Studies on Schismatoglottideae (Araceae) of Borneo XXIV — Two new species of Aridarum from Kalimantan, and notes on the Aridarum Burttii Complex

Authors: Yeng, Wong Sin, Boyce, Peter C., and Ling, Low Shook

Source: Willdenowia, 42(2) : 261-268

Published By: Botanic Garden and Botanical Museum Berlin (BGBM)

URL: https://doi.org/10.3372/wi.42.42211

WONG SIN YENG[1], PETER C. BOYCE[2*] & LOW SHOOK LING[1]

Studies on *Schismatoglottideae (Araceae)* of Borneo XXIV – Two new species of *Aridarum* from Kalimantan, and notes on the *Aridarum* Burttii Complex

Abstract

Wong S. Y., Boyce P. C. & Ling L. S.: Studies on *Schismatoglottideae (Araceae)* of Borneo XXIV – Two new species of *Aridarum* from Kalimantan, and notes on the *Aridarum* Burttii Complex. – Willdenowia 42: 261–268. December 2012. – Online ISSN 1868-6397; © 2012 BGBM Berlin-Dahlem.
Stable URL: http://dx.doi.org/10.3372/wi.42.42211

Two taxonomically novel *Aridarum* species, *A. kazuyae* and *A. orientale,* are described from Kalimantan Timur, Indonesian Borneo. They are most similar to *A. burttii* from Sarawak, and together with *A. minimum* from Kalimantan Barat represent a morphotaxon, here called the Burttii Complex, defined by staminate flowers comprised of one stamen with an obliquely excavated expanded connective, hemispherical interstice staminodes, a spathe limb deliquescing acroscopically from its junction with the lower persistent portion and leaf blades with adaxially prominently raised primary lateral veins. Recognition of the new species proposed here takes the genus *Aridarum* to 12 accepted species. A key to all *Aridarum* species is provided, the two new species are illustrated and a comparison plate of the spadices of the four species assigned to the Burttii Complex as well as notes on the defining morphological features of this species group and some brief observations on pollination are given.

Additional key words: aroids, *Aridarum kazuyae, Aridarum orientale,* taxonomy, rheophyte, Indonesia

Introduction

Aridarum Ridl., a genus of 10 accepted species of obligate rheophytes endemic on Borneo, was last revised by Bogner & Hay (2000), who recognised eight species, including one novelty, and one distinct but undeterminable species represented by sterile material only. Since then, *A. minimum* H. Okada (2006) was described and, based on new collections, *A. crassum* S. Y. Wong & P. C. Boyce was established (Wong & Boyce 2007) for the indeterminable taxon highlighted by Bogner & Hay (2000). Since 2007, examination of more herbarium material coupled with extensive and continuing fieldwork has revealed further undescribed *Aridarum* species. Two novelties resulting from this fieldwork are here described.

Results and Discussion

Aridarum kazuyae S. Y. Wong, P. C. Boyce & S. L. Low, **sp. nov.**
Holotype: Indonesian Borneo, Kalimantan Timur, Kabupaten Malinau, Kecamatan Malinau Selatan, Sembakung, 80 km SW of Malinau, Tempat Wisata Loreh, 3 km N of Long Loreh village, 3°9'24"N, 116°29'36"E, 3.5.2012, *K. Nakamoto AR-3927* (BO!; isotype: SAR!).

Aridarum kazuyae very closely resembles *A. orientale* S. Y. Wong & al. in vegetative appearance but is immediately distinguished by the combination of a long naked sterile interstice separating the pistillate and staminate flower zones, and the concave, verrucate (not convex,

1 Department of Plant Science & Environmental Ecology, Faculty of Resource Science & Technology, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.
2 Pusat Pengajian Kajihayat (School of Biological Sciences), Universiti Sains Malaysia, 11800 USM, Pulau Pinang, Malaysia; *e-mail: phymatarum@gmail.com (author for correspondence).

smooth) stamen connective with serrate-dentate (not rounded) margins.

