Studies on Schismatoglottideae (Araceae) of Borneo LIX – A preliminary conspectus of *Schismatoglottis* Calyptrata Complex Clade species for Sarawak

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ABSTRACT

A preliminary conspectus of species of the *Schismatoglottis* Calyptrata Complex Clade for Sarawak is presented. Six species are accepted, of which *Schismatoglottis baangongensis* S.Y. Wong, Y.C. Hoe & P.C. Boyce is newly described, and *S. muluensis* M. Hotta is resurrected from within *S. calyptrata* (Roxb.) Zoll. & Moritzi. Current evidence does not support the presence of *Schismatoglottis calyptrata sens. strict.* in Sarawak, while occurrence on Borneo as a whole is

questionable. A modified description of *S. calyptrata*, excluding characteristics of Bornean taxa hitherto included in synonymy is provided. An identification key to the accepted species for Sarawak is provided, and most are illustrated from living plants.

KEY WORDS

Geological obligation, *Schismatoglottis ahmadii, Schismatoglottis ardenii, Schismatoglottis clarae, Schismatoglottis baangongensis*, *Schismatoglottis muluensis, Schismatoglottis viridissima*, Araceae

INTRODUCTION

Monographing *Schismatoglottis* Zoll. & Moritzi, Hay & Yuzammi (2000) proposed six informal morphologically defined species' groups, of which one, the Calyptrata Group, is delimited by most species (but see below) having hypogeal hapaxanthic shoot modules (Hay 1996: 2 *et seq.*; Hay & Yuzammi 2000: 9), with all species possessing a fully attached persistent petiolar sheath, and a caducous spathe limb.

Hay & Yuzammi (2000) treated *Schismatoglottis calyptrata* (Roxb.) Zoll. & Moritzi (the generic Type species) as a widespread polymorphic taxon occurring throughout the range of the genus (i.e., SW China to Vanuatu), treating plants from Peninsular Malaysia, Jawa, and New Guinea as a morphologically highly variable species. For Sumatera and Borneo, however, the existence of localized, often geologically or ecologically restricted, morphologically discrete segregate species was acknowledged, as below:

Sumatera

Schismatoglottis ecaudata A. Hay

Borneo – widespread

Schismatoglottis ahmadii A. Hay (rheophytic)

S. trivittata Hallier f. – a species complex.

Borneo – Sarawak

Schismatoglottis clarae A. Hay

S. viridissima A. Hay (granites)

Borneo – Kalimantan

Schismatoglottis canaliculata Engl.

S. emarginata Engl.†

S. grabowskii Engl. (ultramafics)

S. maculata Alderw. †

S. modesta Schott.

S. niewenhuisii Engl.†

S. pumila Hallier f. ex Engl.

S. venusta A. Hay (limestone)

S. zonata Hallier f.

† not accepted by Hay & Yuzammi (2000)

Borneo – Sabah

Schismatoglottis clemensiorum A. Hay (granites)

S. decipiens A. Hay (ultramafics)

S. lingua A. Hay (kerangas)

S. moodii A. Hay

S. scintillans Scherberich & P. C. Boyce – described since Hay & Yuzammi (2000) – see Scherberich & Boyce (2013).

S. silamensis A. Hay (ultramafics)

S. trusmadiensis A. Hay

S. venusta A. Hay (limestone)

In addition, a few species with pleionanthic shoot modules were allocated to the Calyptrata Group (Bornean *Schismatoglottis niahensis* A. Hay, and Philippines *S. merrillii* Engl., *S. luzonensis* Engl. and *S. plurivenia* Alderw. (the last also occurring on Sulawesi). Molecular analyses (Low 2016) failed to resolve any of these pleionanthic species within the Calyptrata Clade.

***Schismatoglottis* Calyptrata Clade**

Molecular analyses (Low 2016) retrieved a robust clade of *Schismatoglottis* species largely conforming to Hay & Yuzammi's Calyptrata Group. Within this clade a well-supported subclade (henceforth called "Calyptrata Complex Clade") was retrieved, composed of Peninsular Malaysian and Bornean species plus *S. calyptrata* (Roxb.) Zoll. & Moritzi from Ambon (the Type locality). The Calyptrata Complex Clade is additionally defined by an hour-glass-shaped spadix, and a stoutly clavate sterile appendix. The internal topography and support values make it apparent that taxa in the Calyptrata Complex Clade do not constitute a single species, with typical *S. calyptrata* (i.e., from Ambon) resolving basal to the remainder of the clade, while the rest divided in two groups, a clade of Bornean taxa (including the Sarawak species which are the subject of the current paper), and a clade of taxa primarily originating from Peninsular Malaysia, to be the subject of a future paper.

Results of floral biology research currently in press (Hoe & Wong, 2016) obliges us to publish a preliminary conspectus of the Sarawak species ahead of those for the reminder of Borneo (for which much taxonomic work remains to be done) in order to validate the taxonomically novel species, ***Schismatoglottis baangongensis* S.Y. Wong, Y.C. Hoe & P.C. Boyce, sp. nov.,** which was the subject of that research.

Dimensions in the descriptions are derived from fertile (i.e., mature) plants. Seedlings have overall smaller measurements.

Geological occurrences are confirmed with reference to Tate (2001).

KEY TO SARAWAK SPECIES OF THE *SCHISMATOGLOTTIS* CALYPTRATA CLADE

1a. Rheophytes . . . . . ***Schismatoglottis ahmadii*** A. Hay

1b. Terrestrial mesophytes or lithophytes 2

2a. Pistillate flower zone not adnate to spathe; lithophytes of Karst limestone. Mulu N.P. ***Schismatoglottis muluensis*** M. Hotta

2b. Pistillate flower zone variously adnate to spathe; Terrestrial mesophytes, if associated with Karst limestone then never occurring epilithically 3

3a. Leaf blades glossy brilliant green, rubbery and sub-succulent; spathe limb remaining green throughout anthesis; spadix appendix hemispherical, staminodes closely appressed, polygonal, smooth medium yellow, contrasting with white staminate flowers. NW Sarawak; granites or sandstones . . . . . ***Schismatoglottis viridissima*** A. Hay

3a. Leaf blades semi-glossy green, softly leathery; spathe limb becoming creamy yellow or white and contrasting with green lower spathe during anthesis; spadix appendix conical to bullet-shaped, staminodes somewhat lax, columnar, slightly round-topped, white to pale yellow, never contrasting with staminate flower colour; not granite associated 4

4a. Leaf blades cordate to broadly sagittate; limestone-associated forest, Padawan (NW Sarawak) ***Schismatoglottis baangongensis*** S.Y. Wong, Y.C. Hoe & P.C. Boyce, **sp. nov.**

4b. Leaf blades narrowly hasto-sagittate to oblong-lanceolate to narrowly obovate; not limestone-associated, N and C Sarawak 5

5a. Leaf blade oblong-lanceolate to narrowly obovate, the base acute to rounded, not at all cordate; pistillate flower zone to adnate to the spathe for ca 1 cm, appendix bullet-shaped; Bintulu & Sarkei . . ***Schismatoglottis clarae*** A. Hay

5b. Leaves narrowly hasto-sagittate; pistillate flower zone not adnate to spathe, appendix conoid; Kapit . . . . . ***Schismatoglottis ardenii*** A. Hay

Schismatoglottis ahmadii A. Hay, Telopea 9: 102(–104), **Figure 14.** 2000. Type: Cult. RBG Sydney Acc. No. 960570 ex Malaysian Borneo, Sabah, Maliau Basin, Gunung Rara FR, 2.5 km upstream from main Maliau Falls (orig coll. *A. Hay, Ahmad et al. 12060*), Aug 1998, *C. Herscovitch s.n.* (holotype SAN!; isotype NSW). **Figure 1.**

Description

Small rheophytic clump-forming herb up to 50 cm tall, but more usually about 20 cm tall. **Stem** condensed, hypogeal (epigeal when occurring on bare rock), modules hapaxanthic, 1–2 cm thick, bright green. **Leaves** few together; **petiole** (6–)12–48 cm long, glabrous, sheathing in the lower 1/3–3⁄5; **petiolar sheath** wings tapering, fully attached to petiole; **blade** rather tough, elliptic to ovato-sagittate, semi-glossy mid-green, sometimes variegated with a single grey-green central stripe, or spattered grey-green throughout, or (rarely) entirely grey, (6–)10–29 cm long × 3.5–16 cm wide, margins smooth to rather conspicuously crispulate, base obtuse to more or less truncate (this most usually) to somewhat cordate with posterior lobes spreading and up to 5 cm long, tip acute to broadly acute and acuminate for 1.5 cm, longest tips often somewhat circinnate; **midrib** abaxially prominent, adaxially somewhat impressed; **primary lateral veins** adaxially somewhat impressed, abaxially prominent, ca 10 on each side of midrib, alternating with lesser interprimaries and diverging at ca 45–60°, occasionally giving off branches similar in thickness to interprimary veins; **secondary venation** adaxially obscure, arising from midrib and frequently from the lower parts of the primary veins; **tertiary venation** adaxially obscure, abaxially forming a rather distinct tessellate reticulum. **Inflorescences** 1–8 together, powerfully esteric-smelling at anthesis, subtended by short cataphylls 2–8 cm long, these often but not always bearing reduced but well-differentiated petiole and blade; **peduncle** about half length of petiole at anthesis but inflorescences first exposed when peduncle very short, and this elongating further in fruit; **spathe** 4–7 cm long; **lower spathe** green, narrowly ovoid, 1–2 cm long, differentiated from spathe limb by an abrupt constriction; **spathe limb** white, broadly ovate, inflated over the appendix then abruptly acuminate for 1–1.5 cm, caducous. *Spadix* sessile, more or less hourglass-shaped, ca 3–4 cm long; **pistillate flower zone** ca 2 cm long, adnate to the spathe for about 1/2 its length, ca 4 mm diam. In the middle, distally attenuate; **pistils** subglobose, somewhat lax in lower part of pistillate zone, more so in the attenuate part, ca 1 mm diam.; **stigma** sessile, button-like, papillate, about 1/2 diameter of ovary; **interpistillar staminodes** scattered among pistils, about equalling to slightly taller than pistils, stalked with spreading flat tops ca 0.6 mm across; **sterile interstice** ill-defined, a partly naked distal portion of pistillate zone with scattered interpistillar staminodes and some ?abortive (undersized stigmas) ovaries; **staminate flower zone** obconic (occasionally widest slightly below tip), ca 1 cm long, ca. 3 mm thick at base, 6 mm thick at top; stamens crowded, dumbbell-shaped

with connective very slightly elevated above the thecae, ca 1 mm across (fresh); appendix more or less hemispherical, to 3–7 mm long; staminodes of appendix columnar, irregularly polygonal with rounded angles, more or less flat-topped to somewhat rounded, whitish, very slightly taller than the stamens, ca 0.6 mm diam. **Fruiting spathes** ellipsoidal, to 4 cm long on erect peduncles.

