

## Studies on *Schismatoglottideae* (*Araceae*) of Borneo LI: *Ooia* Revised, Including a Reconsideration of *Ooia grabowskii*

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Recollection of *Ooia grabowskii* at the Type locality in Kalimantan Selatan, Indonesian Borneo, has revealed the name to have been comprehensively misapplied to five taxonomically new Bornean *Ooia* species, here described as: *Ooia altar* S. Y. Wong & P. C. Boyce, sp. nov., *O. basalticola* S. Y. Wong & P. C. Boyce, sp. nov., *O. glans* S. Y. Wong & P. C. Boyce, sp. nov., *O. secta* S. Y. Wong & P. C. Boyce, sp. nov., and *O. suavis* S. Y. Wong & P. C. Boyce, sp. nov. *Ooia grabowskii* is endemic to the southern portion of the Meratus Mountains, Kalimantan Selatan. Clarification of *O. grabowskii* additionally reveals *Rhynchopyle havilandii* Engl. [= *Piptospatha havilandii* (Engl.) Engl.; *Schismatoglottis havilandii* (Engl.) M. Hotta], until now treated as a heterotypic synonym of *O. grabowskii*, to be a distinct species of *Ooia*: the combination *Ooia havilandii* (Engl.) S. Y. Wong & P. C. Boyce, comb. nov. is made. Newly observed spathe senescence mechanics of *O. grabowskii* and *O. basalticola* are strikingly in agreement with those of *Piptospatha manduensis* Bogner & A. Hay. Combined with the highly atypical (for *Piptospatha*) fragrant inflorescences, pubescent staminate flowers, and deciduous non-pistillate flowers, and typical (for *Ooia*) creeping/rooting stems and pendulous infructescences occurring in *P. manduensis* prompts removal of *P. manduensis* from *Piptospatha* and incorporation into *Ooia* – the combination *Ooia manduensis* (Bogner & A. Hay) S. Y. Wong & P. C. Boyce, comb. nov. is made. These novelties and transfers, taken together with pre-existing species, brings *Ooia* to 10 species. All species are illustrated from living plants, with *Ooia grabowskii* additionally figured from the Berlin Holotype, and from Engler's *Araceae Exsiccatae et Illustratae* No. 196. An identification key to all described *Ooia* species is provided.

**Key words:** Brunei, geological obligation, Kalimantan, rheophytes, Sabah, Sarawak.

*Ooia* S. Y. Wong & P. C. Boyce (Boyce and Wong 2013, 2015, Boyce et al. 2010, Wong and Boyce 2010, 2013) is monophyletic, defined by a persistent spadix axis, deciduous flowers, with pistillate flowers inserted on a conspicuous

cushion (Fig. 7H), a spathe completely persistent to persistent more than half its length, with the persistent portion ovoid-subcylindric to fusiform–funnel-form, and never flaring, and (in most species) production of copious plantlets

from the finer roots. All but three species have pendulous infructescences.

Establishing *Ooia*, Wong and Boyce (2010) followed Bogner and Hay (2000) considering *Ooia grabowskii* ( $\equiv$  *Piptospatha grabowskii* (Engl.) Engl. sensu Bogner and Hay 2000) as a morphologically broadly circumscribed and widespread species. Subsequent fieldwork correlating morphological characteristics with population distributions, geologies, the separation of species by discrete mountain blocks and drainage systems, and in particular re-collection of *O. grabowskii* at its Type locality in Kalimantan Selatan, has shown this approach to be in error. We now consider *Ooia grabowskii sensu* Wong and Boyce (2010) to be a heterogeneous assemblage of species, the greater part of which represents geographically restricted, geologically obligated taxonomic novelties.

With two exceptions (*O. altar* and *O. manduensis*) *Ooia* species are remarkably uniform in overall appearance, the more so when prepared into conventional herbarium specimens (see Boyce and Wong (2012) and Wong and Boyce (2014) for a critique on obstacles to correct interpretation presented by herbarium specimens of rheophytic aroids). *Ooia* species exacerbate this by spathes being not only outwardly highly similar, but also entirely obscuring the spadix upon which the majority of characteristic morphologies occur making observation of such characteristics, even in well-prepared collections, very troublesome. Furthermore, all critical spadix characteristics are lost post-anthesis. Consequently observation (Fig. 13) of living plants, in the field and over a period of several flowering episodes, such as can be enabled by access to a well-documented living collection, is critically important to the understanding of *Ooia* (and indeed to all aroids). It is by these methods that the taxonomy presented here has been arrived at.

Dimensions used in descriptions are derived from fertile (i.e., mature) plants. Seedlings and

root-initiated plantlets have overall smaller measurements.

In verifying geological associations we have been much assisted by the excellent geological map of Tate (2001).

### Key to the species of *Ooia*

1. Infrapistillar pistillodes reduced to a single row at base of spadix ..... 2
  - Infrapistillar pistillodes in several rows at base of spadix ..... 3
2. Infructescences erect; pistillodes absent; pistillate flowers laxly arranged, white. Sabah, Brunei ..... *O. kinabaluensis*
  - Infructescences pendent; pistillodes present as a single row at base of pistillate zone; pistillate flowers densely arranged, medium pink. Kalimantan Utara ..... *O. paxilla*
3. Infructescences erect. Gunung Nuit, NW Kalimantan Barat, basalts ..... *O. basalticola*
  - Infructescences pendulous ..... 4
4. Infrapistillar pistillodes glossy white; staminate flower zone exceeding width of pistillate flower zone. NW & SW Sarawak, sandstone ..... *O. glans*
  - Infrapistillar pistillodes never glossy white; staminate flower zone equalling or narrower than width of pistillate flower zone ..... 5
5. Fruiting spathe with upper portion rotting-deciduous to leave a shortly funnellform lower portion ..... 6
  - Fruiting spathe fully persistent, or only extreme upper margins rotting ..... 7
6. Diminutive creeping plants with much-branched rhizomes; leaf blades elliptic, 4–6 cm long  $\times$  2–3 cm wide; infrapistillar staminodes glossy deep yellow, somewhat lax; inflorescences fragrant of isoamyl acetate. Kalimantan Timur, travertines ..... *O. manduensis*
  - Large erect plants with little-branched rhizomes; leaf blades narrowly elliptic to narrowly lanceolate, very slightly falcate, 15–22 cm long  $\times$  5–6 cm wide; infrapistillar staminodes dirty pale cream, congested;