Medium-sized obligate rheophyte 10–25 cm tall. Stem somewhat condensed, suberect, later to c. 20 cm long, c. 1.5 cm in diameter. *Leaves* up to 12 together, petioles erect with blades arching; *petiole* 6–19 cm long, 2–3 mm in diameter, very weakly D-shaped in cross section, and weakly channelled dorsally, with the edges rounded, sheathing at the extreme base, medium green; *petiolar sheath* with wings extended into a narrowly triangular ligular portion 3–6 cm long, ligule soon deliquescing; *blade* thinly coriaceous, elliptic, 6–18 cm long × 2–6 cm wide, base cuneate, apex acute, shortly acuminate and apiculate for c. 12 mm, adaxially semiglossy dark green, paler abaxially; *midrib* abaxially and adaxially prominent; *primary lateral veins* 4–5 on each side, diverging from the midrib at c. 30°, adaxially prominent; *interprimary veins* very few, much less prominent than primaries and not visibly reaching the midrib or blade margins; *secondary venation* obscure; *tertiary venation* adaxially obscure, abaxially forming a slightly darker irregular reticulum. *Inflorescence* solitary, subtended by a 6–11 cm long, very narrowly triangular somewhat membranous cataphyll. *Peduncle* shorter than the petioles, 9–15 cm long, terete, medium green, inserted dorsal-obliquely on the spathe. *Spathe* broadly ovate, not constricted, c. 6.5 cm long; lower part salverform at anthesis, gibbous ventrally, green, ultimately persistent through fruiting, limb glistening white, apiculate for up to 8 mm, apicule distally green; limb gaping at pistillate anthesis, during staminate anthesis deliquescent acroscopically from the junction of the spathe limb and the persistent lower part, the limb eventually falling to leave the persistent part with a wide ragged margin of degrading tissue, this tissue then liquefying and leaving the salverform persistent lower spathe with a scarred irregular rim. *Spadix* subcylindric 3–3.5 cm long, c. 0.6 cm in diameter; *pistillate flower zone* comprising c. 1/6 of the spadix, obliquely inserted on peduncle, ventral side c. 6 mm long, dorsal side c. 4 mm long, with an incomplete row of clavate white staminodes at the base; pistils subglobose, truncate, c. 2 mm in diameter, green; stigma subsessile, discoid, papillose, slightly less wide than ovary, greyish; interpistillar staminodes absent; *sterile interstice* slender cylindric, naked, white, subequalling the pistillate zone in length, c. 6 mm long, with several incomplete longitudinal ridges and one or two cylindric-clavate staminodes at the top (below the staminate flower zone), white; *staminate flower zone* c. 1/6 of total spadix length, c. 6 mm long × c. 5 mm in diameter, cylindrical, basally abruptly truncate at junction with sterile interstice; staminate flowers each comprised of a single stamen, ± circular in plan view, with a suture between the thecae, comparatively large, c. 2.5 × 2.5 mm, connective verrucate, centrally impressed with the distal (with respect to spadix axis) margins forming a spreading serrate-dentate rim; thecae globose, each c. 1 mm long, displaced to the proximal (with respect to the spadix axis) side of the stamen with distal-pointing horns; thecae horns c. 0.5 mm long, slightly stiff, directed upwards; *appendix* c. 1.9 cm long, comprising slightly more than 1/2 of the entire spadix, bluntly tapering; appendix staminodes mostly comprised of very densely-packed circular and partially coherent verrucate staminodes, the terminal-most few somewhat more laxly arranged and ending to be tuberculate, rarely the appendix clothed mainly with smooth-surfaced tuberculate staminodes with the lowermost reminiscent of staminate flowers but lacking thecae, and transitioning to staminate flowers, cream. *Fruiting spathe* very broadly obconic, c. 1.5 cm diameter, and 1 cm tall, pale to medium green with a ragged scar along the rim; *fruits and seeds* not seen. – Fig. 1.

Ecology — *Aridarum kazuyae* grows on shale river boulders and in waterfalls under wet lower hill forest at an altitude of about 200 m.

Distribution — The species is known only from the type locality in Indonesian Borneo, Kalimantan Timur.

Eponymy — This new *Aridarum* species is named for Kazuya Nakamoto, an indefatigable explorer and excellent grower of aquatic and rheophytic aroids.

