AROIDEANA
International Aroid Society, Inc.

Volume 37E
No 2
December 22, 2014
ISSN 2310-0745

Aroideana is an illustrated annual devoted to information about the family Araceae and published by the International Aroid Society, Inc.
 Manuscripts, corrected proofs, and all editorial correspondence should be sent to: Dr. Derek Burch. All other correspondence is to be sent to:
International Aroid Society,
P.O. Box 43-1853, So. Miami, FL 33143-1853 U.S.A.

Scientific and Nonscientific Manuscripts
Papers must be typed on standard A4 paper, be double spaced throughout, and for hard copy be on consecutively numbered pages, with 2.5 cm (1") margins on all sides. Ideally all manuscripts should be submitted to the editor in electronic format (either on 3.5 inch floppy disk or as an e-mail attachment) in MS Word 7 (or later) or compatible. Authors should follow recommendations of the Council of Biology Editors Style Manual. Measurements are to be in metric units.

Sequences of Sections
Follow this order: title, author name and address, abstract, introduction, materials and methods, results, discussion, acknowledgments, and literature cited. Captions must accompany all tables and figures. Abstracts should summarize the character and scope of the paper in 250 words or less, followed by no more than eight key words. Literature cited must be referenced in the text and listed alphabetically by author.

Illustrations
Line drawings and tables must be in black, high resolution ink, clearly labeled, and consecutively numbered. Photos must be completely labeled and show desired cropping if any. Figures will be published either one column (six cm) or two columns (12.6 cm) wide. Full page illustrations will be no more than 12.6 cm x 20 cm. Original art will be returned to the author. Figures will be published in black and white unless special arrangements have been made with the editor for reproduction in color.

IMPORTANT NOTE:
When submitting material to IAS publications, please realize that the resolution of the photos embedded in Word documents is often not suitable for publishing as individual figures. Though they may look okay in the document, the individual elements can be just thumbnail size or adhered together into a small number of plates. In the past, these articles have been dealt with despite their complexity.

As of now, we can only accept separate high resolution photos in addition to the Word document, in JPEG or TIFF format. Made-up plates in PDF format with high resolution images embedded are acceptable for Aroideana only. Other articles with embedded photos will be returned to the authors. Many thanks for your help in this matter and thank you for supporting Aroideana.

Processing Manuscripts
Upon receipt, manuscripts are acknowledged and sent for critical review. Accepted manuscripts are sent to authors for revision in consideration of reviewers' comments and returned to the editor for typesetting. Page proofs are sent to the author for proofreading, with any changes other than typographical errors being charged to the author at cost at the editor's discretion. Authors with research support will be billed for page charges at the rate of $30.00 per printed page at the editor's discretion.

Voucher Materials
Descriptions of new species require deposit of type materials in a recognized herbarium.

Aroideana ISSN: 0197-4033 (Print) 2310-0745 (Online)

AROIDEANA
International Aroid Society, Inc.

CONTENTS

Front Cover: ***Fenestratarum culum*** P. C. Boyce & S. Y. Wong
Back Cover: ***Piptospatha colata*** S. Y. Wong & P. C. Boyce

Studies on Schismatoglottideae (Araceae) of Borneo XXXXIII: *Fenestratarum culum* - A new genus and species from Kalimantan Barat, Indonesian Borneo

Peter C. Boyce*
Honorary Research Fellow
Institute Of Biodiversity and Environmental Conservation (IBEC)
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
phymatarum@gmail.com

Wong Sin Yeng
Department of Plant Science & Environmental Ecology
Faculty of Resource Science & Technology
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
sywong@frst.unimas.my

***corresponding author**

ABSTRACT

Fenestratarum is described as a new genus of Tribe Schismatoglottideae, with a single novel species, *Fenestratarum culum*. Preliminary molecular analyses places *Fenestratarum* near the base of a clade comprised of *Bakoa*, *Hottarum*, two clades containing species currently assigned to *Aridarum*, and a clade of species presently included in *Piptospatha*.

KEY WORDS

Rheophytic, molecular phylogenetic analyses, *Fenestratarum*, Araceae

INTRODUCTION

The past decade has witnessed discovery of a significant number of novel Bornean aroid taxa belonging to Tribe Schismatoglottideae (see: http://www.aroid.org/gallery/boyce/

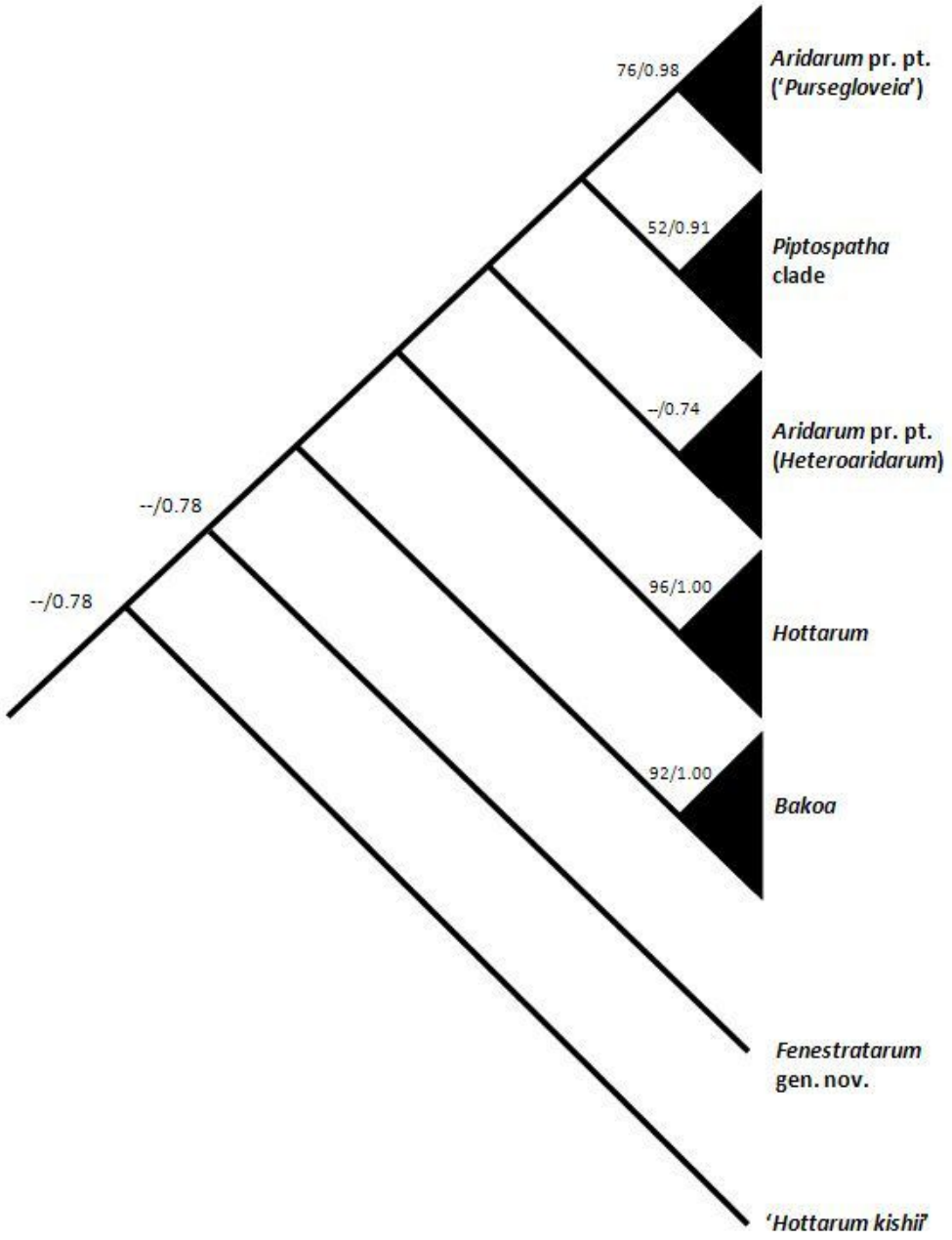

Figure 1.
Schematic diagram of phylogenetic relationships of *Fenestratarum* to their immediate relatives in a partial clade of Tribe Schismatoglottideae as recovered by Low et al. (in prep.) based on data from one nuclear and one plastid DNA region. Figures at nodes indicate support values (Maximum Likelihood/Bayesian Posterior Probabilities).

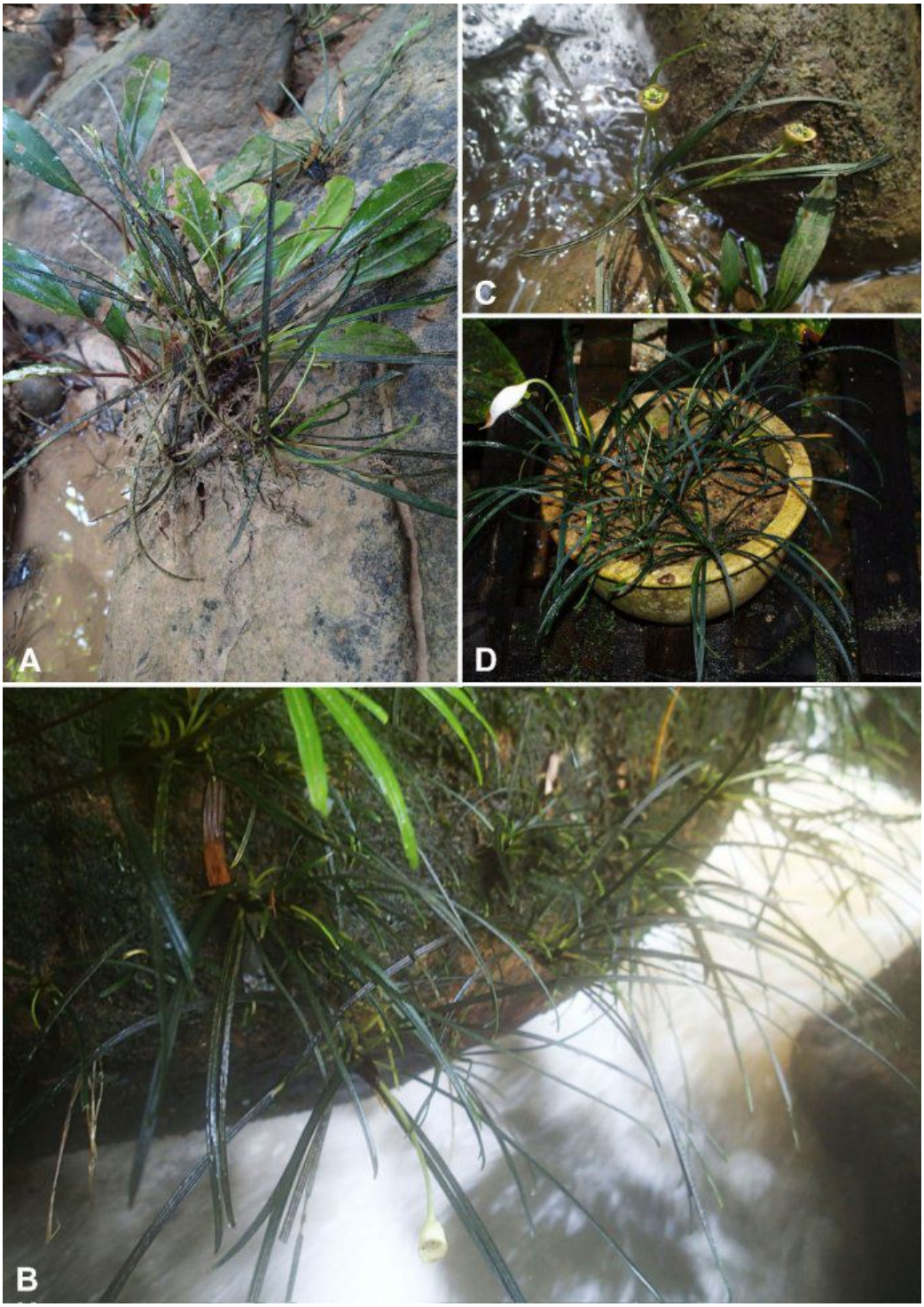

Figure 2. ***Fenestratarum culum*** P. C. Boyce & S. Y. Wong
A, B. & **C.** Plants in habitat, Type locality. Note the post-anthesis inflorescence (spathe limb and spent part of spadix fallen) in **B**, and the erect splash-cups with developing fruits in **C**. D. Plants in cultivation. **A–D** from *AR-4300*. Images A, B & C © Hiroyuki Kishi; D © P.C.Boyce.

Figure 3. ***Fenestratarum culum*** P. C. Boyce & S. Y. Wong
A – C. Inflorescence at pistillate anthesis. Note that the lower spathe margins are fused. **D.** Inflorescence at pistillate anthesis, nearside spathe artificially removed. **E.** Inflorescence at late staminate anthesis, caducous part of spathe removed prematurely. **F.** leaf blade, abaxial view. **A–F** from *AR-4300*. Images © P.C.Boyce.

& http://www.aroid.org/gallery/wong/). Here we continue this by describing a singular new species of rheophytic aroid which on morphological bases cannot be accommodated into any of the currently described genera. Preliminary molecular phylogenetic analyses resolves *Fenestratarum* near the base of a clade comprising the genera *Bakoa*, *Hottarum*, and three clades composed of species currently included in *Aridarum* and *Piptospatha*. Basal to the entire clade is a further clade representing an additional undescribed genus – **Figure 1.**

Fenestratarum P. C. Boyce & S. Y. Wong, **gen. nov.** Type species**:** *Fenestratum culum* P. C. Boyce & S. Y. Wong, **sp. nov. Figures 2 & 3.**

Fenestratarum culum P. C. Boyce & S. Y. Wong, **sp. nov.** Type: Indonesian Borneo, Kalimantan Barat, Ngabang, Landak, Desa Sungai Durian, Riam Desa Sungai Durian, 00°31'41"N 109°47'39"E, 1 Nov. 2013, *H. Kishi AR-4300* (BO!).

Diagnosis

Fenestratarum and its sole species *Fenestratarum culum* are diagnosed by the combination of a nodding inflorescence on a very slender erect peduncle, an unconstricted spathe limb, with the portion equating to the limb having large translucent areas separated by opaque veins, and the portion equating to the lower spathe uniformly opaque, by completely fused lower spathe margins reducing access to the spadix to a narrow opening on the median ventral side of the spathe, thecae in deep pits and lacking thecae horns, sterile appendicle staminodes, basal placentation, orthotropous ovules with a beak-like micropylar appendage, funnel-form splash-cups held erect by straightening of the distal portion of the peduncle, and indehiscent berries.

Fenestratarum, *Hottarum* Bogner & Nicolson and *Bakoa lucens* (Bogner) P. C. Boyce & S. Y. Wong all have thecae set in deep pits. *Fenestratarum* differs by a fenestrate spathe limb, also by completely fused lower spathe margins forming a tube and linear leaf blades with a basally pulvinate petiole. *Fenestratarum* further differs from all *Bakoa* species by the caducous (vs persistent) spathe limb, and an erect splash-cup infructescence. *Fenestratarum* is additionally differentiated from *Bakoa lucens* by fleshy fruits (vs fruits drying to form a caryopsis), and from the remaining *Bakoa* species by indehiscent (vs dehiscent) berries. *Fenestratarum* is distinguished from *Piptospatha* by basal (vs parietal) placentation, and although sharing with *Piptospatha* a nodding inflorescence, the peduncle is much more slender, and no *Piptospatha* has a fenestrate spathe limb, or linear leaf blades. From *Aridarum*, *Fenestratarum* diagnostically lacks thecae horns.

Description

Small obligate rheophytes to ca. 15 cm tall. **Stem** initially compact, later elongating to ca 10 cm, sub-erect, ca. 3 cm in diam.,

basally with copious strong roots. **Leaves** many together, stiffly arching; **petiole** ca. 2 cm long, basal half broadly sheathing and swollen, ca. 5 mm wide, very pale green, remainder of petiole D-shaped in cross-section, ventrally pale matte green, dorsally very deep glossy green; **petiolar sheath** with wings extended into a narrowly triangular ligular caducous portion ca. 3 cm long; **blade** stiffly coriaceous, linear, 11–15 cm long × ca. 5 mm wide, base decurrent, apex acute and apiculate for ca. 4 mm, adaxially very deep glossy green, abaxially matte pale olive green; **midrib** abaxially and adaxially sharply prominent; **primary lateral veins** restricted to one on each side, arising from the base of the blade and remaining at the margin of the blade, meeting at the tip and there coalescing to form the apiculate point; all other veins invisible. **Inflorescence** up to three produced in sequence, alternating with membranous, later papery cataphylls; **peduncle** slender, somewhat exceeding the leaves, ca. 15 cm long × 1.5 – 2 mm in diam., pale green, uppermost part curving forward to hold the inflorescence at slightly less than 90° to the peduncle. **Spathe** ca. 3 cm long, ca. twice length of spadix; **spathe limb** broadly lanceolate with large transparent areas separated by opaque white veins, terminally specked reddish, and extended into a prominent reddish-stained rostrum ca. 4 mm long, limb opening at pistillate anthesis by a ventral elliptic fissure with incurving margins, limb caducous by deliquescence at junction with persistent lower part after staminate anthesis, falling in a single but deliquescing piece together with the spent parts of the spadix; **lower spathe** with fully fused margins, forming a tube, white, persistent after anthesis and forming a funnel-form structure subtending the developing fruits. **Spadi**x sub-cylindric, 13 – 20 mm long × 5 – 7 mm wide; **pistillate flower zone** cylindric, comprised of ca 3 spirals of flowers, narrower than remainder of spadix, accounting for ca. ¼ of spadix, 3 – 6 mm long × 3 – 5 mm in diam., with single row squat polygonal glossy white staminodes at base; **pistils** crowded, sub-globose, ca. 1 mm in diam., pale green; **stigma** sessile, discoid, almost as wide as pistil, , rather coarsely papillate, very pale green; **sterile interstice** 1 – 2 mm long × 5 – 7 mm in diam., composed of a single row of polygonal staminodes, these 1 – 2mm long × 0.5 – 1 mm wide, very pale creamy white; **staminate flower zone** slightly less than ½ of entire spadix length, 5 – 6 mm long × 5 – 7 mm in diam., very pale creamy white; **staminate flowers** large, spirally arranged, each comprised of two stamens, truncate, rhomboid from above, ca. 2 mm long × 1.5 mm wide; **thecae** set in deep pits on the top and bottom (with respect to the spadix axis) of each stamen separated by a conspicuous broad, slightly domed connective; **appendix** 4 – 5 mm long, slightly tapering, obtuse; **appendix staminodes** resembling stamens without thecae, very pale creamy white. **Infructescences** erect. **Fruiting spathe** campanuliform, ca. 1 cm long × ca. 1 cm wide, medium green with a scar along rim; **fruits** obpyriform, ca 3 mm long, stigmatic remain raised, darker green; **seeds** not seen.

Distribution — *Fenestratarum culum* is so far known only from the Type locality.

Ecology — *Fenestratarum culum* is rheophytic on riverside Cretaceous sandstones rocks and boulders under open perhumid lowland at ca. 45m asl.

Etymology — From Latin, *fenestratus*, windowed, + *Arum*, hence windowed arum, coined to describe the unique translucent areas of the spathe limb.

The species epithet is derived from Latin, *culus* [*culum* – neut.], the fundament, or sphincter, in allusion to the highly restricted opening in the spathe limb by which pollinators access the spadix

Notes — The splash-cup infructescence of *Fenestratarum culum* is unique in the Tribe Schismatoglottideae owing to the fused margins.

The molecular analyses upon which the above genus has been resolved forms part of a PhD study of *Aridarum* by Low Shook Ling.

Acknowledgements

This is part of an on-going research which is funded by the Ministry of Higher Education, Malaysia by the Exploratory Research Grant Scheme Vote No. NRGS/1089/2013-(03) and Fundamental Research Grant Scheme Vote No. FRGS/STWN10(01)985/2013(26).

REFERENCES

None

A New Species of *Anthurium* (Araceae) from Brazil

Marcus A. Nadruz Coelho
Instituto de Pesquisas Jardim Botânico do Rio de Janeiro
Rua Pacheco Leão 915, office 111,
ZIP Code 22460–030, Rio de Janeiro, RJ, Brazil.

Morgana F. R. Rabelo
Brandt Meio Ambiente,
Alameda do Ingá 91,
ZIP Code 34000–000, Nova Lima, MG, Brazil.
Corresponding author: mnadruz@jbrj.gov.br

ABSTRACT

A new species of *Anthurium* is described for Brazil, *Anthurium rioacimensis* Nadruz & Rabelo, occurring in the municipality of Rio Acima, Minas Gerais, Brazil. The restricted distribution indicates that studies regarding its conservation are needed. Diagnoses, illustrations and comments on geographic distribution, ecology, phenology and conservation status are provided for the species presented in this article.

KEY WORDS

Taxonomy, conservation *Anthurium*, Araceae, Brazil

RESUMO

Uma espécie nova de *Anthurium* é descrita para o Brasil, *Anthurium rioacimensis* Nadruz & Rabelo, ocorrente no município de Rio Acima, Minas Gerais, Brazil. Apresenta distribuição restrita e estudos sobre a sua conservação se fazem necessários. São fornecidas diagnoses, ilustrações e comentários sobre distribuição geográfica, ecologia, fenologia e estado de conservação da espécie aqui apresentada.

PALAVRAS CHAVE

Taxonomia, conservação, *Anthurium*, Araceae, Brasil

INTRODUCTION

The municipality of Rio Acima is located in the Southeast portion of the Minas Gerais State, Brazil, in the coordinates 20° 04' 42" S and 42° 47' 20" W, with a maximum altitude of 900 m above sea level

Figure 1

Figure 2

Figure 1. *Anthurium rioacimensis* (Rabelo s/n - PAMG 57473) – habit.

Figure 2. *Anthurium rioacimensis* (Rabelo s/n - PAMG 57473) Detail of the cataphylls and prophylls.

(Figure 7). The vegetation type is in a few remaining areas of Seasonal Semideciduous Forest.

The genus *Anthurium* Schott is considered the biggest of the family Araceae with approximately 1500 species (Boyce & Croat, 2011). In Brazil it is represented by 130 species (Coelho et al., 2014), and occurs in all regions of Brazil (Temponi, 2007). With *Anthurium rioacimensis*, the number of known species of this genus rises to 28 for the State of Minas Gerais (Coelho et al., 2014).

