Schismatoglottideae (Araceae) in Malesia II — *Aridarum, Bucephalandra, Phymatarum* and *Piptospatha*

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Abstract

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Contents

Introduction

The Schismatoglottideae is a rather diverse group of rainforest terrestrial, lithophytic or rheophytic herbs centred on Borneo. *Schismatoglottis* Zoll. & Moritzi (Hay and Yuzammi, 2000) is by far the largest genus extending throughout Malesia (except the driest and highest parts) to the tropical Western Pacific, Indochina and the Neotropics. The remaining genera are relatively small to monotypic and, except *Piptospatha* which extends to the Malay Peninsula and Thailand, confined to Borneo. *Schismatoglottis* is predominantly non-rheophytic, but it does include some rheophytic species, most of which are remarkable in that genus for their leaf sheaths which are extremely short but whose wings are extended and connate into a long ligular portion which envelops the subsequent developing leaf. However, not all *Schismatoglottis* species with ligular sheaths are rheophytic, but they are all Bornean. This feature, while appearing in a minority of *Schismatoglottis*, is common to all species of all the remaining genera of Schismatoglottideae which are in turn all obligate or facultative rheophytes.

Schismatoglottis is characterised by, among other features, its constricted spathe which, at first loose and then tight according to phases of female and male anthesis, apparently manages the movement of pollinators (however, no studies of this have been made). In all the other genera of Schismatoglottideae, this feature is lacking, except in monotypic *Phymatarum*. In *Piptospatha*, *Aridarum* and *Bucephalandra*, the spathe is unconstricted. Its limb however, is generally caducous, and the result is that the infructescence is exposed but subtended by a funnel-shaped spathe base, whereas it is enclosed by an urceolate spathe base in *Schismatoglottis*. Dispersal has not been studied in these genera, but it is possible that the rheophytic species, particularly those associated with turbulent water and spray, may be dispersed by water drops hitting the decaying fruits and bouncing the seeds out of the funnel-shaped fruiting spathe. *Phymatarum* is associated with relatively slow-moving water. Some species of

Piptospatha however, have the infructescence completely enclosed by the wholly persistent spathe, which finally disintegrates as the fruits ripen.

The stamens of *Schismatoglottis* are generally truncate, or with extensions of one form or another to the connective, and with the thecae opening through one or two unornamented pores. *Piptospatha* is similar, but the remaining genera, *Aridarum*, *Bucephalandra* and *Phymatarum*, all have truncate stamens with remarkable needle- or horn-like extensions to the staminal thecae from the tips of which the pollen is extruded as a droplet. The ecological significance of this is unclear. *Bucephalandra* is arguably the most specialised of the entire group, having scale-like staminodes between the fertile female and male zones of the spadix. These alter their position during anthesis, at first erect and allowing access to the lower spathe chamber, then spreading and closing the chamber off as the tips come into contact with the inner spathe wall.

Bucephalandra motleyana was the first of the rheophytic Schismatoglottideae to be discovered, named by Schott in 1858 (Schott, 1858). This same species was rediscovered by Beccari, who described a new genus, *Microcasia*, for it — mislead by the original description of *Bucephalandra* which was inaccurate. Beccari (1879) thought this was the smallest of all aroids, though that distinction now goes to the duckweed *Wolffia* (formerly of the Lemnaceae). Nevertheless, of aroids in the traditional sense, it is indeed one of the most minute, sometimes flowering when only a few centimetres tall. The genus *Piptospatha* was described in the same year by N.E. Brown who at Kew intercepted and named many of the new aroids being introduced to stove house horticulture in the later part of the 19th Century. Rather few of the rheophytic Schismatoglottideae are particularly ornamental (and still fewer easy to cultivate), but some *Piptospatha* species are very attractive in flower, especially *P. insignis* (still only known from a single cultivated, now long-dead plant) and the much more common pink-spathed *P. elongata*. Four new genera have been added during the 20th Century.

The tribe has been, and remains, beset with very narrow generic limits. *Gamogyne* N.E. Br. and *Rhynchopyle* Engl. were differentiated from *Piptospatha* by minor characters of the ovary and the latter reduced to a synonym of *Piptospatha* by Engler. *Gamogyne* was maintained by Engler (1912) on the basis of allegedly connate pistils, but this proves to be incorrect: they are merely tightly appressed. *Aridarum* (something of a misnomer deriving from Ridley's (1913) supposition that the type species was xerophytic) differs from *Bucephalandra* in the absence of active scale-like staminodes between the fertile zones, and in having more or less deeply excavated tops to the stamens. *Hottarum* (Bogner and Nicolson in Bogner, 1978) was distinguished from the rest of the tribe by unconstricted spathes, un-horned anthers and basal placentation and therefore from *Piptospatha* by basal placentation alone. We have found that basal placentation occurs in species of *Schismatoglottis* and *Piptospatha s. str.*, and that intermediate states occur between basal and the supposed parietal placentation of those genera. We have therefore sunk *Hottarum* into *Piptospatha* (with one species going into *Schismatoglottis*). Monotypic *Heteroaridarum* (Hotta, 1976) was distinguished from *Aridarum* by the occurrence of an abortive anther between the two fertile anthers of each male flower, and by having basal and (abortive) apical placentation (v. basal with a naked intrusive apical placenta in *Aridarum*). New collections have been made from the type locality of *Heteroaridarum borneense*, and it appears probable that *Heteroaridarum* is based on an abnormal plant and that the type and only species falls into *Aridarum* (see further discussion under *Aridarum borneense*).

With *Hottarum* and *Heteroaridarum* removed, generic limits are still narrow, and we suspect that phylogenetic analysis of the tribe may show that *Schismatoglottis* is paraphyletic, with the other genera derived from a clade including the *Schismatoglottis multiflora* group (see Hay and Yuzammi, 2000). However, we have not anticipated this by reducing all the genera to *Schismatoglottis*, but have made such changes as are

unavoidable and which minimise new nomenclature until such time as a phylogenetic analysis is carried out. Although not yet studied exhaustively for *Schismatoglottis*, it appears that the other genera of Schismatoglottideae collectively and exclusively share seeds with very elongate, curved micropylar appendages. All of those except *Piptospatha* collectively and exclusively share horned staminal thecae. Of those three, *Aridarum*, *Bucephalandra* and *Phymatarum*, the first has unique excavated anthers (except *A. incavatum*), *Bucephalandra* has unique staminodes (mentioned above) and *Phymatarum* has an apparently anomalous constricted spathe like that of *Schismatoglottis*. Otherwise the non-*Schismatoglottis* Schismatoglottideae are characterised by unconstricted spathes, though this character also occurs (but in a somewhat different configuration) in one species of *Schismatoglottis*, *S. barbata* (see Hay and Yuzammi, 2000). For a glossary of terms used see Hay and Yuzammi (2000).

Schismatoglottideae

Schismatoglottideae Nakai, Ord. Fam. Trib. Nov. (1943) 218; Hotta, Acta Phytotax. Geobot. 33 (1982) 127; Mayo et al., Genera of Araceae (1997) 180. — *Schismatoglottidinae* Schott, Prodr. Syst. Aroid. (1860) 318; Engl. in A. & C. DC., Monogr. Phanerogam. 2 (1879) 69 & Pflanzenr. 55 (IV.23Da) (1912) 24. — Type: *Schismatoglottis* Zoll. & Moritzi.

Terrestrial, lithophytic or rheophytic, diminutive to robust (rarely gigantic) evergreen herbs with pleionanthic or hapaxanthic shoots. *Stems* erect to creeping, epigeal to hypogeal, elongate to condensed. *Leaves* often variegated, sometimes variously pubescent; sheaths fully attached to petiole or attached only at base and extended into a ligular portion; blades simple, cordato-sagittate to sublinear, with striate venation, frequently with a tubular mucro. *Inflorescences* solitary or arranged in simple to compound synflorescences. *Spathe* constricted or not, the limb almost always deciduous, commonly caducous. *Spadix* sessile to stipitate, sometimes partly adnate to spathe; basal zone of spadix a row or rows of staminodes, or this zone absent; female zone composed of naked pistils irregularly interspersed or not with interpistillar staminodes; ovary unilocular with basal (rarely also apical) to parietal placentation; ovules several to many, orthotropous to anatropous; sterile interstice present, absent or ill-defined, if present usually composed of staminodes, sometimes of abortive anthers and/or pistils, sometimes partly to mostly naked; male zone of crowded stamens not obviously arranged into male flowers (rarely with the stamens in regular pairs or in longitudinal rows), sometimes with the filaments partly united; anthers truncate or occasionally with the connective elevated; thecae opening through apical pores or tips of thecae extended into needle- or horn-like projections; pollen powdery or extruded in strings or in droplets; appendix present or absent, when present composed of usually columnar, sometimes partly united staminodes. *Fruiting spathe* urceolate and peduncle usually then declinate, to obconic and peduncle then usually erect (mainly in rheophytes); fruit a small more or less colourless to green to yellowish berry; seeds minute, with copious endosperm, usually longitudinally ribbed, often with the outer integument extended into a hooked micropylar appendage; embryo elongate, undifferentiated.

Distribution — Indochina to Oceania, centred on Borneo; outlying species of *Schismatoglottis* in the Neotropics.

Habitat — Mainly in humid forests in 'everwet' tropical areas at low elevation, extending to lower limits of the upper montane zone.

Notes — The tribe is characterised by petiolate leaves with striate venation, naked unisexual flowers, convolute persistent lower spathe, spathe limb deciduous, ovary unilocular, free stamens or only the filaments connate, connective not conspicuously thickened, and thecae opening through apical pores.

Key to genera of Schismatoglottideae

1a. Wings of leaf sheath fully or almost completely attached to the petiole ..... **Schismatoglottis**

1b. Wings of leaf sheath extended into a ligular portion 2

2a. Spathe not constricted; plants glabrous 3

2b. Spathe constricted or if not constricted then plant very coarsely hairy (*Schismatoglottis barbata*) 5

3a. Thecae of anther without horn- or needle-like projections ..... **Piptospatha**

3b. Thecae of anther each with a horn- or needle-like projection 4

4a. Sterile interstice of spadix with flattened scale-like staminodes; anthers not excavated ..... **Bucephalandra**

4b. Sterile interstice absent or with truncate staminodes; anthers nearly always with the top excavated (not in *A. incavatum*) ..... **Aridarum**

5a. Thecae of anther without horn- or needle-like projections ..... **Schismatoglottis**

5b. Thecae of anther each with horn- or needle-like projections ..... **Phymatarum**

Aridarum Ridl.

Aridarum Ridl., J. Bot. 51 (1913) 201; Bogner, Aroideana 2 (1979) 111; Mayo et al., Genera of Araceae (1997) 192, Plate 54. — Type: *Aridarum montanum* Ridl.

Heteroaridarum M. Hotta, Acta Phytotax. Geobot. 27 (1976) 63; Mayo et al., Genera of Araceae (1997) 194, pl. 55. — Type: *Heteroaridarum borneense* M. Hotta [= *Aridarum borneense* (M. Hotta) Bogner & A. Hay].

Small to medium-sized, evergreen herbs. *Stem* decumbent, erect distal part sometimes rather long. *Leaves* several, spiral or rarely distichous (*A. borneense*); petiole sheathing only at base, with long, marcescent ligule; blade coriaceous, linear to elliptic, apex with tubular mucro; primary lateral veins pinnate, weakly or not differentiated, running into distinct marginal vein, higher order venation parallel-pinnate. *Inflorescence* solitary, sometimes more or less nodding; peduncle subequal to or longer than petiole, sometimes more or less deflexed at apex. *Spathe* stoutly ellipsoid, not constricted, convolute and gaping at apex only or broadly boat-shaped and widely gaping to base, lower part persistent, green, upper part caducous, white, cuspidate to acuminate at apex. *Spadix* sessile, cylindric, normally with a few sterile flowers at extreme base, female zone cylindric; pistil naked, shallow, laterally compressed, subhexagonal to subglobose; ovary 1-locular, ovules many, orthotropous to hemiorthotropous, funicle distinct, erect, placenta basal, stigma sessile, slightly concave centrally, as broad as ovary, usually more or less contiguous with neighbouring stigmas; sterile interstice short to absent, composed of sterile stamens; male zone subcylindric to ellipsoid; male flower 2-androus or not recognisable (unistaminate); filaments distinct to very short, free to connate, connective slightly to deeply excavated (rarely not excavated — *A. incavatum*), thecae either opposite or paired on one side of the anther and then situated inside or outside connective cavity, apically narrowed into long or short horn or needle, dehiscing by single apical pores; pollen inaperturate, ellipsoid-oblong, small (mean 23 mm, range 16–31 mm (Grayum, 1992: 21)), exine psilate. *Infructescence* a cluster of berries subtended by the obconic persistent lower spathe; berries globose or ellipsoid to cylindric, stigma remnant persistent; seeds ellipsoid, elongate, with long curved transparent interlinked micropylar appendages; testa longitudinally costate, embryo elongate, endosperm copious.

Distribution — Nine species, all endemic to Borneo.

Habitat — All species are rheophytic, sometimes facultatively lithophytic or terrestrial in forest, usually in deep shade, from the lowlands to lower montane forests.

Notes — *Aridarum* is distinguished from other members of the Schismatoglottideae that have horned anthers by the unconstricted spathe (cf. *Phymatarum*) and the absence of an interstice of flattened staminodes which move during anthesis to allow and then block access to the lower spathe chamber (cf. *Bucephalandra*).

Hotta (1965) recognised two sections in the genus, defined by the relative positions of the thecae on the anther. The distinction still holds and so we recognise the two species groups here, though it is not clear if these sections represent natural subdivisions of the genus. In Sect. *Caulescentia*, where the thecae are placed close together on one side of the anther, there are two contrasting configurations, one in which the stamens are in longitudinally aligned pairs and the thecae are on the sides of the anther facing one another in the pair, and the other in which the stamens are not paired and the thecae are together on the proximal (with respect to the spadix axis) side of the anther. Okada and Mori (2000) suggest that *Aridarum incavatum* may represent a third section because its anthers are not excavated. However, on the basis of the positions of the thecae on the anther, it fits comfortably within Sect. *Aridarum*. We have placed it in that section for the present as it is not clear to us that the unexcavated anther, which may be no more than a consequence of the very robust thecal horns whose bases cover almost the whole top of the anther, warrants differentiation of this species at sectional level.

Key to sections and species

1a. Leaves strongly coriaceous, primary veins not differentiated from secondary venation; secondary venation marked on adaxial side of blade by dense, slightly raised punctae; Sarawak, G. Gaharu ..... **9. Aridarum sp. A**

1b. Not this combination of characters 2

2a. Thecae on each end of the anther (seen from above) **Sect. Aridarum** 3

2b. Thecae together on one side of the anther (seen from above) **Sect. Caulescentia** 6

3a. Leaf blades almost linear; horns of anther thecae long and thin; Sarawak, Santubong ..... **2. A. montanum**

3b. Leaf blades very narrowly elliptic to elliptic; horns of anther thecae short and stubby 4

4a. Leaves distichous; Sarawak, vicinity of Matang ..... **1. A. borneense**

4b. Leaves spiral 5

5a. Spadix with an appendix of staminodes; anthers excavated; horns of the thecae small, on each end of the anther; Sarawak and W Kalimantan ..... **3. A. nicolsonii**

5b. Spadix fertile to apex (possibly except a few apical sterile stamens); anthers not excavated; horns of thecae short but robust, their bases occupying the whole upper surface of the anther; W Kalimantan ..... **4. A. incavatum**

6a. Stamens arranged in pairs; thecae on the inner face of each member of the stamen pair 7

6b. Stamens single (but crowded); thecae on the proximal (with respect to the spadix axis) side of the anther 8

7a. Horns of thecae shorter than width of stamen; Sarawak and Brunei ..... **6. A. caulescens**

7b. Horns of thecae longer than width of stamen; Sarawak ..... **7. A. purseglovei**

8a. Stamens and staminodes coarsely verruculate; appendix well-differentiated; spathe beaked for more than half its length; W Kalimantan, Bidang Menabei ..... **8. A. rostratum**

8b. Stamens and staminodes not verruculate; appendix reduced to a few terminal sterile stamens; spathe not long-beaked; Sarawak and W & C Kalimantan ..... **5. A. burttii**

Sect. *Aridarum*

Aridarum Sect. *Aridarum* M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 25.

1. Aridarum borneense *(M. Hotta) Bogner & A. Hay*, **comb. nov.**

Heteroaridarum borneense M. Hotta, Acta Phytotax. Geobot. 27 (1976) 63, fig. 2; Mayo et al., Genera of Araceae (1997) 194, pl. 55. — Type: Sarawak, Sg. Bungen, c. 20 mi W of Kuching, 27 Apr 1960, *L.B. & E.C. Abbe, B.E. Smythies & Asah 9845* (SAR, holo).

Aridarum annae Bogner, Aroideana 4 (1981) 57, fig. 1–7; Mayo et al., Genera of Araceae (1997) 358, pl. 118, D. — Type: Malaysia, Sarawak, 1st Divn, Sg. Cina ('China'), 11 Sep 1978, *J. Bogner 1400* (M, holo; iso K).

Rheophytic herb 30–60 cm tall. *Stem* condensed, c. 4–10 cm long, c. 2–3 cm diam. *Leaves* c. 5 together, distichous, held in a more or less horizontal fan; petiole (4–)6–40 cm long, 0.2–1 cm diam., sheathing at the extreme base, the wings extended into a very narrowly triangular ligular portion 6–20 cm long which dries reddish brown; blade narrowly elliptic to oblong elliptic, 9–32 cm long × 2.5–11 cm wide, coriaceous, mid- to dark green adaxally, paler abaxially, the base cuneate, the apex acute to broadly acute and apiculate for 0.5–1.4 cm; midrib abaxially prominent, with 4–9 primary lateral veins on each side diverging at c. 45° and running to a marginal vein; secondary venation adaxially obscure, abaxially faint; tertiary venation forming an inconspicuous tessellate reticulum. *Inflorescence* solitary, usually nodding; peduncle subequalling the petioles. *Spathe* 6–8.5 cm long, broadly ovate, apiculate for c. 1 cm, not constricted, the lower c. ⅓ green, convolute and persistent, the upper part white, gaping and then caducous. *Spadix* subcylindric, blunt, 4–6 cm long, 0.8–1 cm diam.; female zone c. 2 cm long, obliquely adnate to the spathe at the base; pistils crowded; ovaries globular to slightly ellipsoid, 1–1.2 mm diam., with basal and apical placentas, the basal placenta bearing numerous orthotropous ovules, the apical placenta naked or with abortive ovules; stigma sessile, discoid, almost as wide as the ovary, centrally impressed, minutely papillate; interpistillar staminodes absent from among the pistils, confined to one or two irregular whorls at the base of the female zone, stipitate, slightly capitate, about as high as the pistils; sterile interstice a few to several whorls of sterile stamens with centrally impressed tops c. 0.4 mm diam.; male zone 3.5–4 cm long, fertile to the apex, pale yellow; stamens crowded, arranged at least in the lower ⅔ of the zone in precise pairs with connate filaments, rectangular from above, 0.8–1 mm across, deeply centrally impressed; thecae on distal and proximal (with respect to spadix axis) sides of the stamen, each with a minute more or less onion-shaped projection (horn) from which the pollen is extruded. *Fruiting spathe* obconic, c. 2 cm diam.