Ecology — Facultative rheophyte on exposed to moderately shaded riverside rocks in lowland to lower montane perhumid to wet forest on sandstones and granites, from 30–1520 m asl.

Distribution — *Schismatoglottis ahmadii* is widespread although localized throughout northern central to NE Borneo.

Notes — Since being described *Schismatoglottis ahmadii* has proven to be a more widespread than initially believed, occurring, albeit locally, from north central through to NE Borneo from almost sea level, e.g., Bintulu, to over 1500 m on Mount Kinabalu.

The variegated and wholly grey leaf blade examples make handsome and easily grown horticultural subjects.

Other material examined: MALAYSIAN BORNEO: **Sarawak: Kapit.** Pergunungan Hose, 02°14'47.2"N 113°41'24.9"E, 22 Apr 2004, *P.C. Boyce & Jeland ak Kisai AR-289* (SAR). **Bintulu.** Bintulu, Air Terjun Baloi, 03°08'34.5"N 113°04'17.2"E, 15 Jan 2007, *P.C. Boyce & Wong Sin Yeng AR-2077* (SAR). **Miri.** Marudi, Long Lama, Mulu N.P., Long Langsat, Sungai Langsat, draining into the Sungai Tutoh, 04°00'03.5"N 114°48'49.8"E, 9 Aug 2006, *P.C. Boyce et al. AR-1979* (SAR); Marudi, Long Lama, Mulu N.P., trail to Deer Cave, 04°01'26.8"N 114°49'32.2"E, 11 Aug 2006, *P.C. Boyce et al. AR-2001* (SAR). **Limbang.** Nanga Medamit, Mulu N.P., Melinau Gorge, 10 Dec 2011, *Tung Lay Soon et al. AR-3712* (SAR); Lawas, Ba kelalan, Long Ritan waterall, 03°59'44"N 115°37'21"E, 9 Apr 2012, *Mike Lo AR-3874* (SAR); Lawas, Long Semadoh, Long Tunid, Lebaluh Waterfall, 04°12'08.7"N 115°36'02.7"E, 26 May 2014, *Mike Lo AR-4758* (SAR). MALAYSIAN BORNEO: **Sabah: Pantai Barat.** Ranau, Sungai Vulanut, 05°51'59.8"N 116°48'23.3"E, 21 Dec 2012, *Mike Lo AR-4092* (SAN, SAR); Kota Kinabalu, Inanam, Kionsom Waterfall, 05°57'24.0"N 116°12'25.3"E, 18 Apr 2014, *Wong Sin Yeng & P.C. Boyce AR-4685* (SAN, SAR) & *Wong Sin Yeng & P.C. Boyce AR-4689* (SAN, SAR); Kota Belud, Kinabalu N.P., Silau-Silau Trail, 06°00'26.6"N 116°32'37.9"E, 10 May 2014 *Wong Sin Yeng & P.C. Boyce AR-4719* (SAN, SAR); Kota Belud, Kinabalu N.P., Poring Hot Springs, trail to Air Terjun Langanan, 06°03'13.8"N 116°41'52.6"E, 11 May 2014, *Wong Sin Yeng & P.C. Boyce AR-4725* (SAN, SAR) & *Wong Sin Yeng & P.C. Boyce AR-4727* (SAN, SAR); Ranau, Karanaan, Gana-gana, Sungai Totom, 05°54'15.0"N 116°38'23.0"E, 10 Sep 2015, *Rosediana Enora Welserd AR-5240* (SAN, SAR). **Interior Division.** Keningau, Tenom - Tambunan road, Kitau, 05°33'00"N 116°16'30"E, 9 May 2012,

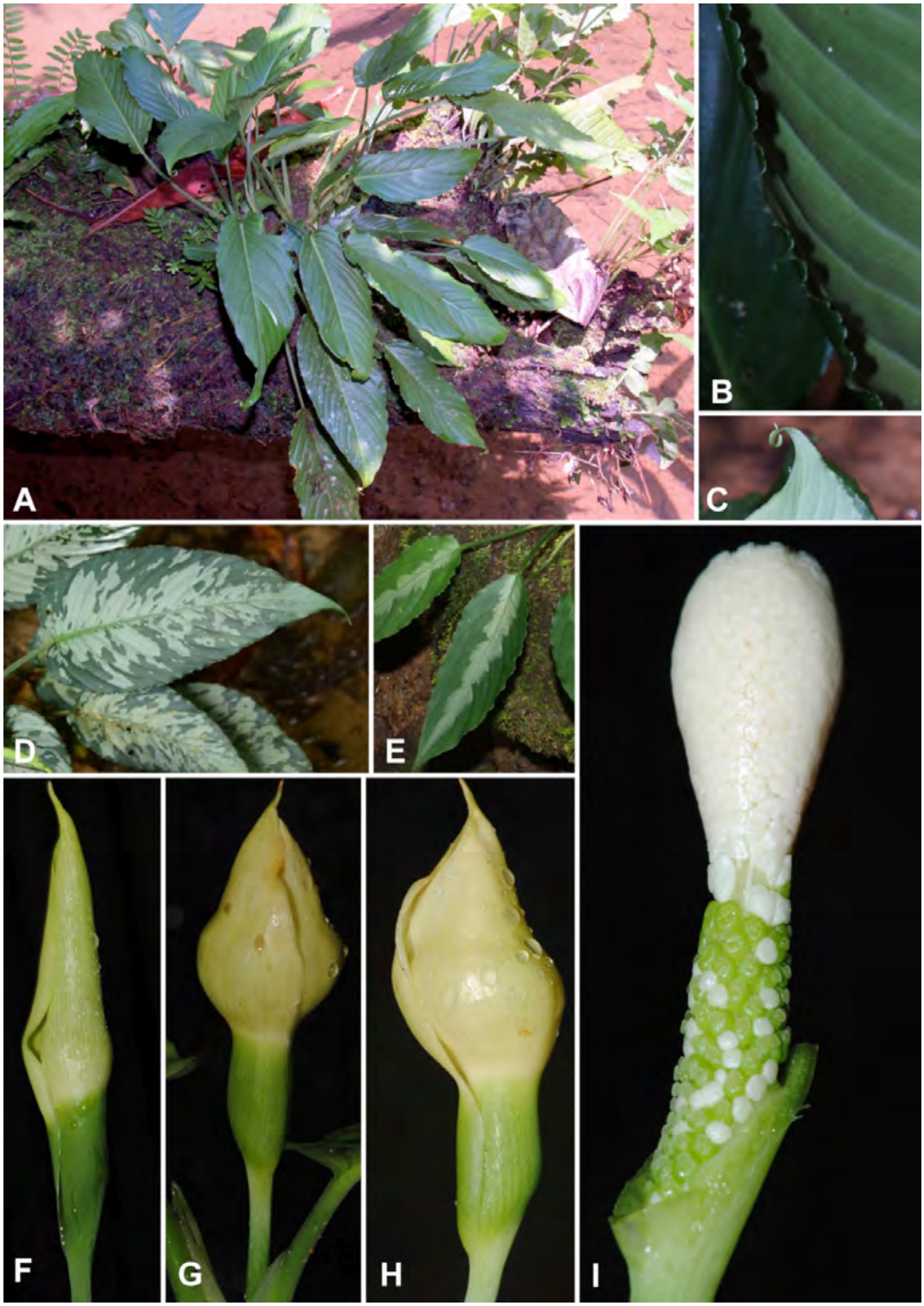

Figure 1. Schismatoglottis ahmadii A. Hay
A. Plant in habitat, Mulu N.P. **B.** Leaf blade margin showing crispulate edge. **C.** Leaf blade showing circinnate tip. **D & E.** Two types of variegation. **F.** Inflorescence at onset of pistillate anthesis. **G & H.** Inflorescence at late of pistillate anthesis. **I.** Spadix at late pistillate anthesis, spathe artificially removed. **A–C** from *AR–1979*; **D & E** from *AR-4725*; **F** from *AR-3908*; **G – I** from *AR-3854*. Images © P.C. Boyce.