Additional specimen seen — Indonesia: Borneo: Kalimantan Timur, Kabupaten Malinau, Kecamatan Malinau Selatan, Sembakung, 80 km SW of Malinau, Tempat Wisata 3 km N of Long Loreh village, 3°9'24" N, 116°29'36" E, 3.5.2012, *K. Nakamoto AR-3910* (SAR).

Discussion — When not in flower, plants of *Aridarum kazuyae* and *A. orientale* are almost indistinguishable. Both are also reminiscent of *A. burttii* Bogner & Nicolson, although this is a smaller-growing species with much darker green leaf blades. Flowering plants of all three (Fig. 3A, B, D) are readily separated by the different morphology of the stamen connective and thecae horns. Vegetatively very different, *A. minimum* is the only other *Aridarum* so far known to possess a naked interstice between the pistillate and staminate flower zones. However, the spadix of *A. minimum* differs in many other ways (Fig. 3C).

The lower persistent spathe of *Aridarum kazuyae* is unusually wide and shallow for the genus, and also somewhat oblique owing to the peduncle insertion. It differs markedly to that of *A. orientale* (compare Fig. 1E and 2G).

Aridarum orientale S. Y. Wong, P. C. Boyce & S. L. Low, **sp. nov.**

Holotype: Indonesian Borneo, Kalimantan Timur, Kabupaten Tana Tidung, Kecamatan Sesayap, Kampung