- inflorescences fragrant of cold cream.  
Kalimantan Selatan, granite and andesite .....  
..... *O. grabowskii*
7. Stigmas domed, bead-like; inflorescences  
fragrant of methyl salicylate. NW Schwaner  
Mountains, Kalimantan Barat, granites .....  
..... *O. altar*
- Stigmas flat, rhomboidal in outline;  
inflorescences not smelling of methyl  
salicylate ..... 8
8. Pistillate flower zone accounting for half  
spadix length; inflorescences strongly  
fragrant of benzaldehyde (almond oil).  
Kanowit, Sarikei and western Song  
(Sarawak), shales ..... *O. secta*
- Pistillate flower zone accounting for one third  
spadix length; inflorescences not smelling of  
benzaldehyde ..... 9
9. Spathe exterior conspicuously striped deep  
reddish pink; infrapistillar pistillodes glossy  
deep yellow; scattered pistillodes separating  
pistillate and staminate flower zones;  
inflorescences fragrant of methyl cinnamate.  
Kalimantan Tengah, unspecified volcanics ...  
..... *O. suavis*
- Spathe concolorous, mostly medium bright  
pink, rarely deep purplish pink, exceptionally  
pure white; infrapistillar pistillodes glossy  
pale cream; pistillate and staminate flower  
zones contiguous; inflorescences odourless.  
Rejang Basin, Kapit, Sarawak, sedimentaries  
..... *O. havilandii*

***Ooia*** S. Y. Wong & P. C. Boyce in Bot. Stud. (Taipei) **51**(4): 545 (2010); Boyce & al. Aroideana **33**: 45, pl. 21 (2010); Boyce & Wong in Aroideana **36**: 98–103 (2013); in Webbia **68**(2): 87–89 (2013); in Aroideana **38**: 112–113, fig. 33 (2015).

**Type:** *Ooia grabowskii* (Engl.) S. Y. Wong & P. C. Boyce.

Small to moderately robust rheophytic herbs. Stem initially erect, in most species becoming conspicuously elongated and rooting along its length; roots copious, stout, strongly adhesive,

active tips with conspicuous gel cap, finer foots usually producing large numbers of plantlets. Leaves several together at each active shoot tip; petiole well-defined, sheathing only at base, wings of sheath extended into a conspicuous soon-deliquesting narrowly triangular ligular portion; blade softly coriaceous, narrowly to broadly elliptic, plain or (in some species) variously blotched paler and darker green, apex tubular-apiculate; midrib prominent; primary lateral veins conspicuous; interprimaries much finer; tertiary venation obscure. Inflorescences solitary, most species fragrant at anthesis; peduncle erect or rarely pendent at anthesis, exceeding petioles. Spathe funnel-form, terminal third inflated and hooded, beaked apically and with few to rather many thick raised ridges internally, especially near the opening, spathe entirely to ca. half its length persistent into fruiting, spathe interior with several thickened raised ribs. Spadix subcylindric to slightly clavate, sessile or shortly stipitate, fertile to tip, axis persistent beyond fruit dispersal; stipe adnate to dorsal side of spathe; flowers unisexual, deciduous from spadix axis; pistillate flower zone weakly obconic; pistils free; stigma sessile, discoid; pistillodes confined to below pistillate flower zone, very conspicuous, irregularly polygonal flat-topped on a very slender stipe, about as tall as pistils, deciduous during fruit development; sterile interstice absent; staminate flowers crowded, each comprising one pair of stamens, deciduous during fruit development; stamens pubescent; connective not visible; thecae opening through apical pores; pollen extruded in thick strings. Infructescence pendulous, rarely erect (*O. basalticola*, *O. paxilla*) or nearly so (*O. kinabaluensis*); fruiting spathe ovoid-subcylindric to fusiform-funnel-form, mouth not flaring, persisting until after fruit/seed dispersal; fruits contained within the persistent spathe; berry depressed-globular to ellipsoid, crowned by old stigma remains, whitish; seed elongate, longitudinally ribbed, with a curved long translucent micropylar appendage up to twice

seed length.

Distribution: 10 species, all endemic to Borneo.

Ecology: Obligate, rarely facultative, rheophytes, mostly occurring lithophytically, occasionally on constantly water-splashed boulders or permanent waterfalls, less often in deep riverbank sand, under lowland to lower montane perhumid to wet forest between 50–2300 m alt.

Eponymy: *Ooia* is named for Mr. Ooi Im Hin who has contributed much data on pollination biology of this tribe.

Notes: Species of *Ooia* and *Piptospatha* are easily confounded owing to the considerable homoplastic similarity of the nodding inflorescences with mostly pink or reddish spathes. In actuality a suite of morphological distinctions separates the two genera, including deciduous flowers, a persistent spadix axis remaining fresh with a role in fruit/seed dispersal producing turbulence when water enters the (usually) pendulous infructescences, either fully persistent spathe limb or spathe limb with various lengths of the distal portion deliquescing, persistent spathe enclosing the fruits, and mostly pendulous infructescences lacking splash-cup dispersal. All *Ooia* species have roots with a conspicuous mucilage-covered active tip, and most produce copious plantlets from the finer roots. Similar adventitious plantlet production is shared with *Hottarum truncatum* (M. Hotta) Bogner & Nicolson (white spathes, pistillate and staminate flower zones contiguous, spadix with an appendix, thecae sunken in deep pits, basal placentation, and erect splash-cups), and *Piptospatha burbidgei* (N. E. Br.) M. Hotta (rose pink spathes, pistillate and staminate flower zones separated by a conspicuous zone of staminodes, spadix fertile to tip, thecae not sunken, parietal placentation, and erect splash-cups). Almost all *Ooia* species have a much-elongated rhizome-like stem rooting along its length, a type unknown in *Piptospatha*.