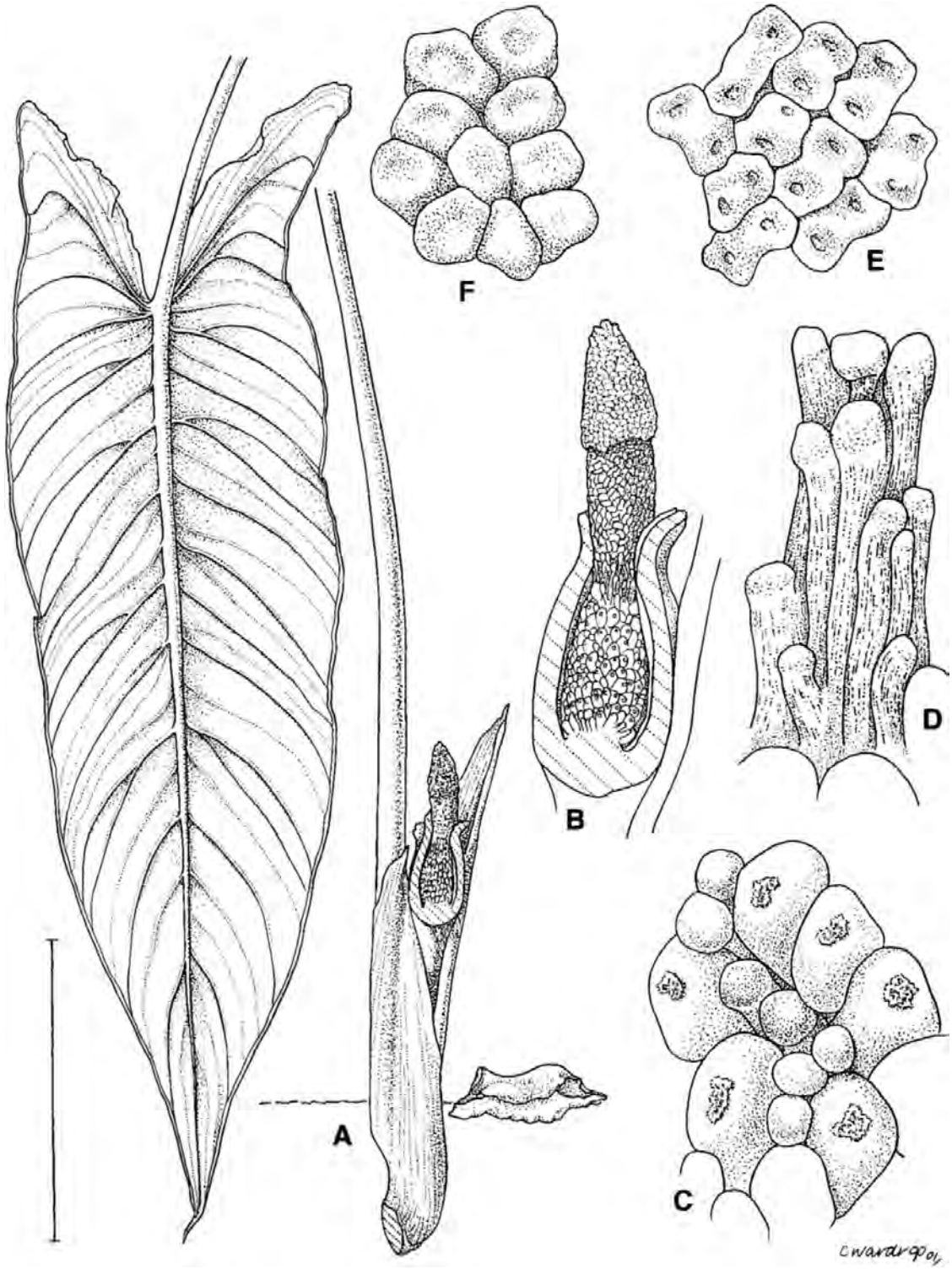

Figure 2. Schismatoglottis ardenii A. Hay
A. Flowering shoot. **B.** Inflorescence with nearside part of spathe removed. **C.** Pistils and interpistillar staminodes. **D.** Staminodes in sterile interstice. **E.** Stamens; **F.** Staminodes of appendix. Image © Aroideana. Used with permission.

Mike Lo AR-3908 (SAN, SAR); Sapulut, Nabawan-Kalabakan road, [Sapulut-Maliau Basin road], 04°42.301''N 116°29.741''E, 17 Nov 2015, *Mike Lo AR-5265* (SAN, SAR). **Dalaman.** Tenom, Sipitang - Tenom road, 04°58'26.4''N 115°43'58.4''E, 15 Feb 2014, *Mike Lo AR-4355* (SAN, SAR). **Tawau.** Lahad Datu, Ulu Segama-Malua F.R., Air Terjun Bilong, *Mike Lo AR-3991* (SAN, SAR). INDONESIAN BORNEO: **Kalimantan Tengah.** Murung Raya, Puruk Cahu, 4 Apr 2012, *K. Nakamoto AR-3854* (BO, SAR); **Kalimantan Utara.** Malinau, 80km S.W. of Malinau, Tempat Wisata 3km N of Loreh village, 3 May 2012, *K. Nakamoto AR-3911* (BO, SAR); Malinau, Metarang Hulu, Longberang, 03°48'25.17''N 116°11'24.72''E, 25 Aug 2012, *K. Nakamoto AR-4015* (BO, SAR); **Kalimantan Timur.** Tanjung Selor, 3 Feb 2012, *K. Nakamoto AR-3751* (BO, SAR).

Schismatoglottis ardenii A. Hay, Aroideana 25: 67(–69), **Figure 1.** 2002 (2003). Type: Cult. Redlynch, Cairns, Queensland ex Malaysian Borneo, Sarawak, Kapit, (orig. coll. *A. Dearden s.n.),* 12 May 2001, *A. Hay s.n.* (holotype NSW). **Figure 2.**

Description

Rather slender clumping mesophytic herb to ca 50 cm tall. *Stem* hypogeal, clump-forming, modules hapaxanthic, ca 1.5 cm diam. *Leaves* 1–3 per crown; **petiole** ca 40 cm long, sheathing in the lower ca 1/4; **petiolar sheath** wings tapering, fully attached to petiole; **blade** narrowly hasto-sagittate, glossy dark-mid green adaxially, paler abaxially, ca 30 cm long, ca 8 cm wide, tip acuminate for ca 4 cm, base deeply divided into two narrowly triangular, distally slightly out-turned posterior lobes to 6 cm long; **midrib** abaxially prominent, slightly impressed adaxially; **primary lateral veins** ca 8 on each side (more concentrated in the proximal 1/3 of blade), regularly alternating with interprimaries and diverging at ca 70°; **tertiary venation** obscure. **Inflorescence** solitary; **peduncle** short, entirely concealed (at anthesis) by subtending cataphyll. **Spathe** ca 6 cm long, abruptly constricted ca 2.5 cm from base; **lower spathe** squat ovoid-cylindric, pale green; **spathe limb** ovoid, slightly gaping, white, caducous and crumbling. **Spadix** sessile, 4.4 cm long, hourglass-shaped; **pistillate flower zone** not adnate to spathe, ca 1.3 cm long, subcylindric, slightly tapering distally; **pistils** crowded, very pale green, more or less ovoid, 1–1.5 mm diam.; **stigma** sessile, small, punctate; **interpistillar staminodes** numerous, narrowly cylindric, barely clavate, about equalling height of ovaries, white, ca 0.5 mm diam.; **sterile interstice** somewhat attenuate, top aligned with spathe constriction, ca 6 mm long, 4 mm diam. in upper part, composed of appressed elongate interpistillar staminodes of few of which with single fertile thecae, and a few partially fertile stamens; **staminate flower zone** narrowly obconic, ca 9 mm long, basally isodiametric with top of staminate flower zone, distally ca 7 mm diam.; **stamens** dumbbell-shaped from above with connective faintly raised between thecae, ca 1 mm across; **appendix** conoid, white, ca

1.3 cm long, basally slightly and abruptly wider than top of staminate zone, ca 9 mm diam., apically tapering to a ragged point; **appendix staminodes** columnar, irregularly polygonal with rounded angles, centrally impressed at apex, ca 0.6 mm diam., distal ones elongate and somewhat bent. **Fruit** unknown.

Ecology — "Steep banks on stream sides in forest."

Distribution — Known only from the un-localized (but see below) Type locality.

Notes — *Schismatoglottis ardenii* is recorded only from Kapit, without precise locality, but most likely from lowland forest in the vicinity of Kapit town, probably at Taman Rekreasi Sebabai, which comprises wet lowland and gallery forest predominantly on shales.

Schismatoglottis baangongensis S.Y. Wong, Y.C. Hoe & P.C. Boyce, **sp. nov.**

Type: Malaysian Borneo, Sarawak, Kuching Division, Padawan, Siburan, Kampung Sikog, trail to Baan Gong waterfall, 01°020'16.1"N, 110°20'09.6"E, 26 Jul 2009, *P.C. Boyce & S.Y. Wong AR-2588* (holotype SAR!; isotypes SAR! – alcohol preserved). **Figure 3 & 4 & 13B.**

Diagnosis

Schismatoglottis baangongensis is most similar to *S. muluensis* differing by the conical (vs almost cylindrical) spadix appendix, larger, longer pale yellow appendix staminodes (vs appendix staminodes small (c. 0.5 mm diam.), white, with the tips not diverging), the appendix having a coarsely papillate appearance (vs nearly smooth), the weakly obconic (vs strongly obconic) staminate flower zone, bright green spadix axis (vs white) and pistils (vs cream), and strongly clavate (vs tips barely expanded) interpistillar staminodes. Leaf blades of *S. baangongensis* are medium green, (vs deep green blades).

Description

Moderately robust clumping to colonial mesophytic herb, 30–90 cm tall. **Stems** hypogeal, modules hapaxanthic, 0.5–1.5 cm diam. **Leaves** 3–5 per crown; **petiole**, 42–48 cm long, weakly channelled ca 1/5 of length, smooth medium green, distally with prominent broken longitudinal darker green striations; **petiolar sheath** 11–14 cm long × 5–10 mm wide, up to 3/10 of petiole length, persistent, longitudinal striated membranous, fully attached or (in very robust specimens) with a very short ligule, equal at both sides, slightly in-rolled or sometimes straight, tapering; **blades** ovato-sagittate to ovato-cordate, occasionally oblong-lanceolate cordate base, 20–39 cm long × 13–23 cm wide, softly coriaceous, adaxially glossy green, abaxially paler, posterior lobes subtriangular, 7–11 cm, sinus 8–11 cm wide, apex acuminate to acute for ca 2 cm, ultimately mucronate for ca 1 cm; **midrib** adaxially flush with blade, raised abaxially, ca 5 mm wide at the