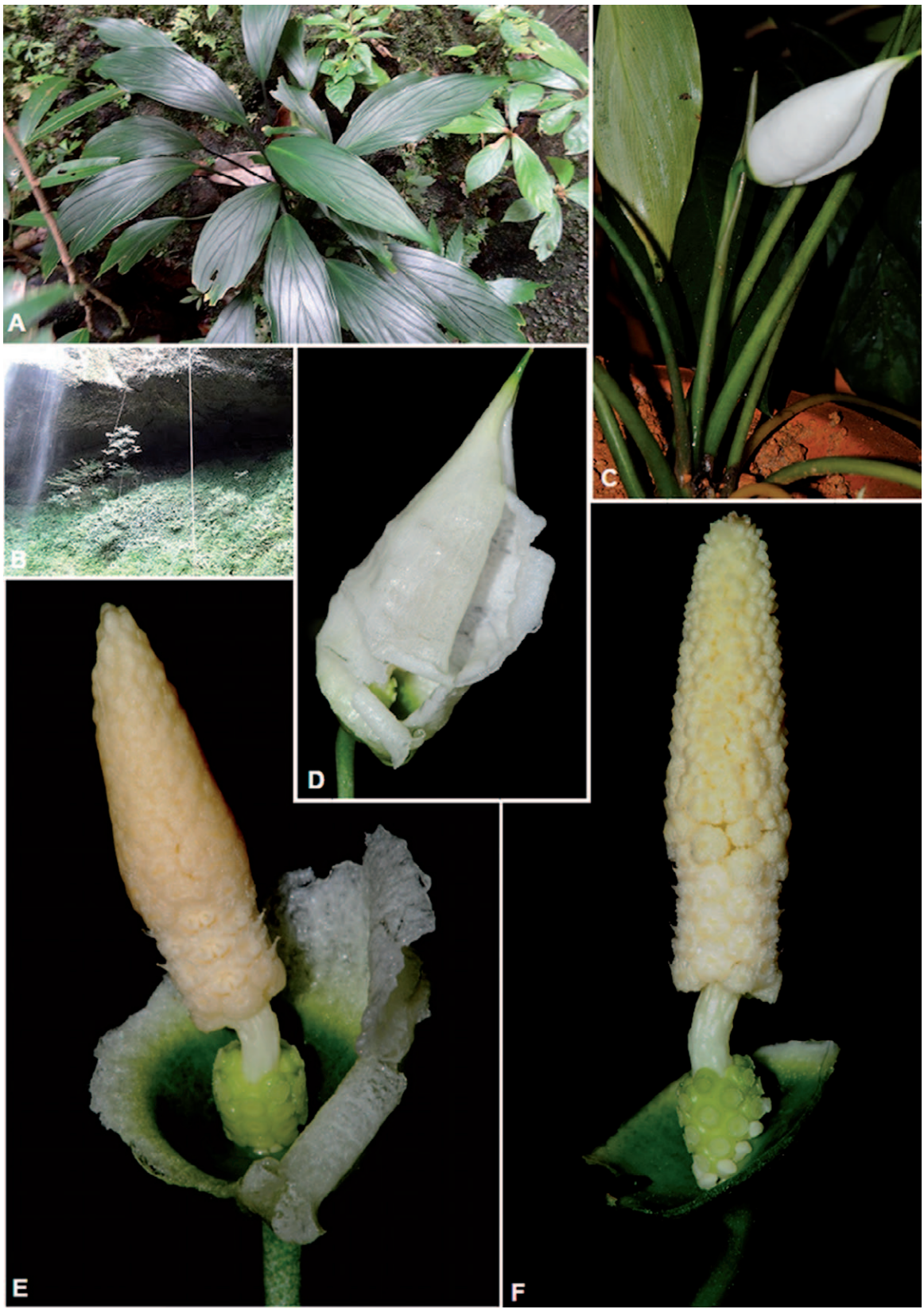

Fig. 1. *Aridarum kazuyae* – A: plant in habitat; B: shale waterfall and overhang, the green expanse at the middle and bottom of the photograph is an extensive pure stand of *A. kazuyae;* C: inflorescence at early pistillate anthesis; D: inflorescence at onset of staminate anthesis, note that the spathe limb has deliquesce from the junction of the lower, persistent spathe; E: inflorescence during staminate anthesis, with the ragged liquefying portions of the spathe limb still adhering to the lower spathe; F: spadix (spathe artificially removed) at early staminate anthesis. – Photographs A–B from *K. Nakamoto AR-3910* by K. Nakamoto; C–F from *K. Nakamoto AR-3927* by P. C. Boyce.

Rian, Air Terjun Gunung Rian, 45 km SE of main road to Tanjung Selor, 3°29'60"N, 116°50'60"E, 19.4.2011, *Kazuya Nakamoto AR-3539* (BO!)

Aridarum orientale is readily distinguished from all other species of the Burttii Complex by the combination of a conspicuous zone of large staminodes below the pistillate flowers, a convex, raised stamen connective with a smooth or slightly sulcate rim, conspicuously globose (not flattened) stamen thecae and the longer, high-arched stiff thecae horns.

