

## Studies on Schismatoglottideae (Araceae) of Borneo XIII: A Revision of the *Schismatoglottis nervosa* Species Complex

WONG SIN YENG

Department of Plant Science and Environmental Ecology, Faculty of  
Resource Science and Technology, Universiti Malaysia Sarawak,  
94300 Samarahan, Sarawak, Malaysia

### Abstract

A revision of the *Schismatoglottis nervosa* Ridl. species complex is presented. Ten species are recognized, of which three species are pre-existing (*S. nervosa*, *S. elegans* A.Hay, and *S. brevicuspis* Hook.f.) and seven are novel and described here (*Schismatoglottis adoceta* S.Y.Wong, *S. linae* S.Y.Wong, *S. matangensis* S.Y.Wong, *S. simonii* S.Y.Wong, *S. tessellata* S.Y.Wong, *S. turbata* S.Y.Wong, and *S. ulusarikeiensis* S.Y.Wong.) The *S. nervosa* species complex is readily delimited by the pungent terpenoid smell when the vegetative tissues are crushed, and by the presence of longitudinally ridged petioles. A key to the *S. nervosa* species complex is presented and all species are illustrated.

### Introduction

*Schismatoglottis* is a genus of in excess of 150 species of terrestrial, lithophytic, and rheophytic herbs occurs within Malesia, but mainly in Borneo. Hay & Yuzammi (2000) presented an alpha-taxonomic revision of the Malesian species, one of the results of which was the recognition of six informal species groupings based primarily on shoot architecture and the senescence mechanics of the upper spathe: Asperata Group, Calyptrata Group, Corneri Group, Multiflora Group, Rupestris Group and Tecturata Group. However, *Schismatoglottis* has been proven as a polyphyletic assemblage (Wong *et al.*, 2010), and this has resulted in the removal of the Rupestris Group into a resurrected genus, *Apoballis* (Wong & Boyce, 2010). Further molecular analysis is being undertaken and will form the basis of further paper (Ting *et al.*, in prep.).

Hay and Yuzammi (2000) placed *S. nervosa* and *S. elegans* (both from Sarawak) in the Asperata Group based on the combination of pleioanthic shoots, the leaf sheath open and nearly always fully attached and persistent, and by the spathe limb opening more-or-less wide and then crumbling-

deliquescent. One species, which occurs in West Malaysia, *Schismatoglottis brevicuspis* Hook.f also belongs to this complex. In addition to these species, a further 7 species, all novel, are recognized here from Sarawak: *Schismatoglottis adoceta* S.Y.Wong, *S. linae* S.Y.Wong, *S. matangensis* S.Y.Wong, *S. simonii* S.Y.Wong, *S. tessellata* S.Y.Wong, *S. turbata* S.Y.Wong, and *S. ulusarikeiensis* S.Y.Wong. The *S. nervosa* species complex is clearly distinguished within the Asperata Group by a pungent terpenoid smell when crushed (tissues odourless when crushed in Asperata Group *s.str.*, i.e., *sensu* Wong), coriaceous to thinly coriaceous ± elliptic leaves with veins prominent abaxially (leaves thinly sub-succulent and fragile with veins obscure to invisible abaxially in Asperata Group *s. str.*), and longitudinally ridged petioles (petioles asperous to puberulent or hispid in Asperata Group *s. str.*), supporting the recognition as a distinct species complex within the group.

The *S. nervosa* species complex comprises terrestrial forest-dwelling herbs commonly on steep soil banks or occurring as obligate or facultative lithophytes on limestones, shales, sandstones and granite. *Schismatoglottis nervosa* and *S. elegans* are restricted to Karst limestones; *Schismatoglottis matangensis* and *S. turbata* to sandstones, and *S. adoceta*, *S. tessellata* and *S. ulusarikeiensis* to shales, *S. simonii* to both limestones and sandstones, and *S. linae* and *S. brevicuspis* to granite.

### Allied taxa

There are additional species in the *S. asperata* group that possess longitudinally and/or puberulent ridged petioles and/or are weakly (not pungently) terpenoid smelling when crushed, of which one, *Schismatoglottis latevaginata* Alderw., described and numerous other species are awaiting formal description. Based on initial observations of the spathe senescence mechanics (spathe at least partially circumscissile before shedding in large pieces) and leaf shape (lamina oblongo-ovate on a disproportionately long petiole), these species are morphologically more closely related to one another than any of them are to species of the *S. nervosa* species complex, and will be the subject of a subsequent paper.

### *Schismatoglottis nervosa* species complex

Small to robust **herbs**, 40-70 cm tall, occasionally up to *ca* 1 m tall, with vegetative tissues emitting a pungent aromatic (terpenoids) smell when crushed. **Stem** epigeal, pleionanthic, erect to decumbent, sometimes ascending and then rooting ('terrestrial climber' *sensu* Boyce), 30-50 cm

long x 2-4 cm thick, adventitiously branched from older portions, rooting along entire length on contact with ground, roots often penetrating petiole bases; leaf scars prominent. **Leaves** few to many (5-15) together; innovations yellowish green; senescent lamina sometimes rotting and falling together with distal portion of petiole to leave the lower portion of the petiole attached to plant, this rotting and falling at a later stage; petioles terete, ca 30-40 cm long, sometimes, up to ca 70 cm long, adaxially channelled or D-shaped in cross section, weakly to strongly longitudinally ridged (resembling celery - *Apium graveolens* - Apiaceae) especially abaxially, minutely (strong lens required) and densely verruculate or glabrous; petiole sheathing in the lower  $\frac{1}{3}$  -  $\frac{1}{2}$ , sheaths fully attached, thinly coriaceous, sometimes leathery, marcescent or persistent, tapering, closed or less often wide open, sometimes with a short rounded free ligular portion; lamina broadly ovate to oblongo-ovate to elliptic, coriaceous or thinly coriaceous, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate, adaxial surface semi-matte, bright deep to medium green, always slightly bullate, abaxial surface paler green, often glaucous, drying strongly discolorous; midrib adaxially flush with lamina, abaxially very prominent; primary venation impressed adaxially, sometimes flush with lamina, strongly raised abaxially, alternating with lesser interprimaries, interprimaries occasionally arising from the bases of the primary veins, both diverging at 45°- 90° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary venation mostly arising from the midrib, occasionally from near the bases of the primary veins, prominent abaxially; tertiary venation forming an obscure to prominent tessellate pattern, variously prominent adaxially and abaxially. **Inflorescences** up to three together (rarely 4), erect, white, moderately fragrant (esterase) at female anthesis; peduncle to ca 2 cm long, concealed by leaf bases, prophylls, and cataphylls at flowering, slightly exerted in fruit; **spathe** interior glossy, exterior semi-glossy; lower spathe differentiated from the limb by a weak constriction correlating with spadix interstice; limb oblongo-lanceolate, white to partially green, weakly coriaceous to somewhat spongy, semi-truncate to shortly to strongly acuminate (to ca 5 mm long), apex mucronate (to ca 2 mm), limb either caducous by crumbling at or just after male anthesis, with remaining fragments deliquescing, or briefly persistent until end of anthesis and thence deliquescent; spadix sessile, isodiametrically adnate on the lower abaxial side relative to the spathe opening; **female zone** conic-cylindric; pistils numerous, close-packed or laxly arranged; stigma sessile, punctiform, minute to large but always smaller in diameter than ovary; interpistillar staminodes confined to a more-or-less single ring at the base of the female zone (rarely among the pistils); sterile interstice present, supra-pistillate pistillode zone often constricted; pistillodes half to twice the diameter of

ovary, close-packed or laxly arranged and followed by a whorl of staminodes, this zone often constricted; **male zone** contiguous with interstice staminodes, cylindrical; stamens close-packed, the whole butterfly or dumbbell-shaped from above; pores oblong to C-shaped, deep to shallow; appendix sub-cylindric, white or yellow when fresh, distally tapering to a blunt or sharp point, basally merging with the male zone or weakly or distinctly wider and slightly truncate; appendix staminodes small to rather large, densely packed, flat-topped to slightly impressed, irregularly polygonal.

### Key to *Schismatoglottis nervosa* species complex

1. Petiole longitudinally ridged; vegetative tissues pungently aromatic (terpenoids) when crushed; leaves  $\pm$  elliptic, thickly to thinly coriaceous with veins prominent abaxially.....**2**
1. Not the above combination ..... remainder of genus (see Hay and Yuzammi, 2000; Hay, 2002)
2. Spathe hardly opening; upper part of spathe limb remaining green during anthesis; stigma green when fresh.....**3**
2. Spathe opening wide; upper part of spathe turns to white during anthesis; stigma white when fresh (except for *S. tessellata*).....**4**
3. Petiolar sheath persistent, opening wide; lamina longer and narrower (ratio  $\geq 3:1$ ); primary venation adaxially flush with surface and with less than 10-15 on each side. Central Sarawak: Sarikei.....***S. ulusarikeiensis***
3. Petiolar sheath marcescent, opening narrow; lamina shorter and wider (ratio  $< 3:1$ ); primary venation adaxially sunken with surface and with 15-20 on each side. West Malaysia: widespread..... ***S. brevicuspis***
4. Appendix white when fresh; petioles puberulent, densely (sometimes minutely) verruculate, longitudinal ridges prominent; leaf apex shortly acuminate to *ca* 1 cm.....**5**
4. Appendix yellow when fresh; petioles glabrous, not verruculate, longitudinal ridges not prominent; leaf apex strongly acuminate to *ca* 3 cm.....**9**
5. Tertiary venation obscure-tessellate; female zone exceeding male zone, pistils laxly arranged, stigma small,  $\frac{1}{5}$  of ovary diam., turning yellow in alcohol; spadix interstice sharply constricted. West Sarawak: Matang.....***S. matangensis***
5. Tertiary venation prominent tessellate; male zone exceeding female zone, pistils crowded, stigma large,  $\frac{1}{3}$  to  $\frac{1}{2}$  of ovary diam., remaining white in alcohol; spadix interstice weakly constricted. Plants of limestone, sandstone and granite. West Sarawak except Matang .....**6**