***Ooia altar*** S. Y. Wong & P. C. Boyce, **sp. nov.** [Fig. 1]

*Ooia altar* differs from all other *Ooia* species by the primary lateral and interprimary veins deeply impressed, with leaf blades having a quilted appearance, a tendency to being stilt-rooted, and by the globose stigmas. Inflorescences smelling of methyl salicylate (oil of wintergreen) at pistillate anthesis, is also a characteristic shared with *O. glans* from which *O. altar* differs by bead-like (not flattened) stigmas, cream (not glossy white) infrapistillar staminodes, and by the veins of the leaf blade deeply impressed.

**Type:** INDONESIA. Indonesian Borneo, Kalimantan Barat, Sekadau, Nanga Taman, south east of Nanga Taman, Gunung Tajam, east slope, 00°27'35.41"S, 111°02'3.21"E, 5 Feb. 2012, K. Nakamoto AR-3773 (BO!–holotype; BO!, SAR!–isotype, all ethyl alcohol preserved).

Moderately robust rheophytic herb ca. 25 cm tall. Stem initially erect, soon becoming conspicuously elongate (at least up to 35 cm), internodes to 1.5 cm long, ca. 1.5 cm diam., roots copious, stout, strongly adhesive, often stilt-rooted, 2.5–3 mm thick, active tips with conspicuous bright green gel cap; adventitious plantlets not observed. Leaves ca. 10 together; petiole dark green to pale greenish tan, usually suffused reddish at least distally, minutely scabrid, 12–17 cm long, 2.5–5 mm diam., weakly D-shaped in cross-section, adaxially with two very narrow keels extending from the blade insertion to the sheath, these distally conspicuously crispulate, sheathing only at the base, with wings extended into a soon deliquescing narrowly triangular ligular portion 4–7 cm long; blade softly coriaceous, elliptic, often broadly so, 12–20 cm long × 5–8.5 cm wide, dark semi-glossy olive-green adaxially, often blotched paler green, abaxially pale olive green, base ovate to cuneate, apex acute to slightly acuminate, and apiculate for 2–3 mm; midrib prominent and finely scabrid abaxially, adaxially bluntly raised; primary lateral veins