Medium-sized obligate rheophyte 10–35 cm tall. *Stem* somewhat condensed, suberect, later to c. 10 cm long, 1.5 cm in diameter. *Leaves* up to 15 together, petioles erect with blades arching; *petiole* 4–17 cm long, 1.5–3 mm in diameter, very weakly D-shaped in cross section, weakly channelled dorsally, with the edges rounded, sheathing at the extreme base, medium green; *petiolar sheath* with wings extended into a narrowly triangular ligular portion 3–6 cm long, this ligule soon deliquescing; *blade* coriaceous, elliptic, 6–16 cm long × 2–5 cm wide, base cuneate, apex acute, shortly acuminate and apiculate for 8–10 mm, adaxially semiglossy dark green, paler abaxially; *midrib* abaxially and adaxially prominent; *primary lateral veins* 4–5 on each side, diverging at c. 30° from the midrib, adaxially prominent; *interprimary veins* very few, much less prominent than primaries and not visibly reaching the midrib or blade margins; *secondary venation* obscure; *tertiary venation* adaxially obscure, abaxially forming a slightly darker irregular reticulum. *Inflorescence* solitary, subtended by a 6–9 cm long very narrowly triangular membranous cataphyll. *Peduncle* mostly shorter than the petioles (exceptionally, longer in environmentally dwarfed individuals), 9–15 cm long, terete, medium green. *Spathe* broadly ovate, not constricted, 4–5.6 cm long, lower part green and ultimately persistent at fruiting, the remainder white, gaping and caducous by acroscopic deliquescence from the junction of the spathe limb with the lower, persistent portion during anthesis, spathe apiculate for up to 1 cm, apicule distally green. *Spadix* subcylindric (1.5–)2–3 cm long, c. 0.6 cm in diameter; *pistillate flower zone* comprising c. 1/4 of the spadix, obliquely inserted on peduncle and subtended by a zone of large, weakly rhomboidal, white staminodes, ventral side of pistillate zone 8–10.9 mm long, dorsal side 3.8–5.6 mm long; pistils subglobose, truncate, c. 2 mm diameter, green; stigma subsessile, discoid, papillose, slightly wider than the ovary, white; interpistillar staminodes absent; *sterile interstice* composed of 2 or 3 clavate-rounded sterile anthers, white; *staminate flower zone* accounting for slightly less than 1/2 of the entire spadix length, 6–9.6 mm long × 4.5–6.8 mm wide; staminate flowers comprised of a single stamen, stamens more or less circular in plan view, with a deep suture between the thecae, comparatively large, c. 2.5 × 2 mm, connective centrally impressed with the margins forming a convex, raised, rounded rim, this smooth, occasionally slightly ridged, the whole somewhat kidney bowl-shaped; thecae globose, c. 1 mm long, displaced to the proximal (with respect to the spadix axis) side of the stamen with distal-pointing horns; thecae horns c. 0.5 mm long, stiff, stout; *appendix* c. 1/3 of the entire spadix, 4–6.6 mm long, bluntly tapering; appendix staminodes comprised of 1–3 branched knobbly sterile stamens, those at the base tending to be larger (up to 2 mm long), white. *Fruiting spathe* broadly obconic, c. 1 cm in diameter, and tall, subtending a ± globose cluster of berries, medium green with a conspicuous pale brown scar from the spathe limb abscission; *berries* globular, c. 3 mm in diameter, crowned with old stigma remnants, many-seeded; *seeds* c. 2 mm long, 0.6–0.7 mm in diameter, narrowly ellipsoid, dark brown, slightly longitudinally ribbed, with a long curved translucent micropylar appendage 1.2–1.5 mm long, the appendages intertwined in the upper part of the berry. – Fig. 2.

Ecology — The species grows on shale river boulders and in waterfalls under lowland perhumid forest, at about 50 m altitude.

Distribution — *Aridarum orientale* is known only from the type locality on Gunung Rian, Kalimantan Timur.

Etymology – The epithet of this *Aridarum* species refers to its distribution in eastern Borneo (orientalis, Latin for "eastern").

Additional specimen seen — Indonesia: Borneo: Kalimantan Timur, Kabupaten Tana Tidung, Kecamatan Sesayap, Kampung Rian, Air Terjun Gunung Rian, 45 km SE of main road to Tanjung Selor, 3°29'60"N, 116°50'60"E, 28.4.2012, *K. Nakamoto AR-3912* (SAR).

Discussion — When not flowering, *Aridarum orientale* and *A. kazuyae* are indistinguishable; in flower, however, *A. orientale* is readily differentiated by lacking a naked interstice and by the convex, smooth or smooth-rimmed (not concave, serrate-dentate) stamen connective. Vegetatively, *A. orientale* is also closely similar to *A. burttii,* but this latter species differs also by the concave stamen connective with serrate-dentate distal rim, furthermore by the presence of globose staminodes at the base of the staminate flower zone (not absent or closely resembling staminate flowers) and by rather soft, short and straight (not long, stiff, arching) thecae horns. The ratio of the spadix zones to spadix length differs in all three species.

