia 30-55 × 7-10 μ. Pileus white to pale buff. On palms ..... *P. luminescens* p. 132
      5. Cheilocystidia gloeocystidial, subcylindric, or none.
         8. Cheilocystidia gloeocystidial. Pileus pale fawn, with a thin gelatinous pellicle. Spores 7-9 × 3.5-4.5 μ. On bamboo ..... *P. bambusifavolus* p. 129
         8. Cheilocystidia none (? very soon obscured).
            9. Acerose basidioles present. Spores 6-9 × 3.5-5.5 μ. Pileus white to pale fawn. Flesh dry. On grasses ..... *P. copelandii* p. 131
            9. Acerose basidioles absent. Fruit-bodies white. Spores 6-7.7 × 3-4 μ. Pileus -1.5 mm wide, with 3-15 pores. Flesh dry. On bamboo, Solomon Isl. ..... *P. pauciporus* p. 136
   4. Spores less than 6 μ long.
      10. Spores 4.5-6 × 2.5-3.3 μ, Acerose basidioles absent. Cheilocystidia not distinct, pore-edge and pileus with unbranched spinulose hyphal ends 3-6 μ wide. Pileus -3 mm wide, white. On dicotyledonous leaves ..... *P. hispidifavolus* p. 132
      10. Spores 3-4 μ long. Acerose basidioles present.
         11. Spores 0.8 μ wide, allantoid. Pileus -4 mm wide, fawn brown, dorsifixed. Cheilocystidia 7-12 μ wide, clavate. On twigs. Borneo ..... *P. microsporus* p. 134
         11. Spores 2-3 μ wide, ellipsoid. Cheilocystidia 3-5 μ wide, cylindric.
            12. Pileus -12 mm wide or more, fawn tan. Cheilocystidia not or slightly gloeocystidial ... . *P. pusillus* p. 136
            12. Pileus -3 mm wide, white then pale fawn. Cheilocystidia strongly gloeocystidial .... *P. gloeocystidiatus* p. 131

Panellus albifavolus *sp. nov.* Fig. 17

Pileus -3 mm latus, subsessilis, reniformis, pruinosulus, albus. Tubi -0.4 mm longi; poris c. 200 μ latis, albis. Caro subgelatinosa.

Sporae 7-8.5 × 4.7-6 μ, late ellipsoideae, haud vel vix amyloideae. Basidiola acerosa nulla. Hymenium in aetate mucilaginosum. Cheilocystidia 15-30 × 3-10 μ, ex apice diverticula lobulata, -10 μ longa emittentia, hyphis dichophysialibus nullis. Hyphae fibulatae, 1.5-3 μ latae, tunicis gelatinosis. Pileocystidia -38 μ longa ut cheilocystidia, leniter incrustata, hyphis dichophysialibus nullis.

Ad ramulos emortuos et petiolos palmae in silva. Borneo, *RSNB 5367* typus, in herb. Corner; Insulae Solomonensis.

Pileus -3 mm wide, subsessile, reniform, horizontal, minutely pruinose, *white, opaque.* Tubes -0.4 mm long, white, pores 180-200 μ wide, minute, *white,* with pruinose edges. Flesh 0.3-0.4 mm thick, entirely subgelatinous, drying horny.

Spores 7-8.5 × 4.7-6 μ, white, smooth, broadly ellipsoid, obtuse, thin-walled, not amyloid or very slightly. Basidia 24-30 × 6.5-8 μ; sterigmata 4, 3-3.5 μ long. Hymenium without acerose basidioles; subhymenium narrow, interwoven; old hymenium with the basidia half-immersed in a more or less structureless firm

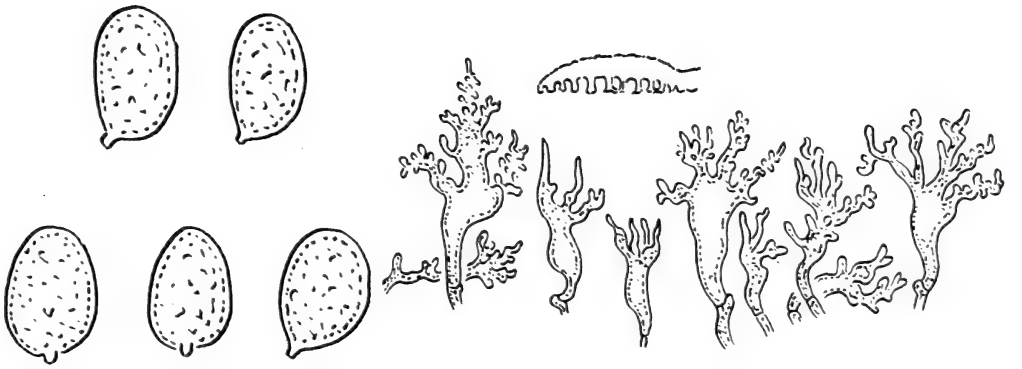

Fig. 17. *Panellus albifavolus*. Fruit-body, × 6; spores, × 1800; pileocystidia, × 600.

mucilage. Cheilocystidia as the pileocystidia but shorter, 15-30 μ long, without excrescent hyphae. Pleurocystidia none. Hyphae 1.5-3 μ wide, clamped, with entirely gelatinous walls, interwoven. Surface of pileus as a loose palisade of subclavate, erect or decumbent, pileocystidia 18-38 × 3-10 μ, the apex with lobulate processes -10 μ long, sometimes with 2-3 distal lobes, thin-walled, *thinly encrusted,* not amyloid, without excrescent hyphae.

On rotten sticks and dead palm-petioles in the forest.

BORNEO. Mt. Kinbabalu, Bembangan River 1700 m alt., 19 Feb. 1964, *RSNB 5367.* — SOLOMON ISLANDS. Guadalcanal, Gallego 500 m alt., 8 July 1965, *RSS 603.*

This seems to approach *Campanella* with inamyloid spores.

Panellus bambusifavolus *sp. nov.* Fig. 18

Pileus -3 mm latus, pleuropodalis reniformis, pallide cervinus. Stipes -1 × 0.5 mm, pileo concolor. Tubi -0.5 mm longi; poris 150-200 μ latis, albocretaceis. Caro sicca sed ad pileum pellicula gelatinosa praedita.

Sporae 7-9 × 3.5-4.5 μ, subcylindricae, amyloideae. Basidiola acerosa copiosa. Cheilocystidia et pileocystidia 3-5 μ lata, cylindrica ut gloeocystidia, hyphis dichophysialibus gelatinosis superantibus. Hyphae fibulatae, 1.5-4 μ latae, tunicis -1 μ crassis, incrustatae; in stipite -12 μ latae, tunicis -2 μ crassis. Superficies pilei pellicula 30-50 μ crassa gelatinosa, ex hyphis 1-2 μ latis ramosis apicibus echinulatis, composita, cystidis immersis.

Ad caules bambusarum in silva. Insulae Solomonenses, San Cristobal, *RSS 898* typus, in herb. Corner.

Pleuropodal with short stem. Pileus -3 mm wide, reniform, convex, opaque, smooth, *pale fawn.* Stem -1 × 0.5 mm, distinct, *pale fawn.* Tubes 0.3-0.5 mm long; pores 150-200 μ wide, rounded, *chalky white.* Flesh 0.3-0.4 mm thick at the base of the pileus, 0.1-0.15 mm near the margin, with a thin gelatinous pellicle.

Spores (6.5-)7-9 × 3.5-4.5 μ, white, smooth, subcylindric, obtuse, pale bluish amyloid. Basidia 24-27 × 6.5-7 μ; sterigmata 4; basidioles acerose, abundant; subhymenium narrow, not corticate, composed of 1.5-2.5 μ hyphae. Cheilocystidia as cylindric gloeocystidia 3-5 μ wide, as on the pileus but shorter, covered by a thin gelatinous pellicle of dichophyses 1-2 μ wide with somewhat echinulate tips, not amyloid. Hyphae 1.5-4 μ wide, clamped, with hyaline walls -1 μ thick, but in the stem with scattered stouter hyphae -12 μ wide with walls -2 μ thick, granular encrusted and often with minute protuberances, closely interwoven, not gelatinous. Surface of pileus covered by a thin gelatinous pellicle 30-50 μ thick, composed of 1-2 μ hyphae irregularly branched and ending in a close membrane of 0.5-1 μ, minutely echinulate, hyphal ends, with immersed, suberect or oblique to decumbent cylindric gloeocystidia -85 × 3-5 μ, very abundant on young pilei but becom-

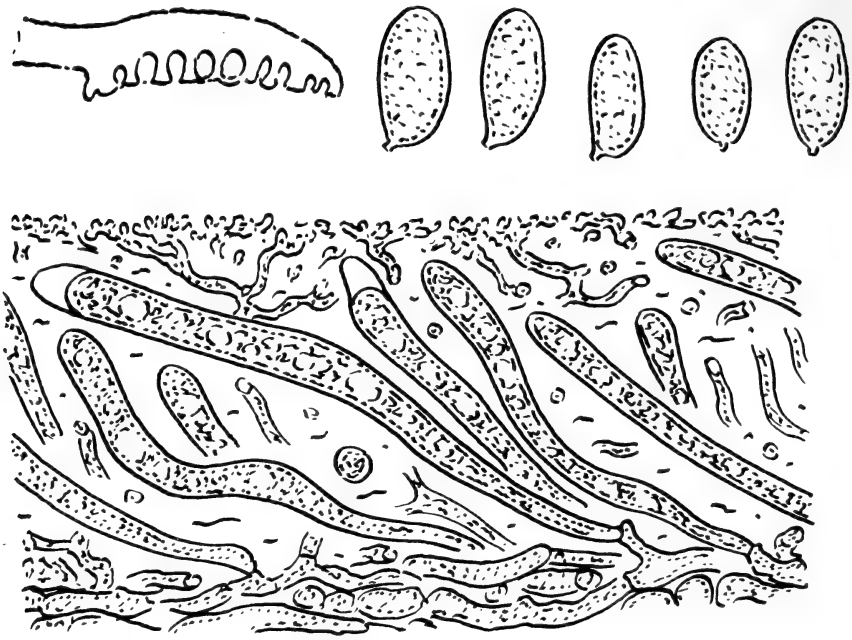

Fig. 18. *Panellus bambusifavolus*. Fruit-body, × 10; spores, × 2000; surface of pileus, × 1000.

ing scarce and inconspicuous, even vacuolate and hyaline, in mature pilei, often with the oleaginous contents shortly retracted from the tip.

On dead bamboo in the forest. Solomon Islands.

San Cristobal, Warahito River, low level, 1 Aug. 1965, *RSS 898*.

The surface of the pileus has the reduced construction of *P. gloeocystidiatus,* and the gelatinous pellicle forms on the pore-edges.

Panellus brunneifavolus *sp. nov.* Figs. 8b, 19

Pileus -3 mm latus, dorsifixus, subsessilis, reniformis, laevis, albus dein pallide cervinobrunneus. Tubi -0.4 mm longi; poris 150-200 μ latis, albocretaceis. Caro subgelatinosa.

Sporae 9-12.5 × 8-11 μ, subglobsae vel ovoideae, amyloideae. Basidiola acerosa copiosa. Cheilocystidia 18-45 × 3-4.5 μ, subcylindrica, tunicis leniter incrassatis, haud oleaginosa, hyphis dichophysialibus superantibus. Hyphae fibulatae, 1.5-5 μ latae, tunicis subgelatinosis, subagglutinatae. Pileocystidia ut cheilocystidia, hyphis dichophysialibus superantibus.

Ad bambusam emortuam in silva. Insulae Solomonenses. Guadalcanal, 2200 m alt., *RSS 1631* typus, in herb. Corner.

Dorsifixed, almost lateral, convex, reniform, white then pale fawn brown. Pileus -3 mm wide, smooth, opaque. Stem practically none. Tubes -0.4 mm long; pores 150-200 μ wide, rounded, *with chalky white edges.* Flesh c. 1 mm thick at the base of the pileus, *subgelatinous.*

Spores 9-12.5 × 8-11 μ, white, smooth, subglobose or ovoid, very pale violaceous amyloid. Basidia 36-40 × 12-15 μ, widely clavate with oleaginous contents (dark brown in Melzer's iodine); sterigmata 4, 6-7.5 μ wide at the base; basidioles acerose, abundant but inconspicuous, hyaline, 3-7 μ wide, shorter than the basidia; subhymenium narrow, not corticate. Cheilocystidia 18-45 × 3-4.5 μ, subcylindric, hyaline, smooth, with slightly thickened wall, often sparse, not gloeocystidial, becoming covered by excrescent, laxly to profusely branched, dichophysial hyphae 1-2 μ wide with stalks 1.5-2.5 μ wide, thinly encrusted, not amyloid. Hyphae 1.5-5 μ wide, clamped, with hyaline subgelatinous walls 1-2 μ thick, compact, almost agglutinated, not amyloid. Surface of pileus with pileocystidia like

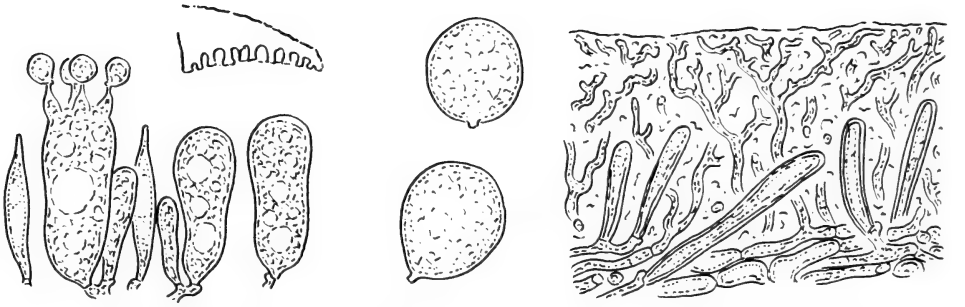

Fig. 19. *Panellus brunneifavolus*. Fruit-body, × 6; spores, × 2000; basidia and surface of pileus, × 600.

the cheilocystidia but becoming scattered and often decumbent, covered by shortly excrescent dichophysial hyphae as a layer c. 40 mm thick.

On dead bamboo in the forest. Solomon Islands.

Guadalcanal, Popomanasiu 2200 m alt., 26 Oct. 1965, *RSS 1631*.

Panellus copelandii (Pat.) Burdsall et Miller

Nova Hedwigia Beih. 51 (1975) 88.

Dictyopanus copelandii Pat., Elmer Leaflets of Philippine Botany 6 (1914) 2254; Kobayasi, Bull. Nat. Sci. Mus. Tokyo 6 (1963) 363.

Pileus -3 mm wide, pleuropodal, reniform to orbicular, pruinose, *white*. Stem 3-6 × 0.25-0.5 mm, longer than the pileus, *white*. Pores slightly radially elongate, 120-180 μ in the long diameter, lamellately decurrent (Kobayasi), *whitish rufous*. Flesh not gelatinous.

Spores 6.5-9 × 3.5-5.5 μ, 6.8-7.8 × 3.5-4.2 μ (Kobayasi), 5-6 × 4-5 μ (Pat.), ovoid, bluish amyloid. Basidia 20-27 × 7-9 μ; acerose basidioles present. Cheilocystidia and pileocystidia not seen. Hyphae 3-6 μ wide, with swellings -9 μ, irregularly thick-walled. Surface of pileus, stem, and pore-edges developing a mat of lobulate and echinulate dichophysial hyphae; no gloeocystidia (Kobayasi).

On dead grass leaves and stems. Philippine Islands.

This description is a summary of previous ones. Patouillard gave the fruit-bodies as whitish with whitish rufous pores. That they should be cinnamon-rufous or hazel according to Burdsall and Miller is misleading and must refer to old, possibly poisoned, herbarium specimens. The species may be wide-spread in Malesia and may connect with those on bamboos in the Solomon Islands. *P. luminescens* on palm-remains has larger spores and pores that are not at all lamelliform. Compare the description of *Favolaschia minima* (Jungh.) Singer (Lloydia 8, 1945, 200).

Panellus gloeocystidiatus (Corner) *comb. nov.* Figs. 4, 5, 8f

Dictyopanus gloeocystidiatus Corner, Trans. Brit. mycol. Soc. 37 (1954) 258, fig. 1, 2; Kobayasi, Bull. Nat. Sci. Mus. Tokyo 6 (1963) 359, fig. 2, 3, pl. 49; Rept Tottori Mycol. Inst. (Japan) 10 (1973) 346.

White then pale fawn, pleuropodal. Pileus -3 mm wide, discoid, scurfy, opaque. Stem 0.2-1 × 0.1-0.5 mm, lateral, white pruinose. Tubes -0.3 mm long; pores c. 100 μ wide, chalky pruinose. Flesh not gelatinous.

Spores 3-3.5 × 2-2.5 μ, white, smooth, ellipsoid, pale bluish grey amyloid. Basidia 13-15 × 4 μ, with 4 sterigmata 3 μ long; acerose basidioles abundant; subhymenium not granular encrusted. Cheilocystidia -40 × 3-5 μ, subcylindric gloeocystidia obtuse, with firm walls. Hyphae clamped, 2-5 μ wide, with firm, slightly thickened and even subdiffluent walls. Surface of pileus with gloeocystidia -90 × 3-5 μ overgrown with lobulate dichophysial hyphae 1-2 μ wide.

On rotten wood in the forest. Borneo.

Mt. Kinabalu, Mahmud River 1300 m alt., 7 Aug. 1961, *RSNB 1656.*

This is the description of a Bornean collection. The species has been recorded hitherto from south Japan, the Bonin Islands, and New Guinea. According to Kobayasi, the pores are luminous and may be somewhat radially arranged, even slightly radially elongate. Burdsall and Miller considered that it might be reduced to *P. pusillus,* but neither Kobayasi nor I am convinced that *P. pusillus* has gloeocystidia. The fruit-bodies of *P. gloeocystidiatus* are also much smaller.

Panellus hispidifavolus *sp. nov.* Fig. 20

Albus, superficie pruinoso-cretacea. Pileus -3 mm latus, pleuropodalis, reniformis. Stipes -0.3 × 0.2 mm, brevissimus. Tubi -350 μ longi; poris 150-180 μ latis. Caro sicca.

Sporae 4.5-6 × 2.5-3.3 μ, ellipsoideae amyloideae. Basidiola acerosa nulla. Cheilocystidia, caulocystidia et pileocystidia ut hyphae cylindricae, haud ramosae, -150 × 3-6 μ, tunicis incrassatis, spinulis -1.5 × 0.5-1 μ echinulatae, etiam apices versus diverticulis obtusis -3 × 1.5 μ, leniter incrustata; hyphis dichophysialibus nullis. Hyphae fibulatae, 2-12 μ latae, tunicis tenuibus.

Ad folia emortua *Tristaniae* (Myrtaceae) in silva. Borneo, mt. Kinabalu, 1800 m alt., *RSNB 5415* typus, in herb. Corner.

White, with finely chalky surfaces. Pileus -3 mm wide, pleuropodal, convex, reniform, opaque, puberulous. Stem -0.3 × 0.2 mm, lateral, very short. Pores minute, 150-180 μ wide, -350 μ deep. Flesh 120-200 μ thick, dry.

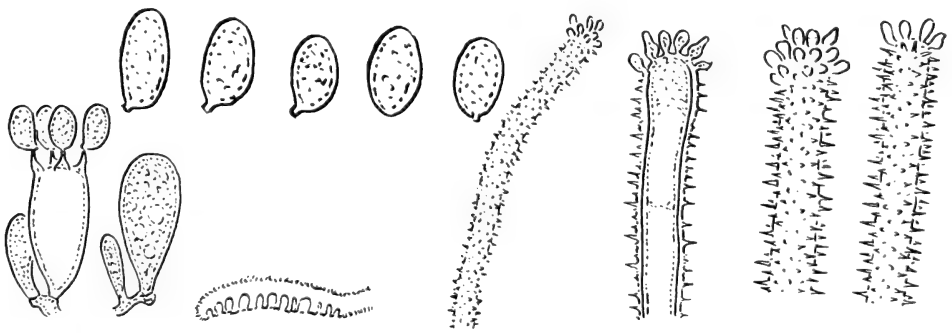

Fig. 20. *Panellus hispidifavolus.* Fruit-body, × 6; spores, × 3400; basidia and one hyphal tip on the pileus, × 600; 3 hyphal tips on the pileus, × 1200.

Spores 4.5-6 × 2.5-3.3 μ, white, smooth, ellipsoid, very pale violaceous amyloid. Basidia 11-15 × 5.8-6.5 μ, widely clavate, short; sterigmata 4; *acerose basidioles none.* Cheilocystidia as encrusted spinulose hyphal ends as on the pileus. Pleurocystidia none. Hyphae 2-12 μ wide, clamped, thin-walled, cylindric, narrow and interwoven in the pileus. Surface of pileus and stem hispidulous with variously projecting, often curved, cylindric, spinulose, unbranched hyphal ends 70-150 × 3-6 μ, with thickened walls densely set with minute spinous processes -1.5 × 0.5-1 μ and often with several stouter obtuse processes -3 × 1.5 μ at the tips (as a cluster of abortive sterigmata), in places thinly encrusted, not amyloid.

On a dead leaf of *Tristania* (Myrtaceae) in the forest. Borneo.

Mt. Kinabalu, Bembangan ridge 1800 m alt., 22 Feb. 1964, *RSNB 5415.*

Remarkable for the surface-structure, stout basidia, and absence of basidioles.

Panellus luminescens (Corner) *comb. nov.* Figs. 2, 8c, 8e

Dictyopanus luminescens Corner, Mycologia 42 (1950) 423.

Pileus 2-4 mm wide, pleuropodal, occasionally mesopodal, convex then flattened and reniform or flabelliform, opaque *white becoming pale alutaceous or pale buff,*

finely chalky pruinose, drying or ageing pale greyish ochraceous and minutely cracked; margin incurved at first, finally flattening, always making the distal wall of the marginal pores. Stem 0.1-1.3 × 0.1-0.5 mm, short, distinct, white, finely chalky pruinose, brownish at the base, pale ochraceous in age. Tubes -350 μ long, 200-250 μ wide, distinctly delimited from the stem, not decurrent, white; pores 70-150 μ wide, with dissepiments 50-80 μ thick (including the hymenium) but appearing wider between the pores, round, *white chalky,* drying pale yellowish. Flesh 100-250 μ thick at the base of the pileus, dry, rather firm, rather tough in the stem, white. Fruit-bodies entirely green phosphorescent, but not so in some collections.

Spores 9-13 × 5-6 μ, mostly 10-11.5 μ long, in some collections 9-11 × 4-5 μ, in others 7.5-9 × 4-4.5 μ, white, smooth, elongate pip-shaped to oblong ellipsoid, contents finely granular, not guttate, pale blue amyloid. Basidia 20-28 × 9-10 μ, or 18-25 × 7.5-8.5 μ with the smaller spores, broadly cylindric-clavate, monomorphic, forming a continuous lining to the tubes; sterigmata 4, 5-6 μ long; basidioles subacerose, numerous. Cheilocystidia 30-55 × 7-10 μ, narrowly clavate, thin-walled, as a sterile edge to the pores, becoming overgrown with excrescent dichophyses as on the pileus, and densely granular encrusted. Pleurocystidia none. Hyphae monomitic, clamped, often branching from the clamp, encrusted with fine granular and crystalline matter soluble in dilute potash, mostly 1.5-4 μ wide and thin-walled; in the *stem* with some longitudinal fusiform inflated cells 100-250 × 6-20 μ, with walls -7 μ thick, singly or in irregular rows of 2-4 cells, often with enlarged clamps, at the base of the stem not inflated but subagglutinated with slightly thickened brownish walls; in the *pileus* and dissepiments uninflated, thin-walled, intricately interwoven, but some radiating or longitudinal, more or less contiguous; hyphal tips at the growing margins 1.5-3 μ wide with cells 10-20 μ long on delimitation. Surface of pileus and stem with a palisade of cystidia like the cheilocystidia becoming disrupted and overgrown by excrescent and heavily encrusted dichophysial hyphae, their ends set with many intricate diverticula 1.5-7 × 0.5-1.5 μ, the pileocystidia also becoming intricately diverticulate.

Development gymnocarpic, direct, with short primordial shaft and epinastic margin to the pileus.

On dead leaf-sheaths and petioles of various palms *(Arenga, Calamus, Pinanga, Rhapis).* Quite common, Malay Peninsula and Borneo.

Most collections of this fungus which I studied in Singapore had the larger spores, but a few had the smaller though no other difference could be detected. The Bornean collection, *RSNB 556,* on *Calamus,* was not luminous; it had the smaller spores.

Panellus megalosporus *sp. nov.* Fig. 8a

Albus, plus minusve sessilis. Pileus -22 mm latus, reniformis, cretaceo-subpruinosus. Tubi -1.5 mm longi; poris 0.2-0.3 mm latis. Caro sicca. Haud luminescens.

Sporae 13-18.5 × 12-16 μ, subglobosae vel late ellipsoideae, amyloideae. Basidia 60-120 × 15-20 μ; sterigmata 4, 11-15 μ longa; basidiola acerosa copiosa. Cheilocystidia etc. ut in *P. orientalis.* Hyphae fibulatae, 2-6 μ latae, tunicis plus minusve incrassatis.

Ad ramulos emortuos in silva. Borneo, mt.Kinabalu, c. 3000 m alt., *RSNB 895* typus, in herb. Corner.

White, more or less sessile. Pileus -15 mm in radius, 22 mm wide, reniform, horizontal, opaque, chalky. Stem very short, thick, lateral, or none, becoming villous at the base. Tubes -1.5 mm long; pores 0.2-0.3 mm wide at first, enlarging to 1.3 mm wide, *subcircular with chalky edges,* drying dark fuscous brown. Flesh dry. Not luminous.

Spores 13-18.5 × 12-16 μ, white, smooth, subglobose or broadly ellipsoid, apiculus 1-1.5 μ long, bluish grey amyloid. Basidia 60-120 × 15-20 μ; sterigmata 4,

11-15 μ long, 3-4 μ wide at the base; basidioles subacute, abundant. Cheilocystidia and hyphal structure as in *P. orientalis*. Pleurocystidia none. Hyphae 2-6 μ wide, clamped, with walls 1-2 μ thick in the stem and old flesh at the base of the pileus, not gelatinous; hymenium eventually becoming more or less invaded by 1-3 μ hyphae branching and lobing round the apices of the basidia.

On fallen twigs in montane oak-forest. Borneo.

Mt. Kinabalu east ridge c. 3000 m. alt., *Corner s.n.*: 29 & 30 June 1961, 15 July 1961; 20 July 1961, *RSNB 895*.

This species of high mountain forest has the largest spores and basidia of the genus.

Panellus microsporus *sp. nov.* Figs. 8g, 21

Dorsifixus, pendens, cervinobrunneus. Pileus -4 mm latus, discoideus. Stipes -1.5 × 1 mm, plus minusve centralis. Tubi -0.6 mm longi; poris 70-100 μ latis, minutis, subangulatis, acie cretaceo-pruinosa, dissepimentis subgelatinosis. Caro sicca.

Sporae 3-4 × 0.8 μ, allantoideae amyliodeae. Basidiola subacerosa copiosa. Cheilocystidia 25-80 × 7-12 μ, clavata vel subcylindrica, ex apicibus saepe diverticulos lobulatos intense amyloideos -4 × 1.5 μ emittentia; hyphis dichophysialibus nullis. Caulocystidia et pileocystidia ut cheilocystidia, dense instructa, irregulariter lobulata; hyphis dichophysialibus nullis; saepe massulis intense amyloideis intermixta. Hyphae fibulatae, 2-6 μ latae, tunicis submucilaginosis praecipue in dissepimentis.

Ad ramulos emortuos in silva. Borneo, mt Kinabalu 1700 m alt., *RSNB 5514* typus, in herb. Corner.

Pendent, dorsifixed, fawn brown. Pileus -4 mm wide, discoid. Stem 1-1.5 × 1 mm, more or less central, expanding obconically into the pileus. Tubes -0.6 mm long; pores 70-100 μ wide, subangular, chalky; dissepiments subgelatinous. Flesh firm, not gelatinous.

Spores 3-4 × 0.8 μ, white, smooth, allantoid, pale violaceous amyloid, very abundant in all fruit-bodies but not seen attached. Basidia 12-15 × 3.5-4 μ;

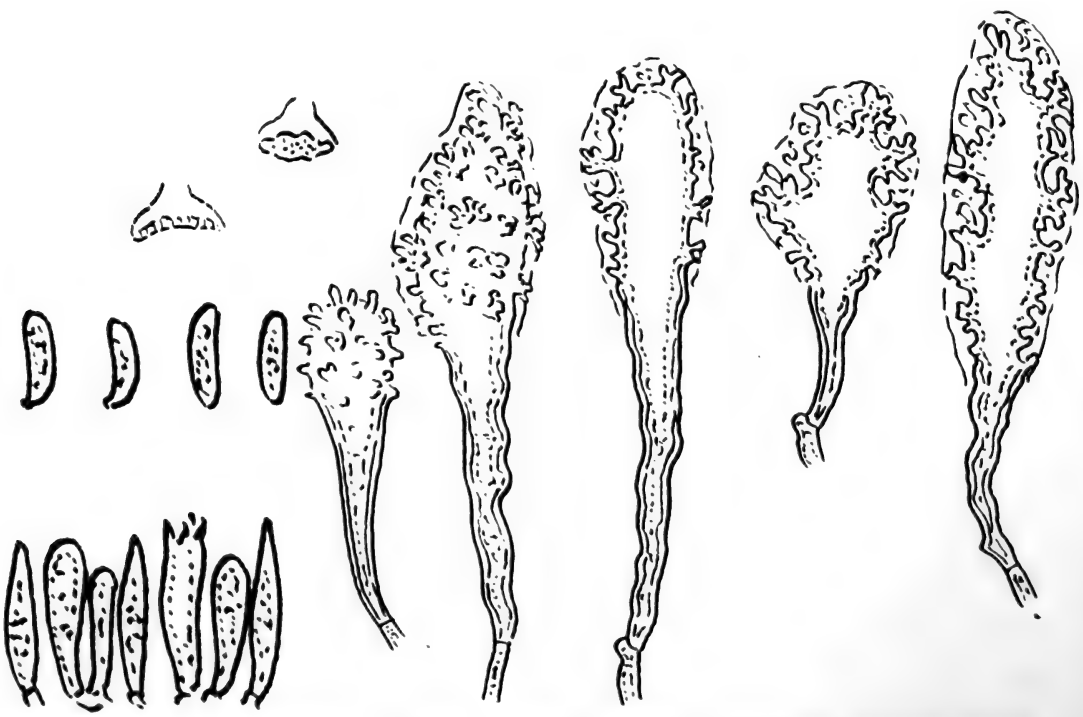

Fig. 21. *Panellus microsporus*. Fruit-body, × 3; spores, × 4000; basidia and cheilocystidia, × 1500.

sterigmata 4; basidioles 1.5-2.5 μ wide, subacerose. Cheilocystidia 25-80 × 7-12 μ, clavate to subcylindric, often shortly lobate at the apex or in the distal part, set distally with many minute, lobulate, strongly blue-black amyloid processes -4 × 1-1.5 μ, granular encrusted, the proximal stalk often with slightly thickened pale brown walls; without independent lobulate hyphae on the sterile pore-edge. Pleurocystidia none; gloeocystidia none. Hyphae 2-6 μ wide, clamped, with hyaline submucilaginous walls 0.5-2 μ thick, longitudinal, regularly arranged. Surface of stem and pileus with a close palisade of erect cystidia similar to the cheilocystidia but more irregularly lobulate, with pale brown walls, without independent lobulate hyphae, the outside of the cells densely set in places with dark, purple-brown, amyloid masses.

On fallen twigs in the forest. Borneo.

Mt. Kinabalu, Bembangan River 1700 m. alt., 27 Feb. 1964, *RSNB 5514*.

This species appears to be abundantly distinct in the dorsifixed *Helotium*-like habit, the large cheilocystidia, the palisade of pileocystidia with amyloid masses, the subgelatinous hyphae, and the minute allantoid spores. They are the smallest among Malesian species of the genus and contrast so strongly with the great spores of the preceding species *P. megalosporus* that they prove how spore-shape may have little generic value.

Panellus orientalis (Y. Kobayasi) *comb. nov.* Figs. 7, 8d, 22

Dictyopanus orientalis Y. Kobayasi, Bull. Nat. Sci. Mus. Tokyo 6 (1963) 360, fig. 3, pl. 50A.

Chalky white, becoming pale buff to pale fawn-ochraceous, finally rufous pink in age, but the pores white. Pileus-17 mm wide, pleuropodal, reniform, finely pruinoso-scurfy, becoming minutely cracked, opaque; margin slightly incurved at first. Stem 1-7 × 2-3 mm, 1-1.5 mm at the base, lateral, dilating upwards into the pileus, pruinoso-puberulous. Tubes -0.7 mm long; pores 150-250 μ wide, circular, elliptic, or slightly radially elongate, with thin cream-white pruinose edges. Flesh firm soft, even subgelatinous, drying very horny.