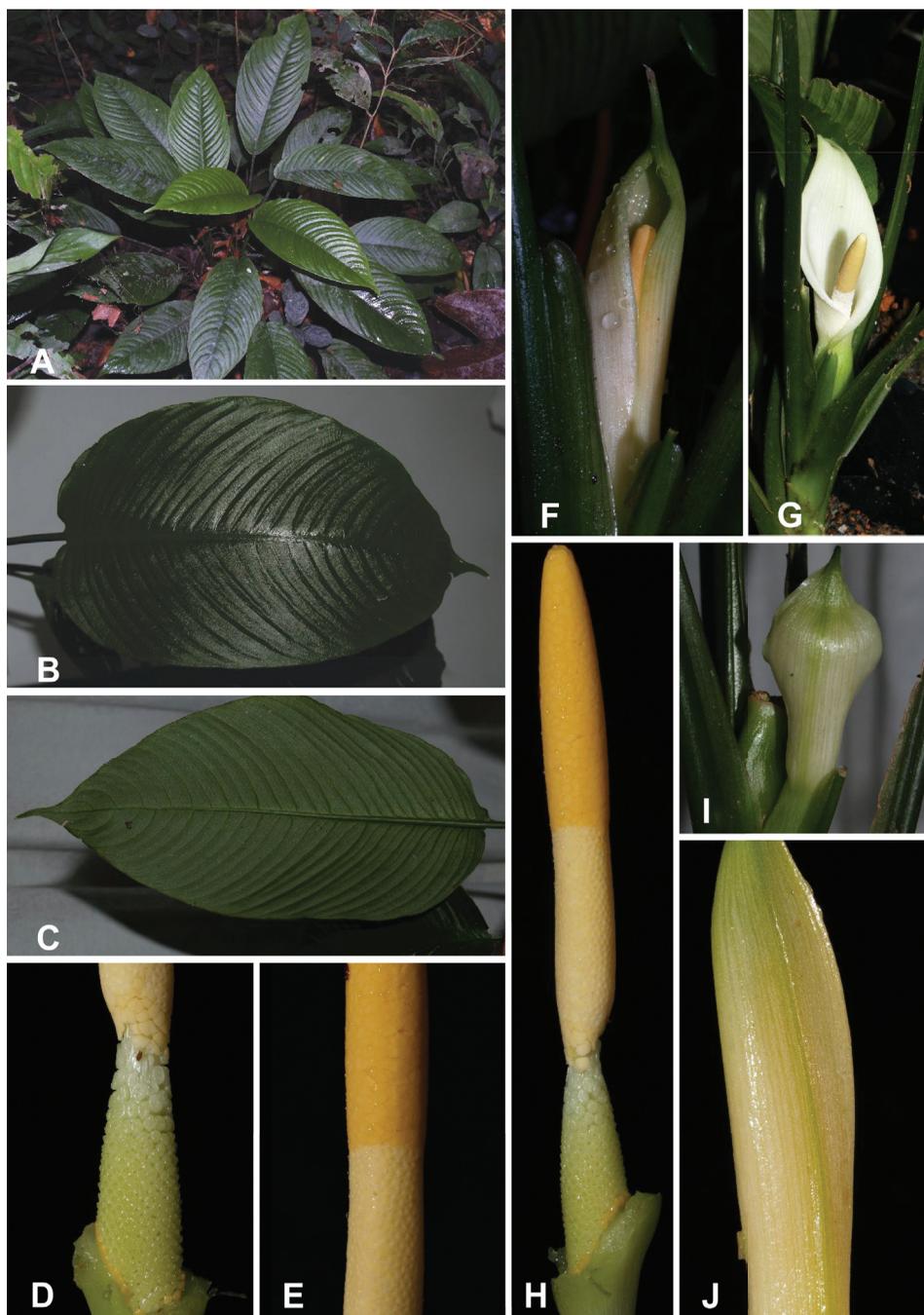
6. Male zone irregularly arranged with uneven surface, male flowers round; appendix markedly wider than male zone and slightly truncate basally in diameter. Plants of sandstone..... ***S. turbata***
6. Male zone evenly arranged with smooth surface, male flowers butterfly shape or dumbbell shape; appendix contiguous with male zone. Plants on a variety of substrates..... **7**
7. Spathe limb splitting into longitudinal strips before deliquescing. Plants of sandstone..... ***S. linae***
7. Spathe limb deliquescent in a whole piece. Plants of limestone..... **8**
8. Stamen pores narrowly C-shaped, deep, connective narrow, rims not alate; stigma  $\frac{1}{2}$  ovary diam.; secondary and tertiary venation not strongly pronounced. Plants weak to robust, sometimes colony forming. Always lithophytic in soil collected in crevices and sinkholes in limestone. Full shade, less than 200 m asl. West Sarawak: Bau..... ***S. nervosa***
8. Stamen pores oblong, shallow, connective broad, rims widely alate; stigma  $\frac{1}{3}$  ovary diam.; secondary and tertiary venation pronounced. Plant robust, always colony forming. Always terrestrial in deep soil on limestones and sandstones. Sometimes in full sun, less than 600 m asl. West Sarawak: Padawan/Serian..... ***S. simonii***
9. Leaf lamina thinly coriaceous, occasionally with grey stripe, adaxially glossy; tertiary venation more tessellate adaxially than abaxially; female flowers green; appendix  $\frac{1}{6}$  of spadix length. Central Sarawak: Kapit..... ***S. tessellata***
9. Leaf lamina coriaceous, never variegated, adaxially semi-matte; tertiary venation more tessellate abaxially than adaxially; female flowers white; appendix  $\frac{1}{2}$  to  $\frac{1}{3}$  of spadix length..... **10**
10. Petiolar sheath leathery; leaf lamina glaucous abaxially, leaf apex shorter (to ca 2 cm); stigma large ( $\frac{1}{2}$  of ovary diameter), staining yellow in alcohol; connective narrow, pore oblong. Plants of shales in central and northeast Sarawak..... ***S. adoceta***
10. Petiolar sheath coriaceous; leaf lamina not glaucous abaxially, leaf apex longer (to ca 3 cm); stigma small ( $\frac{1}{5}$  of ovary diameter), remaining white in alcohol; connective broad, pore C-shaped. Plants of limestones in northwest Sarawak ..... ***S. elegans***

1. ***Schismatoglottis adoceta*** S.Y.Wong, *sp. nov.*

*Ab Schismatoglottis elegans foliis subtus glaucis, laminae foliae apice acuminata brevior (ad 2 cm longa), stigmatibus maioribus (quam ovaria ca  $\frac{1}{2}$  diametro vs.  $\frac{1}{5}$  in S. elegans) et cum alcoholis flavescente (stigmatii S. elegansii sum alcoholis alba remanens). Connectivo antherae anguste, poris*

*oblongo* (vs. *connectivo antherae crasso, poris hippocrepiiformis*: *S. elegans*) *distinguitur*. *Schismatoglottis adocetae in habitu saxa shaleiaca restrictus est* (*S. elegans in habitu calcicola unica*).—**Typus**: Malaysia, Sarawak, Kapit Division, Belaga, km 10 Bakun-Bintulu-Miri road junction, 02° 50' 51.7"; 114° 01' 57.6", 182 m asl, 11 Oct 2005, *P.C.Boyce et al. AR-1408* (holo, SAR). **Plate 1.**

**Leaf** petioles glabrous, slightly channelled and carinate adaxially in cross section; sheathing in the lower  $\frac{1}{5}$  to  $\frac{1}{2}$ , sheath fully attached, closed, tapering, leathery, persistent; lamina broadly ovate to oblongo-ovate, more-or-less elliptic, thinly coriaceous, slightly bullate, 7-9 cm wide x 13-23 cm long, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate to *ca* 2 cm, adaxial surface semi-matte mid-green, abaxial surface paler green, glaucous, drying strongly discoloured, midrib adaxially flush with lamina, abaxially prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially with 17-22 primary lateral veins on each side, alternating with lesser interprimaries, frequently with a few branches from near the base, both diverging at 45°- 60° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary venation, arising from the midrib and the primary veins; tertiary venation obscure tessellate adaxially and abaxially in both living plants and dry specimens. **Inflorescences** up to three in quick succession alternating with foliage leaves *ca* 5 cm long, (i.e. not forming a true synflorescence), fragrant (esterase) at female anthesis; peduncle to *ca* 1 cm, not exerted from leaf bases, slightly exerted in fruit; **spathe** interior glossy, exterior semi-glossy, coriaceous, *ca* 7.5 cm long, lower spathe narrowly ovoid, green when fresh, *ca* 2.5 cm long x 1 cm diam., differentiated from the limb by a weak constriction; limb sub-truncate, white, *ca* 5 cm long, coriaceous, opening wide except for convolute base, at first over-arching, then reflexed, finally more or less twisted and then caducous-crumbling, apex mucronate *ca* 4 mm long, green when fresh; spadix sessile, adnate isodiametrically to the spathe in the lower  $\frac{1}{2}$  of female zone, whitish, to *ca* 5.5 cm long, less than the length of spathe; **female zone** *ca* 1.7 cm long,  $\frac{1}{3}$  of spadix length; pistils many, crowded, round to slightly rhomboid, with weakly bisulcate longitudinal ridges, *ca* 0.5 mm diam. x 0.45 mm long; stigma large, bun-shaped, to *ca* 0.3 mm diam.,  $\frac{1}{2}$  of ovary, punctiform, papillate, yellow in alcohol; interpistillar staminodes very occasional among the pistils, crowded into a row along the spathe/spadix adnation, stalked, clavate and flat-topped, *ca* 0.5 mm diam., similar size to pistils; sterile interstice strongly narrowed, *ca* 1.4 mm diameter in the middle, (2.5-) *ca* 7 mm long which is  $\frac{1}{8}$  of spadix length, basally more or less covered with inflated abortive pistils (reduced stigmas), twice the diameter of ovary, transversely sulcate, apically covered with two rows of sterile stamens, irregular shape, slightly wider than stamens; **male**



**Plate 1.** *Schimatoglottis adoceta* S.Y.Wong. A. Whole plant; B. Leaf lamina adaxially; C. Leaf lamina abaxially; D. Female zone; E. Male zone and yellow appendix; F. Inflorescence during female anthesis; G. Inflorescence during male anthesis; H. Spadix with the spathe artificially removed; I. Spathe at male anthesis; J. Spathe prior to female anthesis. Images © P.C. Boyce

**zone** cylindrical, *ca* 3.6 mm diam.  $\times$  1.2 cm long,  $\frac{1}{3}$  of spadix length, marked increased in diameter from interstice; stamens crowded, truncate, *ca* 0.4 mm across, dumbbell-shaped with the connective not elevated above the thecae, connective narrow, pore oblong and deep; appendix sub-cylindric, *ca* 1.8 cm long,  $\frac{1}{3}$  of spadix length, yellow when fresh, turning white in alcohol, frequently chewed by beetles, tapering to a sharp point, basally more or less not isodiametric with top of male zone; staminodes of appendix more or less columnar, irregularly polygonal, flat-topped, *ca* 0.5-1 mm diameter.

*Other specimens seen:* SARAWAK. Bintulu Division: Bintulu, Bk. Satiam, 02° 59' 33.0"; 112° 56' 01.4", 18 m asl, 12 Aug 2004, *P.C.Boyce & Jeland ak Kisai AR-632.1* (SAR); Bk. Merairi, 02° 46' 26.9"; 113° 39' 19.8", *JS/LC-24 AR-1284* (SAR).

*Distribution:* Central and northeast Sarawak, Kapit and Bintulu Divisions.

*Habitat:* Lithophytic on shale (Bintulu and Kapit Divisions), 18-180 m asl.

*Notes:* *Schismatoglottis adoceta* is clearly distinguished from the rest of the *S. nervosa* complex by having leathery petiolar sheath (coriaceous petiolar sheath in the rest of the complex). *S. adoceta* is most similar to *S. elegans* although readily distinguished by the leaf laminae abaxially glaucous, the leaf apex much shorter-acuminate (to *ca* 2 cm), larger stigma (*S. adoceta*  $\frac{1}{2}$  of ovary diameter vs. *S. elegans*  $\frac{1}{5}$  of ovary diameter) staining yellow in alcohol (remaining white in *S. elegans*), anthers with a narrow connective and oblong pore (*S. adoceta*) whereas anthers in *S. elegans* have a broad connective and a C-shaped pore. *Schismatoglottis adoceta* is restricted to shales as compared to *S. elegans* endemic on limestones. *Schismatoglottis adoceta* differs from *S. tessellata* (also of shales) by coriaceous leaf laminae with the adaxially much less pronounced tertiary venation and the spadix appendix in *S. adoceta* much longer and narrower.

*Etymology:* The specific epithet is derived from the Greek '*adocetus*', unexpected, in allusion to the realization late in the preparation of this manuscript that several elements of *S. elegans* sensu Hay and Yuzammi required a specific recognition.

## 2. *Schismatoglottis brevicuspis* Hook.f.

Fl. Brit. Ind. 6 (1894) 537; Ridl. Materials Fl. Mal. Pen. 3 (1907) 33 & J. Straits Branch Roy. Asiat. Soc. 57 (1910) 113 & Fl. Mal. Pen. 5 (1925) 113; Engl. & Krause, Pflanzenr. 55 (IV.23Da) (1912) 98, *pro parte excl. specim. cit.* Curtis (Penang, Waterfall), Ridley (Selangor, Petaling; Pahang, Tahan River) [i.e. *S.*

*brevipes* Hook.f., q.v.]. –**Type:** Malaysia, Perak, *Scortechini* 612 (holo, K; iso, CAL, SING).

*Other specimens seen:* PENINSULAR MALAYSIA. **Johor:** Muar, Gunung Ledang F.R., Gunung Ledang, (Mt Ophir), 22 Jan 1994, (orig. coll. Hay, A., Samy, A. & Ban Ka 9172) sub. *C. Herscovitch* NSW407380 (KEP 41490, L 0832670); Bukit Tunjok Laut, *Ngadiman* 37088 (SING). **Melaka:** Base of G. Mering, *Ridley s.n.* (SING). **Pahang:** Pulau Tioman, Jason Bay, *Burkill* 1042 (K, SING); Kemaman, Ulu Ayam, Bukit Kajang, *Corner* 30249e (SING); Raub–Bentong boundary, *Furtado* 33097a (SING). **Negeri Sembilan:** Beremban Forest Reserve, foot of Gunung Angsi, *Furtado s.n.* (SING). **Selangor:** Ulu Gombak, *Croat* 53276 (K, MO); Gombak valley, 13 Jan 1994, *C. Herscovitch* NSW407381 (KEP 41493); near Klang Gates Reservoir, *Nicolson* 1140 (K); Genting Peras, *Ridley s.n.* (SING). **Perak:** Hulu Perak, Tasik Banding, n.d., *Baharuddin bin Sulaiman s.n.* (sub. AR-2599, living collection in Semenggoh Botanical Research, Kuching, Sarawak) (SAR, USM); Sungei Batang Padang, Tapah, *Furtado* 33096 (SING); Larut, 14 Jan 1994, *Hay, A., Samy, A. & Ban Ka* 9075 (L 0832668); Kuala Kangsar, Bubu F.R., foothills of Gunung Bubu, 18 Jan 1994, (orig. coll. *Hay, A., Samy, A. & Ban Ka* 9130; Cult. RBG Sydney, Acc. No. 940126 (KEP 41475, L 0832671). **Kelantan:** Gua Musang, Relai F.R. 5°02' N, 102°23' E, 1992, *Kiew, B.H. KBH10* (KEP 38211). **Kedah:** Gunung Bongsu, nr Terap, *Bogner* 1692 (K). INDONESIA: **Sumatera:** Sibolangit, *Alston* 14481 (BM); Sibolangit, Bukit Semiak, *Md Nur* 7368 (K); Aceh, Middle Alas River (Lae Sauraya) area, ca 15 km N of Gelombang, S of Bengkong R., 21 Jul 1985, *de Wilde & de Wilde-Duyffjes* 20188 (L 0239831).