RESULTS

Anthurium rioacimensis Nadruz & Rabelo, **sp. nov.** Type: BRAZIL. MINAS GERAIS: Rio Acima. In the understory of Seasonal Semideciduous Forest surrounding das Velhas River. 08.II.2013, *M.F.R. Rabelo; L.M. Fernandes; R. Guedes s/n* (holotype: RB 587522, Isotype: PAMG 57473). (**Figures 1-6)**

Terrestrial **herb**; **stem** erect; **cataphylls** and **prophylls** whole to slightly decomposed at the apex of the stem, reddish, 1.5–4 cm long. **Leaf** perpendicular to the petiole; **petiole** greenish to vinaceous, sulcate with obtuse adaxial margins, abaxial rounded, 10–24 cm long; **leaf blade**, greenish, elliptical, deflexed, acute-acuminate apex and obtuse-rounded base, discolor, abaxial surface is lighter than adaxial surface, chartaceous, 25–39 x 6–11.6 cm; **midrib** prominent and adaxial surface acute, rounded abaxial surface; **secondary**

Figure 3

Figure 4

Figure 3. *Anthurium rioacimensis* (Rabelo s/n - PAMG 57473) leaf in abaxial view, showing the petiole and median vein forms.

Figure 4. *Anthurium rioacimensis* (Rabelo s/n - PAMG 57473) leaf in adaxial view, showing the petiole and median vein forms.

veins etched on the adaxial surface, prominent on the abaxial surface, 13 on each side; **tertiary veins**, visible, lightly etched; **collecting veins** coming out of the blade base, parallel to edge on the lower third, 0.5–1 cm away from the margin. **Inflorescence** with cylindrical **peduncle**, greenish-vinaceous, 18.5–22.5 cm long.; **spathe** perpendicular to the peduncle in anthesis, deflexed in post-anthesis, greenish, forming a right angle at the junction with the peduncle, 4.3 x 0.6 cm; **spadix** cylindrical, sessile, blackened vinaceous, 11 flowers on the primary spiral and five on the secondary spiral, 4.5–7 cm long. **Flowers** with hood-shaped tepals, dorsally acute, internally convex, 1.9–2 x 1.5 mm; androecium with stamens 2.8–2.9 x 1–1.5 mm, flattened filaments; triangular, dorsifixed and extrorse anthers; gynoecium obovate, 2.5x1.5 mm with two locules in the ovary and one ovule per locule, funiculus with hair, median axial placentation. **Berries** not observed.

Endemic species of Minas Gerais State, Brazil, known only in the Type locality (**Figure 7)**. The species occurs in locations near watercourses, being observed in the understory of the Seasonal Semideciduous Forest, Atlantic Forest, in altitudes above 800 m.

The municipality of Rio Acima has been suffering from mining activities, compromising the preservation of what remains of the forested area. *Anthurium rioacimensis* sp. nov. has been found in well

Figure 5

Figure 6

Figure 5. *Anthurium rioacimensis* (Rabelo s/n - PAMG 57473) inflorescence.

Figure 6. *Anthurium rioacimensis* (Rabelo s/n - PAMG 57473) Adaxial view of the leaf blade, showing the secondary and tertiary veins.

preserved forest areas that are in the intermediate stages of regeneration. The fragment in which the species was found is located between das Velhas River and an unpaved road that connects the municipalities of Rio Acima and Itabirito. In this fragment some signs of anthropogenic alteration were observed, that appears to be ancient occupation, such as ancient oven, disabled tunnel and bamboo plantations, which seems not to interfere in forest conservation stage.

Three scattered individuals were observed in the collection area, occurring close to das Velhas River. According to the IUCN (2014) criteria, the species is Endangered (EN) [B2b (ii; iii; v) + C2a (i)] and, a collection effort aiming to update the distribution and the degree of conservation of the species is necessary.

Anthurium rioacimensis belongs to the section *Urospadix*, subsection *Flavescentiviridia*, for presenting chartaceous leaf blade, greenish discolor with secondary veins visible, furthermore presents spathe and spadix greenish to vinaceous/winelike colour (Coelho, 2009). The specific epithet is dedicated to the type locality, Rio Acima, Minas Gerais State , Brazil.

The species is morphologically similar to *Anthurium lucioi* Nadruz which presents shortly-narrowed laminar base with rectilinear collecting vein and spadix stipitate, differing from *A. rioacimensis* that has obtuse-rounded to cordate laminar base,

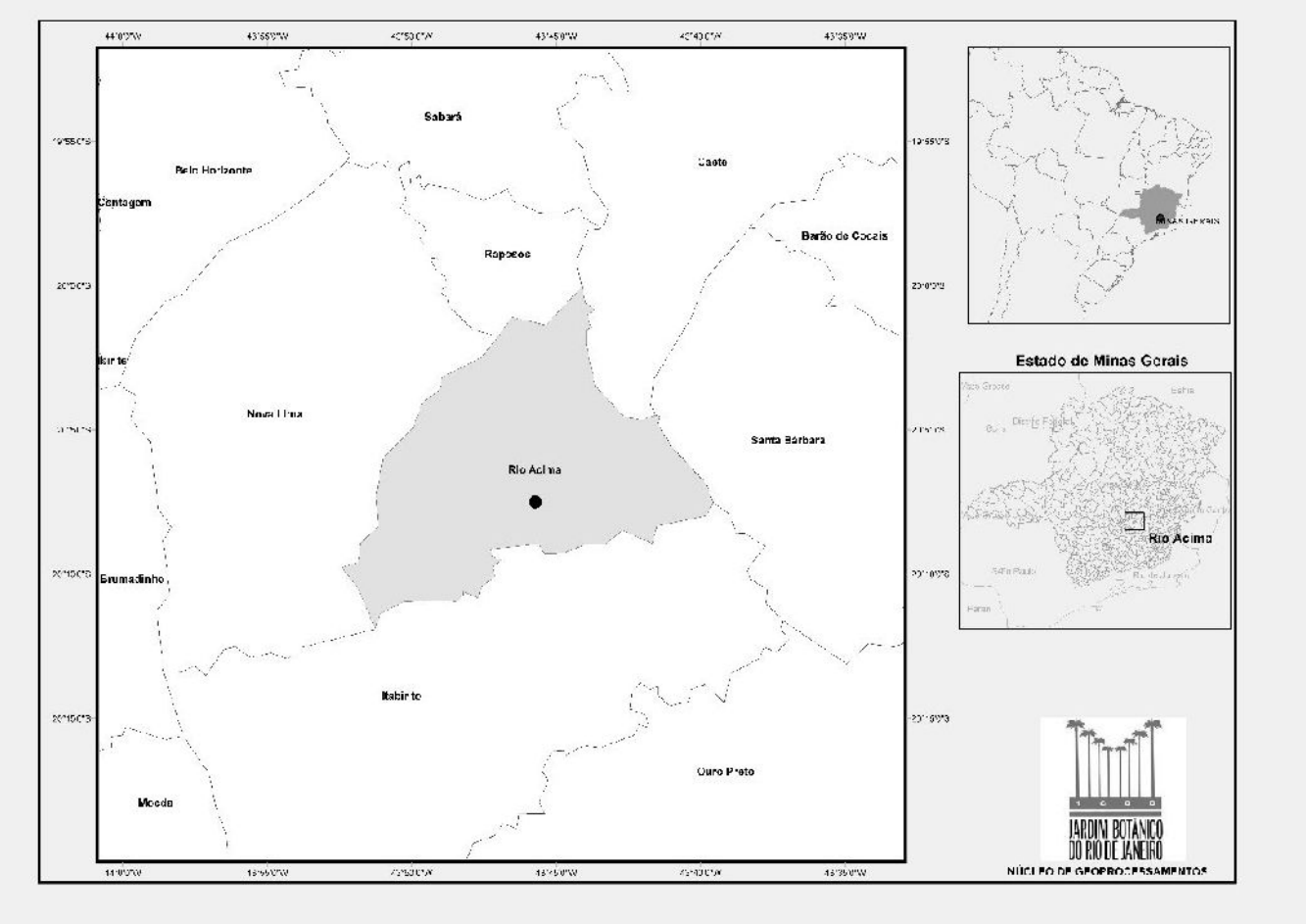

Figure 7. Map

collecting vein parallel to edge and spadix sessile.

ACKNOWLEDGEMENTS

The authors would like to thank Flavia Santiago and Alessandro Paschoalini for the translation support.

REFERENCES

Boyce, P. C. & T. B. Croat, (2011 onwards).The Überlist of Araceae, Totals for Published and Estimated Number of Species in Aroid Genera. *http://www.aroid.org/genera/140601uberlist.pdf*

Coelho, M.A.N., J.L. Waechter & S.J. Mayo. 2009. Revisão taxonômica de *Anthurium* (Araceae) seção *Urospadix* subseção *Flavescentiviridia*. *Rodriguesia* 60(4): 799–864.

Coelho, M.A.N., L.G Temponi & T.A. Pontes. *Anthurium* in *Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro.* Available in: <*http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB4912*>. Access: 27 Jun. 2014.

IUCN. 2014. *The IUCN Red List of Threatened Species*. Version 2014.1. <*http://www.iucnredlist.org*>. Downloaded on 12 June 2014.

Temponi, L.G. 2007. Sistemática de *Anthurium* seção *Urospadix* (Araceae). Doctoral Thesis. Universidade de São Paulo, São Paulo. 143p.

Studies on Schismatoglottideae (Araceae) of Borneo XXXX: *Schismatoglottis petradoxa* and *S. tseui*, new shale-obligate rheophytes of uncertain affinity

Wong Sin Yeng*
Department of Plant Science & Environmental Ecology
Faculty of Resource Science & Technology
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
sywong@frst.unimas.my
***corresponding author**

Peter C. Boyce
Honorary Research Fellow
Institute Of Biodiversity and Environmental Conservation (IBEC)
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
phymatarum@gmail.com

ABSTRACT

Two taxonomically new rheophytic species of *Schismatoglottis* of uncertain affinity, *S. petradoxa* S. Y. Wong & P. C. Boyce **sp. nov.** and *S. tseui* S. Y. Wong & P. C. Boyce **sp. nov.,** are described and illustrated from forested shale waterfalls in central North Borneo.

KEY WORDS

Araceae, Malaysian Borneo, *Schismatoglottis*

INTRODUCTION

Shale geology, in particular riverine shales, are unfailingly one of the richest and most diverse habitats for terrestrial and rheophytic aroids on Borneo. Here we

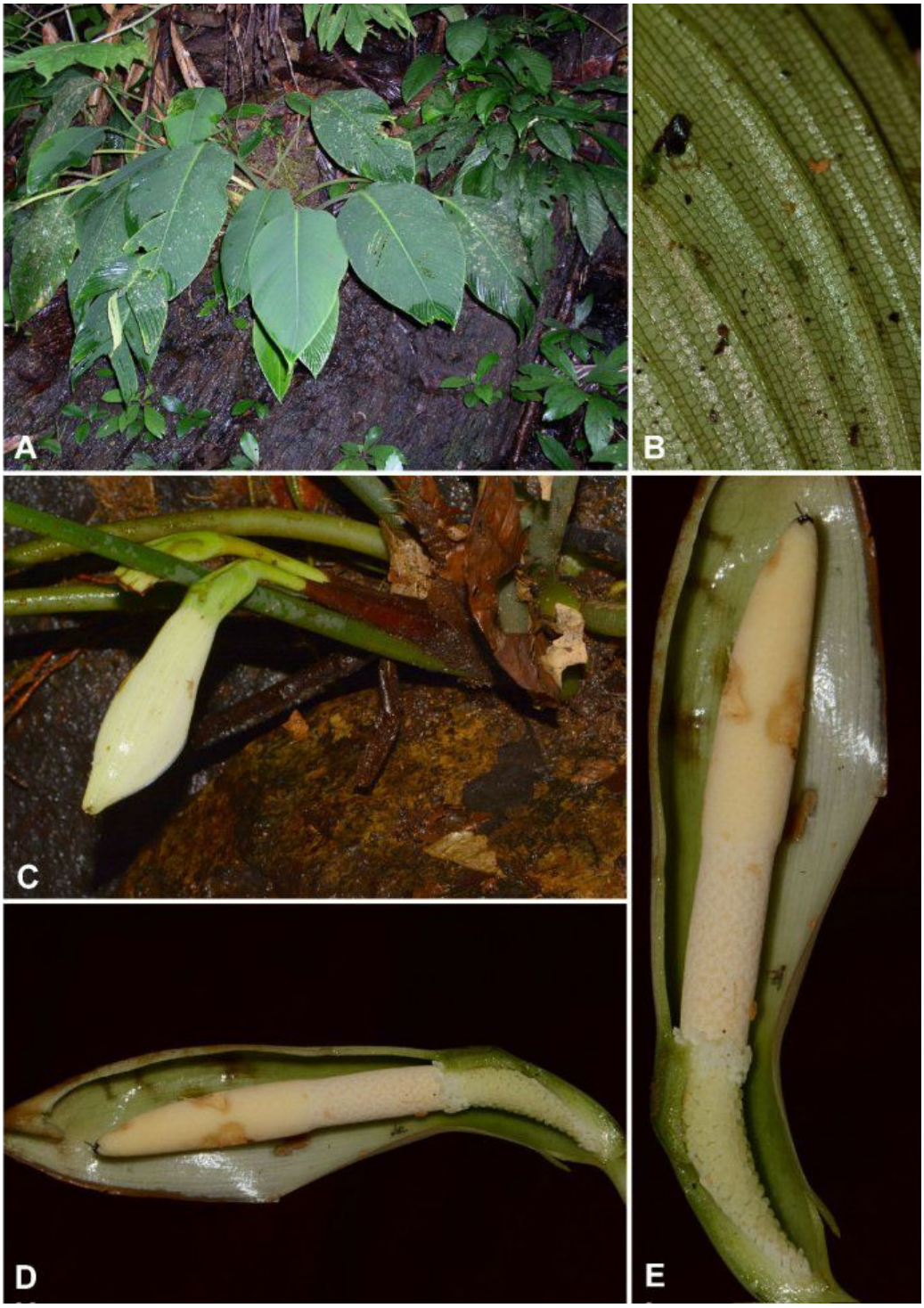

Figure 1. ***Schismatoglottis petradoxa*** S. Y. Wong & P. C. Boyce
A. Plants in habitat. **B.** Detail of tessellate secondary venation. **C.** Inflorescence at pistillate anthesis. **D & E.** Inflorescence at late pistillate anthesis, nearside spathe artificially removed. Note that the interstice staminodes have lengthened. **A** from *AR-464*; **B - E** from *AR-4894*. Images © P.C.Boyce.

describe two new species of *Schismatoglottis* from the shales of central North Borneo.

Schismatoglottis petradoxa S. Y. Wong & P. C. Boyce, **sp. nov.** Type: Malaysian Borneo, Sarawak, Kapit, Taman Rekreasi Sebabai, 01°56′45.6″N 112°54′16.8″E, 19 Apr. 2006, *P. C. Boyce, Jeland ak Kisai & Wong Sin Yeng AR-1787* (holo SAR!; isotypes: SBC!, SBC! [alcohol], SING!). **Figure 1.**

Diagnosis

Schismatoglottis petradoxa is defined by the combination of condensed pleionanthic shoots composed of many single leaved modules, each subtended by a soon-degrading prophyll, leaf blades abaxially with conspicuous tessellate secondary venation, and a synflorescence of pendent inflorescences, each on a long peduncle. In the shoot organization *S. petradoxa* is reminiscent of species of the *Schismatoglottis* Tecturata Group, but otherwise differs by the above mentioned characteristics.

Description

Pendent rheophytic herb to ca. 50 cm. **Stem** much-condensed, creeping-erect in older plants, with internodes to 1 cm long, 1–2 cm diam., densely rooting along its length. **Leaves** several together alternating soon-marcescent, somewhat brittle tapering lanceolate weakly scabrid cataphylls to 10 cm long; **petiole** shorter than blade, arching to almost pendent, 8–25 cm long, sub-terete, proximal third dorsally very slightly flattened, dull green, minutely scabrid, sheathing only at very base, with the petiolar sheath reduced to an obscure ridge; **blade** broadly lanceolate to elliptic, 12–30 cm long × 3–11 cm wide, thick, brittle, adaxially matte medium green, much paler and matte abaxially, base cuneate to narrowly rounded, apex acuminate and apiculate for ca. 1 cm; **midrib** adaxially more or less flush with blade and contrasting cream, especially visible on newer leaves, abaxially prominent; **primary lateral** veins ca. 25 on each side, up to 40 on largest leaf blades, diverging at 45–60°, abaxially conspicuously raised, adaxially slightly impressed, although more deeply impressed in leaves of seedlings; **secondary venation** adaxially visible as a tessellate reticulum in seedlings but obscure in leaves of mature plants, abaxially forming a highly conspicuous dark green tessellate reticulum; **tertiary venation** invisible. **Inflorescence** pendulous, ca. 3 in a simple synflorescence subtended by lanceolate fleshy cataphylls, with a moderate sweet esteric odour at pistillate anthesis; **peduncle** cylindric, subtended by a conspicuous prophyll or cataphyll, up to 20 cm long × 5 mm wide, bright pale green. **Spathe** with a moderate constriction between the lower part and the limb, limb inflating and gaping at pistillate anthesis, opening further at staminate anthesis, 8–9 cm long; **lower spathe** narrowly ovoid and asymmetric, dorsally shallowly flattened-convex corresponding to the adnation of the pistillate flower zone, pale green with very fine darker longitudinal veins, dorsally ca. 1.5 cm long, ventrally ca. 2 cm long, persistent; **spathe limb** exterior white with very fine darker longitudinal lines at

pistillate anthesis, interior dirty whitish-green shading dorsally to glossy green broadly lanceolate 5.5–7.5 cm long, bluntly rostrate for ca. 1 cm, upper half opening at pistillate anthesis and initially via a narrow terminal slit, then wide-gaping (ca. 2.5 cm wide), and weakly fornicate, limb margins reflexing during staminate anthesis, then whole limb degrading-caducous with the rim remaining above the lower spathe insertion reflexing somewhat. **Spadix** 5–6 cm long, subcylindric; **pistillate zone** 1.5 (dorsal side) to 2 cm long (ventral side), narrowly conic, obliquely inserted, distally ca. 6 mm diam., very pale green; **pistils** small, crowded, ca. 1 mm diam., barrel-shaped, pale creamy green; **stigma** sessile, discoid, slightly narrower than top of pistil, ca. 1.5 mm tall × 0.8 mm wide, papillose; **interpistillar pistillodes** forming a row at junction with peduncle, ca. 1.2 mm long, slimmer than pistils, slender-cylindric with a pale orange-brown tip; **sterile interstice** with about 3 rows of staminodes; **interstice staminodes** weakly columnar-polygonal ca. 1 mm across, dull-white, initially equalling the height of pistils, later (late pistillate anthesis) staminodes lengthening to form a ring ca 1/3 wider than fertile zones; **staminate zone** cylindric, ca. 1.5 cm long × 0.4–0.5 cm diam., cream; **stamens** irregularly densely crowded, individual flowers difficult to distinguish, rectangular-dumbbell shaped from above, truncate with thick connective slightly elevated above thecae, thecae opening by a single pore; **appendix** narrowly fusiform, blunt, proximally slightly wider than top of staminate zone, 2.5–3 cm long, widest part ca. 8 mm diam., distally tapering and narrowly obtuse, white; **appendix staminodes** very dense and individually barely differentiated, rectangular-dumbbell shaped from above, much resembling stamens in shape and size, but more regularly arranged. **Fruiting spadix** not seen.

Distribution – Widespread but localized in central North Borneo.

Ecology – *Schismatoglottis petradoxa* occurs as a rheophyte on shaded vertical permanently wet shale waterfalls and rocks in forest streams between 30 – 190 m a.s.l.

Etymology – From Greek *petra*, a rock or stone, and *doxa*, glory – hence, glory of the rocks.

Notes – *Schismatoglottis petradoxa*, appears ostensibly to belong to the *Schismatoglottis* Multiflora Group (Hay & Yuzammi, 2000), but differs by shoot modules consisting of a single foliage leaf subtended by a large, marcescent-deciduous prophyll, and by a much reduced petiolar sheath lacking the extended ligules diagnostic for species of the Multiflora Group. Furthermore, tessellate secondary venation prominently visible on the abaxial surface of the blades is unknown in the Multiflora Group (all species with striate secondary venation), although similar venation patterning occurs in several other species' groups in *Schismatoglottis*.

Figure 2. ***Schismatoglottis tseui*** S. Y. Wong & P. C. Boyce
A. Flowering plant in habitat, Type locality. **B.** Developing infructescence. Note the declinate peduncle. **C.** Leaf blade, abaxial view. **D.** Inflorescence at pistillate anthesis, with chrysomelid beetles and *Colocasiomyia* (Diptera) in attendance. **E.** Inflorescence at pistillate anthesis, spathe limb artificially opened. F. Inflorescence at end of staminate anthesis, spathe artificially removed. **G.** Developing infructescence. **A–G** from *AR-4883*. Images © P.C.Boyce.

By shoot modules consisting of a solitary foliage leaf, with the role of the vestigial petiolar sheath taken over by the prophyll subtending the shoot, *S. petradoxa* is similar to species of the Tecturata Group (Boyce & Wong, 2013), although in all other respects *S. petradoxa* is not clearly placed in the Group.

Other material examined: INDONESIAN BORNEO: Kalimantan Barat: Kabupaten Kapuas Hulu, Kecamatan Embaloh Hulu, 20 km NW of Mataso, 01°19′0.44″N 112°15′4.40″E, 17 May 2013, *Kazuya Nakamoto AR- 4149* (BO!, SAR!); Kabupaten Kapuas Hulu, Kecamatan Embaloh Hulu, Mataso, 01°08′28.13″N 112°23′36.61″E, 17 May 2013, *Kazuya Nakamoto AR- 4152* (BO!, SAR!). MALAYSIAN BORNEO: Sarawak: Sri Aman: Lubok Antu, Batang Ai, Nanga Sumpa, Wong Ensalai, 01°11′00.9″N 112°04′20.8″E, 6 Apr 2005, *P.C.Boyce et al. AR-1148* (SAR!, SBC!); Lubok Antu, Sungai Kelaweh to Sungai Morek, 01°02′04.6″N 111°46′12.5″E, 11 Jun 2014, *Ooi Im Hin & Sunang ak Empin AR-4796* (SAR!, SBC!); Lubok Antu, Batang Ai, Sungai Sepipit, 01°11′54.9″N 111°57′29.4″E, 27 Jul 2014, *S.Y.Wong & P.C.Boyce AR-4894* (SAR!, SBC!). Sarikei: Ulu Sarikei, Air Terjun Ruan, 01°55′02.0″N 111°29′10.7″E, 27 Dec 2012, *P.C.Boyce & Wong Sin Yeng AR-4108* (SAR!, SBC!). Kapit: Taman Rekreasi Sebabai, 01°56′45.6″N 112°54′16.8″E, ca. 50 m a.s.l., 13 Dec 2004, *P. C. Boyce, Jeland ak Kisai & M. Gibernau AR-864* (SAR!) & 16 Mar 2005, *P. C. Boyce, Jeland ak Kisai & Jepom ak Tisai AR-1089* (SAR!); Nanga Gaat, Rejang Wood Concession, km 65 road to Camp Gahada, 01°41′59.7″N 113°31′13.7″E, 16 Dec 2004, *P.C.Boyce, Jeland ak Kisai & M.Gibernau AR-920* (SAR!, SBC!); Kg Nanga Septi, Upper Batang Baleh, ca 1hr speedboat west of Kapit*, K. Nakamoto AR-3561* (SAR!).