insertion; **primary lateral veins** ca 14 per side, diverging at 30°–80° from midrib, adaxially raised towards the midrib, marginally impressed, entirely raised abaxially; **interprimary veins** adaxially raised, alternating irregularly with primaries; **secondary veins** 0–2 arising from each primary vein with 3–4 secondary veins raised from primary veins near to petiole insertion; **tertiary veins** inconspicuous; broken **vein-like pellucid glands** slightly visible abaxially. **Inflorescence** up to 4, erect, strongly esteric smelling during pistillate anthesis, odour absent during staminate anthesis; **peduncle** 10–15 cm long × 4–9 mm wide, terete, green, erect at anthesis; **spathe** 11–12.5 cm long; **lower spathe** narrowly ovoid, ca 4 cm long × ca 2.3 cm wide, green, longitudinally ridged, separated from spathe limb by a constriction coinciding with sterile interstice; **spathe limb** turbinate, ovate when flattened, ca 6.5 cm long × ca 3.3 cm wide, mucronate for ca 2 mm, pale yellowish green at pistillate anthesis, ageing to dull pale yellow during anthesis, caducous in a single piece at onset of staminate anthesis; **spadix** 9–10.5 cm long, shorter than spathe, sessile; **pistillate flower zone** slender obconic, 4–5 cm long × ca 1 cm wide, ca 2/5 of spadix length, bright green; **pistils** densely arranged, sub-cylindric to sub-globose, 0.8–1.2 mm diam.; **style** barely differentiated; **stigma** globose, truncate, smaller than ovary, ca 0.3 mm diam.; **interpistillar staminodes** numerous, strongly clavate, stipe slender, 0.5–0.8 mm in diam., twice height of pistils, waxy white; **sterile interstice** cylindric, 0.5–1 cm long × 5–6.5 mm wide, narrower than pistillate and staminate zone, partially naked, proximally and distally with flattened trapezoid staminodes; **staminate flower zone** weakly sub-conic, proximally narrower, 2.2–2.7 cm long × 9–12 mm wide, ca 3/10 length of spadix, yellowish white; **staminate flowers** densely arranged butterfly-shaped from above, ca 1 mm long × ca 0.5 mm wide, each comprising 2 truncate stamens, thecae sunken, separated by a narrow, raised connective; **appendix** conical, 2.2–2.5 cm long × ca 1 cm wide, ca 3/10 length of spadix, base wider (ca 1 mm) than apex of staminate zone, creamy yellow; **staminodes** columnar, ca 2.5 mm long × ca 1.2 mm wide, somewhat laxly arranged with diverging tips, giving appendix a coarsely papillate appearance, creamy yellow. **Infructescence** urceolate 4–6 cm long × 2–2.2 cm wide, on a declinate peduncle; **lower spathe** persistent, splitting and reflexing at fruit maturity; **fruits** 2–4 mm long × 1–2.5 mm wide, green to yellow; **seeds** ovoid ellipsoid, ca 0.4 mm diam., 13–22 per fruit, encased with greenish yellow gel.

Ecology — Terrestrial in perhumid lowland tropical forest adjacent to (but never occurring epilithically on karst limestone, often growing along trails next to small streams, 70–75 m asl.

Distribution — *Schismatoglottis baangongensis* is known from the type locality and its vicinity.

Figure 3. Schismatoglottis baangongensis S.Y. Wong, Y.C. Hoe & P.C. Boyce. **A.** Plants in habitat. **B.** Plant in habitat. **C.** Detail of synflorescence, with one inflorescence post-anthesis (left), and one at pistillate anthesis (right). **D.** Inflorescence at pistillate anthesis. **A–D** from *AR–2588*. Images © Hoe Yin Chen.

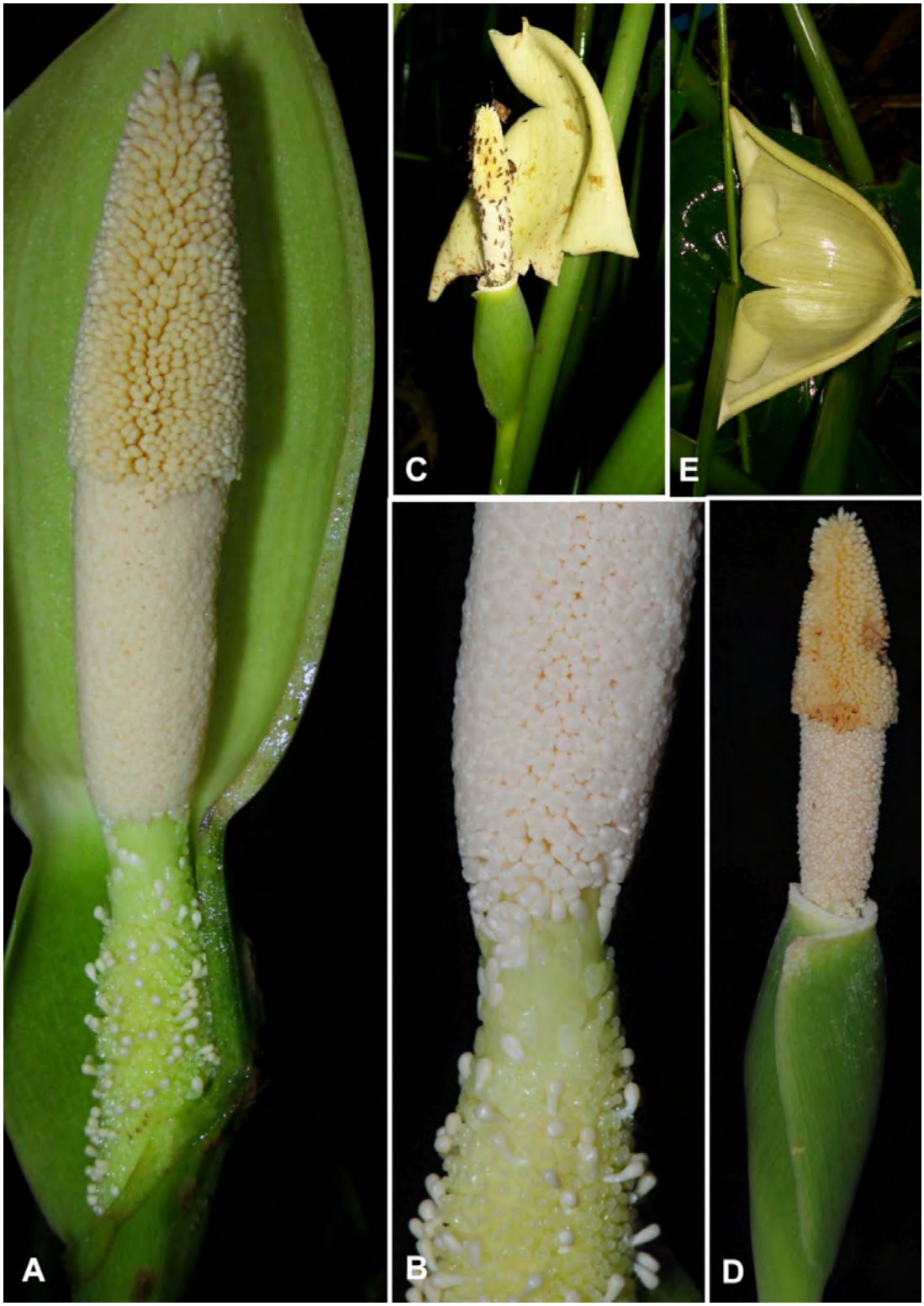

Figure 4. Schismatoglottis baangongensis S.Y. Wong, Y.C. Hoe & P.C. Boyce. **A.** Inflorescence at pistillate anthesis, nearside spathe artificially removed. **B.** Detail of spadix, uppermost portion of pistillate flower zone, sterile interstice, and lowermost portion of staminate flower zone; **C.** Inflorescence at onset of staminate anthesis with spathe limb beginning to shed. **D.** Caducous spathe limb. **E.** Inflorescence post anthesis with spathe limb shed. **A–E** from *AR–2588*. Images © Hoe Yin Chen.

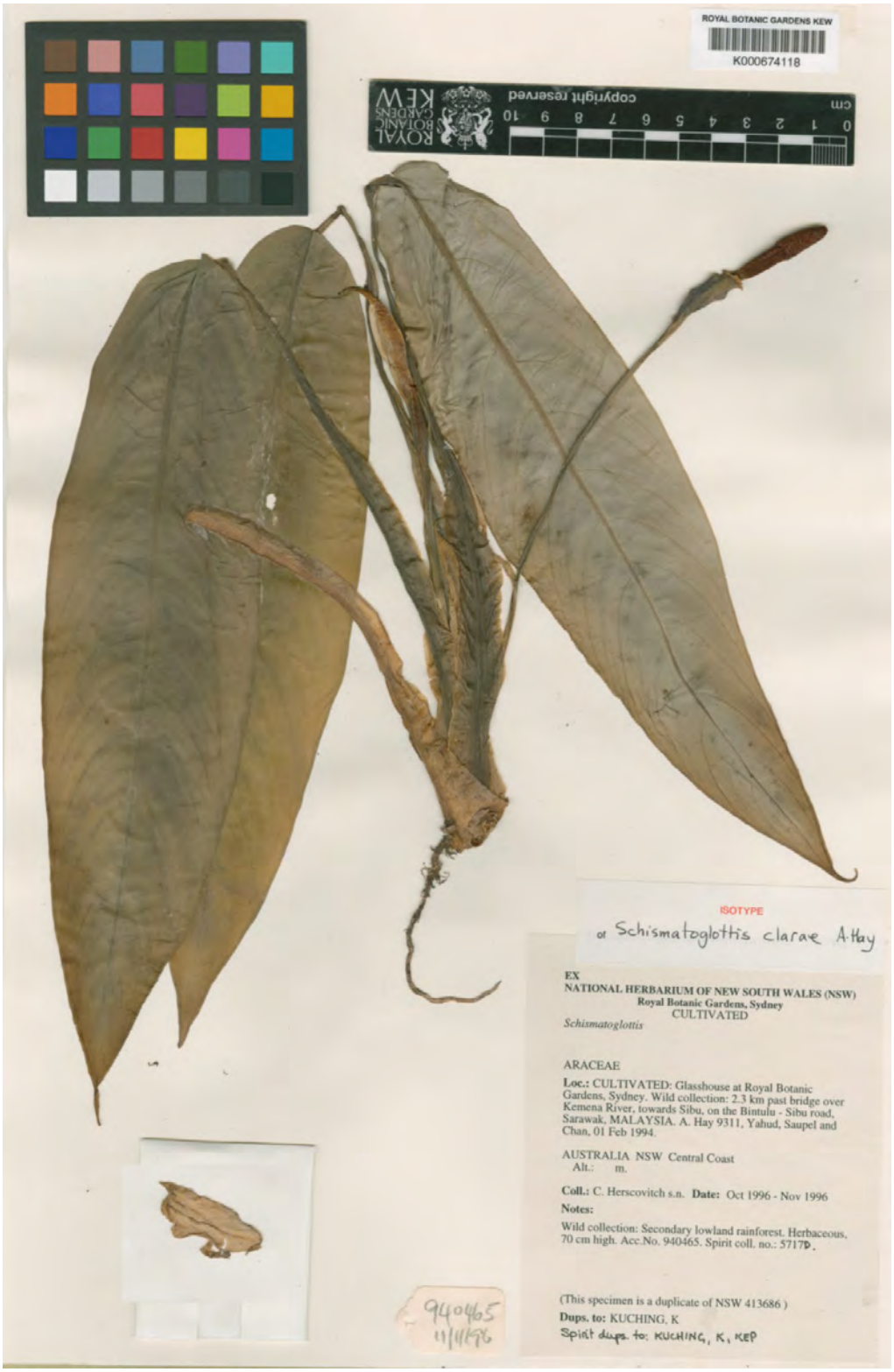

Figure 5. Schismatoglottis clarae A. Hay
A. Hay et al. 9311. Isotype (K). Image © Trustees of the Royal Botanic Gardens, Kew. Used with permission.