*Distribution:* Malay Peninsula and Sumatra (North Sumatera and Aceh provinces)

*Habitat:* In wet gullies and among rocks by streams in lowland rain forest and lowland hill forest, to ca 900 m alt.

*Notes:* P.C. Boyce and the author saw a living collection of this species at Nancy Botanical Garden, France, and realised that this species belongs to the *S. nervosa* complex, although somewhat unusual in the spathe hardly opening and the spathe limb green, a character set otherwise shared only with *S. ulusarikiensis*. A later trip to the aroid garden in Universiti Sains Malaysia, Penang, which also has the living material of *S. brevicuspis* further confirmed the placement of this species.

### 3. *Schismatoglottis elegans* A.Hay

*Telopea* 9(1) (2000): 67. –**Type:** Cultivated in RBG Sydney Acc. No. 940510,

ex Malaysia, Sarawak, Niah National Park, Niah Caves area, along path from Niah town (orig. coll. *Hay et al.* 9359), Feb 1996, *C. Herscovitch s.n.* (holo, SAR; iso, K, KEP, NSW, all + spirit). **Plate 2.**



**Plate 2.** *Schismatoglottis elegans* A.Hay. A. Population in the wild, spreading across the floor, the base of a limestone hill; B. Whole plant occurs in deep litter on limestone; C. Leaf lamina apex (to c. 3 cm long); D. Inflorescence at male anthesis; E. Creeping rhizome; F. Inflorescence post anthesis showing the deliquescing spathe limb. Images © P.C. Boyce

*Other specimens seen:* MALAYSIA. **Sarawak.** Miri Division: Niah Suai, Niah National Park, trail to Great Cave, 03° 49' 09.9"; 113° 46' 52.3", 46 m asl, 13 Oct 2005, *P.C.Boyce et al. AR-1428* (SAR); Niah Suai, Niah National Park, Madu Trail, 03°48' 57.9»; 113° 46'18.3», 34 m asl, 13 Jul 2006, *P.C.Boyce et al. AR-1877* (SAR + spirit); *P.C.Boyce et al. AR-1878* (SAR + spirit); Subis, Gua Sibau, Niah National Park, Trail from Rh. Chang, 24 Aug 2002, *Julaihi A. et al. S. 89319* (SAR).

*Distribution:* Sarawak. Miri Division, endemic to Niah area (Northeast Sarawak).

*Habitat:* Humus-filled crevices in limestone in wet to swampy lowland rainforest, 34-200 m asl.

*Notes:* *Schismatoglottis elegans* is distinguished from *S. nervosa* (in West Sarawak limestone) by leaf laminae not glaucous abaxially and the spadix appendix yellow when fresh. The tip of the leaf lamina acuminate up to *ca* 3 cm. Stamens of *S. elegans* are much rounder, with a broad connective and are the more dumbbell-shaped as compared to other species in the complex. Stamen pores are deepest as compared to other species in the complex. Hay and Yuzammi (2000) mentioned that the appendix staminodes dried with the stalk collapsed but the tops remaining expanded and tending to cohere in groups. However, inflorescence of *AR-1877* does not behave in this manner while some inflorescences of *S. nervosa* behave in the same manner suggesting that this is not a strong differentiating character. The spadix of *AR-1877* differs from other collections in that it has ovaries tetrasulcate with the stigma staining yellow and interstice staminodes and stamens turning darker yellow in alcohol. It is not clear if these are artefacts of the period (post anthesis) of preservation.

*Schismatoglottis elegans* resembles *S. tessellata* although aside from ecological differences (*S. tessellata* is restricted to shales) the latter also differs by having thinly coriaceous leaf laminae with the tessellate tertiary venation adaxially markedly more pronounced, a larger stigma and much shorter and broader spadix appendix.

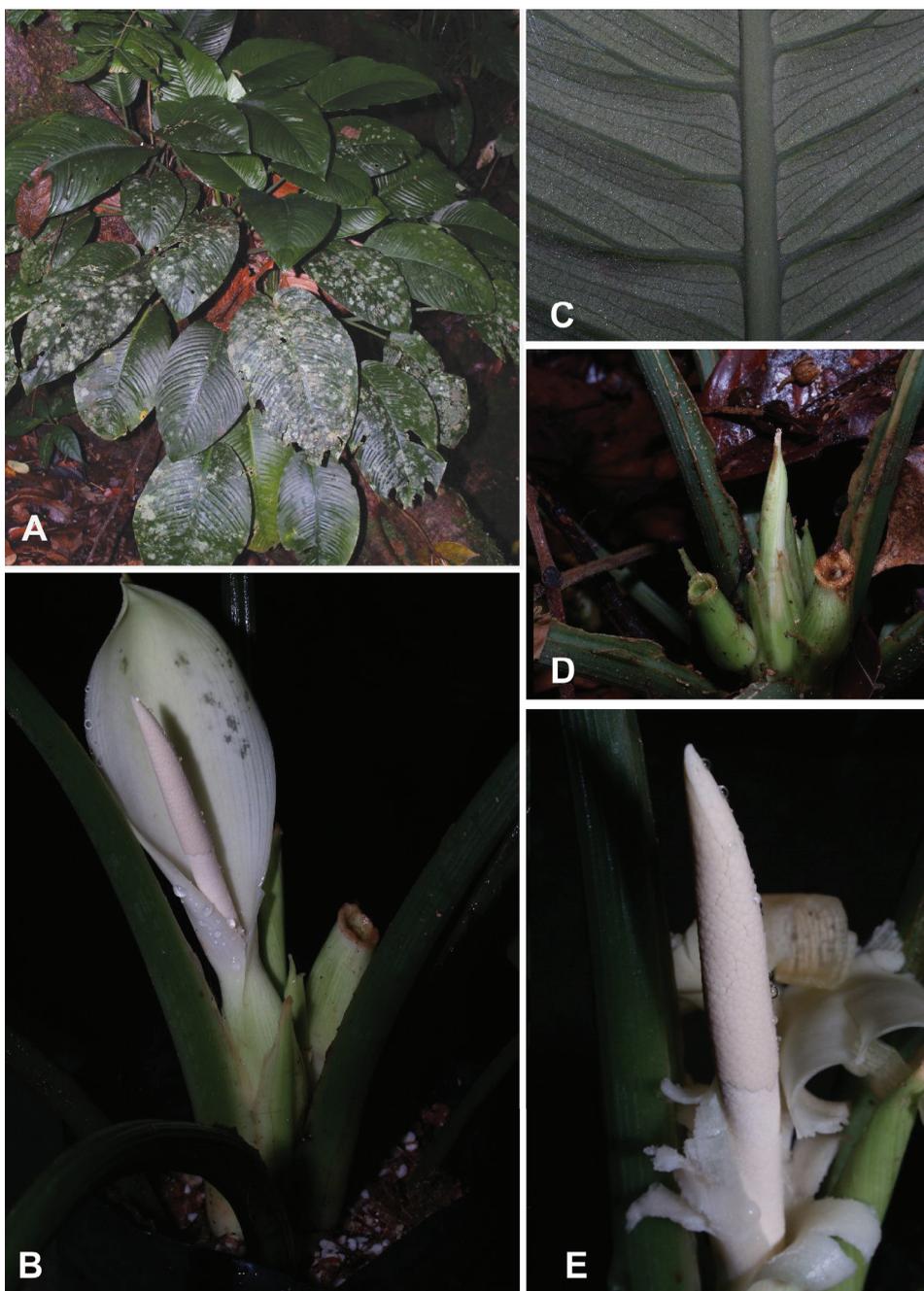
Hay and Yuzammi (2000) noted that *S. elegans* is found in a variety of other localities in rainforest between 800 and 1300 m alt. However, there are considerable doubts about the four specimens cited and pending further investigation, the author suspect these observations represent morphologically similar but different species.

#### 4. *Schismatoglottis lineae* S.Y.Wong, *sp. nov.*

*Schismatoglottis lineae simillima speciebus S. nervosa et S. simonii quae spathae senescens differt. Spathae laminorum findens longitudinalis ante*

*deliquescens*, *staminis connectivo producto latus, poris antherae profundis* (vs. *staminis connectivo producto latus, poris non-profundis*: *S. simonii*, et *staminis connectivo anguste et poris profundis*: *S. nervosa*) *distinguitur. Inter specibus Schismatoglottodorum grex nervosae habitu graniticola terrestri unicus.* – **Typus**: Malaysia, Sarawak, Kuching Division, Lundu, Gunung Gading, below plank walk to swimming area, 01° 41' 31.0"; 109° 50' 44.5", 700 m asl, 14 Dec 2006, *P.C. Boyce et al. AR-2062* (holo, SAR). **Plate 3.**

**Leaf** petioles terete, obscurely longitudinally ridged (clearer under magnification), glabrous, up to *ca* 40 cm long, slightly channelled and carinate adaxially in cross section; sheathing in the lower  $\frac{1}{3}$  to  $\frac{1}{2}$ , sheath fully attached, closed, tapering, coriaceous, marcescent; lamina broadly ovate to oblongo-ovate, more-or-less elliptic, thinly coriaceous, slightly bullate, 8-10 cm wide  $\times$  15-25 cm long, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate to *ca* 3 cm, adaxial surface semi-matte mid-green, abaxial surface paler green, glaucous, drying strongly discoloured, midrib adaxially flush with lamina, abaxially prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially with 18-22 primary lateral veins on each side, alternating with lesser interprimaries, frequently with a few branches from near the base, both diverging at 45°- 60° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary venation, arising from the midrib and the primary veins; tertiary venation obscure tessellate adaxially and abaxially in both living plants and dry specimens. **Inflorescences** up to three in quick succession alternating with foliage leaves *ca* 5 cm long, (i.e. not forming a true synflorescence), fragrant (esterases) at female anthesis; peduncle to *ca* 1 cm, not exerted from leaf bases, slightly exerted in fruit; **spathe** interior glossy, exterior semi-glossy, coriaceous, *ca* 13 cm long, lower spathe narrowly ovoid, green when fresh, *ca* 3.5 cm long  $\times$  1 cm diam., differentiated from the limb by a constriction; limb truncate, white, *ca* 8 cm long, coriaceous, opening wide except for convolute base, at first over-arching, then reflexed, finally more or less twisted and then caducous-crumbling in longitudinal stripes, deliquescent post male anthesis, apex mucronate *ca* 4 mm long; spadix sessile, adnate isodiametrically to the spathe in the lower  $\frac{1}{2}$  of female zone, whitish, to *ca* 10 cm long, less than the length of spathe; **female zone** *ca* 2.5 cm long,  $\frac{1}{3}$  of spadix length; pistils many, crowded, round to slightly rhomboid, with weakly bisulcate longitudinal ridges, *ca* 0.5 mm diam.  $\times$  0.5 mm long; stigma smaller than ovary, bun-shaped, to *ca* 0.3 mm diam., punctiform, papillate; interpistillar staminodes confined into a row along the spathe/spadix adnation, stalked, clavate and flat-topped, *ca* 0.5 mm diam., similar size to pistils; sterile interstice strongly narrowed, *ca* 0.4 cm diameter in the middle, *ca* 5 mm long, basally more



**Plate 3.** *Schimatoglottis lineae* S.Y.Wong. A. Whole plant; B. Inflorescence at male anthesis with an infructescence on the right side; C. Leaf lamina abaxially; D. Emerging inflorescence with two infructescences; E. Inflorescence post anthesis showing the spathe limbs caducous in longitudinal stripes. Images © P.C. Boyce

or less covered with inflated abortive pistils (reduced stigmas), twice the diameter of ovary, transversely sulcate, apically covered with sterile stamens, irregular shape, slightly wider than stamens; **male zone** cylindric, *ca* 5 mm diam.  $\times$  3.5 cm long,  $\frac{1}{3}$  of spadix length, slightly increased in diameter from interstice; stamens crowded, truncate, *ca* 0.4 mm across, dumbbell-shaped with the connective not elevated above the thecae, connective broad, pore oblong and deep; appendix subcylindric, *ca* 3.5 cm long,  $\frac{1}{3}$  of spadix length, white when fresh and in alcohol, tapering to a sharp point, basally more or less not isodiametric with top of male zone; staminodes of appendix more or less columnar, irregularly polygonal, flat-topped, *ca* 0.5-1 mm diameter.

*Distribution:* Sarawak, Kuching Division, endemic to Gunung Gading, Lundu (West Sarawak).

*Habitat:* Terrestrial on pockets of loose soil in deep litter along the stream running through at the base of the granites (Kuching Division), 70 m asl.