Distribution — *Malesia:* Borneo (Sarawak; known only from the vicinity of Matang).

Habitat — Rheophytic on sandstone boulders and wet cliffs in deep shade, c. 200 m alt.

Notes — This species is unique in the Schismatoglottideae in having distichous leaves held in more or less horizontal fans. A striking convergent example in Araceae is *Homalomena geniculata* M. Hotta, also from Sarawak.

Boyce's collection (*774*) and *Bogner 2193* are from the exact type locality of *Heteroaridarum borneense*. These specimens agree almost exactly in gross morphology with the type of *H. borneense*, but lack the third rudimentary anther found in the centre of the male flower of that specimen. They also lack the abortive ovules of the apical placenta, but the apical placenta itself is present. They agree exactly in both gross morphology and these details of floral anatomy with *Aridarum annae*. Following a suggestion by Peter Boyce, we have come to the conclusion that the type of *H. borneense* is probably a teratogenic form and that *H. borneense* and *A. annae* are conspecific.

Other specimens examined: BORNEO: SARAWAK: 1st Divn, just outside Kubah NP, above intake dam on Sg. Bungen, *Bogner 2193* (K, M); 1st Divn, just outside Kubah NP, above intake dam on Sg. Bungen, *Boyce 774* (K); 1st Divn, Matang, Sg. Cina, *Burtt & Woods 2501* (E, SAR).

2. Aridarum montanum Ridl.

Aridarum montanum Ridl., J. Bot. 51 (1913) 201, pl. 527. — Type: Malaysia, Sarawak, Santubong, Oct 1909, *C.J. Brooks 1035* (BM, holo — photo K).

Herb c. 15 cm tall. *Stem* condensed, c. 1 cm long, 0.3–0.4 cm diam. *Leaves* numerous, c. 12 together; petiole 2–3 cm long, c. 1 mm diam., sheathing at the very base, the wings extended into a narrowly triangular ligular portion 2.5–3 cm long, drying red-brown; blade linear-lanceolate, coriaceous, 6–10 cm long × 3.5–4.5 mm wide, the base very narrowly cuneate, the apex very narrowly acute and apiculate for 0.5–1 mm; midrib abaxially very prominent, adaxially more or less flush with the lamina; primary lateral veins not differentiated; secondary venation more or less obscure, running into a relatively thick marginal vein; tertiary venation obscure. *Inflorescence* solitary; peduncle much exceeding the petioles, 9–10 cm long, c. 0.8 mm diam. *Spathe* narrowly ovate, apically acute, unconstricted, 2 cm long, colour and persistence unknown. *Spadix* 1.4–1.5 cm long, c. 0.3 cm diam., subcylindric, distally tapering to an acute apex; female zone 2–3 mm long, about three irregular whorls of subglobose-oblong pistils c. 0.5 mm diam.; stigma sessile, button-like, narrower than the pistils, c. 0.4 mm diam., papillate, centrally impressed; interpistillar staminodes few at the base of the female zone, shortly stipitate, spindle-shaped, narrower and shorter than the pistils (interpistillar staminodes fide Ridley (loc. cit.); absent from the holotype in our observation); sterile interstice absent; male zone 1.2 cm long, c. 2.5 mm diam., fertile to the acute apex; stamens crowded, arranged in pairs, more or less ellipsoid and the pairs rhombohexagonal from above, longitudinally aligned (with respect to spadix axis), c. 1.2–1.5 mm × 0.3–0.4 mm, deeply excavated; thecae on the distal and proximal (with respect to spadix axis) sides of the anther, with long straight very slender horns c. 0.7 mm long, folded in horizontally across the top of and more or less meeting in the middle of the anther. *Fruit* unknown.

Distribution — *Malesia:* Borneo (endemic to Sarawak); known only from the type.

Habitat — Unknown; probably rheophytic. Ridley (loc. cit.) surmised from the slender coriaceous leaves that this plant was xerophytic, hence the generic name which is quite inapt with regard to the other species and probably also to this one.

Notes — *Aridarum montanum* is highly distinctive with its sublinear leaves (in which it recalls some forms of *A. caulescens*) and in the paired stamens with opposite thecae and long, appressed setose horns. The type locality, Santubong, is quite well-collected and it is surprising that this species has not yet been refound. It is perhaps very rare.

3. Aridarum nicolsonii Bogner

Aridarum nicolsonii Bogner, Aroideana 2 (1979) 111, fig. 1–5; Mayo et al., Genera of Araceae (1997) 193, pl. 54 A–H. — Type: Malaysia, Sarawak, Bako National Park, lower Sg. Delima, 8 Aug 1961, *D.H. Nicolson 1335* (US, holo — photo K; iso L, SAR).

Herb 25–40 cm tall. *Stem* condensed, erect, c. 1–4 cm long, 1–1.3 cm diam. *Leaves* several together; petiole 5–14 cm long, 2–4 mm diam., sheathing only at the extreme base, the wings extended into a very narrowly triangular ligular portion 5.5–6.5 cm long; blade coriaceous, dark green adaxially, paler abaxially, narrowly elliptic to broadly oblanceolate, 10–21 cm long × 2–6 cm wide, the base cuneate, the apex acute, acuminate for c. 2 cm and apiculate for 0.5–1 mm; midrib abaxially prominent, adaxially somewhat impressed, with c. 3 very weak (hardly bigger than secondary veins) primary lateral veins on each side, diverging at c. 30–45°; secondary

venation very faint; tertiary venation obscure. *Inflorescence* solitary; peduncle 5–24 cm long, subequalling to exceeding the petioles. *Spathe* more or less broadly ovate, not constricted, 4.5–6.5 cm long, green, obconic and persistent in the lower c. 1.5 cm, the remainder gaping, white, caducous. *Spadix* subcylindric 3–3.5 cm long, 0.5–0.6 cm diam.; female zone 0.8–1.2 cm long, adnate to the spathe on the dorsal side; pistils crowded; ovary globose, c. 1 mm diam., with basal placentation and a naked intrusive apical placenta; stigma sessile, discoid, centrally impressed, barely papillate, as wide as the ovary; interpistillar staminodes absent from among the pistils, a few at the base of the female zone along the spathe/spadix adnation, slightly clavate, shortly stipitate, somewhat shorter than the pistils; sterile interstice 0.2–0.4 cm long, a few to several irregular whorls of truncate centrally impressed more or less circular (from above) staminodes with their filaments connate in groups of 2–4; male zone cylindric 1.2–1.5 cm long; stamens crowded, arranged in precise longitudinally aligned pairs, rectangular, c. 0.8–1 mm across; connective deeply excavated, with the cavity not septate; thecae opposite on the distal and proximal (with respect to the spadix axis) sides of the anther; horns very short, suberect; appendix very shortly cylindric, apically blunt, 0.2–0.7 cm long; staminodes of appendix irregularly polygonal to more or less circular from above, centrally impressed, c. 0.5–0.8 mm diam. *Fruiting spathe* obconic, c. 1.8 cm long and wide at mouth; berries clustered in a globular to slightly elongate group c. 0.8 cm wide and to 1.2 cm long; berries ellipsoid to cylindric, c. 2 mm diam.; seed subcylindric, c. 2 mm long, 0.5 mm diam., slightly ribbed, with an elongate curved translucent micropylar appendage.

Distribution — *Malesia:* Borneo (Sarawak and West Kalimantan).

Habitat — Lithophytic in forest and rheophytic on stream rocks in deep shade, 5–90 m alt.

Notes — *Aridarum nicolsonii* is distinguished from other members of Sect. *Aridarum* by the combination of the short horns, spiral leaves and the spadix with an appendix.

Other specimens examined: BORNEO: SARAWAK: Bako NP, Telok Asam, *Bogner 1440* (K, M, US); G. Santubong, Sg. Tambak, *Bogner 1421* (K, M, US) & *1484* (K, M, SAR, US); G. Santubong, Sg. Binyok, *Bogner 1489* (K, M, SAR, US); Bako NP, Sg. Nipah path, *Carrick & Enoch JC/443* (SAR, SING); G. Santubong, about 16 mi N of Kuching, *Fosberg 43814* (US); Santubong, *Hewitt 6* (SING); G. Lingga, *Hewitt 36* (K); Bako NP, nr Telok Asam, *Nicolson 1312* (SAR, US); Bako NP, Telok Tajor, *Purseglove P4947* (L, SING). KALIMANTAN: W Kalimantan, Serawei, nr Djotta, *Winkler 327* (HBG, L).

4. Aridarum incavatum H. Okada & Y. Mori

Aridarum incavatum H. Okada & Y. Mori, Acta Phytotax. Geobot. 51 (2000) 1, figs. 1 & 4A. — Type: Indonesia, West Kalimantan, Singkawang, Sanggau Ledo, Dawar Vill., Sg. Pisak, 15 Dec 1991, *M. Kato et al. 30486* (TI, holo; iso BO — n.v.).

Herb 10–20 cm tall. *Stem* condensed, erect, c. 1 cm long, 4–5 mm diam. *Leaves* 4–6 together, crowded; petiole 4–9 cm long, c. 1 mm diam., sheathing only at the extreme base, the wings extended into a soon-drying and deciduous narrowly triangular ligular portion 1.5–2 cm long; blade coriaceous, shining green, lanceolate-elliptic, 5–8 cm long × 1–1.5 cm wide, the base cuneate, the apex acuminate and apiculate for c. 3–4 mm; midrib very strong with (6–)8–10 adaxially inconspicuous primary lateral veins on each side, these weakly differentiated from the secondary venation and diverging at c. 30°; secondary venation inconspicuous; tertiary venation obscure. *Inflorescence* solitary, when more than one in series then interspersed with foliage leaves; peduncle about equalling the petioles, 6–9 cm long, 1–1.5 mm diam. *Spathe* white, 2.5–4 cm long, c. 1 cm wide, very narrowly ovoid, apically acuminate and beaked for 3–4 mm, deciduous in the upper ⅔–¾, the lower c. 1 cm persistent and obconic. *Spadix* subcylindric, slightly spindle-shaped, sessile, 1–1.5 cm long, 2.5–3 mm diam.; female zone c. 5 mm long, c. 3 mm diam.; ovaries shortly cylindric, c. 1 mm diam.; stigma sessile, discoid, 0.7 mm diam.; interpistillar staminodes absent; sterile interstice

conspicuous, c. 4 mm long, basally isodiametric with top of female zone, faintly tapering distally; staminodes of interstice irregularly broadly oval from above, c. 1 mm diam., slightly raised apically; male zone c. 7 mm long, more or less fertile to apex, basally slightly wider than the top of the sterile interstice, apically tapering and obtuse; stamens crowded and longitudinally aligned (with respect to spadix axis), narrowly ellipsoid-rectangular from above, c. 0.8 mm across, the connective not excavated; thecae situated on the proximal and distal (with respect to the spadix axis) sides of the anther, each with a short, robust, slightly to strongly in-curved horn 0.2 mm long. *Fruiting spathe* obconic, c. 1 cm long, 1.3 cm diam.; berry and seed not observed.

Distribution — *Malesia:* endemic to Borneo (West Kalimantan); known only from the type.

Habitat — On rocks along a rapid stream, under a waterfall, 350 m alt.

Notes — The arrangement of the thecae on each stamen, positioned on opposite sides of the anther, allies this species with sect. *Aridarum*, but the un-excavated anthers with very robust horns are unique in the genus. The illustration accompanying the protologue shows the horns of the thecae strongly in-curved. However in one inflorescence in the type, the horns are nearly straight. Possibly the position changes according to stage of maturity.

Sect. *Caulescentia*

Aridarum Sect. *Caulescentia* M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 25. — Type: *Aridarum purseglovei* (Furtado) M. Hotta.

5. Aridarum burttii Bogner & Nicolson

Aridarum burttii (*'burtii'*) Bogner & Nicolson, Aroideana 2 (1979) 116, fig. 7–10; Bogner & Nicolson, Willdenowia 21 (1991) 42, fig. 1; Mayo et al., Genera of Araceae (1997) 193, pl. 54, J–K. — Type: Malaysia, Sarawak, Hose Mountains, 1964, *B.L. Burtt & A. Martin 5116* (US, holo; iso E).

Small herb 20–30 cm tall. *Stem* condensed, suberect, to c. 4 cm long, 1.5 cm diam. *Leaves* several together; petiole 4–17 cm long, 1.5–3 mm diam., sheathing at the extreme base, the wings extended into a very narrowly triangular ligular portion to 6 cm long; blade coriaceous, very narrowly elliptic to elliptic, 6–12 cm long × 1.2–4 cm wide, adaxially glossy dark green, paler abaxially, the base cuneate, the apex acute, shortly acuminate and apiculate for 0.5–0.8 mm; midrib abaxially and adaxially prominent with 3–4 abaxially and adaxially prominent primary lateral veins on each side, diverging at c. 30°; secondary and tertiary venation more or less obscure. *Inflorescence* solitary; peduncle usually much exceeding the petioles, 10–20 cm long; spathe broadly ovate, not constricted, c. 4–5 cm long, green and persistent at the extreme base, the rest white, gaping and caducous after anthesis, apiculate for up to 0.8 cm. *Spadix* subcylindric, c. 3 cm long, c. 0.6 cm diam.; female zone c. 1 cm long; pistils subglobose, c. 1 mm diam.; stigma subsessile, discoid, papillose, about as wide as the ovary; interpistillar staminodes absent; sterile interstice composed of an irregular whorl of sterile anthers; male zone c. 2 cm long, terminating in a few sterile or vestigial stamens; stamens more or less round, large, c. 3 mm diam., not arranged into male flowers, centrally impressed with irregularly flared margins, the thecae displaced to the proximal (with respect to the spadix axis) side with distal-pointing (with respect to the spadix axis) horns. *Fruiting spathe* broadly conic, c. 1 cm diam., subtending a more or less hemispheric cluster of berries; berries globular 3–4 mm diam., crowned with old stigma remnants, many-seeded; seed c. 2 mm long, 0.6–0.7 mm diam., narrowly ellipsoid, dark brown, slightly longitudinally ribbed, with a long curved translucent micropylar appendage 1.2–1.5 mm long, the appendages intertwined in the upper part of the berry.

Distribution — *Malesia:* Borneo (Sarawak, West and Central Kalimantan).

Habitat — Rheophytic on rocks in streams and by waterfalls, occasionally terrestrial in forest, c. 900 m alt. (altitudinal data lacking for most collections).

Notes — This species is distinctive in its large stamens with the truncate filament expanded into a more or less frilly-edged circle, seen from above, and the thecae displaced on each stamen towards the base of the spadix and with upturned horns. The leaves typically dry rather pale green.

Other specimens examined: BORNEO: SARAWAK: Hose Mts, Mujong, Ulu Amau, Bukit Lumut, *Ashton S21256* (K, L, SING); Cult. Bot. Gart. München ex RBG Edinburgh, plant from type collection, *Bogner s.n.* (M, US, photo K + K spirit); Lubok Antu Distr., Ulu Sg. Engkari, nr Sg. Kaup, *Chai S34072* (K, L); Kapit, Batang Balleh, Sg. Mengiong, Sg. Entulu, Sg. Sebatu, *Lee S54599* (K); Kapit, Melinau, Sg. Sampurau, Bukit Sampadai, *Paie S25803* (K). KALIMANTAN: W Kalimantan, Headwaters of Sg. Kahayan, 5 km NE of Haruru Vill., *Burley et al. 441B* (L, SING); Central Kalimantan, Project Barito Ulu Base Camp, *Ridsdale PBU267* (L).

6. Aridarum caulescens M. Hotta

Aridarum caulescens M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 25, fig. 3, A–F; Mayo et al., Genera of Araceae (1997) 193, pl. 54 Q–U. — Type: Malaysia, Sarawak, Bintulu Distr., eastern ridge of Bukit Kana, 20 Nov 1963, *M. Hirano & M. Hotta 1468* (KYO, holo; iso L, SAR).

Aridarum caulescens var. *angustifolium* Bogner & Nicolson, Aroideana 2 (1979) 119, fig. 11 & Willdenowia 21 (1991) 43, fig. 2. — Type: Malaysia, Sarawak, Marudi Distr., Ulu Tinjar, Ulu Sg. Chipidi, *P. Chai S.34798* (K, holo; iso KEP, L, M, MO, SAR).

Aridarum hansenii Bogner, Blumea 28 (1983) 403, fig. 1. — Type: Malaysia, Sarawak, G. Mulu National Park, Camp 3, 14 Mar 1978, *C. Hansen 451* (K, holo; iso C, M).

Herb of very variable size, 2.5–c. 30 cm tall. *Stem* condensed, eventually suberect, 2–7(–20) cm long, 0.3–1(–1.5) cm diam., more or less clothed in old leaf bases and fibrous ligule remnants, the older parts becoming bare. *Leaves* few to numerous together; petiole 0.7–8 cm long, 1–2.5 mm diam., adaxially canaliculate, sheathing at the extreme base, the wings extended into a very narrowly triangular ligular portion 1–5 cm long drying dark red-brown; blades coriaceous, adaxially dark green, paler abaxially, very narrowly linear to elliptic, 1–17 cm long × (0.1–)0.3–4 cm wide, the base cuneate, the apex cuspidate to acuminate and apiculate for 0.5–4 mm, the margin hyaline (broad blades) to somewhat thickened and slightly revolute (linear blades); midrib abaxially very prominent, adaxially prominent, with 1–5 primary lateral veins (or these indistinguishable in linear-leaved forms) on each side, only weakly differentiated from the secondary venation, diverging at 20–35° and running to a more or less thick marginal vein; secondary venation adaxially and abaxially faint to completely obscure; tertiary venation mostly completely obscure, sometimes forming a faint tessellate reticulum. *Inflorescence* solitary; peduncle exceeding the petioles, (0.8–)2–5(–10) cm long, 0.4–1 mm diam.; spathe more or less ovoid, not constricted, 1.5–5.5 cm long and apically beaked for 3–4 mm; lower spathe funnel-shaped, green, persistent, the upper part gaping, white, caducous. *Spadix* subcylindric to bluntly spindle-shaped, 0.6–2.8 cm long, 2–6 mm diam.; female zone 0.3–0.8 cm long (reduced to a single whorl of pistils in very small plants), c. 2 mm diam.; pistils crowded; ovary subglobose, 0.5–1.5(–2) mm diam.; stigma sessile, discoid, centrally impressed, about the same width as the ovary; placention basal, with an apical intrusive abortive placenta; interpistillar staminodes absent from among the pistils, confined to a row along the spathe/spadix adnation, shortly stipitate, broadly to narrowly spindle-shaped to almost filamentous, about the height of the pistils; sterile interstice well-defined (two whorls of sterile anthers), to poorly defined (semi-fertile anthers), to

absent; male zone 0.5–1.7 cm long; stamens crowded, arranged in longitudinally aligned pairs, truncate, deeply excavated with the thecae together on the inner (with respect to the stamen pairs) side of the anther, ellipsoid to ellipsoid-oblong from above, (0.8–)1–1.5 mm across; thecae separated by a ridge forming an incomplete septum in the cavity or this weak or absent, very shortly horned, with the horns inside the lip of the anther cavity when rim thick, to more or less marginal when rim thin; appendix absent or c. 1–4 mm long, rounded; staminodes of appendix more or less irregularly polygonal to ellipsoid, flat-topped to more or less excavated, c. 0.5–0.8 mm diam. *Fruiting peduncle* somewhat elongated after anthesis; fruiting spathe obconic, c. 1–1.3 cm diam.; berries densely clustered, obovoid, 2–3 mm diam., crowned with stigma remnants, many-seeded; seeds subcylindric to very narrowly ellipsoid, brown, with the testa slightly ribbed, 1.8–2.1 mm long, 0.3–0.4 mm diam., with a very long, curved micropylar appendage to 1.5 mm long.