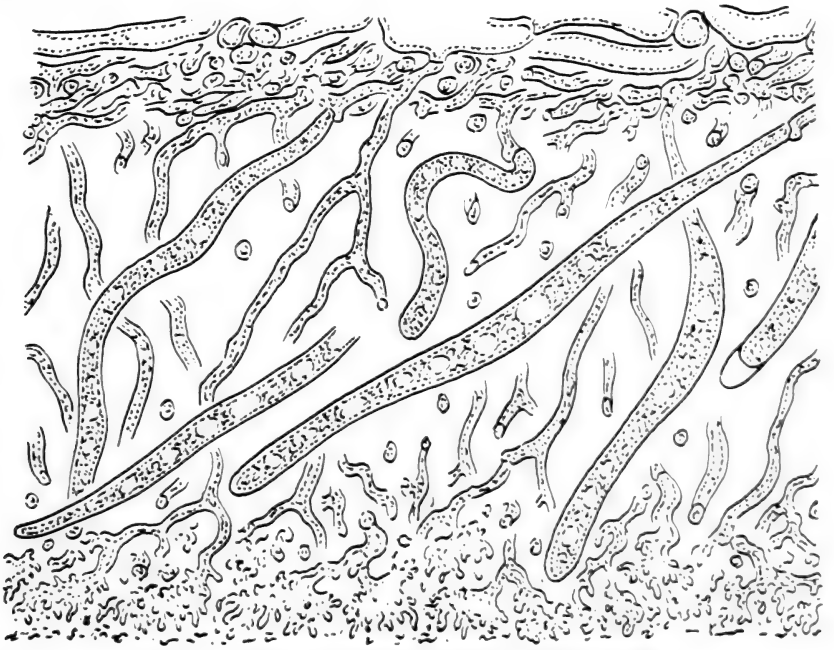

Fig. 22. *Panellus orientalis*. Surface of pileus, × 800.

Spores 6.5-9.5 × 6-8.5 μ, white, smooth, subglobose to lacrymiform, thin-walled, pale indigo amyloid. Basidia 20-40 × 7.5-10 μ; sterigmata 4, 6-8 μ long; basidioles subacute; subhymenium narrow, not corticate. Cheilocystidia 40-190 × 3-6(-7) μ, gloeocystidial with oleaginous contents, thin-walled, cylindric to subclavate, abundant on the pore-edges of young fruit-bodies, often absent (? crushed) from the older, becoming covered with dichophyses with branches 1.5-3 μ wide, often with the ends dilated 4-7 μ wide and set with processes -6 × 1-1.5 μ, wholly immersed in granular incrustation (soluble in dilute potash). Pleurocystidia none. Hyphae 1.5-6 μ wide, clamped, thin-walled, some with subgelatinous walls, in the older tissue with the walls thickening slightly 0.5-1 μ, the cells -180 μ long, often somewhat tuberculate. Surface of stem and young pileus constructed as the pore-edges with gloeocystidia and echinulate dilated ends of dichophysial branches, the older pilei becoming covered with a chalky-incrusted layer, -120 μ thick, of excrescent lobulate dichophyses with the gloeocystidia scarcely distinguishable.

On fallen branches, dead trunks, bark and bits of wood in the forest, south Japan; North Borneo, Solomon Islands, at 800-1800 m altitude.

BORNEO. Mt. Kinabalu 1300-1800 m. alt., *RSNB: 2705, 2952, 5396, 8078,* collected in February, April, August, September. — SOLOMON ISLANDS 800-1800 m. alt., Guadalcanal, Malaita, *RSS: 1652, 1678, 1805,* October to November.

The Japanese specimens, which were considerably smaller than the Malesian, were found not to be luminous by Kobayasi; the tropical have not been tested.

Panellus pauciporus *sp. nov.*

Pileus -1.5 mm latus, sessilis, albus. Tubi 3-15, minuti, albo-cretacei. Caro sicca.

Sporae 6-7.7 × 3-4 μ, subcylindricae amyloideae. Basidiola acerosa nulla. Cheilocystidia et pileocystidia nulla, ad margines tuborum hyphis dichophysialibus copiosis. Hyphae fibulatae, 2-5 μ latae. Superficies pilei hyphis dichophysialibus instructa.

Ad folia emortua bambusae, in silva. Insulae Solomonenses, Guadalcanal 1800 m alt., *RSS 1649* typus, in herb. Corner.

Pileus -1.5 mm wide, *sessile,* lateral, smooth, *white.* Pores *3-15 in all,* minute, white, chalky, not lamellate. Flesh firm, not gelatinous.

Spores 6-7.7 × 3-4 μ, white, smooth, subcylindric, pale blue amyloid. Basidia 17-20 × 7-8 μ, short, wide, with opalescent contents; sterigmata 4, 3.5 μ long; acerose basidioles none. Cheilocystidia none; with many lobulate and subechinulate dichophysial hyphae 1-2 μ wide along the sterile pore-edges and developing between the basidia in the old hymenium. Hyphae clamped, 2-5 μ wide, cylindric with thin firm walls, more or less radiating, the cells -80 μ long. Surface of pileus with a thin covering of incrusted dichophysial hyphae as on the pore-edges, some with slightly dilated echinulate-tuberculate ends -5 μ wide; no distinct pileocystidia.

On a dead bamboo-leaf in the forest. Solomon Islands.

Guadalcanal, Popomanasiu 1800 m alt., 27 Oct. 1965, *RSS 1649.*

Panellus pusillus (Pers. ex Lév.) Burdsall et Miller

Nova Hedwigia Beih, 51 (1975) 85, with synonymy.; Corner, Trans. Brit. mycol. Soc. 37 (1954) 258, as *Dictyopanus pusillus; Cunningham, Polyporaceae New Zealand (1965) 140, as D. rhipidium.*

Pileus 4-12 mm wide, pleuropodal, convex then flattened, reniform, smooth, opaque, *fawn tan.* Stem -3.5 × 0.3-1.5 mm, *fawn tan.* Tubes -0.5 mm long; pores 100-150 μ wide, circular, *white, chalky.* Flesh -0.5 mm thick at the base of the pileus, firm, not gelatinous.

Spores 3-4.5 × 2-2.5 μ, white, smooth, ellipsoid, pale blue amyloid. Basidia 13-20 × 4-5(-6) μ; sterigmata 4, 3 μ long; basidioles acerose, numerous. Cheilo-

cystidia 20-40 × 4-5 μ, cylindric to subclavate, thin-walled, not or scarcely gloeocystidial, producing 1-3 lobulating hyphae from the apex, becoming overtopped by excrescent dichophysial hyphae, in some collections the cheilocystidia indistinct. Pleurocystidia none. Hyphae 2-7(-11) μ wide, monomitic, clamped, with walls -4 μ thick in the stem. Surface of pileus with gloeocystidial hyphal ends 4-5 μ wide overtopped by excrescent dichophysial hyphae more or less profusely diverticulate and densely encrusted, no distinct pileocystidia, the gloeocystidial hyphae lacking from some collections.

On dead wood and dead fallen branches in the forest.

MALAY PENINSULA. Penang Hill 330 m alt., 21 Sept. 1972, *Corner P-81.* — BORNEO. Mt. Kinabalu, east ridge 1000 m. alt., 26 Sept. 1961, *RSNB 1515.* Sandakan, Sepilok Forest low alt., 13 Aug. 1960, *Corner s.n.* — NEW GUINEA. Aiyura 2000 m. alt., 22 Sept. 1960, *Corner s.n.*

This description is drawn from the Malesian collections. They agree in spore-size and microscopic structure with those which I collected in Brazil (Corner 1954), but the fruit-bodies are small and the colour of the living pileus is distinctly brown, not white to pale tan. This pale colour is given for North American specimens by Burdsall and Miller, who find slightly larger spores 4-5.5 × 2-3 μ. Cunningham, in recording the species from Australia and New Zealand, gave the pale colour but the small spores as in the Malesian collections. Whether the species is luminous in Malesia needs to be tested.

Besides differences in the development of cystidia, noted in the description, there were others among these Malesian collections. The Bornean had encrusted subhymenial hyphae, which is rarely the case. The Penang collection had no mat of excrescent dichophysial hyphae on the pileus, but relatively few short lobulating hyphae which formed a thin, bluish amyloid, membrane. Thus, spore-size is the main distinction for the species in the eastern tropics.

Panellus sublamelliformis *sp. nov.* Fig. 23

Pileus -3 mm latus, subsessilis, subdorsifixus, reniformis rimoso-pruinosulus, albus dein pallide cervino-brunneus, aetate subincarnatus. Tubi -0.5 mm longi; poris c. 170 μ latis, rotundatis vel leniter radiato-elongatis, prope marginem pilei sublamelliformibus. Caro sicca.

Sporae 6-7.5 (-8) × 4.5-5.5 μ, late ellipsoideae, amyloideae. Basidiola acerosa copiosa. Cheilocystidia et pileocystidia 22-35 × 7-18 μ, clavata, hyphis dichophysialibus superantibus.

Hyphae fibulatae, 1.5-5 μ latae, massulis resinosis brunneis intermixtae.

Ad caules emortuos bambusarum in silva. Insulae Solomonenses, Guadalcanal, 700 m alt., *RSS 1534* typus, in herb. Corner.

Pileus -3 mm wide, sublateral, slightly dorsifixed, reniform. minutely *rimoso-pruinose,* opaque, *white then pale fawn brown,* pinkish when old. Stem practically none. Tubes -0.5 mm long; pores c. 170 μ wide, *round to slightly radially elongate,*

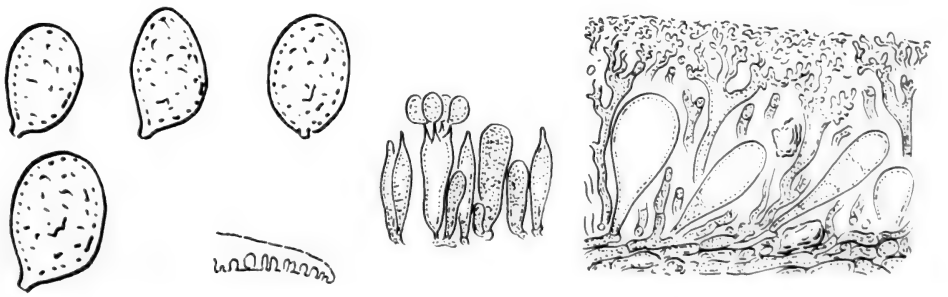

Fig. 23. *Panellus sublamelliformis.* Fruit-body, × 5; spores, × 2000; basidia and surface of pileus, × 500.

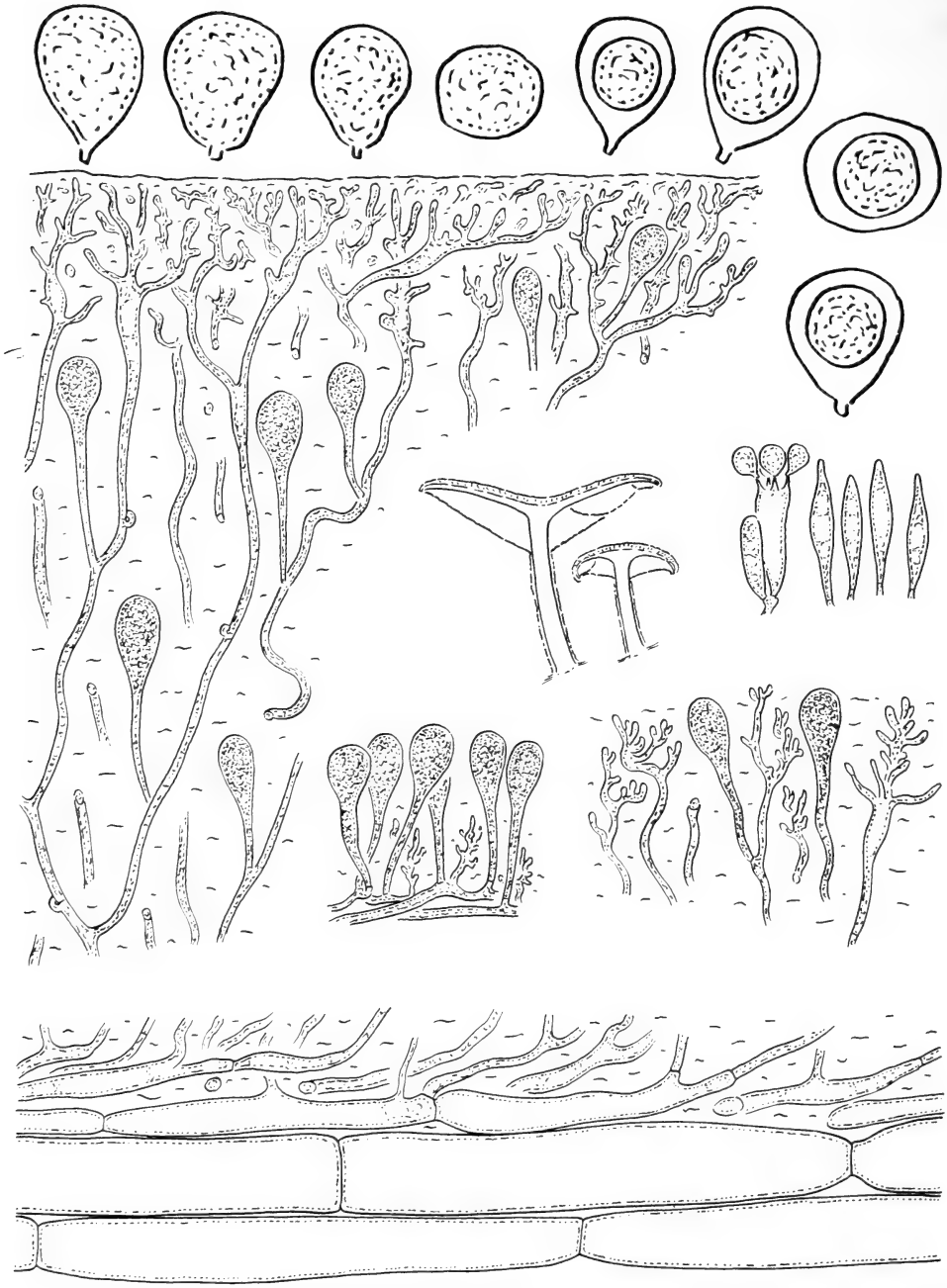

Fig. 24. *Panellus glutinosus*. Fruit-bodies, × 2; spores in side-view and end-view, × 2000; basidia, cheilocystidia (*central*) caulocystidia (*right* of *centre*), and surface of pileus with adjacent hyphae of the flesh, × 500.

towards the margin of the pileus almost shortly lamelliform, white. Flesh 0.2-0.3 mm thick at the base of the pileus, firm, not gelatinous.

Spores 6-7.5(-8) × 4.5-5.5 μ, white, smooth, broadly ellipsoid, obtuse, varying subamygdaliform, very pale bluish amyloid. Basidia 24-29 × 6.5-7.5 μ; sterigmata 4, 4-6 μ long; basidioles acerose, 3-5.5 μ wide, often mucronate, abundant; subhymenium narrow, not corticate. Cheilocystidia 22-35 × 7-18 μ, clavate, thin-walled, smooth, hyaline (not gloeocystidial, even when young), often rather sparse,

becoming overgrown by dichophysial hyphae 40-60 μ long with the body 3-6 μ wide, with closely lobulate branches, thinly encrusted, not amyloid. Hyphae 1.5-5 μ wide, clamped, with firm walls -2 μ thick, compact, *with many extra-hyphal brownish resinous masses* swelling in Melzer's iodine into large vitreous resinous brown globules. Surface of pileus with cystidia and dichophysial hyphae as on the pore-edges, the cystidia abundant near the margin of the pileus and almost as a palisade, becoming spaced over the general surface and much obscured by the excrescent dichophyses and resinous brown masses.

On dead bamboo stems in the forest. Solomon Islands.

Guadalcanal, Tambalusu c. 700 m alt., 19 Oct. 1965, *RSS 1534 and 1536.*

Subgen. **Mesopanellus** *subgen. nov.*

Receptacula mesopodalia marasmioidea, parva. Lamellae decurrentes, haud vel vix reticulato-venosae. Basidiola acerosa copiosa. Cheilocystidia clavata, intus oleaginosa. Hyphae haud granuloso-incrustatae, inflatae. Superficies pilei stipitisque cystidiis clavatis hyphisque dichophysialibus instructa. Duo species, Borneo, Peninsula Malayana. Typus — *P. glutinosus* sp. nov.

Fruit-bodies mesopodal, marasmioid, rather small with pileus -2 cm wide, white then pale ochraceous. Gills decurrent or adnato-decurrent, not dichotomous, not or slightly reticulately veined.

Spores white, smooth, pale amyloid. Basidioles acerose, abundant. Cheilocystidia strongly clavate with oleaginous contents; dichophysial hyphae on the gill-edge, sometimes inconspicuous. Pleurocystidia none. Hyphae not granular incrusted, clamped or not, inflating. Surface of pileus and stem with clavate cystidia and copious dichophysial hyphae.

Key to the species of subgen. *Mesopanellus*

1. Pileus and stem glutinous viscid, with stalked clavate cystidia and dichophysial hyphae in the mucilage. Spores 6-8.5 × 5.5-7 μ, subtriangular in adaxial view. Clamps absent except on the mucilage-hyphae of pileus and stem. Hyphae of stem secondarily septate. Borneo ..... *P. glutinosus* p. 140
1. Pileus and stem dry. Spores 7-8.5 × 4.3-5 μ, not subtriangular. Clamps present; hyphae not secondarily septate. Clavate cheilocystidia not distinctly stalked. Malaya ..... *P. pyruliferus* p. 141

The two species which I have placed in this new subgenus have the spores, basidioles, cystidia, and dichophysial hyphae of subgen. *Panellus* but, with mesopodal fruit-bodies and decurrent gills, they appear to belong to the alliance of *Marasmius*. Their hyphae lack the granular incrustation of typical *Panellus*, but this is a feature, also, of the three species of subgen. *Panellus* which lack the acerose basidioles, and it seems to be typical of the temperate subgen. *Mitellus*. Thus, only the mesopodal stem remains as a satisfactory distinction; along with the thin-walled inflating hyphae, it suggests that *Mesopanellus* is a relic of the ancestry of *Panellus*. Among the species without acerose basidioles, that which seems nearest to *Mesopanellus* is *P. fuscatus*.

This subgenus introduces two new features to *Panellus*. The hyphae in the stem of *P. glutinosus* are secondarily septate; this is a common feature in *Mycena* but not in the alliance of *Marasmius*. Then in this same species, the pileocystidia appear to develop laterally from the dichophysial hyphae (Fig. 24). It may be an illusion caused by the gelatinisation and swelling of the hyphal walls. Thus, the cheilocystidia are terminal with interposed dichophysial hyphae, and the caulocystidia seem to have this same arrangement.

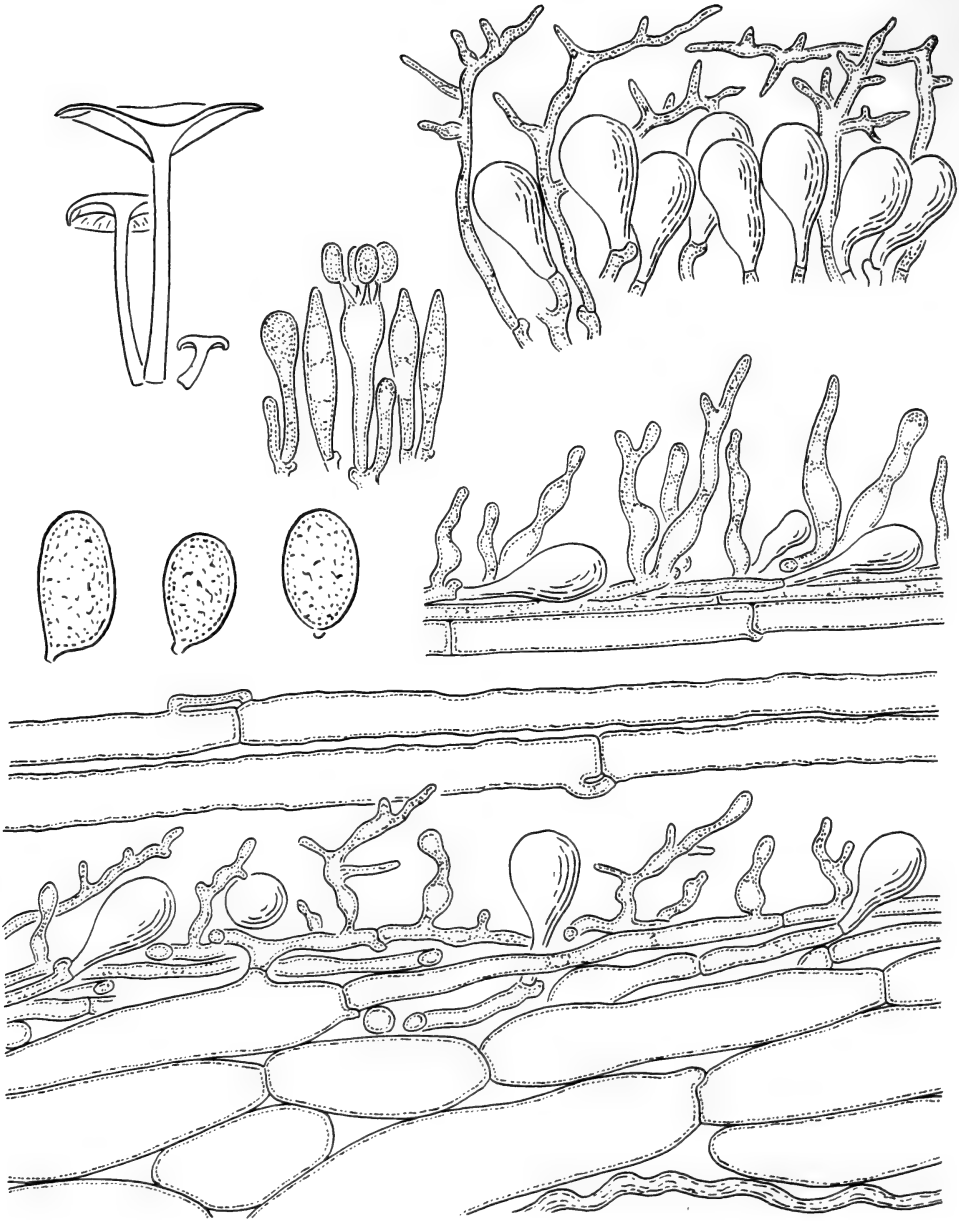

Fig. 25. *Panellus pyruliferus*. Fruit-bodies, × 2.5; spores, × 2300; basidia, cheilocystidia (*above*, surface of stem (*middle* drawing), and surface of pileus (*below*), × c. 500.

Panellus glutinosus *sp. nov.* Fig. 24

Pileus -18 mm latus, convexus dein planus vel subumbilicatus, viscido-glutinosus striatus, albus dein pallide subochraceus. Stipes -12 × 0.5-1.5 mm, centralis, viscidua, albus, ad basim abruptum strigoso-villosus. Lamellae adnato-decurrentes, crassiusculae subgelatinosae, ad basim subreticulatae, albae, acie exsiccata brunneo-gummosa. Caro tenax, ad superficiem pilei stipitisque gelatinosa.

Sporae 6-8.5 × 5.5-7 μ, subgloboso-subtriangulares, amyloideae. Basidiola acerosa copiosa. Cheilocystidia 30-65 × 7-13 μ, clavata, intus oleaginoso-guttulata, hyphis dichophysialibus brevibus intermixta. Caulocystidia et pileocystidia similia, hyphis dichophysialibus gelatinosis superantibus. Hyphae inflatae, haud incrustatae; in stipite -17 μ latae, ordine secundo septatae sine fibulis; in pileo -26 μ latae, ? fibulatae; in superficie viscida 1.5-4 μ latae, fibulatae.

Ad ramulos emortuos in silva. Borneo, mt. Kinabalu, *RSNB 5705A* typus, in herb. Corner.

Pileus -18 mm wide, convex then plane to subumbilicate, *glutinous viscid* from the first, striate, *white then pale dingy ochraceous over the centre; margin slightly incurved at first, without veil.* Stem 6-12 × 0.5-1.5 mm, cylindric, *smeary viscid, white,* at first white pruinose, the abrupt base thinly strigose-villous. Gills adnate to adnato-decurrent, rather *thick, subgelatinous,* with mucilaginous edge, 13-20 primaries -2.5 mm wide, 2-3 ranks, becoming slightly reticulate at the base, *white,* the edge drying brown-gummy. Flesh thin, rather tough, gelatinous at the surface of pileus and stem. Smell slightly fishy.

Spores 6-8.5 × 5.5-7 μ, white, smooth, pip-shaped but rounded *subtriangular* in adaxial view, with oleaginous contents contracting into a refringent mass in dried spores, pale bluish amyloid. apiculus 0.7-1 μ long. Basidia 24-32 × 7.5-8.5 μ, with oleaginous contents; sterigmata 4, 5 μ long; basidioles -33 × 4-6 μ, acerose, abundant; subhymenium narrow, toughly gelatinous, not corticate. Cheilocystidia 30-65 × 7-13 μ, clavate with long narrow stalk 2.5-4 μ wide, smooth, oleaginous-guttulate, as a sterile edge, arising from the longitudinal subgelatinous hyphae of the gill-edge; with small inconspicuous dichophyses 1.5-3.5 μ wide. Pleurocystidia none. Hyphae monomitic, inflated, without clamps except in the mucilage hyphae on pileus and stem, secondarily septate (at least in the stem) the cells 40-280 × 3-17 μ in the stem and strictly longitudinal with broad septa; in the pileus radiating with cells -200 × 3-26 μ, narrow and subgelatinous next to the viscid surface; in the gill-trama as in the pileus but laxly interwoven; turning brownish in Melzer's iodine. Caulocystidia as the clavate cheilocystidia, with more copiously branched mucilaginous dichophyses as the ends of clamped mucilage hyphae 1.5-4 μ wide, bearing the clavate cystidia laterally and forming a mucilaginous layer 70-150 μ thick; the base of the stem with many excrescent 2-4 μ hyphae. Surface of pileus with a mucilaginous layer -400 μ thick, constructed as on the stem but with the mucilage hyphae more or less perpendicular to the surface and the dichophyses less compactly branched. Young pileus with the mucilage layer initiated by excrescent hyphae 1.5-3 μ wide, perpendicular to the surface, developing dichophyses at the ends and the clavate cystidia laterally; not initiated as a compact palisade.

On sticks in the forest, gregarious. Borneo.

Mt. Kinabalu, Mesilau 1600 m alt., 10 March 1964. RSNB 5705A; *16 March 1964, RSNB 5705B;* 1 May 1964, *RSNB 5705C.*

Panellus pyruliferus *sp. nov.* Fig. 25

Ex integro albus, aetate flavidulus. Pileus -10 mm latus, convexus dein concavus, laevis, substriatus, siccus. Stipes -12 × 0.5-1 mm, centralis, pruinosulus, siccus, ad basim subvillosus. Lamellae adnatae vel subdecurrentes, subdistantes, angustae, haud reticulatovenosae. Caro firma, sicca.

Sporae 7-8.5 × 4.3-5 μ, ellipsoideae, haud subtriangulares, amyloideae. Basidiola acerosa copiosa. Cheilocystidia 29-35 × 7-8.5 μ, pyriformia, tenuiter tunicata, intus flavidulo-opalescentia, hyphis dichophysialibus superantibus. Caulocystidia et pileocystidia aut clavata ut cheilocystidia aut subcylindrica, subcapitata, -45 × 5-7 μ, saepe lobulis paucis praedita. Hyphae fibulatae, inflatae, nec incrustatae nec ordine secondo septatae nec gelatinosae; in stipite -17 μ latae; in pileo lamellisque 2-5 μ latae sed prope superficiem pilei 8-20 μ latae.

Ad lignum emortuum in silva. Peninsula Malayana, Pahang, Cameron Highland, *Corner s.n.* 2 Oct. 1966 typus, in herb. Corner.

Entirely white, yellowish in age. Pileus -10 mm wide, convex to concave, smooth, substriate; not viscid; margin slightly incurved at first. Stem 5-12 × 0.5-1 mm, cylindric, finely pruinose, dry, base slightly thickened and subvillous. Gills adnate to subdecurrent, subdistant, *narrow,* 15-20 primaries 0.3-0.7 mm wide, 1-2 ranks, interstices smooth. Flesh firm, drying hard, inodorous.

Spores 7-8.5 × 4.3-5 μ, white, smooth, ellipsoid, obtuse, not subtriangular, pale bluish violaceous amyloid. Basidia 29-35 × 7-8.5 μ; sterigmata 4, 5 μ long;

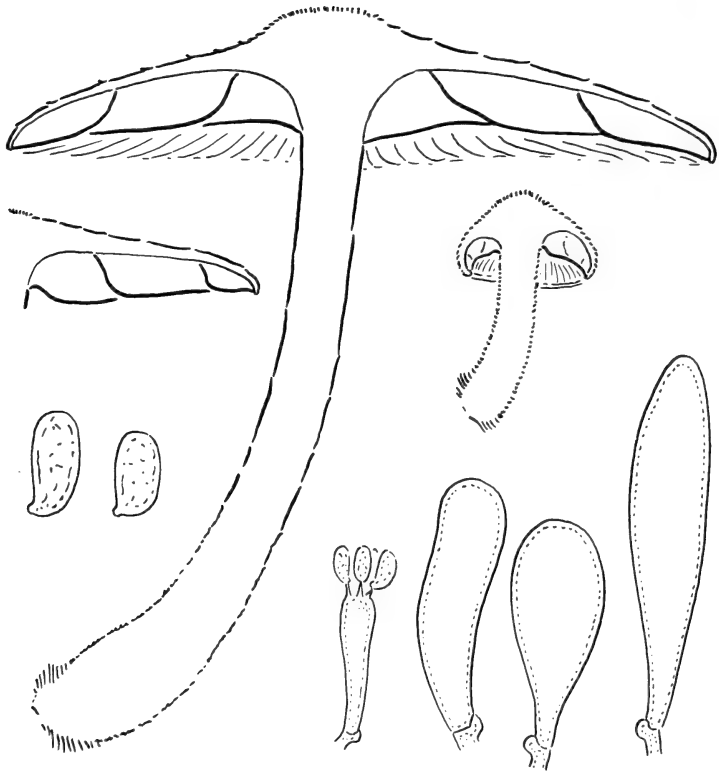

Fig. 26. *Panellus magnus*. Fruit-bodies, × 2; unexpanded fruit-body, × 3; spores, × 2500; basidia and cheilocystidia, × 750.

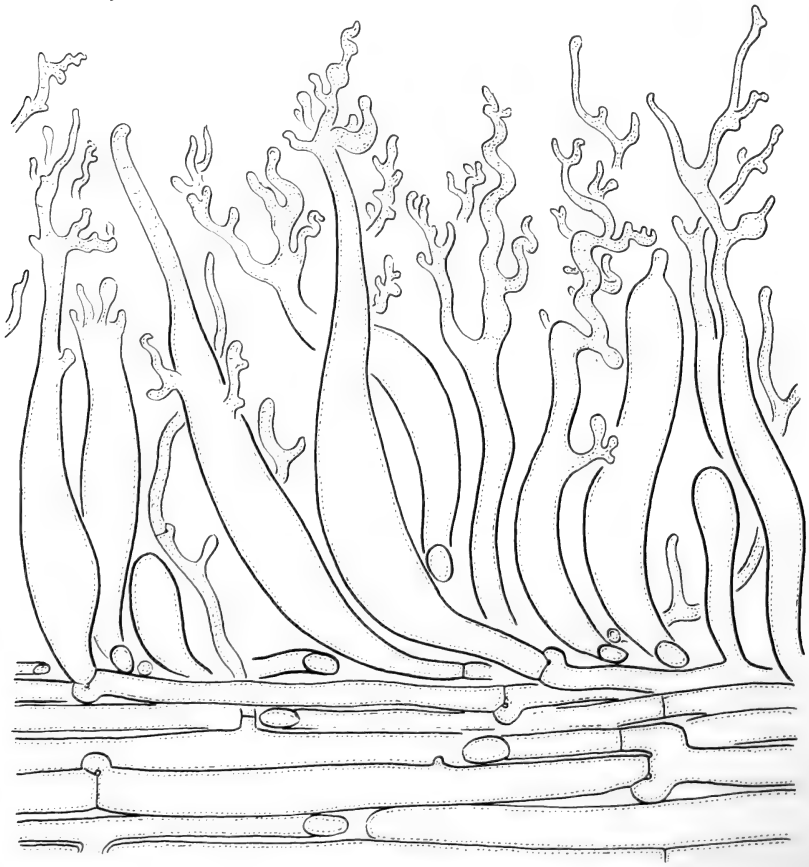

Fig. 27. *Panellus magnus*. Caulocystidia, × 500.

basidioles acerose to subacuminate, abundant. Cheilocystidia -27 × 8-15 μ, pyriform, thin-walled, smooth, with yellowish opalescent contents, as broad sterile edge to the gill, becoming overgrown by narrow, 1-2.5 μ wide, hyphae with spicate branches. Pleurocystidia none. Caulocystidia of two kinds; clavate as the cheilocystidia, more or less decumbent and scattered; as abundant small subcylindric, subcapitate, or subventricose cells -45 × 2.5-5(-7) μ, simple or with one or two processes. Pileocystidia as the caulocystidia, of two kinds, but sparser. Hyphae monomitic, clamped, inflating; cells of the stem 60-300 × 6-17 μ, not or scarcely constricted at the broad septa, longitudinal, the walls often finely undulate and uneven, with a few narrow uninflated hyphae; in the pileus mostly uninflated, 2-5 μ wide, interwoven, with firm walls, but near the upper surface with inflated cells 8-20 μ wide; in the gill-trama uninflated, with firm walls. Oleiferous hyphae 3-6 μ wide scattered in all parts.