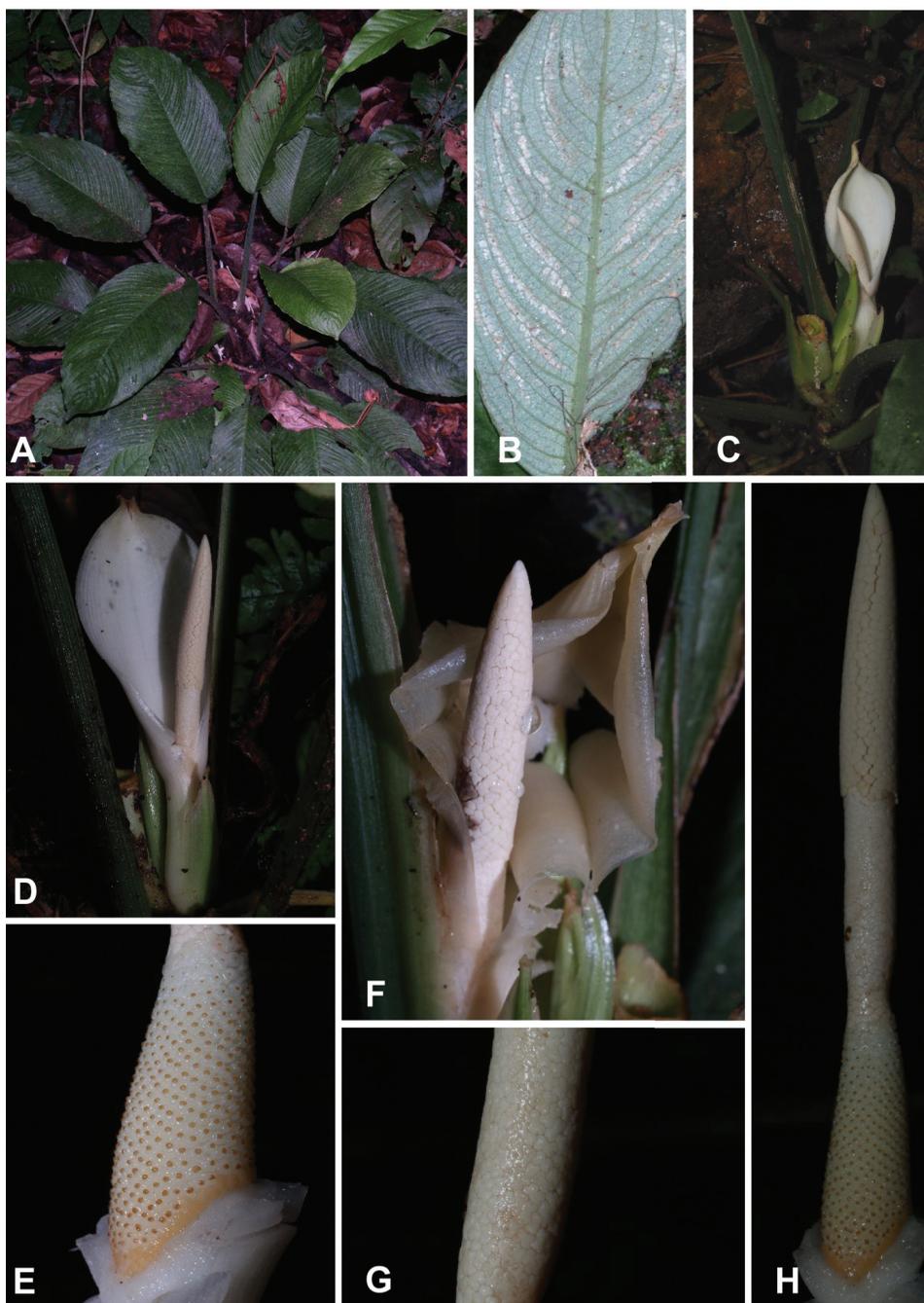
*Notes:* *Schismatoglottis linae* resembles *S. nervosa* and *S. simonii* but is distinguished from these two species by the spathe limb senescence. The spathe limb splits into longitudinal stripes before deliquescing. The connective is broad but stamen pores are deep (broad connective and shallow pore in *S. simonii*, narrow connective and deep pore in *S. nervosa*). Plants are terrestrial along the stream in deep litter on granite surface (the only species in the complex on this geology).

*Etymology:* This species is named for Lin Jenkins who is an avid lover of tropical aroids.

**5. *Schismatoglottis matangensis* S.Y.Wong, sp. nov.**

*Schismatoglottis matangensis* cum *S. nervosa* confunditur sed inflorescentia femina quam inflorescentia mascula excedens, pistillis sublaxis ordinatis, stigmatibus parvis (quam ovaria *ca*  $\frac{1}{3}$  diametro) cum alcoholis flavescens, spadice cum interstitio sterile abrupte constricta et habitu lapis arenaricola restrictus differt. –**Typus:** Malaysia, Sarawak, Kuching Division, Matang, Kubah National Park, Waterfall Trail, 01°35' 40.2"; 110° 10'45.9", 190 m asl, 7 Jun 2006, *P.C.Boyce & S.Y.Wong AR-1830* (holo, SAR). **Plate 4.**

**Leaf** petioles terete, channelled canaliculate adaxially in cross section, 13-20 cm long, strongly longitudinally ridged (like celery) especially abaxially, very minutely (strong lens required) and densely verruculate, sheathing in the lower  $\frac{1}{3}$  -  $\frac{1}{2}$  with the sheaths tapering, closed, and fully attached, marcescent, sometimes with a short rounded ligular portion; lamina



**Plate 4.** *Schimatoglottis matangensis* S.Y.Wong. A. Whole plant; B. Leaf lamina abaxially; C. Inflorescence at male anthesis with an infructescence on the left side; D. Inflorescence at male anthesis; E. Female zone, note the stigma in orange; F. Spathe limb deliquescent post male anthesis; G. Male zone; H. Spadix with the spathe artificially removed. Images © P.C. Boyce

broadly ovate to oblongo-ovate, not elliptic, coriaceous, 13-22 cm long x 7-11 cm wide, the base broadly rounded to slightly retuse, the apex acute and shortly acuminate to *ca* 1 cm, undulate along margin, adaxial surface matte deep green, always slightly bullate, abaxial surface glaucous, paler green, drying strongly discoloured; midrib adaxially flush with lamina but centrally channelled toward leaf base, abaxially very prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially, numerous, 15-22 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins, both diverging at 45°-90° and gradually curving towards the apex before reaching the intermarginal collecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins; tertiary venation forming faint tessellate adaxially and abaxially. **Inflorescences** up to 3 together, erect, white, fragrant (esterases) smell at female anthesis, peduncle to *ca* 1.5 cm long, concealed by cataphylls deliquescing and adhering to spathe limb exterior, slightly exerted in fruit; **spathe**, interior glossy, exterior, semi-glossy, softly coriaceous, *ca* 9.5 cm long, lower spathe very pale green, *ca* 4 cm long × 1.3 cm width, differentiated from the limb by a faint constriction at interstice, narrowly ovoid; limb obovate, white, *ca* 5.5 cm long × 2.2 cm width, upper margin reflex, abruptly acuminate, *ca* 7 mm long and ultimately mucronate apex, *ca* 2 mm long, caducous by crumbling at or just after male anthesis; spadix adnate, isodiametrically attached to  $\frac{1}{4}$  of female zone, subcylindric, 5.2 cm long,  $\frac{1}{2}$  of spadix length; **female zone**, conic-cylindric, ivory in fresh and alcohol, 1.6 cm long × 7 mm diam.,  $\frac{1}{8}$  of spadix length; pistils many but laxly arranged, irregularly round to slight rhomboid from above, *ca* 0.46 mm diam. × 0.72 mm long, stigma, sessile, minute, *ca* 0.15 mm diam.,  $\frac{1}{8}$  of ovary, punctiform, papillate, orange staining in alcohol, ovaries of on lower part zone tending to be bisulcate, ovaries of on upper part zone tending to be trisulcate or tetrasulcate; interpistillar staminodes confined to less than a single ring at the base of the female zone, similar or twice the size of female flower, flat-topped; sterile interstice presents,  $\frac{1}{8}$  of spadix length, supra pistillate pistilode zone (*ca* 2.5 mm long), pistilode larger than pistil, irregularly round, 0.6 mm diam. transitioning into naked zone (1.5 mm long × 2.3 mm diam.) in *AR-1830* or contiguous with infra staminate staminodes zone (*ca* 2.5 mm long), irregularly polygonal, flat-topped, white when fresh but stained orange in alcohol (*AR-1830* & *AR-1865*), strongly narrow at the staminode zone corresponding with the spathe constriction; **male zone** cylindric, 10 mm long × 4 mm diam.,  $\frac{1}{4}$  of spadix length; stamens, butterfly-shaped from above, white when fresh, turning dirty yellow in alcohol (*AR-1830* & *AR-1865*), remaining white in alcohol (*AR-1864*), close-packed, 0.3 mm diam., anthers truncate (flat-topped), connective narrow and thecae large, pores small and

deep, C-shaped with the convex side innermost; appendix sub-cylindric, *ca* 1.9 cm long,  $\frac{1}{3}$  of spadix length, white when fresh and in alcohol, strongly tapering to a sharp end, middle slightly thicker than the base; staminodes of appendix densely packed, flat-topped, irregularly polygonal, *ca* 0.3-1 mm diam.

*Other specimens seen:* MALAYSIA. **Sarawak.** Kuching Division: Matang, trail to Indian Temple, 2 Mar 2004, *P.C.Boyce & Jeland ak Kisai AR-145.3* (SAR); Matang, Kubah National Park, Waterfall Trail, 01°35' 40.2"; 110° 10'45.9", 190 m asl, 7 Jun 2006, *P.C.Boyce & S.Y.Wong AR-1831* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1832* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1833* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1834* (SAR); *ibid.*, 11 Jul 2006, *P.C.Boyce & S.Y.Wong AR-1864* (SAR + spirit); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1865* (SAR + spirit); *ibid.*, *P.C.Boyce & S.Y.Wong, AR-1866* (SAR).

*Distribution:* Sarawak, Kuching Division, endemic to Matang (West Sarawak).

*Habitat:* Evergreen moist forest on Matang series sandstones where terrestrial in deep litter over exposed black soil, sometimes between sandstone rocks, 190-450 m asl.

*Notes:* *Schismatoglottis matangensis* is morphologically different from *S. nervosa* by characters of the inflorescence: female zone exceeding male zone, pistils laxly arranged [in marked contrast to most other species of the *S. nervosa* complex (except for *S. tessellata*) in which pistils are crowded] and minute ( $\frac{1}{3}$  of ovary diam.) two-three lobed stigma staining yellow in alcohol. Other distinguishing characters for *S. matangensis* include a sharp constriction at the interstice, interstice staminodes staining orange in alcohol (*AR-1830 & AR-1865*) and stamens staining orange in alcohol (*AR-1865*) although the remainder of the observed inflorescences have stamens remaining white in alcohol and these colour differences may be an artefact of inflorescence anthesis phase at preservation although stamens of *S. nervosa* always remain white in alcohol irrespective of the phase of the spadix. In robust inflorescences, the appendix displays a marked increase in diameter at the junction of the male zone, contiguous with the male but not isodiametrical.

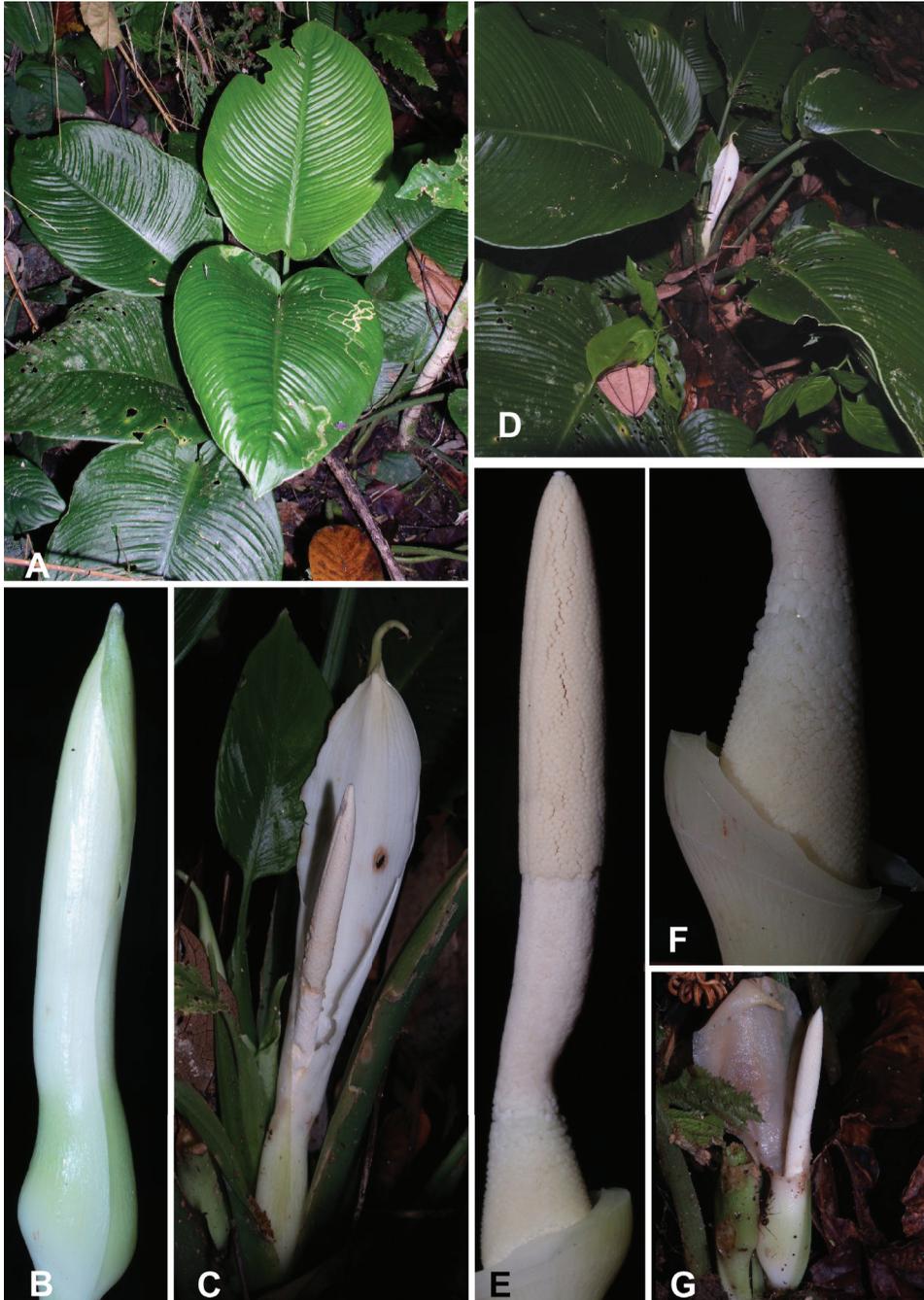
The petiolar sheath is marcescent in *S. matangensis*. Primary venation of *S. matangensis* is more prominent than in *S. nervosa*, however, on average secondary and tertiary venation are less pronounced. *Schismatoglottis matangensis* is restricted to sandstones whereas *S. nervosa* are restricted to karst limestones.