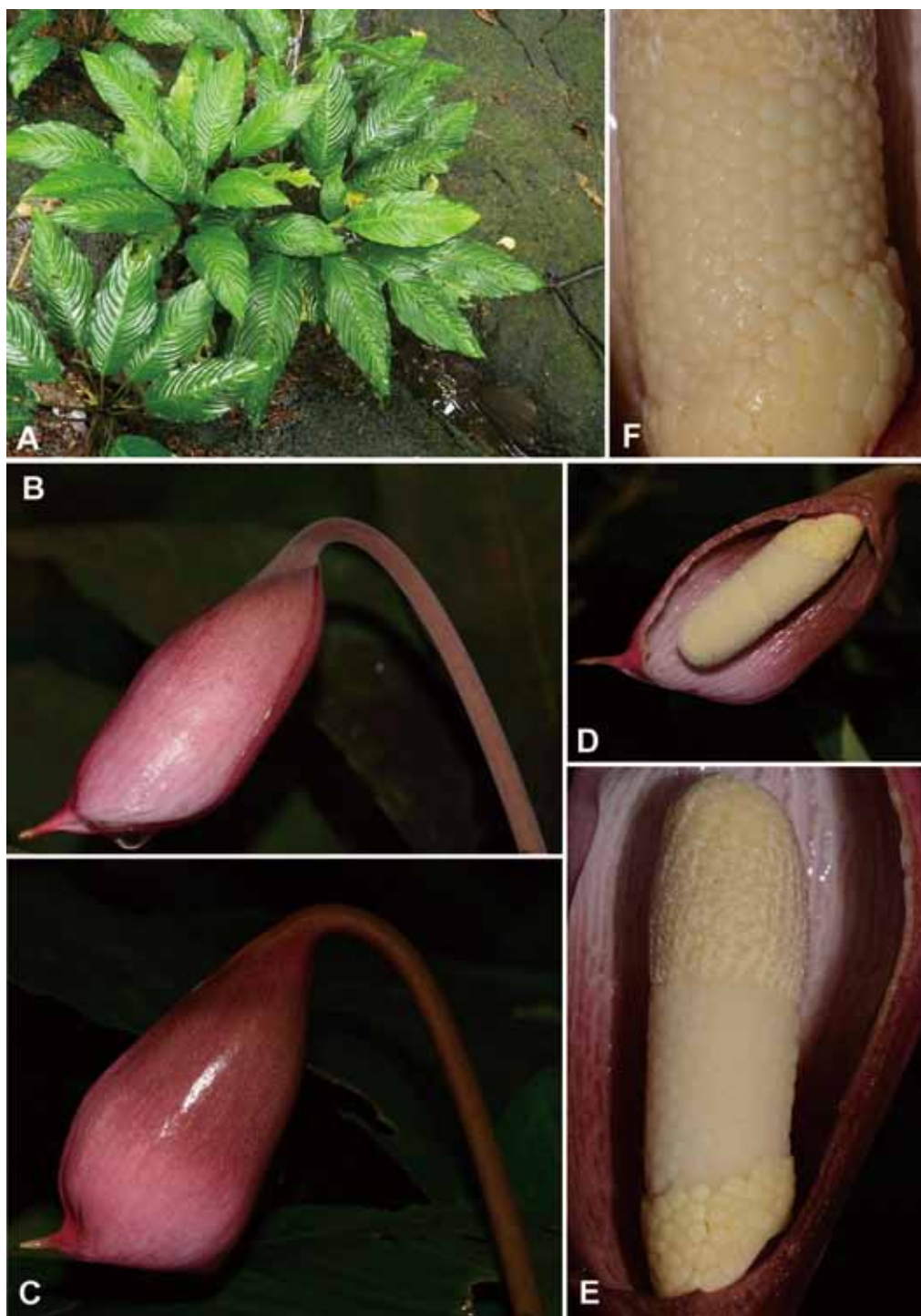


Fig. 1. *Ooia altair* S. Y. Wong & P. C. Boyce. A. Plant in habitat. B. Inflorescence at early pistillate anthesis. C. Inflorescence at early pistillate anthesis. D. Inflorescence at late pistillate anthesis; nearside spathe artificially removed. E. Spadix at pistillate anthesis, nearside spathe artificially removed. F. Detail of pistillate flower zone and lower part of staminate flower zone. A–F from AR-3773. Images © P. C. Boyce.

ca. 18 on each side, adaxially deeply impressed, giving the blade a quilted appearance, abaxially sharply raised; interprimaries much finer, more or less regularly alternating with primaries, slightly raised abaxially, flush with blade adaxially, primaries and interprimaries diverging at ca. 45–60° from the midrib and joining a conspicuous intramarginal veins ca 1 mm from the blade edge; secondary venation abaxially very fine, adaxially obscure; tertiary venation obscure. Inflorescences solitary, fragrant of methyl salicylate at anthesis; peduncle erect, exceeding petioles, 8–15 cm long, ca. 3 mm diam., reddish purple, minutely asperous. Spathe funnellform, 5.5–6.5 cm long, 2.5–3.5 cm diam., terminal third inflated and hooded at staminate anthesis, apically beaked for ca. 10 mm, distal half of spathe limb deliquescing late in staminate anthesis, lower half persistent into fruiting, funnellform portion of spathe externally semi-glossy, reddish purple, inflated hooded portion externally semi-glossy, clear pink with darker longitudinal veins, spathe interior similarly coloured to exterior, highly glossy, inflated part with numerous thickened raised ribs. Spadix 3.5–5 cm long, stoutly cylindrical to slightly clavate, sessile; infrapistillar zone obliquely inserted on peduncle/spathe, ventrally ca. 10 mm long, dorsally ca. 5 mm long, ca. 5 mm diam.; pistillodes individually stipitate, exceeding height of pistils, irregularly polygonal flat-topped on a slender stipe, glossy white, ca. 2 mm diam.; pistillate flower zone slightly obconic, 1–2 cm long, 10–11 mm diam.; pistils columnar ca. 1.2 mm diam.; stigma capitate with a central depression, as wide as pistil, greyish; sterile interstice absent; staminate flower zone 1–2 cm long, 10–12 mm diam., bullet-shaped, apically obtuse, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, more or less rectangular seen from above, ca. 1.1 mm across, pubescent, white; connective not discernible; thecae opening through lateral pores; pollen extruded in thick strings, grey. Fruiting spathe

and infructescence not observed.

Specimens examined: **INDONESIA**. 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-4283 (BO; SAR) & K. Nakamoto AR-4297 (BO; SAR) & K. Nakamoto AR-4298 (BO; SAR).

Distribution: Restricted to the NW flanks of the Schwaner Mountains, Kalimantan Barat.

Ecology: Rheophytic along edges of exposed granite waterfalls and forest streams under moist hill forest between 40 and 350 m above sea level.

Etymology: The trivial epithet, alluding to the diagnostic stigmas, is derived from the Latin noun *altar*, a bead.

Notes: Readily recognizable by the quilted nature of the leaf blades and the stilt-rooted nature of the stems. Plants with the leaf blades spattered with a single colour variegation are not infrequent.

*Ooia altar* co-occurs at the Type locality with several recently described aroids—*Aridarum zygasetum* S. Y. Wong, S. L. Low & P. C. Boyce, *Bucephalandra forcipula* S. Y. Wong & P. C. Boyce, and *Schismatoglottis gui* P. C. Boyce & S. Y. Wong—along with numerous other aroid species which have yet to be determined beyond genus. Together these are a timely reminder, if such were needed, of the almost unbelievable wealth of Bornean flora that remains still to be catalogued and described, to say nothing of studied in detail.

***Ooia basalticola*** S. Y. Wong & P. C. Boyce, **sp. nov.** [Fig. 2]

*Ooia basalticola* is differentiated from all other *Ooia* species by the combination of the spathe limb deliquescing to half its length during late anthesis, and a long-fusiform-funnel-form persistent spathe limb carried on an erect peduncle during fruiting.

**Type:** **INDONESIA**. Indonesian Borneo, Kalimantan Barat, Bengkayang, Sanggau Ledo, foothills and approaches to Gunung Niut, Riam Pangar, 01°07'24.2"N, 109°44'57.3"E, 15 Aug.

2013, P. C. Boyce & Wong Sin Yeng AR-4211 (BO!–holotype; BO!, SAR!–isotype, all ethyl alcohol preserved).