Etymology — Derived from the name of the type locality plus the Latin suffix, *–ensis*, to indicate origin.

Notes —There is persuasive evidence that true *S. calyptrata* is absent at least from Sarawak. On this basis in Sarawak *Schismatoglottis baangongensis* is most similar to *S. muluensis* differing by pistillate flower zone adnate for 2/3 its length to the spathe, the conical spadix appendix, larger, longer pale yellow appendix staminodes, the appendix having a coarsely papillate appearance, the weakly obconic staminate flower zone, bright green spadix axis and pistils, and strongly clavate interpistillar staminodes. Leaf blades of *S. baangongensis* are medium green, in marked contrast to the deep green blades of *S. muluensis*.

Other material examined: MALAYSIAN BORNEO: **Sarawak: Kuching**. Padawan, Siburan, Kampung Sikog, trail to Baan Gong water fall, 01° 20' 16.1"; 110° 20' 09.6", 26 July 2009*, P.C. Boyce & S.Y. Wong Ar2587* (SAR).

Schismatoglottis clarae A. Hay, Telopea 9(1): 118(–119). 2000. Type: Cult. Royal Botanic Gardens Sydney Acc. No. 940465 ex Malaysian Borneo, Sarawak, Bintulu ("7th Divn"), 2.3 km past bridge over Kemena River, towards Sibu on Bintulu-Sibu Road (orig. coll. *A. Hay et al. 9311*), Oct/Nov 1997, *C. Herscovitch s.n.* (holotype NSW + NSW spirit 5717D, isotypes K!, KEP!, SAR!). **Figure 5.**

Description

Robust mesophytic clump forming herb to ca 75 cm tall. **Stem** hypogeal, modules hapaxanthic, ca 2 cm diam. **Leaves** ca 3 per crown; **petiole** to 60 cm long, sheathing in the lower 1/3 – 1/2., wings of sheath tapering, fully attached; **blade** oblong-lanceolate to narrowly obovate, 26–37 cm long × 7–13 cm wide, dark green adaxially, paler below, base acute to rounded, not at all cordate, tip acute and acuminate for ca 2 cm; **midrib** not prominent; **primary lateral veins** ca 11 on each side, alternating with lesser interprimaries, diverging at 45–60° (wider angle towards middle of blade), soon rather abruptly deflected towards tip before joining margin; **secondary veins** rather obscure, arising from midrib; **tertiary veins** forming a tessellate reticulum visible on the adaxial side (dry material), abaxially obscure. **Inflorescences** to 5 together; **peduncle** to 13 cm long, erect, declinate after anthesis, cataphylls hidden in subtending leaf sheath. **Spathe** ca 8 cm long; **lower spathe** ovoid, 3 cm long, green, differentiated from the limb by a distinct constriction; **spathe limb** ovate, whitish, caducous, ca 5 cm long, acuminate for 1 cm. **Spadix** ca 7 cm long, sessile; **pistillate flower zone** 2.2 cm long, adnate to the spathe for 1 cm, subcylindric to slightly conic in upper 1/3, 8 mm diam.; **pistils** crowded, subglobose, 1 mm diam.; **stigma** sessile, button-like, papillate, ca 0.5 mm diam.; **interpistillar staminodes** scattered among the pistils, more or less irregularly polygonal, slightly convex-topped, ca 0.5 mm diam.; **sterile interstice** 8 mm long, stout, slightly conic, 5 mm

diam., with staminodes squashed by the spathe constriction; **staminodes** crowded, irregularly polygonal, ca 0.8 mm diam.; **staminate flower zone** slightly and rather abruptly thicker than sterile zone, ca. 7 mm diam. at base, slightly obconic, ca. 1.6 cm long; **stamens** very crowded, more or less dumbbell-shaped with connective mounded between the thecae, ca 1 mm across; pores more or less elliptic; **appendix** bullet-shaped, ca. 2.4 cm long, base slightly but abruptly wider than top of male zone, ca 1 cm diam., the tip acute; **appendix staminodes** flat-topped, irregularly polygonal, frequently in small connate groups, ca 0.75 mm diam. **Fruiting spathe** narrowly urceolate, to ca 4 cm long. **Fruits** not seen.

Ecology — Terrestrial on slopes in disturbed or old secondary perhumid lowland forest on clay loam, 50 – 150 m asl.

Distribution — *Schismatoglottis clarae* is so far known from the vicinity of Bintulu where it is locally common, and Sarikei where it is known from a single population.

Notes — *Schismatoglottis clarae* is distinguished from other hapaxanthic species allied to *S. calyptrata* by its robust elongate leaf blade with the base not at all cordate, the low interpistillar staminodes, the stout sterile interstice and the bullet-shaped appendix (Hay & Yuzammi 2000).

Other material examined: MALAYSIAN BORNEO: **Sarawak: Sarikei.** Ulu Sarikei, 01°55'05.4"N 111°29'35.8"E, 7 Dec 2005, *P.C. Boyce et al. AR-1589* (SAR) & *P.C. Boyce et al. AR-1590* (SAR). **Bintulu.** Bintulu, Air Terjun Baloi, 03°08'34.5"N 113°04'17.2"E, 15 Jan 2007, *P.C. Boyce & Wong Sin Yeng AR-2071* (SAR).

Schismatoglottis muluensis M. Hotta, Mem. Coll. Sci. Kyoto Imp. Univ., Ser. B, Biol. 32(3): 235(–237), **Figure 6,** A–F. 1966. Type: Malaysian Borneo, Sarawak, Marudi ("Mardi" *sic*), western ridge of Gunung Mulu, 17 Mar 1964, *M. Hotta* 14623 (holotype KYO!). **Figure 6 & 7 & 13C.**

Description

Medium to moderately robust epilithic clumping herb 30–80 cm tall. **Stems** hypogeal, modules hapaxanthic, ca 2 cm diam. **Leaves** 3–5 per crown; **petiole** D-shaped, smooth, 34–47 cm long, green, weakly channelled for ca ½ its length, longitudinal striations prominent but not noticeably darker; **petiolar sheath** 8–14 cm long × 5–10 mm wide, sheathing for 1/4–1/3 of petiole length, persistent, membranous, fully attached with a very short ligule in very robust plants, equal, slightly in-rolled or sometimes straight, tapering, scattered with greenish dots; **leaf blade** ovato-sagittate to ovato-cordate, 25–27 cm long × 13–25.5 cm wide, leathery, adaxially semi-glossy dark green, abaxially paler, posterior lobes subtriangular to rounded, 4.5–8 cm, sinus 3.5–6 cm wide, apex acute to acuminate for 1–2 cm, ultimately with a ca 4 mm tubular mucro; **midrib** adaxially flush with blade, raised

abaxially, 3.5–6 mm at insertion; **primary lateral veins** ca 16 per side, diverging at 30°–80° from the midrib, raised adaxially towards the midrib, marginally impressed, entirely raised abaxially; **interprimary veins** raised adaxially, alternating irregularly with primaries; **secondary veins** 3–4 arising from each primary vein; **tertiary veins** inconspicuous; **vein-like pellucid glands** clearly visible abaxially. **Inflorescences** 1–3, erect, smelling strongly of esteric acid during pistillate anthesis, floral odour absent during staminate anthesis; **peduncle** 10–19 cm long × ca 6 mm wide, long, terete, green, erect at anthesis; **spathe** ca 10 cm long; **lower spathe** ovoid-ellipsoid, ca 4 cm long × ca 1.7 cm wide, dull green, separated from spathe limb by a conspicuous constriction coinciding with lower part of staminate zone; **spathe limb** turbinate (triangular-ovate pressed flat), ca 6.5 cm long × ca 2.5 cm wide, mucronate for ca 5 mm, pale greenish yellow to pure white at pistillate anthesis, caducous in a single piece at onset of staminate anthesis; **spadix** ca 9 cm long, shorter than spathe, sessile; **pistillate flower zone** cylindric, ca 3 cm long × ca 7 mm wide, ca 2/5 length of spadix, creamy yellow; **pistils** densely arranged, sub-globose, ca 1 mm long × 0.4 mm wide; **style** barely differentiated; **stigma** sub-globose, wider than ovary, ca 0.5 mm diam., wet with stigmatic secretion at the onset of pistillate anthesis; **interpistillar staminodes** weakly clavate, stipe slender, ca 0.5 mm in diam., up to twice height of pistils, waxy white; **interstice** cylindric, ca 6 mm long × 5–7 mm wide, partially naked, narrower than fertile zones, white, distally with 2–5 whorls of flattened spheroid staminodes, these intergrading into lower part of staminate zone, proximally pistillodes compressed, intergrading into the upper pistillate zone; **staminate flower zone** weakly conic, narrower proximally, ca 1.8 cm long × ca 5.5 mm wide, ca 2/7 length of spadix, white; **staminate flowers** densely arranged, ca 1 mm long × ca 0.5 mm wide, each comprising 2 truncate stamens, deeply holed, separated by a narrow, raised connective; **appendix** stoutly cylindric, ca 2 cm long × ca 5.5 cm wide, ca 2/7 length of spadix, base slightly (0.2 mm) wider than top of staminate zone, white; **appendix staminodes** densely arranged, sub-globose to sub-columnar, ca 1 mm long × 0.5 mm wide, white. **Infructescences** 1–4, ca 5 cm long × ca 2 cm wide, pendulous; **lower spathe** entirely persistent, splitting-reflexing when ripe; **fruits** ca 2 mm long × ca 1.5 mm wide, green to very pale yellow-green; **seeds** ovoid ellipsoid, ca 0.4 mm diam., longitudinally ridged, 7–40 per fruit, encased in with transparent viscous gel.