On dead wood in the forest, gregarious. Malay Peninsula.

Pahang, Cameron Highland 1700 m. alt., 2 Oct. 1966, *Corner s.n.*

Macroscopically this suggests Omphalina or *Trogia* but the tissue is rather firm and dry. Microscopically it is easily recognised from the small pyriform cystidia with opalescent contents on the gill-edge and surfaces of pileus and stem. It could be looked for in *Marasmiellus* but the amyloid spores do not fit.

Subgen. **Megalopanellus** *subgen. nov.*

Pileus -9 cm latus, plus minus mesopodalis, furfuraceo-squamulosus. Stipes bene evolutus. Caro tenax, haud gelatinosa, inamyloidea. Basidiola acerosa nulla. Cheilocystidia vix diverticulata. Caulocystidia diverticulis ramoso-lobulatis saepe praedita. Superficies pilei trichodermoidea, sine hyphis dichophysialibus. Hyphae fibulatae, inflatae, superficiales tunicis brunneis et brunneo-incrustatis saepe praedita.

Lignicola, Borneo; typus *Panellus magnus* **sp. nov.**

This fungus could be squeezed into several genera with smooth amyloid spores, such as *Clitocybula, Porpoloma* and *Baeospora,* but it has the essential construction of *Panellus* where it assumes a primitive position in stature, hyphae, and squamulose pileus and stem. None of these points seems to have generic distinction when one considers the latitude in other genera such as *Mycena, Pluteus* and *Amanita.* I prefer the large generic concept because so many microgenera are merely transient abstractions from the incompletely known flora of the world. I find in subgen. *Megalopanellus* what one would expect for the derivation of the species with small, lamellate or poroid, fruit-bodies which are the majority. Thus there is a vestige of a trichoderm on the pileus of the lamellate *P. fuscatus.*

Panellus magnus *sp. nov.* Figs. 26-29

Pileus 2-9 cm latus, convexo-planus, saepe subumbonatus, siccus, opacus vel prope marginem anguste striatus, fuscus, marginem versus isabellinus, minute fuscofuligineo-furfuraceus vel subsquamulosus. Stipes 3-6 cm × 3-6 mm, cylindricus vel apicem versus subattenuatus, saepe excentricus, haud lateralis, pallide isabellinus dein e basi abrupto fuscofuligineus, minute fuscofurfuraceus vel squamulosus, apice albopruinoso, sine annulo vel velo. Lamellae sinuato-adnatae vel adnato-decurrentes, confertae, tenues, tenaces, primariae 40-60, 2-4 mm latae, ordinibus 3-4 instructae, acie integra, albae dein isabellinae, aetate fuscofuligineae. Caro in centro pilei -2 mm crassa, plus minusve tenax, subcoriacea, haud gelatinosa, inodora.

Sporae 3.7-6 × 1.8-2.8 μ, albae ellipsoideae, plus minusve intense amyloideae. Cheilocystidia 28-50 × 5-17 μ, subcylindrica, clavata, vel subventricosa, tenuiter tunicata, ex apicibus diverticulis paucis saepe praedita, lamellae acie fertili dispersa. Pleurocystidia nulla vel sparsa ut cheilocystidia. Caulocystidia 30-150 × 4-17 μ, subventricosa, fusiformia, tunicis brunneis, apices versus hyalina et saepe in diverticulos ramosos vel lobulatos producta. Hyphae monomiticae, fibulatae, inflatae -22 μ latae, hyphis angustis

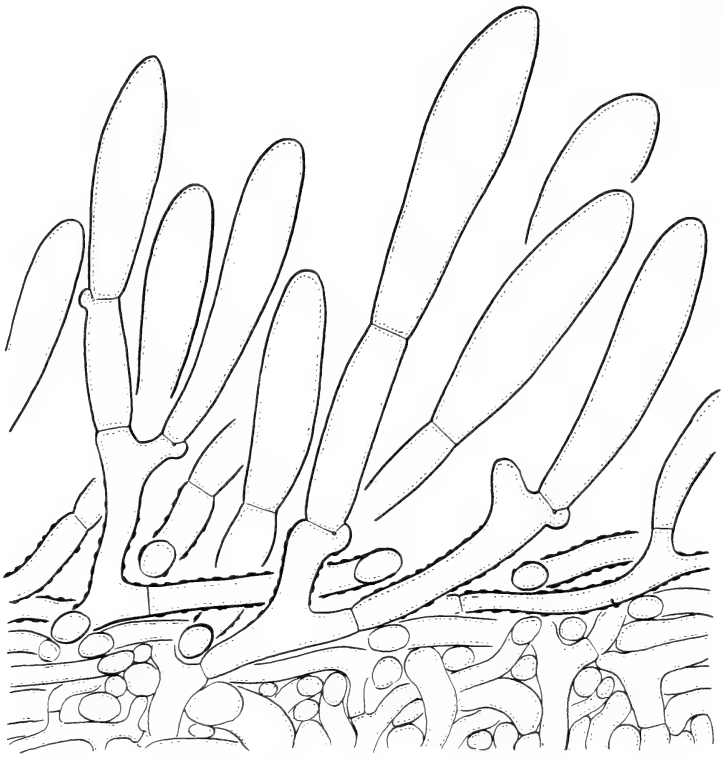

Fig. 28. *Panellus magnus*. Surface of centre of pileus, × 500.

1.5-7 μ latis intermixtis, saepe diverticulis brevibus paucis emittentes, tunicis -0.5 μ incrassatis, sparsim ordine secundo septatae; oleiferae nullae. Superficies pilei trichodermoidea disrupta, hypharum apicibus 0-2 septatis, cellulis apicalibus 45-90 × 4-20 μ, plerumque clavatis, tunicis brunneis; ex hyphis 4-9 μ latis, tunicis brunneis et saepe brunneo-incrustatis, oriens.

Ad truncos ramosque emortuos in silva montana, frequens, caespitosus, Borneo, mt Kinabalu, *RSNB 847* typus, in herb. Corner.

Pileus 2-9 cm wide, conico-convex to *convexo-plane*, often *subumbonate, dry, opaque*, or narrowly striate at the margin, *fuscous, bistre yellowish towards the margin*, becoming paler on expansion, *minutely fuscous fuliginous scurfy or squamulose*, sparsely towards the pallid smooth margin slightly incurved at first. Stem 3-6 cm × 3-6 mm, cylindric or slightly attenuate upwards, *often excentric* but not lateral, *pale livid white then fuscous fuliginous from the base upwards, minutely fuscous squamulose or scurfy*, innately darker fibrillose from the base to the white pruinose apex; without veil and ring. Gills sinuato-adnate to adnato-decurrent, *crowded, thin, tough*, 40-60 primaries 2-4 mm wide, 3-4 ranks, not dichotomous, edge entire, *white then tinged bistre, fuscous fuliginous in age.* Flesh -2 mm thick in the centre of the pileus, rather tough, especially in the stem, white then concolorous. Inodorous; poisonous according to local inhabitants.

Spores 3.7-6 × 1.8-2.8 μ, white, smooth, ellipsoid, blue-black amyloid to pale vinaceous amyloid *(RSNB 1684, 8006)*. Basidia 13-22 × 3.5-4 μ, 4-spored; acerose basidioles absent; subhymenium 10-20 μ thick, composed of 2-3 μ wide interwoven hyphae. Cystidia 28-50 × 5-17 μ, clavate or subventricose, with or without short processes, smooth, thin-walled, projecting -20 μ or almost wholly immersed, *scattered* on the gill-surface and along the fertile gill-edge. Caulocystidia 30-150 × 4-17 μ, more or less fusiform or subventricose with firm brown walls and colourless thin-walled apices, often with narrow lobed or branched processes from the apex, less often the processes lateral, forming a disrupted palisade, eventually invested

with dichophysial hyphae 1.5-2 μ wide. Hyphae monomitic, clamped, inflating, the walls becoming firm and in the stem thickened -0.5 μ, with cells 35-500 $\times$ 8-22 μ in the longitudinal hyphae, narrowed to the septa or not, often somewhat uneven in width, occasionally secondarily septate in the stem, often with one or a few short abortive processes but no true binding hyphae, with narrower hyphae 1.5-7 μ wide interweaving and often rather copiously branched with abortive processes but septate with clamps; no oleiferous hyphae; in the gill-trama, parallel descending, more or less inflated as in the pileus, forming a rather tough tissue, not amyloid. Surface of pileus with a short disrupted pile of hyphal ends with firm brown walls,

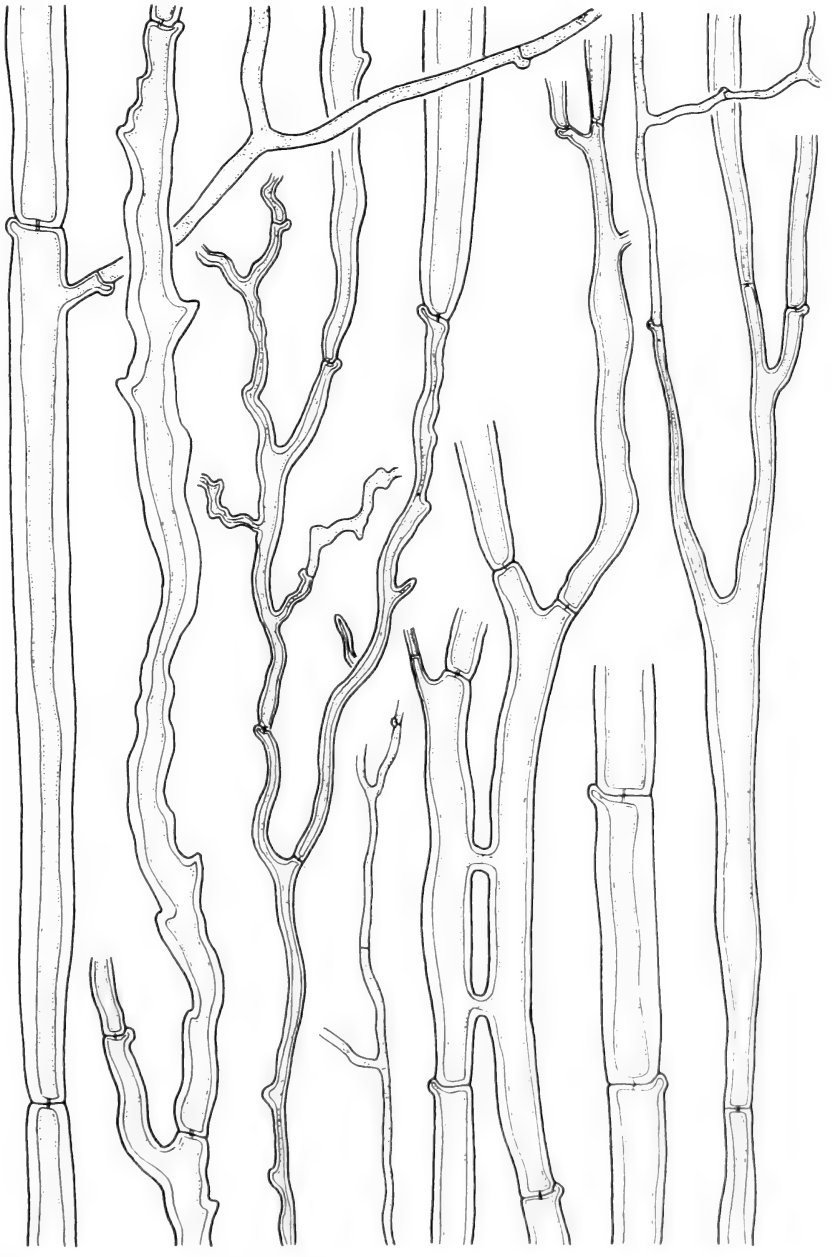

Fig. 29. *Panellus magnus*. Hyphae of the stem, that on the *right* secondary septate with cytoplasm retracted from the apex; $\times$ 500.

1-3 cells long, the terminal cells 45-90 × 4-20 μ, generally clavate and subacute, arising from 4-9 μ wide hyphae with firm brown walls and often with more or less annular brown incrustation; the hyphal ends of the pile more or less erect over the centre of the pileus, more or less decumbent and scattered in clusters over the limb.

Frequent, caespitose, on dead standing trunks and fallen wood in montane forest, Borneo.

Mt. Kinabalu 1700-3500 m alt., 16 July 1961, *RSNB 847;* 9 Aug. 1961, *RSNB 1684;* 20 Feb. 1964, *RSNB 5381;* 31 March 1964. *RSNB 8006.*

The tufts of this pallid fungus are a conspicuous sight on the hard dead trunks which abound in the upper forest on mt. Kinabalu; there, oaks, Myrtaceae, *Rhododendron* and podocarps abound with many other kinds of tree, and I was unable to decide what might have been the host-tree. The Dusun people claimed to know it well for they regarded it as poisonous, but I am not convinced that they distinguished it from *Pleurotus decipiens* (Corner 1981). I did not test whether it was phosporescent. Superficially, this fungus would pass for *Lentinus* in its general sense. The hyphal structure is incipiently dimitic, though not sarcodimitic as in *Trogia,* and the interweaving processes suggest not so much binding hyphae as incipient internal dichophysial hyphae.

References

Burdsall Jr, H.H. and O.K. Miller Jr (1975). A re-evaluation of *Panellus* and *Dictyopanus* (Agaricales). *Nova Hedwigia,* Beih. 51, 79-91. J. Cramer, Vaduz.

Corner, E.J.H. (1950). Descriptions of two luminous tropical agarics (*Dictyopanus* and *Mycena*). *Mycologia* 42: 423-431.

_____. (1954). Further descriptions of luminous agarics. *Trans. Brit. mycol. Soc.* 37: 256-271.

_____. (1981). The agaric genera *Lentinus, Panus* and *Pleurotus. Nova Hedwigia,* Beih. 69. J. Cramer, Vaduz.

_____. (1983). Ad Polyporaceas I. *Nova Hedwigia,* Beih. 75. J. Cramer, Vaduz.

_____. (1984). Ad Polyporaceas II and III. *Nova Hedwigia,* Beih. 78. J. Cramer, Vaduz.

Dennis, R.W.G. (1952). The Laschia-complex. *Kew Bull.* 1952: 325.

_____. (1970). Fungus flora of Venezuela and adjacent countries. *Kew Bull., Addit. Ser. III.*

Jülich, W. (1981). Higher taxa of Basidiomycetes. *Bibliotheca Mycologica* 85. J. Cramer, Vaduz.

Kobayasi, Y. (1963). Revision of the genus *Dictyopanus* with special reference to the Japanese species. *Bull. Nat. Sci. Mus. Tokyo* 6: 356-364.

Macrae, R. (1937). Interfertility phenomena of the American and European forms of *Panus stypticus. Nature* 1937: 674.

Singer, R. (1945). The Laschia-complex (Basidiomycetes). *Lloydia* 8: 170-230.

_____. (1969). Mycoflora Australis. *Nova Hedwigia,* Beih. 29. J. Cramer, Vaduz.

_____. (1975). *The Agaricales in modern taxonomy.* J. Cramer, Vaduz.

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A New Species of *Platycerium* from Peninsular Malaysia

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Abstract

A new species of *Platycerium* from Peninsular Malaysia, *P. platylobum* Aziz Bidin & Razali Jaman is described.

Platycerium platylobum Aziz Bidin & Razali Jaman *sp. nov.* Plates 1 & 2

Platycerio coronario (Koënig ex Muller) Desv. affinis, ab ea differt: paleis rhizomatis usque 20 × 5 mm tantum, apicem versus angustatis, marginibus costae usque apicem manifeste prominentibus; lobis ultimis ramorum duorum inferiorum frondium fertilium quam lobis ceteris frondium majoribus, usque 32 × 4 cm; lobis fertilibus stipitatis (stipite alato 3-5 cm longo), usque 13 cm latis, planis, tenuioribus, profunde aequaliter bilobatis, lobis ambo etiam leviter bilobatis; paraphysibus brevioribus, 3 vel 4 cellulis sonstitutis, radios 11-13 (-15) ferentibus; cellulis induratis annuli sporangiorum 5-6 (-8).

Agreeing in growth-habit and branching of fronds with *Platycerium coronarium* (Koënig ex Muller) Desv., differing as follows: rhizomes-scales to 20 mm long and 5 mm wide only, narrowed towards their apices, the prominent margins of the thickened median band (costa) distinct to the apex of each scale; ultimate lobes of the basal two branches of fertile fronds to 32 × 4 cm, much longer and wider than the ultimate lobes of other branches; fertile lobe stalked (stalk winged, 3-5 cm long), to 13 cm wide, flat, thinner than in *P. coronarium*, deeply bilobed; paraphyses much shorter, consisting of 3 or 4 cells, their rays 11-13 (-15) in number; undurated cells of the annulus of sporangia 5-6 (-8).

Aziz Bidin & Razali Jaman PL 149: Langkawi Island, road to Padang Lunas, c. 30 m alt., 12 Feb. 86. Epiphyte, uncommon (Holotype: UKMB; Isotype: K).

Distribution. Langkawi Island. The ferns were absent from the other islands in the group as well as the interior of Perlis and northern Kedah, all of which share the same monsoonal climate.

Ecology. The species was first found on an old rubber tree, about 4 m high from the base of the trunk, in a village near Padang Lunas about 5 km from Kuah Town. No other species of *Platycerium* was observed in the vicinity. Later collections were from rubber trees in a plantation in Kisap, c. 50 m elevation, about 12 km from Kuah town. There, all the three species were found. *P. coronarium* was found on the higher branches of tall trees while *P. holttumii* and *P. platylobum* were on low branches, 2-5 m above the ground.

This new species differs from other *Platycerium* species which also bear sori on individual lobes in that each individual lobe here has a deep, median incision, the distal part bi-lobed on each side of the incision, with the result that the whole resemble a pair of butterfly wings as opposed to the shape in *P. coronarium* which is kidney or semi-circular and the one in *P. ridleyi*, obovate or elliptical (respectively Holttum, 1968 and Hennipman & Ros, 1982). In this species too, the entire fertile lobe is flat as opposed to concave in both the other two; the paraphyses are

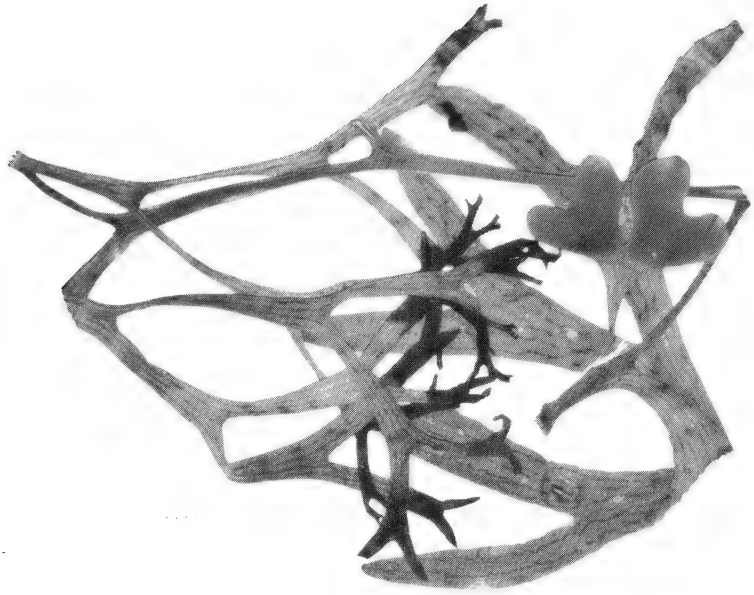

Plate 1. *Platycerium platylobum*, fertile frond.

Plate 2. *Platycerium platylobum*, fertile lobe.

short-stalked (3 to 4 cells long) as against longer stalks in *P. coronarium* (7 to 8 cells long) and *P. ridleyi* (8 to 10 cells). The species is only known from Langkawi Island whereas *P. coronarium* is common throughout the lowlands of Peninsular Malaysia and *P. ridleyi* is limited to the southern part of the Peninsula, i.e., Johore and Singapore (Holttum, 1968).

Acknowledgements

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Literature Cited

Hennipman, E. & M.C. Roos (1982). *A Monograph of the Fern Genus Platycerium (Polypodiaceae)*. North-Holland Publishing Company, Amsterdam, Oxford, New York.

Holttum, R.E. (1968). Flora of Malaya, 2, *Ferns of Malaya*, Government Printer, Singapore.

STUDIES IN THE FERN-GENERA ALLIED TO *TECTARIA* CAV. VI

A conspectus of genera in the Old World regarded as related to *Tectaria*, with descriptions of two genera

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Abstract

A brief conspectus of the palaeotropic genera, regarded by the author as related to *Tectaria* Cav., is presented with: comments on individual genera, descriptions of two new ones, *Chlamydogramme* and *Megalastrum*, some thoughts on inter-relationships, a key to the genera, and also brief comments on neotropic genera.

Introduction

In the first paper of this series (Holttum 1984, p. 314) is the following statement which was intended to show the differences between two groups of genera which together constitute almost the whole of the family Aspidiaceae as arranged by Pichi Sermolli (1977):

Dryopteris group. Midribs of ultimate leaflets grooved, the groove of the rachis bearing the leaflets being open to admit the leaflet-groove, the margin of the leaflet being decurrent (but not prominent) down the side of the rachis; ctenitoid hairs lacking.

Tectaria group. Midribs of ultimate leaflets more or less prominent (in *Tectaria* sometimes slightly grooved) and bearing ctenitoid hairs, usually many.

While working on a monograph of the genus *Ctenitis* in Asia, Malesia and the Western Pacific I discovered the existence within *Ctenitis* as arranged by Ching (1938) of a group of species (his suggested subgenus *Dryopsis*) which has pinna- or pinnule-midribs grooved but with the groove closed near the junction of the pinna with the rachis which bears it. In these species the hairless groove has on its borders thick-based hairs (the cells near the base wider than long) like those in a similar position in *Peranema* and *Nothoperanema*, also some structures which are narrowly scale-like above a similar thick base; these are quite unlike anything in true *Ctenitis* and the species differ from typical *Ctenitis* also in other ways. Mr P.J. Edwards assisted me to make a detailed comparative study of all such species, which we have assigned to a new genus *Dryopsis* in paper II of the present series. The detailed studies show that the distal part of some of the peculiar hairs resembles a single hair of *Ctenitis*. Thus *Dryopsis* may be a connecting link between the *Tectaria* and *Dryopteris* groups of genera. Furthermore, in some genera of the *Tectaria* group the multicellular hairs on the raised upper surfaces of costae are more or less acicular, not contorted on drying as in *Ctenitis*. My distinction between the two groups of genera will therefore need to be modified. I still believe however that the genera I associated together in 1947 as a subfamily Tectarioideae are a natural group.

I have now examined the types of almost all species in the Old World (including Africa) assigned to genera of the *Tectaria* group and here summarize significant information about them in the form of a tentative conspectus, with descriptions of two new genera and some thoughts on their possible inter-relationships, followed by an artificial key. I intend to prepare an account of Malesian species based on this scheme for *Flora Malesiana,* where I hope to publish the facts about them in more detail, and to make formal transfer of some names.

The genera closely associated with *Tectaria* have (where known) 40 chromosomes and lack cylindric glands. The remaining genera have (where known) 41 chromosomes and are divided into two groups, those with and without glands. The genera are arranged below in these categories; possible inter-relationships between members of the categories are then considered.

Tectaria and closely allied genera

Common characters: scales narrow, consisting wholly of narrow cells, never clathrate, rarely abundant on smaller axes of the frond; ctenitoid hairs always present on the upper surface of the rachis; venation and branching (apart from basal pinnae) almost always catadromous; veins all free or variously anastomosing; unicellular cylindric glands lacking; sori in most species indusiate but in some exindusiate and ± spreading along veins, in a few, where the fertile lamina is much contracted, spreading along all veins and covering the whole of the lower surface; chromosome number, where known, 40.

Tectaria Cav.

Anales Hist. Nat. 1: 115 (1799)

This is much the largest genus, consisting of about 210 species of which 40 are neotropic. The best subdivision (not quite a sharp one) appears to be between species (including the type) which have amply anastomosing veins with free branched veinlets in the areoles, and those which have either free veins or veins forming narrow costal areoles lacking included free veinlets and few included veinlets in other areoles (venation of *Sagenia* Presl). A separation of species which are wholly free-veined is not possible; in *T. fuscipes* (Bedd.) C. Chr. sterile fronds have veins forming costal areoles but fertile ones have all veins free. I thus propose to treat *Tectaria* as consisting of two sections.

Sect. **Tectaria**

Including *Hemigramma* (M.G. Price 1974) and *Quercifilix* (W.A. Sledge 1972).

The type species of *Hemigramma*, *H. latifolia* (Goldm.) Copel. (= *Tectaria hilocarpa* (Fée) Price), has simple fronds, the fertile ones much constricted with a simplified venation and sporangia borne all along the closely crowded veins (pl. 1). Copeland (1908) showed that hybrids were formed in Luzon between this and *Tectaria crenata* Cav. In 1928 he enlarged *Hemigramma* by including in it *Gymnopteris decurrens* Hook. from Hong Kong and allied species. But the latter have broader fertile pinnae than the simple fertile fronds of *H. latifolia,* with an ample venation exactly as in the sterile pinnae, and a species in the Malay Peninsula has sori intermediate in form between those of *H. decurrens* and and species of *Tectaria* which have many small sori. Thus *H. latifolia* and *H. decurrens* are related to different species of *Tectaria*. In both, the sporangia are borne all along the veins on a restricted surface. The same is true of the only species of *Quercifilix*, which hybridizes with *Tectaria decurrens* in Ceylon. The species originally named *Leptochilus pentagonalis* R. Bonap., transferred with doubt to *Hemigramma* by Christ-

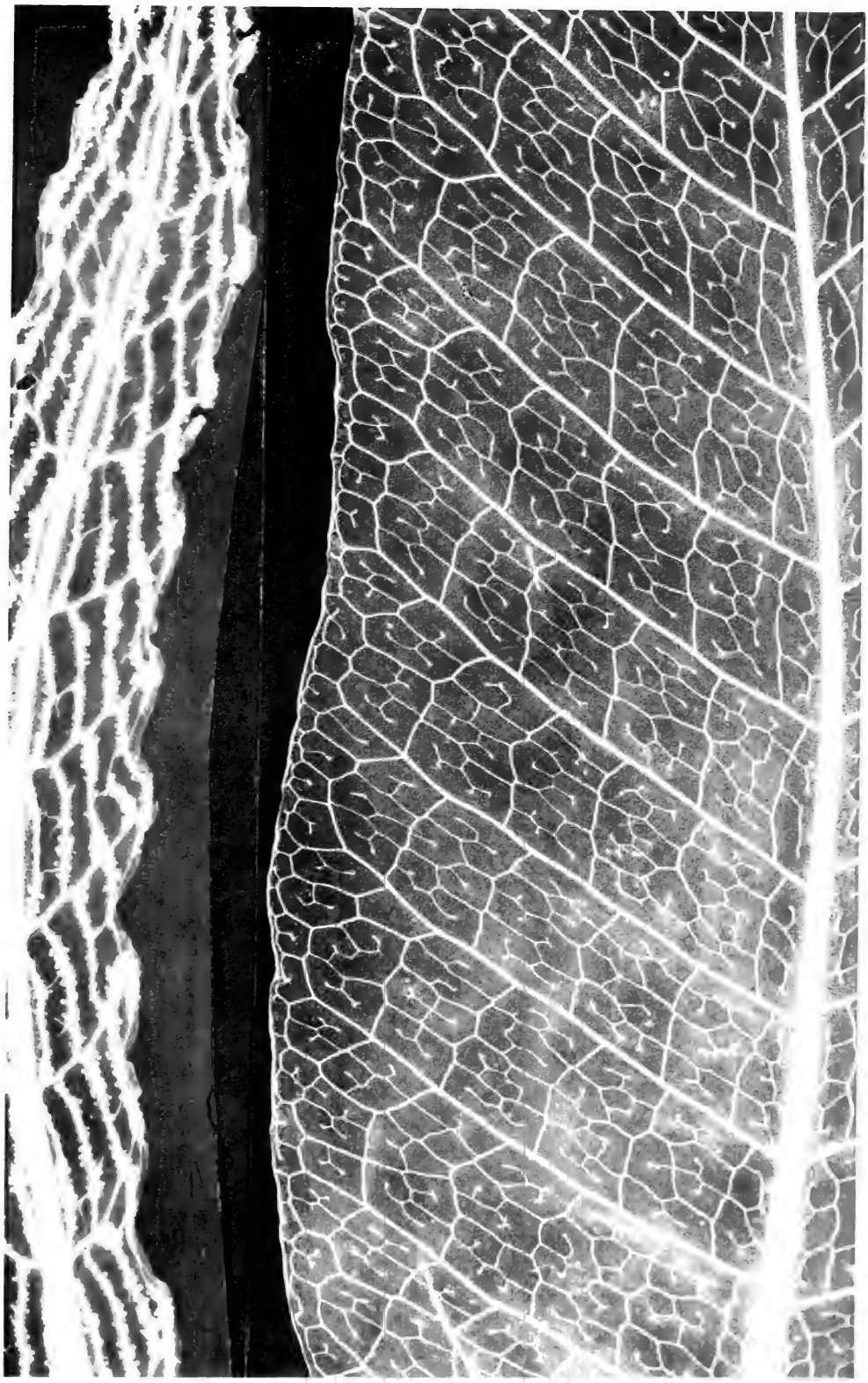


Plate 1. *Hemigramma latifolia* (Goldm.) Copel. = *Tectaria bilobata* (Lee) Price. Venation of fertile (× 4.5) and sterile (× 3) fronds; Java, *Schiffner* s.n. (L).

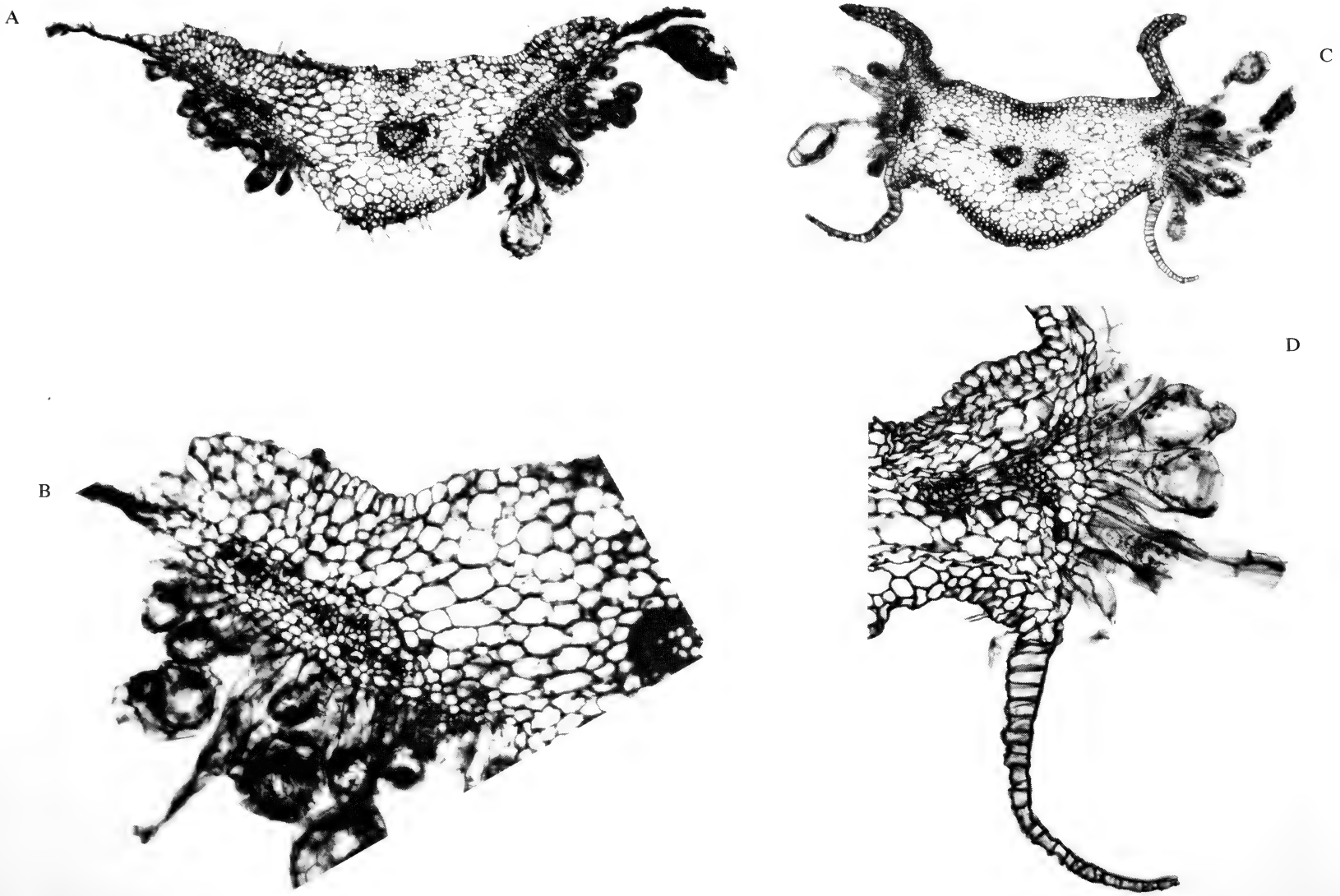


Plate 2. Transverse sections of fertile pinnae. *Hemigramma siifolia: A* (× 2.7), *B* (× 6.7); *Elbert 673,* Lombok (L). *Chlamydogramme hollrungii: C* (× 2.7), *D* (× 6.7.); *Hoogland & Craven 10187,* Papua New Guinea, Sepik District (K).

ensen, appears to be nearer to *Quercifilix* than to any species of *Hemigramma* as arranged by Copeland.