Schismatoglottis tseui S. Y. Wong & P. C. Boyce, **sp. nov.** Type: Malaysian Borneo, Sarawak, Sri Aman, Lubok Antu, Batang Ai, Musing, 01°11′58.6″N 111°57′14.9″E, 110m asl, 27-July 2014, *S.Y.Wong & P.C.Boyce AR-4883* (holo SAR!; isotypes: SBC!, SBC! [alcohol], SING!). **Figure 2.**

Diagnosis

Schismatoglottis tseui is distinguished from all published *Schismatoglottis* species by the branched vermiform interstice staminodes. In the persistent ligular portion to the petiolar sheath and pellucid interprimary veins *S. tseui* is reminiscent of species in the *Schismatoglottis* Hottae Complex, from which it differs by the pendent (vs erect) infructescences and in being wholly glabrous.

Description

Tufted rheophytic herb to ca. 15 cm tall but most a third of this tall. **Stem** erect, congested, internodes to 5 mm long, ca 3 mm in diam., rooting along its length in mud. **Leaves** several together; **petiole** approximately equalling to slightly shorter than blade, 6–8 cm long, sub-terete, dorsally very slightly flattened with angles very weakly alate, sheathing only at extreme base,

wings extended into a triangular ligular persistent portion ca. 3 cm long; **blade** broadly elliptic to broadly lanceolate, 6–10 cm long × 3–5.75 cm wide, thinly coriaceous, adaxially semi-glossy medium green, abaxially paler matte olive-green, base broadly cuneate to rounded, apex bluntly acute and apiculate for ca. 2 mm; **midrib** adaxially more or less very slightly raised, abaxially slightly prominent; **primary lateral veins** ca. 6 on each side arising at 45–60°, conspicuously darker than surrounding tissue; **interprimary veins** much finer than primaries although still conspicuous, somewhat translucent; **secondary venation** adaxially more or less obscure, abaxially very fine and comprised of somewhat dense pellucid veins; **tertiary venation** abaxially forming an obscure sub-tessellate reticulum. **Inflorescence** ca. 3 in a simple synflorescence subtended by one or two lanceolate fleshy cataphylls resembling the ligules, with a weak esteric odour at pistillate anthesis; **peduncle** cylindric, ca. 3 cm long × 3 mm wide. **Spathe** erect at pistillate anthesis, ca 3 cm long, at anthesis lower spathe almost imperceptibly narrower than the spathe limb, without an obvious constriction at the junction of the spathe limb with the lower spathe; **lower spathe** narrowly funnel-form asymmetric, glossy white-yellowish green, dorsally ca. 1 cm long, persistent; **spathe limb** pale yellow-green with darker veining at pistillate anthesis, becoming glossy-white with faint darker longitudinal veins during staminate anthesis, broadly lanceolate, ca 2 cm long, rostrate for ca. 2 mm, inflating at pistillate anthesis and opening via a narrow slit, hardly opening more during staminate anthesis, then degrading and semi-deliquescent. **Spadix** ca 2.5 cm long, subcylindric; **pistillate zone** obliquely inserted on spathe, 7 mm (dorsal side) to 1.7 cm long (ventral side), cylindric, distally ca. 6 mm diam., very pale green; **pistils** comparatively large, rather lax, ca. 1.5 mm diam., stoutly flask-shaped with a slight constriction below the stigma, almost white; **stigma** sessile, discoid, wider than the top of the pistil, ca. 1.8 mm wide, papillose; **interpistillar staminodes** forming a sparse row at the junction with the peduncle, ca. 2 mm long, ascending-aristate, shorter than pistils, translucent very pale green; **sterile interstice** well-defined, with a single row of branched staminodes; **interstice staminodes** comprising a thick base each with 2–5 aristate-vermiform 'arms' ca. 2 mm long, semi-translucent glossy white; **staminate zone** cylindric, ca. 5 mm long × 4 mm wide, white; **stamens** crowded, individual flowers tiny and somewhat difficult to individuate, but seemingly consisting of two anthers each with two thecae, ca. 0.5 mm diam., thecae sub-globose with a single comparatively large terminal pore; **appendix** weakly conic-cylindric, blunt, proximally very slightly wider than the top of the staminate zone, ca 1.3 cm long, widest part ca. 5 mm diam., distally tapering and narrowly obtuse, creamy white; **appendix staminodes** sub-columnar-globose, much resembling stamens in shape but larger, ca 1 mm in diam. **Fruiting spathe** pendulous, narrowly cylindrical, green with a conspicuous scar at the orifice. **Fruits & seeds** not seen.

Distribution – Known only from the Type locality.

Ecology – *Schismatoglottis tseui* occurs as a rheophyte on shaded vertical permanently wet shale waterfalls and rocks in forest streams at between 110–140 m a.s.l.

Eponymy – Named for Robert Tseu, through whose photographic records of the flora and wildlife of Borneo we were first alerted to the existence of this remarkable species.

Notes – The branched, vermiform interstice staminodes are unique for the genus *Schismatoglottis*. The long-persistent ligular portion of the petiolar sheath and the leaf blades abaxially pellucid interprimary veins suggest an affinity with the *Schismatoglottis* Hottae Complex (Wong et al., 2012), although the pendent fruiting spathe and entirely glabrous plants are entirely anomalous for the Hottae Complex.

Plants at pistillate anthesis were observed to attract a species of chrysomelid beetle that chewed through the spathe limb, and at least one species of *Colocasiomyia* (Diptera) which entered the inflorescence though the gap formed in the spathe.

Other material examined: MALAYSIAN BORNEO: Sarawak: Sri Aman, Lubok Antu, Batang Ai, Musing, 01°11′59.94″N 111°57′14.46″E, 12 July 2014, *R.Tseu AR-4861* (SAR!).

References

Boyce, P. C & S. Y. Wong. 2013: Studies on Schismatoglottideae (Araceae) of Borneo XXXIII – A review of the Schismatoglottis Tecturata Group, including description of a new species, *Schismatoglottis evelyniae*. *Aroideana* 36E(1): 4–15.

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

Wong [et al., 2012] S.Y., P.C. Boyce & S.L. Low. 2012: Studies on Schismatoglottideae (Araceae) of Borneo XVII: The *Schismatoglottis hottae* Complex, a new informal taxon, and three new species from Sarawak, Malaysian Borneo. *Gard. Bull. Singapore* 64(1): 257–269.

Acknowledgements

This is part of an on-going research programme funded by the Ministry of Education Malaysia by the Niche Research Grant Scheme Vote No. NRGS/1089/2013-(03).

Fieldwork was most recently under Sarawak Forestry Department Permission to Conduct Research on Biological Resources - Permit No. NCCD.907,4.4(J|d.9)-69 and Park Permit No 140/2013. The collaboration and support of the Sarawak Forestry Department and the Sarawak Biodiversity Centre are gratefully acknowledged.

Germination and seedling emergence of black-vine (*Philodendron corcovadense* Kunth).

Raquel R.B.Negrelle
Lab.OIKOS, Dep.Botânica, UFPR.
Cx.Postal 19031. 81531–990.
Curitiba, Paraná, Brazil.
negrelle@ufpr.br

Francine L. Cuquel
Dep.Fitotecnia, UFPR.
Curitiba, Paraná, Brazil.
francine@ufpr.br

ABSTRACT

Results from the effects of fruit physiological maturity, hydration conditions, and growing media over black-vine (*Philodendron corcovadense* Kunth) seeds germination (under controlled conditions - laboratory) and seedlings emergence (under non-controlled conditions - greenhouse) are presented. Results obtained showed that black-vine seeds from mature fruits (external peel from dark-orange to dark-red) germinated better than immature fruits (external peel from yellow to light-orange). The seed hydration condition (L1: seeds without prior water soaking and volume of water equal to 2.5 times the paper sheets weight; L2: seeds without prior water soaking and volume of water equal 5.0 times the paper sheets weight; L3: prior 24 h water soaking and volume of water equal the paper sheets weight) did not affect the germination rate. Seedling emergence was not affected by growing media [C1: forest litter + sand (1:1 by volume) and C2: forest litter + sand (2:1 by volume)]. Under greenhouse conditions, mist proved to be favorable to seed emergence.

KEY WORDS

Atlantic Forest, *Philodendron corcovadense* Kunth, aroid, ornamental plant.

INTRODUCTION

Philodendron corcovadense Kunth (Araceae), commonly named black-vine, is a hemiepiphyte that naturally grows in the Atlantic Forest (Brazil). It begins its life from a seed that germinates on a canopy branch, initially living as epiphyte. During its development, it sends adventitious roots

downward reaching the ground. At this stage, the roots will start a soil nutritional relation similar to non-epiphyte plants (Coelho, 2000; Nogueira, 2006).

Due to its bright-green leaves, it has been frequently grown for ornamental purposes, such as interior foliage, and floral arrangements (Blanco & Valverde, 2004; Henny et al., 2004). Its hanging roots, popularly known as black-vines, are used in the construction of rural houses, as nail substitutes. However, it's most important use is as raw material for the manufacture of craft products, including basketry, furniture, decorative objects, and toys, being an important income source for rural communities at the coastal area of Parana State (Southern Brazil).

Since there is no *P. corcovadense* cultivation protocol, its use is based only an intense harvesting reaping of wild plants in a non-sustainable way. Harvesters can collect up to 1000 kg of black-vine a day, responding to a growing market demand. Due to this intense harvesting, most of the time without the proper care and hurting the mother-plant, this resource has been dramatically reduced, menacing the maintenance of the species as well as the sustainability of the harvesters' income generation (Valente & Negrelle, 2013), and might cause risk of extinction for some species.

To ensure the environmental and socio-economic sustainability of the *P.corcovadense* uses, there is an urgent need of establishing adequate wild harvesting-management plans as well as domestication and cultivation programs for this species, as suggested by Homma (1993) for other non-wood forest products.

Aiming to provide basis for its cultivation, the results from the evaluation of the effect of fruit physiological maturity, seed hydration conditions, and growing media in *P. corcovadense* seeds germination (laboratory conditions), and seedlings emergence (greenhouse conditions) are presented. Specifically, the main focus was to answer the following questions:

a) Would the harvester's informal way to identify the physiological fruit maturity by the external peel fruit color be adequate to identify seed maturity?

b) What would be the species germination ability under controlled conditions?

c) Would different seed hydration conditions, such as prior water soaking, and growing media moisture level affect the germination rate?

d) Would the emergence capacity inside greenhouse be similar to the germination rate obtained in laboratory under controlled conditions?

e) Would the environmental relative humidity at the greenhouse and the

growing media composition affect the seedling emergence?

MATERIAL AND METHODS

– Plant Material

Adult *Philodendron corcovadense* plants from the Atlantic Forest (Guaratuba, PR, 25° 51' S and 48° 57' W) supplied meaty infructescences (February, 2008) to develop this research. The local weather where they were harvested is a typical tropical rainforest, classified by Köppen as Cfa, without dry season and frosts, average temperature greater than 18^{0}C, and average precipitation of at least 60 mm (IAPAR, 2000). All infructescences were identified and carried to the laboratory where they were classified as; mature, those that showed the external peel color from dark-orange to dark-red, and immature, those which showed the external peel from yellow to light-orange. This classification followed the informal criteria applied by local collectors. All seeds were extracted from the fruit by manual pressure and submitted to the germination test.

– Germination Test

The germination test was performed with four sub-samples of 25 seeds each per treatment, placed inside transparent plastic boxes (11.0 x 11.0 x 3.5 cm) lined with two absorbent paper sheets which were previously moistened. Mature and immature seeds were evaluated using different seed hydration condition (L1: seeds without prior water soaking and volume of water equal to 2.5 times the paper sheets weight; L2: seeds without prior water soaking and volume of water equal 5.0 times the paper sheets weight; L3: prior 24 h water soaking and volume of water equal the paper sheets weight). Experimental design applied was factorial with 2 fruit maturity x 3 seed hydration condition levels. Plastic boxes were maintained during 21 days under controlled temperature at 25 ^{0}C, and constant lighting. Weekly germination rate was evaluated, and results obtained were evaluated by Tukey Test ($\alpha = 0.05$).

– Seedling Emergence

Seeds from mature infructescences were harvested from the same location and sown in flats containing the two growing media: C1- forest litter + sand (1:1 by volume), and C2 - forest litter + sand (2:1 by volume). Flats were maintained during 45 days (from March to April, 2008) inside a "*pad and fan*" greenhouse (18 to 35 ^{0}C, and relative humidity from 50 to 80%) covered with transparent plastic of 150 μ with and without mist. Mist was provided during 15 seconds each 30 minutes from 8:00AM to 5:00PM, during 15 seconds each hour from 17:00PM to 11:00PM, and during 15 seconds each three hours from 11:00 PM to 8:00 AM. Flats without mist were watered daily. Experimental design applied was factorial with 2 growing media x 2 mist conditions with four sub-samples of 32 seeds each, a total of 128 seeds per treatment. Emergence rate was evaluated

after 45 days, and results obtained were evaluated by Tukey Test (α = 0.05).

RESULTS

a. Germination

Seeds harvested from fruits in different maturity stages, defined by peel color, showed significant different germination percentage. Seeds from mature fruits showed a higher germination percentage compared to the immature ones. Regardless of the hydration condition there was no significant difference between the germination levels (Tukey Test; α=0.05) **(Table 1)**.

b. Seedling emergence

Seedling emergence was significantly higher under mist. However, there was no significant difference in emergence between the two growing media tested (Tukey Test; α=0.05) (**Table 2)**.

DISCUSSION

External fruit peel color is not always a good criterion to decide when fruits and seeds reach their physiological maturity (see Pereira, 2009). However, the informal criteria, suggested by the reapers, that the dark-orange to dark-red fruits had the best seeds inside, could be an indicative of the *P. corcovadense* seed maturity. The Araceae external fruit peel color seems to be closely connected with the seed maturation process (see FukaI et al., 2002). The brighter color, observed in fruits near to their seed dispersion, frequently concurs with a higher potential to attract predators and/or dispersers. Araceae individuals generally have meaty fruit, which as they mature

Fruit Maturity	Average Germination (%) ± standard deviation	
	Hydration conditions	
	L2	L3
Mature	77 ± 9.45 aA	76 ± 14.24 aA
Immature	28 ± 8.64 bA	10 ± 5.16 bB

Averages followed by the same capital letters in rows and small letters in columns are not different (Tukey Test, α=0.05)

Table 1: Germination of *Philodendron corcovadense* seeds from mature and immature fruits in distinct hydration conditions (L1: seeds without prior water soaking and volume of water equal to 2.5 times the paper sheets weight; L2: seeds without prior water soaking and volume of water equal 5.0 times the paper sheets weight; L3: prior 24 h

attract ants (Pizo & Oliveira, 2000), birds and mammals (Vieira & Izar, 1999), which collaborate to their predation/ dispersion. However, focusing on the seed harvest to propagate it, it is much better to reap it before the inflorescence is not so attractive to these animals, like when the external peel was from yellow to light-orange. Unfortunately germination rate from fruits harvested in this moment was very low.

Mature fruits showed higher germination rate comparing with some other Araceae (see Yang et al., 1999), without seed dormancy observed on *Colocasia* and *Xanthosoma* (Araceae), as reported by Ellis et al. (1985).

Seed emergence rate was much smaller than the germination rate. Similar results were reported in some other Araceae (see Berkenbrock, 2005). Perhaps it happened because germination test was conducted with constant lightning and for seedling emergence test seeds were bare on the growing media. Generally Araceae germination, such as other epiphytes and hemiepiphytes, does not happen very well when seed are bared (Yang et al., 1999; Anacleto et al., 2008).

Results obtained confirm that water availability is an important factor for hemiepiphytes (Putz & Holbrook, 1986), and water stress is the mainly cause of epiphyte Bromeliads mortality (Winkler et al., 2005). Seed emergence inside greenhouse does not happen without mist, confirming the importance of water for Araceae cited by Henny et al. (2004).

Similar results observed between the two growing media might be explained because they certainly supplied the minimum conditions required for Araceae – well drained and with at least 50% of

Growing Media	Average Emergence (%) ± standard deviation
	Greenhouse conditions
	With mist
Forest litter + sand (1:1)	48.44 ± 18.13a
Forest litter + sand (2:1)	35.95 ± 4.03a
CV	31.13

Averages followed by the same small letters in columns are not different (Tukey Test, α=0.05)

Table 2: Seedling emergence of *Philodendron corcovadense* seeds inside greenhouse in different growing media and mist conditions.

volume of organic matter (see Henny et al., 2004).

Future laboratorial studies must be developed to evaluate the photoperiodic effects over *P. corcovandense* seed germination. The sown depth effects of the growing media over the seedling emergence are also recommended.

Considering all results obtained it is possible to affirm that the reaping of *P. corcovandense* wild plants, in a non-sustainable way, does not occur because is difficult to propagate it by seeds on the environment where it naturally occurs. Even, only the extractive labor probably occurs because reapers don´t know that *P. corcovandense* wild plant has been dramatically reduced, and that this natural resource is not unlimited. Environmental Educational Actions might contribute to reduce the risk of extinction of this species.

CONCLUSIONS

1. The harvester's informal way to identify the physiological fruit maturity of *P. corcovadense* by the external peel fruit color is adequate to identify seed maturity;

2. *P. corcovadense* seeds from mature fruits (external peel from dark-orange to dark-red) germinated better than immature fruits (external peel from yellow to light-orange);

3. Seed hydration condition did not affect the germination rate;

4. Seedling emergence was not affected by growing media tested;

5. Seed germination rate was higher than seedling emergence rate;

6. Mist is favorable to seed emergence inside greenhouse.

ACKNOWLEDGMENTS

To SETI- Secretary for Science, Technology and Higher Education of Paraná State, for the financial support through the Universidade sem Fronteiras (University without borders) Program. To Dr. Maristela Panobianco for the use of the laboratory facilities. To Ana Carolina Zimmerman and Silvane Hoffman, for helping on setting and monitoring the experiments.

REFERENCES

Anacleto, A., R.R.B. Negrelle, & H. Koehler. 2008. Germinação de *Aechmea nudicaulis* (L.) Griseb. (Bromeliaceae) em diferentes substratos alternativos ao pó de xaxim. *Acta Sci. Agron.*, 30(1): 73–79.

Berkenbrock, I.S. 2005. *Fundamentos para conservação de Anthurium coriaceum G. Don (Araceae), uma espécie potencialmente ameaçada à extinção no sul do Brasil.* Florianópolis, Santa Catarina. UFSC/ PPG Recursos Genéticos Vegetais, Florianópolis, 59 pp.

Blanco, M. & R. Valverde. 2004. Micropropagacíon de *Philodendron* sp. (Posiblemente *P. corcovadense*). *Rev. Agron. Costarricense*, 28(1): 39–46.

Brasil. Ministério da Agricultura e Reforma Agrária. 2009. *Regras para análise de sementes***.** LAVAR/SNAD/MA, Brasília, 365 pp.

Coelho, M. A. N. 2000. *Philodendron* Schott (Araceae): morfologia e taxonomia das espécies da Reserva de Macaé de Cima – Nova Friburgo, Rio de Janeiro, Brasil. *Rodriguesia*, 51(78/79): 21–68.

Ellis, R.H., T.D. Hong & E. H. Roberts. 1985. *Handbook of seed technology for genebanks.* FAO, Rome, 210 pp.

FukaI, S., A. Hasegawa, M. Goi & N. Yamasaki. 2002. Seed propagation of *Arisaema sikokianum* (Araceae). *Acta Hort.* 570: 327–330.

Henny, R.J., D.J. Norman & J. Chen. 2004. Progress in ornamental aroid breeding research. *Ann. Miss. Bot. Gard.,* 91: 464-–72.

Homma, A. K. O. 1993. *Extrativismo Vegetal na Amazônia - Limites e Oportunidades.* EMBRAPA-SPI, Brasília, 22 pp. IAPAR - Instituto Agronômico do Paraná. 2000. *Cartas climáticas básicas do Estado do Paraná***.** IAPAR, Londrina, CD-Rom.

Nogueira, A.S., A.J. Santos, A.M. Bittencourt, D.R. Bolzo & F.S Paula. 2006. Aspectos produtivos e econômicos da cadeia produtiva do cipó-preto no litoral Paranaense. *Floresta*, 36(3): 343–348.

Pereira, C. 2009. *Ponto de colheita de frutos, qualidade e armazenamento de sementes de Nidularium innocentiii* (Lem.) e *Nidularium procerum* (Lindm). UFPR/ PPG Agronomia/ Produção Vegetal, Curitiba, 78 pp.

Putz, F.E. & N.M. Holbrook. 1986. Notes on the natural history of hemiepiphytes. *Selbyana,* 9: 61–69.

Valente, T.P. & R.R.B. Negrelle. 2013. Sustainability of non-timber forest products harvesting – cipó-preto roots (Philodendron corcovadense Kunth) in south Brazil. *Forests, Trees and Livelihoods*, 22(3):170–176.

Vieira, E.M. & P. Izar. 1999. Interactions between aroids and arboreal mammals in the Brazilian Atlantic rainforest. *Plant Ecology,* 145: 75–82.

Winkler, M., K. Hulbe & P. Hietz. 2005. Effect of canopy position on germination and seedling survival of epiphytic Bromeliads in a Mexican Humid Montane Forest. *Ann. Bot.* 95: 1039–1047.

Yang, J., J. Lovett-Doust & L. Lovett-Doust. 1999. Seed germination patterns in green dragon (*Arisaema dracontium*, Araceae). *Am. J Bot.*, 86(8): 1160–1167.