Distribution — *Malesia:* endemic to Borneo (Sarawak, Brunei).

Habitat — Sometimes locally abundant on river banks, in pebble beds and on boulders near waterfalls, from sea level to 1300 m alt.

Notes — *Aridarum caulescens* is extremely variable in overall size and in leaf shape, the most diminutive and narrow-leaved specimens tending to grow on mossy boulders, while more robust specimens tend to grow in sites where the roots have access to more nutrients.

Aridarum hansenii was characterised by the incompletely septate anther cavity with thinner walls and a more rectangular shape. Additionally the appendix is reduced by comparison to that of *A. caulescens* and an interstice is absent. However, there are a number of more or less intermediate specimens, and we find we can no longer maintain *A. hansenii* as a separate species.

Aridarum caulescens is difficult to distinguish from *Bucephalandra motleyana* in the absence of flowers. It differs from that species in the absence of large flattened staminodes in the interstice and in the longitudinally aligned pairs of stamens.

Other specimens examined: BORNEO: SARAWAK: Sg. Belaga, lower rapids, *Ashton S18289* (K, L); Maputi, *Brooke 10128* (L, SING); Hose Mts, above Ulu Melinau Falls, *Burtt & Martin 5009* (E, photo K); 7th Divn, Ulu Sg. Melinau, Hose Mts, Bukit Salong, *Chai S37273* (K, L); 4th Divn., G. Mulu NP, *Martin S38923* (K, L); 7th Divn, Kapit, Sut, Sg. Bena, *Paie S41699* (K, L). BRUNEI: Belait, Sg. Rampayoh, *Atkins et al. 605* (K); Belait Distr., Labi, Kg Teraja, along Sg. Teraja, *Boyce & Jangarum 250* (K, L); Selapon, banks of Sg. Selapon, upriver from village, *S. Drausfield et al. 1170* (K); Belait Distr., Labi Subdistr., Mendaram Valley, *Johns 6813* (K); Belait, Kg Terawan, *van Niel 3492* (L); Belait, Labi Subdistr., Sg. Manaram, nr Bukit Teraja trail, *Sands & Fikir 5506* (K).

7. Aridarum purseglovei (Furtado) M. Hotta

Aridarum purseglovei (Furtado) M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 25. — *Microcasia purseglovei* Furtado, Gard. Bull. Sing. 17 (1959) 276, un-numbered fig. p. 277. — Type: Malaysia, Sarawak, Tau Range, Sg. Mayeng, 4 Jun 1956, *J.W. Purseglove P.5344* (SING, holo — photo K; iso K, L).

Aridarum longipedunculatum M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 26, fig. 3, G–M. — Type: Malaysia, Sarawak, 4th Divn, Bintulu Distr., along valley of Ulu Sg. Bejangang, eastern part of Bukit Kana, 21 Nov 1963, *M. Hotta 15381* (KYO, holo — photo K; iso L).

Herb 20–25 cm tall. *Stem* erect, more or less condensed, 4–6 (or more?) cm long, c. 8 mm diam., rooting below and between the leaves. *Leaves* to c. 10 together; petiole 7–12 cm long, sheathing only at the extreme base, the wings extended into a narrowly triangular ligular portion c. 5 cm long, drying reddish brown; blade coriaceous, narrowly elliptic to elliptic, 9–13 cm long × 1.5–2.5 cm wide, adaxially dark green,

paler abaxially, the base cuneate, the apex acute and apiculate for c. 5 mm; midrib adaxially prominent, less so abaxially, with c. 3 very weak primary lateral veins (hardly differentiated from the secondary venation) on each side diverging at c. 30°; secondary venation very fine, adaxially obscure; tertiary venation obscure. *Inflorescence* solitary; peduncle much exceeding the petioles, 11–20 cm long. *Spathe* broadly ovate, c. 6 cm long, apiculate for c. 2 mm, basally green and persistent for c. 1.5 cm, the rest white, wide-gaping, caducous. *Spadix* 2–3 cm long, 0.5–0.7 cm diam., subcylindric, yellow; female zone c. 1 cm long, basally obliquely adnate to the spathe; ovaries globose, c. 1 mm diam.; stigma sessile, discoid, somewhat convex and narrowly centrally impressed, densely papillate, more or less contiguous with neighbouring stigmas; interpistillar staminodes absent from among the pistils, confined to a rather dense row along the spathe/spadix adnation, scale-like, narrow, 1–1.5 mm long; sterile interstice absent; male zone 1–1.5 cm long, slightly tapering distally, blunt, fertile to apex; stamens crowded, the connective deeply excavated, arranged in longitudinally aligned pairs, 'B'-shaped from above with the straight sides outermost in each pair, c. 1.5 mm across; thecae together on the inner (with respect to the stamen pairs) side of the anther, with conspicuous long erect horns almost 1 mm long. *Fruit* a many seeded berry (observed only immature); immature seed subcylindric, c. 0.6 mm long, 0.3 mm diam., brown, with a long, curved transparent micropylar appendage.

Distribution — *Malesia:* Borneo (endemic to Sarawak).

Habitat — Lithophytic on rocks near river to rheophytic on river banks below flood level in shade of primary dipterocarp forest, often gregarious; only one altitudinal record at 200 m alt.

Notes — Hotta (loc. cit.) distinguished *A. longipedunculatum* from *A. purseglovei* by the former's shorter stem, ovoid pollen sac, nearly flat stigma and shorter male part of the spadix. We have examined the types of each species and conclude that, given the very strong morphological similarity between the two in other respects, coupled with the observation that such subtle differences in the shape of the stigma and pollen sacs are likely due to differing stages of floral maturity, the two elements are conspecific.

The illustration which Furtado (loc. cit.) provided for *Microcasia purseglovei*, besides being of poor quality, contains an error: the thecae of each anther, as viewed from above, are portrayed aligned transversely when they are in fact aligned parallel to the long axis of the spadix.

Other specimens examined: BORNEO: SARAWAK: Ulu Mayeng, Kakus, *Ashton 19298* (GH, L, SING); Anap, Bukit Mersing, *Sibat ak Luang S22534* (K).

8. Aridarum rostratum *Bogner & A. Hay*, **sp. nov.**

Ab *Aridaro burttii* spatha longe rostrata, inflorescentia feminea tenuiore, antheris et staminodiis verruculosis, appendice conspicuo differt. — TYPUS: Indonesia, West Kalimantan, Bidang Menabei, 1924/5, *Hans Winkler 1066* (L, holo; iso HBG).

Herb 20–35 cm tall. *Stem* condensed, 4–5 cm long, 0.5–0.7 cm diam., with tough roots emerging through the leaf bases. *Leaves* 8–10 together; petiole 5–20 cm long, 1.2–2 mm diam., adaxially canaliculate, sheathing at the extreme base with the wings extended into a sublinear ligular apically rounded portion 4.5–8 cm long; blade narrowly elliptic to narrowly obovate, coriaceous, adaxially dark green, paler abaxially, 6–18 cm long × 2–5.5 cm wide, the base cuneate, the apex cuspidate and apiculate for 1–3 mm, the margin slightly undulate (collector's note); midrib abaxially prominent, adaxially more or less flush with the lamina, with 5–7 weak primary lateral veins on each side, alternating with faint interprimaries and diverging at 35–40°, running to a marginal vein; secondary venation abaxially and adaxially very faint; tertiary venation obscure.

Inflorescence solitary; peduncle slender, exceeding the petioles, 15–22 cm long, 1.2–2 mm diam. *Spathe* 6–8 cm long, more than twice the length of the spadix, broadly lanceolate, the upper part extended into a long straight beak c. 0.9 cm long, dark green at the base, the remainder white and probably caducous. *Spadix* subcylindric-spindle-shaped, 2.5–3 cm long; female zone c. 0.8 cm long, thinner than the remainder, narrowly obconic, c. 3 mm diam., adnate to the spathe in the lower ½; pistils crowded; ovary subglobose, c. 1 mm diam.; stigma sessile, discoid, contiguous with neighbouring stigmas, drying dark brown, rather coarsely papillate; placentation basal; interpistillar staminodes absent; sterile interstice slightly obconic, 2 mm long, distally 5 mm diam., 2–4 irregular whorls of sterile stamens from c. 0.5 mm (basal ones) to 0.9 mm diam. (distal ones), these triangular-cordate from above, aligned with the points facing the spadix apex, truncate, verruculate on the surface; male zone c. 1 cm long, 0.5 cm diam., yellow; stamens large, spirally arranged, truncate, circular-rhomboid from above, apically verruculose, 1.2–1.4 mm diam.; thecae together on the proximal (with respect to the spadix axis) side of the anther, with conspicuous 0.8–1.2 mm long upturned horns each ending in a very narrow pore; appendix c. 1 cm long, c. 0.5 cm diam., slightly tapering, obtuse; staminodes of appendix resembling stamens without thecae. *Fruit* unknown. — **Figs 1 & 2.**

Distribution — *Malesia:* Borneo (West Kalimantan); known only from the type.

Habitat — Little data: primary forest at c. 700 m alt.

Notes — The stamens in *A. rostratum* are very similar to those of *A. burttii*, differing in the warty surface which also appears on the staminodes. It also differs from that species in the long appendix and very elongate spathe, to which the specific epithet refers.

9. Aridarum sp. A (*Ilias & Azahari S35676*)

Diminutive herb c. 11 cm tall. *Stem* condensed, short, c. 2 cm long, 1 cm diam. *Leaves* several together, clustered; petiole shorter than the blade, to c. 4.5 cm long, sheathing at the extreme base, the wings extended into a very narrowly triangular ligular portion c. 2.2 cm long drying dark red-brown; blade strongly coriaceous, faintly asperous in the dry state, broadly oblanceolate to broadly oblong-lanceolate to elliptic to narrowly obovate, 5–7 cm long × 2–2.5 cm wide, the base cuneate, the apex acute to obtuse, very shortly acuminate and apiculate for c. 1.5 mm, the margin revolute; midrib abaxially and adaxially prominent; primary lateral veins not differentiated from secondary; secondary and tertiary venation adaxially conspicuous due to dark brown slightly raised epidermal punctae running along the courses of the veins, abaxial side less densely punctate and venation more obscure. *Inflorescence* unknown. *Infructescence* solitary; peduncle 5.5–6.5 cm long, erect; fruiting spathe obconic, c. 1 cm diam. — **Fig. 3.**

Distribution — *Malesia:* endemic to Borneo (Sarawak); known from a single collection from Gunung Gaharu.

Habitat — At summit of G. Gaharu in mossy forest, growing on wet cliff surface at c. 850 m alt.

Notes — This species is only known from fruiting material, and we are therefore not able to ascribe it to genus with certainty. It could also be placed in *Bucephalandra* or *Piptospatha*, but we feel at present that *Aridarum* is the more probable. In any of these genera it is nevertheless very distinctive with its extremely coriaceous leaves without primary lateral veins differentiated from the secondaries, and with the courses of the secondary venation marked conspicuously on the adaxial side of the leaf by dense, slightly raised punctae. More material is needed from this locality.

Specimen examined: BORNEO: SARAWAK: 1st Divn, Simunjan, 70th Mile, Serian/Simanggang Rd, Gunong Gaharu, *Ilias & Azahari S35676* (K, L).

Fig. 1. *Aridarum rostratum* Bogner & A. Hay. **a,** Habit; **b,** Part of spadix showing top of female zone, interstice and base of male zone. (*Winkler 1066*). Scale bar: a = 3 cm; b = 4 mm.

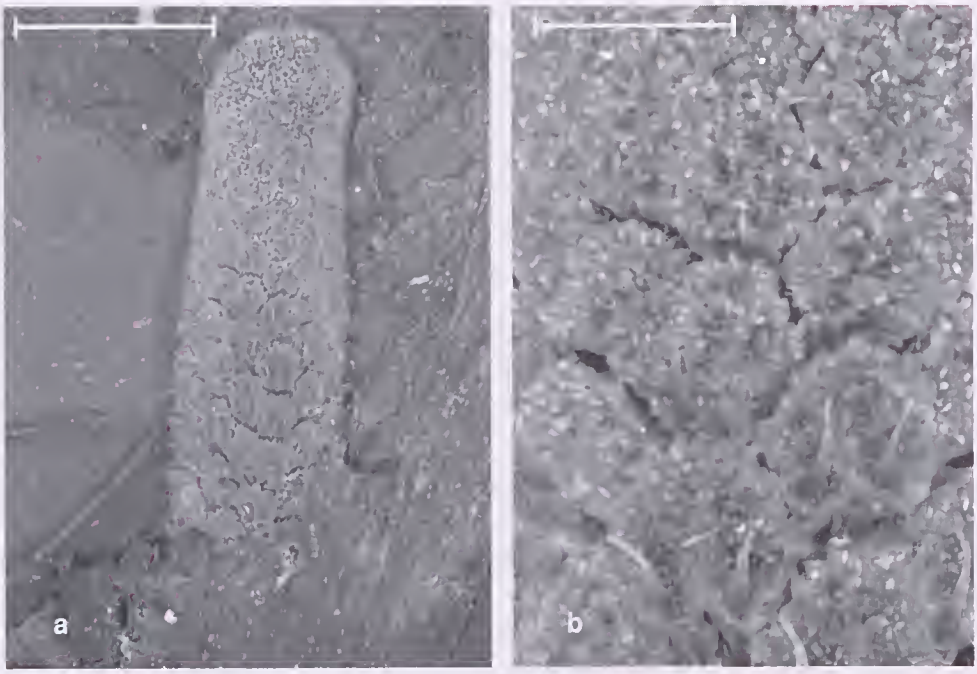

Fig. 2. *Aridarum rostratum* Bogner & A. Hay. **a,** Spadix with persistent spathe base below; **b,** Detail of upper part of spadix with fertile, horned stamens (below) and staminodes of the appendix (above). (*Winkler 1066*). Scale bars: a = 6 mm; b = 1.5 mm.

Fig. 3. *Aridarum* sp. A. Whole plant (*Ilias & Azahari S 35676*). Scale bar: = 3 cm.

Bucephalandra Schott

Bucephalandra Schott, Gen. Aroid. (1858) t. 56; Prodr. Syst. Aroid. (1860) 319; Engl. in A. & C. DC., Monogr. Phanerogam. 2 (1879) 354; Engl., Pflanzenr. 55 (IV.23Da) (1912) 122; Bogner, Aroideana 3 (1980) 136; Mayo et al., Genera of Araceae (1997) 189, pl. 52. — Type: *Bucephalandra motleyana* Schott.

Microcasia Becc., Bull. Soc. Tosc. Ortic. 4 (1879) 180; Engl. in A. & C. DC., Monogr. Phanerogam. 2 (1879) 299; Engl. in Becc., Malesia 1 (1883) 289; Engl., Pflanzenr. 55 (IV.23Da) (1912) 128; Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 20. — Type: *Microcasia pygmaea* Becc. [= *Bucephalandra motleyana* Schott].

Minute to medium-sized evergreen herbs. *Stem* creeping, apex upright. *Leaves* numerous; petiolar sheath with long marcescent ligule; blade elliptic, elliptic-oblong, linear-oblanceolate to obovate, coriaceous, punctate below, apex with tubular mucro; primary lateral veins pinnate, running into distinct marginal vein, higher order venation parallel-pinnate. *Inflorescence* solitary; peduncle subequal to petiole at anthesis, elongating later. *Spathe* ellipsoid, cuspidate, not constricted, lower part light green, convolute, broadly funnel-shaped, persistent, later subtending enclosing developing fruits, upper part white, gaping at anthesis, caducous immediately afterwards. *Spadix* sessile, shorter than spathe, with a few pistillodes at extreme base, female zone cylindric, narrower than upper parts, with pistils in 2–6 spirals; pistil depressed-globose, 1-locular, ovules many, orthotropous, attenuate towards micropyle, funicle distinct, placenta basal, stigma sessile, discoid, slightly concave in centre, narrower than ovary; sterile interstice a few rows (usually 2) of flattened, smooth, scale-like staminodes; male zone with 2–5 rows of stamens; stamens not grouped into flowers; filament distinct but short, flattened, connective ± inconspicuous, thecae ellipsoid, extrorse, dehiscing by pore at tip of conspicuous apical horn; pollen extruded in a droplet, inaperturate, ellipsoid, medium-sized (range 28–30 mm long (Grayum, 1992: 21), exine psilate; terminal appendix globose or ellipsoid to subcylindric, composed of truncate, obpyramidal to subcylindric, apically papillose staminodes, the uppermost ± connate. *Fruit* a globose to ellipsoid berry with numerous seeds; seed narrow-ellipsoid, with long, curved micropylar appendage, testa very slightly longitudinally ribbed to scabrous; embryo straight, elongate; endosperm copious.

Distribution — Two species, endemic to Borneo.

Habitat — Rheophytic in tropical humid forest.

Notes — *Bucephalandra* was originally misdescribed (see Bogner 1980), and it was because of this that *Microcasia* came to be erected even though their types are now considered to be conspecific.

Key to species

1a. Plants robust, to 40 cm tall; leaf blades to 25 cm long, with c. 16–20 primary lateral veins on each side of the midrib; E Kalimantan ..... **1. B. gigantea**

1b. Plants much smaller, at most 20 cm tall (usually much less); leaf blades at most 10 cm long, with (0–)1–4 primary lateral veins on each side of the midrib; widespread in Borneo ..... **2. B. motleyana**

1. Bucephalandra gigantea Bogner

Bucephalandra gigantea Bogner, Pl. Syst. Evol. 145 (1984) 159, figs 1–2; Mayo et al., Genera of Araceae (1997) 190, pl. 52, L–M. — Type: Indonesia, Kalimantan, Central East Borneo, W. Koetai, Kiau River, 25 Oct 1925, *F.H. Endert 4580* (K, holo; iso BO, L).