Sect. **Sagenia** (Presl) Holttum, *stat. nov.*

Sagenia Presl, Tent. Pterid. 86 (1836), as regards venation. Type species (selected here): *Sagenia latifolia* Presl, l.c. fig. 23 = *Tectaria mexicana* (Fée) Morton, Amer. Fern Journ. 56: 133 (1966), not *T. latifolia* (Forst.) Copel.

Stenosemia Presl, which has sterile fronds with *Sagenia* venation and much-contracted fertile ones, also *Cionidium* Moore which has extra-marginal sori terminal on veins, are included here.

Species of sect. *Sagenia* which have all veins free are a minority. They are most abundant in mainland S.E. Asia; apart from the Philippines, very few occur in Malesia and the Pacific. I regard these free-veined species as representing the original form of the genus and S.E. Asia as its probable centre of origin. The largest fronds are borne by *T. ingens* (Atk.) Holttum of Sikkim, attaining a length of 3 m. Two free-veined species in the neotropics have been included in *Tectaria*: *T. brauniana* (Karst.) C. Chr. and *T. pedata* (Desv.) R. & A. Tryon. They are certainly not related to the free-veined species of Asia; see below for further comment.

Genera related to *Tectaria* sect. *Tectaria*

Tectaridium Copel.

Philip. J. Sci. 30: 329 (1926).

Sterile fronds simple and unlobed, with venation as *Tectaria* sect. *Tectaria*; fertile fronds lobed to the costa, the very narrow lobes bearing indusiate sori; intermediate forms are frequent. There is only one species, which does not appear to be nearly related to any species of *Tectaria*.

Chlamydogramme Holttum, *gen. nov.*

Generi Tectariae Cav. affinis; frondes pinnatae, valde dimorphae; pinnae frondis sterilis simplices, integrae, venis ut in *Tectaria* sect. *Tectaria* ordinatis; pinnae frondis fertilis anguste lineares, soris linearibus marginalibus laminae et indusiis prope costas in juventute tectis. Type species: *Chlamydogramme hollrungi* (Kuhn) Holttum, **comb. nov.**

(*Gymnopteris hollrungii* Kuha in Schum. & Hollrung. Fl. Kaiser Wilhelmsl.: 8 (1889); *Hemigramma hollrungii* (Kuhn) Copel.)

Chlamydogramme hollrungi (Kuhn) Holttum *comb. nov.*

This species has fronds very similar in general aspect to those of the species from Lombok originally described as *Leptochilus siifolius* by Rosenstock and also transferred to *Hemigramma* by Copeland, but with a continuous indusium (not noticed by Copeland) along each side of the pinna-midrib in fertile pinnae; sections of fertile pinnae of the two species are shown in plate 2.

Chlamydogramme is comparable to the tropical American genus *Dictyoxiphium* Hook. but the latter has simple fronds, the fertile ones not greatly constricted so that the continuous indusium is not near the midrib. The two genera are not nearly related.

Genera related to *Tectaria* sect. *Sagenia*

Heterogonium Presl, emend. Holttum

Kalikasan 4: 205-231 (1975).

Basal pinnae always narrowed towards their bases on the basiscopic side; vena-

tion as in *Tectaria* sect. *Sagenia* even in fronds with broad pinnae, only differing in less frequent free veinlets in non-costal areoles; sori often exindusiate and variously ± elongate along the veins, in a few species running along all veins in a constricted fertile lamina; about 20 species, mainly Malesian.

Though the shape of the basal pinnae is the only constant character distinguishing species of this genus from those of *Tectaria* sect. *Sagenia*, they collectively have a variety of other characters and appear to form a natural group which is more sharply distinct from *Tectaria* sect. *Tectaria* than is sect. *Sagenia*. The only evidence I have seen of hybridization with species of *Tectaria* sect. *Sagenia* is provided by some Philippine specimens, collected by M. G. Price, which appear to be hybrids between *H. pinnatum* (Copel.) Holttum (a tetraploid with constricted fertile fronds) and *Tectaria aurita* (Sw.) S. Chandra (Stenosemia aurita Presl), which T.G. Walker (1973) found also to be a tetraploid with n = 80.

R.C. Ching (1938) has proposed a genus named *Ctenitopsis* which includes free-veined species of both *Heterogonium* and *Tectaria*; in my view it is not a natural group. Copeland has included such species in *Ctenitis*.

Psomiocarpa Presl.

Epim. Bot.: 161 (185).

The single species has sterile fronds which are small but bipinnate, with the same frond-form as some Philippine species of *Tectaria* sect. *Sagenia*, but the fertile fronds have extremely small pinnules quite covered with sporangia. M.G. Price has found plants intermediate between this and a bipinnate species of *Tectaria*. Pichi Sermolli (1977: 465) has wrongly placed this genus near *Ctenitis*.

Aenigmopteris Holttum

Blumea 30: 1-11 (1984).

The five species have elongate fronds with many pinnae which are more finely dissected than those of any species of *Tectaria* sect. *Sagenia*; pinna-lobes, which are themselves deeply lobed, are connected by narrow wings along the pinna-midrib and thus resemble *Lastreopsis* but the margin of the wing is not thickened and the rachis is not winged; as in *Tectaria* sect. *Sagenia* there are thick hairs between veins on the upper surface.

Genera having unicellular cylindric glands

The following four genera agree in having unicellular cylindric glands on the stalks of sporangia, in many species also on the margins of indusia and/or appressed to veins; they agree also in having the chromosome number 41, but they differ from each other in many ways.

Ctenitis C. Chr.

Verdoorn, Manual Pterid.: 544 (1938).

This was originally named *Dryopteris* subg. *Ctenitis* in Christensen's *Monograph of the genus Dryopteris* (part 1: 82-112, 1913; part 2: 31-93, 1920). He there dealt only with American species and defined the subgenus very broadly. In my recent study of all palaeotropic species I have felt obliged to limit a genus named *Ctenitis* by excluding Christensen's groups of *Dryopteris subincisa (Megalastrum* of the present conspectus) and of *Dryopteris protensa* (*Triplophyllum* Holttum 1986). I have not attempted to assess critically all the other neotropic groups recognized by

Christensen but believe that they would accord to my definition of *Ctenitis*. As thus limited, the genus comprises about 100 species and is considerably diversified in both the Old World and the New. In the Old World there are three distinct groups of species: the group of *C. submarginalis* (Langsd. & Fisch.) Ching (type species of the genus) which is mainly American but extends to Africa and the Mascarene Islands, and the species of mainland Asia, Malesia and the Western Pacific which are divisible into two groups which are sharply distinct from each other in both scales and spores (Holttum 1985). Two Hawaiian species are very different in spores from any in the western Pacific and I think also from any in the Americas. Thus the genus *Ctenitis*, worldwide, needs a new conspectus and I do not propose formal subdivisions for the Malesian species.

Ctenitis differs from *Tectaria* in its glands, its fragile gland-fringed indusia, in having abundant scales which are at least in part clathrate on all the smaller axes of the frond, also in having fronds which in almost all species are more finely divided, the ultimate leaflets almost always deeply lobed and always with free veins.

Lastreopsis Ching, emend. Tindale

Contr. N.S.W. Nat. Herb. 3: 249-339 (1965).

In Tindale's monograph of the genus 33 species are recognized; since then a few more have been added. Their fronds are finely divided somewhat as in *Ctenitis* but differ in scales, which are more like those of *Tectaria*, and in the thickened decurrent basiscopic margins of leaflets which form wings on the axes to which they are attached. The hairs in this genus are notably varied; ctenitoid hairs occur in most species, but in some the hairs on the upper surface of axes of the frond are rigid and more or less acicular, not contorted on drying; such hairs are characteristic of *Megalastrum*, described below. *Lastreopsis* is pantropic in distribution but the monograph by Tindale does not indicate any subdivision into natural groups of species. I suggest that the nature of the hairs on the upper surface of axes of the frond might offer clues to the distinction of sections within the genus. My impression is that the species of West Africa need more study.

Pleocnemia Presl. emend. Holttum

Kew Bull. 29: 341-357 (1974).

This genus of 19 species, mainly Malesian, was based by Presl on the venation (which agrees with *Tectaria* sect. *Sagenia*) and on the exindusiate sori of the sole original species, but there are also indusiate species and Presl did not notice the two most distinctive characters, namely the presence of teeth in the sinuses between pinnule-lobes and of cylindric glands which are usually yellow or orange in contrast to the usually pallid glands of most species of *Ctenitis*. The fronds of mature plants of all species are large, and the pattern of vascular strands in the stipe is more complex than in the other genera.

Coveniella Tindale

Gard. Bull. Sing. 39:169 (1986).

Caudex slender, long-creeping, with closely approximate fronds; scales very short, consisting of short cells which are not clathrate, those on the rachis and costae grading to ctenitoid hairs; short slender pluricellular hairs abundant near bases of stipes, variably abundant on both surfaces of the rachis, unicellular glands sparsely present on various parts of the fronds; fronds simply pinnate, pinnae entire and narrowed near their bases, the lower ones stalked, not articulate to the rachis; veins in pinnate groups, the basal veins in each group free, successive ones anasto-

mosing to produce short free excurrent veinlets; sori exindusiate, short cylindric glands present on sporangium-stalks; n = 41 (S.K. Roy).

Only one species is known, in Queensland and north-eastern New South Wales; it was originally named *Polypodium peocilophlebium* Hook.

Genera lacking glands

The following five genera agree with the gland-bearing ones in having 41 chromosomes but in other ways are not closely related. They show varied indications of relationship to either *Tectaria* or *Ctenitis* except *Cyclopeltis* which is probably related to *Coveniella*. A sixth genus, *Pseudotectaria*, has not yet been examined cytologically.

Ataxipteris Holttum

Blumea 30: 10 (1984).

The sole species of this genus, from southern China and Japan, has fronds agreeing exactly in form and venation with those of some free-veined species of *Tectaria* but has abundant rachis-scales much like those of *Ctenitis*; its spores are similar to those of one palaeotropic group in *Ctenitis*.

Pteridrys C. Chr. & Ching

Bull. Fan Mem. Inst. Biol. Bot. 5: 129 (1934).

Scales narrow as in *Tectaria* but with strongly cordate base; fronds simply pinnate; pinnae deeply lobed with a tooth in each sinus between lobes, the tooth projecting out of the plane of the pinna; veins free, arranged as in free-veined *Tectaria*; ctenitoid hairs few, near the bases of pinnae, sometimes on both surfaces of costae.

This genus of seven species is distributed in mainland S.E. Asia, Ceylon and Malesia. The sinus-teeth are like those of *Pleocnemia* but in other ways the two genera differ considerably.

Triplophyllum Holttum

Kew Bull 41:239 (1986).

As arranged by Holttum there are twenty species with a centre of distribution in Africa; there are five species in tropical America and two in Madagascar. Most species have been placed by recent authors in *Ctenitis*, but two have anastomosing veins and so have been assigned to *Tectaria*, though their vein-branching is mainly anadromous and their pattern of anastomosis is slightly different. Their scales are *Tectaria*-like, also their spores. They all have a long-creeping caudex and fronds of young plants are almost symmetrically tripartite. *T. dicksonioides* (Fée) Holttum in Brazil has minute spherical glands on the lower surface.

Cyclopeltis J. Sm.

Bot. Mag. 72 (Comp.): 36 (1846).

Scales narrow, sometimes with dentate margins, the teeth consisting of outgrowths from single cells; fronds simply pinnate, the pinnae unlobed and articulate to the rachis, sessile with cordate basiscopic bases which overlap the upper surface of the rachis; veins free, their lower branches not nearly reaching the margin; very short hairs consisting of several cells present on both upper and lower surfaces of rachis and costae, more abundant on the lower surface; sori covered with peltate indusia; spores similar to those of some species of *Tectaria*.

A genus of about six species, rather uniform and widely distributed in tropical America, more diversified in SE Asia and Malesia. The teeth on the margins of scales, where present, differ from those of other palaeotropic genera, the teeth of which are formed by the projecting common wall between adjacent marginal cells.

Megalastrum Holttum, *gen. nov.*

"Group of *Dryopteris subincisa*" C. Chr., K. Danske Vid. Selsk. Skr. VIII, 6: 59 (1920).

Caudex crassus, modice arborescens; stipes dense paleaceus, paleis breviter dentatis vel integris; lamina frondis magna, copiose bipinnata, pinnulis profunde lobatis, pinnis infimis basin basiscopicam versus auctis; venae omnes liberae, infimis supra basin sinuum inter lobos pinnularum terminatis; paleae axium frondis non clathratae, dentatae vel integrae, plerumque multae; rhachides pinnarum costaeque pinnularum supra pilosae, pilis acicularibus, pluricellularibus, in sicco non contortis; glandulae cylindricae unicellulares desunt; indusia, ubi adsunt, magna, firma, pilosa; sporae minute spinulosae; n = 41.

Type species: **Megalastrum villosum** (L.) Holttum, *comb. nov.* (*Polypodium villosum* L., Sp. Pl. 1093 (1753).

In his monograph of 1920 Christensen included thirty neotropic species in this group as part of his subgenus *Ctenitis*. John Smith, who had seen some of them in cultivation at Kew, included them in the genus *Lastrea*, calling them "the *villosa* group"; he recognized their distinctive character and suggested (1875: 216) that they might form a genus for which the name *Megalastrum* would be appropriate. In this as in many other ways he showed greater understanding (gained by observation of living plants) than most of his contemporaries, and I am happy to adopt his suggested name. T.G. Walker (1966), in Jamaica, found that plants of the type species of *Megalastrum*, each being the outgrowth of a single cell, as in *Cyclopeltis*. found it to be tetraploid. Spores are illustrated on Plate 3.

One species should be excluded from Christensen's original list; it was first named *Polypodium grande* by Presl. In form, venation and thick texture, its fronds are very similar to those of *Ataxipteris* (of China and Japan) but its scales are very different; their marginal teeth are also differently formed from those of the type species of *Megalastrum*, each being the outgrowth of a single cell, as in *Cyclopeltis*.

In Africa there is only one species of this genus, *M. lanuginosum*. In its indusia and spores it agrees closely with *M. villosum*; its distribution extends to Madagascar and the Mascarene Islands, where there are four more species. These African and Mascarene species do not have the dentate scales which are characteristic of most species in the neotropics. New names for them are proposed as follows.

Megalastrum lanuginosum (Kaulf.) Holttum, *comb. nov.*

Aspidium lanuginosum Kaulf., Enum. Fil. Chamisso: 244 (1824).

Megalastrum magnum (Bak.) Holttum, *comb. nov.*

Nephrodium magnum Bak., J. Bot. 22: 142 (1884).

Megalastrum exaggeratum (Bak.) Holttum, *comb. nov.*

Nephrodium crinitum var *exaggeratum* Bak., Ann. Bot. 5: 319 (1892).

Megalastrum lanatum (Fée) Holttum, *comb. nov.*

Phegopteris lanata Fée, Gen. Fil. 246 (1852).

Megalastrum canacae (Holttum) Holttum, *comb. nov.*

Ctenitis canacae Holttum, Kew Bull. 38: 128 (1983).

Pseudotectaria Tard.

Notul. Syst. (Paris) 15: 87, pl. 6 (1955).

The type species, originally named *Tectaria decaryana* C. Chr., has in its suprabasal pinnae a venation comparable to that in *Meniscium* (Thelypteridaceae) but in the basal part of its basal pinnae the venation is more complex and more like that of *Tectaria* sect. *Sagenia* (see C. Chr. 1932, pl. 19). The shape of the basal pinnae shows some resemblance to *Heterogonium*, but the basal basiscopic lobes are not gradually reduced. The outer veins of costal and costular areoles in the basal pinnae of *P. decaryana* are not parallel to the costae and costules as in *Tectaria* sect. *Sagenia* and *Heterogonium*; they are formed by upcurved veins which in fertile pinnae each bears a sorus, meeting to produce one or more excurrent free veinlets. In the second species of *Pseudotectaria, P. crinigera* (C. Chr.) Tard., the pinnae are distinctly lobed with rather widely spaced costules, and the venation throughout (as shown in C. Chr. 1932, pl. 18) resembles that in the basal pinnae of *P. decaryana*. The smaller scales in both species are abundant, narrow, thin, with all cells elongate and showing a clear lumen, contrasting with the rigid opaque scales of *Tectaria*. I suggest that the first four species of Christensen's *Dryopteris* subg. *Ctenitis* (1932: 57-58 and pl. 13, 14) are related to the species of *Pseudotectaria* and should probably be transferred to it (Mme Tardieu-Blot mentioned this possible relationship in 1955); they certainly do not belong to *Ctenitis* as understood in the present conspectus.

Thus I suggest that *Pseudotectaria* represents a development of anastomosis which has occurred on an evolutionary line distinct from that of *Tectaria*, comparable with the parallel development in *Triplophyllum*.

Discussion

In view of the pantropic distribution of *Tectaria* and *Ctenitis* (the largest genera) and the great range of form among the other genera, this group must have had a long evolutionary history during which connecting links have disappeared. There can be no doubt that *Tectaria* and the smaller genera here associated with it are closely allied, and I suggest that there is good evidence for an origin of *Tectaria* in SE. Asia, as free-veined species occur there from which, within the genus now existing, there is every gradation to species with elaborate anastomosis of veins (in Thailand, the distinction between sect. *Tectaria* and sect. *Sagenia* is not quite sharp).

The genera which have unicellular cylindric glands are not a closely allied group. *Pleocnemia* resembles *Tectaria* sect. *Sagenia* in venation but differs in the presence of sinus-teeth and glands, in the former agreeing with *Pteridrys* (which lacks glands) and in the latter with *Ctenitis*. Another genus which lacks glands, *Ataxipteris*, has the frond-form and venation of free-veined *Tectaria* but abundant scales very like those of *Ctenitis*. *Lastreopsis* is near *Ctenitis* (in which it was included by Copeland) in glands but more like *Tectaria* in scales and has more variable hairs and more varied branching of fronds. The sole species of *Coveniella* has no clear resemblance to any other genus; its simple pinnae and their venation are nearest to those of *Cyclopeltis* and the glands on sporangium-stalks resemble those of *Ctenitis*, but there are now no Australian species of either genus.

The situation is further complicated by the fact that *Tectaria* and closely related genera have the chromosome number 40 (no counts yet for *Psomiocarpa* and *Aenigmopteris*) whereas all the rest have 41. If we assume that 40 is the older number, 41 may have developed on various evolutionary lines. But there are three different genera which appear to show affinities with both *Tectaria* (40) and *Ctenitis (41): thus no simple evolutionary pattern seems possible.*

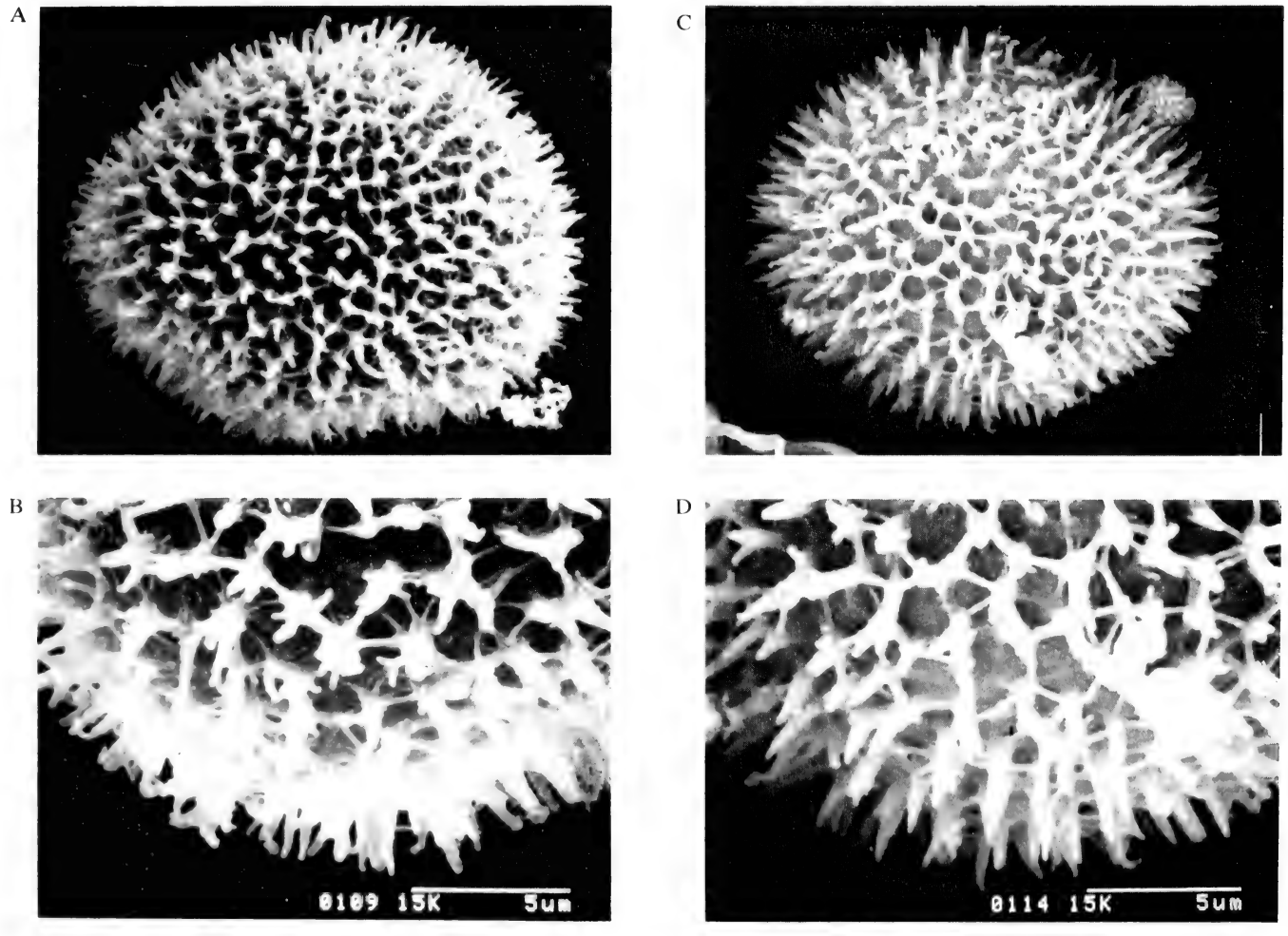
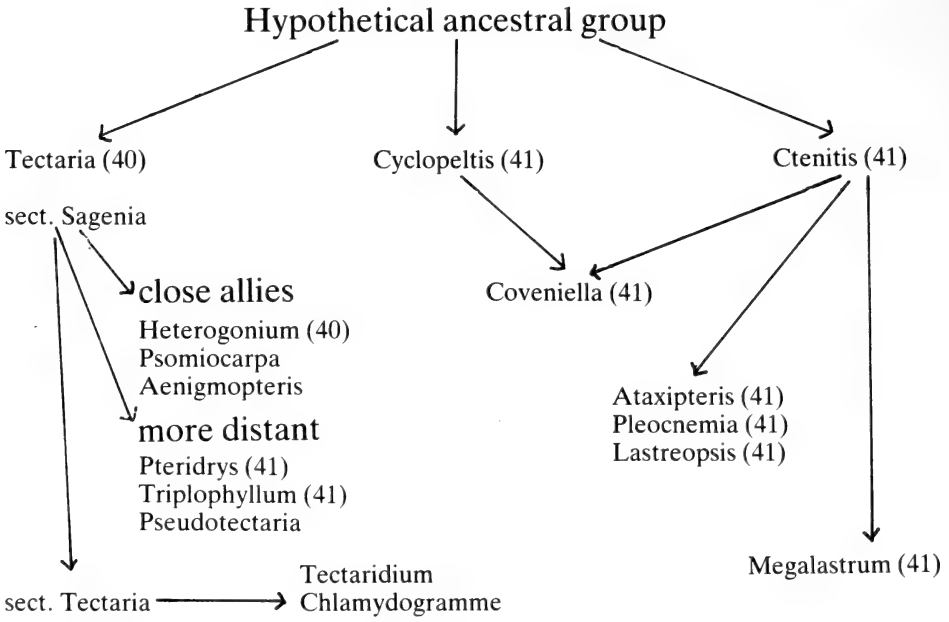


Plate 3. Spores of *Megalastrum*. *M. lanuginosum*: *A* (× 1750), *B* (× 3500); *Gerrard 1933*, Natal (K). *M. villosum*: *C* (× 1750), *D* (× 3500); *Bancroft* s.n. 1850, Jamaica (K).

The puzzle seems to me resolvable by assuming that on rare occasions there has been genetic interchange between species of Tectaria and *Ctenitis*. The existence of the single species of *Ataxipteris* (41) with some characters in common with *Tectaria* and some with *Ctenitis* looks like the result of such a process. *Pleocnemia* (41), with 19 species spread over a wide area, may be the result of a gene interchange which took place at an earlier time.

I suggest that such interchanges may be summarized in the form of a diagram.



Notes on Neotropic Genera

Pichi Sermolli (1977) recognizes the following genera which I regard as allied to *Tectaria: Dictyoxiphium* Hook., *Amphiblestra* Presl, *Pleuroderris* Maxon, *Camptodium* Fée, *Fadyenia* Hook. and *Atalopteris* Maxon & C. Chr. All these except *Atalopteris* are monotypic and clearly related to *Tectaria* and are united to *Tectaria* by Tryon & Tryon (1982: 470). *Atalopteris* is clearly related to *Ctenitis* and is considered separately below.

Dictyoxiphium has simple fronds with the venation of *Tectaria* sect. *Tectaria*. They have continuous indusiate submarginal sori, in which they agree with *Chlamdogramme* but the fertile ones are not contracted. *Dictyoxiphium* hybridizes with *Tectaria incisa* Cav. to produce *Pleuroderris* (Wagner 1978). *Amphiblestra* has deeply lobed fronds with the venation of *Tectaria* sect. *Tectaria* and continuous submarginal exindusiate sori. The recognition of *Dictyoxiphium* and *Amphiblestra* as distinct genera is largely a matter of convenience.

Camptodium has small opaque fronds with free veins arranged as in some palaeotrophic species of *Tectaria* sect. *Sagenia* but is not nearly related to them. It is specialized in adaptation to growth on limestone rocks in sheltered places. *Fadyenia* is also reduced and specialized, with a rather irregular anastomosis of veins not quite like that of sect. *Sagenia*.

The species first named *Polypodium grande* by Presl, referred to above under *Megalastrum*, is very large but with a venation essentially similar to that of *Camptodium*, agreeing also in its opaque fronds but differing in its peculiarly dentate scales. This species needs further study; I suggest that it should have generic rank.

Another species which needs further study is *Tectaria brauniana* (Karst.) C. Chr. This has deeply pinnatifid fronds of thin texture, its lobes again deeply pinnatifid; its veins are free, arranged as in free-veined palaeotropic species of sect. *Sagenia*. It is peculiar in its slender creeping caudex bearing thin translucent scales and in the presence of minute sessile or subsessile spherical glands on the lower surface and on indusia; these glands are similar to those of *Triplophyllum dicksonioides* (Fée) Holttum and I have seen no similar ones on any other species of *Tectaria*.

Atalopteris has sterile fronds similar in form to those of the type species of *Ctenitis* but differing in crenate pinna-lobes and the separation of one or more lobes as pinnules on basal pinnae. Its fertile fronds have greatly contracted pinnae bearing exindusiate sori in which the sporangium-stalks bear glands as in *Ctenitis*. There are also abundant cylindrical glands on the lower surface of sterile pinnae. The small scales on rachis and costae are thin with light brown cell-walls; I see no isodiametric cells and the scales are not so clearly clathrate as those in *Ctenitis submarginalis*.

Artificial Key to the Palaeotropic Genera

1. Teeth present at the bases of sinuses between pinna- or pinnule-lobes, the teeth projecting out of the plane of the lamina (in some species present only in distal sinuses)
   2. Fronds simply pinnate with free veins; no glands on lamina or in sori ..... *Pteridrys*
   2′. Fronds mostly bipinnate, their veins forming at least costal areoles; cylindric or ovoid unicellular glands present on stalks of sporangia and/or on lower surface of lamina ..... *Pleocnemia*
1′. Teeth of this kind lacking
   3. All axes of the frond bearing copious scales, the smaller ones at least partly clathrate with isodiametric cells
      4. Cylindric glands present on young indusia and elsewhere; pinnae (and usually pinnules) deeply lobed, the basal basiscopic vein in each lobe arising from the costule of the lobe and ending above the base of the sinus ..... *Ctenitis*
      4′. Cylindric glands lacking; pinnae less deeply lobed, the basal basiscopic vein in each lobe usually arising from the costa of the pinna and ending below the base of the sinus ... *Ataxipteris*
   3′. Smaller axes of the frond bearing scales which are few (except in *Megalastrum* and *Pseudotectaria*) and not thus clathrate; unicellular glands lacking except in *Lastreopsis*
      5. Veins in sterile fronds anastomosing copiously; free veinlets present in areoles (including those along the costa) variously directed and in most species forked
         6. Fertile fronds greatly contracted and bearing indusia
            7. Sterile fronds simple; fertile ones irregularly deeply lobed; indusia reniform *Tectaridium*
            7′. Sterile fronds pinnate; pinnae of fertile fronds linear, with continuous indusia along each side of the costae ..... *Chlamydogramme*
         6′. Fertile fronds not greatly contracted, or if so lacking indusia ..... *Tectaria* sect. *Tectaria*
      5′. Veins anastomosing to form costal areoles which lack free veinlets, or all veins free
         8. Some thick multicellular hairs present between veins on the upper surface, at least near sinuses between lobes; where veins anastomose, the costal areoles narrow and of even width
            9. Basal basiscopic lobe or pinnule of basal pinnae longer than the other lobes or pinules
               10. Fronds not greatly longer than wide
                  11. Veins anastomosing in some species; fertile fronds, if greatly contracted, not bearing very small pinnules ..... *Tectaria* sect. *Sagenia*
                  11′. veins all free; fertile fronds bipinnate with very small pinnules; no indusia ..... *Psomiocarpa*
               10′. Fronds greatly longer than wide, with many pinnae gradually increasing in size downwards ..... *Aenigmopteris*
            9. Basal basiscopic lobe of basal pinnae much reduced, these pinnae widest at about mid-length ..... *Heterogonium*
         8′. No thick hairs present between veins on upper surface; where veins anastomose (*Triplophyllum* and *Pseudotectaria*) the costal areoles not elongate nor of even width
            12. Pinnae entire or slightly lobed; lateral veins in pinnae forming pinnate groups, basal veinlets in each group, where free, not nearly reaching the margin

13. Veinlets all free; pinnae articulated to rachis ..... *Cyclopeltis*
13′. One or more pairs of veinlets joining to form a short excurrent veinlet; pinnae not articulated
14. Anastomosis confined to suprabasal veinlets ..... *Coveniella*
14′. Anastomosis, where it occurs, including basal veinlets ..... *Pseudotectaria*

12′. Pinnae various, in almost all cases at least deeply lobed; most free veins reaching or nearly reaching the margin
15. Fronds very large, bipinnate, arising from a massive erect caudex; upper surface of axes of frond bearing multiseptate thin-walled acicular hairs ..... *Megalastrum*
15′. Fronds never very large, pinnae various; caudex not massive and erect; hairs on upper surface of axes of frond either firm and terete or ctenitoid
16. Bases of leaflets decurrent as a narrow wing with thickened margin; fronds of young plants not tripartite; hairs on upper surface of axes various; glands present on lower surface and on sproangia ..... *Lastreopsis*
16′. Bases of leaflets not thus decurrent; fronds of young plants tripartite except in *T. varians*; hairs on upper surface of axes always ctenitoid; no cylindric glands present ..... *Triplophyllum*

Acknowledgements

I am indebted to the Director, Rijksherbarium, Leiden, for the loan of the type of *Hemigramma siifolia* and permission to cut sections of its pinnae, to Dr Mary Tindale (Sydney) and Dr S.K. Roy (Banaras Hindu University) for information about the genus *Coveniella*, to Prof. E. Hennipman (Utrecht) for the preparation showing venation in *Hemigramma latifolia*, and to Mr M.G. Price (Ann Arbor) for Philippine specimens of *Psomiocarpa* and its hybrid with a species of *Tectaria*; also to Mr Tim Lawrence (Jodrell Laboratory, Kew) for sections of fertile pinnae of *Hemigramma siifolia* and *Chlamydogramme hollrungii* and to Mr P.J. Edwards (Herbarium, Kew) for the SEM photographs of spores; to all of whom I express grateful thanks.

Postscript

When writing the above in early 1986 I did not know of the publication by S.K. Roy and A.N. Rao of a paper entitled *A brief cytotaxonomic survey of Singapore ferns* (Journal of the Singapore Academy of Science, 14: 53-64, 1985). One observation published in that paper is relevant to the present discussion of *Tectaria* and allied genera.