Ecology — Epilithic on karst limestone under perhumid lowland tropical forest, 40 – 75 m asl.

Distribution — *Schismatoglottis muluensis* is only known from the Karst limestone formations at Mulu N.P., where it is notably abundant along the trail to Deer Cave.

Notes — In Sarawak *S. muluensis* is most reminiscent of *S. baangongensis*, differing by

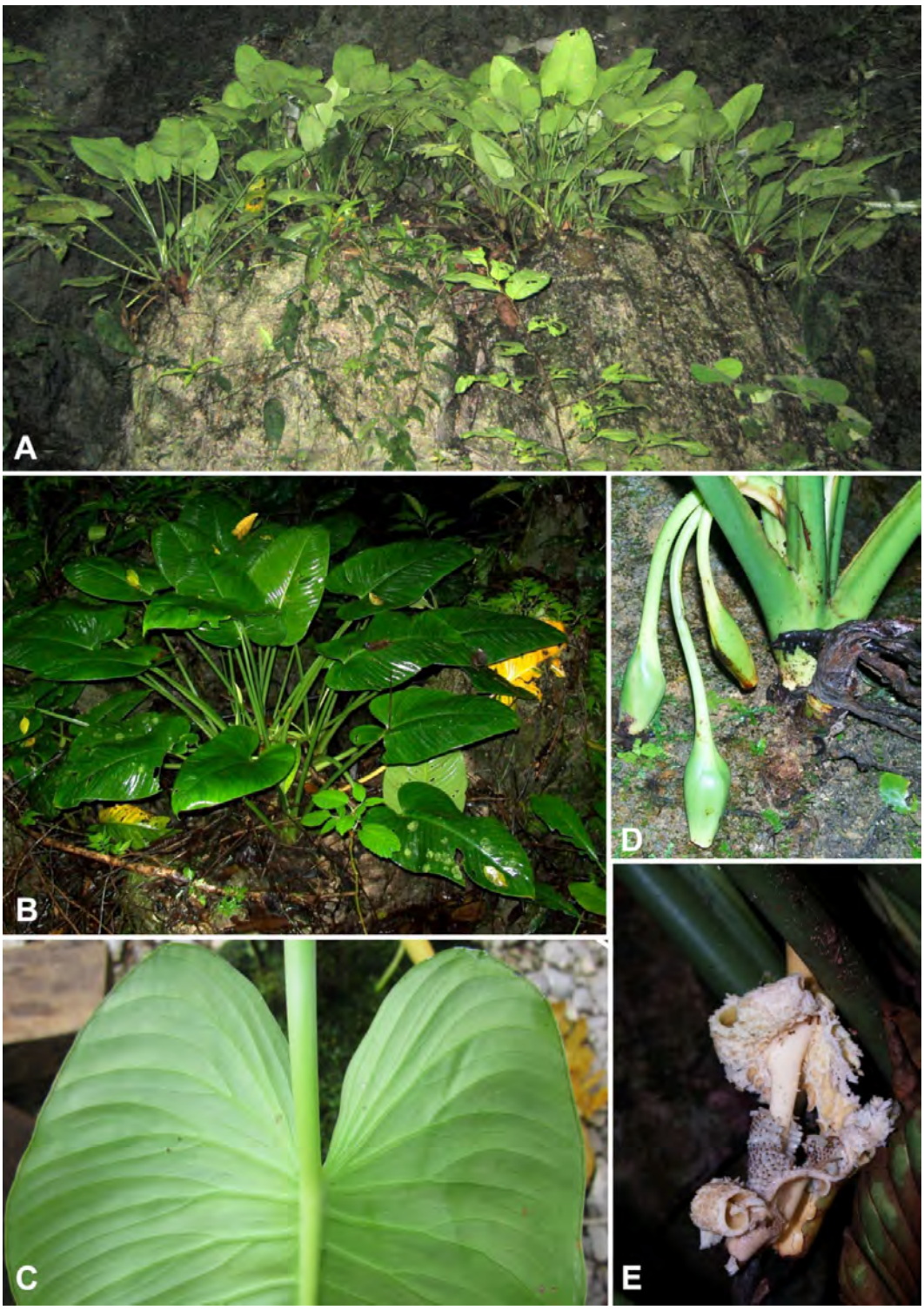

Figure 6. Schismatoglottis muluensis M. Hotta. **A & B** Plants in habitat occurring lithophytically on limestone. **C.** Abaxial side of leaf blade showing secondary veins arising from primary laterals. **D.** Developing infructescences. **E**. Ripe infructescence splitting to reveal fruits; naked portion of axis has fruits already been dispersed. **A–E** from *AR-1949*. Images © P.C. Boyce.

Figure 7. Schismatoglottis muluensis M. Hotta. **A.** Inflorescence at mid pistillate anthesis. **B.** Spadix at late pistillate anthesis, spathe artificially removed. Note that many of the interpistillar staminodes have been eaten. **C.** Inflorescence at onset of staminate anthesis with spathe limb beginning to shed. **A–C** from *AR-1949*. Images © P.C. Boyce.

Figure 8. Schismatoglottis viridissima A. Hay
A. Plant in habitat, Gunung Gading N.P. **B.** Inflorescence at pistillate anthesis. **C.** Inflorescence at onset of staminate anthesis, spathe limb beginning to fall. **D.** Inflorescence at late staminate anthesis, spathe limb almost shed. **E.** Spadix at late pistillate anthesis, spathe artificially removed. **F.** Inflorescence post anthesis with spathe limb shed. **E.** Spadix at late pistillate anthesis, spathe artificially removed. **A–C** from *AR-5258*. Images © P.C. Boyce.

the stoutly cylindrical spadix appendix, much smaller, shorter white appendix staminodes, almost smooth appendix, markedly obconic staminate flower zone, white spadix axis and creamy yellow pistils, and weakly clavate interpistillar staminodes. Leaf blades of *S. muluensis* are deep green.

Other material examined: MALAYSIAN BORNEO: **Sarawak: Miri**. Marudi, Long Lama, Mulu N.P., trail to Deer Cave, 04°02'N, 114°49'E, 8 Aug 2006, *P. C. Boyce et al. AR-1941* (SAR) & 27 Sep 2007, *P. C. Boyce et al. AR-2204* (SAR); Marudi, Long Lama, Mulu N.P., trail to Clearwater Cave, 04°04' N, 114°50' E, 8 Aug 2006, *P. C. Boyce et al. AR-1964* (SAR).

Schismatoglottis viridissima A. Hay, Telopea 9: 154. 2000. Type: Cult. RBG Sydney Acc. No. 940550 ex Malaysian Borneo, Sarawak, Kuching, Lundu, Gunung Gading (orig. coll. *A. Hay et al. 9397*) *C. Herscovitch s.n.* (holotype SAR!; isotypes K!, KEP!, L!, NSW, US). **Figure 8.**

Description

Small mesophytic clump forming herb to 25 cm tall. **Stem** hypogeal, modules hapaxanthic, ca 0.5 cm diam. **Leaves** ca 5 together in each crown; **petiole** to 20 cm long, sheathing in the lower third; petiolar sheath wings fully attached, tapering but apically truncate; **blade** narrowly ovate, brilliant green with a rubbery thinly sub-succulent texture, c. 16 cm long × 7 cm wide, base cordate with rounded posterior lobes to 1.5 cm long, tip acute; **midrib** rather prominent; **primary lateral veins** ca 7 on each side, irregularly alternating with lesser interprimaries and diverging at 60–80°; **secondary venation** mostly arising from the midrib, some from bases of primary veins; **tertiary venation** forming an indistinct tessellate reticulum on both surfaces (visible in dry material). **Inflorescences** 2–3 together; **peduncle** fleshy, ca 4 cm long, mostly hidden by sheaths of subtending leaves. **Spathe** ca 9 cm long; **lower spathe** narrowly ovoid, ca 4 cm long, differentiated from limb by an abrupt constriction; **limb** ca 5 cm long, very broadly ovate, inflated over staminate zone and appendix and then acute, finally acuminate for ca 1 cm, greenish, caducous. **Spadix** 5–6 cm long, sessile, more or less hourglass-shaped; **pistillate flower zone** about half the length of spadix, ca 3 cm long, adnate to spathe in lower 2/3, ca 7 mm diam. in middle, then somewhat conic and attenuate to 5 mm diam.; **pistils** somewhat lax, more so in distal part of pistillate zone, bottle-shaped, bright green, ca 1 mm diam. in lower part of zone, ca 2 mm diam. higher up; **interpistillar staminodes** scattered among pistils, more or less mushroom-shaped, equalling ovaries in height, ca 0.5 mm diam.; **sterile interstice** ill-defined, upper 4 mm of pistillate zone thickly attenuate and occupied by mixed staminodes, stamens and ?abortive is "?" correct? pistils; **staminate flower zone** ca 1.4 cm long, subcylindric, ca 5 mm diam. in lower 5 mm (held within lower spathe chamber), remainder abruptly obconic, to ca 9 mm diam. and exserted

from lower spathe chamber; **stamens** crowded, truncate, hourglass-shaped, with connective thin and not at all elevated above thecae, ca 1 mm across; **appendix** shortly bullet-shaped, base slightly but abruptly wider than top of staminate flower zone, ca 1 cm wide at base, ca 1.3 cm long; **appendix staminodes** flat-topped, centrally impressed, irregularly polygonal, 0.5–0.7 mm diam., dull medium yellow. **Fruit** unknown.

Ecology — Terrestrial in medium to light shade under perhumid lowland to upper hill forest on granites or sandstones; 10 – 940 m asl.

Distribution — *Schismatoglottis viridissima* occurs throughout NW Sarawak on acidic geologies – the Type locality and Bukit Muan are granites; elsewhere (e.g., Puncak Borneo, etc.) populations occur on sandstones.