Medium sized rheophytic herb ca. 25 cm tall. Stem erect, ca. 10 cm tall, internodes to 1.5 cm long, ca. 1.5 cm diam., roots copious, strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous pale yellow gel cap; adventitious plantlets sparse. Leaves ca. 20 together; petiole dark brownish green, minutely scabrid, 15–24 cm long, 3–4 mm diam., weakly D-shaped in cross-section, adaxially with two very narrow keels extending from the blade insertion to the sheath, sheathing only at the base, with wings extended into a soon deliquescing narrowly triangular ligular portion 3–7 cm long; blade softly coriaceous, narrowly elliptic, 14–18 cm long × 4.5–6 cm wide, dark matte olive-green adaxially, abaxially pale olive green, base cuneate, apex acute and apiculate for 2–3 mm; midrib prominent and faintly scabrid abaxially, adaxially bluntly raised; primary lateral veins ca. 9 on each side, somewhat raised abaxially, slightly impressed adaxially, tinged reddish brown; interprimaries very fine and numerous, reddish, flush with blade, primaries and interprimaries diverging at ca. 45–60° from the midrib and joining a weakly defined intramarginal vein along the blade edge; secondary venation abaxially extremely fine; tertiary venation obscure. Inflorescences solitary, occasionally 2 together alternating with prophylls, without smell; peduncle erect, exceeding petioles, 8–12 cm long, ca. 2 mm diam., reddish brown. Spathe ovoid-subcylindric, ca. 5 cm long, 1.5 cm diam., apically beaked for ca. 6 mm, terminal 1/4 deliquescing, lower 3/4 persistent, semi-glossy reddish brown, orthotropous on a pendent peduncle at anthesis. Spadix 3–3.5 cm long, cylindrical, sessile; infrapistillar zone obliquely inserted on peduncle/spathe, ventrally ca. 5 mm long, dorsally ca. 2 mm long, ca. 3 mm wide; pistillodes individually stipitate, exceeding height of pistils, irregularly polygonal flat-topped on a very slender stipe,

deep yellow, ca. 1 mm diam.; pistillate flower zone slightly fusiform, ca. 9 mm long, ca. 6 mm diam.; pistils columnar ca. 1.2 mm diam.; stigma globose, about as wide as pistil, creamy; sterile interstice absent; staminate flower zone ca. 15 mm long, ca. 7 mm diam., tapering-cylindric, apically blunt, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, ellipsoid, ca 1 mm across, pubescent, deep yellow; connective not visible; thecae opening through sub-apical pores; pollen extruded in slender strings, cream. Fruiting spathe ovoid-subcylindric, deep reddish brown, initially pendent, becoming erect as fruits develop; infructescence not observed.

Specimens examined: **INDONESIA**. Indonesian Borneo. Kalimantan Barat, Bengkayang, Tujuh Belas, foothills and approaches to Gunung Niut, Dawar Riam Marum, 01°03'21.6"N 109°48'27.2"E, 2 Jun. 2014, P. C. Boyce, Wong Sin Yeng & Low Shook Lin AR-4768 (BO); Bengkayang, Tujuh Belas, foothills and approaches to Gunung Niut, Dawar Riam Empang, 01°03'18.3"N 109°47'04.7"E, 2 Jun. 2014, P. C. Boyce, Wong Sin Yeng & Low Shook Lin AR-4771 (BO).

Distribution: Recorded only from the foothills of Gunung Niut, NW Kalimantan Barat.

Ecology: Rheophytic on exposed basalt waterfalls under perhumid hill forest between 90–325 m above sea level.

Etymology: From Latin *cola* (derived from *incola*, an inhabitant or dweller) + basalt; and referring to this species being restricted to basalt geology.

Notes: *Ooia basalticola* occurs on waterfalls subjected to very powerful torrents during spate flow. It is speculated that the erect infructescences of *O. basalticola* are in some way adaptive to this with water flushing out the fruits and seeds from above. A similar situation may exist in *Ooia paxilla*, which occurs on constantly water-washed rocks.

*Ooia basalticola* co-occurs at the same Type locality as *Aridarum incavatum* H. Okada & Y. Mori, together with the more widespread alkaline-geology restricted *Bucephalandra*

*bogneri* S. Y. Wong & P. C. Boyce and *Piptospatha viridistigma* P. C. Boyce, S. Y. Wong & Bogner, widespread *Schismatoglottis tectorata* (Schott) Engl., and three undescribed species of *Homalomena*.

***Ooia glans* S. Y. Wong & P. C. Boyce, sp. nov.** [Fig. 3]

*Ooia glans* differs from all other *Ooia* species by the combination of glossy white infrapistillar pistillodes, the staminate flower zone exceeding the width of the pistillate flower zone, and inflorescences smelling of methyl salicylate (oil of wintergreen). *Ooia altar*, which also produces an oil of wintergreen fragrance, differs from *O. glans* by the flattened (not bead-like) stigmas, glossy white (not cream) infrapistillar staminodes, and by the veins of the leaf blade not deeply impressed.

**Type:** MALAYSIA. Malaysian Borneo, Sarawak, Kuching, Matang, Kubah N. P., Sungai Bungen, 01°36'30.9"N 110°11'35.0"E, Ooi Im Hin AR-2339 (SAR!–holotype; SAR!–isotype, ethyl alcohol preserved).