On p. 60 is Roy's report that a chromosome count from a plant of *Heterogonium sagenioides* showed n = 41, illustrated in fig. 36, whereas in an Appendix to my book on the ferns of the Malay Peninsula (1955) Manton had reported n = 40 for the same species, with her figure 15. In writing the present paper I assumed Manton's n = 40 to be correct.

In view of this discrepancy, and of the fact that the illustration published by Roy and Rao does not provide clear evidence, I wrote to Prof Manton to ask whether she could add any further information. Her reply is that she has re-examined her preparation from a plant originating in Singapore, in consultation with Dr T.G. Walker (Newcastle upon Tyne), and that they confirm the original report of n = 40. Dr Walker reports also that he made preparations from a plant of *Heterogonium pinnatum* (Copel.) Holttum cultivated at Kew (origin G. Mulu, Sarawak, *A.C. Jermy 13318*) and that this showed n = 80; Manton's report on this species was n = 80-82, with a note that better material was needed.

Much more evidence on the chromosomes of species in this group of genera is desirable.

References

Ching, R.C. (1938). A revision of the Chinese and Sikkim-Himalayan *Dryopteris* with reference to some species in the neighbouring regions, III. *Bull. Fan Mem. Inst. Biol. Bot.* 8: 275-334.

Christensen, C. (1932). The Pteridophyta of Madagascar. *Dansk Bot. Ark.* 7: 1-253, pl. 1-80.

Copeland, E.B. (1908). New or interesting Philippine ferns. *Philip. J. Sci. Bot.* 3: 31-37, pl. 1-4.

_____ (1928). Genus *Hemigramma* Christ, in *Leptochilus* and genera confused with it. *Philip. J. Sci.* 37: 402-408.

Holttum, R.E. (1985). Studies in the genera allied to *Tectaria* Cav., IV. The genus *Ctenitis* in Asia, Malesia and the Western Pacific. *Blumea* 31: 1-38.

_____ (1986). Ibid. V. *Triplophyllum*, a new genus of Africa and America. *Kew Bull.* 41:237-260.

Pichi Sermolli, R.E.G. (1977). Tentamen Pteridiphytorum genera in taxonomicum ordinem redigendi. *Webbia* 31: 313-512.

Price, M.G. (1974). Nine new fern names. *Kalikasan* 3: 173-178.

Sledge, W.A. (1972). The tectarioid ferns of Ceylon. *Kew Bull.* 27: 407-424.

Smith, J. (1875). *Historia Filicum*. London, Macmillan.

Tardieu-Blot, M.L. (1955). Sur les Tectarioideae de Madagascar et des Mascareignes, avec description d'un genre nouveau *Pseudotectaria*. *Notul. Syst.* (Paris) 15: 86-90.

Tryon, R.M. & A.F. (1982). *Ferns and Allied Plants with special reference to Tropical America*. New York, Springer.

Wagner, W.H. & F.S. (1978) The singular origin of the Central American fern *Pleuroderris michleriana*. *Neotropica* 10: 254-264.

Walker, T.G. (1966). A cytotaxonomic survey of the pteridophytes of Jamaica. *Trans. R. Soc. Edinb.* 66: 169-237.

_____ (1973). Evidence from cytology in the classification of ferns, in A.C. Jermy et al. (eds): The Phylogeny and Classification of the Ferns. *Bot. Journ. Linn. Soc.* 67, Suppl. I: 91-110.

A New Genus and Three New Species of Pteridophytes from North Eastern Queensland

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Abstract

A new genus, *Coveniella* (Dryopteridaceae), composed of a single species, *C. poecilophlebia* (Hook.) Tind., **comb. nov.,** is described. Two species of *Lastreoposis* (Dryopteridaceae) viz. *L. tinarooensis* and *L. walleri* as well as a species of *Diplazium* (Athyriaceae) viz. *D. queenslandicum* are also described as new.

Coveniella Tind., *gen. nov.* (Fig. 1)

Coveniella Tind.; a *Lastreopsis* differt lamina 1- pinnata, venis pro majore parte anastomosantibus, ex parte omnino liberis, costulis 25-46-jugatis, prominulis, plus minusve parallelis, utroque latere venulis 4-7 obliquis instructis, venulis infimis liberis quarum una e costa exorta, in venulis 1-3 medianis ramulo congruenti e costula contingua respondenti in venulam brevem plerumque liberam excurrentem conjuncto, venulis superioribus plerumque liberis usque and marginem pinnae attingentibus, soris inter costulas irregulariter biseriatim dispositis. — Type species: *Coveniella poecilophlebia* (Hook.) Tind. **comb. nov.**

Coveniella poecilophlebia (Hook.) Tind. *comb. nov.* Fig. 1

Polypodium poecilophlebium Hook. Sp. Fil. 5: 14 (1863). — Type: Dunk Island, NE. coast of Australia, Voyage of the Rattlesnake. *Macgillivray* (K, holo), n.v.

Terrestrial fern. Rhizome long-creeping, radial, dictyostelic, clothed with short, very broadly ovate, dark brown, denticulate scales with 1-3 golden glands on the margin. Stipes erect, never articulated to the rhizome, having several, distinct vascular bundles, with the xylem strands of the larger adaxial vascular bundles with hooked ends. Lamina 1-pinnate, 15-30 cm long, 10-30 cm broad, chartaceous, catadromous except in the lowest pinnae. Pinnae 12-23 cm long, 2-4.5 cm broad, oblong or narrowly lanceolate, with 1-6 lateral pairs and a similar terminal pinna, the lowest not reduced, the apex acuminate or rarely obtuse, the margin undulate or crenate but serrate towards the apex, unequally cuneate at the base. *Ctenitis*-hairs 5-12-celled, scattered along the rhachises, costae, costules and veinlets. Rhachis not deeply grooved above, the median portion slightly elevated, clothed above and below with stiff antrorsely curved, 3-4-celled hairs, the margins of the groove confluent with the decurrent margins on the bases of the pinnae. Costae raised on the upper surface, clothed below with linear or lanceolate, attenuated scales with the margin fimbriate towards the base. Veins anastomosing for the greater part, in part *quite free*. Costules 25-46-jugate, prominent, more or less parallel, 3-6 mm apart, with 4-7 oblique veinlets on each side; with the lowest veinlets free, one of them arising from the costa, in the 1-3 middle veinlets the corresponding branchlet from the contiguous costule joined in a short, usually free, excurrent veinlet, with the upper veinlets mostly free, reaching the margin of the pinna. Sori orbicular, exindusiate, 0.4-0.8(-1.0) mm in diameter, mostly borne on the middle of the veinlets or sometimes towards the apex of the veinlets or at the

junction of the veinlets, in 2 irregular rows between the costules. Sporangia with 13-17 indurated cells of the annulus; pedicel long, bearing 1-2 glandular, sessile, oblong, unicellular, golden hairs. Spores bilateral, monolete, globoso-ellipsoidal or almost globose, brown, with ruguloso-saccate perispores. Glandular, oblong, appressed, unicellular, golden hairs sparsely clothe the lamina, rhachises, costae, costules and veins.

Distribution. terrestrial in rainforests often near streams and lakes in the Cook and Kennedy Districts of NE. Queensland.

Selected Specimens Examined: QUEENSLAND. Cook District: Iron Range, June 1948, *L.J. Brass 19151* (BRI, K); Whitfield Range, July 1964, *A.W. Dockrill W 10* (K, NSW). North Kennedy District: Conway State Forest, between Airlie and Shute Harbour, June 1965, *L.J. Webb and T.G. Tracey 7578* (BRI, CANB).

Chromosome Counts: $2n = 82$, $n = 41$, (diploid). Voucher: S.F.R. 185, Downfall L.A., Queensland, *A.W. Dockrill 1115* (NSW), (pers. comm. S.K. Roy).

This new monotypic genus is named in honour of Mr. Robert G. Coveny, Botanical Collector at the Royal Botanic Gardens, Sydney, in gratitude for his continued assistance in obtaining material for my researches on pteridophytes.

I am including *Coveniella* in the *Ctenitis-Lastreopsis* group of genera in the family Dryopteridaceae, because it it characterized by the following features: *(1)* orbicular sori; *(2)* several, small, distinct vascular bundles in the stipes; *(3)* multicellular *Ctenitis*-hairs with dark red septae on the fronds; *(4)* golden, 1-celled, glandular hairs on the fronds as well as 1-2 on the long narrow pedicels of the non-setose sporangia; and *(5)* basic chromosome number of 41. It differs from *Ctenitis* and *Lastreopsis* which have free veins in their decompound laminas, whereas in *Coveniella* the 1-pinnate laminas have a very complex, partly meniscoid venation. The most outstanding characteristic of the new genus is the nature of the basal veinlets which are always free, ending blindly and one of them very often arises from the costa between the costules.

C. poecilophlebia superficially resembles some members of the family Thelypteridaceae but the latter have needle-like hairs on the fronds, stipes with 2 vascular bundles at the base soon uniting to form a single strand (U-shaped in section) and the basic chromosome number ranges from 27 to 36 (except 33).

Lastreopsis tinarooensis Tind., *sp. nov.* Fig. 2

Lastreopsis tinarooensis Tind., a *L. grayi* D. Jones stipitibus non profunde sulcatis pilis typi *Ctenitidis* circiter 0.1 mm longis subtus vestitis, rhachidibus secundariis inconspicue alatis, pinnis quaternariis in lobulos 3-5 spathulatos late dispositos usque ad 2.5 mm longos profunde divisis, sporangiis usque ad 50 per sorum, statim diagnoscenda. — Type: Queensland, Cook District, State Forest Reserve, 185, Kalorama L.A., 17° 06'S 145° 35'E, on rocks in very shady humid creek, alt. 1000 m. *B. Gray 1398* (QRS, holo; NSW, iso).

Lastreopsis tinarooensis Tind. is readily distinguished from *L. grayi* by the shallowly grooved stipes clothed on the lower surface with *Ctenitis*-hairs about 0.1 mm long, by the inconspicuously winged secondary rhachises, by the quaternary pinnae deeply divided into 3-5 spathulate, widely spaced lobules up to 2.5 mm long and by up to 50 sporangia per sorus.

Distribution. terrestrial in rainforests of the Cook District, NE. Queensland.

Specimens Examined: QUEENSLAND. Cook District: Tinaroo Hills, Atherton Tableland, *D. Jones (BRI 200744-5);* Mt Lewis, Sept 1977, *J.A. Armstrong 1073A* (NSW); near Danbulla, ca 3400 ft [ca 1020 m], Nov 1942, *S.T. Blake 14752A (BRI 165807).*

Chromosome Counts: $2n = 82$, $n = 41$. Voucher: *J.A. Armstrong 1073A* (NSW), (pers. com. S.K. Roy).

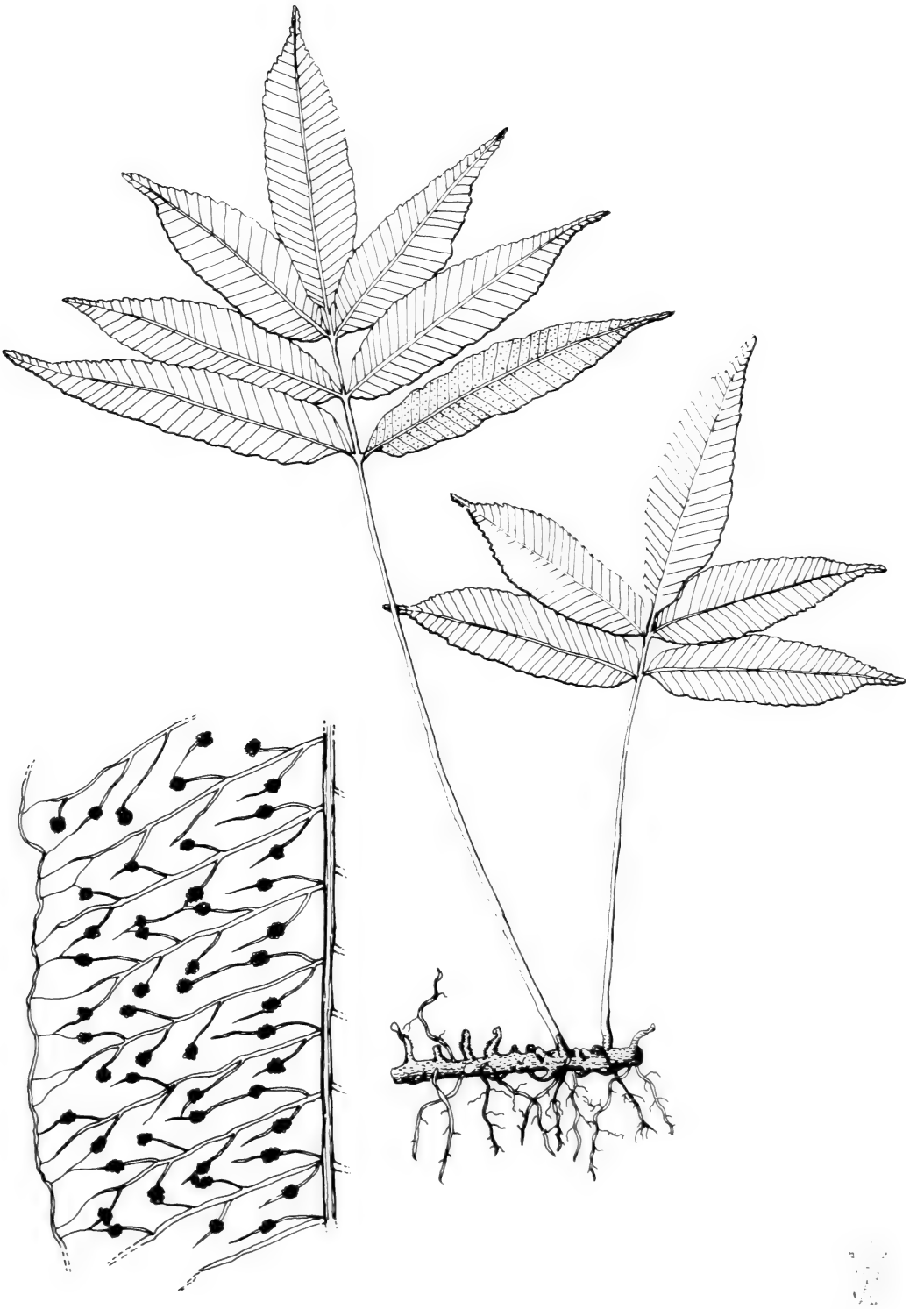

Fig. 1. *Coveniella poecilophlebia* (Hook.) Tind.
a. habit study, × ½; *b*, portion of pinna with sori, × 3. — *a-b* from *L.J. Brass 20175*.

Fig. 2. *Lasteopsis tinarooensis* Tind.
Ba, lowest primary pinna, × ⅔. *Bb*, tertiary pinna with sori, × 4. *Bc*, upper surface of rhachises, × 4. *Bd*, rhizome, × ⅓

This species is closely allied to *Lastreopsis grayi* D. Jones in *Muelleria* 3: 245-249 (1977). The differences between these two species are discussed in detail by Jones (*l.c.* p. 248), *L. tinarooensis* being cited as *Lastreopsis* sp. pending my publication of this new taxon. Both species are figured (*l.c.* p. 247).

Lastreopsis walleri Tind. *sp. nov.* Fig. 3

Lastreopsis walleri Tind.; a *L. tenera* (R. Br.) Tind. rhizomate valde robusta breviter repenti 1-2.5 cm crasso, rhizomatis stipitis rhachidisque paleis margine et pagina setis numerosis instructis et apice excepto pinnulis basiscopicis sessilibus nullis ad rhachidem primariam adnatis statim diagnoscenda. — Type: Queensland, Cook District, Allumbah, (Herberton) Feb. 1910, *R.F. Waller NSW 1576* (NSW, holo).

Lastreopsis walleri Tind. is readily distinguished from *L. tenera* by its very robust, shortly creeping rhizome 1-2.5 cm broad, by the numerous setae on the margin and surface of the scales of the rhizome, stipe and rhachis, and except at the apex by the lack of the basiscopic sessile pinnules adnate to the primary rhachis.

Distribution. terrestrial in rainforests of the Cook District, NE. Queensland.

Specimen Examined: QUEENSLAND. Cook District: S.F.R. 251, Charmillin L.A., 17° 40'S, 145° 30'E, alt. 750 m, Sept 1976, *A.M. Dockrill 1268* (BRI 228508-14).

The channel on the upper surface of the main rhachis is poorly defined except near the base, and the 2 ridges on the upper surface are also less prominent than in

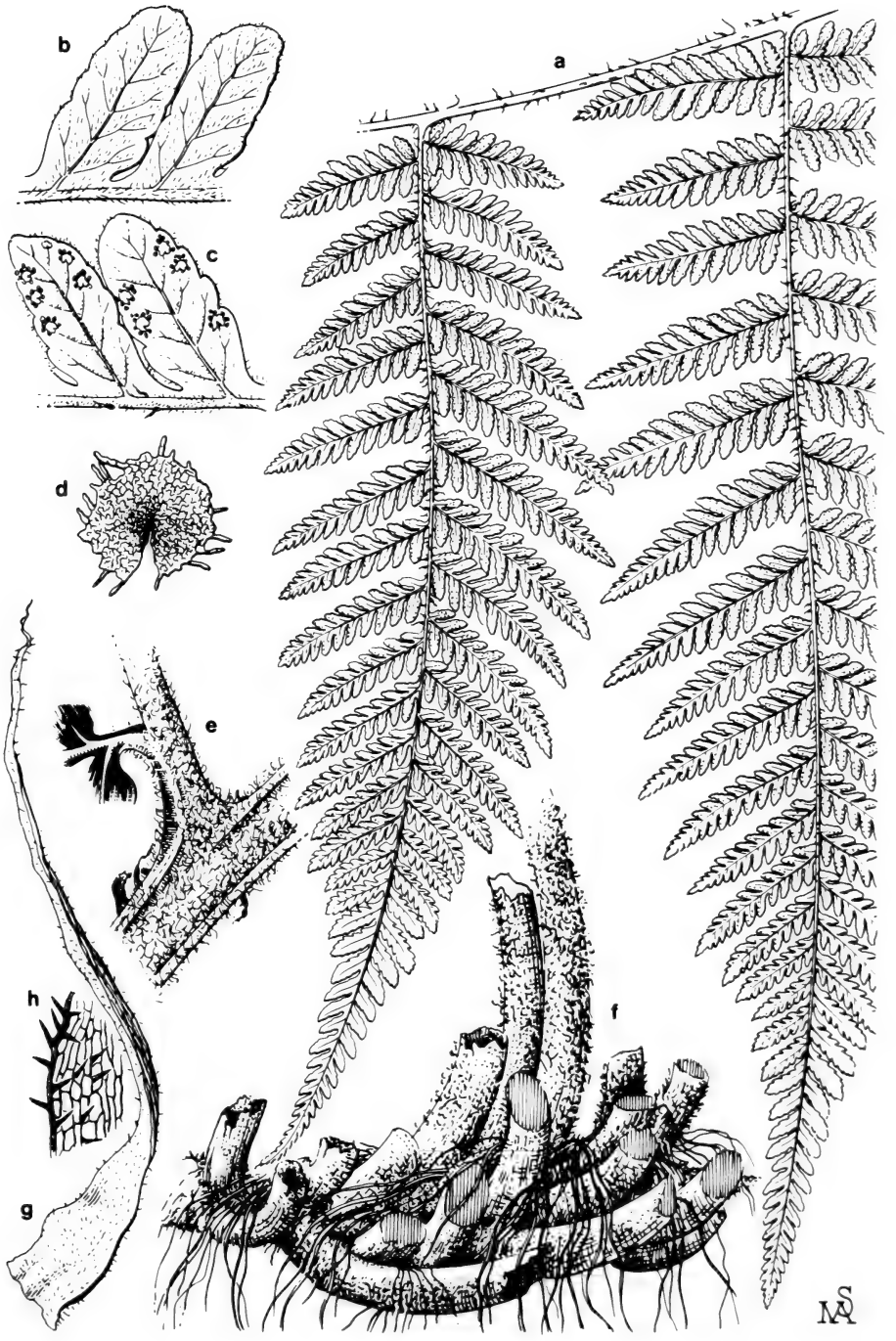

Fig. 3. *Lastreopsis walleri* Tind.
a, two primary pinnae, × ⅔; *b*, adaxial surface of two tertiary pinnae, × 4; *c*, abaxial surface of two tertiary pinnae with sori, × 4; *d*, *indusium*, × *33*; *e*, adaxial surface of rhachises, × 4; *f*, rhizome, × ⅔; *g*, scale of rhizome, × 8; *h* marginal cells of rhizome scale, × 33.

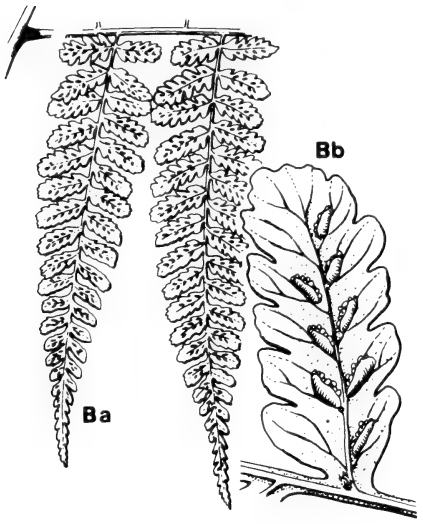

Fig. 4. *Diplazium queenslandicum* Tind.
Ba, two fertile secondary pinnae, × ⅔. *Bb*, tertiary pinna with sori, × 4.

the other species of *Lastreopsis* except *L. tenera*. However these 2 ridges are continuous with the slightly thickened leaf-margins of the ultimate segments of the primary pinnae as in all species of this genus.

Diplazium queenslandicum Tind. *sp. nov.* Fig. 4

Diplazium queenslandicum Tind: a *Diplazio assimili* (Endl.) Beddome differt frondibus maioribus, atroviridibus, saepe 150-200 cm longis, 75-90 cm latis, caudice erecto, crasso, usque 1 m alto et 15 cm diametro, paleis caudicis obscuris, maioribus, 9-17 mm longis et 2.5-5 mm latis; pinnis secundariis numerosioribus, caudatis et 19-33-jugis; pinnulis tertiariis truncatis vel late rotundatis, 6-14-jugis, pinnulis tertiariis infimis plerumque 6-12 mm longis et 3-6 mm latis. — Type: Queensland. Cook District: Palmerston National Park, growing along old snigging track in rainforest ca 1 mile [1.6] km S. of Highway and ca 20 miles [32.3 km] WSW. of Innisfail, alt. ca 2100 ft [630 m] 14 Sept. 1960, *L.S. Smith 11270* (BRI 29863-5, holo; NSW, iso).

Diplazium queenslandicum Tind. differs from *Diplazium assimile* in its larger, dark green fronds 150-200 cm long and 75-90 cm broad, in its erect, thick caudex up to 1 m high and 15 cm in diameter, in its larger, dull caudex scales 9-17 mm long and 2.5-5 mm broad, by the more numerous, caudate secondary pinnae 19-33-jugate, by the truncate or broadly rounded 6-14-jugate tertiary pinnules and by the lowest tertiary pinnules usually 6-12 mm long and 3-6 mm broad.

Distribution. terrestrial in rainforests of the Cook District, north-eastern Queensland.

Selected Specimens Examined: QUEENSLAND: Cook District: Tinaroo Range, alt. 3500 ft [ca 1050 m], Feb. 1962, *L.J. Webb and J.G. Tracey 5779* (BRI); back of Bartle Frère, July 1913, *W.W. Watts* NSW *P978;* Mt Spurgeon, Root Creek, Sept 1936, *C.T. White 10607* (BRI).

D. queenslandicum is closely allied to *D. assimile* which occurs in Norfolk Island and Australia (south-eastern Queensland and north-eastern New South Wales). The latter species is a smaller fern ca 40-120 cm high, with light green fronds and an erect caudex (up to 4 cm high) bearing lustrous scales 5-8 mm long and 1.5-3 mm broad.

Acknowledgements

Valuable assistance was given by the Director, Queensland Herbarium, for providing the illustrations as well as material on loan for study. My thanks are due to Mr. S. B. Andrews for his generous botanical co-operation. I am grateful to the late Mr. H.K. Airy Shaw, Royal Botanic Gardens, Kew, England, for kindly checking my Latin diagnoses except for that of *Lastreopsis tinarooensis* which was checked by Dr. A. Kanis, Australian National Herbarium, Canberra. I wish to thank Professor R.E. Holttum for examining the holotype and other material of *Coveniella poecilophlebia* in the Herbarium, Kew, England, at my request. My thanks are also due to Professor S.K. Roy, Banaras Hindu University, Varanasi, India, for allowing me to publish his chromosome counts of two species. The illustrations were drawn by Ms. M. Saul except that of *C. poecilophlebia* which was prepared by Mr. W. Smith.

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Notes on Asiatic *Cassine* L. (Celastraceae)

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Abstract

Three endemic species, i.e., *Cassine glauca* (Rottb.) O.K., *C. balae* Kosterm. **sp. nov.**, and *C. congylos* Kosterm. **sp. nov.** occur in Sri Lanka. *Elaeodendron glaucum* Roxb. is conspecific with *C. balae*, having a woody, very thick putamen and hardly any mesocarp. *C. glauca* O.K. has a thin putamen and plenty of juicy mesocarp. *C. congylos* is based on *Elaeodendron glaucum* var. *montanum* Thw.

The commonest species in South India is *C. albens* (Retz.) Kosterm. **comb. nov.** (**synonyms:** *C. roxburghii* (W. & A.) Ramanoorthy and *Neerija dichotoma* Roxb.); much rarer is *C. paniculata* (W. & A.) Ramanoorthy.

A North Indian species is *C. grossa* (Roxb.) Kosterm. **comb. nov.**, based on *Euonymus grossa* Wall. ex Roxb., in North India it grows up to 2000 m altitude.

The Javanese species, originally described as *Elaeodendron glaucum* var. *macrocarpum* Kds. & Val. is raised to specific rank as *Cassine koordersii* Kosterm. **sp. nov.** The Moluccan species represents *C. obiensis* Kosterm., but the species from Timor island is kept separate (*C. elliptica* (Dec.) O.K.).

Introduction

The rediscovery of the true *Cassine (Elaeodendron) glauca* (Rottb.) O.K. in the beach forest near Trincomalee on Sri Lanka's West coast started a train of investigations and conclusions, making the treatment of the Malesian species by Ding Hou (1962) untenable.

The confusion started with Lawson's uncritical lumping (1875) of some quite distinct species, a procedure accepted by Ding Hou (1962) and Matthew (1983) although Wight and Arnott (1834) and even earlier, Graham (1830) had already pointed out, that true *C. glauca* does not occur outside Sir Lanka. The confusion was compounded by Roxburgh's description of what he thought was *C. glauca*, a tree grown in the Botanic Garden of Calcutta from seed obtained from Sri Lanka.

Nobody seems to have noticed that the name *Elaeodendron roxburghii* W. & A. is illegitimate as *Neerija* has priority.

The North Indian species, as described by Brandis (1906) a.o., is again different and might be conspecific with our *C. grossa*.

Contrary to Ding Hou's contention that fruiting material cannot or can only be ascribed to its proper species with difficulty, my conclusion is that the fruit has the most important specific characters.

Two groups can be recognized, one having juicy fruit with abundant juicy mesocarp and a thin, crustaceous putamen, differently shaped in the various species and the other having hardly any mesocarp (dry fruit) and a very thick, hard putamen.

Other distinctive characters are the colour and shape of the fruit, and, the colour, shape, and especially the size of the petals. The leaves vary much in the same species, the length of the petiole and the shape of the incisions of the leaf serrations may be used with some care.

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The name *Elaeodendrum* is attributable to Murray, Syst. Veg., ed. 14 (1784) 241; the orthography was changed to *Elaeodendron* by Jacquin f., *Nov. Act. Helv.* 1 (1787) (cf. Backer & Bakh., *Fl., Java* 2 (1965) 55, in note).

We have not discussed the merits and demerits of fusing *Elaeodendrum* and *Cassine*. In the first edition of Engler & Prantl., *Nat. Pfl. fam.* (1892), Loesener has followed O. Kuntze (1892) in combining the two, but dissociated them again in the second edition (1942) as did Robson (Bolet. *Soc. Broter.* 39 (1965) 37). Since the differences between the two genera are trifling and hardly applicable at the generic level, we have followed O. Kuntze's and Ding Hou's example of fusing them.

Indian Species

Cassine grossa (Wall. ex Roxb.) Kosterm., **comb. nov.**

Euonymus grossa Wallich ex Roxburgh, Fl. Ind., ed. Wall. 2(1824) 408; Voigt, Hort. suburb. Calcut. (1834) 65; Lawson in Hooker f., Fl. Brit. Ind. 1(1875) 623 (as a syn. of *Elaeodendron glaucum* (Rottb.) Pers.) — Typus: *Wallich Cat. 4291* (K), *n.v.*, from Nepal, fls. small, greenish.

Elaeodendron glaucum Auct. (non Pers.) Lawson, l.c., *p.p.*; Auct. (non Pers.) Collett, Fl. Siml. (1902) 88; Auct. (non Pers.) Brandis, Ind. Trees (1906) 164, p.p.; Auct. (non Pers.) Kanjilal, For. Fl. Siwalik and Jaunsar (1911) 95; Auct. (non Pers.) Parker, Fl. Punjab, ed. 2(1924) 81; Auct. (non Pers.) Osmaston, For. Fl. Kumaon (1927) 98; Auct. (non Pers.) Benthall, Trees Calcutta (1946) 112, p.p.; Auct. (non Pers.) Prain, Beng. Pl. 1(1963) 230.

Cassine glauca Auct. (non O.K.) Hara, Fl. E. Himalaya (1966) 188; Auct. (non O.K.) Sidiqui in Fl. Pakistan 109(1977) 2.

Note. The only specimen available for examination (BO) was a flowering one from a cultivated plant in the Calcutta Botanic Garden, of which leaf and flower match the description. The fruit of this species is unknown. It might be conspecific with the material described by Brandis (1906), Kanjilal (1911), Parker (1924), Osmaston (1927), Benthall (1946) and Prain (1963), described erroneously under *Elaeodendron glaucum*. The fruit is described as yellowish green when ripe, small and with a thin putamen.

Cassine paniculata (W. & A.) Ramanoorthy

Ramanoorthy in Saldanha & Nicholson, Fl. Hassan Distr., Karnataka (1976) 308. — Elaeodendron paniculatum Wight & Arnott, Prodr. Fl. Ind. or. (1834) 157; Lawson in Hooker f., Fl. Brit. Ind. 1(1875) 623 (as a syn. of *Elaeodendron glaucum*); Gamble, Fl. Madras (1910) 212(152). — Typus: *Colemale*, fl., Herb. Wight.

Note. The species was known only in the flowering stage. Ramanoorthy (provided that his disposition is correct) described the fruit as fleshy, elliptic, the ovary trilocular, the petals spathulate, 4.5-5 mm long, the margin reflexed towards the base; according to him a very rare species.

Gamble differentiates it from *Elaeodendron glaucum* (non O.K.) (= *Cassine albens*) by its large flowers, 0.4 inch in diam. and stout up to 4-inch long cymes, in *C. albens* the flowers are only 0.25 inch in diam. and the cymes under 2 inch long.

Cassine albens (Retz.) Kosterm., **comb. nov.** Fig. 1

Schrebera albens Retzius, Observ. Bot. 6(1791) 25, t. 3; Willdenow, Spec. Pl. 1(1791) 1092; Roxburgh, Pl. Corom. 2(1798) 2 (in nota); Fl. Ind. 1(1832) 638 (as a syn. of *Elaeodendron glaucum* sensu Roxb.); Persoon, Syn. 1(1805) 241 (as a syn. of *Elaeodendron glaucum*); Lawson in Hooker f., Fl. Brit. Ind. 1(1875) 623 (as a syn. of *Elaeodendron glaucum*). — Typus: *Koenig s.n.*, fl., fr., Coromandel (Lund).

Neerija dichotoma Roxburgh, Fl. Ind., ed. Wall. 2(1824) 444; ed. Carey 1(1832) 646; repr. (1874) 217; Wight & Arnott, Prodr. Fl. Ind. or: (1834) 157 (as a syn. of *Elaeodendron roxburghii* W. & A.); Lawson, l.c. 623 (as a syn. of *Elaeodendron glaucum*); Ding Hou in Fl. Males, Ser., 6(1962) 286 (as a syn. of *Cassine glauca*). — Typus: *Roxburgh s.n.*, coast of Coromandel(?).