Notes — The dwarf habit and brilliant green rubbery leaves are immediately diagnostic. Morphologically rather similar plants occur on Karst limestone in NW Sarawak, and elsewhere on a variety of acidic sedimentaries throughout much of Sarawak, as far east as Limbang and south to the Gaat river (C Kapit). More work is required to determine if these populations are extensions of a single widespread species or represent a series of locally endemic segregates.

Other material examined: MALAYSIAN BORNEO: **Sarawak: Kuching**. Padawan, Puncak Borneo, trail to Hornbill Resort golf course maintenance kampong, 01°07'35.1"N 110°13'28.8"E, 30 Sep 2003, *P.C. Boyce & Jeland ak Kisai AR-95* (SAR); Lundu, Gunung Gading N.P., 01°42'N 109°50'E, 3 Mar 2004, *P.C. Boyce & Jeland ak Kisai AR-235* (SAR); Bau, Kampung Jugan, Sungai Boyuh, 22 May 2004, *Jeland ak Kisai & Jepom ak Tisai AR-417* (SAR); Sematan, Teluk Selabang, Sungai Semunsan Buta, 9 Oct 2004, *P.C. Boyce & Jepom ak Tisai AR-723* (SAR); Bau, Segong, Gunung Opar, 01°27'07.3"N 110°04'00.5"E, 9 Nov 2005, *P.C. Boyce et al. AR-1504* (SAR); Siburan, Kampung Giam, Air Terjun Giam, 01°19'20.7"N 110°16'21.4"E, 7 Feb 2006, *P.C. Boyce et al. AR-1689* (SAR); Lundu, Kampung Stungkur, 17 Apr 2006, *P.C. Boyce & Jepom ak Tisai AR-1769* (SAR); Lundu, Gunung Gading N.P., trail to waterfalls, Waterfall 3, 01°41'53.1"N 109°50'20.0"E, 14 Nov 2006, *P.C. Boyce & Wong Sin Yeng AR-2047* (SAR); Lundu, Gunung Gading N.P., trail to waterfalls, Waterfall 1, 01°41'28.3"N 109°50'43.6"E, 14 Nov 2006, *P.C. Boyce & Wong Sin Yeng AR-2048* (SAR); Matang, Kubah N.P., Waterfall Trail, 01°35'40.2"N 110°10'45.9"E, 28 Jul 2007, *P.C. Boyce et al. AR- 2126* (SAR); Sematan, Kampung Temaga Dayak, Sungai Temaga, 01°47'00.2"N 109°43'34.8"E, 23 Mar 2014, *Wong Sin Yeng & P.C. Boyce AR-4644* (SAR); Sematan, Kampung Sebako, Air Terjun Sebako, 01°42'09.0"N 109°42'28.2"E, 5 Jul 2014, *Ooi Im Hin, et al. AR-4849* (SAR); Lundu, Gunung Perigi, 01°44'24.9"N 109°49'03.9"E, 12 Jul 2014, *Ooi Im Hin et al*

AR-4901 (SAR); Sematan, Kampung Temaga Dayak, Sungai Temaga, trail to Gunung Pueh, 01°50'03.5"N 109°40'35.4"E, 7 Aug 2014, *Jepom ak Tisai et al. AR-4859* (SAR); Padawan, Jalan Link, Kampung Begu, 01°12'15.70"N 110°19'51.30"E, 8 Nov 2014, *Wong Sin Yeng & P.C. Boyce AR-4968* (SAR); Lundu, Gunung Gading N.P., trail above *Rafflesia* Site C, 01°41'29.8"N 109°50'22.7"E, 13 Aug 2009, *P.C. Boyce & Wong Sin Yeng AR-5072* (SAR); Bau, Kampung Peninjau Lama, Bung Muan [Gunung Serembu], Brooke Trail, 01°26'00.9"N 110°13'22.6"E, 8 Nov 2015, *Wong Sin Yeng & P.C. Boyce AR-5258* (SAR).

SCHISMATOGLOTTIS CALYPTRATA IN AMBON

Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi in Moritzi, Syst. Verz. 83 (1846). Type: *Arisarum esculentum* Rumph., Herb. Amboin. 5, t. 111, **Figure 1** (1747). (lecto; selected by Hay, 1996). Epitype: Indonesia, Maluku, Ambon, *A. Zippelius s.n.,* (L!; designated by Hay & Yuzammi, 2000). **Figure 9–12, & 13A**

Homotypic Synonyms. *Calla calyptrata* Roxb., Fl. Ind. 3 (1832) 514 (1832). *Homalomena calyptrata* (Roxb.) Kunth, Enum. Pl. 3 (1841) 57 (1841). [*Colocasia? humilis* Hassk., Flora 25 (2), Beibl. 1: 10 (Jul 1842); Tijdschr. Ned. Ind. 4(2): 237 (1842), nom. superfl. pro *Schismatoglottis calyptrata* (based on *Arisarum esculentum* Rumph., Herb. Amboin. 5, t. 111, **Figure 1** (1747)]. [*Colocasia? humilis* var. *major* Hassk., Tijdschr. Nat. Gesch. & Physiol. 9: 160 (Aug/Sep 1842); Hassk., Cat. Hort. Bot. Bog. (1844) 56, nom. superfl. pro var. typ.]. *Zantedeschia calyptrata* (Roxb.) C. Koch, Ind. Sem. Hort. Berol. App. 9 (1854). [*Schismatoglottis calyptrata* var. *concolor* Hallier f., Bull. Herb. Boiss. 620 (1898); Ridl., Materials Fl. Mal. Pen. 3: 31 (1907); Engl., Pflanzenr. 55 (IV.23Da): 115 (1912); Ridl., Fl. Mal. Pen. 5: 111 (1925), nom. superfl. pro var. typ.].

Description

Moderate to robust mesophytic stoloniferous herb forming colonies, or clump-forming, 35–60 cm tall. **Stem** hypogeal, modules hapaxanthic, 1–2 cm diam. **Leaves** ca 6 per crown; **petiole** smooth, medium green with slightly darker broken striations, 15–50 cm long; **petiolar sheath** ca 1/3 petiole length, wings of sheath fully attached, persistent, tapering or, especially in diminutive forms, shortly and bluntly ligular at apex; **blade** usually dull to slightly semi-glossy mid-green, sometimes variegated with 1–2 bands or irregularly spotted grey-green to yellowish green, c. 7–35 cm long, widest at the base or ca 1/3 along its length, ca 4–18 cm wide, mostly cordate to sagittate; **midrib** somewhat abaxially prominent; **primary lateral veins** 6–15 per side, irregularly alternating with lesser interprimaries, diverging at 45–70°, nearly always raised adaxially towards the midrib, marginally impressed, entirely raised abaxially, mostly not branched but occasionally with 1 or 2 branches especially in lower part of blade; **secondary venation**

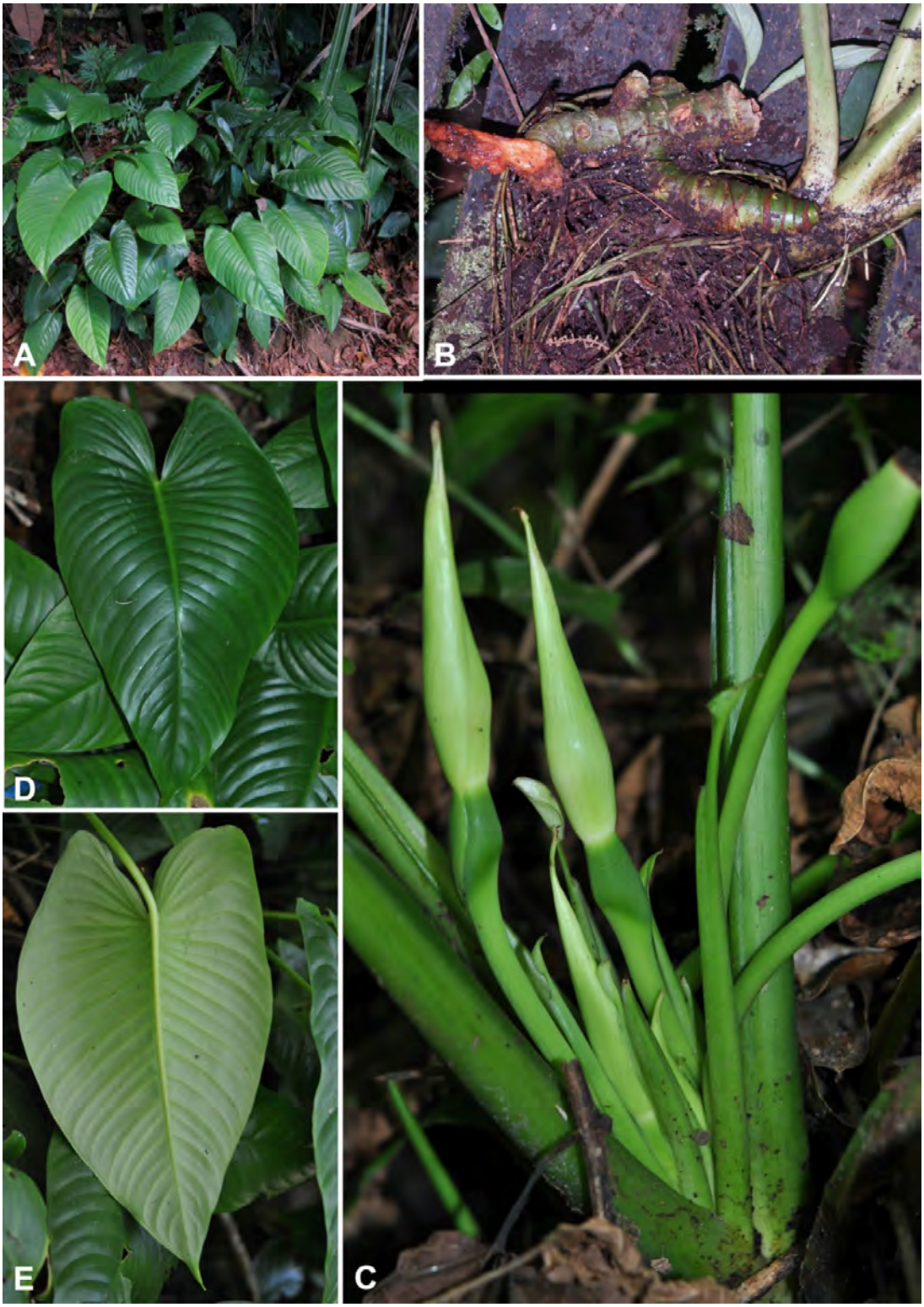

Figure 9. Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi
A. Plants in habitat, Ambon. **B.** Excavated stems showing hapaxanthic modules. **C.** Detail of flowering plant with two inflorescences close to anthesis and a developing infructescence. **D.** Leaf blade adaxial surface. **E.** Leaf blade abaxial surface. **A–E** from *AR-4268*. Images © Hoe Yin Chen.