*Etymology*: The specific epithet from the Matang Massif, the type locality and so far the only known site for this species.

#### 6. *Schismatoglottis nervosa* Ridl.

*Schismatoglottis nervosa* Ridl., Journ. As. Soc. Straits 49 (1907) 50; Hay & Yuzammi, *Telopea* 9(1) (2000) 73. –**Typus**: Cult. in Singapore Botanic Gardens, ex Malaysia, Sarawak, Bau, Jan 1907, *H. N. Ridley* s.n. (holo, SING, 2 sheets). **Plate 5**.

*Other specimens seen*: MALAYSIA. **Sarawak**. Kuching Division: Bau, Bk. Krian, 28 May 1972, *J.A.R. Anderson* S. 31966 (SAR); Bau, Krokong, Gua Peri-peri (Fairy Cave), 01° 22' 51.9"; 110° 07' 09.3", 30 m asl, 29 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-145.1* (SAR); Bau, Krokong, Kampung Tringgus, Sg. Bong, 01° 15' 32.2"; 110° 05' 37.2", 81 m asl, 21 Jul 2004, *P.C.Boyce & Jeland ak Kisai AR-525* (SAR); Bau, Gn. Bidi, 01° 23' 27.0"; 110° 07' 07.6", 50 m asl, 6 Jan 2005, *P.C.Boyce & Jeland ak Kisai AR-944* (SAR + spirit); Bau, Kampung Bogag, Gn. Tibugai, 01° 21' 31.1"; 110° 03' 48.7", 80 m asl, 6 Jan 2005, *P.C.Boyce & Jeland ak Kisai AR-950* (SAR); Bau, Krokong, Gua Peri-Peri (Fairy Cave), 01° 22' 51.9"; 110° 07' 09.3", 30 m asl, 25 May 2006, *P.C.Boyce & S.Y.Wong AR-1823* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1824* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1825* (SAR); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1826* (SAR + spirit); *ibid.*, *P.C.Boyce & S.Y.Wong AR-1827* (SAR + spirit); Bau, Kampung Jugan, 01° 28' 46.4"; 110° 05' 08.5", 72 m asl, 25 Jun 2004, *P.C.Boyce et al. AR-491* (SAR); Bau, Gn. Singai, 17 Nov 2004, *P.C.Boyce et al. AR-752* (SAR); Bau, Krokong, Kampung Tringgus, 01° 15' 40.2"; 110° 05' 35.9", 80 m asl, 19 Feb 2005, *P.C.Boyce et al. AR-992* (SAR); Bau, Gn. Juita, 01° 23' 48.7"; 110° 08' 07.2", 35 m asl, 28 Oct 2005, *P.C.Boyce et al. AR-1499* (SAR); Bau, Segong, Gn. Opar, 01° 27' 07.3"; 110° 04' 00.5", 79 m asl, 9 Nov 2005, *P.C.Boyce et al. AR-1502* (SAR); Bau, Krokong, Kampung Tringgus, 01° 15' 40.2"; 110° 05' 35.9", 81 m asl, 27 Jun 2006, *P.C.Boyce et al. AR-1845* (SAR + spirit); Bau, Gn. Lanyang, 10 Apr 2002, *Connie, G et al. SBC 2807* (SAR); Bau, Kampung Jugan, 19 Jun 2004, *Jeland ak Kisai & Jipom ak Tisai AR-474* (SAR); Bau, Gn. Poing, 23 Sep 2001, *Julia, S. et al. SBC 345* (SAR); locality not recorded, 26 Feb 2002, *Julia, S. et al. SBC 2155* (SAR); Bau, Bk. Jebong, 6 Jul 1970, *P.F.Lehmann* S. 30136 (SAR); Bau, Jambusan, Gn. Batu, 19 Feb 2002, *K. Meekiong et al. SBC 1662* (SAR); Bau, Jambusan, Gn. Batu, 19 Feb 2002, *K. Meekiong et al. SBC 1929* (SAR); Bau, Jambusan, Gn. Jebong, 5 Mar 2002, *K. Meekiong et al. SBC 1953* (SAR); Bau, Bengoh range, Pangkalan Tebang, logging road, 6 Jul 1996, *M. Mohizah* S 73890 (SAR); 2 miles east of Bau, 6 Aug 1961, *D. H. Nicolson* (SAR, US); Bau, Krokong, Gua Peri-Peri (Fairy Cave), 22 Mar 1999, *Patsipun et al. S. 79985* (SAR); Bau, Gn. Tabai, 13 Mar 2002, *Shaevy W. et al. SBC 2298* (SAR).



**Plate 5.** *Schismatoglottis nervosa* Ridl. A. Whole plant; B. Inflorescence prior to anthesis; C. Inflorescence at male anthesis; D. Whole plant with an inflorescence at male anthesis; E. Spadix with the spathe artificially removed; F. Female zone; G. Spathe limb deliquescent post anthesis. Images © P.C. Boyce

*Distribution:* Sarawak, Kuching Division, endemic to the Bau area (West Sarawak).

*Habitat:* Evergreen moist forest on karst limestone in the Bau area. Terrestrial in deep litter or lithophytic in soil collected in crevices and sinkholes in limestone; rarely along stream banks, 30-160 m asl.

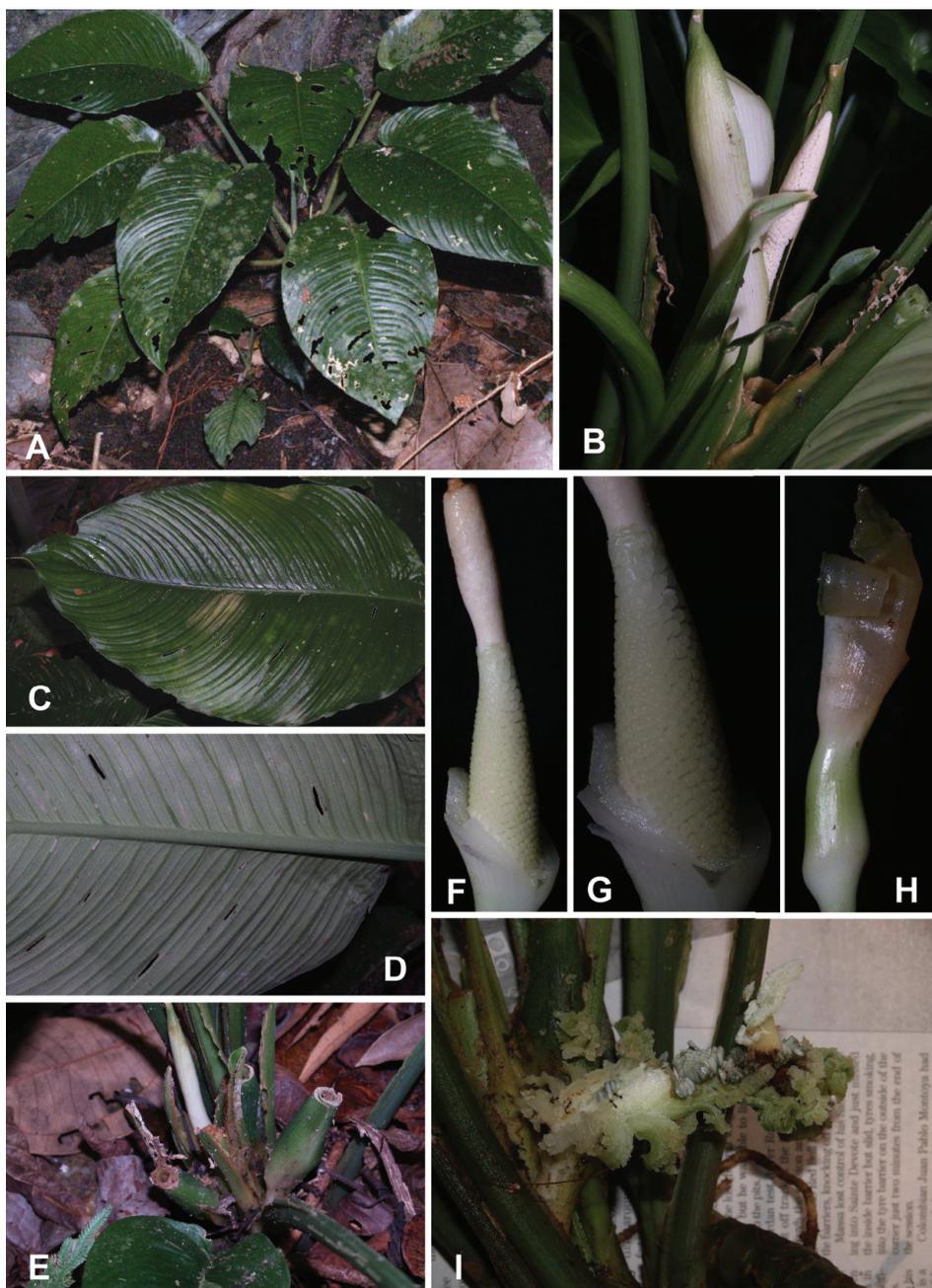
*Notes:* Hay and Yuzammi (2000) were unclear whether the interstice was present or the fertile zones were contiguous. Based on the author's observation, the interstice is always present with pistillodes at the lower part and staminodes at the upper part and without the presence of naked zone. In the type specimen, the presence of the interstice is not clear due to damage to the spadix at the crucial area of the interstice. In all collections the female zone is shorter than the male zone, whereas *S. matangensis* has a longer female zone than male zone. Stigmas of *S. nervosa* are larger than those of *S. matangensis* and always remain white in alcohol.

In the type specimen, there are two types of staminodes on the appendix of the inflorescence. The lower staminodes are very irregularly rhomboid, smaller (*ca* 0.5 mm diam.) while the upper staminodes are regularly rhomboid and larger (0.5-1 mm diam.). A naked zone, which has dried black, is present at the tip of appendix.