Herb c. 40 cm tall. *Stem* with short internodes c. 5 mm long, ?erect, 4 (–?) cm long (incomplete), c. 1 cm diam. *Leaves* to 10 together; petiole 15–28 cm long, sheathing at the extreme base, the wings extended into a very narrowly triangular ligular portion 5–12 cm long drying dark brown; blade elliptic, 18–25 cm long × 6–7 cm wide, abaxially punctulate, the base cuneate, the apex acuminate and apiculate for 5 mm; midrib abaxially prominent, slightly prominent adaxially, with 16–20 close-spaced primary lateral veins on each side, alternating with interprimaries and diverging at c. 45°; between the primary and interprimary veins finer secondary veins and between them a third order of striate venation finer still; ultimate venation (cross veinlets) obscure. *Inflorescences* small relative to leaves, in small synflorescences produced in series of 2–3 each consisting of 2 inflorescences subtended by lanceolate cataphylls to 6 cm long; peduncle 6–12 cm long, slender. *Spathe* ovate, 2.5–3.5 cm long, apiculate for 4–10 mm, the lower c. 1 cm persistent, the upper part falling (?caducous). *Spadix* 1.5–2 cm long; female zone 3–5 mm long, 1.8–3 mm diam.; ovary depressed-globular, 0.6–0.7 mm diam.; stigma sessile, disc-like, 0.3–0.4 mm diam.; interpistillar staminodes apparently absent (material poor); sterile interstice composed of 1–2 irregular whorls of more or less elliptic scale-like staminodes 1–1.5 mm long; male zone 4–5 mm long, 2–3 mm diam., cylindric; filaments of stamens more or less truncate, hidden from view by the prominent, rather elongate horned thecae 1.3–1.8 mm long; thecae together on the lower (with respect to spadix) side of the stamen, upward-facing (with respect to spadix); appendix subcylindric, 6–10 mm long, 2–3 mm diam., apically obtuse; staminodes of appendix irregular ellipsoid to roundish in surface view, truncate, 0.5–0.6 mm diam., apically papillose. *Fruiting spathe* funnel-shaped, 0.8–1 cm diam.; berries depressed globular, 1.5–2 mm diam., several-seeded; seed elongate, 1.1–1.5 mm long, c. 0.4 mm diam., with a curved micropylar appendage; testa slightly ribbed.

Distribution — *Malesia:* endemic to Borneo (East Kalimantan); known only from the type.

Habitat — Unknown; type collected at 700 m alt.

Notes — *Bucephalandra gigantea* is distinguished from *B. motleyana* by its much larger vegetative size, leaves with very numerous primary lateral veins, and the stamens with relatively slender, long-horned thecae. The inflorescence is almost always solitary in *B. motleyana* (sometimes a few in series but then interspersed with foliage leaves), while in *B. gigantea* a series of synflorescences is produced.

2. Bucephalandra motleyana Schott

Bucephalandra motleyana Schott, Gen. Aroid. (1858) t. 56; Schott, Prodr. Syst. Aroid. (1860) 319; Engl., Pflanzenr. 55 (IV.23Da) (1912) 122, fig. 74; Bogner, Aroideana 3 (1980) 137, figs 1–15; Boyce, Kew Mag. 12 (1995) 131, pl. 272; Mayo et al., Genera of Araceae (1997) 190, pl. 52, A–C & 358, pl. 118, B. — Type: Borneo, *Motley 404* (K, holo; iso K).

Microcasia pygmaea Becc., Bull. Soc. Tosc. Ortic. 4 (1879) 180, fig. 8; Engl. in Becc., Malesia 1 (1883) 290, t. 22, figs 21–24 & Pflanzenr. 55 (IV.23Da) (1912) 129, fig. 77, A–D. — Type: Malaysia, Sarawak, Entabai, 8 Oct 1867, *O. Beccari PB 3883* (FI, holo; iso B).

Microcasia elliptica Engl., Bull. Soc. Tosc. Ortic. 4 (1879) 299; Engl. in Becc., Malesia 1 (1883) 290, t. 25, figs 2–8 & Pflanzenr. 55 (IV.23Da) (1912) 130, fig. 77, E–K. — Type: Malaysia, Sarawak, 1866, *O. Beccari PB 2817* (FI, holo).

Microcasia muluensis M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 20, fig. 1 A–F. — Type: Malaysia, Sarawak, 4th Divn, along Sg. Payau from Sg. Melinau Paku to Rubang Payau, foot of G. Mulu, 22 Mar 1964, *M. Hotta 15329* (KYO, holo — photo K).

Microcasia oblanceolata M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 21, fig. 1 G–M. — Type: Brunei Darussalam, Temburong Prov., vicinity of Labu, Bukit Peradayan, 25 Jan 1964, *M. Hotta 13586* (KYO, holo; iso L, SAR).

Bucephalandra catherineae P.C. Boyce, Bogner & Mayo, Kew Mag. 12 (1995) 152, unnumbered fig.; Mayo et al., Genera of Araceae (1997) 190, pl. 52, P–Q. — Type: Indonesia, Central Kalimantan, G. Sg. Pendan, 14 Oct 1991, *E. de Vogel & P. Cribb 9210* (L, holo; iso K spirit 57575).

Bucephalandra magnifolia H. Okada & Y. Mori, Acta Phytotax. Geobot. 51 (2000) 4, figs. 2 & 4B. — Type: Indonesia, East Kalimantan, Bulungan, Long Bawan, G. Malim, 11 Sep 1990, *H. Okada & D. Komara 5024* (TI, holo; iso BO — n.v.).

Small herb 5–20 cm tall. *Stem* more or less condensed, creeping to suberect, 3–10 cm long, 0.4–0.8 cm diam. *Leaves* to c. 10 together; petiole (0.5–)1–8 cm long, 2–2.5 mm diam., adaxially canaliculate, reddish, sheathing at the extreme base, the wings extended into a very narrowly triangular ligular portion to 3 cm long, drying dark reddish brown; blade obovate to elliptic to very narrowly oblanceolate, rarely sublinear, (0.7–) 5–7(–10) cm long × (0.3–)2–2.8 cm wide, more or less coriaceous, glossy dark green adaxially, paler abaxially and sometimes tinged reddish, finely punctate on both surfaces, the base cuneate, the apex acute to rounded and apiculate for 1–2.5 mm, the margin somewhat revolute (very narrow forms) to somewhat undulate (broader leaved forms); midrib abaxially and adaxially prominent, reddish abaxially, with (1–)3–4 primary lateral veins on each side (absent in very narrow form), diverging at 25–60° and running to a marginal vein; secondary venation adaxially more or less obscure, abaxially fine and not dense (c. 1–1.5 mm apart); tertiary venation adaxially obscure, abaxially forming a faint tessellate reticulum. *Inflorescence* solitary, very rarely in a small synflorescence in robust specimens; peduncle exceeding the petioles, 2–13 cm long, reddish. *Spathe* broadly ovate, not constricted, (0.7–)2–3 cm long, the lower part funnel-shaped, green, persistent, the limb gaping, white, caducous, apiculate for 2–3 mm. *Spadix* (0.5–)1.2–2.5 cm long; female zone (0.1–)0.3–0.5 cm long, (0.15–)0.3–0.5 cm diam., 2–5 whorls of pistils; pistils ovoid to depressed globular, 0.6–1 mm diam.; stigma sessile, discoid, about half the diameter of the ovary, somewhat impressed centrally; interpistillar staminodes absent from among the pistils, absent or 1–a few at the base of the female zone, very small, c. 0.25 mm diam., subsessile; interstice consisting of 1–2 whorls of scale-like staminodes 1–2 mm long × 0.8–1.5 mm wide, at first erect then spreading; male zone 0.2–0.4 cm long, 0.1–0.3 cm diam., consisting of 2–5 irregular whorls of stamens; stamens large, to 1 mm across, truncate, with at first inflated then flatter thecae on the proximal (with respect to the spadix axis) side of the stamen; thecae with at first upward- then outward-pointing (with respect to the spadix) horns 0.2–0.3 mm long each with a minute pore at the tip; appendix globular to ellipsoid, 0.2–1 cm long, 0.2–0.5 cm diam., yellow; staminodes of appendix obpyramidal to subcylindric, truncate, sometimes partially connate especially in the distal part of the appendix, 0.5–1 mm diam., papillose on the upper surface. *Fruiting spathe* funnel-shaped, 0.5–1.2 cm diam.; berry depressed-globular to ellipsoid-oblong, 1–1.8 mm long, 1–1.5 mm diam., with numerous seeds; seed narrowly ellipsoid, 1–2 mm long, 0.25–0.3 mm diam., light brown, very slightly longitudinally ribbed to scabrid, with a curved micropylar appendage to 1 mm long.

Distribution — *Malesia:* endemic to Borneo (widespread, but only one record from Sabah).

Habitat — Rheophytic on rocks by and in streams and waterfalls in shade or partial shade. The great majority of the numerous collections made of this species are from

350 m alt or lower, although a few reach 500 m. *Geesink 9028* is exceptional in having been collected at 1200 m alt. This is one of very few collections from East Kalimantan and the plants are rather more robust than normal. However, inflorescence features place this collection within *B. motleyana*.

Notes — Bogner (1980) discussed variability and synonymy in *Bucephalandra motleyana*. We have decided to reduce the recently described *B. catherineae* to the synonymy of *B. motleyana* as well. It has extremely narrow, almost linear leaves. While *B. motleyana s. str.* has very variable leaves and the narrowest are very narrowly (ob)lanceolate, there do not yet appear to be intermediates between those and the remarkable leaves of *B. catherineae*. However, the inflorescence of *B. catherineae* falls well within the range of variability found in *B. motleyana*. *Aridarum caulescens*, which is ecologically very similar to *B. motleyana*, has an essentially complete series from elliptic to sub-linear leaves, and we predict that intermediates will be found that will connect the extreme leaves of *B. catherineae* with those of *B. motleyana*. The tufted habit which according to Boyce et al. (1995) distinguished *B. catherineae* from *B. motleyana*, is in fact also found in the latter.

The very recently described *B. magnifolia* is also placed in the synonymy of *B. motleyana*. Okada and Mori (loc. cit.) propose that it is distinguishable from *B. motleyana* on the basis of its larger size, acuminate leaf apex and more slender appendix. We have been fortunate enough to examine many specimens of *Bucephalandra* from all over Borneo and it appears to us that these features do not cause *B. magnifolia* to fall outside our concept of *B. motleyana*.

Selected other specimens examined (see also Bogner, 1980): **BORNEO:** SARAWAK: 1st Divn, Tebakang area, Bukit Alak, *Awa & Paie S45634* (K); 1st Divn, N slopes of Mt Penrissen, *Jacobs 5047* (B); 1st Divn, Tebekang/Serian, Kg Pechin, *Yii S46154* (K). BRUNEI: Temburong Prov., Kuala Belalong, Batu Apoi FR, Sg. Apan, *Hansen 1625* (K, SING); Temburong Prov., Temburong R. valley, *Johns et al. 7130* (K). SABAH: Pensiangan Distr., Batu Tinahas, *Kiew & Anthony RK 4404* (K, L, SING). KALIMANTAN: W Kalimantan, Headwaters of Sg. Kahayan, 5 km NW of Tumbang Sian logging camp, Sikatan Wana Raya logging concession, *Burley et al. 727* (K, L, SING); W Kalimantan, 150 km NE of Pontianak, G. Bentuang area, *Burley et al. 2340* (K); W Kalimantan, Serawai, Sg. Merah, *Church et al. 1960* (K); E Kalimantan, between Long Bawan and Panado, *Geesink 9028* (L); C Kalimantan, Bukit Raya area, upper Samba R., 60–80 km NNW of Tumbang Samba, base camp Tumbang Riang, *Mogea & de Wilde 3670* (K, L).

Phymatarum M. Hotta

Phymatarum M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 29; Bogner, Pl. Syst. Evol. 144 (1984) 62, fig. 5–8; Mayo et al., Genera of Araceae (1997) 189, pl. 53 & 358, pl. 118, C. — Type: *Phymatarum borneense* M. Hotta.

Small herbs. *Stem* creeping to decumbent. *Leaves* several; petiolar sheath fairly short with long marcescent ligule; blade narrowly elliptic, somewhat coriaceous, apex with tubular mucro; primary lateral veins pinnate, running into conspicuous marginal vein, alternating with interprimary and secondary venation; higher order venation inconspicuously transverse-reticulate. *Inflorescence* solitary; peduncle erect, shorter or subequal to petiole. *Spathe* constricted between tube and blade, tube convolute, persistent, green, blade longer, boat-shaped and gaping at anthesis, whitish, cuspidate, caducous after anthesis. *Spadix* at extreme base bearing a few neuter organs or not; female zone conoid to subcylindric, basally adnate to spathe; pistils depressed-globose; ovary 1-locular; ovules many, hemiorthotropous, funicle long; placenta basal; stigma sessile, slightly concave centrally, narrower than ovary, very thinly discoid; sterile interstice a cylindric to ellipsoid zone of staminodes; staminodes sub-prismatic, tuberculate, flattened or excavated, lowermost either with or without central, short,

subulate projection, uppermost more slender, relatively longer, otherwise similar but never with projections; male zone very short and slightly narrower than the interstice; stamens not arranged in male flowers, free, filament short, connective inconspicuous, thecae tuberculate, each ending in a curved horn dehiscing by apical pore; pollen inaperturate, ellipsoid, small (mean 19 µm (Grayum: 1992: 21)) exine psilate; terminal appendix elongate–conoid, bearing sterile male flowers. *Fruit* a many-seeded, depressed-obovoid, slightly furrowed, greenish-white berry; seed ellipsoid, with long micropylar appendage; testa costate; embryo elongate, straight; endosperm copious.

Distribution — Endemic to Borneo, monotypic.

Habitat — Rheophytic at low elevation.

Notes — This genus is easily distinguished from all others in the Schismatoglottideae by the combination of horned thecae of the stamens and the constricted spathe.

1. Phymatarum borneense M. Hotta

Phymatarum borneense M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 29, fig. 5, A–G; Bogner, Pl. Syst. Evol. 144 (1984) 62, figs 5–8; Mayo et al., Genera of Araceae (1997) 189, pl. 53 & 358, pl. 118, C. — Type: Brunei Darussalam, Temburong Prov., en route from Kg Biang to Bukit Biang, 20 Jan 1964, *M. Hotta 13314* (KYO, holo — photo K; iso SAR).

Phymatarum montanum M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 29, fig. 5, H–K. — Type: Malaysia, Sarawak, Mardi, foot of G. Mulu, along Sg. Payau between Sg. Melinau Paku and Rubang Payau, 22 Mar 1964, *M. Hotta 15268* (KYO, holo — photo K).

More or less repent, sometimes pendent herb to c. 40 cm long. *Stem* fleshy, somewhat condensed to elongate with internodes to 3 cm long, c. 1–2 cm diam., usually rooting along its length in mud. *Leaves* several together; petiole shorter than to subequalling the blade, 5–27 cm long, adaxially somewhat flattened and crisped-alate, sheathing only at the extreme base, the wings extended into a very narrowly triangular ligular portion 4–8 cm long, drying pale brown; blade broadly oblanceolate to narrowly elliptic, 12–25 cm long × 2.5–8 cm wide, thickly membranous to distinctly coriaceous, adaxially glossy dark green, paler abaxially and there often with the major venation tinged purplish, the base cuneate to narrowly rounded, the apex shortly acuminate and apiculate for 1–4 mm; midrib abaxially prominent, adaxially more or less flush with the lamina, with about 10 primary lateral veins on each side regularly alternating with lesser interprimaries and diverging at 45–60°; secondary venation adaxially more or less obscure, abaxially fine; tertiary venation forming a fine tessellate reticulum abaxially to obscure (depending on blade thickness). *Inflorescence* solitary to 3 in a synflorescence subtended by lanceolate cataphylls resembling the ligules; exposed peduncle shorter than the spathe at anthesis, becoming longer afterwards, sometimes completely concealed by cataphylls at anthesis, c. 6 cm long. *Spathe* more or less erect, 6–9.5 cm long, constricted; lower spathe narrowly ovoid and slightly asymmetric, green to purplish green, c. 3 cm long, persistent; limb cream to pink, broadly lanceolate, apiculate for c. 7 mm, wide-gaping then reflexed, caducous. *Spadix* 5–7 cm long, subcylindric (slightly attenuate at top of female zone); female zone 1.8–2.5 cm long, narrowly conic, obliquely inserted, distally c. 0.5 cm diam.; pistils large, crowded, to 3 mm diam., strongly depressed-globular; stigma sessile, discoid, slightly centrally impressed, not or barely raised above the surface of the top of the ovary, papillose; interpistillar staminodes absent from among the pistils (very occasionally one or two among the lower pistils), otherwise confined to an interrupted whorl around the base of the spadix, shortly stipitate, ovoid-conic, sometimes with a narrow tongue-like extension to one side of the tip, somewhat higher than the pistils; sterile

interstice robust, subcylindric, the base corresponding with the base of the spathe limb and wider than the top of the female zone, 0.7–1 cm long, 0.5–0.6 cm diam.; staminodes of interstice truncate, irregularly rounded-rectangular and transversely aligned from above, somewhat impressed centrally, densely papillate, sometimes bearing vestigial horns or these absent, 2–3 mm across; male zone cylindric to faintly conoid, 0.6–1.3 cm long, distally 0.4–0.5 cm diam.; stamens large, transversely (with respect to spadix) aligned and strictly superposed in longitudinal (with respect to spadix) rows, rounded-rectangular, c. 2 mm across, apically densely tubercular-papillate, centrally somewhat impressed; thecae paired on the proximal (with respect to spadix axis) side of the stamen, with slender, spreading and distally sharply down-turned horns c. 0.8 mm long; appendix narrowly conic, basally slightly to distinctly wider than the top of the male zone, 2.5–3.5 cm long, basally 0.5–0.7 cm diam., distally tapering and narrowly obtuse; staminodes of appendix truncate, apically densely tuberculate, sometimes centrally impressed, more or less round from above, centrally impressed, c. 2 mm diam., partly connate into groups of 3–4, the groups more or less longitudinally aligned like the stamens. *Fruiting spathe* narrowly urceolate, c. 3 cm long; berry obovate-oblong, 5–6 mm long, c. 4 mm diam., greenish white; seed ellipsoid, 4–5 mm long, c. 1.5 mm diam., with a long curved micropylar appendage; testa longitudinally ridged.

Distribution — *Malesia:* endemic to Borneo (restricted to central and northern Sarawak, and Brunei).