Key to the species of *Aridarum*

1. Staminate flowers comprised of one stamen; thecae on the proximal side of the flower (with respect to spadix axis) 2

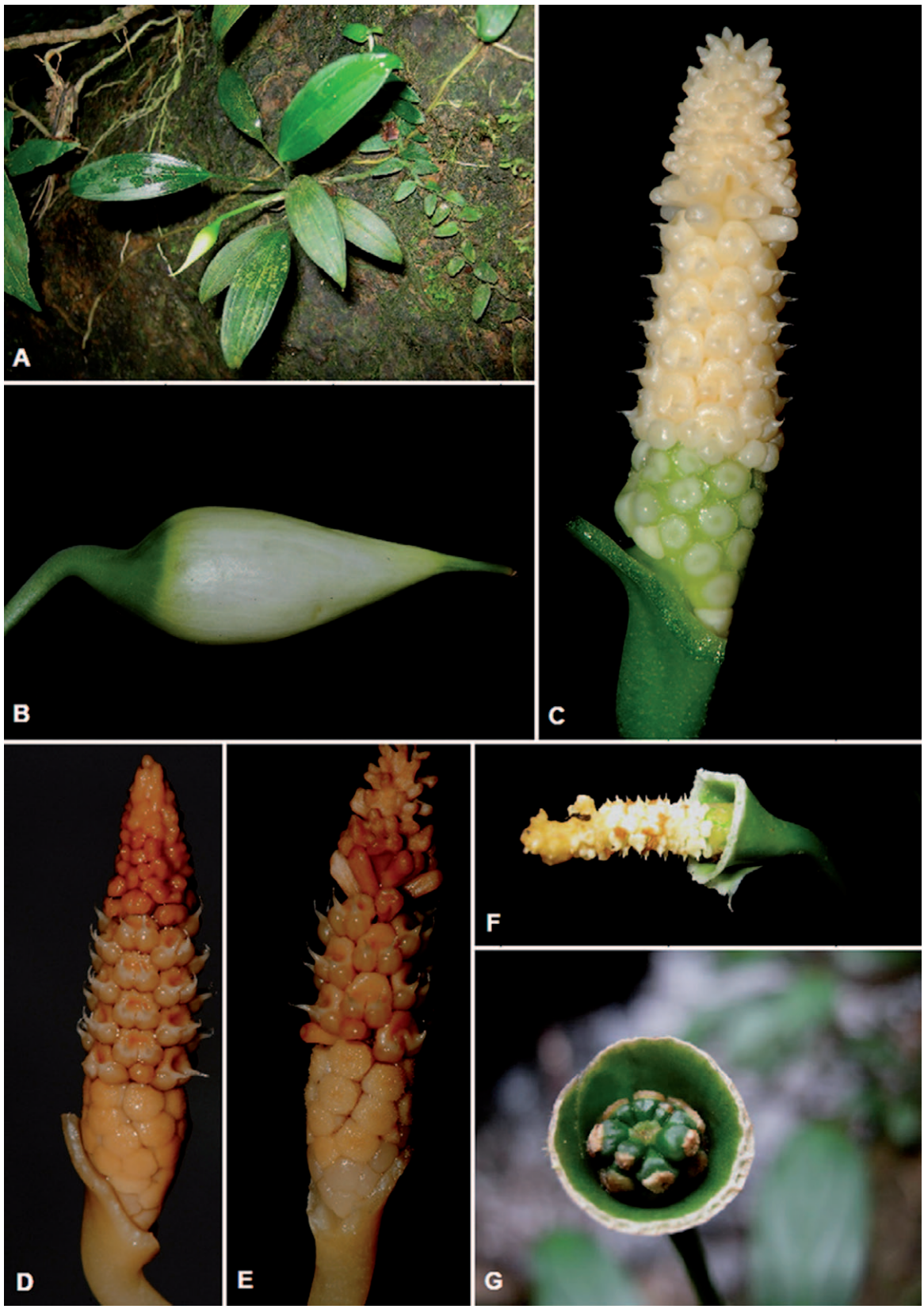

Fig. 2. *Aridarum orientale* – A: plant in habitat; B: inflorescence at pistillate anthesis; C: spadix at early pistillate anthesis, spathe artificially removed; D–E: alcohol preserved spadices to show typical variation of plants from one population; F: inflorescence at late staminate anthesis, with the lower spathe persisting after the spathe limb has been shed; note the damage to the appendix resulting from chrysomelid beetle predation during pollination; G: infructescence at mid-maturity; the scar along the rim of the persistent lower spathe results from the spathe limb being shed during anthesis. – Photographs A, D–G from *K. Nakamoto AR-3539,* B–C from *K. Nakamoto AR-3912;* A, F–G by K. Nakamoto; B–E by P. C. by Boyce.