Studies on Schismatoglottideae (Araceae) of Borneo XXXXII: Additional new species of *Aridarum*

Wong Sin Yeng[1*] & Low Shook Ling[2]
Department of Plant Science & Environmental Ecology
Faculty of Resource Science & Technology
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
[1]sywong@frst.unimas.my
[2]shookling5052@hotmail.com
[*]corresponding author

Peter C. Boyce
Honorary Research Fellow
Institute Of Biodiversity and Environmental Conservation (IBEC)
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
phymatarum@gmail.com

ABSTRACT

Three new species of *Aridarum* are described and illustrated: *Aridarum perplexum* S. Y. Wong, S. L. Low & P. C. Boyce from Kalimantan Barat, Indonesian Borneo, *Aridarum sabahense* S. Y. Wong, S. L. Low & P. C. Boyce from Sabah, Malaysian Borneo, and *Aridarum spissum* S. Y. Wong, S. L. Low & P. C. Boyce from Sarawak, Malaysian Borneo. Together these novelties take the genus *Aridarum* to 24 accepted, described species. The new species inserted into an updated identification key to *Aridarum* species.

KEY WORDS

Araceae, *Aridarum,* Borneo, Malaysia, Sarawak, Sabah, Indonesia, Kalimantan, rheophytic.

INTRODUCTION

Recent fieldwork and flowering of hitherto un-flowered plants in our research

collection has revealed three taxonomically new species of *Aridarum* additional to those comprising the most recent publications for *Aridarum* (Boyce & Wong, 2013; Wong et al., 2012, 2014). We describe these three novelties below.

KEY TO THE SPECIES OF *ARIDARUM*

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

– Staminate flowers each comprised of two stamens; thecae on the longitudinal ends, or the inner face of each anther of the stamen pair 12

2. Thecae attached to ventral side of connective, globose-ellipsoid; interstice staminodes spathulate . . . . . ***Aridarum sabahense***

– Thecae embedded in connective; interstice staminodes not spathulate 3

3. Connective not expanded, individual staminate flowers horseshoe-shaped; staminodes of interstice horseshoe-shaped, expanding laterally post pistillate anthesis; spathe limb caducous, falling by lesion from the lower, persistent spathe; primary lateral veins not conspicuously raised 4

– 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; spathe limb deliquescing acroscopically from the junction with the lower persistent part; leaf blades with the primary lateral veins raised conspicuously adaxially 9

4. Leaf blades quilted, abaxially with conspicuous pellucid interprimary veins; adaxially with primary lateral veins impressed; petioles scabrous; staminate flowers completely verruculose; appendix staminodes deeply and irregularly fissured. Central northern Schwaner Mountains (Melawi and Sanggau, Kalimantan Barat), sandstones . . . . . ***A. rostratum***

– Leaf blades smooth, lacking pellucid interprimary veins, or these veins obscure 5

5. Leaf blades abaxially with obscure pellucid interprimary veins; primary lateral veins visible; petioles microscopically scabridulous; staminate only connective having a verruculose margin. Sintang, granites . . . . ***A. perplexum***

– Leaf blades abaxially without pellucid interprimary veins; primary lateral veins barely visible; petioles smooth; staminate flowers glabrous, or with only connective having a verruculose margin 6

6. Thecae horns stout. Gunung Sepangin (Putussibau, Kalimantan Barat), granites . . . . . ***A. uncum***

– Thecae horns very slender 7

7. Leaf blades adaxially slightly velvety very dark green; spathe ca 5.5 cm long; spadix ca 2.5 cm long; interpistillar staminodes absent; interstice staminodes rather weakly differentiated from the staminate flowers; appendix staminodes lacking glands. Western Muller Mountains, Nanga Suruk (Kapuas Hulu, Kalimantan Barat), volcanics . . . . ***A. surukense***

– Leaf blades semi-glossy medium to dark green; spathe ca 7 cm long; spadix 3.5 – 4 cm long; interpistillar staminodes present at the base of the spadix; interstice staminodes well differentiated from the staminate flowers; appendix staminodes with conspicuous pellucid glands 8

8. Staminate flowers in ca 3 rows, white. Nanga Taman (Kalimantan Barat), sandstones . . . . . ***A. hippocrepis***

– Staminate flowers in ca 6 rows, pale orange. Schwaner Mountains, Gunung Alat (Sintang, Kalimantan Barat), metamorphics . . . . . ***A. alatense***

9. 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. Loreh (Malinau Selatan, Kalimantan Utara), shales . . . . . ***A. kazuyae***

– 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 10

10. Leaf blades linear-lanceolate, adaxially with strong marginal veins; pistillate flower zone with a few vermiform staminodes at the base. Muller Range (Kalimantan Tengah), volcanics . . . . ***A. minimum***

– Leaf blades not linear-lanceolate; pistillate flower zone with none or prismatic staminodes at the base 11

11. 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. Gunung Rian, (Tana Tidung, Kalimantan Utara), shales . . . . . ***A. orientale***

– Stamen connective concave, distal rim serrate-dentate; staminodes at base of staminate flower zone globose; thecae horns rather soft, short, straight. Hose Mountains (Kapit, C. Sarawak), limestones . . . . . ***A. burttii***

12. Thecae on each end of each anther 13

– Thecae on the inner face of each member of the stamen pair 19

13. Horns of thecae very long and thin, with the tips overlapping; stamen connective not excavated 14

– Horns of anther thecae short and stubby; stamen connective excavated or not 15

14. Leaf blades linear-lanceolate, stiffly coriaceous, up to 10 cm long × 4.5 mm wide; stems very slender (ca 3–4 mm diam.), trailing, clothed in netted persistent fibers; spathe ca 2 cm long; spadix ca 1.5 cm long; staminate flower connective umbonate. Scattered localities in Sri Aman & Sarikei (W. Sarawak), shales . . . . . ***A. montanum***

– Leaf blades elliptic, softly coriaceous, up to 22 cm long × 5 cm wide; stems stout. (ca 2.5 cm diam.), erect, naked; spathe ca 9 cm long; spadix ca 4.5 cm long; staminate flower connective flat with a shallow central longitudinal groove. Nanga Taman (Kalimantan Barat) & Kudangan (Kalimantan Tengah), granites . . . . . ***A. zygosetum***

15. Stamen connective deeply excavated; thecae horns slender with a narrow base . . . 16

– Stamen connective not excavated; thecae horns stout, their bases occupying the whole upper surface of the anther 22

16. Thecae horns blunt, peg-like, erect; interstice staminodes oblong in plan outline, with a deep, oblong excavation filled at pistillate anthesis with a yellowish sticky substance. Riam Marthin Billa (Malinau Selatan, Kalimantan Utara), very hard shales . . . . . ***A. hebe***

– Thecae horns pointed, triangular, directed into the cavity of the connective; interstice staminodes ± circular in plan outline, with an empty circular excavation. W Sarawak .. 17

17. Leaf arrangement strictly distichous. Matang (NW Sarawak), sandstones and granodiorite . . . . ***A. borneense***

– Leaf arrangement not so 18

18. 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. Gunung Gaharu & Batu Balau ('Bukit Lingga') (Sri Aman–SW Sarawak), alkaline volcanics . . . . ***A. crassum***

– Leaf blade rubbery-coriaceous, matte medium green adaxially when fresh; stigma as wide as ovary; thecae horns long, pointed at the end. Bako & Santubong (NW Sarawak), sandstones . . . . . ***A. nicolsonii***

19. Staminate flowers pubescent 20

– Staminate flowers glabrous 23

20. Leaf blades very stiff, sharply V-shaped in cross-section with the tip acicular (sharply pointed); mid-rib and marginal veins equally prominent; stems very short, naked. Similaju (Sarawak: Bintulu), lowland sandstones . . . . . ***A. velutandrum***

– Leaf blades leathery, blade flat, tip not acicular 21

21. Leaf blades elliptic to elliptic-lanceolate, ca 1 cm wide; cataphyll, ligule, and leaf base remnants degrading completely; spadix ca 2 cm long, appendix staminodes dome-shaped, very densely pubescent. Lawas (Sarawak), lowland sandstones . . . . .. ***A. spissum***

– Leaf blades very narrowly linear with undulate-crispulate margins, ca 2–2.5 mm wide; cataphyll, ligule, and leaf base remnants fibrous-netted; spadix up to 8 mm long; appendix staminodes, mostly flat-topped, occasionally more or less excavated, only very slightly pubescent. Loagan Bunut (Sarawak: Miri–Marudi), upper hill forest sandstones . . . . ***A. orestum***

22. Plants 10–20 cm tall; leaves erect, 9–17 cm long, leaf blades lanceolate-elliptic; peduncle 6–9 cm long; spathe 2.5–4 cm long; spadix 1–1.5 cm long. Gunung Niut (NW Kalimantan Barat), basalts . . . . . ***A. incavatum***

– Plants 2 cm tall; leaves appressed, ca 3 cm long, leaf blades oblanceolate; peduncle ca 5 mm long; spathe ca 1.5 cm long; spadix ca 4.5 mm long. Batang Balleh (Kapit – C. Sarawak), shales . . . . . ***A. pendek***

23. Horns of thecae shorter than width of stamen. E Sarawak and Brunei, mainly sandstones . . . . ***A. caulescens***

– Horns of thecae longer than width of stamen. NE Sarawak, shales . . . ***A. purseglovei***

Figure 1. *Aridarum perplexum* S. Y. Wong, S. L. Low & P. C. Boyce
A. & B. Plants in habitat, Type locality. **C.** Inflorescence at pistillate anthesis – spathe limb inflates but does not open wide. **D.** Inflorescence at late staminate anthesis – spathe limb shed with basal portion reflexing. **E.** Spadix at pistillate anthesis, spathe limb artificially removed/ **F.** Inflorescence post-anthesis – the retained portion of spathe limb deliquescing. **A–D** from *AR-4299*. Images A & B © K.Nakamoto; C–F © P. C. Boyce.

Aridarum perplexum S. Y. Wong, S. L .Low & P. C. Boyce, **sp. nov.** Type**:** Indonesian Borneo, Kalimantan Barat, Sintang, Sepauk, Kayu Lapis, Nanga Pari, 68 km south of Kayu Lapis, 00°00'2.38"S 111°00 '33.99"E, 23 Oct 2013, *K. Nakamoto AR-4299* (holo BO–alcohol!; iso SAR–alcohol!). **Figure 1.**

Diagnosis

On the basis of spadix structure *Aridarum perplexum* is most similar to *A. rostratum* although readily differentiated by the smooth leaf blades (vs leaf blades quilted) with, abaxially, only slightly conspicuous (vs very conspicuous) pellucid interprimary veins. Ecologically *A. perplexum* is distinguished from *A. rostratum* by being a plant of lowland granites, as opposed to a mid-elevation plant confined to sandstones.

Description

Small to medium-sized obligate clumping rheophytes to ca 12 cm tall. **Stem** condensed, sub-erect, ca 1.5 cm in diam., with copious strong roots. **Leaves** many together, arching; **petiole** 5–8 cm long, weakly D-shaped, ca 3 mm wide × ca 3 mm high, sheathing at extreme base, almost microscopically scabridulous matte medium green; **petiolar sheath** with wings extended into a very narrowly triangular ligular portion up to 3 cm long, ligule margins in-rolled and almost tubular, persistent; **blade** softly coriaceous, narrowly-elliptic, 11–15 cm long × 3–5 cm wide, base cuneate, apex acute acuminate, apiculate for ca 3 mm, adaxially matte dark olive green, paler green; *midrib* abaxially somewhat sharply prominent, adaxially bluntly raised; **primary lateral veins** ca 4 per on each side, weakly raised abaxially, slightly impressed adaxially, diverging at ca 30°; **interprimary veins** twice as numerous as primaries, much less conspicuous and slightly translucent; **secondary venation** adaxially invisible, abaxially nearly invisible. **Inflorescence** solitary; **peduncle** slender, exceeding petioles, 12–15 cm long × 1.2–3 mm in diam. **Spathe ca** 7 cm long, ca twice length of spadix, broadly lanceolate, upper part extended into a short beak ca 2 mm long, barely opening at pistillate anthesis, lower persistent part of spathe dark, remainder white, limb caducous by deliquescence at junction with persistent lower part at staminate anthesis, falling in ragged, adhering strips. **Spadi**x sub-cylindric, ca 3.5 cm long; **pistillate flower zone** slender slightly obconic, markedly thinner than rest of spadix, comprising ca ⅓ of spadix, ca 8mm long × ca 3 mm in diam., adnate to spathe in lower ¼, with few clavate-cylindrical yellow-tipped staminodes at base; **pistils** crowded, sub-globose, ca 1 mm in diam., pale greenish white; **stigma** sessile, discoid, narrower than pistil, drying dark brown, rather coarsely papillate; **sterile interstice ca** 2 mm long × distally 5–6 mm in diam., with 1 whorl of staminodes from ca 0.5 mm long, these triangular-cordate from above, aligned with points facing spadix apex, truncate, smooth; **staminate flower zone** slightly less than ⅓ of entire spadix length, ca 1 cm long × 5–7 mm in diam., creamy yellow; **staminate flowers**

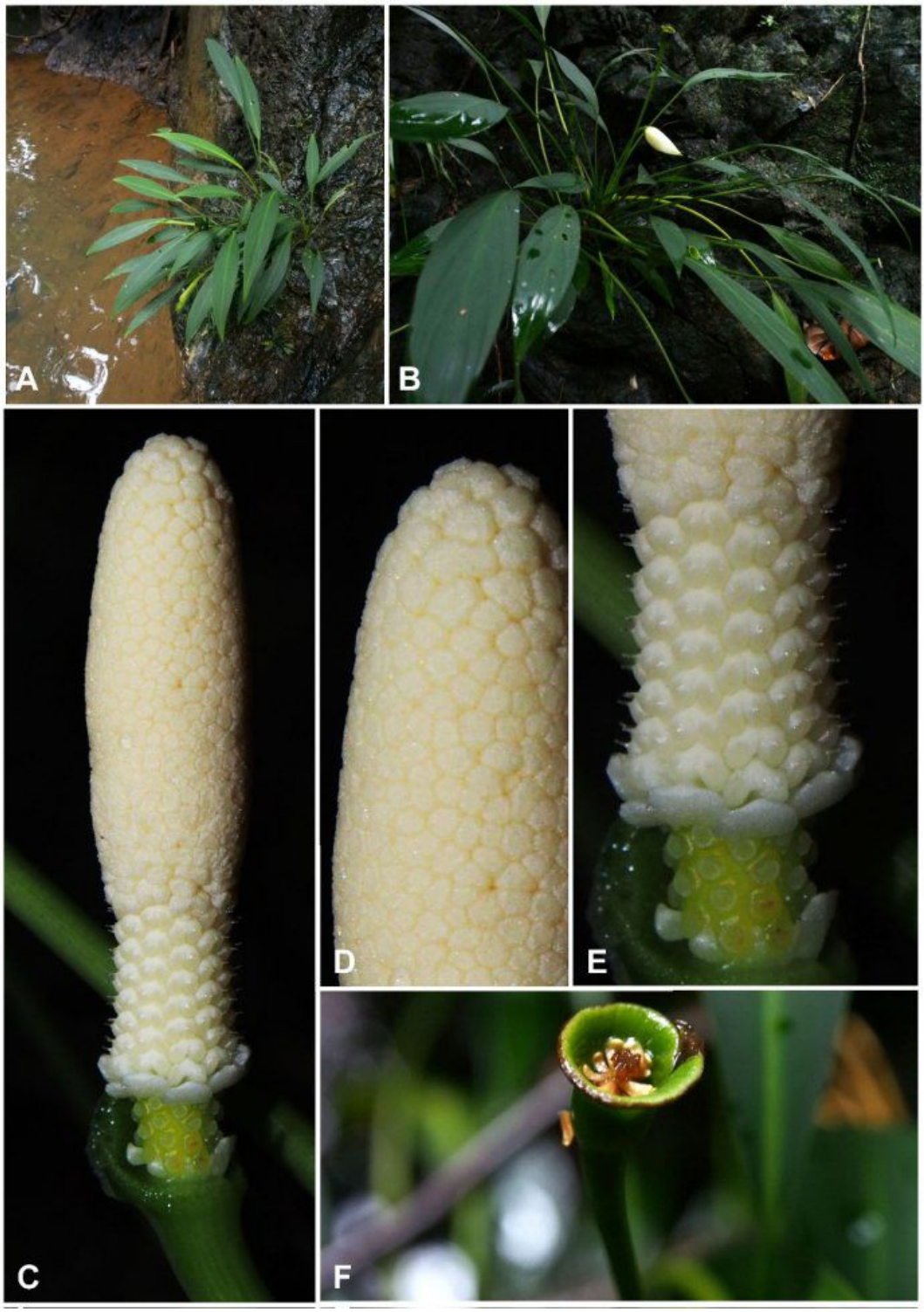

Figure 2. *Aridarum sabahense* S. Y. Wong, S. L. Low & P. C. Boyce
A & B. Plants in habitat, Type locality. **C.** Spadix at onset of staminate anthesis, spathe artificially removed. **D**. Detail of appendix staminodes. **E.** Detail of fertile flower zones and interpistillar staminodes. **F**. Sub-mature infructescence; note that the interpistillar staminodes are beginning to be lost. **A–F** from *AR-4093*. Images A, B & F © M.Lo; C–E © P. C. Boyce.

large, spirally arranged, truncate, circular-rhomboid from above, apically verruculose, 1.2–1.4 mm in diam.; **thecae** together on proximal (with respect to spadix axis) side of anther, separated by a conspicuous narrow suture, with obscure 0.8–1.2 mm long upturned horns each ending in a very narrow pore; **appendix** ca 14 mm long × 5–6 mm in diam., slightly tapering, obtuse; **appendix staminodes** with lowermost ones resembling stamens without thecae, uppermost more columnar with verrucate tops. **Infructescences** pendulous. **Fruiting spathe** campanuliform, ca 2 cm long × ca 1 cm wide, medium green with a scar along rim; persistent staminodes initially glossy white, later becoming green; **fruits and seeds** not seen.

Distribution — *Aridarum perplexum* is so far known only from the Type locality.

Ecology — *Aridarum perplexum* is rheophytic on riverside granite rocks and boulders under open perhumid lowland at ca 40m asl.

Etymology — From Latin, *perplexus* [*perplexum*–neut.], puzzling, coined by way of reference to our initial surprise when examining living plants and alcohol-preserved of this species. Initially we were convinced that the inflorescences belonged to a different species, *A. rostratum* Boner & A. Hay. Only later did plants flower in our research collection, confirming the origin of the inflorescences.

Notes —The spadix of *Aridarum perplexum* is extremely similar to that of *A. rostratum* although the species are readily distinguishable vegetatively. In its association with lowland granite *Aridarum perplexum* is ecologically differentiated from *A. rostratum*, a plant of sandstone waterfalls under hill or upper hill forest.

Aridarum perplexum is the sixth described species of the Rostratum Complex.

Aridarum sabahense S. Y. Wong, S. L. Low & P. C. Boyce, **sp. nov.** Type: Malaysian Borneo, Sabah, Sandakan, Kinabatangan, Telupit, Gunung Tawai, 05°35'45.6"N, 117°04'36.7"E, 18 Dec. 2012, *M.Lo AR-4093* (SAN!; isotype SAR!). **Figure 2.**

Diagnosis

Aridarum sabahense is unique in the genus by combination of globose thecae and spathulate interpistillar staminodes. In overall aspect, by the nodding spathe on a long, slender peduncle, and by the spathe limb hardly opening at pistillate anthesis and deliquescing acroscopically during staminate anthesis *A. sabahense* appears allied to the *Aridarum* Rostratum Complex, from which it differs, in addition to the aforementioned characteristics, by possessing an erect salver-form (vs nodding, narrowly campanuliform) persistent lower spathe.

Description

Medium-sized clumping obligate rheophytes to 40 cm tall but mostly half this size. **Stem** erect and somewhat condensed, ca 2 cm in diam., active portions obscured by dense leaf bases, older parts naked with conspicuous scars. **Leaves** many, several together, petioles erect with blades very slightly arching; individual modules with 3–5 leaves, modules subtended by a linear-triangular 2-keeled persistent prophyll to 5 cm long and ca 5 mm wide; **petiole** 12–17 cm long, basally weakly D-shaped in cross section, ca 3 mm wide × ca 2.5 mm high, sheathing at extreme base, matte medium green; **petiolar sheath** with wings extended into a narrowly triangular somewhat twisted persistent ligular portion ca 9 cm long; **blade** softly coriaceous, elliptic, 18–23 cm long × 2.5–3.5 cm wide, base cuneate to slightly decurrent, apex acuminate, apiculate for ca 3 mm, adaxially semi-glossy medium green, matte and paler green abaxially; **midrib** abaxially prominent, adaxially slightly bluntly raised; **primary lateral veins** ca 4 on each side, adaxially well-defined, these diverging at ca 30°, adaxially merging into slightly raised marginal vein running very close to leaf margin; **interprimary veins** invisible adaxially, abaxially slightly darker than primaries**; secondary venation** forming a slightly obscure tessellate reticulum. **Inflorescence** solitary, nodding on an erect peduncle, subtended by a ca 5 cm long, very narrowly triangular somewhat leathery cataphyll; **peduncle** slender, more-or-less erect, shorter than leaves, up to 17 cm long, ca 3 mm in diam., terete, matte medium green, inserted slightly obliquely on spathe; **spathe** narrowly ovate with an acuminate tip, not constricted, ca 7 cm long, lower part campanuliform at anthesis, medium green, ultimately persistent through fruiting, long-apiculate for up to 1.5 cm, limb exterior glistening white, interior greenish in lower 1/3, remainder white, apicule distally green; **limb** inflating and then gaping at pistillate anthesis, prior to staminate anthesis limb caducous from above junction with persistent lower part, limb falling more-or-less intact with basal portion remaining, recurving and then deliquescing to leave erect salverform persistent lower spathe, with a scarred regular rim. **Spadix** cylindric, 3.5–4 cm long × ca 8 mm in diam. sessile; **pistillate flower zone** weakly obconic, narrower than other fertile parts of spadix, comprising about 1/5 of spadix, ca 8 mm long × ca 5 mm in diam.; **pistils** rhombic, truncate, ca 1.1 mm in diam., bright pale green; **stigma** sessile, capitate, papillose, narrower than ovary medium green, producing a conspicuous stigmatic droplet at anthesis, turning brownish at post anthesis; **sterile interstice** equalling base of staminate zone in width, with 1–2 whorls of spathulate staminodes, these ca 1.5 mm long × 0.75 mm wide, white; **staminate flower zone** *ca* 1/3 of total spadix length, ca 1 cm long, lower part equalling width of sterile interstice; **staminate flowers** densely packed, each comprised of two stamens, ivory, ± horseshoe-shaped, ca 2 × 1 mm, connective excavated; **thecae** globose-ellipsoid, ventral on connective, each ca 1 mm long; **thecae horns** two per stamen, *ca* 0.5 mm long, very narrow, spreading.