Habitat — Rheophytic, occasionally terrestrial on very wet forest floor, in deep shade at low elevation.

Notes — Hotta (loc. cit.) distinguished *Phymatarum montanum* from *P. borneense* by the latter's larger size, erect stem, narrower leaf blade, fewer neuter organs at the base of the spadix, fewer ovules in the ovary, and the staminodes between the female and male zones being hornless. There are connecting intermediates in all these respects. With regard to the last, it is not uncommon for there to be some staminodes with and some without horns in the sterile interstice. Moreover, despite its name, *P. montanum* is not a montane element and it is differentiated from *P. borneense* by neither ecology nor geography.

Phymatarum borneense is a variable species, notably with regard to the thickness of the leaves which are sometimes markedly coriaceous. It is often locally abundant, and it is remarkable that it was not recognised until the 1960's. Typically it inhabits the steep banks of muddy, meandering lowland streams and, less frequently, the floor of low-lying forest where it may be inundated in wet periods. The plants are evidently completely submerged at times and are often encountered when exposed with the leaves coated in silt; they do not seem to be found, however, below the low water mark and cannot be regarded as aquatic.

Other specimens examined: BORNEO: SARAWAK: Ulu Tubau, *Ashton S18397* (K); N Setungan, Segan, *Ashton S22033* (K, L, SING); 8–9 mi from Limbang, along Sg. Bakol, *Bogner 1506* (K); 9th Divn, Bandar Sri Aman–Sibu Rd, 156 km before Sibu below bridge over Sg. Undup, *Boyce 720* (K); Simanggang, *Brooke 10731* (L); Tatau, path to Bukit Buan, *Purseglove P5460* (K, L, SING). BRUNEI: Belait Distr., Sg. Deriam, *Boyce et al. 341* (K, L); Temburong Distr., Sg. Temburong at Kuala Belalong, *Boyce et al. 398* (K, L); Temburong Prov., Selapon, banks of Sg. Selapon, up river from village, *Dransfield et al. 6919* (K); Temburong Prov., Selapon, banks of Sg. Batu Apoi, *S. Dransfield et al. 1550* (K); Temburong Prov., en route from Kg Biang to Bukit Biang, *Hotta 13315* (L).

Piptospatha N.E. Br.

Piptospatha N.E. Br., Gard. Chron., Ser. 2, 11 (1879) 138; Engl., Pflanzenr. 55 (IV.23Da) (1912) 124; Ridl., Fl. Mal. Pen. 5 (1925) 114; Mayo et al., Genera of Araceae (1997) 184, pl. 50, A–M. — Type: *Piptospatha insignis* N.E. Br.

Rhynchopyle Engl., Bot. Jahrb. Syst. 1 (1880 '1881') 183. — Lectotype: *Rhynchopyle elongata* (Engl.) Engl. [= *Piptospatha elongata* (Engl.) N.E. Br.] (selected by Nicolson 1967).

Gamogyne N.E. Br., J. Bot. 20 (1882) 195; Engl., Pflanzenr. 55 (IV.23Da) (1912) 123. — *Piptospatha* sect. *Gamogyne* (N.E. Br.) M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 26. — Type: *Gamogyne burbidgei* N.E. Br. [= *Piptospatha burbidgei* (N.E. Br.) M. Hotta].

Hottarum Bogner & Nicolson, Aroideana 1 (1978 '1979') 72; Mayo et al., Genera of Araceae (1997) 187, pl. 51 [p.p., excl. *H. sarikeense* Bogner & M. Hotta — i.e. *Schismatoglottis*]. — *Microcasia* sect. *Truncatae* M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 21. — Type: *Hottarum truncatum* (M. Hotta) Bogner & Nicolson (*Microcasia truncata* M. Hotta) [= *Piptospatha truncata* (M. Hotta) Bogner & A. Hay].

Small to medium-sized evergreen herbs. *Stem* erect or decumbent, usually more or less condensed. *Leaves* several; petiole sheath short with long, marcescent ligule; blade elongate-lanceolate to elliptic or oblanceolate, coriaceous, apex with tubular mucro; primary lateral veins pinnate, running into distinct marginal vein, secondary laterals and higher order venation parallel-pinnate. *Inflorescence* solitary, usually nodding; peduncle subequal to or longer than petiole (rarely very short — *P. brevipedunculata*). *Spathe* stoutly ellipsoid, not constricted, often pink, lower part persistent and cup-like, upper part slightly gaping at anthesis, caducous or persistent, cuspidate to acuminate. *Spadix* sessile with ± oblique insertion to shortly stipitate with the stipe adnate to the spathe, sometimes with staminodes or sterile ?pistils (homology unclear in some cases) at extreme base or a robust basal sterile zone; female zone cylindric; pistils free or cohering to neighbouring ones; ovary 1-locular; ovules man;, placentae 2–4, parietal, or parietal and basal, or basal; stigma ± sessile or elevated on a short style, usually as broad as ovary and more or less contiguous with adjacent ones; male zone contiguous with female, or separated by a short interstice of staminodes, cylindric to ellipsoid, equal in diameter to female, obtuse; stamens arranged in pairs or irregular, free, compressed, anthers truncate, connective ± flat or expanded apically or with conical beak (*P. insignis*) overtopping thecae; thecae oblong-ellipsoid, dehiscing by apical pore; pollen inaperturate, ellipsoid, small to medium-sized (mean 25 µm (Grayum, 1992: 21)), exine psilate; appendix short, reduced to a few terminal sterile stamens, or absent; staminodes of appendix truncate, subclavate, prismatic. *Infructescence* a cluster of berries subtended by the obconic spathe base, or held within the entirely persistent, finally disintegrating spathe; berry obovoid to subcylindric, small, green; seed elongate-ellipsoid to cylindric, with long, curved micropylar appendage; testa slightly costate; embryo elongate, endosperm copious.

Distribution — 11 species from Southern Thailand to West Malesia. In *Malesia:* 11 species, Malay Peninsula and Borneo.

Habitat — Obligate rheophytes along streams and by waterfalls in lowland to lower montane rainforest areas.

Notes — *Piptospatha* is expanded here to include most species of *Hottarum*, which differed only in its basal placentation. If that character is ignored, it becomes clear that the species of Schismatoglottideae with truncate, non-horned stamens and basal placentation, are a heterogeneous assemblage, *Hottarum sarikeense* falling clearly within *Schismatoglottis*, and *H. truncatum* within *Piptospatha s. str.* Basal placentation is also found in *Piptospatha burbidgei* linking within that species to parietal-subbasal

placentation, and likewise in *P. grabowskii*. *Schismatoglottis longifolia* Ridl. also has subbasal placentation (in material studied from Sarawak).

Piptospatha grabowskii has the previously unrecognised characteristic of a persistent spathe, where the genus more typically has a caducous limb — leaving a broadly obconic fruiting spathe cup. A persistent spathe is also found in *Piptospatha kinabaluense*, while that of *P. truncatum* has a caducous limb.

Piptospatha differs from *Schismatoglottis* in its unconstricted spathe (this feature is also found in *S. barbata*, but in a unique configuration unlikely to be homologous with that in *Piptospatha* (see Hay and Yuzammi, 2000)). This character is apparently correlated with seed morphology: seeds of *Piptospatha s. lat.* having an extended micropylar appendage, where *Schismatoglottis* apparently does not. However, we must make the caveat that only a minority of *Schismatoglottis* have been examined in this respect. It seems likely that *Piptospatha* will eventually be subsumed into *Schismatoglottis*. However, the now-expanded *Piptospatha* appears homogeneous, and it seems preferable to wait until the relationships of genera within the tribe can be evaluated phylogenetically before making further nomenclatural changes.

Hotta (1965) made a partly explicit infrageneric classification of *Piptospatha* when he reduced *Gamogyne* to sectional status. We have not followed this, as the definition of *Gamogyne* was based on a single (apparently also mis-observed) character. For convenience we have here divided the species into informal groups based on whether or not the spathe is fully persistent.

Key to species

1a. Spathe limb caducous (**P. elongata group**) 2
1b. Spathe limb persistent (**P. grabowskii group**) 9

2a. Peduncle shorter than spathe; W Kalimantan ..... **1. P. brevipedunculata**
2b. Peduncle much exceeding the spathe 3

3a. Sterile interstice well-defined; NW Borneo ..... **2. P. burbidgei**
3b. Sterile interstice absent 4

4a. Connective extended into a pronounced elongate beak; Sabah ..... **4. P. insignis**
4b. Connective not raised above the thecae or shortly elevated and obtuse 5

5a. Anthers pubescent to papillose 6
5b. Anthers glabrous 8

6a. Connective swollen; Malay Peninsula ..... **7. P. ridleyi**
6b. Connective not swollen 7

7a. Anthers in closely appressed regularly arranged pairs; Malay Peninsula and Thailand ..... **6. P. perakensis**
7b. Anthers (seen from above) irregularly arranged; E Kalimantan ..... **5. P. manduensis.**

8a. Spadix usually with slightly narrowed sterile appendix (male zone rarely fertile to apex); diminutive plant with leaf blades to c. 7 cm long; petiole with narrow crispate wings distally; Sarawak. ..... **8. P. truncata**
8b. Male zone fertile to apex; more robust plant with leaf blades 10–24 cm long; petiole without crispate wings; Sarawak, Kalimantan ..... **3. P. elongata**

9a. Much of spadix, including part of male zone, adnate to spathe; stamens glabrous; Sarawak ..... **11. P. lucens**
9b. At most only base of spadix adnate to spathe; stamens hairy to papillose on upper surface 10

10a. Female zone free, stigmas as wide as ovary, usually on a distinct style; basal sterile zone partly adnate to spathe; widespread in Borneo ..... **9. P. grabowskii**

10b. Lower part of female zone adnate to the spathe; stigmas narrower than ovary, sessile; NW Borneo ..... **10. P. kinabaluensis**

Piptospatha elongata group

Spathe limb caducous.

Eight species, Borneo to Thailand.

1. Piptospatha brevipedunculata *(H. Okada & Y. Mori) Bogner & A. Hay*, **comb. nov.**

Hottarum brevipedunculatum H. Okada & Y. Mori, Acta Phytotax. Geobot. 51 (2000) 7, figs 3 & 4C. — Type: Indonesia, West Kalimantan, Putussibau, a branch of upper stream of Sg. Kapuas, Sg. Keriau, Salim vill., 13 Jan 1992, *H. Okada & D. Komara 32321* (TI, holo; iso BO — n.v.).

Herb to c. 30 cm tall. *Stem* condensed, to c. 4.5 cm long and 0.8–1.5 cm diam., with strong roots to 2–3 mm diam. *Leaves* numerous, crowded; petiole (8–)15–20(–35) cm long, 1.5–2.5 mm diam., canaliculate adaxially, sheathing at the extreme base, the wings of the sheath extended into a narrowly triangular, membranous, ligular portion 1.5–4 cm long, drying brown; blade coriaceous, shining green, lanceolate to narrowly elliptic, (7–)10–18 cm long × (1.4–)2–2.5 cm wide, the base cuneate and somewhat decurrent, the apex acuminate and apiculate for (2–)4–6 mm, the margin thickened and recurved; midrib abaxially very prominent, somewhat prominent adaxially; primary lateral veins not or hardly differentiated from the secondary venation, adaxially inconspicuous, numerous and dense — c. 1 mm apart, diverging at c. 30° and running to a marginal vein; tertiary venation obscure. *Inflorescence* solitary, erect; peduncle much shorter than the petiole, 1.2–3 cm long, 1–1.8 mm diam. *Spathe* white, 3–4 cm long, 5–7 mm wide, apiculate for 2–3 mm, persistent in the lower c. ⅔, the upper part falling after anthesis. *Spadix* 2.5–3.5 cm long, sessile; female zone c. 5 mm long, c. 4 mm diam.; ovary depressed-globular, c. 1.5 mm diam.; stigma sessile, discoid, centrally somewhat impressed, c. 1 mm diam.; interpistillar staminodes not observed; sterile interstice isodiametric with the fertile zones, c. 5 mm long; male zone subcylindric, 0.8–1.3 cm long, 5 mm diam.; stamens crowded, not regularly arranged, weakly dumbbell-shaped from above, flat-topped, c. 1 mm across, with conspicuous circular pores; appendix tapering to an obtuse point, 1–1.3 cm long, basally c. 5 mm diam.; staminodes of appendix flat-topped, irregularly polygonal, 1–1.5 mm diam. *Fruiting spathe* 2–2.5 cm long, 1–1.5 cm wide; berry c. 4 mm diam., crowned with persistent stigma remnants; seed subglobular, c. 1 × 1 mm, ribbed, brown, with a transparent micropylar appendage c. 0.8 mm long.

Distribution — *Malesia:* Borneo (West and Central Kalimantan).

Habitat — Rheophytic on rocks along a rapid stream, c. 100 m alt.

Notes — This species, with its unconstricted spathe and un-horned thecae, falls uncontroversially into our concept of *Piptospatha*. The very short peduncle distinguishes it from all other known species in the genus and the erect rather than nodding spathe is unusual. In these later respects, and in aspect and ecology, this species superficially resembles *Schismatoglottis josefii* A. Hay, which differs in its constricted spathe and in each theca of the anther having two small pores.

Other specimen examined: BORNEO: KALIMANTAN: Central Kalimantan, P.B.U. base camp and environs, *Ridsdale 163* (K).

2. Piptospatha burbidgei (N.E. Br.) M. Hotta

Piptospatha burbidgei (N.E. Br.) M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 27, fig. 4, A–F; Mayo et al., Genera of Araceae (1997) 186, pl. 50, C–F & 357, pl. 117, D. — *Gamogyne burbidgei* N.E. Br., J. Bot. 20 (1882) 196. — Type: Malaysia, Sabah, Bukit Sagan, *Burbidge s.n.* (K, holo).

Rheophytic herb to 13–20 (–25) cm tall. *Stem* short, erect, 3–4 cm long, c. 1 cm diam. *Leaves* several; petiole minutely tuberculate when dry, relatively short, 2.5–5 cm long, c. 2 mm diam., tinged brown, canaliculate adaxially and with fine strongly to weakly crispate wings, sheathing at the extreme base with the wings extended into a narrow ligular portion 2–4 cm long; blade coriaceous, dark green adaxially, paler abaxially, very narrowly elliptic to oblanceolate, 6–16 cm long × 1.2–3 cm wide, the base cuneate, the apex acute and apiculate for 2–3 mm; midrib very prominent abaxially, somewhat raised adaxially, with 7–9 fine, adaxially obscure primary lateral veins on each side diverging at c. 30° and running to a well-defined submarginal vein; secondary venation very fine and dense; tertiary venation obscure. *Inflorescence* solitary (occasionally two together, but interspersed with foliage leaves); peduncle much exceeding the petioles, 12–15 cm long, erect. *Spathe* held obliquely erect, c. 3 cm long, ovoid, apically beaked for c. 3 mm, creamy white to salmon pink (sometimes pink and whitish), the upper part caducous. *Spadix* free, sessile to very shortly stipitate, 1.5–2 cm long, subcylindric (becoming distinctly narrower at the sterile zone at anthesis — see Notes); female zone 5–6 mm long × 4–5 mm diam.; staminodes absent from among the pistils and usually also the base of the female zone — occasionally one or two present and then subsessile, subglobose, c. 0.5 mm diam., drying white; ovary shortly columnar, c. 1 mm high; stigma sessile, broadly discoid, slightly centrally impressed, contiguous with neighbouring stigmas, c. 0.7 mm diam., coarsely papillate at anthesis; sterile interstice c. 4 mm long and in diam., composed of c. 5 irregular whorls of columnar, irregularly polygonal staminodes with slightly raised rims, c. 0.5 mm diam.; male zone 0.8–1 cm long, basally isodiametric with sterile interstice, slightly tapering to an obtuse tip, fertile to apex or with a few terminal abortive stamens; stamens more or less irregularly rectangular-dumbbell-shaped, flat-topped apart from a shallow groove across the connective running from pore to pore, c. 0.5 mm across; thecae opening through single apical pores with the pollen extruded in threads. *Fruiting spathe* green to brownish, broadly obconic, c. 1.5–1.8 cm diam.; berries clustered, cylindric, topped with old stigma remnants, 1.9–2 mm long, c. 1 mm diam.; seed subcylindric, brown, c. 1.6 mm long, 0.3 mm diam., with long curved micropylar appendage 0.8–1 mm long.

Distribution — *Malesia:* endemic to NW Borneo.

Habitat — Rheophytic among boulders in stream beds or on stream banks, below 100m alt.

Notes — *Piptospatha burbidgei* is distinguished by its usually extremely fine primary venation and the petiole shorter than the blade, the usually very shortly stipitate spadix with the stipe more or less free, not or hardly adnate to the spathe, the coarsely papillate (at anthesis) laterally contiguous stigmas, the sterile interstice and the almost flat-topped glabrous stamens.

Hotta (loc. cit.) illustrated connate pistils. This may appear to be the case in fresh material, but in dried specimens it becomes clear that although the pistils are closely appressed, they are individuated.

Wood SAN 15500 differs from other material in having barely alate, faintly asperous petioles which, together with the midrib, are somewhat thicker than usual. The specimen is in fruit. More material from its locality is required.

Other specimens examined: BORNEO: SARAWAK: 4th Divn, Ulu Tinjar, Mt Dulit, nr Long Kapa, *Richards 1091* (K, L). BRUNEI: Temburong Distr., S. Temburong, above Kuala Belalong, *Argent et al. 9142* (K); Temburong Distr., Sg. Temburong at Kuala Belalong, *Boyce et al. 355* (K, L); Temburong Distr., Sg. Tongkat, a branch of Sg. Batu Apoi, *Hotta 13735* (L); Temburong Distr., Batu Apoi FR, *Poulsen 19* (K). SABAH: Kalabakan Distr., Ulu Segama, *Krispinus SAN 95575* (K); Tawau Distr., Tawau River FR, *Meijer SAN 19468* (K, L); Sipitang Distr., Ulu Moyah, 8 mi SSE of Malamau, *Wood SAN 15500* (L, SING).

3. Piptospatha elongata (Engl.) N.E. Br.

Piptospatha elongata (Engl.) N.E. Br., Curtis's Bot. Mag. 51 (1895) in descr. ad t. 7410; Engl., Pflanzenr. 55 (IV.23Da) (1912) 124, fig. 75; Ridl., J. Bot. 51 (1913) 202. — *Rhynchopyle elongata* (Engl.) Engl., Bot. Jahrb. Syst. 1 (1881) 184 & in Becc., Malesia 1 (1882) 289, pl. 23, figs 3–15. — *Schismatoglottis elongata* Engl., Bull. Soc. Tosc. Ortic. (1879) 298. — Type: Malaysia, Sarawak, Lundu, G. Gading, June 1867, *O. Beccari P.B. 2308* (FI, holo).