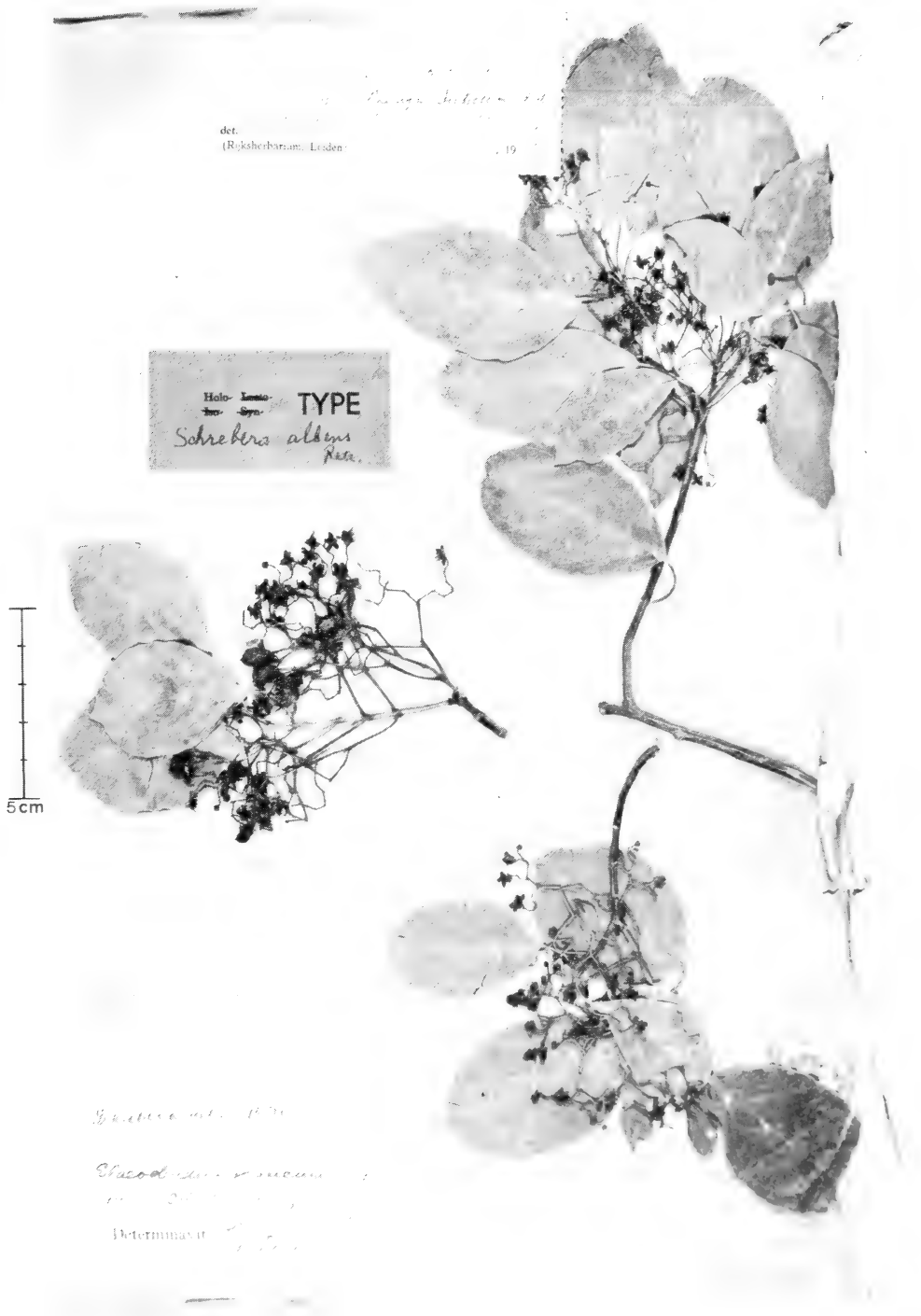

Fig. 1 *Cassine albens* (Retz.) Kosterm., holo (Lund).

Rhamus nerija Sprengel, Syst. Veget. 4, Suppl. (1821) 86; W. & A., l.c.; Lawson, l.c. (as a syn. of *E. glaucum*).

Elaeodendron roxburghii Wight & Arnott, Prodr. l.c.; Graham, Catal. Bombay Pl. (1830) 50; Dalzell & Gibson, Bombay Fl. (1861) 48; Wight, Illustr. (1820) 178, t. 71 (excellent plate); Beddome, Fl. sylv. (1871) 148; Lawson, l.c. 623 (as a syn. of *E. glaucum*); Gamble, Fl. Madras, l.c. 211 (as a syn. of *E. glaucum*); Ding Hou, l.c. (as a syn. of *Cassine glauca*); Ramanoorthy in Saldanha & Nicholson, Fl. Hassan Distr., Karnataka (1976) 318; Matthew,, Fl. Tamilnadu, Carnatic 1(1983) 254 (as a syn. of *Cassine glauca* var. *glauca*). — *Elaeodendron glaucum* var. *roxburghii* Lawson, l.c. 623. — *Cassine glauca* var. *roxburghii* Pierre, Fl. For. Cochinch. 4(1893), t. 296 A. — *Cassine roxburghii* (W. & A.) Ramanoorthy, l.c.

Elaeodendron glaucum Auct. (non Pers.) Lawson, l.c., p.p.; Auct. (non Pers.) Cooke, Fl. Bombay 1(1902) 233; Auct. (non Pers.) Gamble, l.c. 211(152); Auct. (non Pers.) Ding Hou, l.c., p.p.

Celastrus glaucus (Rottb.) Vahl, Symb. Bot. 2(1791) 42 (quoad descript. p.p.); Auct. (non Vahl) Roxburgh, Fl. Ind., ed. 2, 1(1832) 638; Auct. (non Vahl) Lawson, l.c.; Auct. (non Vahl) Ding Hou, l.c.

Cassine glauca Auct. (non O.K.) Ding Hou, l.c.; Auct. (non O.K.) Ramaswamy & Razi, Fl. Bangalore Distr. (1973); Auct. (non O.K.) Ramanoorthy, l.c. 318; Auct. (non O.K.) Matthew, l.c. 254 (var. glauca), vol. 2(1982), t. 141; Roxburgh's plate no. 73 (British Museum, n.v.).

Vernacular name. Nerija (Telinga language ex Roxburgh).

Distribution. South India, Courtallam, Nilgirris, Malabar, Coromandel, perhaps further northwards to Mysore. Common, but scattered.

Massive, but usually a short-boled tree, up to 25 m tall and 60 cm dbh. Bark smooth, grey, finely cracked; live bark up to 4 mm thick, outside reddish, inside yellowish. Leaves opposite and somewhat scattered, oval to oblong, usually serrate-crenate. Panicles axillary and extra-axillary, many-flowered with very thin, patent dichotomous branches. Flowers yellowish, not exceeding 6 mm in diam. Drupe one-celled by abortion, obovoid, red when ripe, succulent with a soft, thin, crustaceous putamen.

Note. Retzius' *Schrebera albens* was based on a specimen collected by Koenig, in flower and fruit, now preserved in the Lund Herbarium in Sweden. On the verso of the type sheet the caption is similar to that of the type specimen of *Mangifera glauca* (*Cassine glauca* O.K.) Rottb. of the Copenhagen herbarium with a slight difference. The habitat is simply marked as Ceylon and Coromandel. The specimen is correctly depicted by Retzius showing flowers and fruit which are more elaborately described by Retzius than those of *Mangifera glauca* by Rottboell.

The two specimens, one in Copenhagen and the other in Lund, differ in their fruit characters and since the rediscovery of the entirely Ceylonese *Cassine glauca*, it has become obvious that Koening had sent to Rottboell in Copenhagen a specimen collected in Sri Lanka and another to Retzius in Lund collected in India and this he had captioned on the label of the Copenhagen specimen as "In the forests of Ceylon and near heathen temples in Coromandel".

It was Graham (1830) who first expressed his doubt, i.e., whether the Ceylon plant also occurred in India and Wight and Arnott were the ones who, with the same opinion, separated the two south Indian species into *Elaeodendron roxburghii* (based on *Neerija dichotoma* Roxb.) and *E. paniculatum*.

Wight and Arnott were, however, unfamiliar with the true identity of *Elaeodendron glaucum* of Sri Lanka. They accepted Roxburgh's *Elaeodendron glaucum* as being conspecific with Rottboell's *Mangifera glauca*.

After the rediscovery of the true *Cassine glauca* (Rottb.) O.K., it is known now, that the tree, which Roxburgh obtained from Ceylon (in this paper named *Cassine balae* Kosterm.) is not identical with the species that Rottboell described.

Cassine albens has the same kind of inflorescence with extremely thin branches as that of *C. glauca*; the flower is also similar in size but white, and, only half the size of those in the Ceylonese *C. balae*. Roxburgh stated that the fruit was red, different from the pure white one of *C. glauca* but the main difference is in the shape, obovoid to obovate-ellipsoid in *C. albens* and spindle-like with both ends strongly pointed in *C. glauca*. Both have a thin crustaceous putamen and sufficient mesocarp.

Of *C. albens* I have collected a specimen near Courtallam in South India in a rather dry forest higher up than the village, where also Wight's specimen was collected in July 1835.

After the lumping of several distinct species by Lawson (1875), it was only Ramanoorthy (1976) who interpreted the South Indian species correctly, referring them to *Cassine* as *C. roxburghii* and *C. paniculata*; the author missed the point that the specific epithet of the first should have been *dichotoma* (from *Neerija dichotoma* Roxb.).

Ding Hou (1962) and Matthew (1983) stuck to Lawson's concept and Vahl based the name *Celastrus glaucus* on *Mangifera glauca* Rottb., but the description (Ding Hou stated wrongly that the name was a *nomen nudum*) was based on Koenig's specimen in Lund, the base of *Schrebera albens*. Brandis' specimen of *Elaeodendron glaucum* (non O.K.) is not conspecific with *Cassine albens,* because of the yellowish brown petals and yellowish green fruit. This seems to be the same species as that described by Kanjilal, Osmaston, Benthall, Collett and Prain (*Cassine grossa*). Parker's described specimens have a large thickening at the base of the petals; they are something else.

Pittard's species from Indochina belongs to the group with a thick, woody putamen and is allied with *Cassine balae*.

Southern Tamilnadu, Courtallam, fr., *Kostermans 26003* (AAU, L); Nilgirris, fl., *Hooker f. & Thomson s.n.* (L); Concan, fr., *Stocks s.n.* (L); locality not indicated, fl., Herb. Wight 461 (L).

Species of Sri Lanka

Cassine glauca (Rottb.) O.K. Figs. 2 & 3

O. Kuntze, Rev. Gen. Pl. 1(1891) 114; Auct. (non O.K.) Pierre, Fl. For. Cochinch. 4(1893), t. 296 A; Auct. (non O.K.) Loessener in Engler & Prantl, Nat. Pfl. fam. 3(5) (1892) 214; ed. 2, 20 b (1942) 173; Auct. (non O.K.) Ding Hou in Fl. Males., Ser. I, 6(2) (1962) 286. — *Mangifera glauca* Rottboell, Nye Saml. Videnskabl. Selskabs Skrifter (Nov. Act. Haffn.), Anden Deel (vol. 2) (1783) 533-555, tab. IV, f. 1 (exclud. *Melmedya*); Roxburgh, Fl. Ind., ed. Carey 1(1832) 638 (as a syn. of *Elaeodendron glaucum*); Lawson in Hooker f., Fl. Brit. Ind. 1(1875) 623 (as a syn. of *E. glaucum*); Ding Hou, l.c. (as a syn. of *Cassine glauca*). — *Celastrus glaucus* (non R. Br.) (Rottb.) Vahl, Symbol. bot. 2(1791) 42 (exclud. descript., which is *Cassine albens*); Moon, Catal. (1824) 17; Thwaites, Enum. Pl. Zeyl. (1858) 73 (as a syn. of *Elaeodendron glaucum*); Trimen, Hand. Fl. Ceylon 1(1893) 271, p.p. (as a syn. of *E. glaucum*); Alston in id. 6 (Suppl.) (1931) 42, p.p. (as a syn. of E. glaucum). — *Elaeodendron glaucum* (Rottb.) Persoon, Syn. 1(1805) 241; Thwaites, l.c. (exclud. var. *montanum*); Lawson, l.c. 623 (pro minime parte); Trimen, l.c., p.p.; Auct. (non Pers.) Loessener, l.c.; Weeratunga, Kumar, Sultanbawa & Balasubramaniam in Proc. Assoc. Adv. Sci. (1983) Sec. E, p. 74.

Senacia glauca Lamk., Dict. Sci., Suppl. (1817) 128. — Senacier glauque Lamarck, Illustr. Genres 2(1798) and in Dict. Sci. Suppl. (1817) 128. — Typus: *König s.n.*, fl., fr., e Ceylon (C).

Usually small trees, glabrous in all their parts. Bark smooth, greyish white, thin, with yellowish underside; live bark red. Leaves opposite, the young ones conspicuously acuminate. Panicles with very slender peduncles and very thin, dichotomous, patent branchlets (much thinner than in *C. balae*). Flowers green, c. 5 mm in diam.; petals with white tips. Fruit narrowly ellipsoid, glossy porcelain white with 1-mm thick, soft, juicy, sweetish mesocarp and thin, crustaceous, spindle like, pale yellowish putamen, conspicuously pointed at both ends, one-seeded by abortion.

Fig. 2 *Cassine glauca* (Rottb.) O.K., holo (C).

History. The paper on *Mangifera glauca* was read by Rottboell on December 13, 1782 and published in 1783. It was based on a specimen, sent to him by Koenig, a physician, employed by a Missionary Station in South India. The type sheet in the Copenhagen Herbarium consists of a large flowering and fruiting branch of which the lower right hand part was depicted by Rottboell. The specimen is marked on the verso of the sheet: "Ex India orientalis. Genus novum. Arbor Pentandra Monogynia. Flore infero. S(t)ylus conica. Fructus baccata drupacea nux semibilocularia. Habitat Zeylone nemorosis, in Coromandelia prope templa idolatrorum. K(oenig).".

This caption has caused confusion. It has been interpreted that Koenig collected from a single tree in Ceylon and had seen (what he believed to be) the same species grown near a temple in South India.

This is now shown to be incorrect. At least two specimens are involved, the one sent to Rottboell, originating from Sri Lanka and another one sent to Retzius, which was from the coast of Coromandel (described by Retzius as *Schrebera albens* Retz.).

Rottboell believed his specimen to be a *Mangifera*. He depicted the slender, elongate, slightly curved fruitlets, but did not describe them to a great extent. Retzius presented a better description of the fruit of his specimen (which represents *Cassine albens* Kosterm.).

When Vahl (1791) had before him Retzius' specimen he recognized its relationship with Rottboell's *Mangifera glauca*, at the same time inserting it in the proper family as *Celastrus glaucus* Vahl. He presented a lengthy description (hence not as Ding Hou stated that *Celastrus glaucus* is a *nomen nudum*) which indicates that he described Retzius' specimen (of. under Cassine *albens* Kosterm.).

Some time later, Roxburgh (Hort. Bengal. 18(1814)) (cf. also Voigt, Hort. suburb. Calcut. 67(1845) received seeds from a Ceylonese *Elaeodendron* (*Cassine*) species, which subsequently was grown in the Calcutta Botanical Garden and which he described as Elaeodendron *glaucum*, apparently assuming that there was only one species of *Elaeodendron* in Sri Lanka (it is, however, another, distinct species, named here *Cassine balae* Kosterm.) (cf. under that species.).

In the same Flora of Roxburgh *Neerija dichotoma* was described, which is conspecific with *Schrebera albens* Retz. This species was later correctly referred to *Elaeodendron* by Wight & Arnott (1824) although with the illigitimate name *E. roxburghii* (cf. under *C. albens* Kosterm.).

Rottboell added in synonymy the vernacular name Helmedija, a misspelling of Waelmedija (wael= climber) of Linnaeus, Fl. Zeyl. (1743) 204, no. 439 (the name is of Hermann, Mus. Zeyl. 13; the specimen is on folio 76 of Hermann's Herbarium in the British Museum, Natural History London. It represents *Hippocratea indica* Willd.). It was Retzius who already doubted its conspecificity with *Mangifera glauca* Rottb.

Wight & Arnott (1814) were the first to note that the Ceylonese *Elaeodendron glaucum* (sensu Roxburgh) did not occur outside of Sri Lanka and named the South Indian species *Elaeodendron roxburghii* and *E. paniculatum*. The only one, who heeded this was Ramanoorthy (1976) who excluded *Elaeodendron glaucum* from India and named the South Indian species *Cassine roxburghii* and *C. paniculata*.

Lawson (1875) uncritically lumped all species from Sri Lanka and India under *Elaeodendron glaucum* yet recognizing two varieties: *roxburghii* and one unnamed from Canara, which is perhaps not a *Cassine*.

Assuming that Roxburgh had been correct in that his plant (introduced from Sri Lanka) represented Rottboell's *Mangifera glauca* (*Cassine glauca* O.K.), Thwaites and Trimen (1893) must have named the only *then* known Ceylonese species:

Fig. 3 *Mangifera glauca* Rottb., original drawing (*lower figure*).

Elaeodendron glaucum (now *C. balae* Kosterm.). Thwaites had separated the variety *montanum,* which I have raised to specific rank as *C. congylos* Kosterm. The specimen *C.P. 1227* is the true *C. glauca.*

Ding Hou (1962) followed Lawson's concept, not aware of the salient differences of the fruit characters, evident in the figures of Rottboell (*Cassine glauca*) and of Wight (1820) (*Cassine albens*), and Roxburgh's description. After the correct disposition of Ramanoorthy (1976), Matthew (1983) reverted to Lawson's faulty conception.

The rediscovery of the real *Cassine glauca* (Rottb.) O.K. took place in the garden of the Nillavely Beach Hotel near Trincomalee on the west coast of Sri Lanka, which consists of the original beach forest between the Hotel and the beach, of which the hotel owner had had the good sense of cutting out only the underbrush, in this way creating a shady garden, where, while seated and sipping a glass of beer, I found that the tree above me provided the key to all this confusion and misinterpretation.

Contrary to Ding Hou's statement that fruiting specimens of *Cassine* are difficult to identify I have arrived at the conclusion that it is the fruit that provides the distinguishing characteristics.

There are two groups in *Cassine,* one with juicy fruit with an ample mesocarp and a thin, crustaceous putamen (*Cassine glauca, C. albens* and perhaps *C. paniculata*) and a second, without any appreciable mesocarp and a very thick, woody putamen (*Cassine balae, C. congylos,* perhaps some north Indian *Cassine,* and the Malesian species). The Malesian *Cassine viburnifolia* falls in the first group.

The slender, elongate, glossy white, juicy fruitlets of *Cassine glauca* with their slender, spindle-like, thin putamens, gradually, strongly pointed at the ends, cannot be confused with fruits of other known *Cassine species.*

Chemistry. The leaves have a sternutatory and fumigatory action. They are also used as a snuff to relieve headaches. The gum from the tree dissolves in water to give an adhesive. The seeds and bark contain seven friedelane derivates, these include friedelin, canophyllal, friedelan-3-on-25-1, friedelan-3-01, elaeandrol (17-dihydroxy-28-norfriedelan-3-one), canophyllol, friedelan-3-on-25-1 and the trioxygenated friedelane elaeodendradiol (17,25-hydroxy 28-norfriedelan-3-one).

Later G. Weeratynga, V. Kumar, M. Uus Sultanbawa, S. Balasubramaniam (section E, page 74) found three other trioxygenated fridelane derivatives: ketodiol and a dioxo-alcohol (25,28-dihydroxy friedelane-3-one) and dioxoalcohol (3,28-dioxo friedelane-25-1).

Sri Lanka. Beach near Trincomalee, Dry Zone, beach forest, April, fl., fr., *Kostermans 27719* (AAU, G, L); Madu Rd. to Mannar Isl., Dry Zone, low, May, fl., *Kostermans 24887* (AAU, G, L); Jaffna Distr., along main road, Ghavakachari, low, Aug., fr., *Balasubramaniam 2189* (AAU, PDA); Puttalam Distr., Manampuri, low, dry zone, May, fl., *Cramer 4665* (L, PDA); Beriliya forest near Elpitiya, Galle Distr., low, fl., fr., fr. June, *Kostermans 27790* (AAU, PDA), *Kostermans 24887* (BO); locallity not indicated, fl., *C.P. 1227* (BO, PDA).

Cassine balae Kosterm., *sp. nov.*

Elaeodendron glaucum Auct. (non Pers.) Roxburgh, Coromandel Pl. 2(1798) 2; Hort. Bengal. (1814) 18; Fl. Ind., ed. 2, 1(1832) 638; repr. Carey's edit. (1874) 214 (exclud. *Schrebera albens* Retz., *Celastrus glaucus* Vahl, and *Mangifera glauca* Rottb.); Auct. (non Pers.) Voigt, Hort. suburb. Calcut. (1834) 167; Trimen, Handb. Fl. Ceylon 1(1893) 271, p.p. (exclud. Schrebera *albens* Retz., *Celastrus glaucus* Vahl, *Elaeodendron roxburghii* W. & A.); Lawson in Hooker f., Fl., Brit. Ind. 1(1875) 628, pro minime parte, quoad cit. Ceylon; Auct. (non Pers.) Ding Hou in Fl. Males., Ser. 1, 6(2) (1962) 286.

Elaeodendron balae Kosterm. ex G. Weeratunga, V. Kumar, M.U.S. Sultanbawa & S. Balasubramaniam (invalid, no latin diagnosis), J. Chem. Soc. Perkin Trans. 1(1982) 2457.

Arbor in omnibus partibus glabra, follis oppositis, sub-coriaceis, obovato-ellipticis mucronulatis vel obtusis, margine serrato-crenulatis, basin versus sensim cuneastis, nervo mediano supra plana vel subimpressa, subtus graciliter prominula, costis paucis, paniculis axillaribus multi-floris dichotomis, petalis tenuibus oblongis obtusis 2-3.5 mm longis, ramulis sat crassis, fructibus maturis subglobosis mucronatus, mesocarpium deest, putamen crassum lignosum. Typus: *Balasubramaniam 2213* (AAU, K, L, holo).

Tree, up to 20 m tall and up to 90 cm dbh., glabrous in all its parts, older trees very massive. Bark smooth, grey to light brown, often lenticellate, 0.5 mm thick; live bark red. Branchlets slender, cylindrical, smooth. Leaves opposite, subcoriaceous, obovate-elliptic to sub-obovate-to obovate-oblong, 2.5 × 5 — 4 × 7 — 5 × 9 — 8 × 10 cm, with an obtuse mucro (usually bent down) or obtuse, base gradually cuneate; above midrib thin, level with the surface or partly subimpressed, lateral nerves faint; below midrib thin, prominulous, lateral nerves erect-patent, 5-6 (rarely up to 7-8) pairs, at some distance from the margin arcuately anastomosing or the apical ones running out, connected by a loose, very fine, rather irregular reticulation. Petioles thin, glossy, 1.5-2 cm, flat above. Leaf margin shallowly remotely serrate.

Panicles sometimes forming loose, compound panicles with some small apical leaves, axillary, the partial inflorescences rather few-flowered, up to 6 cm long with long slender peduncles and branchlets which are thicker than those of *C. glauca*, repeatedly dichotomous. Pedicels filiform, 10-13 mm. Flowers green (or the petal white), 5-7 mm in diam. Calyx lobes 5, roundish, concave. Petals 5, 2-2.5 mm long, oblong, obtuse. Nectary a green pentagonal fleshy, scalloped gland. Stamens five, filaments short, inserted in the disc, at first erect, later curving down to below the calyx. Ovary immersed in the disc, 2-celled, each with 2 ovules, attached to the bottom of the cell. Style very short, conical; stigma simple, obtuse. Drupe almost round to slightly ellipsoid-globose, up to 18 × 24 mm, shortly sharply pointed, smooth, green at maturity; mesocarp practically none; putamen with 5 mm thick, very hard, woody wall with one cavity (by abortion), with two longitudinal lines at each side, slightly compressed.

Distribution. Endemic to Sri Lanka.

Ecology. Dry, hot zones of North and East Sri Lanka, in coastal areas on sandy soils; also more inland in savannah vegetation. Can stand a prolonged dry spell. The putamen splits into two halves after a prolonged period of soaking and rotting.

Vernacular names. Nareloo, Neraloo (Sinhalese), Perun or Piyaree (Tamil).

Note. The Javanese *Cassine koordersii* Kosterm. (*Elaeodendron glaucum*, var. *macrocarpum* Koord. & Val.) is very close, but has a much smaller inflorescence, smaller flowers and much shorter petioles; the fruits are the same.

The leaves vary extremely and have minute, scaly stipules at each side of the internal base of each petiole. In north-east Sri Lanka, on dunes and sterile sandy coastal areas, we often find this tree as a many-short-boled bushy shrub, which I have never seen in flower. Its leaves are often large and sharply prickly serrate and is called in Tamil Kurativa or Kuruku vaichchi. It is this which Roxburgh records as Ceylon Tea, under which name it was sent from Ceylon to the Calcutta Botanic Garden by General McDowall.

Chemistry

G. Weeratunga, V. Kumar, M.U.S. Sultanbawa & S. Balasubramaniam re-

ported a 28, 29-dihydroxyfriedelane-3-one, a friedelane with two oxygenated methyl groups in the bark of *Cassine balae*. The only friedelane with two oxygenated methyl groups previously reported is salaspermic acid, isolated from *Salacia macrosperma*.

The seed of *C. glauca* contains a cardiac glycoside with double-linked sugar substitute, whereas the bark had a similar glycoside, five friedelanes and two norfriedelanes.

A light petroleum extract of the root bark of *C. balae* was found to contain four triterpene methides of which three were identified as pristimerin, tingenone and 20-hydroxytingenone on the basis of their physical properties and comparison with authentic material. Another compound is perhaps 3, 22-dihydroxy-24, 29-nor-D: A-friede-oleana-2,5,7,9(11), 10(1)-pentaen-2,21 dione 6, a quinone methide.

Moreover they isolated a new triterpene: D. friedo-oleana derivative. According to G. Weeratunga, L. Bohlin, F. Sandberg and V. Kumar (24th Annual Meeting, July 24-28, 1983, The American Society of Pharmacognosy, University of Mississippi, Oxford Campus, School of Pharmacy, Abstracts of Papers no. 95) an ethylacetate extract of the rootbark contained 3,3`, 5,5`, 7-pentahydroxy 4-methoxy, 2,3-cis-flavane as the major constituent; furthermore a novel leucoanthocyanidin was isolated.

Specimens examined.

Talaimannar, Mannar Distr., Northern Prov., sandy scrubland, Nov., buds, *Kundu et al. 623* (PDA); Trincomalee Distr., Upuvelu along border of Blue lagoon, rooted in brackish water, March buds *Cramer 4938* (PDA); Trincomalee, Jan., fl., *Worthington 742* (K); Wilpattu Nat. Park, July, fl., *Wirawan et al. 955* (BO, L, PDA); Batticaloa Distr., Kalkuda Resthouse, June, fr., *Waas 639 (PDA); ibid., June, y. fr., Worthington 6295* (K); Polonaruwa Ruin area, May, buds, *Kostermans 24309* (L, PDA); ibid., Oct. fl., *Ripley 222* (PDA); *ibid.*, July, after anthes., *Ripley 67 (PDA); ibid.*, Apr., fl., *Hladik 788* (PDA); along road to Gal Oya Nat. Park Inginiyagala, Amparai Distr., ster., *Meyer et al. 162* (PDA); Ruhuna Nat. Park, mouth of Kumbukkan Oya, beach, May fl., *Jayasuriya 2016* (AAU, PDA); Tissa-maharana, Kataragama road, Sept., y. fr., Coorey s.n. (PDA); Yala Bungalow, Ruhuna Park, Oct., fl. *Wirawan 681* (PDA); *ibid.*, Oct., fl., fr., *Nooteboom 332* (AAU, L, PDA); Buttuwa Beach area, June, fl., *Comanor 899* and Apr., fl., *Fosberg 50333* (AAU, L, PDA); *ibid.*, ster., *Worthington 5681* (K); Badulla Distr., Jamburagala, semi savannah, sandy, Jan., fl., *Fosberg et al. 51612* (PDA); Divulane forest, Ampara Distr., May, fl., *Jayasuriya 2085* (AAU); Wellawaya, Aug., fl., *Worthington 2992 & 4903* (K); mile 187 near Wellawaya, Moneragala Distr., June, buds, fr., *Meyer 199* (L, PDA); Habantotta, along the coast, Sept., fr., *Balasubramaniam 2213* (BO, K, L); *Amaduwa, fl. 1853*, inter *C.P. 1227* and *2520* (PDA).

Cassine congylos Kosterm., *sp. nov.*

Elaeodendron glaucum, var. *montanum* Thwaites, Enum. Pl. Zeyl. (1858) 73; Lawson in Hooker f., Fl. Brit. Ind. 1(1875) 623; Trimen, Handb. Fl. Ceylon 1(1893) 272. — Typus: *C.P. 2520* (PDA).

Cassine glauca, var. *montana* (Thw.) Pierre, Fl. for. Cochinch. 4(1893), t. 296.

Arbor magna in omnibus partibus glabra, cortice subtus ochraceis, foliis rigide coriaceis oppositis late ellipticis vel subobovato-ellipticis, apice rotundatis vel obscure mucronatis, basi sensim attenuatis acutis vel obtusis, margine obscure serratis, supra nervo mediano vix prominulo, nervis lateralibus tenuibus prominulis, subtus nervo mediano prominentibus, nervis lateralibus suberecto-patentibus vix prominulis filiformibus, rete obscure laxis, petiolis gracilibus supra concavis, sat brevibus, paniculis axilaribus paucifloris, pedicellis filiformibus sat longis, lobis calycinum depresso-rotundatis, petalis viridis oblongis sat longis, discus magnis incrassatis, filamentis brevibus sat latis reflexis; stylo conico brevibus; fructus subglobosis viridis, mesocarpium deest, putamen crassum apiculatum, globosum. — Typus: *Kostermans 27791* (L).

Tree, up to 30 m tall and 100 cm dbh. Bark brownish to yellowish brown, dark, roughish, pustular, 1 mm thick, underneath orange, inflammable (burns like kerosene); live bark red, 10 mm thick. All parts glabrous. Leaves opposite (rarely

sub-opposite), rigidly coriaceous, broadly elliptic to sub-obovate-elliptic, 2.5 × 3.5 — 4 × 6 cm, apex rounded or mucronate, towards the base slightly tapered, the base acute or obtuse; margin rather obscurely, remotely serrate; above midrib hardly prominent, lateral nerves thin, prominulous, below paler, midrib thin, prominent, lateral nerves erect-patent to more patent, thin, prominulous, 5-7 pairs, in between a rather obscure, lax reticulation. Petiole slender, concave above, 5-15 mm.

Panicles axillary, rather few-flowered, up to 7 cm long with few, remote, slender branchlets, the 1-mm long, narrow, acute bracts persistent. Pedicels slender, 3 mm. Calyx lobes depressed-orbicular, 2.5 mm diam. Petals green, oblong, the margins lighter green, ca. 5 mm long. Disc large, thick, up to 3 mm in diam., slightly incised. Filaments rather broad, 1-1.5 mm long, in the incisions of the disk, reflexed; style short, conical; stigma inconspicuous.

Fruit sub-globose, green at maturity, 2-3 cm diam., smooth, with short sharp point, one cavity (by abortion of the other); mesocarp practically none; putamen very hard, very thick, sharply apiculate, base obtuse, superficially longitudinally wavily grooved with appressed tree-like fibres.

Distribution. Endemic to Sri Lanka, Knuckles Massive.

Ecology. Wet, evergreen forest but with a yearly dry spell of 2-3 months, at c. 1000 m altitude.

Note. Trimen commented, that, although the flowers were larger, the fruit larger and the petioles shorter, it did not merit specific rank. There are even more differentiating characters, like the rigidly coriaceous leaves and the orange under side of the dead bark.

Lawson erroneously quotes it as coming from the drier parts of Ceylon; it is a wet zone plant.

Specimens examined.

Deltota, Dec. 1855, fl., *C.P. 2520* (BO, PDA); Dimboola, 5000 ft., Apr. 1852, fl., *C.P. 2520* (PDA); Knuckles Mts., Madulkelle area, Hemachandra' cardamon estate, alt. 1000 m, June, fl., *Kostermans 25070* (AAU, BO, L, P, PDA, US); ibid., base Dusingalle, 1000 m alt., Aug., fl., *Kostermans 27791* (AAU, G, K, L); ibid., Dec., fallen fr., *Jayasuriya 2550* (AARH, G, K, L).

Malesian Species

Cassine elliptica (Decsne.) O.K. Fig. 4

O. Kuntze, Rev. Gen. Pl. (1891) 114. — *Elaeodendron ellipticum* Decaisne in Nouv. Arch. Mus. Hist. nat. Paris, Ser. II, 3(1834) 478 (separately paged reprint p. 150); Ding Hou in Fl. Males., Ser. I, 6(1962) 286 (as a syn. of *Cassine glauca,* var. *cochinchinensis* Pierre). — Type: *Riedlé s.n.* (P).

The type specimen was collected in the island of Timor, East Indonesia, and is a flowering twig. Miquel (Fl. Ind. bat. 1(2) (1859) 591) mentioned a second specimen, but this could not be found.

The leaves of Riedlé's specimen differ considerably from those of the Javanese *C. koordersii* and the Moluccan *C. obiensis;* the base tapers gradually in the almost absent petiole. The inflorescence, extra-axillary, is a few-flowered, very shortly and thinly branched cyme on a thin, long common peduncle, also different from that of *C. koordersii.*

The leaves resemble strongly those of *C. australe* (Vent.) O.K. from Australia, but this should have fruit with a juicy thick mesocarp and the flowers 4-merous.

Cassine koordersii Kosterm., *sp. nov.*

Elaeodendron glaucum Auct. (non O.K.), var. *macrocarpum* Koorders & Valeton, Bijdr. Kennis

Fig. 4 *Cassine elliptica* (Decsne.) Kosterm., holo (P).

Booms. Java 7(1900) 101-102. — Typus: *Koorders 30086* (BO), ripe fruit.

Cassine glauca, var. *cochincinensis* Auct. (non Pierre) Ding Hou in Fl. Males., Ser. 1, 6(1962) 286, fig. 18, f. 9 (exclud. *Elaeodendron ellipticum* Decsne.); Auct. (non Pierre) Backer & Bakh., Fl. Java 2(1965) 55.