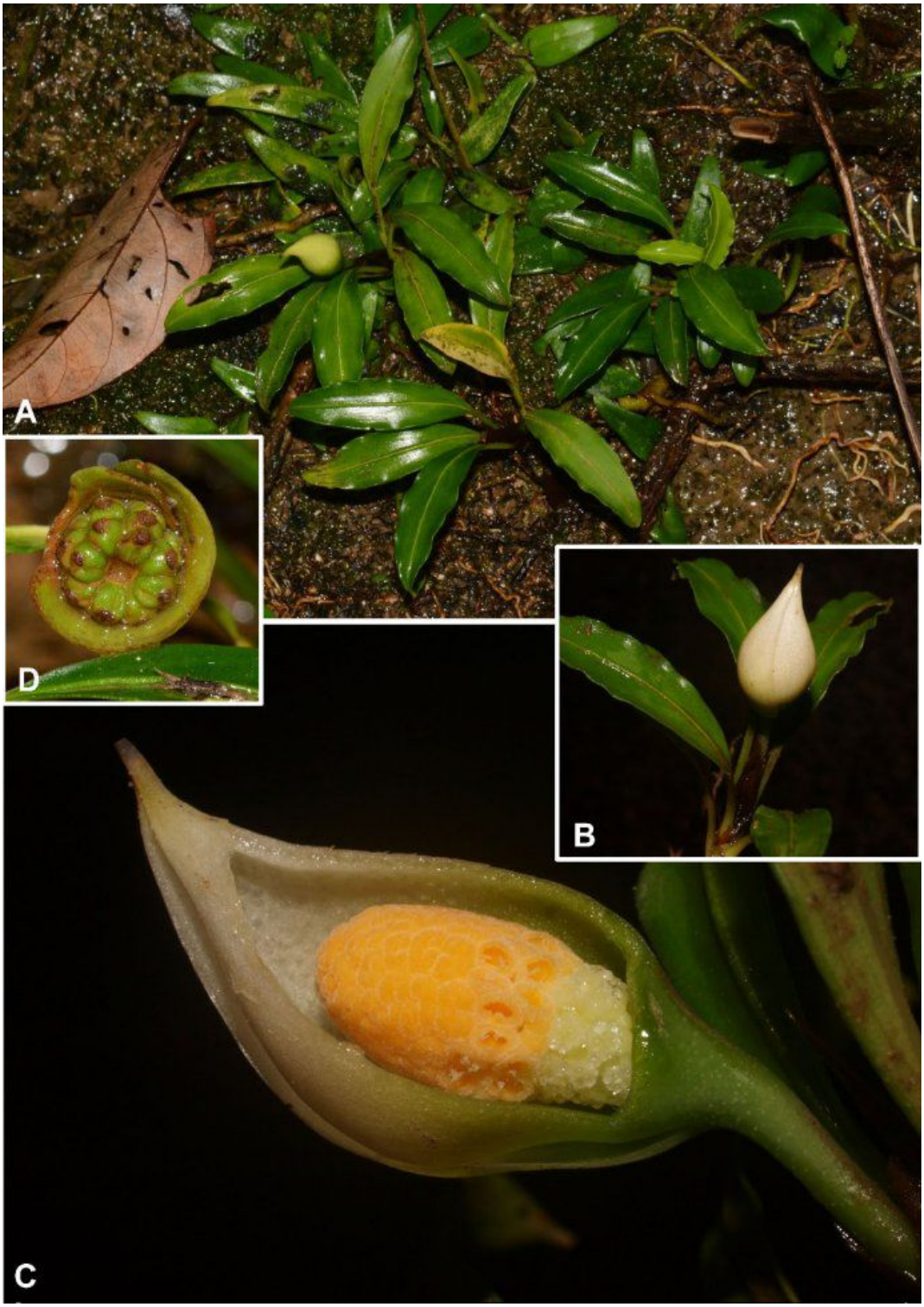

Figure 3. *Aridarum spissum* S. Y. Wong, S. L. Low & P. C. Boyce
A. Flowering plant in habitat, Type locality. **B.** Inflorescence at just prior to pistillate anthesis. **C.** Inflorescence at pistillate anthesis, nearside spathe artificially removed. **D.** Developing infructescence. **A–D** from *AR-4349*. Images © P. C. Boyce.

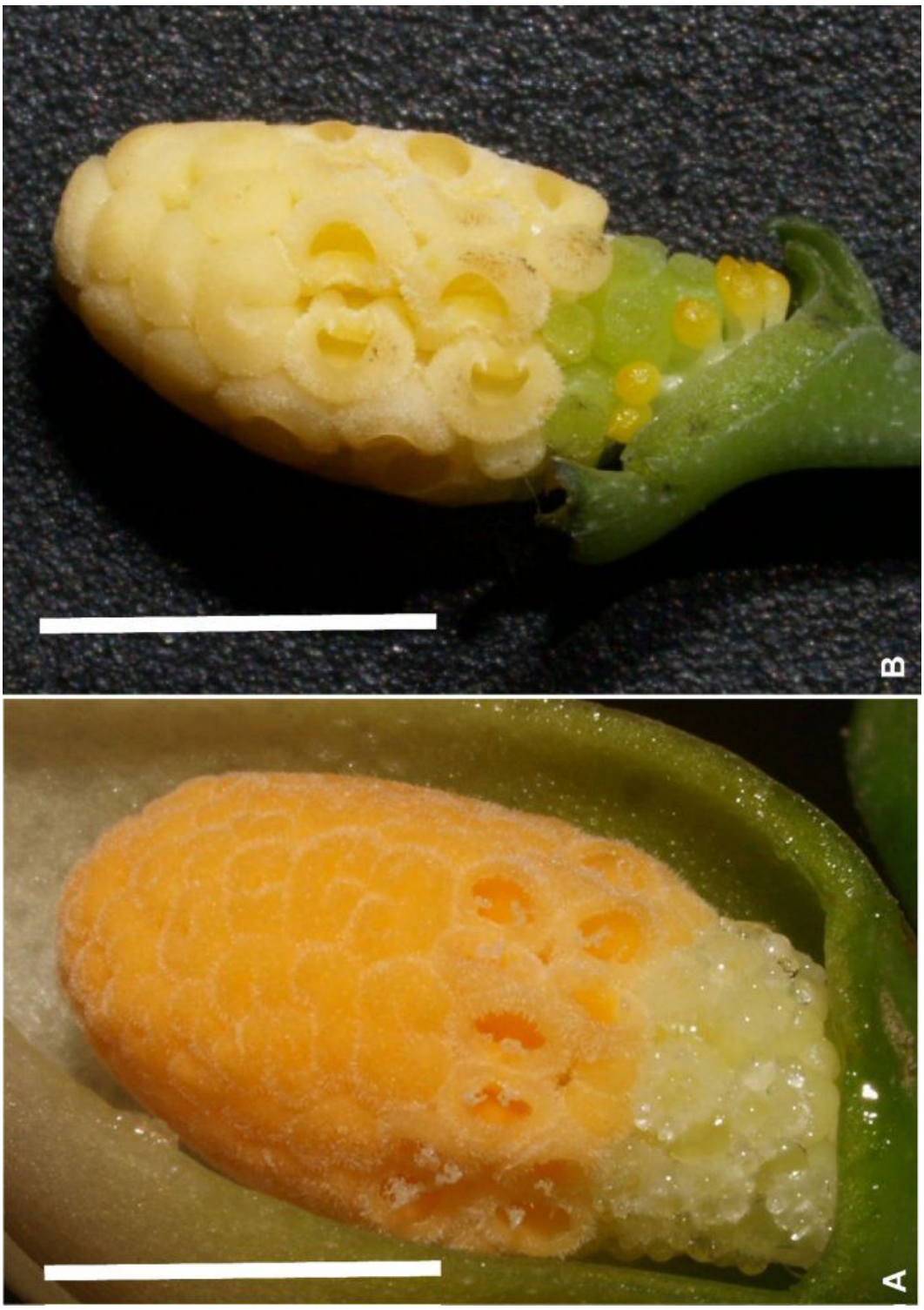

Figure 4. Spadix of *Aridarum spissum* and *Aridarum velutandrum* compared, spathe artificially removed. **A.** *Aridarum spissum* S. Y. Wong, S. L. Low & P. C. Boyce – Scale bar = 1 cm. **B.** *Aridarum velutandrum* S. Y. Wong, S. L. Low & P. C. Boyce – Scale bar = 5 mm. **A** from *AR-4349*; **B** from *AR-1915*. Images © P. C. Boyce.

Infructescence in base of an erect salverform persistent lower spathe; **Fruits and seeds** not seen.

Distribution — *Aridarum sabahense* is known only from the Type locality and nearby Bidu-Bidu F.R.. At the Type locality *A. sabahense* co-occurs with *Bucephalandra ultramafica* S. Y. Wong & P. C. Boyce.

Ecology — *Aridarum sabahense* occurs as an obligate rheophyte on ultramafic (ultrabasic) river boulders and waterfalls under moist lowland forest between 135 and 300 m above sea level.

Etymology — From Sabah + *ensis*, a suffix denoting a place of origin.

Notes — *Aridarum sabahense* has a combination of characteristics that render relationships difficult to determine. In overall aspect *A. sabahense* would appear to belong to the *Aridarum* Rostratum Complex, with which it shares a nodding spathe on a long, slender peduncle, and a spathe limb that hardly opens at pistillate anthesis and which deliquesces acroscopically during staminate anthesis However, the erect salver-form persistent lower spathe, staminate flowers with globose thecae, and spathulate interpistillar staminodes are strongly reminiscent of species of *Bucephalandra*. Molecular analyses is underway to attempt to better elucidate relationships.

Aridarum sabahense is the first species of the genus recorded for Sabah, although several species have been described from neighbouring Kalimantan Utara and Kalimantan Timur, Indonesian Borneo.

Other material examined: MALAYSIAN BORNEO. Sabah, Sandakan, Labuk & Sugut, Bidu-Bidu F.R., 05°49'05.6"N 117°20'17.0"E, 8 Dec. 2013, *M. Lo AR-4360* (SAN!–alcohol; SAR!–alcohol).

Aridarum spissum S. Y. Wong, S. L. Low & P. C. Boyce, **sp. nov.** Type**:** Malaysian Borneo, Sarawak, Limbang, Lawas, Long Spangan, along the Lawas - Dawit road, 04°43'49.4"N 115°23'55.3"E, 15 Feb. 2014, *P. C. Boyce & Wong Sin Yeng AR-4349* (holo SAR–alcohol!; iso SBC–alcohol!). **Figure 3 & 4A.**

Diagnosis

Aridarum spissum shares pubescent staminate flowers with highland *A. orestum* and lowland *A. velutandrum*, but is readily differentiated from either by longer (ca. 2 cm vs 6–8 mm), much stouter spadix, the longer and much broader leaf blades, and by the dome-shaped, very densely pubescent appendix staminodes. From *A. velutandrum A. spissum* may be further distinguished the globose, sessile, white (vs clavate, stipitate, deep yellow) sub-pistillar staminodes and pale cream (vs bright green) pistils.

Description

Diminutive mat-forming obligate rheophytes to 7 cm tall. **Stem** elongated, eventually sub- decumbent and rooting with active portion sub-erect, 1–6 cm long, 3–4 mm in diam., active portions obscured by leaf bases, older parts becoming bare. **Leaves** few to numerous together, mostly in tufts at tips of shoots; **petiole** ca 2.5 cm long, ca 1.5 mm in diam., adaxially canaliculate, sheathing at extreme base; **petiolar sheath** with wings extended into a very narrowly triangular ligular portion 1 cm long drying dark red-brown and then marcescent; **blade** coriaceous, adaxially dark green, paler abaxially, elliptic to elliptic-lanceolate, 2.5–4 cm long × ca 1 cm wide, base narrowly cuneate, apex acute, apiculate for ca 1 mm, margin somewhat thickened and slightly undulate; **midrib** abaxially very prominent, adaxially prominent, primary lateral veins indistinguishable from interprimary venation, diverging at 20–35° and running to a more or less thick marginal vein; **secondary venation** adaxially and abaxially very faint to completely obscure; **tertiary venation** mostly completely obscure in living material, forming a faint tessellate reticulum in dry material. **Inflorescence** solitary; **peduncle** stout, exceeding petioles, ca 2 cm long × 1.5 mm in diam., terete, pale green; **spathe** more or less ovoid with apex recurved, not constricted, ca 2.5 cm long and apically beaked for 3–4 mm; **lower part** campanulate, green, persistent, upper part gaping at anthesis, glistening white, caducous during or just following staminate anthesis, apical beak medium green. **Spadix** stoutly cylindrical, ca 2 cm long, ca 1 cm in diam.; **pistillate flower zone** *ca* 5 mm long, slightly narrower than remainder of spadix, comprised of 3–4 whorls of pistils; **pistils** crowded, sub-globose, ca 1.5 mm in diam.; **stigma** sessile, discoid, centrally impressed, about same width as ovary; **interpistillar staminodes** confined to a row along spathe/spadix adnation, globose, sessile, white, ca 0.75 mm in diam., about height of pistils; **sterile interstice** absent; **staminate flower zone ca** 5 mm long, composed of ca 2 rows of fertile flowers; **staminate flowers** pubescent, crowded, each composed of two stamens arranged in longitudinally aligned pairs, truncate, deeply excavated with thecae together on inner (with respect to stamen pairs) side of anther, ellipsoid to ellipsoid-oblong from above, ca 1 mm long × 2 mm wide; **thecae** separated by a ridge forming a septum in cavity, very shortly horned, with horns inside lip of anther cavity; **appendix** ca 1 cm long, blunt, equalling staminate flower zone in width; **appendix staminodes** more or less irregularly globular to ellipsoid, dome-shaped, densely pubescent, deep yellow, ca 1 mm diam. **Fruiting** spathe thick-walled, conical; **fruits** irregularly globose, somewhat depressed, deep green with a large conspicuous brown stigmatic remnant.

Distribution — *Aridarum spissum* is known only from the Type locality.

Ecology — *Aridarum spissum* occurs as a rheophyte on sandstone riverside banks under lowland humid forest at about 60 asl.

Etymology — From Latin, *spissus* (neut. *spissum*) – thick, crowded, or dense – and used as a means to describe both the comparatively wide diameter of the spadix, and the congested arrangement of the staminate flowers and the appendix staminodes.

Notes — *Aridarum spissum* is evidently closely related to *A. velutandrum* S. Y. Wong, S. L. Low & P. C. Boyce and *A. orestum* S. Y. Wong, S. L. Low & P. C. Boyce by sharing pubescent staminate flowers, although the three species are very different vegetatively in addition to the morphologies highlighted in the above diagnosis.

References

Boyce, P.C. & S.Y. Wong. 2013. Studies on Schismatoglottideae (Araceae) of Borneo XXVII–New species of *Aridarum*, and notes on the *Aridarum* Rostratum Complex. *Willdenowia* 43: 91–99.

Wong S.Y. [et al. 2012], P.C. Boyce & S.L. Low. 2012. 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.

Wong S. Y. [et al. 2014], S. L. Low & P.C. Boyce. 2014. Studies on Schismatoglottideae (Araceae) of Borneo XXXV–Seven New Species of *Aridarum*. *Aroideana* 37: 91–32.

Acknowledgements

This is part of an on-going research which is funded by the Ministry of Higher Education, Malaysia by the Exploratory Research Grant Scheme Vote No. NRGS/1089/2013-(03) and Fundamental Research Grant Scheme Vote No. FRGS/STWN10(01)985/2013(26).
Fieldwork was most recently under Sarawak Forestry Department Permission to Conduct Research on Biological Resources - Permit No. NCCD.907,4.4(J|d.9)-69 and Park Permit No 140/2013. The collaboration and support of the Sarawak Forestry Department and the Sarawak Biodiversity Centre are gratefully acknowledged.

Studies on Schismatoglottideae (Araceae) of Borneo XXXXIV: *Piptospatha nivea*, a new species from Kalimantan Tengah, Indonesian Borneo

Peter C. Boyce*
Honorary Research Fellow
Institute Of Biodiversity and Environmental Conservation (IBEC)
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
phymatarum@gmail.com

Wong Sin Yeng
Department of Plant Science & Environmental Ecology
Faculty of Resource Science & Technology
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
sywong@frst.unimas.my

Abdul Sahal
xtrembetta@yahoo.co.id

*corresponding author

ABSTRACT

Piptospatha nivea is described and illustrated as new species, unique among Bornean *Piptospatha* by possessing a white spathe limb, and compared with the nearest most similar species, *Piptospatha colata* S.Y.Wong & P.C.Boyce. Aside from possessing a striking and unique inflorescence *P. nivea* represents an almost 300 km southerly extension to the known range of the genus.

KEY WORDS

Rheophytic, Quaternary sediments

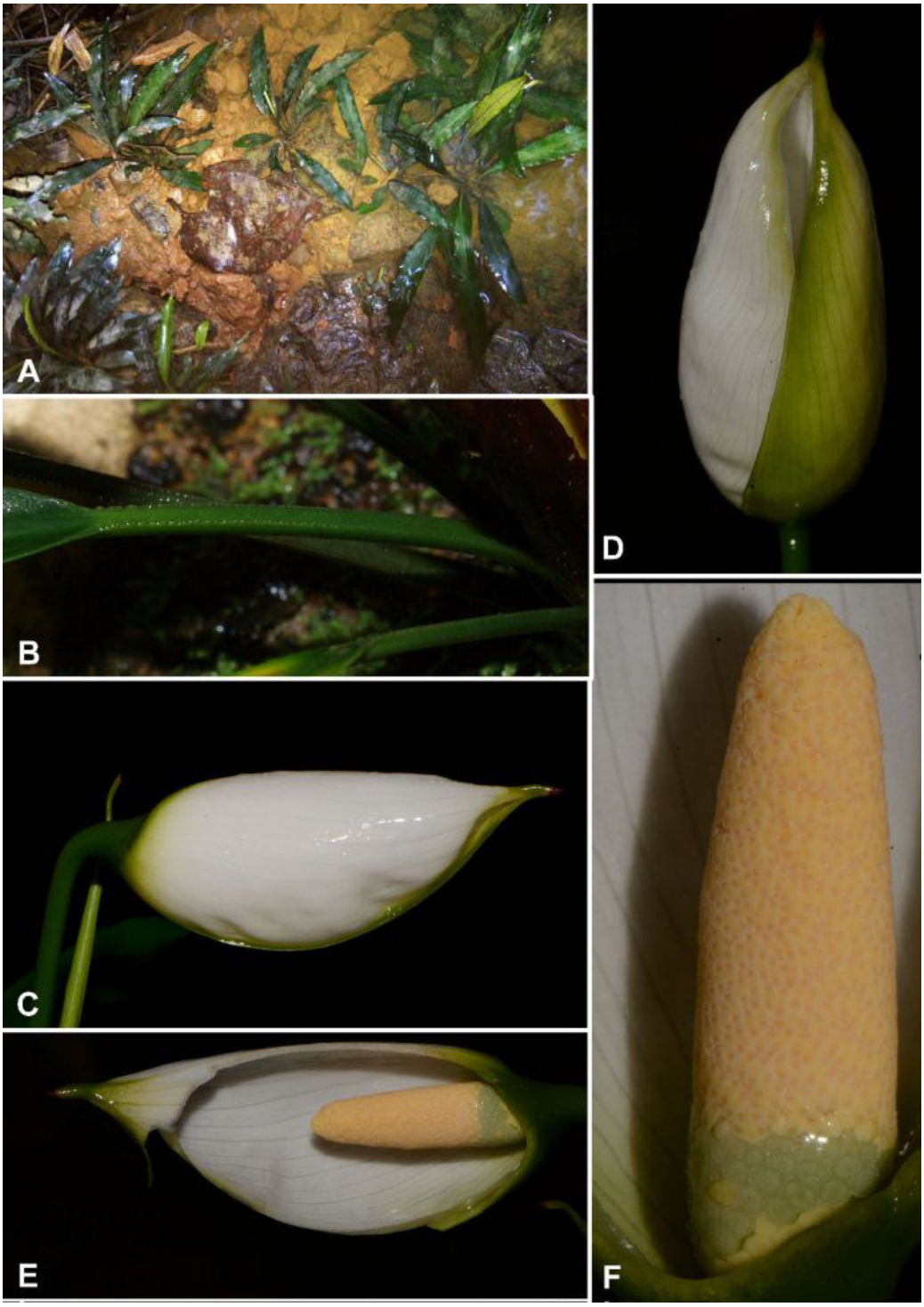

Figure 1. ***Piptospatha nivea*** P. C. Boyce, S. Y. Wong & Sahal
A. Plants in habitat, Type locality. **B.** Detail of the alate-scabrous petiole. **C**. Inflorescence at pistillate anthesis. **D.** Inflorescence at pistillate anthesis, ventral view to show the difference in colour of the overlapping (green) and overlapped (white) portions of the spathe limb. **E.** Inflorescence at pistillate anthesis, nearside spathe artificially removed. **F.** Spadix at pistillate anthesis. All from *AR-4300*. Image A © Abdul Sahal; images B – F © P. C. Boyce.

INTRODUCTION

Fieldwork on Borneo continues to reveal remarkable levels of novel taxonomic diversity. Here we describe an unusual species of the genus *Piptospatha* N.E.Br. which is unique on Borneo by possessing a white spathe limb, and metallic deep blue-green leaf blades. The plant originates from the Quaternary sandstones of Kuala Kapuas in southern Kalimantan Tengah, close to the border with Kalimantan Selatan, making it as extension of almost 300 km south of the known range of the genus.

Piptospatha nivea P. C. Boyce, S. Y. Wong & Sahal, **sp. nov.** Type: Indonesian Borneo, Kalimantan Tengah, Kapuas, Kuala Kapuas, exact locality withheld, 1 Nov. 2013, *A. Sahal AR-4300* (holo BO!). **Figure 1.**

Diagnosis

Piptospatha nivea is overall most similar to *Piptospatha colata* S.Y.Wong & P.C.Boyce differing by the pure white spathe limb and deep glossy green lower spathe, and by the glossy metallic deep blue-green leaf blades with the primary lateral veins barely impressed.