Figure 10. Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi
A. Inflorescence at onset of pistillate anthesis. **B.** Inflorescence at end of pistillate anthesis, spathe limb almost shed. **C.** Spadix at pistillate anthesis, spathe artificially removed. **D.** Fallen spathe limb. **E.** Inflorescence post-anthesis. Note that spathe limb is lost, leaving a dark scar, and that the post-anthesis staminate flowers (in light brown) are now well-differentiated from the spadix appendix (cream). **A–E** from *AR-4268*. Images © Hoe Yin Chen.

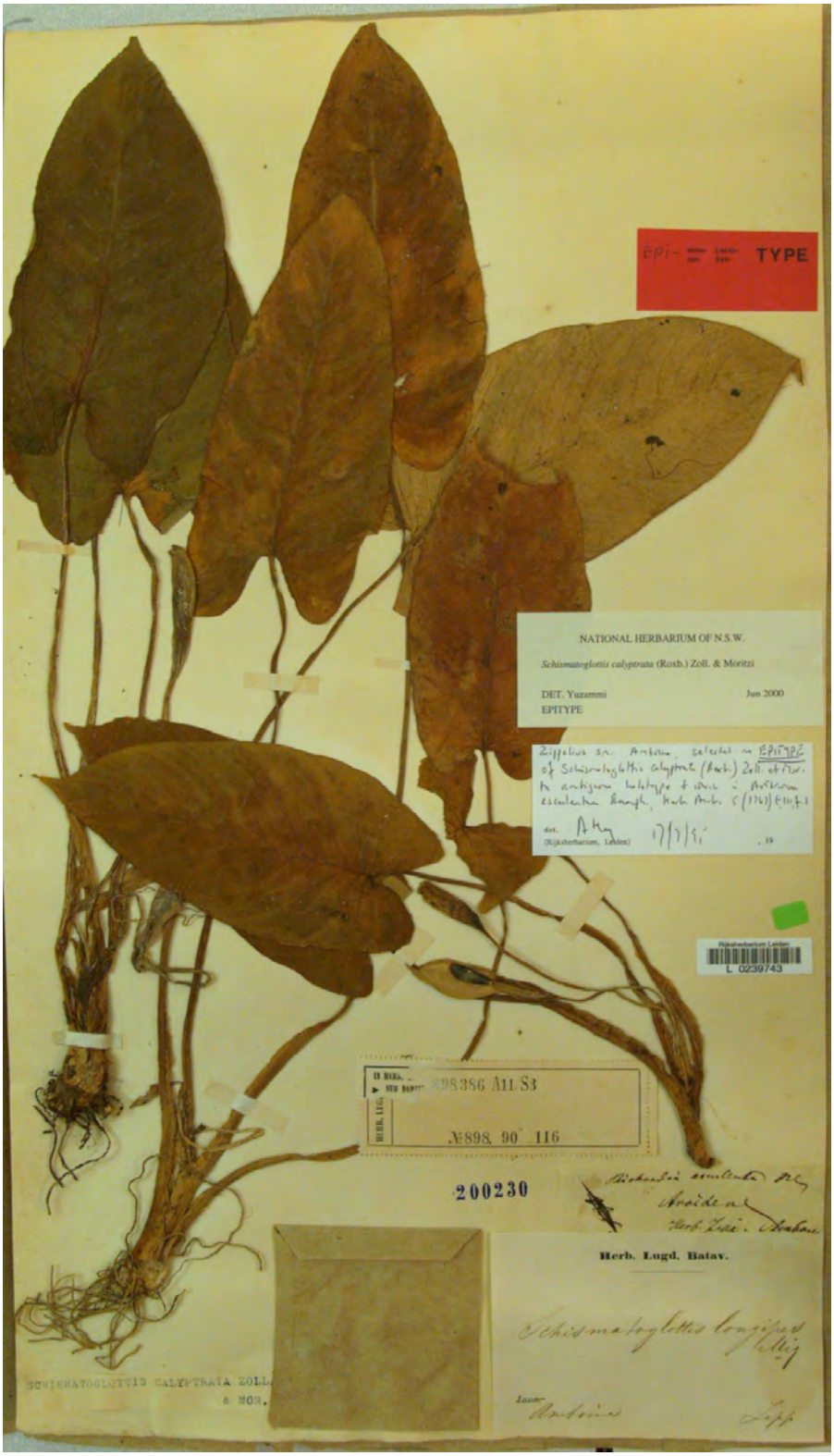

Figure 11. Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi
A. Zippelius s.n. Epitype (L), Image © Naturalis Biodiversity Center. Used with permission.

Figure 12. Schismatoglottis calyptrata (Roxb.) Zoll. & Moritzi
Arisarum esculentum Rumph., Herbarium Amboinense 5, t. 111, **Figure 1** (1747). Lectotype of *Schismatoglottis calyptrata* (Roxb.) Zoll. & Moritzi.

Figure 13. Spadix of *Schismatoglottis* Calyptrata Complex Clade species compared.
A. *Schismatoglottis calyptrata* (Roxb.) Zoll. & Moritzi. **B. *Schismatoglottis baangongensis*** S.Y. Wong, Y.C. Hoe & P.C. Boyce. **C. *Schismatoglottis muluensis*** M. Hotta. **A.** from *AR-4268*; **B.** from *AR–2588*; **C.** from *AR-1949*. Image A © Hoe Yin Chen; images B & C © P.C.Boyce.

arising mostly from the midrib, sometimes from the bases of primary veins; **tertiary venation** inconspicuous. **Inflorescences** 1–8 together, with a strong esteric odour at pistillate anthesis; **peduncle (**exposed part) 8–14 cm, erect at anthesis, then deflected in fruit. **Spathe** 8–12 cm long; **lower spathe** narrowly ovoid, ca half the length of whole spathe, green; **limb** differentiated from lower spathe by an abrupt constriction corresponding to the base of the staminate zone of the spadix, at pistillate anthesis much inflated, narrowing and turbinate, the apex conspicuously mucronate, completely surrounding the spadix and gaping ventrally or with the margins loosely overlapping, creamy to pale greenish-yellow, caducous immediately after pistillate anthesis. **Spadix** ca 3/4 length of spathe, narrowly hourglass-shaped; **pistillate flower zone** about half length of whole spadix, partially adnate to spathe, ca 5–8 mm diam. below, distally tapering to c. 3–4 mm diam.; **pistils** pale green, close-packed, c. 1 mm tall, c. 0.5 mm diam., flask-shaped and close-packed below, distally becoming more widely spaced and subglobose, finally rather widely scattered and squashed by constricting spathe; **stigmas** button-like, papillate, raised on a short style; **interpistillar staminodes** white, mostly conspicuously taller than pistils, few in number, scattered, stalked, clavate; interstice between staminate and pistillate zones absent save sometimes for a relative concentration of interpistillar staminodes amongst distal pistils; **staminate flower zone** narrowly obconic, approximately half length of pistillate zone, distally ca 0.5–1 cm diam., ivory; **anthers** dumbbell-shaped from above, ca 0.5 × 1 mm, with thecae apically impressed, connective shorter than to very slightly elevated above thecae; **appendix** elongated bullet-shaped, basally nearly always somewhat wider than apex of staminate zone, creamy yellow; **appendix staminodes** appendix columnar, irregularly and very weakly polygonal, flat- to slightly round-topped, ca 0.5 mm diam. *Fruiting spathe* declinate, urceolate.

Ecology — Lowland perhumid forest, and forest margins in both wet and well-drained sites.

Distribution — In its broadest circumscription (Hay & Yuzammi, 2000) *S. calyptrata* occurs from tropical southwestern China to Indo-China east to Vanuatu and south to Jawa. Our present interpretation precludes the presence of *S. calyptrata* at least for Sarawak and casts doubt its occurrence on Borneo.

Notes — The description provided excludes characteristics from material originating from Sarawak. As noted by Hay (Hay & Yuzammi 2000), ecological data (substrate, habitat, etc.) are lacking in most collections, "but where such data are available, it has been possible to segregate morphologically very closely allied, eco-geographically distinct species. Refinement of the circumscription of *S. calyptrata* and the recognition of segregate species in other parts of its range (particularly Sulawesi) seems a likely outcome of further field

study. Attention to dispersal mechanisms in this widespread species with no obvious long-distance dispersal syndrome would likely inform understanding of the biogeography of the genus."

References

Hay, A. 1996. The genus *Schismatoglottis* Zoll. & Moritzi (Araceae–Schismatoglottideae) in Peninsular Malaysia and Singapore. *Sandakania* 7: 1–30.

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

Hoe Y. C. & S. Y. Wong. 2016. Floral biology of *Schismatoglottis baangongensis* (Araceae) in West Sarawak, Malaysian Borneo. *Pl. Syst. Evol.* DOI 10.1007s00606-016-1329-z

Low S. L. 2016: *Phylogeny and aspects of reproductive biology of Aridarum (Schismatoglottideae: Araceae)*. – Unpublished Ph.D. Thesis. Universiti Malaysia Sarawak, Malaysia.

Scherberich, D. & P. C. Boyce. 2013. Studies on Schismatoglottideae (Araceae) of Borneo XXVI – *Schismatoglottis scintillans*, a new species with horticultural potential from Sabah, Malaysian Borneo. *Willdenowia* 43: 87–90.

Tate, R. B. 2001. The geology of Borneo island CDROM. – Kuala Lumpur: Persatuan Geologi Malaysia / Geological Society of Malaysia.

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