Arbor in omnibus partibus glabra, follis oppositis late ellipticis vel subobovato-ellipticis margine crenulato-serratis, petiolis brevibus, inflorescentiis axillaribus paucifloris pedunculis gracilibus, fructus late ellipsoideus vel subglobosus apiculatus, mesocarpium nullus, putamen crassum durum.

Tree up to 30 m tall, up to 95 cm dbh., all its parts glabrous. Bark smooth, grey, pustular. Leaves opposite, thinly coriaceous, broadly elliptic to subobovate elliptic, very shallowly crenate-serrate or entire, 4.5-15 × 2.5-6 cm, base rounded or acute, obscurely very shortly acuminate (acumen turned side-ways), both surfaces densely, minutely reticulate, lateral nerves c. 6 pairs. Petiole slender, short, 1-1.5 cm.

Inflorescences axillary, very short, few-flowered, 1-4 cm long on 1-2 cm long slender peduncle, cyme apical. Pedicel 2-4(-5) mm. Calyx lobes broadly rounded. Flowers green. Petals oblong, obtuse, 2.5-4 mm. Disc green. Filaments 1.5-2 mm, after anthesis strongly reflexed.

Fruit broadly subovate-ellipsoid to globose, 2-2.5 × 1.5-2 cm, very shortly, sharply apiculate, base rounded; exocarp rather tough, mesocarp hardly represented; endocarp 3-7 mm thick, hard, woody or bony, obtuse, one-seeded by abortion of the other.

Distribution. Only known from the Poeger (Puger) area in the Besuki Residency in East Java in the valley of Lampesan and on the Watangan Mts, not rare on periodically very dry soil of weathered coral limestone in teak and other dry forest types.

The numerous collections brought together by Koorders and his assistants are mostly sterile. Only a single specimen had very small, few-flowered cymes and another had a few ripe fruits, which were globose.

The species is characterized by the very short petioles and inflorescences. In fruit characters it is exactly like the Moluccan *C. obiensis*, with which it might be found eventually to be.

Cassine obiensis Kosterm., *sp. nov.*

Arbor magna in omnibus partibus glabris, foliis oppositis chartaceis ellipticis subobtusis serratis, petiolis tenuibus supra concavis, fructus ovoideus laevibus mucronulatus, mesocarpium sub-deest, putamen percrassum lignosum, semen unicum. — Typus: de Vogel 4173 (BO).

Tree, glabrous in all its parts, 40 m tall, bole 20 m, dbh. 40 cm, straight; buttresses 2 m high, out 1 m, thick 8 cm. Dead bark 2 mm thick, pale brownish, not fissured, not peeling off; live bark 6 mm, reddish ochre. Twigs rather slender, smooth, cylindrical, finely longitudinally ribbed. Leaves opposite, chartaceous, elliptic, 4 × 8 — 4.5 × 10 cm, obtuse or obscurely very broadly obtusely acuminate, base shortly acute; above smooth, midrib slightly prominulous, lateral nerves faint; below midrib slender, prominent, lateral nerves up to 12 pairs, erect-patent, at some distance from the margin arcuately anastomosing, reticulation lax, faint. Petioles slender, 10-15 mm long, concave above.

Fruit ovoid, smooth, green (fresh), apiculate and with two opposite, shallow, longitudinal grooves; exocarp 0.5 mm thick, mesocarp 0.5 mm thick, putamen very hard, woody, 4-10 mm thick with one assymmetric (by abortion) cavity; seed one, flat, 1.5 cm wide.

Distribution. Indonesia, Moluccas.

Note. Related to *Cassine koordersii* Kosterm. from Java, but the fruit ovoid, much larger and the putamen with a twice as thick wall.

The type sheet consists of a leafy branch and some detached fruit.

Additional material.

INDONESIA: North Moluccas, Obi Isl., Anggai, Mt. Batu Putih, 1° 24' S, 48' E, alt. 600 m, hillside with many limestone outcrops and boulders, covered with clayer soil, rather dense primary forest, 40 m tall with rather little undergrowth, rare tree, 19 Nov., fr., *de Vogel 4173* (BO, L); S. and E. Moluccas: Tanimbar Isl., Ilgney, Ottimer, ster., *bb. 24295* (BO); March, fr., *bb. 24207* (BO, L); Key Isl., fr., *Jaheri 167* and *382* (BO).

Acknowledgements

It took considerable time to distangle the misinterpretations of Koenig's material, on which *Cassine glauca* and *C. albens* are based and without the much appreciated assistance of Dr Bertel Hansen (Copenhagen herbarium) we would certainly not have succeeded. We like to express here also our gratitude to the Curator of the Lund Herbarium (Sweden) for the loan of the type specimen of *Schrebera albens* Retz. and to the Directors of the Leiden and Aarhus Herbaria, to permit us to examine the specimens in their Institutes.

Last, not least, we thank Dr Ding Hou of the Rijksherbarium, Leiden, who extended to us his generous assistance.

The Genus *Pandanus* (Pandanaceae) On Christmas Island, Indian Ocean

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Abstract

Two species of *Pandanus* occur on the remote Christmas Island (Indian Ocean), south of Java (105° 40' E, 10° 30'S), although three binominals have been published. The correct names for the species, a key for their identification, synonymy, and descriptive notes, with illustrations of new or distinctive features, are here presented. *Pandanus christmatensis* is shown to be a member of subg. *Pandanus*, sect. *Pandanus*, closely related to *P. tectorius* Park., and especially so to *P. platycarpus Warb. P. elatus* is shown not to be a member of sect. *Pandanus*, as previously stated, but rather, in sect. *Roussinia* (of subg. *Rykia*), previously considered monotypic with *P. leram* Jones ex Fontana. Several critical features, including the hair-tufted anther apiculi, shared by *P. leram* and *P. elatus*, reveal their close relationship.

Introduction

According to Murray's Introduction in Andrews' *Monograph of Christmas Island* (1900), Christmas Island has been known to navigators since about the middle of the seventeenth century. Java, the nearest land mass, is about 190 miles to the north. To the south-west, at a distance of about 550 miles, are the low atolls, the Cocos-Keeling Islands. Christmas Island itself is an ancient, uplifted limestone summit. Its geology is somewhat complex, and basalts and phosphate-bearing rocks are also present. It is the latter which account for the past interest and current industry on the island, phosphate being now the export product. The Island lies in the same latitude, south of the equator, as Fatuhiva in the Marquesas Islands, San Cristobal Island in the Solomon Islands, Cape Delgado on the coast of Mozambique, and is only a short distance south of the latitude of Luanda in Angola and Recife in Brazil. Accordingly it has a fully tropical climate. Christmas Island was shown on a map prepared by Pieter Goos, published in Holland in 1666 (on which it is called Moni). It is not certain who applied the name by which it is presently known. The Island is mentioned by Dampier who visited it in March 1688. Subsequently, it was touched on by several voyagers, but the first real exploration was attempted in 1857 by the frigate H.M.S. *Amethyst*. In 1886 the survey ship *Flying Fish* under Captain Maclear examined it and some specimens of plants and animals were brought home, the first to represent its flora and fauna. Captain Pelham Aldrich called at it in H.M.S. *Egeria* in 1887, and some natural history collections were made by J.J. Lister. In 1888 it was placed under the Government of the Straits Settlements by the visit of H.M.S. *Impérieuse*. In 1890, H.M.S. *Redpole* stopped there for a few hours, allowing H.N. Ridley, of the Botanic Gardens, Singapore, to make some plant collections (Ridley, 1891).

The principal collections from Christmas Island date from the residential work of Charles W. Andrews, who arrived there in July 1897 and remained for nearly a

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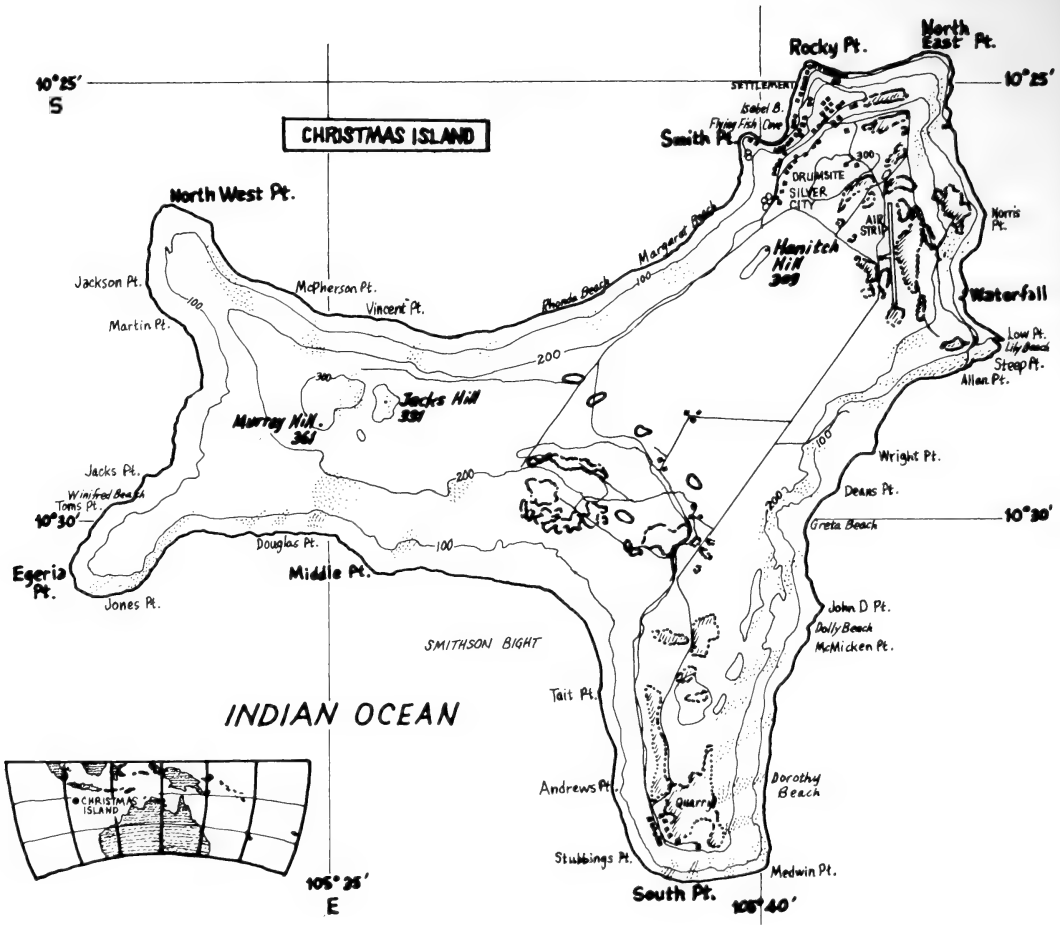

Fig. 1. Christmas Island. from the original which was based on *Atlas of Australia,* Map 159, Reader's Digest Services Pty Ltd. Sydney.

year. In October 1904, Ridley collected there again, later publishing some new species (Ridley, 1906), including two binomials in *Pandanus* discussed further ahead.

The map view of the Island (Fig. 1) may be likened to a standing dog, facing east; its tail is North West Point; its hind leg is Egeria point; its front leg is South Point; and the larger north-eastern part includes the Settlement; the ears are Rocky Point and North East Point, while the muzzle is Norris Point and Low Point, with Waterfall in between. The greatest distance east to west is about 17 km, and north to south about 17.5 km. The highest points are Murray Hill, in the western part (361 m) with Jack's Hill near it (331 m); and Hanitch Hill, in the north-eastern part (309 m). At a distance of 1-3 km inland from the coast, abrupt steep cliffs rise which border the interior plateau, which slopes gently to the south and west. Its surface has shallow valleys and low ridges. The margin is often marked by limestone pinnacles.

The soil is mostly (apart from the reefs and pinnacles) a brown loam strewn with phosphate nodules and often also with fragments of basalt.

The collections of Andrews resulted in the publication of *A Monograph of Christmas Island* (Andrews, 1900) and this embodied the studies of several botanists and zoologists, mostly of the British Museum (Natural History) staff. In the *Monograph,* the enumerated flora contained 111 species of Dicotyledons, 18 of

Monocotyledons, 22 of Pteridophytes, 8 of Bryophytes, and 31 other lower cryptogamous plants, mostly Fungi, as well as one Gymnosperm (*Cycas circinalis*).

The Genus *Pandanus* in Christmas Island

Andrews collected staminate flowers of one *Pandanus* species during his visit in 1897. This was subsequently described by Martelli (1905), who named it *Pandanus christmatensis*. In 1904 Ridley obtained fruiting collections representing two species which he himself named as new. Of one he also obtained good staminate material.

The Christmas Island pandans were reviewed by St. John (1965). He accepted two species, for which he used the names applied by Ridley, providing full descriptions (and good illustrations) of *Pandanus elatus* Ridl. (fruit and staminate flowers), and of *P. nativitatis* Ridl. (fruiting specimens), based on Ridley's collections in the Herbarium of the Botanic Gardens, Singapore. Although St. John mentions briefly that Martelli had previously described (to Ridley) a *Pandanus* species from the island, he neither reports its name nor attempts to deal with it taxonomically and nomenclaturally, remarking merely that the specimen was "fragmentary, staminate material." This material (i.e., Andrews' collection) was evidently not further studied.

Realizing that further investigation of the Christmas Island pandans was necessary in order to resolve the problem of how many species were in fact indigenous there, I requested full new collections from the Conservation Officer, Mr. D.A. Powell, who responded most helpfully. From him I later received excellent collections and notes, which are cited below and which confirm that there are two indigenous species on the island. The collections made by Mr. Powell and his colleague, Mr. H'ng Kim Chey, represent fruiting and staminate flowering material of both species. With this complete representation, it is now clear that one of the names proposed by Ridley, *P. nativitatis*, must be regarded as a synonym of *P. christmatensis* Martelli. This is the species of the coastal regions. The second, limited to the central plateau, retains the original name proposed for it by Ridley, *P. elatus*.

Key to species

Tree to 20 m tall; pistillate cephalium, when ripe, somewhat oblong-cylindric-ellipsoid, to about 33 cm long, bearing about 100 phalanges; phalanges 7.5-9 cm long, more or less transversely compressed, apex low convex; carpels 4-12, mostly 6-9 per phalange; stigmas large, erect, 3-4 mm long and wide. Staminate spikes 12-20 cm long; staminate phalanges 12-18 mm long, of 15-23 stamens clustered at apex of the long (to 9 mm) column; anthers 3-4 mm long, apiculus c. 0.5 mm, acute, bearing a minute tuft of glandular hairs at the apex. Staminate bracts to 40-50 cm long, apex acute, closely spinulose-margined. ..... *Pandanus elatus*

Shrub or small tree to c. 5 m tall; pistillate cephalium, when ripe, ellipsoid or ovoid-ellipsoid, to about 25 cm long, bearing about 60 phalanges; phalanges 5.5-8 cm long, plump, not compressed, apex rounded to convex; carpels many, usually 15-26 (or sometimes fewer, to 9); stigmas about 1-1.5 mm long and wide. Staminate spikes mostly 7-9 cm long; staminate phalanges fastigiate, 15-20 mm long, stamens racemose along the column, the free basal part of the column at most 5 mm long; anthers c. 5 mm long, apiculus 0.5 mm long, acute, glabrous. Staminate bracts to 65 cm long, but the apical part very narrow attenuate and flagellate, at apex with very remotely spinulose margins. ..... *Pandanus christmatensis*

Subg. *Rykia* Section *Roussinia*

Pandanus elatus Ridley Plate 1. Figs. 2, 3 & 7

Ridley, J. Str. Br. Roy. Asiat. Soc. 45 (1906) 239; St. John, Pacif. Sci. 19 (1965) 113, figs. 215-216.

St. John has provided full descriptions and illustrations of both the pistillate and staminate plants, to which the recently collected specimens conform fully, while providing the basis for some corrections and emendations.

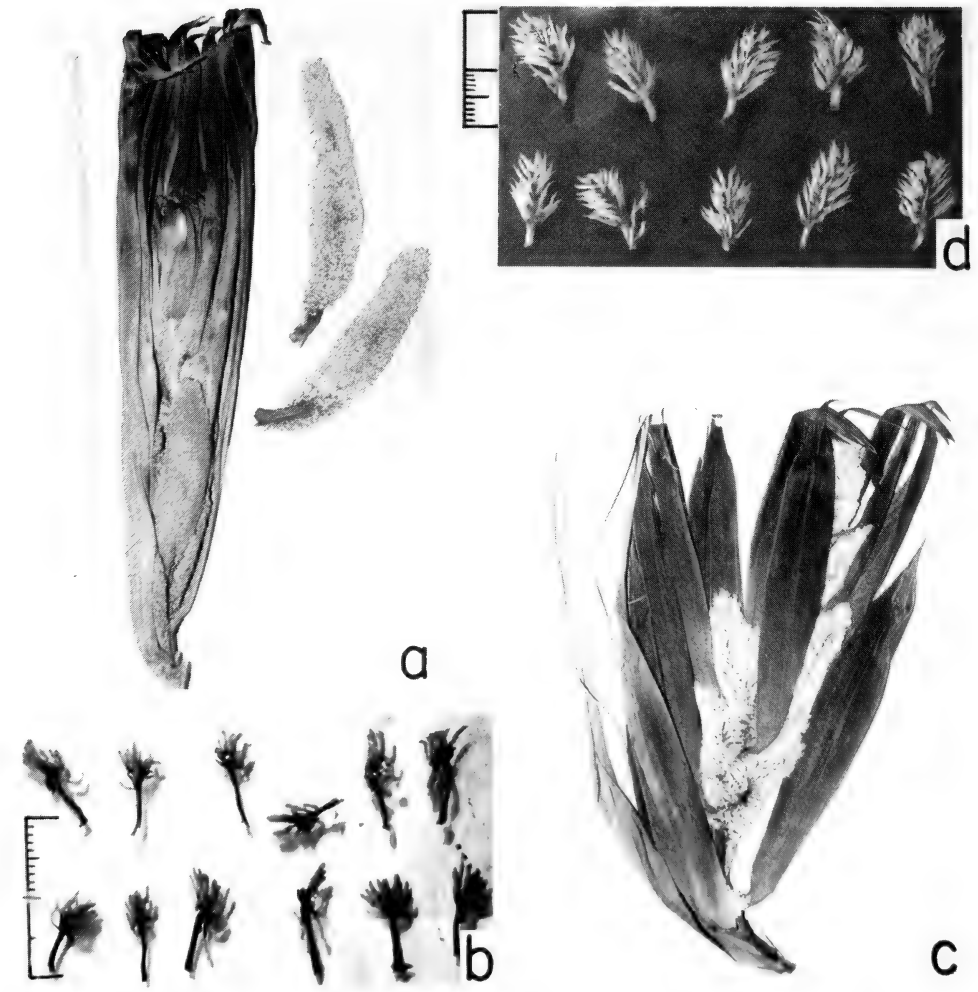

Plate 1. Staminate flowers and inflorescences of *Pandanus elatus (a, b)* and *P. christmatensis (c, d)*. *a*, Part of a staminate inflorescence from Powell & H'ng 10 Oct. 1983; *b*, staminate phalanges from the same collection. *c*, Staminate inflorescence from Powell & H'ng Nov. 1983; *d*, staminate phalanges from the same collection. Scale in *b* & *d* show a 2-cm bar with 1 cm divided into mm.

The acute rather than flagelliform apices of the bracts, which moreover have rather densely spinulose margins, are distinctive features that help to distinguish plants of *P. elatus* from those of *P. christmatensis*.

More significant, and not mentioned in St. John's description, are the hair-tufts of the apiculi of the anthers of *P. elatus*. These are formed of glandular hairs and are observed on almost all the stamens. The staminate phalanges bear generally 12-18 (or up to 23) stamens subumbellately arranged on the column apex, which contains usually 4 or 5 vascular bundles in a single circle, and lacks crystal cells, as seen in the cross-sectional view (fig. 3B). The papillosity referred to by St. John said to occur on the column and filaments is an artifact; these structures are in fact smooth, and the so-called papillae are probably merely adherent pollen grains. The pollen grains are about 23 μ long, slightly larger than those of *P. christmatensis*, and the spinules are somewhat more numerous and longer.

The very large stigmas are noteworthy, as well as the usually obvious transverse seriation of the carpels and resulting compression of the pistillate phalanges. The

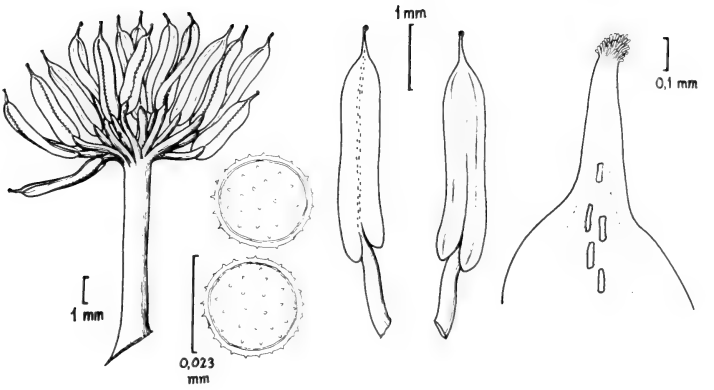

Fig. 2. *Pandanus elatus*, details of staminate structure. *Left* to *right:* a complete phalange; pollen; anther, dorsal face; anther, ventral face; anther tip showing tuft on apiculus.

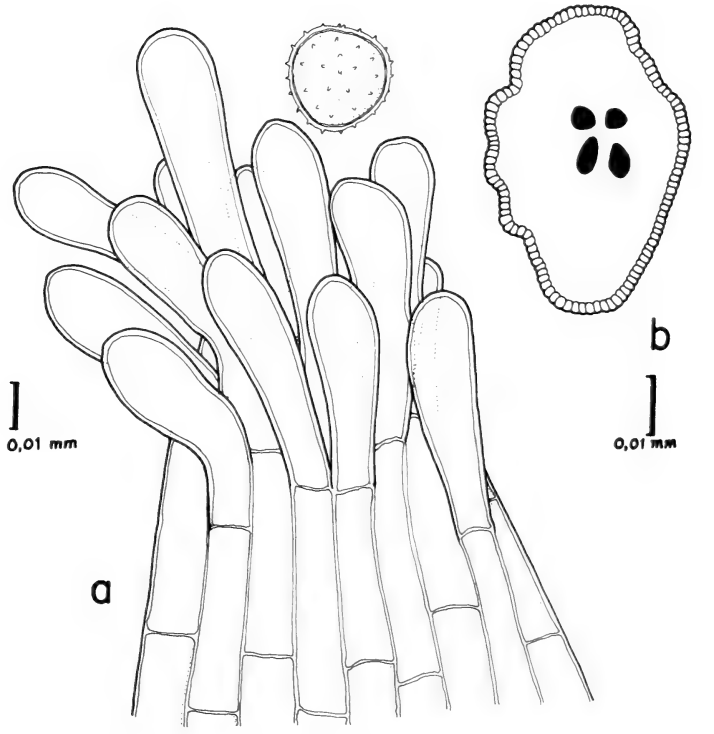

Fig. 3. *Pandanus elatus*, details of staminate structure. *a*, tip of apiculus, showing the papilliform glandular hairs and one pollen grain. *b*, Transection at midlevel of one 18-stamened phalange, showing 4 vascular bundles; note absence of crystal cells. Drawn by K.L. Huynh.

outermost carpels appear sterile, their loculi being smaller and lacking endosperm. Often there are only two or three loculi with normal endosperm. The phalanges not infrequently have adherent, imperfect, small peripheral carpels or ferulae (as is true also of *P. christmatensis*).

LECTOTYPE. *H.N. Ridley* in October 1904, Christmas Island, plateau (SING). Isolectotype in K. Staminate paratype: *H.N. Ridley* in October 1904, Murray Hill track, Christmas Island (SING).

RELATIONSHIPS. *Pandanus elatus* was placed in subg. *Pandanus* sect. *Pandanus* by St. John (1965), clearly on the basis of the pistillate phalanges only. The species was overlooked by Martelli who omitted it in his *Enumeration* of species in *Webbia* 4, 1 (1913).

Pandanus elatus differs from authentic members of section Pandanus, such as *P. tectorius, P. odoratissimus,* and *P. christmatensis,* in several respects, including the compression of the pistillate phalanges, subumbellate arrangement of stamens, arrangement of the vascular bundles in the column, and the papillae or hair-tufts of the anther apiculi. These features exclude *P. elatus* from section *Pandanus*. On the other hand, three of the features are to be found in *Pandanus leram* Jones ex Fontana, a species of the Andaman and Nicobar Islands with an occurrence in South Java (Nusa Kambangan Island, off Tjilatjap), and of the Maldive Islands. This species is cultivated in Sri Lanka and elsewhere (Stone, 1977). In *P. leram,* the compression of the pistillate phalanges, with more or less clear transverse seriation of the carpels, the large stigmas, and similar leaves and branching habit are to be found, as well as the staminal arrangement and apicular hair-tufts of *P. elatus*.

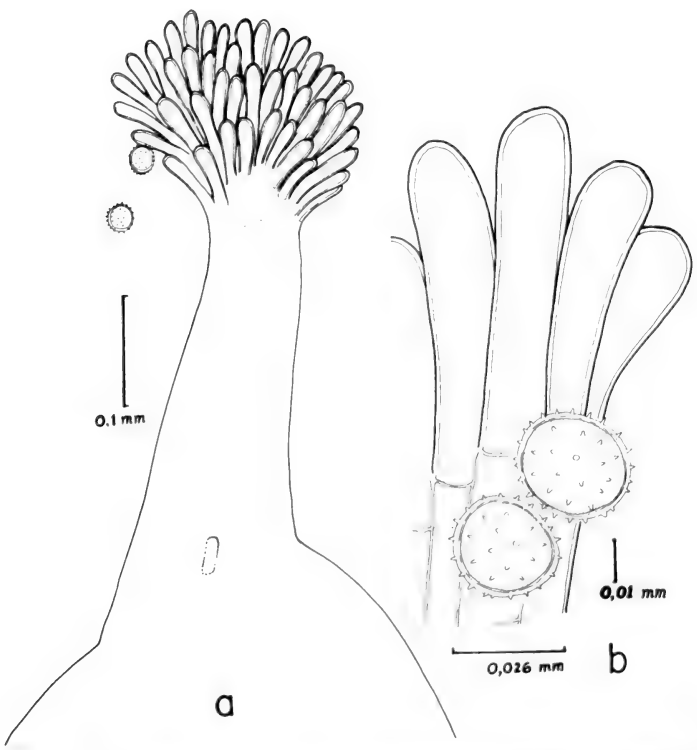

Fig. 4. *Pandanus leram,* details of staminate structure. *a,* Anther apiculus, showing tuft of hairs at tip, with 2 pollen grains; *b,* enlarged view of tuft hairs and pollen grains. From *Stone 11102* (KLU), Sri Lanka.

However, the column contains somewhat more numerous vascular bundles which, moreover, are usually in two circles not one. The pollen grains of *P. leram* are slightly larger than those of *P. elatus* (c. 26 μ rather than c. 23 μ).

Pandanus leram is the sole member of sect. *Roussinia* (Gaudich.) Stone (Stone, 1983). The perceptible similarity of *P. elatus* based on vegetative, foliar, fruit, and staminate characters, indicates that *P. elatus* must be assigned to section *Roussinia* as a second member. On geographical grounds also, this relationship is plausible.

The hair-tufts of the stamens are not restricted to this section; they also occur in a number of other species in several different sections, including sections *Asterodontia* (subg. *Rykia*), *Barrotia* and *Brongniartia* (subg. *Lophostigma*).

Pandanus elatus is endemic to Christmas Island, limited to the high limestone plateau. It is most similar to *P. leram* var. *andamanensium* (Kurz) Stone.

Subg. *Pandanus* Section *Pandanus*

Pandanus christmatensis Martelli Plate 1. Figs. 5-7

P. nativitatis Ridley, J. Straits Branch, Roy. Asiat. Soc. 45 (1906) 238. St. John, Pacif. Sci. 19 (1965) 116, f. 217.

To the description provided by St. John can be added the following emendations and alterations.

The pistillate cephalia are ovoid-ellipsoid, up to about 22 × 21 cm (when dried), on peduncles at most 2 cm diameter. There are about 55-70 phalanges per cephalium. The phalanges are distinctly polycarpellate, with about 18-21 carpels being the usual number per phalange, though those with both more numerous (to 26) and fewer (to 9) can be found. St. John's description was based on only three phalanges. In the recent collections the phalanges are about the same size or slightly larger, the apical surface is usually somewhat more convex, but in other respects there is good agreement.

The staminate inflorescences are typical for species of sect. *Pandanus,* the lower and transitional floral bracts being distally protracted into flagelliform tips; these

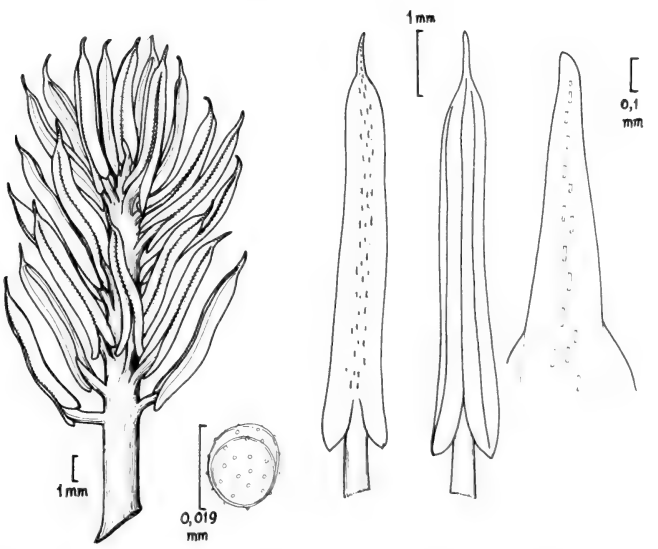

Fig. 5. *Pandanus christmatensis,* details of staminate structure. *Left to right:* one complete phalange; pollen grain; anther, dorsal face; anther, ventral face; tip of apiculus. Note distribution of raphide cells (*small rectangles*).

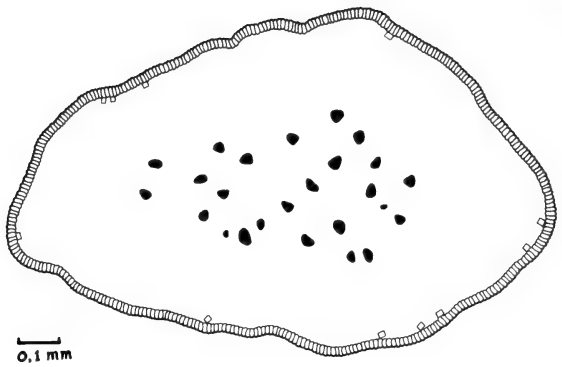

Fig. 6. *Pandanus christmatensis*. Transection at midlevel of column of 31-stamened phalange, with 25 vascular bundles. Note occurrence of crystal cells (*small squares)* just below epidermis. Drawn by K.L. Huynh.

have sparse and remote marginal spinules. The spikes are comparatively short, up to about 10 cm long. The phalanges are dense, about 15-20 mm long, composed of 15-32 stamens, racemosely arranged along the column, only the base (4-5 mm) of the column free; the anthers are about 5 mm long, with a distinct acute apiculus c. 0.5 mm long, the tip of which is smooth and glabrous.

The pollen grains are about 19 μ long, slightly smaller than those of *P. elatus,* with fewer and somewhat shorter spinules.

The column contains several vascular bundles (fewer than the number of stamens), which are arranged in 2 or 3 circles, as is typical in sect. *Pandanus*. Several crystal-cells are to be seen beneath the epidermis (fig. 6) in cross-sectional view. Each crystalliferous cell contains a single crystal.

HOLOTYPE. Christmas Island, *C. W. Andrews* in 1897, staminate flowers (BM). Original citation: HAB. Christmas Island nell'Oceano Indiano (Andrews in Herb. British Museum); Martelli, 1905, 1.c. No other specimens cited. Type of *P. nativitatis* Ridley: *H.N. Ridley* in October 1904, Waterfall, Christmas Island (Indian Ocean), in SING.

The relationships of *P. christmatensis* are clearly with the core species of subg. *Pandanus* section *Pandanus,* including the type species, *P. tectorius* Park. ex Z.; but more particularly with a taxon named *P. platycarpus* Warb., said to be from Zanzibar (though this was disputed by Martelli, who considered it to be from Java)*, the type specimen, collected by E.H.L. Krause, was illustrated by Martelli (1913) in t. VII; and what is possibly the same taxon is shown in a photograph captioned "*P. tectorius* Sol." as figure 6 in van Steenis's *Flora Malesiana* sample treatment, ser. I, vol. 2, *Pandanus in Malaysian vegetation types* of 1954. Also quite similar is the taxon named *P. intraconicus* St. John from Aldabra Island (see the illustration figure 334 in *Pacif. Sci.* 18 (1974) 96-97). This in turn matches pretty well with a collection from Cocos-Keeling Atoll (with an unpublished specific name) made by H. St. John, no. 26414, in the Bishop Museum, Honolulu. The phalanges of this latter collection match so well with those of *P. platycarpus* that I

* Martelli published his view that *P. platycarpus* was not a native of Zanzibar in the *Atti Soc. Toscana Sci. Nat.* 42: 57-59, 1933. He apparently compared Krause's specimen to material from Java and assumed that the plants seen by Krause were not native (either introduced or spontaneous but presumably ephemeral). This is possible, but since closely related species such as *P. kirkii* are clearly indigenous along the East African coast, the actual occurrence of *P. platycarpus* in Zanzibar does not appear in doubt.

would not hesitate to regard them as of the same species; phalanges of *P. intraconicus* differ in the somewhat more prominent carpel tips; while in *P. christmatensis*, the phalange apex is more rounded, the carpel tips still more prominent, the sides of the phalange are not scarred so much, and the lateral sutures are more obvious. These are nonetheless all quite similar, and it is noteworthy that all occur in a latitudinal belt only some 5° wide but about 60° in longitudinal extent (or a little more if Zanzibar is included), across the middle of the Indian Ocean. Of interest too is the record of "P. tectorius" from Rodriguez Island, illustrated by Martelli (1913) in tab. 2, fig. 6), which although not the same as the species mentioned above, appears approximately in the same drift zone (but about 5° farther south).