Description

Solitary rheophytic herb to 15 cm tall. **Roots** strong, ca 2 mm in diameter. **Stem** short, condensed, to 20 mm in diameter, all except oldest portions obscured by leaf bases. **Leaves** many together, spreading or arching, forming a sparse rosette; **petiole** 3.5–8 cm long, up to 2.5 mm in diameter, bases clasping stem, D-shaped in cross-section with dorsal angles narrowly alate-scabrous, dark green; **petiolar sheath** attached only at the extreme base, the remainder a free narrowly triangular ligular portion, ca 5 cm long, this marcescent and ultimately deciduous, dark reddish brown; **leaf blades** narrowly elliptic, 8–15 cm long × 2–2.5 cm wide, base cuneate, apex acute with stout tubule ca 5 mm long, in life glossy dark metallic blue-green adaxially, light green abaxially; mid-rib bluntly slightly raised adaxially, weakly rounded-raised and; **primary lateral veins** ca 7 per side, parallel pinnate, barely impressed adaxially, very slightly raised abaxially; **interprimary lateral** veins weaker than primary laterals although still quite conspicuous, interprimary veins joining a weakly defined sub-marginal collecting vein; all other venation obscure. **Inflorescence** solitary or up to 3 in sequence; **peduncle** ca15 cm long (at anthesis), ca 3.5 mm in diameter, minutely scabrous, medium green. **Spathe** held at ca 90° to peduncle at anthesis, not constricted, glossy medium green in late bud, spathe limb opening with portion overlapped in bud pure white and the overlapping portion stained lime green along the margin and above the lower persistent lower spathe, limb interior uniformly pure white, persistent lower portion and terminal rostrum deep green; **spathe limb** ca 5 cm long, base ca 1.5 cm wide, mid-way inflated to ca 2.5 cm, ventrally constricted and terminating in a rostrum ca 6 mm long, internally lacking

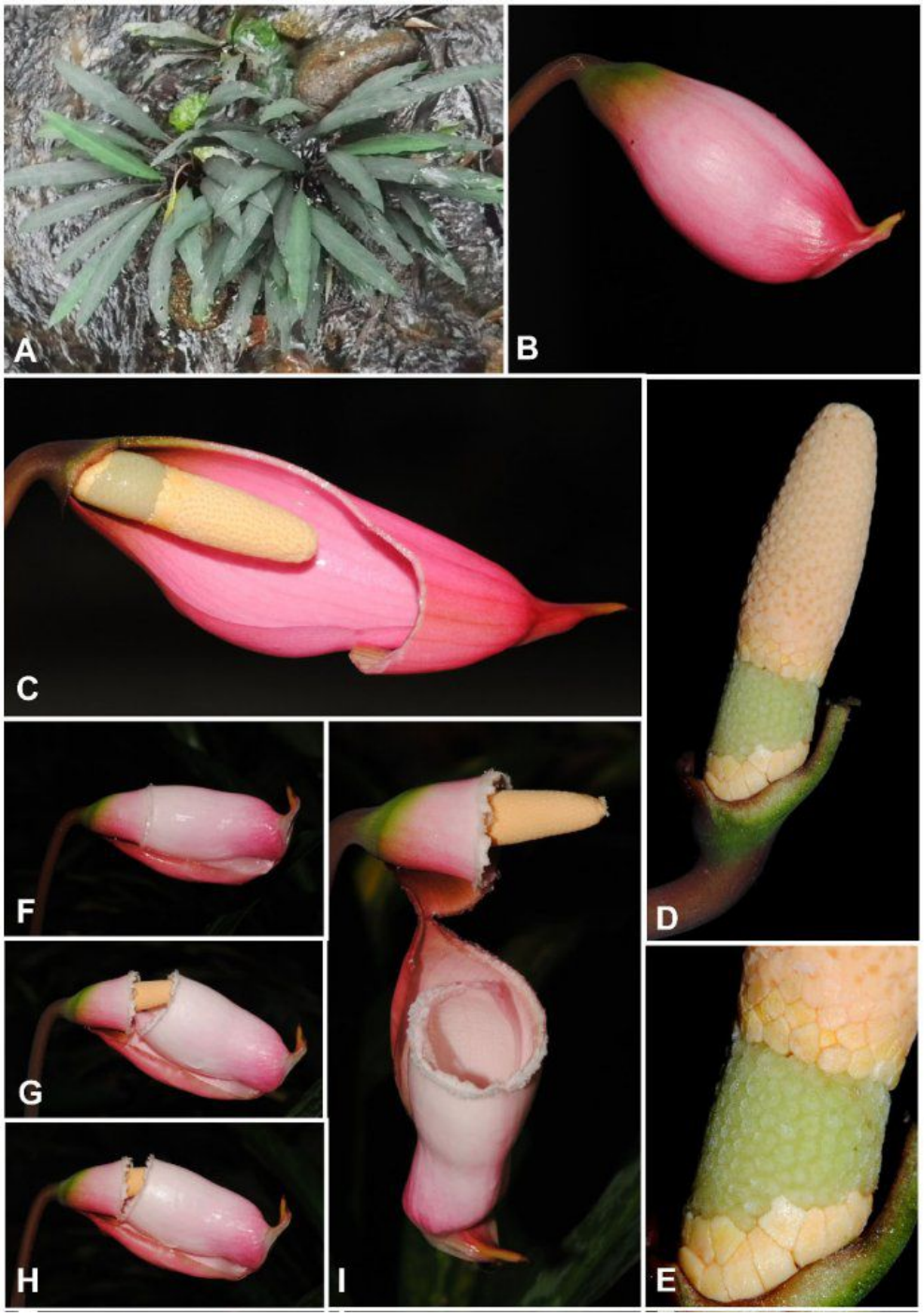

Figure 2. ***Piptospatha colata*** S. Y. Wong & P. C. Boyce
A. Plant in habitat, Type locality. **B.** Inflorescence at staminate anthesis. Detail of the alate-scabrous petiole. **C**. Inflorescence at pistillate anthesis, window artificially cut in nearside spathe. **D.** Spadix at pistillate anthesis. **E.** Detail of pistillate flower zone, staminodes, and lower part of staminate flower zone. **F – I.** Inflorescence at staminate anthesis showing the abscission, separation, and falling of the spathe limb. All from *AR-3665*. Image A © Nakamoto Kazuya; images B – I © P. C. Boyce.

rostral keels. **Spadix** ca 2 cm long × ca 7 mm in diam. at the base, slightly tapering-cylindrical, base slightly obliquely inserted onto spathe/peduncle; **pistillate flower zone** jade-green with 1 rows of rhomboidal truncate pale yellow staminodes inserted basally, weakly barrel-shaped, ca 1cm long × 1 cm in diam.; **pistils** cylindrical, truncate, very congested, ca 0.6 mm diameter; **stigma** weakly umbonate, papillate, as wide as ovary; pistillate and staminate zones separated by a zone ca 1 mm long comprised of ca 1 whorls of staminodes, these rhomboidal-polygonal, truncate, pale yellow; **staminate flower zone** cream, equalling pistillate zone in width at base, distally tapering, ca 1.6 cm long × 5 mm in diam. at base, apex blunt; **staminate flowers** congested and irregularly arranged, comprised of paired stamens, irregularly oblong and very weakly butterfly shaped, ca 0.5 mm wide × ca 1 mm long, connective truncate, glabrous; thecae lateral, ca 0.3 mm, ellipsoid with a wide rim, sunken into a shallow pit. **Infructescence** salverform, ca 1.5 cm wide, medium green. **Fruits** and **seeds** not observed.

Distribution — *Piptospatha nivea* is so far known only from the Type locality where it is locally abundant.

Ecology — *Piptospatha nivea* is rheophytic on Quaternary sediments open perhumid lowland forest at ca 55m asl.

Etymology — From Latin, *niveus*, snowy, selected to emphasize the diagnostic white spathe limb.

Notes — *Piptospatha nivea* is thus far unique among Bornean species by the white spathe limb. Combined with the metallic deep blue-green leaf blades, the white inflorescence renders *P. nivea* a highly ornamental species. Only one other *Piptospatha* is known with a white spathe, the West Malaysian and far southern Thai *P. perakensis* (Engl.) Engl., which differs considerably from *P. nivea*.

The overall form of the inflorescence structure, and notably the spadix, of *Piptospatha nivea* is most closely reminiscent of *P. colata* (**Figure 2)**, although the spathe limb colour readily differentiates them. In the form and colour of the leaf blades, as well as ecology (*P. colata* is obligated to granite), and distribution, *P. nivea* and *P. colata* are readily distinguished.

Owing to the ornamental potential of this plant we are withholding the exact locality in order to protect wild populations from commercial poaching.

References

Boyce, P.C. & Wong S.Y. 2013. Studies on Schismatoglottideae (Araceae) of Borneo XXIII: *Piptospatha colata* and *P. deceptrix*, taxonomic novelties from Borneo. *Gard. Bull. Singapore* 65(1): 7–17.

Acknowledgements

This is part of an on-going research which is funded by the Ministry of Higher Education, Malaysia by the Exploratory Research Grant Scheme Vote No. NRGS/1089/2013-(03) and Fundamental Research Grant Scheme Vote No. FRGS/STWN10(01)985/2013(26).

Studies on Schismatoglottideae (Araceae) of Borneo XXXXV: The flowering and fruit development of *Schismatoglottis tecturata*

Wong Sin Yeng
Department of Plant Science & Environmental Ecology
Faculty of Resource Science & Technology
Universiti Malaysia Sarawak
94300 Kota Samarahan, Sarawak
Malaysia
sywong@frst.unimas.my

Peter C. Boyce*
Honorary Research Fellow
Institute Of Biodiversity and Environmental Conservation (IBEC)
Universiti Malaysia Sarawak
94300 Kota Samarahan
Sarawak, Malaysia
phymatarum@gmail.com
***corresponding author**

ABSTRACT

The flowering and fruit development of *Schismatoglottis tecturata* (Schott) Engl.is illustrated.

KEY WORDS

Acroscopically splitting spathe, basiscopically, mediascopically

INTRODUCTION

Schismatoglottis tecturata (Schott) Engl. is a facultative rheophyte (**Figure 1)** widespread and often locally common on Borneo, and with a distribution disjunction on Gunung Ranai (Pulau Ranai, Natuna islands, Riau Archipelago, Indonesia). *Schismatoglottis tecturata* is a highly distinctive species, one of about five *Schismatoglottis* species in which

the petiolar sheath is reduced to a very short thickened collar, and the protective role of the sheath is taken on by the cataphylls which alternate with the foliage leaves (Hay & Yuzammi 2000; Boyce & Wong 2013) – **Figures 7 & 8**. In nature the leaves variable with respect to width and markings of the leaf blades, even within a single population (**Figures 2–6**), although inflorescences do not vary significantly (**Figures 12 – 17**).

The spathe of *S. tecturata* differs from all other described *Schismatoglottis* species in the manner in which it senesces: only the marginal and distal parts of the spathe limb wither after anthesis, while the remainder persists well into infructescence. This is in marked contrast with almost all other *Schismatoglottis* in which the spathe limb is deciduous from its junction with the persistent lower spathe, with the point usually marked by a constriction (**Figures 9 – 11**). It is evident that the withering portion of the spathe in *Schismatoglottis tecturata* is homologous with the spathe limb in other *Schismatoglottis*.

Schismatoglottis tecturata also differs from all other species, including those sharing the similar shoot module morphology, by the manner in which the persistent spathe protecting the infructescence splits acroscopically to expose and liberate the ripe berries (**Figures 34 – 38**) – all other *Schismatoglottis*, where known, have the lower spathe splitting mediascopically (**Figure 39)** or basiscopically (**Figure 40)**.

Here we provide a photo essay of the process of anthesis, spathe senescence, infructescence development, and fruit release in *Schismatoglottis tecturata*.

Figure 1

Figure 2

Figure 1. *Schismatoglottis tecturata* (Schott) Engl. in habitat, central Sarawak. Although on a river back the plants are well-above the normal maximum flood-zone, although in exceptionally wet periods they would be subject to spathe flow.

Figures 2 – 6. *Schismatoglottis tecturata* (Schott) Engl. showing typical variation in leaf blade proportions and markings.

Figure 3

Figure 4

Figure 5

Figure 6

Figures 2 – 6. *Schismatoglottis tecturata* (Schott) Engl. showing typical variation in leaf blade proportions and markings.

Figure 7. *Schismatoglottis tecturata* (Schott) Engl. Detail of the very short petiolar sheath – the curving reddish brown collar at the base of the left hand petiole. The decomposing brown tissue enclosing the right hand petiole is a degrading cataphyll.

Figure 8. *Schismatoglottis tecturata* (Schott) Engl. Overall view of the petiole bases. The brown cataphyll surrounding the petiole of most recently-emerged leaf is clearly visible.

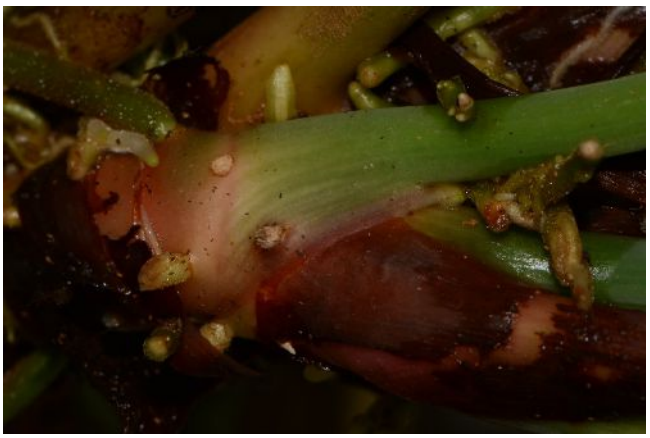

Figure 7

Figure 8

Figure 9

Figure 9. *Schismatoglottis tecturata* (Schott) Engl. Inflorescence at pistillate anthesis

Figure 10

Figure 10. *Schismatoglottis* sp. The typical constriction separating the persistent lower part and the deciduous limb is readily seen.

Figure 11. *Schismatoglottis* sp. Spathe limb being shed during staminate anthesis.

Figure 12. *Schismatoglottis tecturata* (Schott) Engl. Inflorescence at late pistillate anthesis. The two insects are *Colocasiomyia* (Diptera).

Figure 11

Figure 12

Figure 13

Figure 13. *Schismatoglottis tecturata* (Schott) Engl. Inflorescence at late pistillate anthesis with nearside spathe artificially removed to display the spadix.

Figure 14

Figure 14. *Schismatoglottis tecturata* (Schott) Engl. Inflorescence at late pistillate anthesis showing detail of the basal two thirds of the spadix.

Figure 15. *Schismatoglottis tecturata* (Schott) Engl. Spathe artificially removed to better display the ring of large staminodes at the base of the pistillate flower zone.

Figure 16. *Schismatoglottis tecturata* (Schott) Engl. Spadix at pistillate anthesis.

Figure 15

Figure 16

Figure 17

Figure 18

Figure 17. *Schismatoglottis tecturata* (Schott) Engl. Spadix at late staminate anthesis. Note the change in the appearance of the staminate flowers as compared with the same flowers in **Figure 16.** Note, too, that the spadix appendix is now clearly differentiated.

Figure 18. *Schismatoglottis tecturata* (Schott) Engl. flowering in habitat. The beetles are Chrysomelidae plundering the inflorescences for pollen.

Figure 19

Figure 20

Figure 21

Figure 22

Figures 19 & 20. *Schismatoglottis tecturata* (Schott) Engl. inflorescence at early staminate anthesis. Note that the margins and distal portion of the spathe limb is beginning to darken (compare with **Figures 9** & 12).

Figures 21 & 22. *Schismatoglottis tecturata* (Schott) Engl. inflorescence at late staminate anthesis. The spathe margins and distal portion of the spathe are now beginning to degrade.

Figures 23 – 25. *Schismatoglottis tecturata* (Schott) Engl. inflorescence post staminate anthesis. The degradation of the spathe margins and distal portion of the spathe is now quite clear. Note in **Figure 25** that the tissue at the horizon of the still green spathe and the degraded margin is now dead.

Figure 23

Figure 24

Figure 25

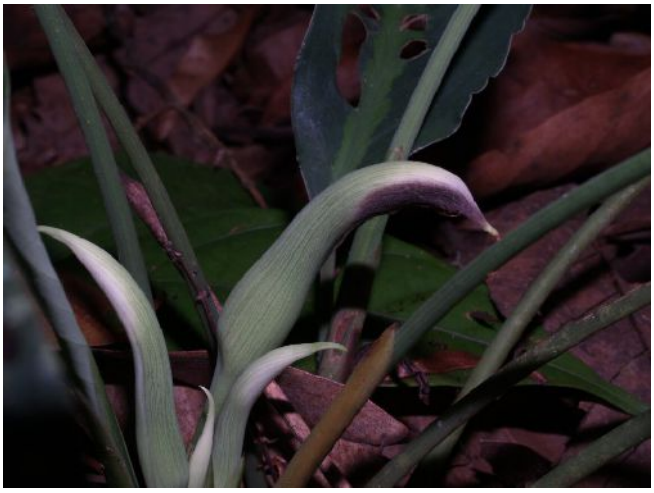

Figure 26

Figures 26 & 27. *Schismatoglottis tecturata* (Schott) Engl. in habitat with post-anthesis inflorescences. Note the dry tissue along the margins and the distal part of the spathe. Compare the position of this degraded tissue with the spathe limb being shed in **Figure 11.** It is plausible that the green portion of the spathe in *S. tecturata* is the equivalent of the lower spathe in other *Schismatoglottis* species, as exemplified in **Figure 11.**

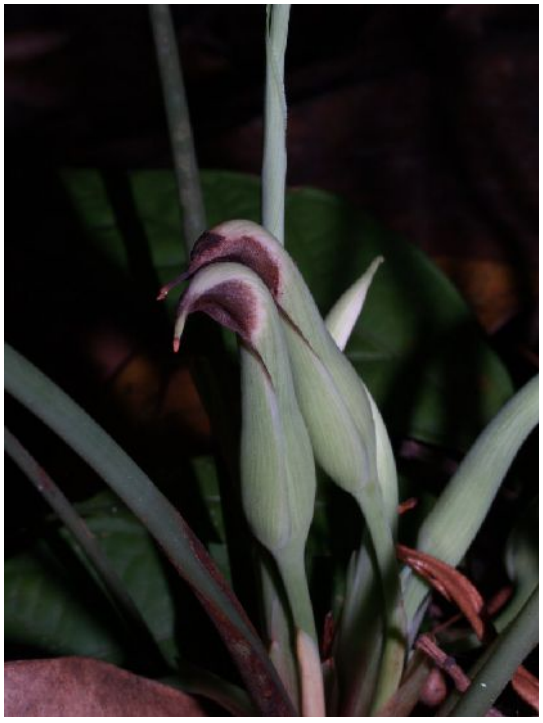

Figure 27

Figure 28

Figure 29

Figure 30

Figures 28 & 29. *Schismatoglottis tecturata* (Schott) Engl. in habitat with post-anthesis inflorescences. In this instance persistent wetness has resulted in the rotting (deliquescing) of the spent parts of the spathe. Note that the basal part of the spathe is now swelling owing to the developing fruits. Note, too, that the persistent portion of the spathe has become green.

Figure 31

Figures 30 – 33. *Schismatoglottis tecturata* (Schott) Engl. in habitat with developing infructescences. The scar left by the shedding of the margins and distal portion of the spathe is clearly visible in **Figure 33.**

Figure 32

Figure 33

Figure 34

Figure 34. *Schismatoglottis tecturata* (Schott) Engl. Splitting of the spathe at fruit ripeness. Note that the spathe has turned brown.

Figure 35. *Schismatoglottis tecturata* (Schott) Engl. Spathe, split from the peduncle/sopathe insertion, with the spathe walls curling acroscopically. Compare this with the mediascopically (**Figure 39)** and basiscopically (**Figure 40)** splitting of spathes.

Figure 35

Figures 36 – 38. *Schismatoglottis tecturata* (Schott) Engl. Further movements of the spathe wall reveal and enable release of the ripe berries.

Figure 36

Figure 37

Figure 38

Figure 39. *Schismatoglottis* sp. Infructescence splitting mediascopically.

Figure 40. *Schismatoglottis* sp. Infructescence splitting basiscopically.

Figure 39

Figure 40

References

Boyce, P.C. & Wong S.Y. 2013 Studies on Schismatoglottideae (Araceae) of Borneo XXXIII – A review of the *Schismatoglottis* Tecturata Group, including description of a new species, *Schismatoglottis evelyniae*. Aroideana 36E(1): 4–15.

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

Acknowledgements

This is part of an on-going research which is funded by the Ministry of Higher Education, Malaysia by the Exploratory Research Grant Scheme Vote No. NRGS/1089/2013-(03).

Ethnobotany of Medicinal Aroids in Xishuangbanna, Yunnan Province, China

Bo Liu, Yujing Liu*, Wujisiguleng Cao, Shuang Zhang, Zhengze Liu, Yanan Ni, Feifei Li
College of Life and Environmental Sciences,
Minzu University of China
Beijing 100081, China
PHONE:+86–010–68936070, FAX:+86–010–68930381

*** Yujing Liu also at: Jiangsu University, Jiangsu, China, 212013**

ABSTRACT

Based on ethnobotanical investigation and references review, five species of Araceae are reported as of great medicinal value in Xishuangbanna, Yunnan. They are *Alocasia cucullata* (Lour.) G. Don, *A. odora* (Roxb.) C. Koch, *Colocasia esculenta* (L.) Schott, *C. gigantea* (Blume) Hook.f. and *Lasia spinosa* (L.) Thwait. Their scientific name, Chinese name, local name, distribution, use in traditional medicine, a review of natural-product chemical constituents, potential ecological depositions and conservation issue are described and discussed. Conclusion has been made that these aroids have great exploitation and utilization value, but future work is still needed to make full use of these species.

KEY WORDS

Ethnobotany; Araceae; Chemical constituents; Xishuangbanna, China

INTRODUCTION

Araceae Juss. is one of the highly medicinal valuable families in angiosperm, mainly because of its species diversity, occurrence in a wide range of habitats in accordance with hotspots of both biodiversity and ethnic groups, especially in subtropical and tropical area including Southeast Asia, and the New World tropics. Its status as an integral part of the culture and the family-based economy of many traditional communities for therapeutics, food, ornamentation, fence etc.