Schismatoglottis marginata Engl., Bull. Soc. Tosc. Ortic 4 (1879) 298. — *Rhynchopyle marginata* (Engl.) Engl., Bot. Jahrb. Syst. 1 (1881) 184 & in Becc., Malesia 1 (1882) 288, pl. 23, figs 1–2. — *Piptospatha marginata* (Engl.) N.E. Br., Curtis's Bot. Mag. 51 (1895) in descr. ad tab. 7410; Engl., Pflanzenr. 55 (IV.23Da) (1912) 125 — Type: Malaysia, Sarawak, *O. Beccari P.B. 3838* (FI, holo; iso B).

Gamogyne pulchra N.E. Br., Kew Bull. (1910) 197 & Curtis's Bot. Mag. 135 (1910) t. 8330. — Type: see notes.

Piptospatha rigidifolia Engl., Pflanzenr. 55 (IV.23Da) (1912) 127. — Type: Malaysia, Sarawak, 1st Divn, Lundu, Sep 1905, *H.N. Ridley s.n.* (SING, lecto — **selected here**).

?Piptospatha angustifolia Engl. ex Alderw., Bull. Jard. Bot. Buitenzorg III, 4 (1920) 193; Bogner, Pl. Syst. Evol. 142 (1983) 52. — Type: Indonesia, Kalimantan, *H. Hallier 614* (BO, holo).

Rheophytic herb 16–40 cm high. *Stem* condensed, 2–6 cm long, 0.8–1.3 cm diam. with robust more or less reddish-tinged roots 1.5–2.5 mm diam. *Leaves* several to 12 together; petiole 6–15 cm long, 1.5–2.5 mm diam., slightly canaliculate adaxially, sheathing only at the extreme base, the wings extended into a narrowly triangular purple to reddish ligular portion 3–8 cm long drying dark brown; blade very narrowly elliptic to narrowly elliptic-oblong to oblanceolate, coriaceous, dark green adaxially, paler abaxially, 10–24 cm long × 1.5–3.5 cm wide, the base cuneate, the apex acute and apiculate for 2–3 mm; midrib robust, abaxially prominent, adaxially impressed, with (6–)7–10 primary lateral veins on each side diverging at 35–45° and more or less regularly alternating with lesser interprimary veins especially in the lower half of the blade; secondary venation adaxially more or less obscure, abaxially fine and dense; tertiary venation obscure. *Inflorescence* solitary (or 2–3 together but then alternating with foliage leaves); peduncle shorter than to equalling, rarely exceeding the length of the whole leaf, 11–22 cm long, 1.8–2.2 mm diam., purple to reddish. *Spathe* more or less nodding at anthesis, subcylindric–obovoid, 3–4 cm long, apically beaked for 3–4 mm, pink, opening in the upper third, then the upper part caducous. *Spadix* cylindric, more or less sessile, or somewhat stipitate and then with the stipe adnate to the spathe, 2–2.5 cm long, 0.4–0.5 cm diam.; female zone cylindric, 5–7 mm long, 5–7 mm diam.; ovary subcylindric to subprismatic, c. 0.9 mm diam.; stigma sessile, as broad as the ovary, thinly discoid; interpistillar staminodes absent from among the pistils; neuter organs (staminodes or possibly pistillodes) confined to 1–3 irregular and somewhat oblique rows at the base of the female zone, truncate, more or less sessile, 0.7–0.9 mm diam., about as high as the pistils; sterile interstice absent; male zone cylindric, isodiametric with female zone, 1.3–1.7 cm long, apically obtuse; stamens crowded, truncate, the connective not raised, more or less rectangular from above, glabrous, 1.2–1.4 mm

across. *Fruiting spathe* broadly funnel-shaped, erect, 1.2–1.5 cm diam.; berry obovoid, c. 3.5 mm long × 1.2–2 mm diam.; seed cylindric, very slightly ribbed, 1.4–1.6 mm long, brown but outer integument translucent, with a long curved micropylar appendage which rots away in old seeds.

Distribution — *Malesia:* endemic to Borneo (West Kalimantan and SW Sarawak; one collection from East Kalimantan and one from G. Mulu).

Habitat — Rheophytic on rocks in and beside streams and on waterfall ledges, on a variety of substrates including limestone, 100–1000 m alt.

Notes — *Piptospatha elongata* closely resembles *P. grabowskii*, and differs chiefly in the caducous upper spathe and the consequently differing form of the fruiting spathe.

Gamogyne pulchra was described from living material cultivated at Kew which Ridley (1913) collected at G. Gading, near Lundu in Sarawak. Very shortly after it was first published, it figured in Curtis's Botanical Magazine (loc. cit.). For this revision, we have not been able to study thoroughly the material which N.E. Brown preserved, as it was on loan elsewhere at the time this work was carried out. We have, however, cursorily examined it on previous occasions. Brown also cited in the protologue a specimen of Ridley's from G. Pulai, Johor, which is *P. ridleyi*. Since the Bornean plant was clearly that intended to be *G. pulchra*, and the inclusion of material of *P. ridleyi* a mistake, it would be undesirable to lectotypify with the specimen of *P. ridleyi*. We have not taken any action to lectotypify *G. pulchra*, but have been guided in the application of this name by the above-cited plate and by comparison with the large quantity of material of *Piptospatha* which has been collected from G. Gading, all of which conforms with *P. elongata*.

Piptospatha marginata falls uncontroversially within *P. elongata*, sharing similar leaf venation and shape, spadix morphology and the caducous spathe limb.

The specimen selected as lectotype of *P. rigidifolia* is the best preserved of the syntypes we have examined.

Piptospatha angustifolia appears to conform with *P. elongata*, but the type is now lacking inflorescence details and it is included here in the synonymy of *P. elongata* provisionally.

Other specimens examined: BORNEO: SARAWAK: 4th Divn, G. Mulu NP, Sg. Lansat, *Argent et al. 692* (L); Serian, Sg. Renchang, *Ashton S21298* (K, L); 1st Divn, Tabakang, B. Alak, *Awa & Paie S45730* (K); Lundu, *Brooke 8410* (L); Lundu, G. Gading, *Chai S18484* (GH, K, L, SING); 1st Divn, Lundu, G. Gading, *Clemens & Clemens 21924* (GH, K); 1st Divn, Lundu, G. Gading, *Foxworthy 326* (SING); Lingga, Batu Gajah, *Hullett s.n.* (SING); Lundu, Sebuluh, *Ismawi et al. S62244* (K); 1st Divn, Padawan, Stabut, *Mamit S29953* (K); 1st Divn, Lundu, Sg. Batu, *Mamit S35218* (K, L); 1st Divn, G. Sirang, nr Sarawak/Kalimantan border, *Mamit S35875* (L); 1st Divn, Lundu, G. Gading, *Micholitz s.n.* (SING); Matang FR, 10 mi W of Kuching, *Nicolson 1264* (K, L); Lundu, G. Gading, *Purseglove & Shah P4534* (K, L, SING); 1st Divn, Lundu, G. Gading, *Sinclair & bin Tassin 10365* (K, L, SING); Sg. Pasir Ulu, *Yahud et al. S61925* (K); 1st Divn, Kg Sadil, Mini Hydro Station, *Yii S51335* (K). KALIMANTAN: W Kalimantan, Serawai, 3 km S of Nanga Jelundung, *Church et al. 2787* (K); E Kalimantan, Pujungan Distr., Kayan Mentarang Reserve, in Puak R. Valley N of Batu Mayo mt, c. 8 km NW of Puak vill., *McDonald & Ismail 3615* (GH); Bukit Tikau, *Nieuwenhuis 432* (B); Bidang Menabei, *Winkler 798* (HBG).

4. Piptospatha insignis N.E. Br.

Piptospatha insignis N.E. Br., Gard. Chron. 11 (1879) 138, fig. 20; Hook.f., Curtis's Bot. Mag. 107 (1881) t. 6598; Engl., Pflanzenr. 55 (IV.23Da) (1912) 127. — Type: Cult. RBG Kew ex Malaysia, Sabah, (orig. coll. *Burbidge 95*), *N.E. Brown s.n.* (K, holo; iso BM — fide Boyce and Bogner in Hay et al., 1995: 97).

Small herb c. 12 cm tall. *Stem* condensed, c. 1 cm diam. *Leaves* several; petiole shorter than the blade, 3–5 cm long, sheathing at the extreme base, the wings extended into a ligular portion to 5 cm long drying dark brown; blade very narrowly lanceolate to very narrowly elliptic 9–14 cm long × 0.8–1.8 cm wide, coriaceous, dark green adaxially, paler abaxially, the base cuneate-decurrent, asymmetric, the tip acuminate and apiculate for 2–3 mm, the margin slightly revolute; midrib abaxially and adaxially prominent, with 3 fine primary lateral veins on each side diverging at c. 25° running to a marginal vein; secondary venation adaxially obscure, abaxially very faint; tertiary venation obscure. *Inflorescence* solitary (to 2–3 together, but interspersed with foliage leaves); peduncle exceeding the petioles, 6–9 cm long, reddish. *Spathe* at first erect, then horizontal, then nodding at anthesis, white suffused pink, the apex entirely pink, slightly upturned, apiculate for 2 mm. *Spadix* 1.5 cm long, subcylindric, shortly stipitate with the stipe adnate to the spathe; female zone 5 mm long, 4 mm diam.; pistils ovoid, c. 0.8 mm diam., weakly 4–5-angular; stigma sessile, discoid, weakly angular, as wide as the ovary; interpistillar staminodes absent among the pistils, several along the adaxial side of the stipe, a few at the base of the female zone on the abaxial side, stipitate, clavate, slightly taller than the pistils, the tops c. 0.6 mm diam.; sterile interstice absent; male zone subcylindric, obtuse, slightly wider than female zone, c. 8 mm long; stamens free, crowded, not obviously grouped, c. 0.6 mm across, with the connective elevated into a pointed projection c. 1 mm long; thecae truncate, opening through single apical slit-like pores. *Fruit* unknown, the lower spathe persisting level with the top of the female zone.

Distribution — *Malesia:* endemic to Borneo (Sabah); known only from a cultivated plant from which the type and subsequent material was preserved, all without specific provenance indicated.

Habitat — Unknown; probably rheophytic.

Notes — We have been unable to make a detailed examination of the type (K) for this revision, as it was on loan elsewhere at the time this work was carried out. However, J.B. has examined it on a previous occasion, and we have been able to study subsequent material gathered from the same plant preserved at K.

This species is unique in the genus in its long-projecting connective.

Other specimens examined: BORNEO: ?SABAH: Cult. RBG Kew ex Hort. Veitch May 1881, *Brown s.n.* (K) & May 1892, *Anon. s.n.* (K).

5. Piptospatha manduensis *A. Hay & Bogner*, **sp. nov.**

A *Piptospatha truncata* antheris puberulis, staminodiis infra inflorescentiam femineam robustioribus, inflorescentia mascula ad apice fertili differt. — TYPUS: Indonesia, East Kalimantan, Sangkulirang District, Sg. Mandu Region, North of Sangkulirang, 14 Aug 1957, *A. Kostermans 13493a* (L, holo; iso K, SING).

Diminutive rheophytic herb to 14 cm tall. *Stem* decumbent-creeping to c. 5 cm long, c. 2.5 mm diam., with internodes c. 2 mm long. *Leaves* to 8 together, clustered or distributed along the stem; petiole 3–8 cm long, c. 1.3 mm diam., adaxially somewhat canaliculate and narrowly crisped-alate, sheathing at the extreme base, the wings extended into a narrowly triangular ligular portion to 2 cm long; blade weakly coriaceous, elliptic, 4–6 cm long × 2–3 cm wide, the base broadly acute to obtuse, the apex acute and apiculate for 1–2 mm; midrib slightly prominent abaxially, adaxially flush with the lamina, with 2–3 primary lateral veins on each side, irregularly alternating with lesser interprimaries, diverging at 45–60° and joining a conspicuous submarginal vein; secondary venation adaxially obscure, abaxially fine and somewhat distant (c. 1 mm apart); tertiary venation adaxially obscure, abaxially obscure or forming a very faint tessellate reticulum. *Inflorescence* solitary; peduncle (subequalling to)

exceeding the leaves, 7–11 cm long. *Spathe* narrowly ovoid, 2–2.5 cm long with a slightly up-turned beak c. 3 mm long, pink with darker red stripes, the upper c. half caducous. *Spadix* 0.8–1.2 cm long, subcylindric, free; female zone 2–3.5 mm long; ovary ovoid, 1–1.2 mm diam.; stigma sessile, discoid, about as wide as the ovary, papillate, drying dark brown; interpistillar staminodes absent from among the pistils, confined to 3–5 oblique whorls at the base of the female zone, flat-topped, shortly stipitate, irregularly polygonal, slightly wider than the ovaries; sterile interstice absent; male zone shortly cylindric, apically obtuse, fertile throughout, c. 0.6 cm long, c. 4 mm diam.; stamens crowded, truncate, rectangular ellipsoid from above, 0.9–1 mm across, apically minutely and densely hairy; theca opening through an apical pore. *Fruiting peduncle* not much elongating; fruiting spathe broadly funnel-shaped, to 1 cm long and wide; berries clustered, subcylindric to obovoid with persistent stigma remnant, 3–3.3 mm long; seed subcylindric with a curved micropylar appendage as long as the body of the seed, appendages interlinked in the fruit holding the seeds together; testa light brown and slightly longitudinally ribbed. — **Fig. 4.**

Distribution — *Malesia:* Borneo — (East Kalimantan); known only from the type locality.

Habitat — On travertine in river, 50 m alt.

Notes — *Piptospatha nanduensis* resembles *P. truncata* in its diminutive habit, but differs in the hairy stamens, the male zone fertile to the apex and in the more robust zone of staminodes below the female zone. *Piptospatha kinabaluensis* is of similar dimensions, but differs in the persistent spathe to which the lower part of the spadix is adnate and the staminodes confined to the spathe/spadix adnation. *Piptospatha kinabaluensis* is a montane species.

6. Piptospatha perakensis (Engl.) Engl.

Piptospatha perakensis (Engl.) Engl., Pflanzenr. 71 (IV.23E) (1920) 2* [i.e. supplementary pages]; Ridl., Fl. Mal. Pen. 5 (1925) 114; Henderson, Malayan Wildfl., Monocots (1954) 232, fig. 138, A (excl. fig. 138, B — i.e. *P. elongata*). — *Piptospatha elongata* var. *perakensis* Engl., Pflanzenr. 55 (IV.23Da) (1912) 125. — *Rhynchopyle perakensis* (Engl.) Ridl., J. Bot. 51 (1913) 202. — Type: Malaysia, Malacca, Tampin Hill, Waterfall, May 1894, *J.S. Goodenough 1850* (SING, lecto; isolecto CAL — **selected here**).

[*Schismatoglottis elongata* auct. non Engl.: Hook.f., Fl. Brit. Ind. 6 (1893) 539.]

[*Piptospatha elongata* auct. non (Engl.) N.E. Br.: Ridl., Mat. Fl. Mal. Pen. 3 (1907) 35].

Rheophytic herb 10–40 cm tall. *Stem* short, condensed, 2–4 cm long, 0.7–1 cm diam.; roots thick, extensive and tough, 1.5–2 mm diam., with many thinner roots of second order. *Leaves* few to several together; petiole 6–15 cm long, 1.5–2 mm diam., canaliculate on upper side, sheathing only at the extreme base, the wings extended into a narrow ligular portion 3–7 cm long; blade coriaceous, adaxially dark mid-green, paler abaxially, elliptic (to oblong elliptic) 10–26 cm long × 1.5–7 cm wide, the base cuneate, the apex acute and shortly apiculate for 1–1.5 mm, the margin weakly to strongly crispate especially in the distal part; midrib and primary venation very prominent abaxially, drying pale orange to straw-coloured; primary lateral veins 5–8(–10) on each side of the midrib, diverging at c. 45°, running to a thick marginal vein; secondary venation distinctly finer than primaries. *Inflorescence* solitary (sometimes 2–3 in series but alternating with foliage leaves); peduncle erect, 3–16 cm long. *Spathe* nodding at anthesis, narrowly ovoid, c. 3 cm long, apically beaked for c. 4 mm, cream to greenish, the upper part caducous. *Spadix* c. 2 cm long, shortly stipitate with the stipe adnate to the spathe; female zone subcylindric, c. 0.7 cm long × 0.5 cm diam.; pistils more or less ovoid, c. 0.5 mm diam.; stigma sessile, thickly discoid, about as broad as the ovary (dry), papillate, not contiguous with neighbouring stigmas (dry); interpistillar staminodes confined to a small group or irregular whorl at the base of the

Fig. 4. *Piptospatha manduensis* A. Hay & Bogner. **a**, Habit; **b**, Infructescence; **c**, Spadix; **d**, Berry; **e**, Seed. (*Kostermans 13493a*). Scale bar: a, b = 2 cm; c = 4 mm; d = 1.4 mm; e = 1 mm

female zone, stipitate, flat-topped, about as high as the pistils, c. 0.5 mm diam.; sterile interstice absent; male zone fertile to apex, bluntly ellipsoid-subcylindric, c. 1 × 0.5 cm; stamens truncate, more or less flat-topped (somewhat rounded), narrowly rectangular-elliptic from above, mostly in closely appressed pairs, the anther finely and densely pubescent, c. 0.8 mm across. *Fruiting spathe* obconic, green; berries yellowish when ripe, in a more or less hemispherical group c. 1.5 cm diam., obovoid, 2.2–2.4 mm long × 1.5 mm diam., with persistent stigma remnant apically; seeds several, subcylindric, c. 1–1.2 mm long; testa slightly ribbed, brown, with a prominently curved micropylar appendage. — **Fig. 5.**

Distribution — Southern Thailand to West Malesia. In *Malesia:* Malay Peninsula.

Habitat — Rheophytic on boulders in streams and by waterfalls and stream banks, 100– c. 1400 m alt.

Notes — This species is distinguished by the abaxially prominent midrib and primary venation which dries pale orange to straw-coloured, the spadix with basal staminodes but contiguous male and female zones, and the truncate pubescent anthers.

Piptospatha perakensis is very variable in size even at one locality; depauperate plants may flower when as little as 10 cm tall.

Engler cited several syntypes in the protologue of *P. elongata* var. *perakensis* (Engler, loc. cit.). They are conspecific. We have selected that with the best-preserved flowering structures as lectotype.