**7. *Schismatoglottis simonii* S.Y.Wong, *sp. nov.***

*A Schismatoglottis nervosa habitu robustis coloniis, veneris laminarum secundariis et tertiariis plus prominentis, stigmatibus plus late, connectivo antherae crasso, poris oblongo, non profundus quam marginem late alatis differt.* –**Typus:** Malaysia, Sarawak, Samarahan, Serian, Kidadum, Sugun Karang, 01°06' 17.6"; 110° 29'04.5", 100 m asl, 29 Jun 2006, *P.C.Boyce et al. AR-1859* (holo, SAR). **Plate 6.**

**Leaf** petioles terete, channelled slightly canaliculate adaxially in cross section, 13-40 cm long, strongly longitudinally ridged (like celery) especially abaxially at the base, very minutely (strong lens required) and densely verruculate, sheathing in the lower  $\frac{1}{3}$ -  $\frac{1}{2}$  with the wings tapering, and fully attached, marcescent, sometimes with a short rounded ligular portion; lamina broadly ovate to oblongo-ovate, sometimes elliptic, 12-30 cm long x 6-20 cm wide, coriaceous, adaxial surface semi-glossy deep green, always slightly bullate, abaxial surface paler green, glaucous, drying strongly discolourous, the base broadly rounded to sub-truncate, slightly retuse to cuneate, the apex acute and shortly acuminate to *ca* 1 cm, undulate along margin; midrib



**Plate 6.** *Schismatoglottis simonii* S.Y.Wong. A. Whole plant; B. Inflorescence during male anthesis; C. Leaf lamina adaxially; D. Leaf lamina abaxially; E. Emerging inflorescence with three infructescence flanking on each side; F. Spadix with spathe artificially removed; G. Female zone; H. Spathe limb starting to deliquescent post male anthesis; I. Infructescence ripen to reveal the seeds.

adaxially flush with the lamina but centrally channelled toward the leaf base, abaxially very prominent raised canaliculate; primary venation impressed adaxially, strongly raised abaxially, numerous, 16-25 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins, diverging at 60°-90° and gradually curving towards the tip before reaching the intermarginal collecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins; tertiary venation forming tessellate reticulum adaxially and abaxially, more notable abaxially. **Inflorescences** up to three together, erect, white, fragrant (esterases) smell at female anthesis; subtended by lanceolate cataphylls to *ca* 6 cm long; peduncle to *ca* 2.5 cm long, concealed by leaf bases and cataphylls at flowering, slightly exerted in fruit; **spathe**, interior glossy, exterior semi-glossy, softly coriaceous, *ca* 9 cm long; lower spathe, ovoid, pale green when fresh and white in alcohol, *ca* 2.5 cm long × 1.5 cm diam., differentiated from the limb by a faint constriction coinciding with interstice; limb oblongo-lanceolate, white when fresh and in alcohol, *ca* 5.5 cm long, apex, green when fresh, mucronate for *ca* 5.8 mm, caducous by disintegrating or crumbling at or just after male anthesis; spadix sessile, adnate isodiametrically to the spathe in the lower  $\frac{1}{6}$  of female zone, subcylindric, *ca* 7 cm long subequalling the spathe; **female zone** ovoid, ivory when fresh and in alcohol, 1.8 cm long × 0.8 cm diam.,  $\frac{1}{3}$  of spadix length; pistils numerous and close-packed, rhomboid to round from above, *ca* 1.19 mm long × 0.56 mm diam.; stigma sessile, punctiform, large, 0.20 mm diam.,  $\frac{1}{3}$  of ovary, raised; interpistillar staminodes confined to more or less a single ring at the base of the female zone, irregularly polygonal from above, about the same size as the ovaries shorter than pistils; sterile interstice present, supra pistillate pistillodes zone, white, *ca* 1.8 mm long,  $\frac{1}{4}$  of spadix length, strongly narrow in the upper half of pistillodes zone corresponding with the spathe constriction, pistillodes irregularly polygonal, large, *ca* 1 mm diam., twice the size of ovary, centrally impressed; sometimes naked zone present; followed by a whorl of incompletely abortive stamens, *ca* 2.6 mm long, staminodes, irregularly squat-columnar, flat-topped, 0.62 mm diam.; **male zone** contiguous with interstice staminodes, cylindric, 1.3 cm long × 4.2 mm diam., slightly less than  $\frac{1}{3}$  of spadix length; stamens close-packed, irregular dumbbell-shaped from above and neighbouring anthers with their lobes interdigitating, white when fresh and remaining white in alcohol, *ca* 0.6 mm diam., anthers truncate, connective broad and elevated, thecae large; pores oblong and shallow, rims widely alate; appendix cylindric, 2.6 cm long × 4.8 mm diam., slightly less than  $\frac{1}{3}$  of spadix length, white when fresh and in alcohol, abruptly widen at base, distally tapering to sharp point; staminodes of appendix densely packed, flat-topped to slightly centrally impressed, irregularly polygonal, *ca* 0.5-1 mm diam.

*Other specimens seen:* MALAYSIA. **Sarawak**, Kuching Division: Padawan, Kampung Bengoh, Danu road, Gn. Temuang, Sg. Abang, 01° 15' 38.6"; 110° 15' 31.4", 50 m asl, 16 Feb 2006, *P.C.Boyce et al. AR-1707* (SAR); Padawan, 10 mi s.w. of main Kuching-Serian Highway, 01° 10'; 110° 20', 30 Sep 1981, *T. B.Croat 53179* (SAR); Siburan, Kampung Giam, Air Terjun Giam, 01° 19' 11.2"; 110° 16' 11.4", 37 m asl, 7 Feb 2006, *P.C.Boyce et al. AR-1693* (SAR); Samarahan Division: Serian, Mongkos, Kampung Batu Mawang, Labak Ebang, Utak Samat, 5 Jan 2006, Simon Kutuh ak Paru AR-1666 (SAR); Serian, Gn. Ampungan, 01° 09' 08.2"; 110° 37' 21.2", 450 m asl, 21 Nov 2003, *P.C.Boyce & Jeland ak Kisai AR-92.4* (SAR); Serian, Pichin, Umon Murut, Tiab Belanting, 01° 08' 03.7"; 110° 27' 00.3", 90 m asl, 15 Jun 2005, *P.C.Boyce et al. AR-1215* (SAR); *ibid.*, 15 Jun 2005, *P.C.Boyce et al. AR-1220* (SAR + spirit); Serian, Mongkos, Kampung Batu, Gn. Selabur, 00°57' 26.2"; 110° 30' 15.8", 100 m asl, 15 Mar 2006, *P.C.Boyce et al. AR-1724* (SAR); Serian, Kidadum, Sugun Karang, 01°06' 17.6"; 110° 29'04.5", 100 m asl, 7 Apr 2006, *P.C.Boyce et al. AR-1764* (SAR); Serian, Gn. Ampungan, 01° 09' 10.1"; 110° 37' 26.2", 568 m asl, 28 Aug 2006, *P.C.Boyce et al. AR-2003* (SAR + spirit); Serian, Pichin, Gunung Kedadum, Sugun Kerang, 13 Nov 2004, *Simon Kutuh ak Paru AR-750* (SAR); Serian, Pichin, Labu, Sg. Tiyab, 26 Jul 2005, *Simon Kutuh ak Paru AR-1299* (SAR); Serian, Kampung Selabi, Sg. Mawang, 2 Feb 2006, *Simon Kutuh ak Paru AR-1703* (SAR); Serian, Taman Rekreasi Rachan, 01° 08' 34.9"; 110° 35' 02.4", 57 m asl, 18 Oct 2006, *P.C.Boyce & S.Y.Wong AR-2038* (SAR).

*Distribution:* Sarawak, Kuching & Samarahan Divisions, endemic to the Padawan/Serian areas (West Sarawak).

*Habitat:* Always terrestrial in deep soil on limestones and sandstones, sometimes lithophytic on permanent wet areas of limestone but not in direct water flow, sometimes not in full shade. Large colony forming, 50-600 m asl.

*Notes:* *Schismatoglottis simonii* is clearly closely allied to *S. nervosa* but leaf laminae are wider in *S. simonii* than *S. nervosa* [length: width ratio (to 3:2 in *S. simonii*, to 2:1 in *S. nervosa*)]. Secondary and tertiary venations in *S. simonii* are more pronounced than *S. nervosa*. The zonation in the spadix of *S. simonii* is equally distributed among the female, male and appendix ( $\frac{1}{2}$  each) as compared to *S. nervosa* (female zone,  $\frac{1}{4}$ ; male zone  $\frac{1}{4}$ ; appendix  $\frac{1}{2}$ ). The stigma narrower in *S. simonii* as compared to *S. nervosa* while the stamens have a broad connective, with shallow oblong pores. *S. simonii* tends to form large colony and much more robust than *S. nervosa*.

*Etymology*: This species is named for Mr Simon Kutuh ak Paru, occasional member of our field team, who has so ably organised field trips to Padawan limestones.

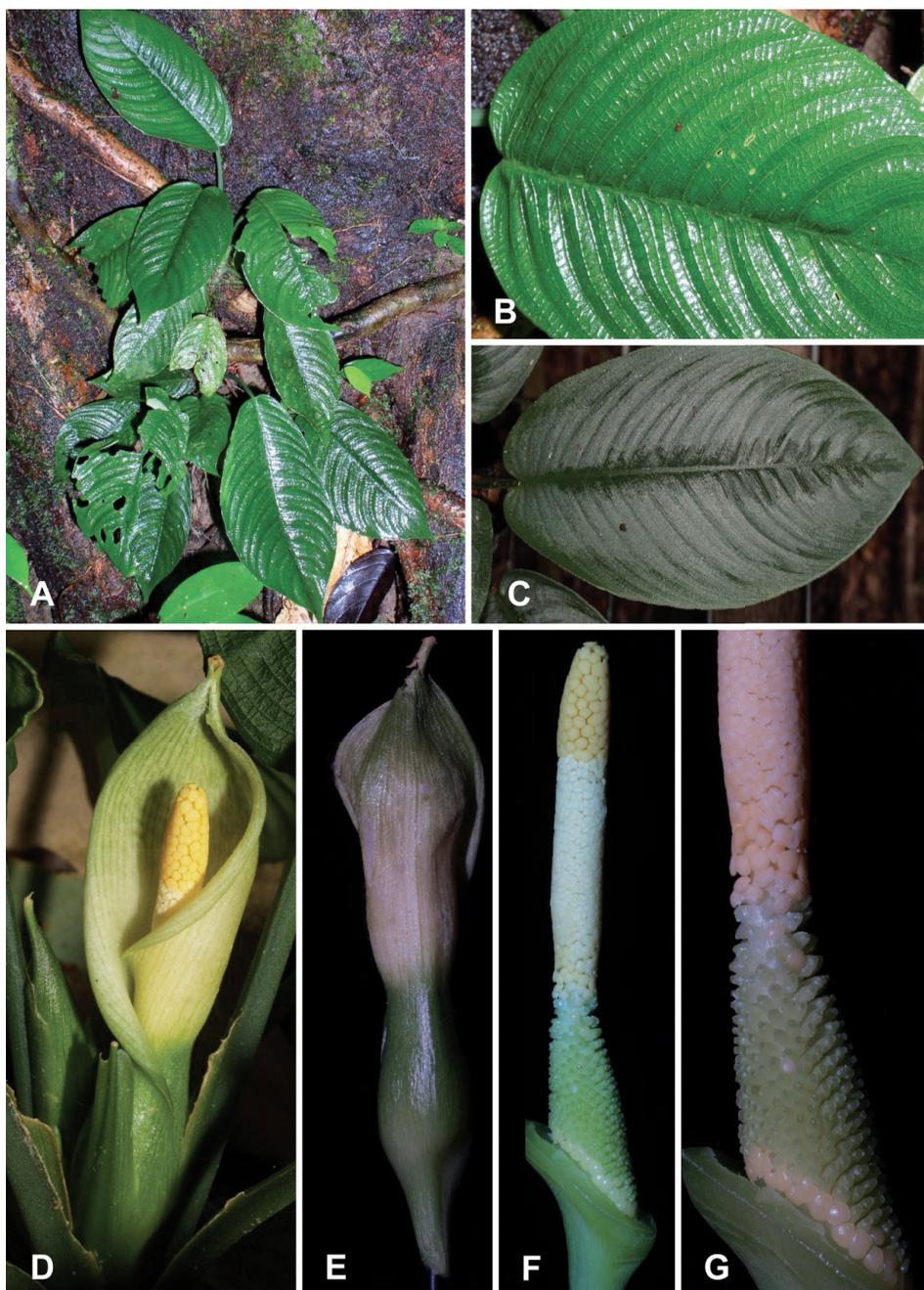
8. *Schismatoglottis tessellata* S.Y.Wong, *sp. nov.*

*Folii lamina tenuiter coriaceis, nervis tertiariis tessellatis abaxialiter et adaxialiter valde prominentibus quamquam venis adaxialiter valde prominentibus, stigmatibus amplis globuliformis (quam ovaria ca ½ diametro); appendice crasso brevioribus, usque ad tertiam partem longitudinis spadice toto in complexu nervosae unica est. In habitu saxa shaleiaca restrictus. –*

**Typus**: Malaysia, Sarawak, Kapit, Taman Rekreasi Sebabai, 01° 56' 45.6"; 112° 54' 16.8", 50 m asl, 16 Mar 2005, P.C.Boyce et al. AR-1087 (holo, SAR).