China harbors a rich Araceae flora, 26 genera and 181 species of aroids, in which 72 species are endemic to the country. The use of aroids as medicine in South China is

very common, and has a long history; taro (*Colocasia esculenta*) was recorded as an herbal medicine around 220–450 AD; Ban xia (*Pinellia ternata*) firstly appeared in "Huang Di Nei Jing" as a medicinal plant in 475–221 BC, and other species such as Qiannian Jian (*Homalomena occulta*) and Yan Yu (*Remusatia vivipara*) were used early, while the cultivation of konjac (*Amorphophallus konjac*) in China happened at least 1700 years ago. However, many medicinal species of Araceae in China still need to be explored and testified.

For the research, Xishuangbanna, with high plant diversity and ethnic diversity was chosen as the research site. Field investigation and ethnobotany survey were made to perform an ethnobotanical study involving these aroids in the municipality of Xishuangbanna. The present paper summarized the results of the investigation, and related research about chemical constituents of the selected species have been reviewed. Medicinal aroids plants identified are a potential source for new bioactive compounds of therapeutic value in ethnomedicine.

Materials and Methods

The study site

Xishuangbanna Dai Autonomous Prefecture is a tropical area of China situated in southernmost Yunnan Province, on the border with Laos and Burma (**Figure 1)**. Lying between 21°00' and 21°30' North Latitude and 99°55' and 101°15' East Longitude, the prefecture occupies 19,220 square kilometers of territory. It is known popularly as the "Kingdom of Plants and Animals". A great diversity of vegetation types including tropical rain forest, seasonal rain forest, montane rain forest. Xishuangbanna lies at the transitional zone between the floras of Malaya, Indo-Himalaya, and South China and therefore boasts a great number of plant species. So far, about 4,000 species of vascular plants have been identified. Meanwhile, there are more than 13 ethnic groups aborigines, who harbor profound traditional knowledge.

Plant collections

The ethnobotanic survey were carried out in Xishuangbanna between 2011 and 2012. The field study was preceded by an ethnobotanical study in which we established the related villages of different ethnic groups. About 60 family in 4 community (Menglun, Jinghong, Manbian, Jinuoshan) were surveyed.

During the investigation, ethnobotanical data were collected through different interview methods: participatory rural appraisal (PRA), direct observation, semi-structured interviews, key informant interviews, individual discussions and focus group discussions (FGD) (Alexiades & Sheldon, 1996; Long & Wang, 1996; Chambers, 1994). At the beginning of the research, we conducted open interviews with tour guides and local leaders in Xishuangbanna. We asked what aroids

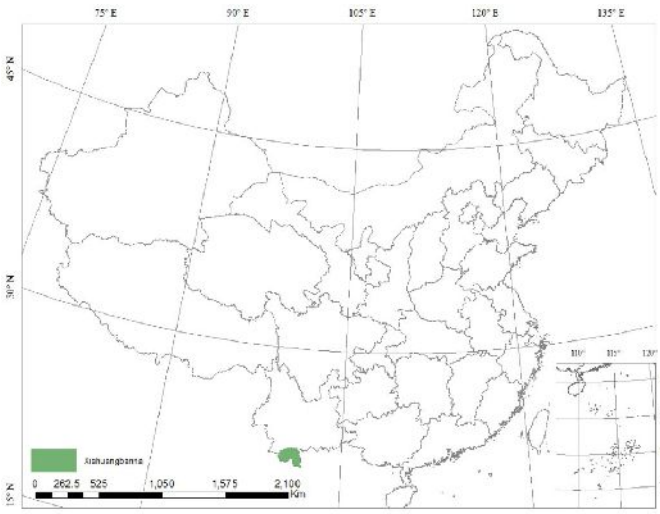

Figure 1

Figure 2

Figure 1 Location of Xishuangbanna in China

Figure 2 Wild population of *Alocasia cucullata*

species they knew in the region. We wrote down all names, and sorted out the candidate species by its ethnic use, information on traditional ethnoveterinary medicine knowledge and choice of treatment providers was also obtained. Then, for each species, color photographs occurring in the area was shown to the community members being interviewed (Martin, 2010), to record the culture value that may have effects on their traditional life (Li et al., 2014). Specimens of target species were collected, examined and identified by the authors and other taxonomists and deposited in the Herbarium of the Minzu University of China (Beijing).

Results and discussion

A total of 5 ethnospecies, belonging to 5 botanical species are investigated as frequently used medicinal species. Their traditional medicinal use, economic and ethnobotanical applications are presented in this paper listed in Table 1 by Dai, Yi, Yao, Han, Hani, Jinuo and other ethnic groups, in addition to notes on their uses as fences, wild edible plant and fodder.

Ethnobotany informant consensus and chemical components study on medicinal aroid species

The medicinal uses of the different aroid species were classified into two categories: medicines and veterinary drug and fences (Tab. 1). Since the five aroids were used by many different cultures in

Figure 3

Figure 4

Figure 3 Wild population of *Alocasia odora*

Figure 4 *Colocasia esculenta* planted in the yard of Miao people

Xishuangbanna, the ethnobotanical uses detailed are listed by ethnic groups, besides, chemical composition of each species for testify of ethnomedical uses have been reviewed and synthesized.

1. *Alocasia cucullata*

This species is widely used mainly as medicinal plant by local ethnic groups: Dai people use ground fresh rhizome externally on skins to cure snake and insect bites, cough, pulmonary tuberculosis, bronchitis and so forth. Yao people use its fresh rhizome externally for treating otitis, inflammation and swelling, burnt. Yi people use its fresh rhizome for curing leprosy.

For chemical composition, this species has been reported for the roots containing amino acids 0.99%, and the other containing calcium oxalate and cyanogenic glycosides, etc_ (Li, 1990). Other researchers isolated N-acetyl-D-lactosamine (LacNAc) (Xiao et al., 2014; Kaur et al., 2005), and 12 kinds of other chemical components (Xiao et al. 2014), they are steroids, alkaloids and phenolic compounds. Some compounds have good biological activity, 100μg/mL concentration N-acetyl-D-lactosamine has 50% inhibition for human cervical cancer cells, and when in vitro low dose (10μg / mL) have the effect of promoting human peripheral blood mononuclear cells in mitosis (Peng et al., 2013).

2. *Alocasia odora*

The rhizomes are medicinal by local Dao, Yi and Zhuang people, for abdomen

Figure 5

Figure 6

Figure 5 Wild individual of *Colocasia gigantea* in Menlun, Xishuangbanna

Figure 6 Local people feed pigs using petioles of *Colocasia gigantea*.

ache, cholera and hernia. Besides, this species has an excellent value for ornamentation for its huge leaves, unique shape, easy cultivation and few insect pests: it has been cultivated indoors or outdoors as an important tropical ornamental plant in Xishuangbanna.

For chemical composition, it is reported a total of 10 compounds were isolated and identified as a triterpenoid glycosides, two flavonoid C-glycosides, 5 lignan glycosides, a lignan and an alkaloid (Viet et al., 2006).

3. *Colocasia esculenta* (taro)

In Xishuangbanna, taro is widely cultivated by local people mainly for food, ornamentals or fodder. Also it is used as a medicine: tubers medicinal for curing mastitis, mouth sores, carbuncles sore treatment, cervical lymphadenopathy, burns, trauma and bleeding; petioles for curing hives and scabies. It is a good drug diet species, it does not contain solanine, is easy to digest and does not cause poisoning. It is a good main food. Due to starch granules in taro, and only one tenth of potato starch, the digestibility is up to 98.8%. However, the whole plant is poisonous, and the tuber especially highly poisonous if it is not fully cooked (if somebody has mistakenly eaten the raw tuber and has the phenomenon of tongue and throat burning, itching, swelling), the use a little vinegar with ginger, taken orally can get rid of the toxin).

It should be noticed that aboriginal peoples have a traditional wisdom for the cultivation of this species, and have handed

down some conventions for planting, such as to use middle sized and undeveloped tuber as seedlings; intercropping with fruit or corn crop to get higher productivity and less plant disease and insect bites; seedling tuber should be placed in a warm, dry and well ventilated cellar or indoor for long time conservation.

Chemical composition of *C. esculenta* has been studied. (Li et al., 2005) showing that the abstraction of taro stems contain hentriaconta-, stigmasterol, canola sterols, β-sitosterol, palmitic acid, daucosterol. Taro contains 19 kinds of trace elements, including K, Ca, Si, P, Fe, Mg, Mn, Na, Al, Cu, Ti, Ba, Sn, Cr, B, Ni, Mo, Ag, V (Li et al., 1996)) . In addition, it also contains 17 kinds of free amino acids, a total of 89.8mg / 100g, seven kinds of essential amino acids which the body needs for health (totalof 17.1mg / 100g), water-soluble polysaccharide 12.0% (Li et al., 1996). Aroma components of taro research shows that the main aroma components contained in fresh taro is 2C, 6C, 8C and 11C of alcohols . Oxalate is ubiquitous substance in Araceae, content of oxalate in taro is 328–460 mg / 100g .

4. *Colocasia gigantea*

This species in Xishuangbanna region is very important with *C. gigantea* also used as feed or medicinal source. For example Hani people feed leaves to pigs, they think a small amount of leaf can kill insects inside pig stomach, but too many leaves will cause pig anorexia. Also it can be used as a vegetable good for health, people of many ethnic groups and collect their petioles cultivated for food, fresh leaf petiole is very common sold in the local bazaar. It is widely cultivated in tropical regions since wild individuals are not able to be eaten because of the hemp flavor.

Currently very few studies have been made of the chemical composition of this species. Liu recently used a chemical fingerprint method (LC-MS) for *C. gigantean,* with cultivation and wild-type analyzed, 24 peaks, preliminary judgment mainly glycosides and flavonoids, such as the orientin, isoorientin, isoschaftoside, vicenin, Lut-6-C-Hex-8-C-Pent, etc. In the wild-type Lut-6-C-pent-8-C-Hex and Lut-7-O-Rhmn (1→2) Hex were found, but were not detected in the cultivated-type.

5. *Lasia spinosa*

This species' tender leaves are used frequently by local people for vegetables, some local markets investigated are selling the leaves seasonally. Moreover, the rhizomes are used by Dai, Hani and Jinuo ethnic group as ethnomedicine: Dai people use the rhizome to cure lymphadenopathy, lymph nodes inflammation, gastritis, dyspepsia, snake bites, bruises, rheumatoid arthritis; Hani people use the rhizome function the same as Dai people in Xishuangbanna. Jinuo people use the rhizome for treatment of chronic gastritis, dyspepsia and rheumatic joint pain.

Figure 7

Figure 8

Figure 7 Cultivated *Colocasia gigantea* for vegetable in Manbian, Xishuangbanna

Figure 8 *Lasia spinosa* shoots sold in the traditional market

A series of phytochemistry studies have been conducted for its leaves and rhizome, it has been reported to have anticestodal efficacy, antinociceptive efficacy, antioxidants efficacy, leaf extracts showed mild antimicrobial property . The rhizome is a rich source of dietary fiber with 40% - 75% of total dietary fiber on dry weight basis, (7.2% - 7.5% on fresh weight basis) constituting 35% - 60% and 4% - 18% of insoluble and soluble fiber respectively. The rhizome can be considered as a valuable functional food from the viewpoint of its antioxidant and dietary fiber content (Shefana & Ekanayake, 2009).

Pharmacological activities compared with the ethnobotanic uses

Many aroids are used as traditional remedies or food. In our analysis, we have compared the folk phytotherapeutical data collected in our study with data present in the phytochemistry literature, many of new research information reported concerning *Alocasia odora*, *Colocasia esculenta*, and *Lasia spinosa*. On the contrary, for *A. cucullata* and *C. gigantea*, few researches have been found for the chemical components. The pharmacological activities of only *Colocasia esculenta*, and *Lasia spinosa* are partly in agreement with the ethnobotanic uses reported in this paper.

Traditional knowledge of Araceae still needs to be discovered, inventoried, and verified. For *C. esculenta*, although it has been cultivated for more than 1700 years, the medical use seems not fully recognized by us, the medicinal value are practiced only in some remote areas such as Xishuangbanna.

For *A. cucullata* and *A. odora*, they are ordinarily known as ornamental or fence plant, while, the medicinal values, according interviews of local people, are very efficient for some disease, while this kind of use is only known and practiced in some restricted parts. For *C. gigantea*, which is famous and well preserved by the tropical ethnic groups, the medicinal value are still being tested.

To sum up, the phytochemistry of these species is poorly known and identifying new bioactive compounds deserves further study. Although further testing is needed, it appears, based on the evidence of these studies and historical use, these species may still have some beneficial applications in modem medicine. Chemical study explained the traditional knowledge of indigenous usage . Future tests on many microorganisms and conditions should be carried out to testify the historical record of use whether they contains some special secondary metabolomics products that are useful for indicating their applications for some traditional ailments.

Frequency of medicinal and drug diet aroids used in Xishuangbanna

During the ethnobotanical survey, we found these aroids are frequently used by local people: *A. cucullata*, *Lasia spinosa* are known by all the families consulted, while *A. odora* is know by 35 families, *Colocasia gigantea* and *C. esculenta* are known mainly for their edible value but not for medicinal value, but as diet drugs *C. gigantea* and *C. esculenta* are very popular too. More than 200 species are recorded used by local people for edible vegetables , while the two species can be seen in most family's yard and in the traditional market, 45 families out of 60 planted *C. gigantea*, 32 families cultivated *C. esculenta*: they can be listed into the top 10 most frequently eaten vegetables for local people.

Ecological biomass resources and their commercial potential

Although the utilization is limited and only regional, wild resources of *C. gigantea*, *Lasia spinosa* and *A. cucullata* are very abundant in Xishuangbanna. We observed wild populations growing in valleys near the river, hillsides or roadsides during expeditions near villages, consequently, they have great potentials for making medicinal resources and they can easily to be put under mass production. Further researches are still needed to make full utilization of the natural resources.

These species play an important role in providing local people with cheap and effective medicine, and various vital nutrition elements as edible wild plants. And as previous shown *A. cucullata* and *C. esculenta* were reported to have low fat, high dietary fiber, all essential amino acids, various mineral elements and vitamins, we can deduce petioles of *C. gigantea* should have the same nutrition for they have a very close systematic relationship. Wild edible plants can provide resources for future exploitation as new health foods. As living standards improve, there is a globally

increased demand for healthy and safe food .. Compared to conventional, cultivated vegetables, wild food plants require less care, are not affected by pesticide pollution, and are a rich source of micronutrients. It is generally believed that local people are more likely to support and participate in conservation initiatives if they can receive direct benefits from such efforts. If managed sustainably, these plants could be a good means of income generation for rural communities.

Issues of conservation

Wild resources of Araceae species are threatened by various natural causes and human activities in Xishuangbanna. Extreme weather caused by global climate change, such as severe droughts and accompanied by increasing insect damage, has resulted in the decrease and even loss of plant populations. For *C. gigantea*, which relies on certain kinds of insects for pollination, the increasing temperature has resulted in the upset of insect life cycles so as to make the propagations of *C. gigantea* difficult. Various human activities such as land use change, habitat destruction, overharvesting and over-grazing, are major threats. In recent years, with the decreasing of traditional Swidden Agrosystem, increasing rubber tree farms, construction of roads, reservoirs and other infrastructure, wild habitats for edible plants were severely impacted (Xu et al., 2009). This is especially the case for *C. gigantea* and *A. odora*, which are vulnerable to the change of habitat.

Moreover, the traditional knowledge associated with aroids is also decreasing. Therefore, systematic documentation of indigenous knowledge and biological resources is of great significance . Along with economic development and increasing income, only a few people want to collect or cultivate wild edible or medicinal plants . The younger generation is becoming less interested in them, thus causing the giant loss of traditional knowledge. In Xishuangbanna where tourism is booming and local people eagerly want to serve as guides or drivers in tourist areas to pursue more money or discard their original living style of swidden agriculture and instead grow rubber trees in all their land, which is predicted to have soil organism loss and soil compaction. With the convenience of modern western medicine, residents can buy medicine more cheaply from drugstores than ever before and do not need to collect wild species. However, in more remote rural communities where transportation is still inconvenient and people are very poor, they seldom go to the drugstore, and indigenous knowledge about wild ethnotaxa is relatively intact. During our survey we found that most people are reluctant to cultivate *C. gigantea* now because planting rubber trees can bring more cash income.

ACKNOWLEDGMENTS

Thanks to all interviewed local people in Xishuangbanna, leaders and local guides, especially Yi Wan, Qi Xiu, Shifu Zhu; also thanks Dr. Bo Pan from Xishuangbanna tropical botanical garden. Special thanks to

NAME OF PLANT	CHINESE NAME/PINYIN	LOCAL NAME	ETHNIC USE BY COMMUNITIES
Alocasia cucullata (Lour.) G. Don	老虎芋/laohu yu	Banbie, manbi (Dai ethnic group); Doubuhou, wogao, luodaiyi (Yao ethnic group)	Medicinal; Hedges
A. odora (Roxb.) C. Koch	海芋/hai yu	Banbiao (Dai ethnic group)	Medicinal; Ornamentation
Colocasia esculenta (L.) Schott	芋/yu	Dupiye, Yutou (Local people)	Medicinal; Crop; Fodder
C. gigantea (Blume) Hook.f.	大野芋/daye yu	Pagfu (Dai ethnic group); Kai yang (Hani ethnic group); Zao liyang (Jinuo ethnic group); Houbun (Yao ethnic group); Bai yugan (Yi ethnic group)	Veterinary drug; Ornamentation; Cultivated as edible plant; Fodder
Lasia spinosa (L.) Thwait.	刺芋	Panan, Pakena, Hepanan (Dai ethnic group); Re yu (Hani ethnic group); Yangduo (Jinuo ethnic group)	Medicinal; Veterinary drug; Wild edible plant

Table. 1 Five aroids uses by the Xishuangbanna Community: Chinese name, Local name, and Ethnic use.

the financial support of 111 Project B08044, and National Natural Science Foundation of China (No. 31400182, 31400192, 31070288 & 31161140345).

REFERENCES

Acharya, K. P. & R. Acharya. 2010. Eating from the wild: indigenous knowledge on wild edible plants in Parroha VDC of Rupandehi district, Central Nepal. *Int. J. Sci.* **3**: 28–48.

Acharya, R. & K. P. Acharya. 2009. Ethnobotanical study of medicinal plants used by Tharu community of Parroha VDC, Rupandehi district, Nepal. *Scientific World* **7**: 80–84.

New species of *Xanthosoma* (Araceae) from Western French Guiana

Thomas B. Croat
P.A. Schulze Curator of Botany
Missouri Botanical Garden
P.O. Box 299, St. Louis, MO 63166
Thomas.croat@mobot.org

Vincent Pelletier
Biotope Amazonie-Caraïbes
French Guiana

Ludovic Salomon
Biotope Amazonie-Caraïbes
French Guiana

Jean Weigel
Agroforesterie de la Comté
French Guiana

ABSTRACT

A new species of helophytic *Xanthosoma*, *X. nodosum* Croat & V. Pelletier, is reported for western French Guiana. The species is a member of section *Xanthosoma* and is allied with *X. sagittifolium* (L.) Schott and *X. jacquinii* Schott but differs from both of those species by its hydric habit and conspicuously arrayed short knobby root-like propagules on its stem. In addition, *Xanthosoma jacquinii* also differs by having a spathe tube which is dark purple on the inside.

KEY WORDS

Araceae, *Xanthosoma*, French Guiana, new species.

INTRODUCTION

The genus *Xanthosoma* remains one of most taxonomically difficult and poorly known genera of Araceae in the Neotropics. There are currently 67 published species with numerous known but unpublished new species. In addition to Xanthosoma nodosum Croat & V. Pelletier which is described here, the species

Figure 1

Figure 2

Figure 1. *Xanthosoma* cf. *nodosum* Croat & V. Pelletier (*Pelletier 301*). Habit of plant near Lezard River.

Figure 2. *Xanthosoma* cf. nodosum Croat & V. Pelletier (*Pelletier 301*). Stem showing closely arranged rows of root-like propagules, near Lezard River.

Note that images for ***Figures 1-3*** *were taken of plants from a different population in the vicinity of Elysée, near the Lezard River (04°45'14"N, 54°02'44"W).*

currently reported for the Guianas include *Xanthosoma acutum* E. G. Gonç., *X. belophyllum* (Willd.) Kunth, *X. caracu* K. Koch & C. D. Bouché, *X. conspurcatum* Schott, *X. cordatum* N. E. Br., *X. granvillei* Croat & S. A. Thomps., *X. helleborifolium* (Jacq.) Schott, *X. sagittifolium* (L.) Schott, *X. striatipes* (Kunth & C. D. Bouché) Madison, *X. striolatum* Mart. ex Schott, *X. undipes* (K. Koch & C. D. Bouché) K. Koch and *X. violaceum* Schott.

Figure 3

Figure 4

Figure 3. *Xanthosoma* cf . *nodosum* Croat & V. Pelletier (*Pelletier 301*). Stem showing close-up of the propagules which are easily dislodged from the stems near Lezard River.

Figure 4. *Xanthosoma nodosum* Croat & V. Pelletier (*Pelletier 301*). propagules after having been removed from stem; near vicinity of "Yaou".

Species with rhizomatous stems which form a prominent erect trunk include *Xanthosoma granvillei*, *X. sagittifolium* & *X. undipes*. Those with tuberous stems are *Xanthosoma acutum*, *X. belophyllum*, *X. caracu*, *X. conspurcatum* and *X. violaceum*. *Xanthosoma granvillei* differs from *X. nodosum* by having smooth stems, in having the interior of the spathe tube dark purple and the pistillate portion of the spadix bright orange; *X. undipes*, another large species, differs from *X. nodosum* by having the spathe tube purple within; *X. sagittifolium* shares the greenish spathe tube interior of *X. nodosum* but differs by typically having a thicker and smooth stem and leaf blades and petioles which are somewhat glaucous. The remaining species from the Guianas all differ in having tuberous stems. *Xanthosoma acutum* also differs by its small size, usually blackish drying mottled sagittate-subhastate leaf blades; *X. belophyllum* possesses a spathe tube which is greenish inside but differs from *X. nodosum* by having a stem growing only weakly above the soil and in lacking the short root-like propagules; *X. violaceum* also differs by having the spathe tube purple on the interior surface and *X. conspurcatum* differs by having its tuberous stems as well as by its small stature and leaf blades with flaring subhastate lobes.

HISTORY OF DISCOVERY

Plants with short knobby offsets on their stem were first discovered by Vincent

Figure 5

Figure 6

Figure 5. *Xanthosoma nodosum* Croat & V. Pelletier (*Pelletier 301*). Inflorescence at anthesis with strings of pollen exuding from stamens; near vicinity of "Yaou".

Figure 6. *Xanthosoma nodosum* Croat & V. Pelletier (*Pelletier 301*). Inflorescence at anthesis showing fertile male flowers and sterile male flowers with the lowermost male flowers yellowish; near vicinity of "Yaou".