Medium-sized rheophytic herb ca. 25 cm tall. Stem erect, ca. 10 cm tall, internodes to 1.5 cm long, ca. 1.5 cm diam., roots copious, strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous pale yellow gel cap; adventitious plantlets sparse. Leaves ca. eight together; petiole pale tan to reddish brown green, minutely scabrid, 8–11 cm long, 2–4 mm diam., D-shaped in cross-section, adaxially distally with two short very narrow minutely crispulate keels extending from the blade insertion, sheathing only at the base, with wings extended into a soon deliquescing narrowly triangular ligular portion 3–5 cm long; blade moderately to rather softly coriaceous, narrowly elliptic to elliptic, 17–23 cm long × 5–8 cm wide, medium matte olive-green adaxially, abaxially pale olive green, base cuneate, apex acute and apiculate for 2–3 mm; midrib prominent and finely scabrid abaxially, tan to reddish, adaxially bluntly raised; primary lateral veins ca 14 on each side,

somewhat raised, reddish brown; interprimaries much finer, more-or-less regularly alternating with primaries, primaries and interprimaries diverging at ca. 60° from the midrib and joining a weakly defined intramarginal vein ca. 0.5 mm in from the blade edge; secondary venation abaxially very fine, adaxially obscure; tertiary venation obscure. Inflorescences 2–3 together alternating with prophylls; smelling weakly of methyl salicylate; peduncle erect, exceeding petioles, 8–14 cm long, ca. 4 mm diam., scabrid, pale yellowish brown. Spathe ovoid-subcylindric, 5.5–7 cm long, ca. 1.5 cm diam., apically beaked for ca. 8 mm, fully persistent, bright pale to medium pink. Spadix 3.5–5 cm long, cylindrical, sessile; infrapistillar zone obliquely inserted on peduncle/spathe, ventrally ca. 12 mm long, dorsally ca. 6 mm long, ca. 8 mm diam.; pistillodes individually stipitate, exceeding height of pistils, irregularly polygonal flat-topped on a very slender stipe, deep yellow, ca 1 mm diam.; pistillate flower zone slightly fusiform, ca. 9 mm long, ca. 6 mm diam.; pistils columnar, ca. 1.2 mm diam.; stigma globose, about as wide as pistil, creamy; sterile interstice absent; staminate flower zone ca. 15 mm long, ca. 7 mm diam., tapering-cylindric, apically blunt, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, ellipsoid, ca. 1 mm across, pubescent, deep yellow; connective not visible; thecae opening through sub-apical pores; pollen extruded in slender strings, cream. Fruiting spathe ovoid-subcylindric, deep reddish brown, pendulous; infructescence not observed.

Specimens examined: MALAYSIA. Malaysian Borneo. Sarawak, Kuching. Padawan, Puncak Borneo, Borneo Heights Resort, Jungle Trail, 01°07'33.5"N 110°12'57.4"E, 15 Sep. 2014, Wong Sin Yeng & P. C. Boyce AR-93 (SAR); Bau, Singai, Batu Taring, 19 Jun. 2004, Jeland ak Kisai & Jepom ak Tisai AR-469 (SAR); Padawan, Kampung Sadir, 1°06'45"N 110°16'15"E, 2 Feb. 2006, Simon Kutuh ak Paru AR-1699 (SAR); Matang, Kubah N. P., Waterfall Trail, 01°35'40.2"N 110°10'45.9"E, 28 Jul. 2007, P. C. Boyce, Wong Sin Yeng & S. Maclean AR-2117 (SAR); Matang, Kubah N. P. Sungai Bungen, 01°36'30.9"N 110°11'35.0"E, 28 Jul. 2007, P. C. Boyce,