Fig. 3. Spadices (spathe artificially removed) in the *Aridarum* Burtii Complex – A: *A. burttii* from *P. C. Boyce AR-3726;* B: *A. kazuyae* from *K. Nakamoto AR-3927*; C: *A. minimum* from *K. Nakamoto AR-3847*; D: *A. orientale* from *K. Nakamoto AR-3912*. – Scale bar = 1 cm; photographs by P. C. Boyce.

– Staminate flowers comprised of two stamens; thecae on the ends or the inner face of each anther of the stamen pair 6
2. Connective not expanded, horseshoe-shaped; staminodes of interstice horseshoe-shaped, expanding laterally post pistillate anthesis; stamens and staminodes coarsely verruculate; spathe limb caducous, falling by lesion from the lower, persistent spathe; primary lateral veins not conspicuously raised . . . . . ***A. rostratum*** Bogner & A. Hay
– Connective expanded on the distal side (with respect to the spadix axis) into a rim; staminodes of interstice (if present) never horseshoe-shaped and never expanding; stamens and staminodes smooth or verrucate; spathe limb deliquescing acroscopically from the junction with the lower persistent part; leaf blades with the primary lateral veins conspicuously raised adaxially 3
3. Pistillate and staminate flower zones separated by a naked interstice equalling the staminate flower zone in length; staminodes few, cylindric-clavate, at base of staminate flower zone; stamens and appendix staminodes verrucate . . . . . ***A. kazuyae*** S. Y. Wong & al.
– Pistillate and staminate flower zones not separated by a naked interstice, or if interstice present then very short; staminodes at base of staminate zone absent or globose; stamens and appendix staminodes smooth 4
4. Leaf blades linear-lanceolate, adaxially with strong marginal veins; pistillate flower zone with a few vermiform staminodes at the base. Kalimantan Barat . . . . . ***A. minimum*** H. Okada
– Leaf blades not linear-lanceolate; pistillate flower zone with none or prismatic staminodes at the base 5
5. Stamen connective convex, distal rim rounded, smooth or slightly sulcate; staminodes at base of staminate flower zone absent or closely resembling staminate flowers; thecae horns long, stiff, arching. Kalimantan Timur . . . . . ***A. orientale*** S. Y. Wong & al.
– Stamen connective concave, distal rim serrate-dentate; staminodes at base of staminate flower zone globose; thecae horns rather soft, short, straight. C. Sarawak (Kapit) . . . . . ***A. burttii*** Bogner & Nicolson
6. Thecae on each end of each anther 7
– Thecae on the inner face of each member of the stamen pair 11
7. Leaf blades linear; horns of thecae very long and thin,

with the tips overlapping; stamen connective umbonate. Sarawak (Sri Aman) . . . ***A. montanum*** Ridl.
– Leaf blades narrowly elliptic to elliptic; horns of anther thecae short and stubby; stamen connective excavated or rarely flat 8
8. Leaf arrangement strictly distichous. Sarawak (vicinity of Matang) . . . . . ***A. borneense*** (M. Hotta) Bogner & A. Hay
– Leaf arrangement spiral 9
9. Stamen connective not excavated; horns of thecae short but robust, their bases occupying the whole upper surface of the anther. West Kalimantan . . . . . ***A. incavatum*** H. Okada & Y. Mori
– Stamen connective excavated; horns of the thecae small, on the narrow ends of the anther. Sarawak and West Kalimantan 10
10. Leaf blade very stiffly coriaceous, glossy deep green adaxially when fresh; stigma $^2/_3$ of ovary diameter; thecae horns very short, rounded at the end. Sarawak (Gunung Gaharu & Batu Balau ('Bukit Lingga') . . . . . ***A. crassum*** S. Y. Wong & P. C. Boyce
– Leaf blade rubbery-coriaceous, matte medium green adaxially when fresh; stigma as wide as ovary; thecae horns long, pointed at the end. Sarawak (Bako & Santubong) . . . . . ***A. nicolsonii*** Bogner
11. Horns of thecae shorter than width of stamen. Sarawak and Brunei . . . . . ***A. caulescens*** M. Hotta
– Horns of thecae longer than width of stamen. Sarawak . . . . . ***A. purseglovei*** (Furtado) M. Hotta