Pelletier & Ludovic Salomon while on a survey mission with their company in the region of Elysée, near the Lezard River in western French Guiana. Vincent brought this population to the attention of the senior author by sending photographs. It seemed apparent that the species was new to science but without herbarium material of fertile plants there was little interest in pursuing the matter further. Jean Weigel then returned to this locality and collected leaves and inflorescences of this species. This specimen is registered as *Sophie Gonzalez 3000*. Unfortunately the old inflorescence on the plant did not allow the senior collector to correctly describe this species. This collection continues not to be identified with certainty in the absence of knowledge of the flower colors.

Later, Ludovic Salomon found a second population much further to the south but again in western French Guiana, in Yaou, near Maripasoula. That population had flowering individuals and again photographs were sent to the senior author. At this point it was possible to begin drafting a complete description of the plant and it was reported as a new species. Neither Pelletier nor Salomon had gathered the essential herbarium material even though living plants were collected and initially established with Joep Moonen at Emerald Jungle Village in Matoury. Later this

Figure 7

Figure 8

Figure 7. *Xanthosoma nodosum* Croat & V. Pelletier (*Pelletier 301*). Inflorescence at anthesis showing outer abaxial surface; near vicinity of "Yaou".

Figure 8. *Xanthosoma nodosum* Croat & V. Pelletier (*Pelletier 301*). Inflorescence at anthesis showing greenish interior (adaxial) spathe tube surface and whitish inner surface of spathe blade; near vicinity of "Yaou".

material was transferred to nursery in Cayenne as well as to Geneviève Ferry at the Conservatoire et Jardins Botaniques de Nancy in France. An attempt is being made to establish the species in a living collection where further studies can be made on the species.

We were fortunate that the company Biotope Amazonie-Caraïbes with which Pelletier and Salomon were employed had such sufficient interest in collecting this interesting new species that they agreed to launch a special expedition whereby Pelletier was able to return to western French Guiana to gather flowering individuals to prepare adequate herbarium material to describe the plant.

Xanthosoma nodosum Croat & V. Pelletier, **sp. nov.** Type: FRENCH GUIANA. Near the Commune of Maripasoula, adjacent to the Maroni River on the border with Suriname, vicinity of "Yaou" located within the SMYD mining concession (Mining Company Yaou Dorlin), 03°43'15.6 ' N, 53°57'04.3'W, 110 m, 23 June 2014, *Vincent Pelletier 301* (holotype, CAY; isotypes, K, MO, NCY, P, US. **Figures 4–10**.

The species is a member of section *Xanthosoma* characterized by its stout erect stems, conspicuously disposed short stout stubby propagules, semi-erect leaves, petioles sheathed to nearly the middle,

Figure 9

Figure 10

Figure 9. *Xanthosoma nodosum* Croat & V. Pelletier (*Pelletier 301*). Inflorescence at anthesis showing yellowish green pistillate spadix and the partially eaten sterile male section; near vicinity of "Yaou".

Figure 10. *Xanthosoma nodosum* Croat & V. Pelletier (*Pelletier 301*). Young infructescence showing pale yellowish green fruits nearing maturity; near vicinity of "Yaou".

ovate-sagittate blades which have the major veins on the upper surface sunken and have the posterior lobes directed toward the base or directed somewhat outward as well as by its pairs of inflorescences with a spathe tube dark green outside and pale green inside and a pale yellowish green pistillate portion of the spadix. The conspicuous and easily detachable propagules borne low down on the stem have unquestionably evolved as a means of aquatic vegetative dispersal for vegetative reproduction since the species is restricted to areas along water courses.

Xanthosoma nodosum is probably related to *X. caulotuberculatum* G. S. Bunting (Bunting, 1975) which was described as having similar propagules on the stem. That species is known for certain only from Venezuela in an area of sandy soils located in a *Premontane wet forest* life zone at 850–900 m elevation and has leaves with thicker leaf blades that dry dark brown not light green. In addition, *Xanthosoma caulotuberculatum* has a much broader petiole, more broadly curved posterior ribs with 5(6) pairs of acroscopic basal veins (versus 3(4) for *X. nodosum*), with a more gradually spathulate sinus and with the naked portion of the posterior rib ending before departure of the 2nd pair of basal veins (versus after the

departure of the 2nd pair of basal veins for *X. nodosum*) and more obscure and more widely spaced tertiary veins on the lower blade surface.

Xanthosoma nodosum keys to *X. jacquinii* Schott in the as yet unpublished treatment of the Araceae for the Flora of the Guianas (Croat, in prep.) which differs in lacking the short knobby propagules on its stem and by having a spathe tube which is dark purple on the inside. It might also be confused with *X. sagittifolium* Schott which differs in typically having much larger leaves with the posterior lobes held closely together and generally lacking any naked portion of the posterior rib as well as by having a smooth stem.

Growing in swampy areas and along stream banks; **stems** to 1.8 m tall with the lower portion reclining across the ground; **internodes** 6–12 cm diam., light brown with fragments of dark brown epidermis with shallow longitudinal furrows and with conspicuous rows of propagules appearing like new roots at a casual look, arranged in irregular rows, these densely arranged and multidirectional at soil line, easily removable, 1.4–2.3 cm long, 7–10 mm diam., light brown, rounded at the apex with purplish brown tip, covered with occasional thin removable scales with several weakly protruding buds, the surface scurfy; **petioles** to 62–95 cm long, sheathed 0.38 to 0.54 its length (sheath 28.5–44.5 cm long), 3.3–4.5 cm wide, 2.5–4 cm thick and obtusely flattened adaxially at base, nearly terete midway, 12–17 mm wide, 12–16 mm thick, somewhat flattened near apex, 12 mm wide, 8 mm thick, the old petioles rotting and hanging on stem for a while, then deciduous; **blades** ovate-sagittate, 37.5 –50 cm long, 22.5–34.5 cm wide, 1.3–1.7(7) times longer that wide, 0.45–0.62 times as long as petioles, rounded with a weakly down-turned acumen at apex, deeply lobed at base; thinly coriaceous, medium dark green and semiglossy above, moderately paler and semiglossy below, drying dark green and matte above, moderately paler grayish yellow-green and weakly glossy below; **anterior lobe** 23–24.5 long, broadly convex on margins; **posterior lobes** ca. 1/3 as long as anterior lobe, 16–20.5 cm long, 9–12.5 cm wide at constriction, 9.5–14.5 cm wide at broadest point, in living condition directed toward base but somewhat outward, elevated at an angle to the midrib with lobes not touching and forming a spathulate or narrowly V-shaped sinus, sometimes overlapping with a closed semicircular sinus on larger leaves, the apex bluntly pointed; inner margin of posterior lobe gradually tapered to posterior rib; **posterior rib** directed straight to tip of lobe with basal veins regularly branching off, 4–5 acroscopic, 3–4 basioscopic, naked 1.7–2.8 cm; **sinus** parabolic to spathulate, becoming broadly hippocrepiform when blade is flattened; **midrib** obtusely sunken and concolorous above, narrowly rounded and paler below, drying concolorous and sunken above, round-raised, brownish, darker than surface and matte below; **primary lateral veins** 5–7 pairs obtusely sunken and concolorous above, narrowly rounded or convex, paler below, drying

brownish, darker than surface, 5-ribbed, the ribs finely granular; **tertiary veins** flat, clearly visible but not at all raised. INFLORESCENCES 2–3 per axil, erect; **peduncle** 14–15 cm long in flower, 5 x 10 mm, (to 20 cm long in fruit); **spathe** 15.5 cm long; **tube** 4.5 cm long, 2 cm diam., dark green and semiglossy outside, pale green on inside; **spathe blade** 11.7 cm long, flattening to 5.1 cm wide, markedly arched otherwise stiffly erect at anthesis, weakly medium green outside medially, greenish white along margins; inner surface pale greenish white and semiglossy; constricted area 1.5 cm diam. (flattening to 3.5 cm wide); **spadix** 13.5 cm long, erect with staminate spadix 11.3 cm long, 9–10 mm diam., creamy white, stiffly erect, moderately narrowed to a narrow bluntly rounded point; sterile staminate spadix 2.3 cm long (the portion actually eaten 1 cm long),1.2 cm diam. at base, 9 mm diam. at apex; **pistillate portion** 2.2 cm long in front, 1.3 cm long in rear, pale yellowish green; pistils ovoid, 3-locular; style thickened, ca. 2 mm thick; stigma 1.5–2 mm wide, depressed-globose with a prominent central funnel; ovules many, born on the lower portion of the central axis, 0.1 mm long, about twice as long as broad, funicle shorter than ovule width or about as long as ovule. INFRUCTESCENCES with spathe tube 6.5– 9 cm long, 2.9–5.5 cm diam.; spadix 3.5–4 cm diam.; berries greenish, obovoid, 7–8 mm long, 5 x 4 mm wide, turning whitish in alcohol; seeds ca. 10 per locule, black, 1.2 mm long, 1 mm diam., shiny, smooth.

Xanthosoma nodosum is endemic to French Guiana, known only from the western fringe of the region in areas of what is probably *Tropical moist forest* (estimated because no Holdridge life zone map exists for the area (Holdridge et al., 1971)). Comparable areas of similar elevation in southern Venezuela are classified as *Tropical moist forest* life zones, for example. The new species occurs in semi-open swampy areas or on hydromorphic soils along small shady streams, growing in moderately dense stands. In addition to the type locality plants closely resembling the new species have been also seen elsewhere in central French Guiana in the vicinity of Elysée (**Figures 8–**10), near the Lezard River, 04°45'14 " N, 54°02'44"W, as well as at Kotika on Maroni River, 03°57'15" N, 54°17'20"W. In light of the fact that there appears to be another species with very different inflorescence coloring associated with *Xanthosoma nodosum* these populations need to be revisited when they are in flower in order to be certain that they do represent *X. nodosum*. Thus, while the photographs of the habit (**Figure 8)**, the stem (**Figure 9)** and the close-up of the root-like propagules appear to be exactly like those of the type plant in Yaou, we have labeled these photos *Xanthosoma* cf. *nodosum* because the plants were not in flower at the time and thus their exact identity could not be known.

At the time that the type specimens were collected near Maripasoula, a curious second species was found growing in close proximity to the new species. It was also collected but unfortunately without leaves.

At the time it was simply believed to represent another plant in the population but that species differed dramatically by having an inflorescence which had the inner spathe tube color dark purple, not pale green and a bright and dark orange pistillate spadix, not a pale yellowish green pistillate portion. That plant which is presently known only from its inflorescence which was vouchered as a spirit collection under the number *V. Pelletier 307* will be further studied before we can determine it after leaves are collected.

A collection from Guyana (*T. McDowell 4205*) from the Barima-Waini Region at 91 m elevation is also reported to have small tubers to 3 cm long and 1 cm diam. Unfortunately no notes were given about the color of the spathe tube or the pistillate spadix. Another collection from Suriname (*Wessels Boer 1217*) is described as having a stem 40 cm tall which is densely covered with short aerial roots. Unfortunately the collection mentions nothing else of importance. Both of these collections must be compared with *Xanthosoma nodosum* since it might be the same or another closely related species. The collection in Suriname is positioned perfectly to be in the same habit, in a marshy creek in a forest just as in French Guiana but the collection from Guyana was made from NW Guyana and made no mention of being collected in swampy conditions.

The species epithet comes from the Latin "nodosus" (meaning knotted or knobby) referring to the knobby short propagules born mostly in rows on the stem.

ACKNOWLEDGMENTS

The authors wish to thank Vincent Rufray, Biotope Amazonie-Caraïbes administrator, an environmental investigation firm for providing assistance to recollect this species and to Sophie Gonzalez, Curator of the CAY herbarium for drying and shipping specimens to St. Louis. We also thank the Mining Company Yaou Dorlin (groupe AUPLATA SA) for understanding the importance of this discovery and for providing assistance in allowing us to return to the area for essential herbarium specimens.

REFERENCES

Bunting, G. S. 1975 (1977). Nuevas especies para la revisión de las Aráceas Venezolanas. *Acta Bot. Venez.* 10: 263–335.

Holdridge, L. R., W. H. Hatheway, T. Liang & J. A. Tosi. 1971. Forest Environments in Tropical Life Zones. Pergamon Press, New York.

Rediscovery of *Arisaema pierreanum* Engl. after 145 Years, and its Current Status

Nguyen Van Du*, Tran Van Tien, Le Cong Sy, Nguyen Thi Van Anh
Institute of Ecology and Biological Resources –
Vietnam Academy of Science and Technology

INTRODUCTION

The genus *Arisaema* belongs to the Arum family – Araceae, which includes about 210 species Govaerts & Frodin, 2002 and is distributed from temperate to tropical areas, mainly in high mountain region. Since established by Martius in 1831, the genus *Arisaema* was studied by different authors such as Schott (1860), Engler (1920), D. Chatterjee (1955), Hara (1971), Li Heng (1979), Ohashi and Murata (1980), Murata (1984), V.D. Nguyen (1998, 2000, 2002, 2005, 2007).

In Engler's publication, many new species from different countries were described. Among them, *Arisaema pierreanum* was described based on the collection from Ba Den mountain (Tay Ninh province of Vietnam) made by L. Pierre in his journey in Indochina in 1869. Over 150 years passed without any collection of this species made from other places and with no information published on this species. This paper redescribes the species with more detailed morphological characters, discusses the status of the plant now, and provides images of living plants.

THE HISTORY OF ARISAEMA PIERREANUM ENGL.

The species was first described in 1920 by Engler in *Das Pflanzenzeich* based on Pierre's collection from Southern Vietnam. In 1942, when Gagnepain wrote "Aracceae" in '*Flore Générale de l'Indo-Chine*', he agreed with Engler that *A. pierreanum* is different from other species in Indochina. Murata also agreed 42 years later, that *A. pierreanum* is a distinct species in his publication 'An attempt at an infrageneric classification of the genus *Arisaema* (Araceae)' (Murata, 1984). In 1999, after studying a type specimen loaned to Smithsonian Institution, V.D. Nguyen reconfirmed *A. pierreanum* as a distinct species (identified label attached on the type specimen sheet). Compared with *A. harmandii* V.D. Nguyen recognised that *A. pierreanum* is much different in the male spadix having a much longer fertile portion and stamens dense in arrangement. Twice , in 2003 and 2006, in their book *The genus Arisaema,* Gusman & Gusman combined *A. pierreanum* into *A. roxburghii.* They stated that "it is difficult to separate *A. pierreanum* from *A. harmandii,* i.e. *A. roxburghii"* and he

Figure 1. Arisaema pierreanum Engl.: A. Habit with fructescence; B. Young inflorescence; C. Mature inflorescence ; D. Spathe opened and male spadix; E. Fertile portion

put the name *A. pierreanum* as a synonym of the name *A. roxburghii*.

Figure 1. Last year, the first author had an opportunity to visit Ba Den mountain together with a Chinese group from Academy of Science and Technology of China. His hope was to find *A. pierreanum*. Fortunately after 3 hours walking up the mountain he found plants of *Arisaema* growing on rocks. Herbarium specimens were collected without flowers but also some tubers for growing later. After several months growing in Hanoi, the plant flowered in April 2014. It was not a surprise that *Arisaema pierreanum* is much different from *A. roxburghii*. Truly *A. pierreanum* is a beautiful *Arisaema* species with its yellow spathe and a long duration in flower (for about two weeks). This is the first time a living plant collection of the species was made, 94 years after the plant was named by Engler and 145 years since the first collection by Pierre.

Arisaema pierreanum Engl.

Engl. Pflanzenr. 73 (IV. 23 F): 159 (1920); ***Typus:*** Vietnam: Tay Ninh, núi Ba Den, *Pierre sine num* (holo. – B!, iso. – P!);

Gagnep. Fl. Gén. Indoch. 6: 1186 (1942); Murata, Journ. Fac. Sci. Univ. Tokyo 3(13): 467 (1984);

Govaert & al. World Checkl. Bibliogr. Arac. 201 (2002);

V.D. Nguyen, in N.T. Ban, "Araceae" Checkl. Pl. Vietn. 3: 881 (2005).

Tuberous herbaceous plant, 25–40 cm high. Tuber small globose, 2–2.5 cm diam., covered by fibres remaining from leaf decay. *Leaf* solitary; petiole light meat-red colour, 23–40 cm long, sheath conspicuous at base only, upper part, c. 11–13.5 cm from cylindrical base, sheathed at base, convoluted with sheath margin conspicuous, upper part cylindrical; leaf blade trifoliolate; leaflets stipitate, 2 mm long at lateral leaflets, 1–2 cm at middle leaflet, elongate lanceolate, (10)16–21 cm long, (3)6–8.5 cm wide at widest point, base acute, apex acuminate, acumination 1 cm long, with arista 1 cm long; lateral veins 11–12 pairs, conspicuous, middle veins originate from lateral veins, sometime originate from midrib, collective vein distant from margin 4–5 mm; medium green, glossy at surface. *Inflorescence* solitary; peduncle slender, 14–28 cm long, dark meat red colour; spathe without auricular, spathe tube cylindrical or conical, 2.2–2.4 cm long, 1 cm diam. at base, 1.5 cm diam. near apex point, a little constricted at apex; spathe lamina lanceolate to triangular, 4–7 cm long, 1.5–3.5 cm wide at base, apex acuminate, 1 cm long, very light brown on light yellow background at tube part, yellow-greenish at lamina part, more green at upper when young, becoming really light yellow when older; male spadix with fertile portion cylindrical or conical, as long as spathe tube or a little longer, c. 2.2–2.6 cm long, 3–4 mm diam., flower dense, surface irregular; appendix filiform, 20–25 mm long, 1–1.5 mm diam., light yellow.

Stamens not really grouped; anthers short ovate, dehiscent by elliptical pores.

***Habitat*:** The plant grows on rocks under shade of evergreen rainy season tropical forest on high mountain 300–800 m above sea level.

Biology: Flowering in April to May. Inflorescence of *A. pierreanum* is fresh for two weeks.

***Specimens studied*:** Vietnam, Tay Ninh, Ba Den mountain, Pierr sine num. in 1869, about 300 m alt. (B, P); Nguyen Van Du, TQ-VN ???? (HN).

Relationship between arisaema pierreanum and other species

Arisaema pierreanum is a tuberous plant, the petiole having a conspicuous pseudostem and trifoliolate leaf blade stipe and leaf lobes with long petiolules. Following Gusman (2003; 2006), *Arisaema pierreanum* belongs to sect. Fimbriata, in the group including *A. roxburghii, A. condaoensis, A. harmandii and A. siamicum.* Among them, *A. roxburghii, A. harmandii* and *A. siamicum* share the character of having the appendix hardly exserted from spathe tube. *A. condaoensis* is distinguished from others by having a long appendix, much exserted from spathe tube. *A. pierreanum* is distinguished from others by its male spadix having long cylindrical, light conical fertile portion, and its stamens not in groups and densely arranged.

***Conservation*:** *Arisaema pierreanum* is an endemic species of Vietnam. Up to now its distribution known only from Ba Den mountain. The plant grown at a nearby Pagoda which is regarded as a sacred place so it is not disturbed too much. However the plant is vulnerable if any construction of the Pagoda is made without attention to plant conservation. Base on criterion of IUCN (2001), the plant should be arranged at VU level.

ACKNOWLEDGEMENT

The first author would like to thank the support from NAFOSTED grant number xxxx for our study Araceae in Vietnam and would like to thank the cooperation between Institute of Ecology and Biological Resources – Vietnam Academy of Science and Technology and Academy of Science and Technology of China in expedition in Ba Den mountain in Tay Ninh province of South Vietnam in 2013 where topotype were recollected.

REFERENCES

Chatterjee D. 1955. Indian and Burmese species of *Arisaema. Bull. Bot. Soc. Bengal* 8: 118–139.

Engler, A. 1920. *Das Planzenreich* 4, 23F: 159.

Gagnepain F. 1942. Aracées – *Arisaema*. *Flore Générale de l'Indo-Chine* 6: 1182–1191. Masson, Paris.

Govaert & al. 2002. *World Checkl. Bibliogr. Arac*. 201.

Gusman, G. & L. Gusman, 2003. *The genus Arisaema. A Monograph for botanists and nature lovers*. A.R.G. Gartner Verlag Kommanditgesellschaft. Ruggell, Germany.

Gusman, G. & L. Gusman, 2006. *The genus Arisaema. A Monograph for botanists and nature lovers*. Second revised and enlarged edition. A.R.G. Gartner Verlag Kommanditgesellschaft. Ruggell, Germany. ISBN 3–906166–37–6. 474 p.

Hara H. 1971. A revision of Eastern Himalayan species of the genus *Arisaema* (Araceae). *Flora of Eastern Himalaya. Second report*. 321–354. Univ. of Tokyo Press, Tokyo.

IUCN 2001. IUCN Red List Categories and Criteria. Version 3.1. IUCN Species Survival Commission. – Gland & Cambridge: IUCN.

Li, H. 1979. *Arisaema*. *Flora Yunnanica*. Academia Sinica Press 2: 799–833.

Mayo, S.L., J. Bogner & P. C. Boyce, 1997. *The Genera of Araceae*. Kew: Royal Botanic Gardens. ISBN 1–900347–22–9. 370 p.

Murata, J. 1984. An attempt at an infrageneric classification of the genus *Arisaema* (Araceae). *J. Fac. Sc. Univ. Tokyo* sect. 3(13): 431–482.

Nguyen V.D. & P.C. Boyce, 2005. Two new species of the genus *Arisaema* (Araceae) from Northern Vietnam. *Folia Malaysiana*, vol. 6 (1 & 2): 35–40.

Nguyen V.D. 1998. Discovery of new species of the genus *Arisaema* (Araceae) with medicinal value. *J. Material Medica* 3 (4): 102–103, 125. (Vietnamese).

Nguyen V.D. 2000. Two new species of *Arisaema* from Vietnam. *Aroideana*, 23: 36–40.

Nguyen V.D. 2002. Three new records of the genus *Arisaema* (Araceae) for Flora of Vietnam and their medicinal values. *J. Material Medica* 7 (3): 69–73.

Nguyen V.D. 2005. Two new records of the genus *Arisaema* (Araceae) for the Flora of Vietnam. *Proc. The 1st Nat. Sc. Conf. Ecol. Biol. Res*. 62–64. Agric. Publ. House, Hanoi. (Vietnamese).

Nguyen V.D. 2007. Two new records of the genus *Arisaema* (Araceae) for flora of Vietnam. *VNU J. Sciences 23*: 86–90.