WONG SIN YENG¹, PETER C. BOYCE²* & LOW SHOOK LING¹

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

Abstract


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 indeterminable 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 deliquescent; 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 acuminate 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 stamine 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 incompleteness of 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 stamine flower zone), white; staminate flower zone c. 1/6 of total spadix length, c. 6 mm long × 5 mm in diameter, cylindric, 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 1/3 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 stamine flowers but lacking thecae, and transitioning to stamine flowers, cream. Fruiting spathe very broadly obiconic, 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.


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 stamine 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.
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 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 deliquescent; 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 obscured, adaxially forming a slightly darker irregular reticulum. Inflorescence solitary, subedent 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 flowering, the remainder white, gaping and caducous by acroscopic deliquescent from the junction of the spathe limb with the lower, persistent portion during anthesis, spathe apiculate for up to 1 cm, apiculate distally green. Spadix subcylindric (1.5–)2–3 cm long, c. 0.6 cm in diameter; pistillate flower zone comprising c. 1/3 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; pistil subglobose, truncate, c. 2 mm diameter, green; stigma subsessile, discoid, papillose, slightly wider than the ovary, white; interstaminal staminodes absent; sterile interstice composed of 2 or 3 clavate-rounded sterile anthers, white; staminean flower zone accounting for slightly less than 1/3 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; theca horns c. 0.5 mm long, stiff, stout; appendix c. 1/3 of the entire spadix, 4–6.6 mm long, bluntly tapering; appendix staminal comprising of 1–3 branched knobly 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.
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; spathelimb 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 verruculate; 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, 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 vermiciform 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 another thecae short and stubby; stamen connective excava-
ted or rarely flat ........................................... 8
8. Leaf arrangement strictly distichous. Sarawak (vicinity of Matang) .............................................. 9
- Leaf arrangement spiral .................................. 8
9. Stamen connective not excavated; horns of the-
cae 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 ½ 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 & San-
tubong) .................................................. 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-
funnelliform) 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 con-
Gibernau M., Chartier M. & Barabé D. 2010: Recent
advances towards an evolutionary comprehension of

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