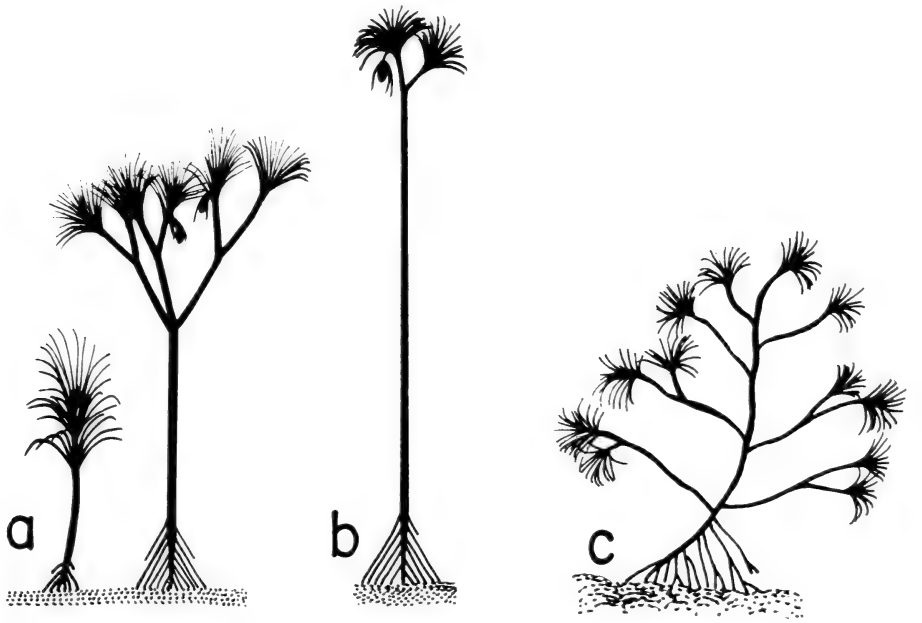

Fig. 7. Habit silhouettes of 3 *Pandanus* species: *a*, *P. elatus*, juvenile and adult; *P. leram*, modified from Gaudichaud's illustration of *Roussinia indica*. *c*, *P. christmatensis*. *a* & *c* from photographs by D.A. Powell.

Differences in Habit (Fig. 7)

Habit and branching pattern in *Pandanus elatus* and *P. christmatensis* differ. In the former the young plant remains unbranched for some considerable time, and may reach a height of as much as 12 or 13 m before branching, depending on the canopy height of the surrounding vegetation. Branching is somewhat sparse, usually a trichotomy, and the branches themselves di- or tri-chotomously branched in due course. The main trunk remains quite erect, and the proproots tend to form a fairly compact inverted cone 1-1.5 m high. In habit, *P. elatus* further reveals its affinities, this pattern of growth being found not only in *P. leram* (see the habit sketch in the original illustration of *Roussinia indica* Gaudich., Bot. Voy. Bonite Pl. 21, f. 1, 1843), but also in other species in subg. *Rykia* (e.g. *P furcatus* Roxb., *P. houllettei* Carr., *P. lais* Kurz, etc.).

In contrast, the habit of *P. christmatensis* is, as in its relatives, more fruticose, the trunks branching at a comparatively early stage, with the branches tending to be more spreading, more irregular, the trunk continuing but not so straight, and the proproots often supporting the leaning or even partly horizontal base of the trunk, themselves often branching and interwoven. The overall appearance is thus very

much like that found in *P. tectorius*, *P. odoratissimus*, *P. kirkii*, and other species of sect. *Pandanus*.

These habit characters, supplemented by the habitat differences, thus permit not only the recognition of the species, but lend furtheir support to the allocation of *P. elatus* to sect. *Roussinia* of subg. *Rykia*, and of *P. christmatensis* to sect. Pandanus of subg. *Pandanus*.

Acknowledgements

Examination of the anatomy of the staminal columns in flowers of *Pandanus elatus* and *P. christmatensis* was undertaken by Dr K.L. Huynh (Institute Botanique, Universit de Neuchatel, Switzerland), who also prepared figures 4b and 6, and suggested several valuable emendations to the text. This cooperation is gratefully acknowledged.

Much of the original stimulus in studying the species reported on here is the result of the letters, photographs, and collections of D.A. Powell and H'ng Kim Chey. Additional photographs by them will be found associated with the herbarium sheets in K, KLU, and PH.

References

Andrews, C.W. (1900). *A Monograph of Christmas Island (Indian Ocean):* Physical Features and Geology by Charles W. Andrews, B.A., B.Sc., F.G.S. With Descriptions of the fauna and flora by numerous contributors. London: Trustees of the British Museum (Natural History).

Martelli, U. (1905). *Pandanus* — nuova specie descritte. *Webbia*, 1: 361-371.

Ridley, H.N. (1891). A day at Christmas Island. *Journal of the Straits Branch, Royal Asiatic Society*, 23: 123-140.

Ridley, H.N. (1906). An Expedition to Christmas Island. *Journal of the Straits Branch, Royal Asiatic Society*, 45: 137-271.

St. John, H. (1965). Revision of the genus *Pandanus* Stickman, Part 18. *Pandanus* of Christmas Island, Indian Ocean, and of the Anamba Islands, Indonesia. *Pacific Science*, 19: 113-119.

Stone, B.C. (1977). On the identity of the Nicobar Breadfruit and a record of *Pandanus leram* fruit in beach drift in Pulau Langkawi, Kedah. *The Malayan Nature Journal*, 30: 93-102.

———. (1983). Revisio Pandanacearum, Part II. *Pandanus* subgenus *Rykia* (DeVr.) Kurz (sections *Gressittia*, *Rykiopsis*, and *Solmsia* excepted). *Federation Museums Journal*, new series, 28: 1-100. (Sect. *Roussinia*, cfr. pp. 91-93).

Warburg, O. (1900). Pandanaceae. In A. Engler (ed.), *Das Pflanzenreich*, Heft 3, IV. 9: 1-99.

The Use of Tifgreen and Tifdwarf Bermuda Grasses in two Singapore Golf Courses

WONG YEW KWAN*

Abstract

The two Bermuda grasses were introduced into Singapore in 1981 for use in the Serapong Golf Course of Sentosa and Tanah Merah Golf Course near the Changi Airport. The rooting medium for both courses is sand and the turf was established by sprig sowing.

Tifgreen was used for the fairways and Tifdwarf for the greens. Cultural practices based on recommendations of the consultants to the two golf courses are described. Observed pests and diseases are mentioned. It was the intention of the two Clubs to keep the introduced turf as pure cultures in the courses. Eventually it was decided that only the greens would be maintained as such as it was found too costly to do extensive weeding in Singapore where labour is relatively expensive and the invasion by local grasses and sedges overwhelming. Some of these are briefly described and/or featured in the various photographs.

All in all it is reckoned that because of the ease of propagation and their fast growth, these Bermuda grasses do constitute an easy source of turf to green up a large area within a short time, although initial weeding is essential for proper establishment if sprig sowing is done.

The two Tif grasses have been developed by the Coastal Plain Experiment Station at Tifton, Georgia, U.S.A. The sprigs for turfing up the Serapong Course at Sentosa Island and the course at Tanah Merah Country Club (TMCC) were introduced into Singapore through the Jagorawi Golf Course near Bogor, Indonesia, in February 1981. Together with these two grasses, Santa Ana (another Bermuda variety developed in California) was also brought in. The intention was to use Santa Ana for the tee stations, Tifgreen for fairways and Tifdwarf for the greens. Indeed the two courses were so planted. For the introduction one plastic bagfull (about 0.03 cu m or 1.0 cu ft) of fresh stolons of each hybrid was brought in and these were planted in the Sentosa Development Corporation nursery for further propagation.

The Bermuda grasses belong to the genus called *Cynodon*. According to Beard (1973) they have all originated from East Africa. Repeated interspecific crosses between *Cynodon dactylon*, *C. transvaalensis*, *Cynodon* × *magennisii*, and *C. incompletus* var. *hirsutus* have given rise to many so-called warm season grasses, including Tifgreen and Tifdwarf. Such varieties are used for turfed areas in the warmer regions of the United States. *C. dactylon*, incidentally, is a common grass in Singapore, found in open fields and wasteland. It is a rather coarse grass with a bluish tinge. This texture contrasts very sharply with Tifgreen and Tifdwarf, which are more like the fine varieties of *Zoysia* and *Digitaria*, commonly used for putting greens in this part of the world. Between Tifgreen and Tifdwarf, the latter tends to have shorter internodal lengths and a much higher shoot density, hence its choice for the putting greens. Some stolons and culms of the two Tif Grasses are shown in Plates 1 and 2. Note that both grasses show inflorescences. Indeed, if allowed to grow at long mowing intervals, the two grasses flower freely in Singapore all the year around. It is, however, not known whether they set seeds or if they are sterile.

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*Mr Wong is a founder member of TMCC and was at various times serving on its management committee & the Sentosa Golf Board.

Plate 1. Tifgreen Bermuda Grass, stolons, culms, and inflorescence.

Plate 2. Tifdwarf Bermuda Grass, stolons, culms, and inflorescence.

Method of Planting and Turf Establishment

The TMCC course is located on land reclaimed from the sea, using both inland soil fills as well as sand pumped from the sea; while the Serapong course is located both on *in-situ* land and partially on reclaimed land using sea sand as fills. The consultant to the two courses specified that the sprigs be planted in sand for all tees, fairways and greens. It was therefore necessary for a layer of sand to be placed over the finished land form if the material used for the formation of the topography were not sand itself. The thickness of this layer varied between 5.0 and 45 cm or more for the fairways and tees while for the greens 45 and 50 cm was specified. The top 5.0 cm or so of sand was mixed with coco-peat before sowing of the sprigs. By volume the mixture is said to be 80% sand and 20% coco-peat. Sowing was effected by making grooves in the sand and burying the sprigs in the grooves. The depth of the grooves was about 5 cm.

Coco-peat comes from the husk (mesocarp) of the coconut. The husk contains fibres embedded in soft tissue and it is shredded commercially to extract the fibres for making chair and car cushion fillings. In the process, the soft tissue drops out as dust. This particulate material is what the horticulturist calls coco-peat. It does not come from the cocoa plant as some people may think. Neither is it a true peat.

The use of coco-peat to form an admixture with sand serves two purposes: one is to increase moisture retention and the other, after the material has decomposed, is to improve the cation-exchange capacity of the rooting medium. There may well be other organic materials available for use, e.g. sewage sludge, but coco-peat has a great advantage in that unlike sludge it is completely weed-free. As sand is equally or relatively weed-free the sprigs in effect are given a wholesome rooting medium. This accounts for the relative ease with which the turf was established although initial weeding still had to be carried out until the turf covered up the ground completely. This took some 6 to 8 weeks or even longer.

As the rooting medium is sandy it is essential that watering of the newly planted sprigs be done at least once a day during a dry spell. Normally this would not be a problem if sprigging is done after the installation of the irrigation system covering both the greens and the fairways. But if for any reason sprigging has to be done before irrigation installation then to irrigate large areas of planted surfaces could pose a problem even assuming the presence of a water source. Apart from the need to join up long hoses to reach a faraway fairway or green, labour and its supervision may also be a problem. In the case of TMCC there was not much of a problem as the course had irrigation installed progressively before sprigging was proceeded with but the Serapong Course had some problem because as an after-thought, the management committee wanted to convert it from what was supposed to have been a links course to one with more turf and trees. This was achieved only after the addition of many sprinkler heads onto an extended irrigation reticulation.

The sandy rooting medium also meant the need for heavier initial manuring. This had to be done in a state of reduced buffering action because the medium was sand. In such a situation "often but little" is indeed the golden rule for the application of fertilizers. Unfortunately there is in the tropics a complete lack of information in this field. No scientific work has yet been done on manuring in relation to the kind of turf used, the texture of the rooting medium, and the prevailing climatic conditions. Nevertheless, fertilization as depicted in the ensuing section did make the grass grow. The consultant also recommended liming in general. This was found to induce wide-spread iron deficiency, symptomised by general chlorosis in extensive patches of turf. This symptom disappeared only recently some three years after liming was stopped.

Manurial Regime

During the establishment stage the greens, fairways and tees were given a compound fertilizer of composition 1:1:1 in terms of N, P_2O_5 and K_20 the rate being pegged against N and the aim was to give about 0.5 kg of N per 100 m^2 of turf area per month. After the turf was established, the rates were increased, understandably because of the increase in mowing frequency. The table below shows the regime of fertilization, followed at least for some time, after the turf was established and the course opened for play.

	Rate Kg/100m^2	Frequency	Fertiliz. Analysis	Amt/mth N	P_2O_5	K_2O
Greens	3	2 × /mth	16-4-8	0.96	0.24	0.48
F/ways	5	1 × 6 wks	12-12-17	0.40	0.40	0.57
	10	1 × 6 wks	31-0-0	2.07	0.00	0.00
Tees	4	1 × 3 wks	16-4-8	0.85	0.21	0.43

It will be noted that the above manurial regime has an overwhelming amount of N. While this encouraged vegetative growth it also led to undesirable thatching. Combined with a low content of P and K the regime produced a soft grass with shallow roots. As a result when TMCC ran into some problem of water supply during dry spells, the whole course turned brown. Fortunately this problem was solved by pumping water from a not-too-far-away sewage treatment plant to supplement water gathered in several ponds in TMCC. This incidentally also shows that sewage water could be used for irrigating turf, although as used for the TMCC course the sewage water is diluted by surface run off finding its way into the ponds. This has been going on since 1982 and up to the time of writing the course is none the worse. Algae do break out faster during wet spells and when watering is not regulated, due to the ready source of these organisms in the irrigation water enriched by the sewage water.

The manurial treatments shown in the table above also shows some contradictions between rate of manuring and the amount of nutrients removed from the turf. In terms of N, for example, nearly one and a half times more of this element is applied to the fairways than to the greens, this difference despite the fact that the greens are mowed everyday while the fairways are mowed once a week. It is not difficult to see that conceivably much more nutrients are removed from the greens than from the fairways because of the more frequent mowing. Granted that Tifdwarf is a slower growing grass compared with Tifgreen, the discrepancy in fertilizer input is still difficult to justify.

Until a more scientific basis is established for manurial prescription any recommendation currently given is mere guess work. The scientific basis can be arrived at through sampling of turf coming from a known surface area, and analysing for its nutrient contents. Doing this over a fairly long period of time in different parts of the course and under different weather conditions we shall then be able to know how much nutrient is removed through mowing. Our fertilization programme should aim at least at replacing the amount removed.

Invasion of the Courses by Local Grasses and Sedges

When the two courses were constructed, it was the intention of both management committtees to keep tees, fairways and greens pure with the introduced grasses only. However, after the courses were open for play and after some rather expensive rounds of weeding, the idea of purity for the fairways was abandoned. Only the greens and the tees were to be kept pure. At the time of writing, however,

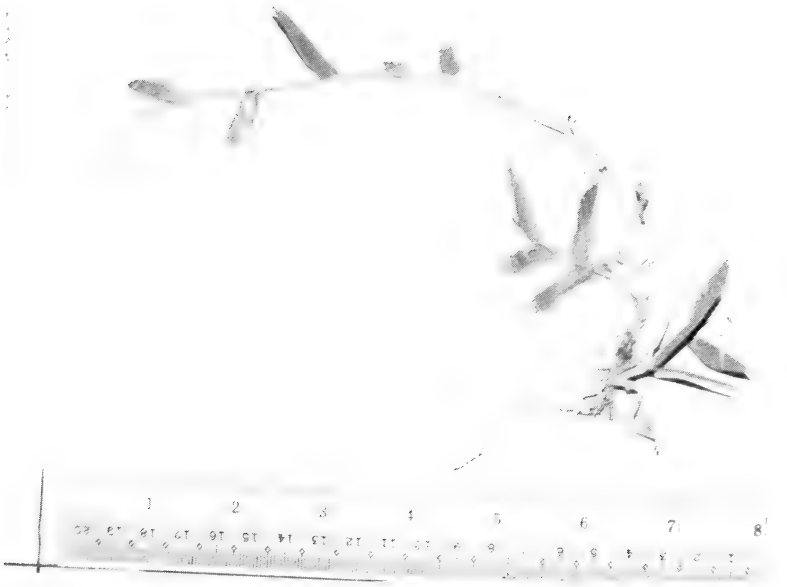

Plate 3. *Brachiara distachya,* one of the early invaders of the Tifgreen in all fairways. See also Plate 8.

Plate 4. *Cyperus kyllingia,* rhizomes and shoots. This soft sedge is another early invader of the Tifgreen. See also Plate 7.

Plate 5. *Cyperus radians*. Multiple shoots from a rosette that has been teased apart. Note the wiry nature of the leaves and inflorescence stalks. See also Plate 6.

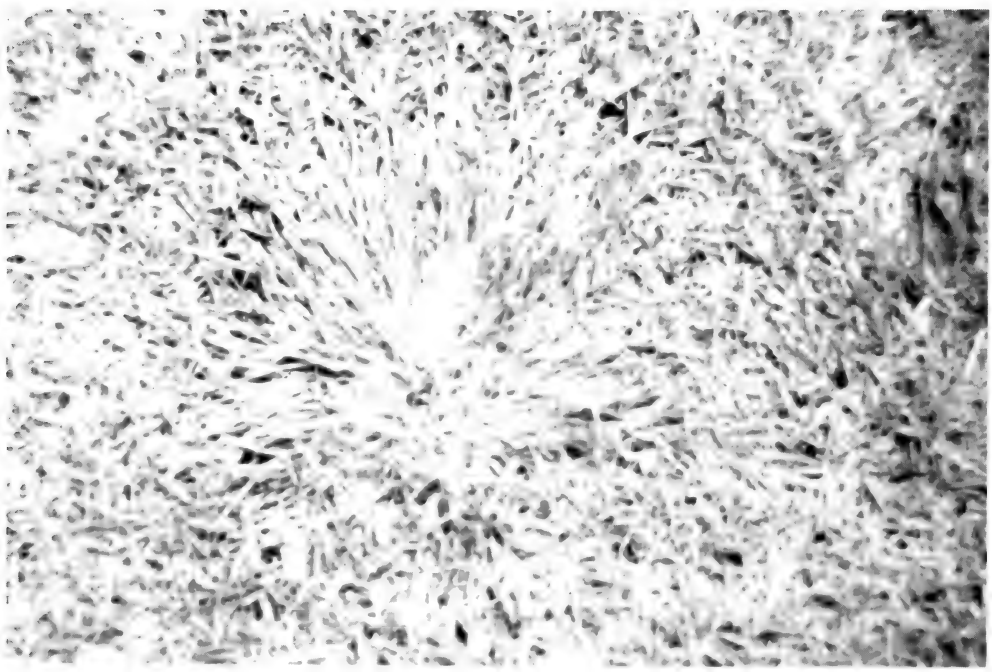

Plate 6. *Cyperus radians*, a single rosette/tuft made up of scores of shoots. Its flattened nature makes it easy for the rosette to escape mowing.

practically all the tee stations in TMCC have been invaded and indeed overwhelmed by local grasses and sedges.

One grass and two sedges spearheaded the invasion of the turf and they have become permanent components of the fairways. They are *Brachiara distachya* (Plate 3) *Cyperus kyllingia* (Plate 4) and *C. radians* (Plate 5). *C. radians* is a tufted sedge with wiry leaves and inflorescence stalks (see Plate 6) whereas *C. kyllingia* is a much softer sedge (see Plate 7). Indeed if mowing can keep this sedge short and prevent it from producing its small round inflorescence, then it can be accepted as a fairly good turf. In fact both courses have extensive patches of this sedge. *Cyperus radians* on the other hand forms individual tufts, usually in the moister parts of the fairways and a large patch of the tufts could present a rather ugly picture because of its coarseness. Mowing would not improve its appearance as the tuft tends to flatten out into a rosette, adpressed to the ground (see Plate 6). The cutting blades of the mowing machine could not touch the wiry strands.

Brachiara distachya is a soft grass with an elliptic leaf blade (see Plates 3 & 8). The untrained eye may mistake it for the ordinary so-called Cow Grass *(Axonopus compressus)* but *B. distachya* is dull green contrasting with the brighter green of *Axonopus compressus,* which also has a glossy surface (cf. Plate 9). Like *Axonopus, Brachiara* creeps horizontally with the culms adpressed to the ground. Leaf blades which have been partially cut by mowing show a necrotic cut edge and this can be seen easily on the course.

Brachiara starts as a small nucleus well concealed by the Tifgreen. By the time it is noticed, the grass would have several rooted culms. This should be the time to have it weeded out by uprooting. But one just could not cope with literally thousands of such proliferating nuclei all over the course. This grass is so successful that it is estimated to cover some 30% of the fairway areas, forming large pure patches to the complete exclusion of any other grass.

Apart from the three plants mentioned above one can also find other so-called weeds invading the Tifgreen both in the fairways and in the roughs. Amongst the common ones are *Axonopus compressus* (Cow Grass), *Digitaria setigera* (Syn. *D. marginata*), *Digitaria didactyla* (Serangoon Grass), *Eleusine indica, Ischaemum* spp., *Panicum* spp. and *Eragrostis* spp. A couple of herbaceous weeds also appear here and there. They are *Borreria setidens,* the clover *Desmodium trifolium, Euphorbia hirta* and *E. thymifolia.* The latter *Euphorbia* caused quite a bit of problem in the Serapong Course in Sentosa because in some fairways and aprons its proliferation was rampant. (Some of these plants are shown in Plates 10 to 14 inclusive.)

So far we have not mentioned anything about control of the weeds or the unwanted plants by using weedicides. During the course of the past few years someone did suggest that but in so far as *Brachiara distachya* and *Cyperus kyllingia* are concerned they are far too numerous and all too pervading to allow chemical control. To spot spray these when they formed small nuclei would be like looking for needles in haystacks and if we start spraying the larger visible patches, then we are going to create a patchwork of dead turf all over the course.

Someone also suggested using pre-emergent weedicides to treat an area before it is turfed. This may well be successful from the start but it is doubtful if we could keep the turf pure subsequently without continual weeding. Moreover, the pre-emergent weedicides are known to be fairly expensive. To treat the whole course before turfing is to incur a big extra cost.

Pests and Diseases

For the fairways little attention is paid to these two aspects of maintenance work but for the greens there is a constant watch-out for outbreaks of pests and or

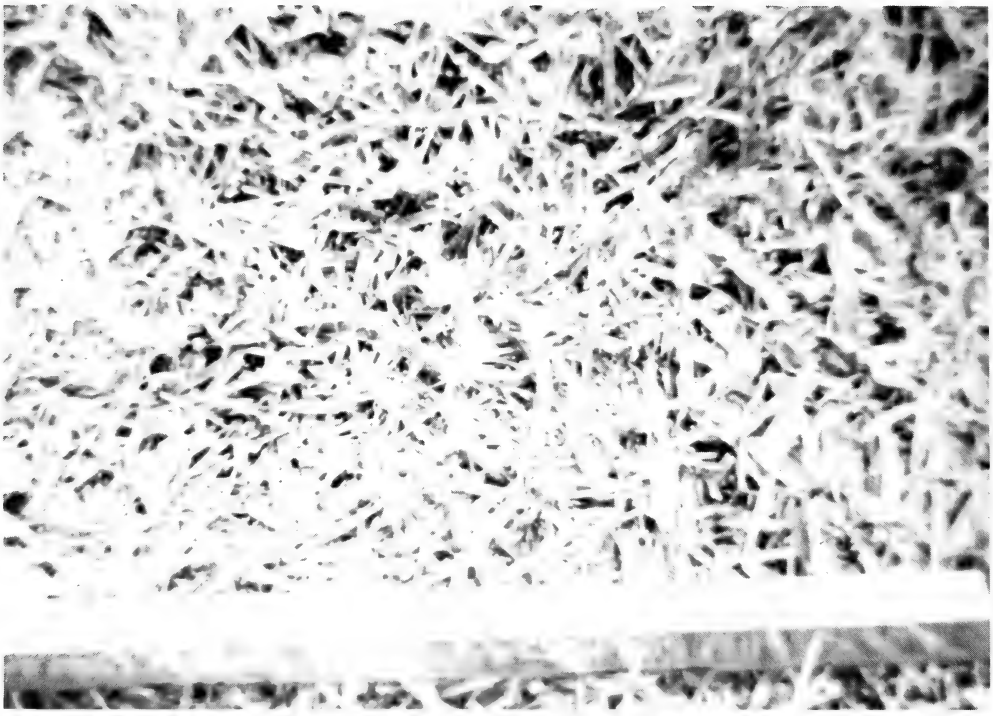

Plate 7. *Cyperus kyllingia* flowering in the rough. Compared with *C. radians* this is a much softer sedge.

Plate 8. *Brachiara distachya* about to finish off the Tifgreen in a patch of turf. *B. distachya* has broad elliptic leaves. Close scrutiny will reveal the fine Tifgreen.

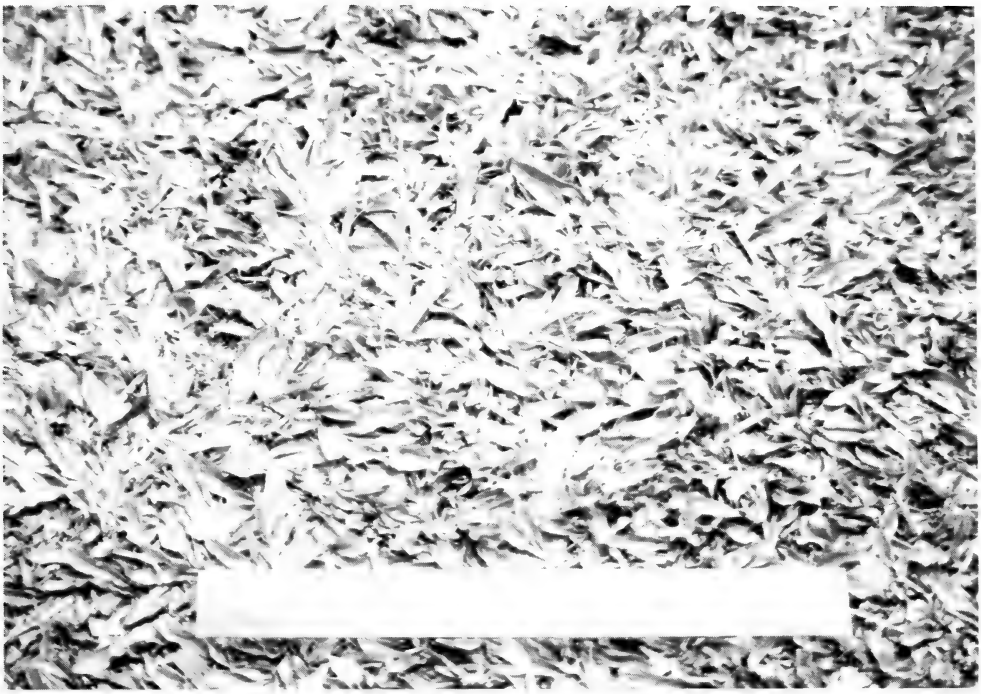

Plate 9. *Axonopus compressus*, the so-called Cow Grass.

Plate 10. A close-up view of stolons and culms of *Digitaria didactyla*.

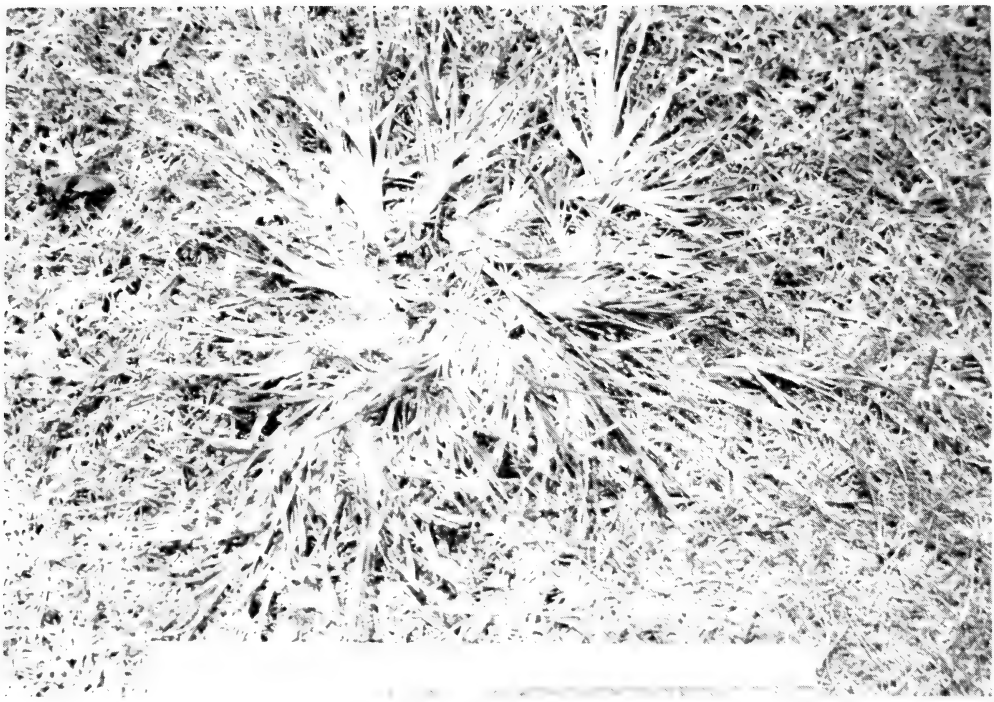

Plate 11. A compact group of the obnoxious weed *Eleusine indica*. Mowing has flattened the culms but could not get rid of them.

Plate 12. *Digitaria marginata*, invading Tifgreen in the rough.

Plate 13. *Euphorbia hirta (left)* and *E. thymifolia (right)*. These are two common herbaceous weeds invading fairways and aprons.

Plate 14. *Borreria setidens*, a herbaceous weed invading Tifgreen in the rough.

diseases. Tifdwarf, however, seems to have encountered relatively few problems in this respect. The only ones seem to be the occasional fungal attack, resulting in dying back patches here and there in the green, or rarely an outbreak of cutworms may send the green keeper rushing for his sprayers. Such events, however, are no more than what other varieties of turf used for the green would experience.

During one of the fungal outbreaks at TMCC some 4 years ago, the Primary Production Department plant pathologist was called in to track down the identity of the fungus or fungi. It was discovered that the malady responsible seemed to be a *Curvularia*.

When there is an outbreak of pests such as cutworms, the caterpillars of one of the Noctuid Moths, drenching the affected green with Sevin, a carbamate, is effective. After the worms are got rid of, a few more weekly rounds of prophylactic spraying will put the green back to normal. In the case of fungal outbreak the common practice is to use the fungicide Benlate. Spraying is done weekly until symptoms disappear. This could be followed by a short period of prophylactic treatment, perhaps at a longer spraying interval, say once in two weeks.

Conclusion

Based on the experience in Singapore it would appear that the two Tif grasses did constitute an easy source of grass to turf up a large expanse of land. They proliferate fast so that a relatively small nursery area is sufficient to propagate the initial amount for planting up an area of fairway or green. Thereafter the planted materials become further sources of the grasses. Indeed it has been found that the growth is in exponential fashion. It is said that an area of planted material will be ready for harvesting in about 8 to 10 weeks, this area providing enough planting material for an area 20 times its original size. This has been found to be true.

It is reckoned that it would be futile to try to keep the fairways pure. This is difficult even if management is prepared to spend money to have manual weeding carried out. Neither would it be practicable to carry out chemical control. The best thing to do is to let plant succession take place, after the Tifgreen has properly established itself, under constant mowing, which in itself is an effective way of keeping out most of the coarse and upright grasses. For the really obnoxious ones, viz. *Cyperus radians* and *Eleusine indica,* which fortunately occur in isolated or distinct units, manual digging continually may be the answer to keep them under control. The resultant turf, such as is seen emerging in Serapong and TMCC, is perfectly acceptable as playing surfaces.

References

Beard, J.B. (1973). *Turf Grass: Science and Culture.* Prentice-Hall, Inc., Englewood Cliffs, N.J. Pg 132 et. seq.

Henderson, M.R. (1954). *Malayan Wild Flowers: Monocotyledons.* Published by the Malayan Nature Society, Kuala Lumpur.

———. (1974). *Malayan Wild Flowers: Dicotyledons.* Published by the Malayan Nature Society, Kuala Lumpur. Reprint.

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