**Plate 7.**

**Leaf** petioles, slightly D-shaped but slightly carinate channelled to the base of lamina adaxially in cross section, glabrous, longitudinal ridges only visible with magnification, long, 20-30 cm long; sheathing in the lower 1/3 to 1/2 with the sheaths tapering, fully attached, open, persistent to marcescent; lamina broadly ovate to oblong ovate, thinly coriaceous, 13-21 cm long × 5-10 cm wide, sometimes variegated with grey stripes on each side adaxially, the base cuneate to slightly retuse, the apex acute and strongly acuminate for ca 0.7-2 cm, adaxial surface semi-glossy deep green, abaxial surface paler green, always slightly bullate, glaucous, drying strongly discolourous; midrib adaxially flush with the lamina but centrally channelled at the leaf base, abaxially very prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially, numerous, 11-20 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins, diverging at 45°-60° and gradually curving towards the tip before reaching the intermarginal collecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins; tertiary venation forming distinctive tessellate adaxially and abaxially, more notable adaxially. **Inflorescences** up to three together, erect, white, fragrant (esterases) smell at female anthesis; concealed by oblongo-lanceolate cataphyll, ca 7 cm long, peduncle to ca 2 cm, slightly exerted in fruit; **spathe**, interior glossy, exterior semi-glossy, softly coriaceous, ca 9 cm long; lower spathe broadly ovoid, ca 1.7 cm diam. × 3.8 cm long, differentiated from the limb by a faint constriction coinciding with interstice; limb broadly lanceolate, rather coriaceous, caducous by crumbling at or just after male anthesis; spadix, sessile, isodiametrically attached to the spathe in the lower 1/3 of **female zone**, conic-cylindric, ca 5.9 cm long; female zone, conic-cylindric, white when fresh but very slightly yellow in alcohol, 1.4



**Plate 7.** *Schismatoglottis tessellata* S.Y.Wong. A. Whole plant on shales; B. Leaf lamina adaxially revealing the tessellate venation; C. Leaf lamina variation; D. Inflorescence at male anthesis; E. Spathe at male anthesis; F. Spadix with spathe artificially removed; G. Female zone, interstice and part of male zone. Images © P.C. Boyce

cm long  $\times$  7 mm diam.,  $\frac{1}{4}$  of spadix length; pistils numerous, laxly-arranged, elongate-ovoid to subcylindric, *ca* 1.70 mm long  $\times$  0.53 mm diam.; stigma sessile, large bun-shaped, *ca* 0.26 mm diam.,  $\frac{1}{2}$  of ovary, raised, papillate; interpistillar staminodes confined to more or less a single ring at the base of the female zone, irregularly polygonal from above, twice the size of ovaries, flat-topped, shorter than pistils; sterile interstice presence, 1.2 cm long,  $\frac{1}{6}$  of spadix length, pistils transitioning gradually into laxly spirally arranged pistilode that are *ca* half to two times larger than pistil, irregularly round, white when fresh and in alcohol, *ca* 7 mm long, sharp constriction in between pistillode and staminode zones; staminodes, larger than stamens, irregular polygonal, flat-topped, white when fresh and turning yellow in alcohol, *ca* 5 mm long; **male zone**, cylindric, *ca* 2.2 cm long  $\times$  4.8 mm diam.,  $\frac{1}{6}$  of spadix length; stamens close-packed, irregularly butterfly-shaped from above and neighbouring anthers with their lobes interdigitating, 0.5 mm diam., anthers truncate, connective broad and thecae large, pores large accounting of the entire top of the thecae and shallow, C-shaped, the rims narrowly alate; appendix conic-cylindric, 1.2 cm long  $\times$  5.3 mm diam.,  $\frac{1}{6}$  of spadix length, yellow when fresh, turning white in alcohol, distally tapering to a very blunt point, basally slightly thicker than the male zone, middle thicker than basal; staminodes of appendix loosely arranged, large staminode, flat-topped, 0.7-1.2 mm across, squat-columnar.

*Other specimens seen:* MALAYSIA. **Sarawak**, Kapit Division: Nanga Gaat, Rejang Wood Concession, Sg. Piat, 01° 38' 09.1"; 113° 24' 09.9", 200 m asl, 14 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-103.1*; *P.C.Boyce & Jeland ak Kisai AR 103.2* (SAR); *ibid.*, 14 Oct 2003, *P.C.Boyce & Jeland ak Kisai AR-105* (SAR); Nanga Gaat, km 3.5 after heli-logging camp on road to Camp Gahada, Sg. Bereng, 01° 45' 36.0"; 113° 27' 54.7", 228 m asl, 15 Dec 2004, *P.C.Boyce et al. AR-888* (SAR); *ibid.*, 19 Apr 2006, *P.C.Boyce et al. AR-1792* (SAR); *ibid.*, 19 Apr 2006, *P.C.Boyce et al. AR-1794* (SAR).

*Distribution:* Central Sarawak (Kapit Division).

*Habitat:* Evergreen moist forest on shale where either on steep earth banks or lithophytic on muddy shale, 50-228 m asl.

*Notes:* This species is distinguishable by its thinly coriaceous leaves texture and tertiary venation strongly raised-tessellate in both surfaces of leaf, but more prominently adaxially. The pistils are laxly arranged with large (compared to ovary diameter) bun-shaped stigmas, while the appendix is shorter and broader ( $\frac{1}{6}$  of spadix length) than other species of the *S. nervosa* species complex. *Schismatoglottis tessellata* bears some resemblance to *S.*

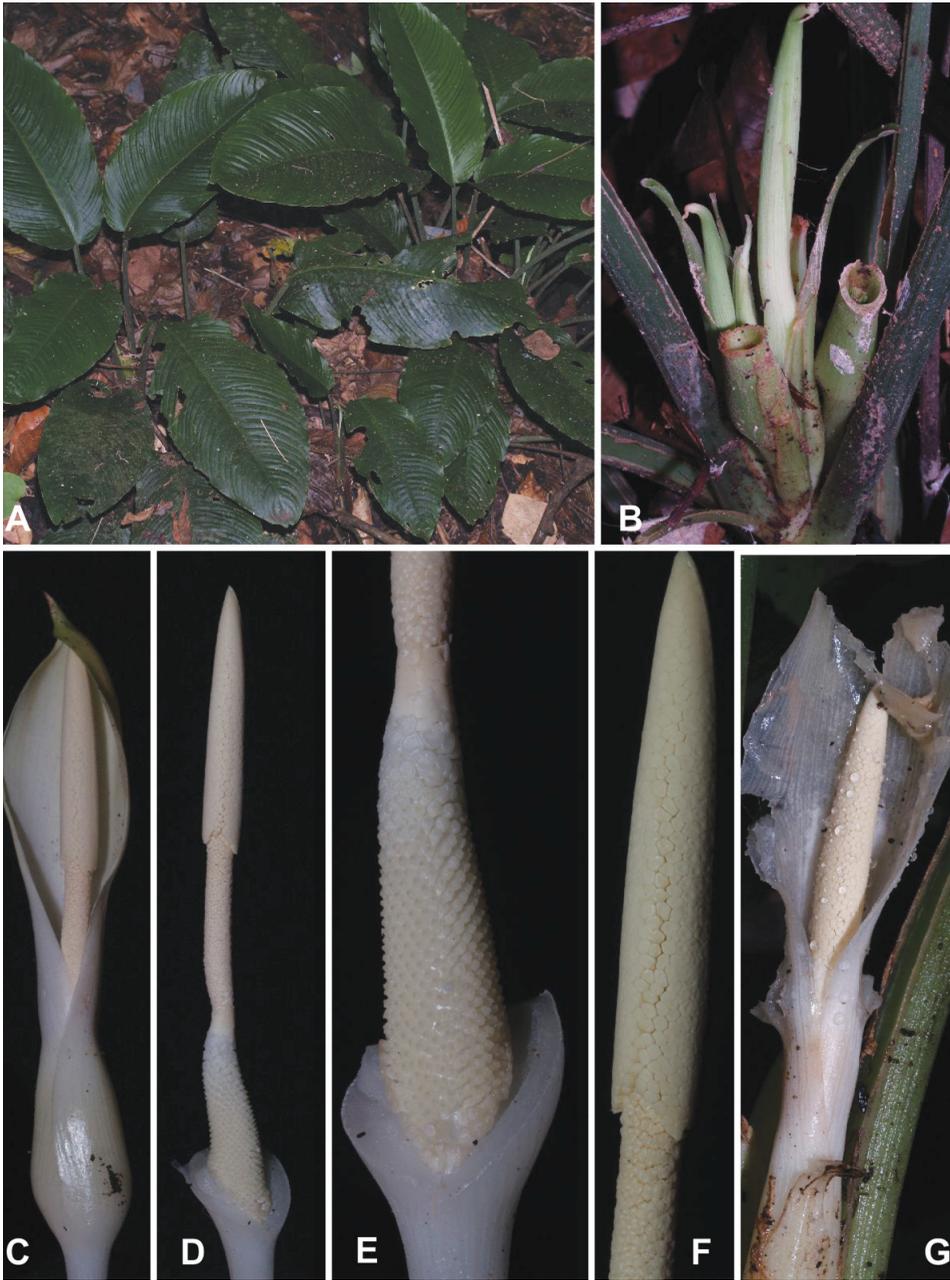
*elegans* but is readily separable by its thinly coriaceous leaf lamina, adaxially strongly prominent tessellate tertiary venation (hence the epithet) and shorter leaf apex. The stigma is large bun-shaped in *S. tessellata* as compared to small stigma in *S. elegans*. *Schismatoglottis tessellata* is restricted to shales, as observed so far. Occasionally, leaf laminae of *S. tessellata* are variegated with grey stripes on each side adaxially.

*Etymology*: The epithet reflects the prominently raised-tessellate venation that immediately distinguishes this species.

9. *Schismatoglottis turbata* S.Y.Wong, *sp. nov.*

*Schismatoglottis turbata ad alii specibus Schismatoglottodorum grex floribus masculinus parvus, rotundis, densiter irregularis dispositae, poris profunde differt. Appendice quam inflorescentiae masculae apicem sigillatim crassiore distinguitur.* –**Typus**: Malaysia, Sarawak, Kuching Division, Sempadi, Sg. Limau, Bukit Kankar, 01°39' 44.2"; 109°59'56.5", 41 m asl, 25 Aug 2007, P.C.Boyce et al. AR-2143 (holo, SAR). **Plate 8.**

**Leaf** petioles terete, obscurely longitudinally ridged (clearer under magnification), glabrous, up to *ca* 30 cm long, slightly channelled and carinate adaxially in cross section; sheathing in the lower  $\frac{1}{3}$  to  $\frac{1}{2}$ , sheath fully attached, closed, tapering, leathery, persistent; lamina broadly ovate to oblongo-ovate, more-or-less elliptic, thinly coriaceous, slightly bullate, 7-9 cm wide  $\times$  13-23 cm long, base broadly rounded to sub-truncate, slightly retuse or cuneate, apex acute to strongly acuminate to *ca* 2 cm, adaxial surface semi-matte mid-green, abaxial surface paler green, glaucous, drying strongly discolorous, midrib adaxially flush with lamina, abaxially prominent, raised canaliculate in cross section; primary venation impressed adaxially, strongly raised abaxially with up to 20 primary lateral veins on each side, alternating with lesser interprimaries, frequently with a few branches from near the base, both diverging at 45°- 60° and gradually curving towards the apex before reaching the inter-marginal collecting vein; secondary venation, arising from the midrib and the primary veins; tertiary venation obscure tessellate adaxially and abaxially in both living plants and dry specimens. **Inflorescences** up to four in quick succession alternating with foliage leaves *ca* 5 cm long, (i.e. not forming a true synflorescence), fragrant (esterases) at female anthesis; peduncle to *ca* 1 cm, not exerted from leaf bases, slightly exerted in fruit; **spathe** interior glossy, exterior semi-glossy, coriaceous, *ca* 7.5 cm long, lower spathe narrowly ovoid, green when fresh, *ca* 2.5 cm long  $\times$  1 cm diam., differentiated from the limb by a weak constriction; limb sub-truncate, white, *ca* 5 cm long, coriaceous, opening wide except for convolute base, at first over-arching, then reflexed, finally more or less twisted and



**Plate 8.** *Schismatoglottis turbata* S.Y.Wong. A. Whole plant; B. Two emerging inflorescences with two infructescences; C. Inflorescence at male anthesis; D. Spadix with spathe artificially removed; E. Female flowers, interstice and part of male zone; F. Male zone and appendix; G. Spathe limb deliquescent post anthesis. Images © P.C. Boyce

then caducous-crumbling, apex mucronate *ca* 4 mm long, green when fresh; spadix sessile, adnate isodiametrically to the spathe in the lower  $\frac{1}{2}$  of female zone, whitish, to *ca* 5.5 cm long, less than the length of spathe; **female zone** *ca* 1.7 cm long,  $\frac{1}{3}$  of spadix length; pistils many, crowded, round to slightly rhomboid, with weakly bisulcate longitudinal ridges, *ca* 0.5 mm diam. x 0.45 mm long; stigma large, bun-shaped, to *ca* 0.3 mm diam.,  $\frac{1}{2}$  of ovary, punctiform, papillate, yellow in alcohol; inter pistillar staminodes very occasional among the pistils, crowded into a row along the spathe/spadix adnation, stalked, clavate and flat-topped, *ca* 0.5 mm diam., similar size to pistils; sterile interstice strongly narrowed, *ca* 1.4 mm diameter in the middle, (2.5-) *ca* 7 mm long which is  $\frac{1}{8}$  of spadix length, basally more or less covered with inflated abortive pistils (reduced stigmas), twice the diameter of ovary, transversely sulcate, apically covered with two rows of sterile stamens, irregular shape, slightly wider than stamens; **male zone** cylindrical, *ca* 3.6 mm diam. x 1.2 cm long,  $\frac{1}{3}$  of spadix length, marked increased in diameter from interstice; stamens crowded, truncate, *ca* 0.4 mm across, dumbbell-shaped with the connective not elevated above the thecae, connective narrow, pore oblong and deep; appendix subcylindric, *ca* 1.8 cm long,  $\frac{1}{3}$  of spadix length, yellow when fresh, turning white in alcohol, frequently chewed by beetles, tapering to a sharp point, basally more or less not isodiametric with top of male zone; staminodes of appendix more or less columnar, irregularly polygonal, flat-topped, *ca* 0.5-1 mm diameter.