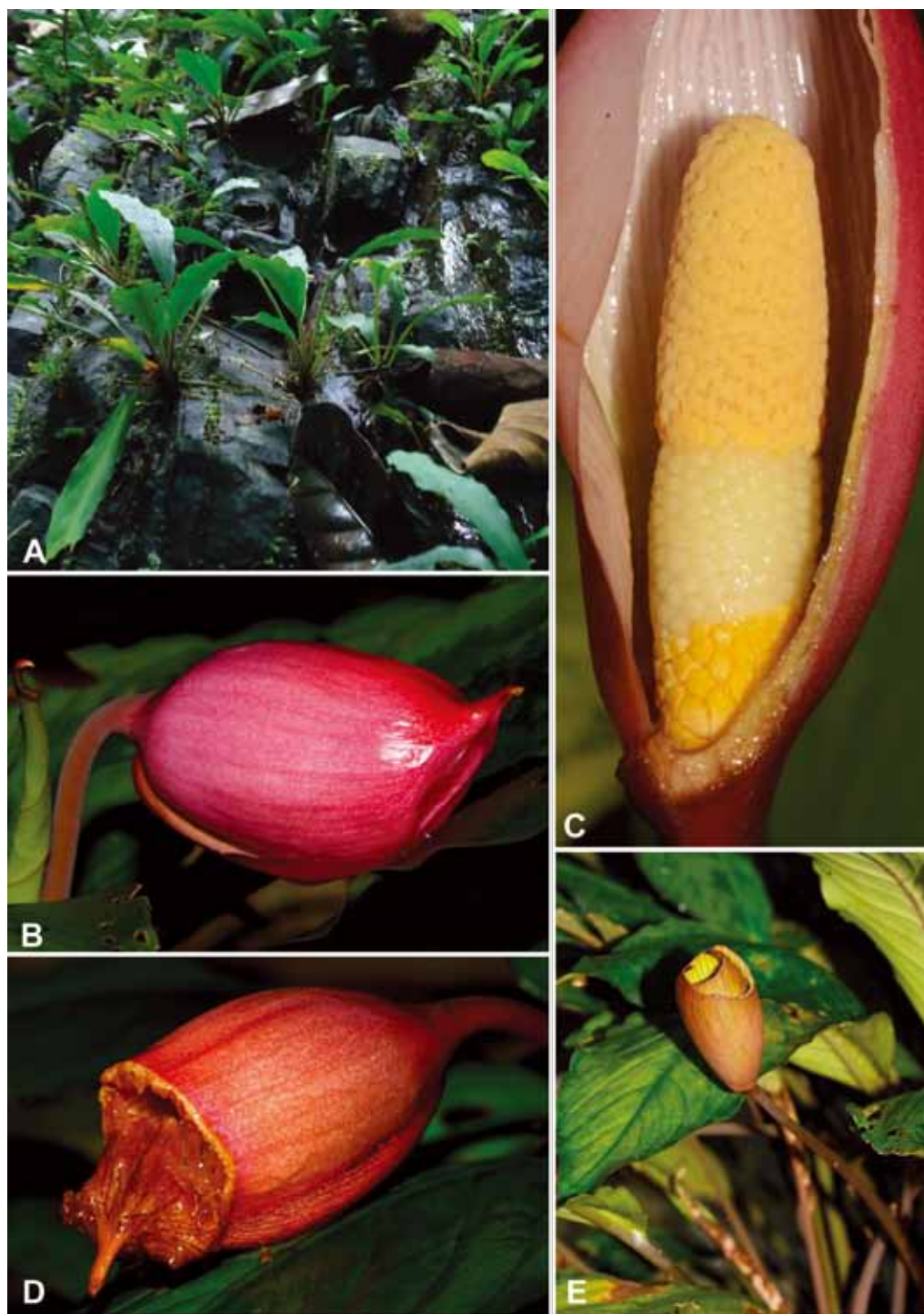


Fig. 2. *Ooia basalticola* S. Y. Wong & P. C. Boyce. A. Plants in habitat rooted on bare basalt blocks. B. Inflorescence at pistillate anthesis. C. Inflorescence at late pistillate anthesis; nearside spathe artificially removed. D. Inflorescence post anthesis with terminal portion deliquescing. E. Developing infructescence showing erect posture. A–E from AR-4211. Images © P. C. Boyce.

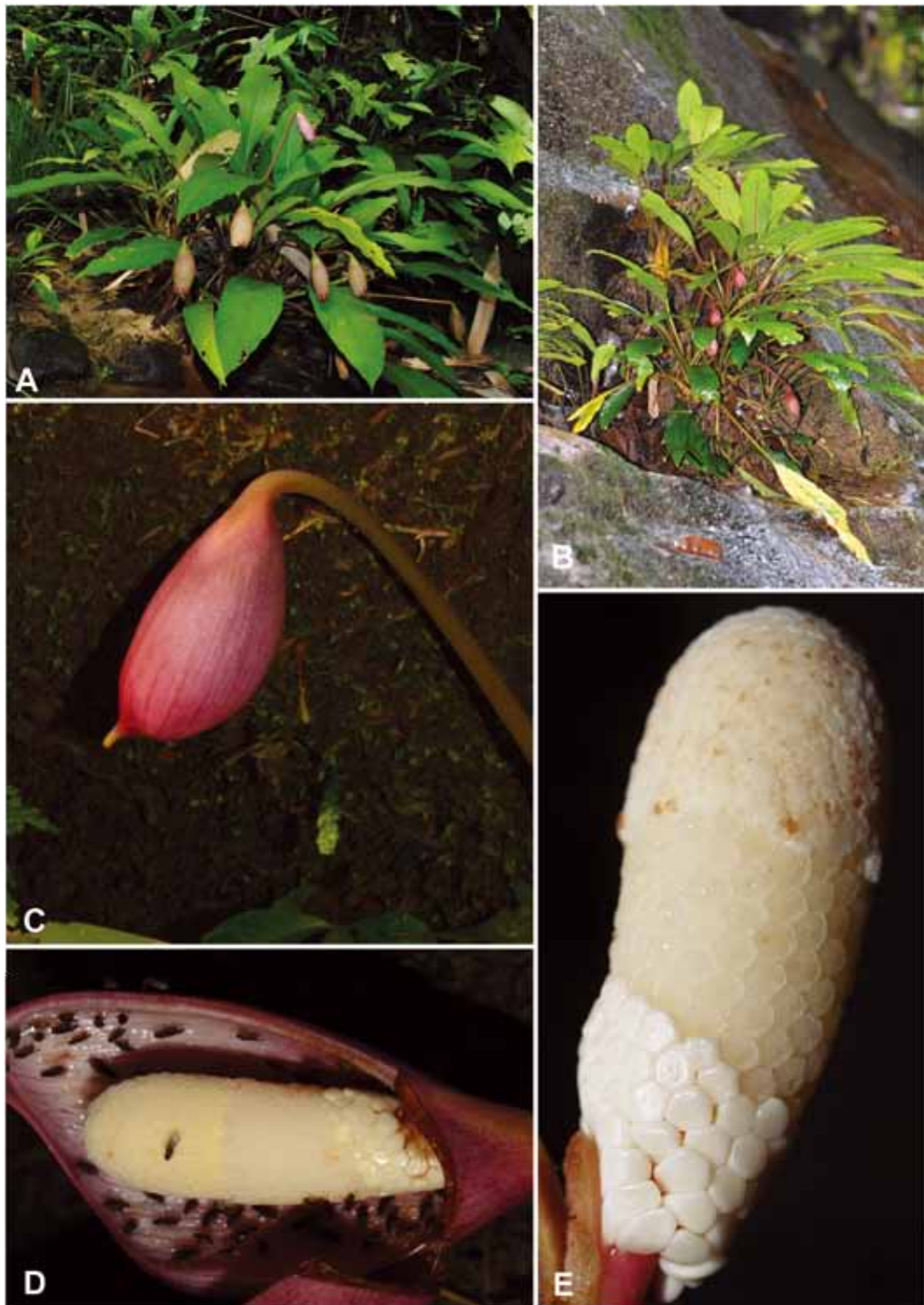


Fig. 3. *Ooia glans* S. Y. Wong & P. C. Boyce. A and B. Plants in habitat. C. Inflorescence at onset pistillate anthesis. D. Spadix at pistillate anthesis with spathe artificially removed; note numerous *Colocasiomyia* flies on spathe limb interior. E. Spadix at pistillate anthesis, spathe artificially removed. A from AR-3864. B from AR-2443. C–E from AR-4979. Images © P. C. Boyce.