The *Aridarum* Burttii Complex

Recognition of the two novel species above brings into focus the existence of a distinct species group within *Aridarum* defined by unistaminate flowers with distally positioned thecae and a proximally expanded connective, spathes senescing by acroscopic deliquescence from the junction of the lower persistent portion and the limb, a well-developed spadix appendix, and leaf blades adaxially with very prominently raised primary lateral veins. Four species are included, the two here described, plus *Aridarum burttii* and *A. minimum*. The last differs vegetatively by having very narrow leaf blades, with the primary lateral veins reduced to conspicuously thickened margins, but in all other respects it agrees with other species of the Burttii Complex. The spadices of all four species are illustrated in Fig. 3.

Aridarum rostratum appears to represent a different and distinct group of unistaminate *Aridarum* species, differing from those of the Burttii Complex by the stamens lacking a distally expanded connective, horseshoe-shaped interstice staminodes expanding laterally post pistillate and prior to staminate anthesis, and a spathe limb caducous by simple lesion from the lower persistent part (not deliquescing acroscopically). It differs further by the leaf blades lacking the adaxially conspicuously raised primary lateral veins characteristic of the Burttii Complex. The verrucate staminate flowers of *A. rostratum* are superficially reminiscent to those of *Phymatarum* M. Hotta, while the overall morphology of the interstice staminodes of *A. rostratum* is somewhat evocative of those of *Bucephalandra* Schott, another unistaminate genus which also has species with a verrucate appendix but conspicuous interstitial staminodes. *Phymatarum* differs from *A. rostratum* (and indeed from all other thecae horn possessing *Schismatoglottideae*) by the spathe with a strong constriction demarcating the lower persistent part from the caducous limb, and by an urceolate (not salver- or funneliform) persistent lower spathe. *Bucephalandra* is distinct from *A. rostratum* by the flattened, smooth, scale-like staminodes which are erect during pistillate anthesis, spread later, become green post anthesis and persist to protect the developing fruit.

Pollination

The pollinators of *Aridarum* species have yet to be confirmed, although observations have shown *A. nicolsonii* to be visited by *Colocasiomyia* flies (Gibernau & al. 2010). In addition to observing flies, the authors have seen numerous instances of beetles of families *Chrysomelidae* and *Nitidulidae* as visitors to *Aridarum* inflorescences. Josef Bogner reports seeing *Nitidulidae* beetles visiting *A. nicolsonii* and notes that these beetles are known to feed on pollen (Bogner, pers. comm.). The authors have often observed chrysomelid beetles chewing the staminate flowers of several *Aridarum* species, producing in the type of damage shown in Fig. 2F.

Acknowledgements

The study visits to the herbaria mentioned in this paper were funded under the first author's ITTO Fellowship Ref. 026/09A. This is part of an on-going research which is funded by the Ministry of Higher Education, Malaysia by fundamental research grant scheme vote: FRGS/01(12)/709/2009(25). We also wish to extend our thanks to the Directors or Curators of B, BO, K, L, M, SAR and SING for allowing access to material, and to their staff for facilitating our observations.

References

Bogner J. & Hay A. 2000: *Schismatoglottideae* in Malesia II – *Aridarum, Bucephalandra, Phymatarum* and *Piptospatha*. – Telopea **9:** 183–194.

Gibernau M., Chartier M. & Barabé D. 2010: Recent advances towards an rvolutionary comprehension of *Araceae* pollination. – Pp. 101–114 in: Seberg O., Petersen G., Barfod A. S. & Davis J. I. (ed.), Diversity, phylogeny & evolution in the monocotyledons. – Denmark: Aarhus University.

Okada H. 2006: A new species of *Aridarum, Schismatoglottideae,* from the Muller Range, Central Kalimantan, Indonesia. – Acta Phytotax. Geobot. **57:** 61–64.

Wong S. Y. & Boyce P. C. 2007: Studies on *Schismatoglottideae (Araceae)* of Borneo II: *Aridarum crassum,* a new species from Sarawak, Malaysian Borneo. – Gard. Bull. Singapore **58:** 279–286.