*Other specimens seen:* MALAYSIA. **Sarawak**, Kuching Division, Sempadi, Sg. Limau, 250 m asl, 26 Mar 2004, P.C.Boyce & Jeland ak Kisai AR-271 (SAR).

*Distribution:* Southern Sarawak, Kuching Division.

*Habitat:* Lithophytic on sandstone (Kuching Division), 41-250 m asl.

*Notes:* *Schismatoglottis turbata* is clearly distinguished from the rest of the *S. nervosa* complex by having small and round male flowers with deep pores. The male zone is dense but irregularly arranged. The appendix is markedly increased in diameter than the male zone.

*Etymology:* The specific epithet is derived from the Latin 'turbatus', exasperating, in allusion to the feeling on discovering yet another novel species in the *S. nervosa* complex.

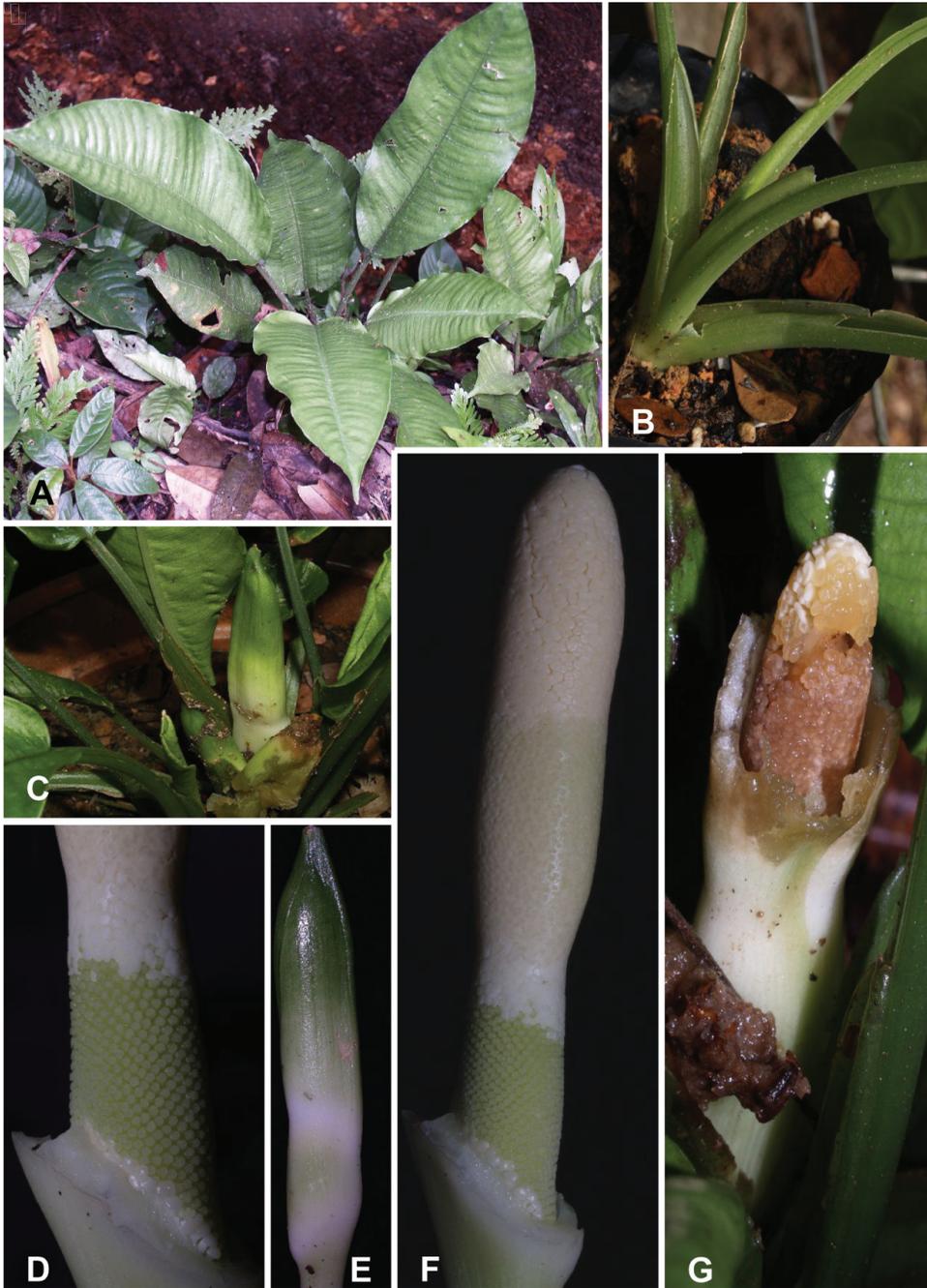
10. *Schismatoglottis ulusarikeiensis* S.Y.Wong, *sp. nov.*

*Ab alii speciebus grex nervosae Borneensibus spathae laminorum pro parte*

*major viridis (non in toto albis) et per anthesin haud aperiens distinguitur.*

–**Typus:** Malaysia, Sarawak, Sarikei Division, Ulu Sarikei, 01° 55' 05.4"; 111° 29' 35.8", 59 m asl, 7 Dec 2005, *P.C.Boyce et al. AR-1588* (holo, SAR). **Plate 9.**

**Leaves** few together (to *ca* 5), innovations yellowish green, the lamina sometimes rotting and leaving behind portion of petiole, with this rotting away at a later stage; petioles terete, channelled slightly canaliculate adaxially in cross section, sometimes D-shaped in cross section, strongly longitudinally ridged, very minutely (strong lens required) and densely verrucate, 13-20 cm long, sheathing in the lower  $\frac{1}{3}$  to  $\frac{1}{2}$  with the sheaths tapering, fully attached, wide open persistent; lamina always oblongo-ovate, sometimes ovate, softly coriaceous, 13-21 cm long  $\times$  5-9 cm wide (ratio up to *ca* 3:1), the base broadly rounded to sub-truncate, slightly retuse to cuneate, the apex acute to *ca* 1 cm, adaxial surface semi-glossy mid green, abaxial surface paler green, always slightly bullate, glaucous, drying strongly discolourous; midrib adaxially flush with the lamina but centrally channelled at the leaf base, abaxially very prominent, raised canaliculate in cross section; primary venation prominent but flushed on adaxial surface, sometimes slightly impressed, strongly raised abaxially, numerous, 10-15 on each side of the midrib, alternating with lesser interprimaries or these occasionally arising from the bases of the primary veins but only occur at the leaf bases, diverging at 60°- 80° and gradually curving towards the tip before reaching the intermarginal collecting vein; secondary veins mostly arising from the midrib, occasionally from near the bases of the primary veins, obscure adaxially and abaxially; tessellate tertiary venation, obscure adaxially and prominent abaxially. **Inflorescences** up to three together, erect, white, 6.5 to 7 cm long, peduncle 1.5 to 2.5 cm, slightly exerted during fruiting; **spathe**, interior glossy, exterior semi-glossy, thickly coriaceous, *ca* 9 cm long; lower spathe broadly ovoid, *ca* 1.5cm diam.  $\times$  3.5 cm long, white when fresh, differentiated from the limb by a faint constriction coinciding with the upper part of interstice; limb lanceolate, thickly coriaceous, caducous by melting at or just after male anthesis, upper part of the limb green prior to anthesis; spadix, sessile, isodiametrically attached to the spathe in the lower  $\frac{1}{4}$  of female zone, cylindrical, 5.5-6 cm long; **female zone**, cylindrical, green when fresh but yellow in alcohol, 1.5-2.2 cm long  $\times$  7-10 mm diam.,  $\frac{1}{4}$  of spadix length; pistils numerous, tightly arranged, elongate-ovoid to subcylindric, *ca* 0.50 mm diam.; stigma sessile, large bun-shaped, *ca* 0.40 mm diam., overtopping ovary, raised, papillate; interpistillar staminodes confined to more or less a single ring at the base of the female zone, but sometimes in robust inflorescence, a few scattering towards the distal part of the female zone, irregularly polygonal from above, twice the size of ovaries, flat-topped, shorter than pistils; sterile interstice presence, 0.6-1 cm long  $\times$  0.7-1 cm wide,



**Plate 9.** *Schismatoglottis ulsarikeiensis* S.Y.Wong. **A.** Whole plant; **B.** Petiolar sheath persistent and open; **C.** Inflorescence at just before female anthesis; **D.** Female zone, interstice and part of male zone; **E.** Spathe prior to anthesis; **F.** Spadix with spathe artificially removed; **G.** Inflorescence post male anthesis with the appendix and spathe limb deliquescent.

pistillodes that are c. half to two times larger than pistil, irregularly round, white when fresh and in alcohol, ca 7 mm long, sharp constriction in between pistillode and staminode zones; staminodes, larger than stamens, irregular polygonal, flat-topped, white when fresh and turning yellow in alcohol, ca 5 mm long; **male zone**, cylindric, ca 1.8-2.2 cm long  $\times$  7 mm diam.,  $\frac{1}{3}$  of spadix length; stamens close-packed, irregularly butterfly-shaped from above and neighbouring anthers with their lobes interdigitating, 0.5 mm diam., anthers truncate, connective narrow and thecae large, pores large accounting of the entire top of the thecae and shallow, C-shaped, the rims narrowly alate; appendix cylindric, 2.1-2.3 cm long  $\times$  7 mm diam.,  $\frac{1}{3}$  of spadix length, white when fresh and in alcohol, blunt point at distal, basally contiguous with the male zone; staminodes of appendix tightly arranged, large staminode, flat-topped, 0.7-1.2 mm across, squat-columnar, staminodes at the distal portion, sometimes forms slit. Fruits immature during observation.

*Other specimens seen:* MALAYSIA. **Sarawak**, Sarikei Division: Ulu Sarikei; 01° 55' 05.4"; 111° 29' 35.8"; 59 m asl, 7 Dec 2005, *P.C.Boyce et al. AR-1577* (SAR); *ibid.*, 7 Dec 2005, *P.C.Boyce et al. AR-1579* (SAR); *ibid.*, 7 Dec 2005, *P.C.Boyce et al. AR-1588* (SAR); *ibid.*, 7 Dec 2005, *P.C.Boyce et al. AR-1635* (SAR).

*Distribution:* Central Sarawak, Sarikei Division. Known only from the type locality.

*Habitat:* Evergreen moist lowland forest on shales, 59 m asl.

*Notes:* *Schismatoglottis ulusarikeiensis* is immediately distinguishable from the rest of the *S. nervosa* complex with primary venation adaxially flush with surface and with less than 10-15 on each side. Petioles are terete, strongly longitudinally ridged and without hyaline margin in *S. ulusarikeiensis*. The lamina is longer but narrower as compared to the rest of the species in the complex. The upper part of the spathe limb remains in green form prior to anthesis and this is unobserved in any other species in the complex. The spathe limb is barely open during anthesis and this is only observed in *S. brevicuspis*. The spadix is robust and forms a uniform width throughout the different zones. The female flowers are green when fresh and this is only observed in *S. tessellata*.

*Etymology:* The specific epithet is derived from the name of the type and only known locality.

### Acknowledgements

This study is funded by the Ministry of Higher Education, Malaysia by fundamental research grant scheme No. FRGS/01(04)/609/2006(42) under Sarawak Forestry Department Research Permit No. NPW.907.4.2(I)-101 & Park Permit No. 58/20076. The collaboration and support of the Sarawak Forestry Corporation, the Forest Research Centre (Kuching), and the Sarawak Biodiversity Centre, are gratefully acknowledged. Special thanks are due to P. C. Boyce for his comments on the manuscript.

### References

- Hay, A. and Yuzammi. 2000. Schismatoglottideae in Malesia I – *Schismatoglottis*. *Telopea* **9(1)**: 1-178.
- Ridley, H.N. 1907. New or rare Malayan plants. III. *Journal of the Straits Branch of the Royal Asiatic Society* **49**: 11-52.
- Wong, S.Y. & Boyce, P.C. 2010. Studies on Schismatoglottideae (Araceae) of Borneo IX: A new genus, *Hestia*, and resurrection of *Apoballis*. *Botanical Studies* **51**: 249-255.
- Wong, S.Y., P.C. Boyce, A.S. Othman and C.P. Leaw. 2010. Molecular phylogeny of tribe Schismatoglottideae based on two plastid markers and recognition of a new tribe, Philonotieae, from the neotropics. *Taxon* **59(1)**: 117-124.