Other specimens examined: MALAY PENINSULA: Selangor, Ulu Langat, above Pansoon, *van Balgooy 2246* (L); Kelantan, Tanah Merah, Pergau Dam site, logging rd to Sg. Suih Intake, *Boyce 665* (K); Perak, Bukit Larut, *Boyce 691* (K); Pahang, Cameron Highlands, Sg Uruil, *Burkill 780* (SING); Perak, ?Taiping Hills [sic], *Curtis s.n.* (SING); Pahang, Ulu Telom, *Dolman 27615* (SING); Perak, Batang Padang, Jor, *Henderson 10824* (SING); Cult. RBG Sydney Acc. No. 940301 ex Terengganu, Sekayu, Ayer Terjun (orig. coll. *Hay 9233*), *Herscovitch s.n.* (K, NSW); Negeri Sembilan, G Tampin, *Holttum 9543* (K,SING); Terengganu, Batu Biwa, *Kiew RK2352* (SING); Perak, Sg. Groh, hills E of Gopeng, *Ng FRI 1588* (SING); Perak, Maxwell's Hill, *Nicolson 1093* (SING); Pahang, Raub, *Poore 859* (K); Selangor, Pahang Track, *Ridley s.n.* (SING); Negeri Sembilan, Tampin Waterfall, *Ridley s.n.* (K); Pahang, Upper Tahan R, *Ridley s.n.* (SING); Selangor, Ulu Gombak, *Ridley s.n.* (K); Pahang, Sg. Tahan, *Ridley s.n. & 2395* (both SING); Selangor, Semankok Pass, *Ridley 12026* (SING); Pahang, Telom, *Ridley 13843* (K); Perak, *Scortechini 1317* (K, SING); Perak, Maxwell's Hill, *Wray 3222* (SING). **THAILAND:** Pattani, Bacho 'Bachaw', *Kerr 7210* (K).

7. Piptospatha ridleyi N.E. Br. ex Hook. f.

Piptospatha ridleyi N.E. Br. ex Hook.f., Curtis's Bot. Mag. 51 (1895) t. 7410; Ridl., Mat. Fl. Mal. Pen. 3 (1907) 35; Engl., Pflanzenr. 55 (IV.23Da) (1912) 127; Ridl., Fl. Mal. Pen. 5 (1925) 114. — Type: Cult. RBG Kew ex Malaysia, Johor, (orig. coll. *H.N. Ridley*), ?1893, *N.E. Brown s.n.* (K, holo).

Piptospatha ridleyi var. *lanceolata* Ridl., Fl. Mal. Pen. 5 (1925) 114. — Type: Malaysia, Johor, Ulu Kahang, 1 Jun 1923, *R.E. Holttum 10865* (SING, holo).

Rheophytic herb (8–)10–30(–40) cm tall with strong extensive roots 1–2 mm diam. *Stem* condensed, 1–3 cm long, 5–8 mm diam. *Leaves* few to several together; petiole (3–)5–15(–18) cm long, 0.9–2.5 mm diam., often reddish, adaxially canaliculate, sheathing only at the extreme base, the wings extended into a narrow ligular portion 2–7 cm long at first reddish then drying brown; blade (narrowly) elliptic (4–)6–18(–23) cm long × (1–)2.5–6(–8) cm wide, coriaceous, the base cuneate, the apex acute and apiculate for 1–3 mm, adaxially dark green, usually but not always variegated in an irregularly spattered pattern of paler green, abaxially paler; midrib abaxially very prominent, adaxially slightly impressed, with (3–)4–7(–10) primary lateral veins on each side, diverging at c. 30–60°, running to a distinct submarginal vein; primary lateral veins

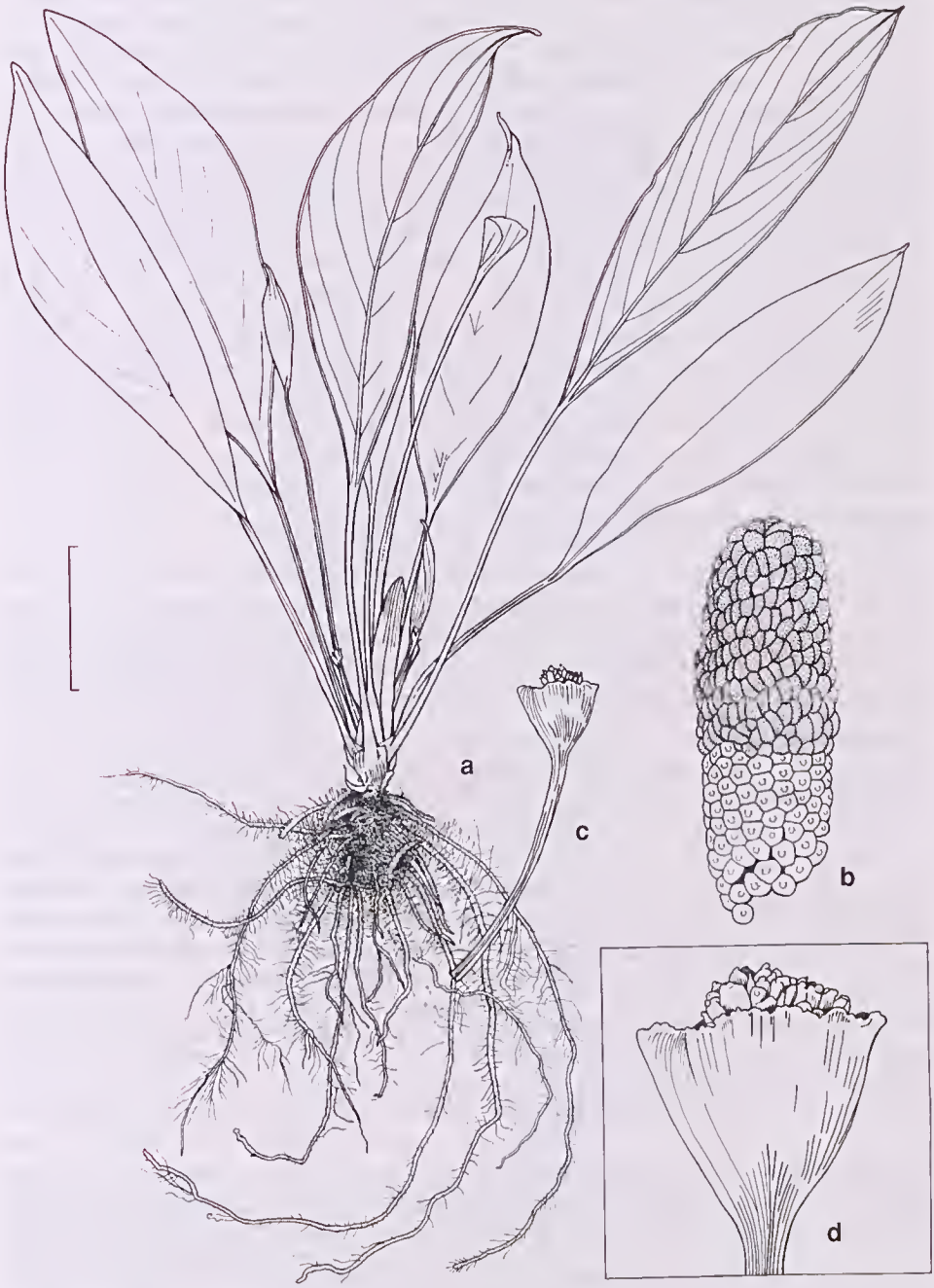

Fig. 5. *Piptospatha perakensis* (Engl.) Engl. **a,** Habit; **b,** Spadix; **c,** Infructescence; **d,** Infructescence enlarged. (a: *Poore 859*; b: RBG Sydney Acc. No. 940301; c,d: *Holttum 9543*). Scale bar: a, c = 3 cm; b = 6.7 mm; d = 1 cm.

not or hardly prominent abaxially, rather fine; secondary venation adaxially obscure; tertiary venation forming a faint tessellate reticulum (dry). *Inflorescence* solitary; peduncle much exceeding the petioles at anthesis, 10–25 cm long, pale reddish brown (?always); spathe broadly ovoid, c. 2.5–3 cm long, pink in the caducous upper part with darker veins and small dots, the lower part green, apically rather abruptly beaked for c. 3 mm, at anthesis gaping in the distal part. *Spadix* subcylindric-clavate, about half the length of the spathe, shortly stipitate with the stipe fully adnate to the spathe; female zone c. 5 mm long × 4 mm diam.; pistils more or less ovoid, c. 0.5 mm diam.; stigma very slightly raised on an indistinct style, rather thickly discoid, about the diameter of the ovary; interpistillar staminodes restricted to an irregular whorl at the base of the female zone, whitish, more or less obpyramidal and shortly stipitate, about half the height of the pistils; sterile interstice absent; male zone ellipsoid, slightly but distinctly broader than the female zone, c. 7 mm long × 6 mm diam., fertile to apex; stamens truncate, more or less rectangular-dumbbell-shaped, rather irregularly aligned in pairs, the connective somewhat to distinctly mounded between the pores and usually finely and densely pubescent (occasionally glabrous). *Fruiling spathe* broadly obconic, c. 1.5 cm diam.; berries clustered, subcylindric to obovoid, 2–3 mm long, 1.1–1.5 mm diam.; seed subcylindric to elongate ellipsoid, 1.5–1.8 mm long, 0.5–0.6 mm diam., brown; testa longitudinally ribbed, with a long curved transparent micropylar appendage c. 1.5 mm long, the appendages interlinked in fruit.

Distribution — *Malesia*: Malay Peninsula (Johor; one collection from Pahang).

Habitat — Rheophytic on rocks in and along streams, 100–900 m alt.

Notes — *Piptospatha ridleyi* is distinguished from *P. perakensis*, to which it is evidently closely allied, by the fewer, weaker primary lateral veins, not drying straw-coloured, the frequently variegated leaf blade, the pink spathe, the basal staminodes more or less obpyramidal and the stamens not arranged in such distinct pairs as those of *P. perakensis*.

The type, made from a plant cultivated at Kew sent in 1893 by Ridley from Johor, is deposited at K. Although we have examined it cursorily on previous occasions, we were unable thoroughly to study it for this revision as it was on loan elsewhere at the time this work was carried out. The above-cited plate in Curtis's Botanical Magazine, and the accompanying description, seem atypical only in the very robust proportions of the inflorescence (about twice the size of the wild-collected specimens) and in the very boldly spattered variegation pattern, which is more finely maculate in the wild-collected specimens. The stamens are illustrated with a distinctly mounded pubescent connective: both the degree of pubescence and the extent to which the connective is raised vary among the other material we have examined. The larger dimensions of the spathe portrayed in the type are not included in the description here, as they may be an error or an artefact of cultivation.

Ridley's var. *lanceolata* is linked to more broad-leaved forms by intermediates and there seems no basis for maintaining it.

Other specimens examined: MALAY PENINSULA: Johor, G. Pulai, *Ahmad SA 1044* (SING); Johor, G. Pulai, *Best 7720* (SING); Johor, G. Pulai, N side, *Burkill 2577* (K, L, SING); Johor, Sg. Pelopah Kiri, *Corner 33580* (K, L, SING); Johor, Sg. Bebatu, *Distr. Forest Officer s.n.* (SING); Johor, G. Pulai, *Henderson 28156* (SING); Johor, Sg. Gatong, Labis FR, *Henderson 38252* (SING); Johor, Ulu Kahang, *Holttum 10865* (K); Johor, G. Muntahak, *Holttum 19934* (K, SING); Johor, Ulu Endau, Sg. Jawang, *Kiew RK2033* (SING); Johor, G. Pulai, *Maxwell 78-14* (L); Johor, Bukit Tunjok Laut, *Ngadiman 36933* (K, L, SING); Johor, G. Pulai, *Mhd Nur s.n.* (SING); Johor, G. Panti, *Ridley s.n.* (SING); Johor, G. Pulai, *Ridley 12191* (SING); Pahang, Rompin, Lesong FR, Sg. Linchin, nr. Sg. Kayu Pagar, *Saw FRI 37551* (K); Johor, Kluang, G. Blumut, *Mhd Shah & Sanusi 2229* (SING); Johor, G. Pulai, Sg. Ayer Hitam Besar, *Sinclair 10577* (B, K, L).

8. Piptospatha truncata *(M. Hotta) Bogner & A. Hay*, **comb. nov.**

Microcasia truncata M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1965) 22, fig. 2. — *Hottarum truncatum* Bogner & Nicolson, Aroideana 1 (1978 '1979') 72. — Type: Malaysia, Sarawak, Bintulu, along Ulu Sg. Kakus, between Sg. Biyah and Sg. Mubong, 11 Nov 1963, *M. Hirano & M. Hotta 1012* (KYO, holo — photo K).

Herb 10–13 cm tall. *Stem* short, c. 1 cm long, 0.3–0.5 cm diam., ascending. *Leaves* to 9 together; petiole shorter to longer than the blade, 3–7 cm long, adaxially canaliculate with crispate margins, sheathing at the extreme base, the wings extended into a lanceolate ligular portion 2–3.5 cm long; blade dark green above, paler below, coriaceous, oblong-elliptic to oblanceolate, the apex acute or rounded and apiculate for 1–2 mm, the base attenuate to cuneate, the margin very minutely undulate and slightly revolute, 4–7 cm long, 1.5–2.3 cm wide; midrib abaxially and adaxially prominent, with 3–5 adaxially rather obscure primary lateral veins on each side diverging at 35–45° then running towards the tip; secondary venation adaxially obscure, abaxially fine and dense; tertiary venation obscure. *Inflorescence* solitary; peduncle 5–11 cm long, 9–13 cm long in fruit. *Spathe* 1.7–2.8 cm long, the lower part convolute and persistent, the upper part gaping and caducous. *Spadix* 1–1.7 cm long, weakly clavate; female zone 2–4 mm long, c. 2 mm diam.; ovary depressed globular, 0.9 mm diam., with basal placentation; stigma sessile, discoid, centrally impressed, narrower than the ovary, c. 0.5 mm diam.; interpistillar staminodes absent from among the pistils, one or two or an irregular whorl at the base of the female zone, sessile, truncate, slightly narrower and lower than the pistils; male zone 6–10 mm long, somewhat ellipsoid, 2.5 mm diam., at the base with a few sterile stamens, with the apical 1.5 mm slightly narrowed, rounded and bearing sterile stamens; stamens crowded, truncate, glabrous, arranged more or less in longitudinally aligned pairs, rectangular-elliptic from above, c. 1.3 mm across, with thecae opening through single apical pores. *Fruiting spathe* funnel-shaped, c. 1 cm diam., containing a cluster of berries; berry depressed globular, 1.3–1.5 mm diam., crowned with the persistent stigma; seed 1–1.2 mm long, c. 0.5 mm diam., slightly curved, dark brown, rough, barely ribbed, with a long curved and transparent micropylar appendage c. 1 mm long.

Distribution — *Malesia*: Borneo (endemic to Sarawak).

Habitat — Apparently rheophytic — the only habitat record in Hotta (loc. cit.) is from *Hirano & Hotta 1012* (KYO), saying 'on wet riverside rock'. A later collection (*Burtt & Martin 4922*) notes 'rocks in river'. *Brooke 8954* notes 'on bank of river under trees'. Altitudinal data are wanting, but the original collections are from areas of low elevation.

Notes — This species clearly belongs in *Piptospatha* on the basis of the truncate stamens and unconstricted long-pedunculate and nodding spathe of which the upper half is caducous. It differs from *P. manduensis*, which it resembles in its diminutive size and caducous upper spathe, in its glabrous anthers and in the apical part of the male zone forming a short sterile appendix.

Vegetatively *Piptospatha truncata* very closely resembles the more common *Bucephalandra motleyana* and *Aridarum caulescens*. These three species can only be reliably distinguished with flowering material. However, the dry material of *P. truncata* has extremely dark adaxial sides of the leaves.

Other specimens examined: BORNEO: SARAWAK: Nanga Mujong, *Brooke 8954* (L, SING); Hose Mts, Gorge of Sg. Simpurai, *Burtt & Martin 4922* (E); 4th Divn, Bintulu Distr., along Ulu Sg. Kakus from Sg. Tingli to Sg. Biyah, *Hirano & Hotta 845* (KYO); 7th Divn, Kapit, Balleh, Ulu Sg. Mengiong, Sg. Entemu, *Othman et al. S61727* (K).

Piptospatha grabowskii group

Spathe entirely persistent.

3 species, Borneo.

9. Piptospatha grabowskii (Engl.) Engl.

Piptospatha grabowskii (Engl.) Engl., Pflanzenr. 55 (IV.23Da) (1912) 125. — *Rhynchopyle grabowskii* Engl., Bot. Jahrb. Syst. 25 (1898) 20 & Araceae exsicc. et illustr. No. 196 (sine diagnosi). — Type: Indonesia, South East Kalimantan, Mindai-Pramassamalai hills, on rocks of waterfalls of the Pitanakan, 17 Jun 1882, *F. Grabowski s.n.* (B, holo).

Piptospatha havilandii (Engl.) Engl., Pflanzenr. 55 (IV.23Da) (1912) 128. — *Rhynchopyle havilandii* Engl., Bot. Jahrb. Syst. 37 (1905) 125. — *Schismatoglottis havilandii* (Engl.) M. Hotta, Mem. Coll. Sci. Univ. Kyoto, Ser. B, 32 (1966) 233. — Type: Malaysia, Sarawak, Rejang, Belaga, Nov 1892, *G.D. Haviland 2191* (BM, holo — n.v.; iso CAL, K, SING).

[*Piptospatha elongata* sensu auct. non (Engl.) N.E. Br.: Mayo et al., Genera of Araceae (1997) 186, pl. 50A; Beaman & Beaman, Pl. Mt Kinabalu 3 (1998) 80, pl. 8A.]

Rheophytic herb 20–50 cm tall. *Stem* c. 4–8(–20) cm long, mostly condensed, occasionally more elongate with internodes to 1 cm long, 0.6–1.5 cm diam., roots strong, 2.5–4 mm diam. *Leaves* c. 4–8 together; petiole green to purple, 6–23 cm long, 2.5–3 mm diam., adaxially canaliculate, sheathing only at extreme base, the wings extended into a narrowly triangular ligular portion 5–10 cm long; blade narrowly elliptic to elliptic-oblong, 12–28 cm long × 4–10 cm wide, dull mid- to dark green adaxially, very rarely variegated in an irregular spattered pattern, abaxially paler, coriaceous, the base cuneate, the apex acute and apiculate for 2–3 mm; midrib prominent abaxially, adaxially somewhat impressed, sometimes abaxially purple, with 8–14(–20) primary lateral veins on each side, more or less regularly alternating with lesser interprimaries and diverging at c. 45–60°; secondary venation abaxially fine, adaxially obscure; tertiary venation obscure. *Inflorescence* solitary (sometimes a few together but alternating with foliage leaves); peduncle 10–22 cm long, 2–3 mm diam., always shorter than the leaves, green to purple. *Spathe* ovoid-subcylindric, (2–)3–5 cm long, 0.8–1.4 cm diam., apically beaked for 2.5–4 mm, persistent, rose pink to purple to brownish pink, more or less nodding at anthesis. *Spadix* (1.2–)2.2–3 cm long, subcylindric to slightly clavate, shortly stipitate with the stipe adnate to the spathe, white to yellowish; female zone (0.3–)0.5–1 cm long, 0.3–0.9 cm diam.; ovary ovoid, weakly angled, c. 1.4 mm diam.; stigma sessile to raised on a short style to 0.5 mm long, discoid, about as wide as the ovary, drying almost black; interpistillar staminodes absent from among the pistils, confined to a robust zone below the female zone of up to 6 oblique whorls; staminodes shortly stipitate, to 1.2 mm diam., irregularly polygonal, flat-topped with the centre usually somewhat impressed and the margins pale coloured (? with dried exudate); sterile interstice absent; male zone cylindric to ellipsoid, apically obtuse, fertile to apex; stamens crowded, mostly arranged in pairs, truncate, flat-topped, more or less rectangular from above, c. 1.1 mm across, minutely hairy on the upper surface especially at the margins; thecae opening through single apical pores. *Fruiting spathe* ovoid-subcylindric, green to reddish green to greenish brown, obliquely erect, to 5 cm long, persistent then eventually more or less disintegrating; fruits in a dense cluster; berry broadly obovoid, crowded with old stigma remnant, 2–2.5 mm long, 2.8–3.2 mm diam.; seed subcylindric, 2.4–2.6 mm long, slightly ribbed, light brown with a transparent long curved micropylar appendage. — **Fig. 6.**

Distribution — *Malesia:* endemic to Borneo (Sarawak, Sabah, scattered localities in Kalimantan).

Fig. 6. *Piptospatha grabowskii* (Engl.) Engl. **a, b,** Habit, broader and narrower-leaved forms; **c,** Spadix. (a: *Paie S 45112*; b: *Boyce 1434*; c: *Chai S 36010*). Scale bar: a, b = 4 cm; c = 4 mm.

Habitat — Rheophytic in and beside streams and waterfalls over a variety of substrates including ultramafic, limestone etc., lowlands to c. 2000 m alt.

Notes — *Piptospatha grabowskii* is distinguished from *P. elongata*, which it resembles especially in gross spadix morphology, by the persistent spathe, more or less hairy anthers (especially on the upper margins) and the usually larger zone of staminodes below the female zone. In a number of specimens there appears to be a more or less distinct style, but this is not universal, some plants having, like *P. elongata*, sessile stigmas. Generally the leaves of *P. grabowskii* are relatively broader and with more primary veins.

The type of *Piptospatha havilandii* differs little from that of *P. grabowskii*, having slightly narrower leaves and short styles. However, they very closely resemble each other in the several basal whorls of staminodes on the spadix, the minutely hairy upper surface of the stamens and the persistent spathe. Plants with subsessile stigmas and broader leaves, thus resembling the type of *P. grabowskii*, together with intermediates, occur in the vicinity of the type locality of *P. havilandii*. Engler's illustration (loc. cit.) of *P. grabowskii* does not show the conspicuous staminodes which are clearly present on the type.

Other specimens examined: BORNEO: SARAWAK: Pakan, *Bogner 1350* (K); Sg. Sibirak, Kg Bilayang, *Bogner 1358* (K); 3rd Divn, Teneong, *Brooke 9137* (L, SING); 1st Divn, 13th mi, Matang, *Brooke 9441 & 9471* (both L); 5th Divn, Bakelalan, *Brooke 10392* (L); 7th Divn, Sg. Kapit beyond Rumah Undut, *Chai S36010* (K, L); 4th Divn, Kelabit Highlands, around Pa Dalih, *Christensen 222 & 604* (both K); 2nd Divn, Lubok Antu, Delok R, nr Nanga Sumpa, *Christensen 1200* (K); Gat, Upper Rejang R, *Clemens & Clemens 22131* (K); Rejang, Kapit, Kalong, *Haviland 3130* (SING); 1st Divn, N slopes of G. Penrissen, *Jacobs 5005* (B, K, L); 1st Divn, Padawan, Tibia Sapit, nr Sarawak/Kalimantan border, *Mamit S25875* (K); 1st Divn, Kg Sadir, c. 50 mi from Kuching, *Mamit S33367* (L); Kalabit Highlands, Batu Lawi, *Nooteboom & Chai 2305* (B, L); 7th Divn, Kapit, Balleh, Sg. Entawau, *Othman S41566* (L); 7th Divn, Kapit, Ulu Belaga, Ulu Sg. Sepako, *Othman et al. S43886* (K); 4th Divn, Merurong Plateau, Ulu Sg. Pesu, *Othman et al. S49116* (K); 7th Divn, *Othman et al. S43886* (L); 7th Divn, Kapit, Sut, Sg. Bena, *Paie S41701*(K, L); 2nd Divn, Simanggang, Tisak Sekarang, Ulu Sg. Panabun, *Paie S45112* (K, L); 2nd Divn, Simanggang, Sekarang, Kg Entalau, Sg. Antu, *Paie S45158* (K, L); Tau Range, Sg. Mayeng, *Purseglove 5298* (K, L, SING); 1st Divn, Padawan, Ulu Sg. Sluba, G. Merubong, *Yii S 51388* (K). KALIMANTAN: without locality, *Amdjah 234* (K, L); S Kalimantan, foot of G. Besar, Ratan Arai to Bato Kamba, *Murata 4250* (L); E Kalimantan, Wanariset, Long Sg. Barang, *van Valkenburg 1040* (K); W Kalimantan, Serawei, nr Djotta, *Winkler 330* (HBG, L). SABAH: Kinabalu, Sg. Liwagu, NE of Kundasing, *Allen AK66-34* (SING); Ranau Distr., Ulu Sg. Liwogu, *Amin et al. 123353* (K); Kota Belud Distr., Melangkap Kappa, NW side of G. Kinabalu, *Beaman et al. 8594* (K); Tenom Distr., Ulu Senagong, *Boyce 1434* (K); Kinabalu, Ulu Liwagu & Ulu Mesilau, *Chew et al. 2501* (K, L, SING); Kinabalu, Kundusan, *Clemens & Clemens 29136* (GH, K, L, SING); Kinabalu, Dehobang R, *Clemens & Clemens 31876* (GH); Kotabalu Distr., Kg Kiau Nuluh, *Jsimin Dianeh 461* (K); Tenom Distr., Kaang, *Krispinus 120082* (K); Pensiangan Distr., Kg Pun Batu, Bukit Pun Batu, *Lim et al. 1502* (SING); G. Trusmadi, *Nooteboom 1389* (B, L) & *1417* (L); Kinabalu, Penibukan, Sg. Tahubang, *Nooteboom & Aban 1508* (B, K, L); Kinabalu, Bukit Burong trail, *Price 165* (K); Kinabalu NP, near park HQ, *Vermeulen & Chan 392* (L).

10. Piptospatha kinabaluensis *(Bogner) Bogner & A. Hay*, **comb. nov.**

Hottarum kinabaluense Bogner, Pl. Syst. Evol. 145 (1984) 161, fig. 3, 4; Mayo et al., Genera of Araceae (1997) 188, pl. 51, K–Q; Beaman & Beaman, Pl. Mt Kinabalu 3 (1998) 80. — Type: Malaysia, Sabah, S slope of Mt. Kinabalu, E tributary of Sg. Mesilau, at old trail between Mesilau Cave and Janet's Halt, 7 Sep 1963, *S. Collenette 21634* (L, holo; iso K).

[*Piptospatha grabowskii* sensu auctt. non (Engl.) Engl.: Beaman & Beaman, Pl. Mt Kinabalu 3 (1998) 80].

['*Piptospatha* cf. *uarginata*' Beaman & Beaman, loc. cit.].

Diminutive to moderately robust herb 10–50 cm tall. *Stem* condensed, 1–10 cm long, 0.4–1.5 cm diam., sometimes reddish. *Leaves* few together; petiole 2.5–30 cm long, 0.9–3 mm diam., sheathing only at the extreme base, the wings extended into a narrowly triangular ligular portion 2–16 cm long; blade coriaceous, narrowly elliptic to ovate, 3–21 cm long × 1.3–9.5 cm wide, the base cuneate, the apex acute to shortly acuminate and apiculate for 1–4 mm; midrib robust, abaxially somewhat prominent, with (3–)4–12 primary lateral veins on each side, in very robust specimens more or less regularly alternating with lesser interprimaries, diverging at c. 60°; secondary venation fine, adaxially more or less obscure; tertiary venation forming a faint tessellate reticulum abaxially. *Inflorescence* solitary; peduncle 4–18 cm long, slender. *Spathe* 1.6–2 cm long (to 3.2 cm in fruit), reddish, persistent, held more or less erect, more or less obovoid, apiculate for 1–4 mm. *Spadix* 1.5–1.8 cm long, obliquely adnate to the spathe at the base; female zone 6–8 mm long, c. 3 mm diam.; pistils 1–1.2 mm high, c. 0.6–0.8 mm diam.; ovary ellipsoid, with basal placentation; stigma sessile, discoid, slightly narrower than the ovary, c. 0.5 mm diam.; interpistillar staminodes absent from within, below or above the female zone; interstice absent; male zone 0.9–1 cm long, more or less ellipsoid, apically obtuse; stamens crowded, truncate, elongate to more or less rectangular from above, papillate, 0.8–0.9 mm across. *Fruits* completely included within the persistent spathe; berry depressed-globular, 2–4.5 mm diam., crowned by old stigma remnants; seed elongate, 2–3 mm long, brown, longitudinally ribbed, with a curved long translucent micropylar appendage up to twice the length of the seed.

Distribution — *Malesia*: endemic to North West Borneo (Brunei, Sabah).

Habitat — Facultatively rheophytic, lithophytic or terrestrial in shade, 750–2300 m alt.

Notes — *Piptospatha kinabaluensis* differs from *P. truncata*, which is of similar diminutive proportions to those of small specimens of the former, in the persistent spathe.

Piptospatha kinabaluensis is extremely variable in size vegetatively. The upper dimensions in the description are from two exceptionally large collections (*Chew et al. 708* and *Furtado s.n.*) which we at first thought must be a different species. However, they match smaller specimens exactly in inflorescence. They are approached, but by no means reached in size by *Ogata 11083*.

Other specimens examined: BORNEO: BRUNEI: Temburong Prov., G. Retak, *Johns 6743* (K); Temburong Prov., Amo, headwaters of Temburong R, NE of G. Retak, *Sands et al. 5375* (K). SABAH: Ranau Distr., Mesilau ('Mosilou'), *Amin 123519* (K); Ranau Distr., above upper edge of Mt Kinabalu Golf Course site nr E Mesilau R., *Beaman et al. 7473* (K); G. Kinabalu, Eastern Shoulder, *Chew et al. 708* (K, L); Kinabalu, Silau Basin, *Furtado sub Clemens & Clemens 29135* (K, L, SING); Mt Kinabalu, Marai Parai, *Clemens & Clemens 32290* (GH, L); Kinabalu NP, Park Headquarters, *Edwards 2162* (K); Kinabalu, Kundasang by the Liwagu R., *Furtado s.n.* (SING); Ranau Distr., Kundasang, nr Golf Course, *Madani 111616* (K); Nr HQ of Kinabalu NP, *Ogata 11083* (L).

11. Piptospatha lucens *(Bogner) Bogner & A. Hay*, **comb. nov.**

Hottarum lucens Bogner, Pl. Syst. Evol. 142 (1983) 49, fig. 1–3; Mayo et al., Genera of Araceae (1997) 188, pl. 51, A–E. — Type: Malaysia, Sarawak, Bako National Park, Sg. Tajor, 19 Sep 1978, *J. Bogner 1439* (K, holo; iso K, US).

Herb to c. 30 cm tall. *Stem* condensed, with stiff roots 1–1.5 mm diam. *Leaves* several together; petiole (5–)6–10 cm long, 0.2–0.3 cm diam., slightly flattened adaxially, sheathing only at the extreme base, the wings extended into a very narrowly triangular ligular portion 3.5–6.5 cm long drying dark brown; blade very narrowly elliptic, slightly coriaceous, 8–22 cm long × 1–3 cm wide, shiny dark green adaxially, abaxially paler, the base cuneate, the apex narrowly acute, slightly acuminate and

apiculate for 2–3 mm; midrib abaxially prominent with 4–6 very fine primary lateral veins on each side hardly differentiated in thickness from the secondary venation and diverging at c. 30°; secondary veins adaxially more or less obscure, abaxially fine and rather faint, running to a thicker marginal vein; tertiary venation forming an inconspicuous tessellate reticulum abaxially. *Inflorescence* solitary; peduncle 4–8 cm long, green. *Spathe* 3.5–5 cm long, more or less oblanceolate, hardly constricted, lower part green, limb white, apiculate for 6–8 mm. *Spadix* 2.5–4 cm long, adnate to the spathe in the lower 2/3; female zone completely adnate to the spathe on the dorsal side, c. 1 cm long, 0.4 cm diam.; ovary depressed globose and weakly angular, 1–1.5 mm diam., light green, placentation basal, ovules long-beaked; stigma sessile, narrower than the ovary, c. 0.4 mm diam., button-like, papillate, whitish; interpistillar staminodes absent from the female zone; sterile interstice robust, 6–9 mm long, somewhat thicker than the female zone, 5–7 mm diam., dorsally adnate to the spathe, composed of large truncate mostly irregularly polygonal staminodes 0.8–1.5 mm diam. and these also distributed up the dorsal side of the male zone to the spadix apex; male zone subcylindric-ellipsoid, to c. 2 cm long, apically narrowly acute and sterile, basally adnate to the spathe on the dorsal side, sometimes with only the ventral-most stamens (those exposed by gaping spathe limb) fertile, or more extensively fertile, but always sterile on the dorsal side; stamens crowded, truncate, dumbbell-shaped to irregularly rectangular from above, often with the connective irregularly broadened on one side, 0.9–1.2 mm across; thecae each opening through a conspicuous, broad-rimmed pore. *Fruiting spathe* more or less persistent in entirety; berry depressed globular, 2–2.5 mm diam.; seed ellipsoid, 1.2–1.5 mm long, not observed ripe, but with the micropylar beak nevertheless somewhat extended, testa slightly ribbed.

Distribution — *Malesia:* West Borneo (known only from Sanggau in W Kalimantan and Bako National Park in Sarawak).

Habitat — Lithophytic in forest, and rheophytic near stream or waterfalls, c. 30 m alt.

Notes — In dismantling *Hottarum*, the placement of *H. lucens* is problematic. The inflorescence does not have the nodding character apparent in other *Piptospatha* species (except *P. brevipedunculata* and possibly *P. kinabaluensis*). The spathe appears somewhat constricted, but the extent to which the spadix is adnate to the spathe creates some distortion and it is not really possible to compare spathe shape directly with that, for example, in *Schismatoglottis*. The spathe is however, persistent into fruit. The stamens are more similar to those of many *Schismatoglottis* than to those of other species of *Piptospatha*, having large rims to the pores and a generally narrow connective. We have not yet been able to examine the seeds to see if they have the micropylar appendage typical of *Piptospatha*; however, the ovules in very young fruits do have a micropylar beak that is proportionately extended over that of younger ovules, suggesting that a micropylar appendage may be developing. Fruiting material needs to be collected. We therefore only provisionally place this species in *Piptospatha*.

Other specimens examined: BORNEO: SARAWAK: Bako National Park, Telok Tajor, mouth of Sg. Tajor, *Ashton S17945* (GH, K, L, SING); Bako National Park, Telok Tajor, *Purseglove P4944* (K, L, SING). KALIMANTAN: W Kalimantan, Sanggau, *Elsener 184* (K, L).

Doubtful species

12. Piptospatha remiformis Ridl.

Piptospatha remiformis Ridl., J. Straits Br. Roy. Asiat. Soc. 49 (1907) 51. — Type: Malaysia, Sarawak, Mt Lingga, *J. Hewitt ?s.n.* (?SING — n.v.).

This species was described from fruiting material (hence it is not even certain that it is *Piptospatha*) collected by Hewitt at Mt Lingga. We have not been able to locate the type, which was presumably deposited at SING. Hewitt collected *Aridarum nicolsonii* at Mt Lingga (*Hewitt 36*) so it is possible that *Piptospatha remiformis* was based on a duplicate of that collection.

Excluded species

Hottarum sarikeense Bogner & M. Hotta

Hottarum sarikeense Bogner & M. Hotta, Bull. Mus. Natl. Hist. Nat., B Adansonia 5 (1983) 27 = *Schismatoglottis sarikeensis* (Bogner & M. Hotta) A. Hay & Bogner, Telopea 9(2000) 100.

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References

Beccari, O. (1879) La più piccola delle Araceae, *Microcasia pygmaea* Becc. *Bull. Soc. Tosc. Ortic.* 4: 179–181.

Bogner, J. (1978 '1979'). A critical list of the Aroid genera. *Aroideana* 1: 63–73.

Bogner, J. (1980) The genus *Bucephalandra* Schott. *Aroideana* 3: 134–143.

Boyce, P.C., Bogner, J. and Mayo, S. (1995) *Bucephalandra catherineae*, a new species from Kalimantan. *Curtis's Bot. Mag.* 12: 150–153.

Brown, N.E. (1879) *Piptospatha insignis*. *Gard. Chron. New Ser.* 11: 138.

Engler, A. (1912) Araceae-Homalomeninae und Schismatoglottidinae. *Das Pflanzenreich* 55 (IV.23Da): 1–134.

Grayum, M.H. (1992) Comparative external pollen ultrastructure of the Araceae and putatively related taxa. *Monogr. Syst. Bot.* 43: 1–167.

Hay, A., Boyce, P.C., Hetterscheid, W.L.A., Jacobsen, N., Murata, J. and Bogner, J. (1995) Checklist of the Araceae of Malesia, Australia and the Tropical Western Pacific Region. *Blumea* Suppl. 8: 1–161.

Hay, A. and Yuzammi (2000) The Schismatoglottideae (Araceae) in Malesia I: *Schismatoglottis*. *Telopea* 9: 1–177

Hotta, M. (1965) Notes on the Schismatoglottidinae of Borneo. I. *Mem. Coll. Sci. Univ. Kyoto, Ser. B*, 32: 19–30.

Hotta, M. (1976) Notes on Bornean plants III. *Pedicellarum* and *Heteroaridarum*, two new genera of the aroids. *Acta Phytotax. Geobot.* 27: 61–65.

Okada, H. and Mori, Y (2000) Three new species of Schismatoglottideae, Araceae, from Borneo. *Acta Phytotax. Geobot.* 51: 1–9.
Ridley, H.N. (1913) Some Bornean Aroideae. *J. Bot.* 51: 201–202.
Schott, H.W. (1858) *Genera Aroidearum*. (Ueberreuter: Vienna).

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Editorial Note: This paper, as a precursor to *Flora Malesiana*, is not in standard *Telopea* format.

Index to scientific names

[Synonyms in italics, new formal names in bold; authorities given only for names of taxa treated here. Bold page numbers indicate formal treatments; asterisks indicate illustrations].