Wong Sin Yeng & S. Maclean AR-2118 (SAR); Bau, Bongo Range, trail to Tegora Mine, 01°19'41.5"N 110°09'19.0"E, 8 Sep. 2007, P. C. Boyce, Wong Sin Yeng & A. Kocyan AR-2186 (SAR); Matang, Kubah N. P., Sungai Bungen, 01°36'30.9"N 110°11'35.0"E, Ooi Im Hin AR-2339 (SAR); Matang, Kubah N. P., Waterfall Trail, 01°35'40.2"N 110°10'45.9"E, 2 May 2009, P. C. Boyce & Wong Sin Yeng AR-2443 (SAR); Padawan, Annah Rais, upstream from main hot springs, 01°14'27.32"N 110°17'02.63"E, 13 Aug. 2011, P. C. Boyce & Wong Sin Yeng AR-3617 (SAR); Padawan, Kampung Sadir, Air Terjun Mabi, 01°06'44.2"N 110°15'18.3"E, 6 Apr. 2012, P. C. Boyce & al. AR-3864 (SAR); Bau, Krokong, Kampung Tringgus, trail on the right side of the football field, 0°15'04.3"N 110°06'13.5"E, 29 Mar. 2014, Ooi Im Him & Jeland ak Kisai AR-4681 (SAR); Matang, Matang Family Park, Sungai Cina, 01°36'45.25"N 110°12'16.38"E, 24 Jun. 2014, Wong Sin Yeng AR-4829 (SAR); Padawan, Puncak Borneo, Sungai Semangas, 01°08'26.6"N 110°13'36.1"E, 16 Sep. 2014, Wong Sin Yeng & P. C. Boyce AR-4979 (SAR); Padawan, Kampung Danu, riverside below kampong, 01°16'30.3"N 110°14'55.2"E, 5 Oct. 2014, Wong Sin Yeng & P. C. Boyce AR-4991 (SAR).

**Distribution:** *Ooia glans* occurs on two independent outcroppings of Paleogene sediments in western Sarawak – the NW Sarawak Matang Massif and the SW Sarawak Puncak Borneo. The Puncak Borneo outcropping extends into Kalimantan Barat and it is highly probable that *O. glans* occurs there also, although there are as yet no records for Kalimantan.

**Ecology:** Rheophytic on exposed Paleogene sediments (sandstones) under perhumid hill forest between 45–890 m above sea level.

**Etymology:** Contrived from the Latin noun *glans* –an acorn– used by way of describing the shape of the staminate flower zone.

**Notes:** The large glossy white infrapistillar staminodes are immediately diagnostic.

*Ooia glans* is atypical in the genus by occurring over a considerable altitudinal range, although there are no discernible morphological dissimilarities between plants from the lowlands and those from the highest known localities.

***Ooia grabowskii*** (Engl.) S. Y. Wong & P. C. Boyce, Bot. Stud. (Taipei) **51**(4): 545 (2010) — *Rhynchopyle grabowskii* Engl., Bot. Jahrb. Syst.

**25: 20** (1898) — *Piptospatha grabowskii* (Engl.) Engl., Pflanzenr. **55** (IV.23Da): 125 (1912).

[Figs. 4–6]

**Type:** **INDONESIA.** Indonesian Borneo, Kalimantan Selatan, Mindai-Pramassamalai hills, on rocks of waterfalls of the Pitanakan [translated from original German], 17 Jun. 1882, F. Grabowski s.n. (B!–holotype).

Medium sized rheophytic herb ca. 25 cm tall. Stem erect, ca 10 cm tall, internodes to 1.5 cm long, ca. 1.5 cm diam., roots copious, strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous pale yellow gel cap; adventitious plantlets abundant on the finer roots. Leaves ca 10 together; petiole dark bronze green, basal-most part clear pink, minutely scabrid, 11–17 cm long, 2–5 mm diam., D-shaped in cross-section, adaxially with two very narrow pinkish keels extending from the blade insertion to the sheath, sheathing only at the base, with wings extended into a soon deliquescing narrowly triangular ligular portion ca. 5 cm long; blade softly coriaceous, narrowly elliptic to narrowly lanceolate, very slightly falcate, 15–22 cm long × 5–6 cm wide, dark somewhat velvety olive-green adaxially, abaxially pale olive green, base cuneate, apex acute to acuminate, apiculate for 2–3 mm; midrib prominent and finely scabrid abaxially, the lower part sometimes with reddish tinges, adaxially bluntly raised; primary lateral veins ca. 14 on each side, somewhat raised abaxially, slightly impressed adaxially; interprimaries finer, more-or-less regularly alternating with primaries, primaries and interprimaries diverging at ca. 45° from the midrib and joining a well-defined intramarginal vein ca. 0.5 mm in from the blade edge; secondary venation abaxially very fine, adaxially obscure; tertiary venation obscure. Inflorescences 2–3 together alternating with prophylls; fragrant of cold cream at anthesis; peduncle erect, exceeding petioles, 11–13 cm long, ca. 2 mm diam., reddish brown, minutely scabrid. Spathe ovoid-subcylindric, ca. 3.5 cm long, 1 cm diam., apically beaked for ca. 4 mm,

upper half of spathe degrading-deliquesting post anthesis, semi-glossy pale pink with darker shading and fine veining in the lower third, terminal fifth faintly olive-green shaded, spathe nodding on an erect peduncle at anthesis. Spadix ca. 3 cm long, subcylindric to, sessile; pistillate flower zone cylindric, ca. 2 cm long long, ca. 4 mm diam.; pistils ovoid ca. 1.2 mm diam., pink; stigma sessile, discoid, wider than ovary, pale pink; pistillodes in ca. 2 rows below the pistillate flower zone, individually stipitate, about as tall as pistils, ca. 1.2 mm diam., irregularly polygonal flat-topped on a stipe, pale cream; sterile interstice absent; staminate flower zone 9–11 mm long, 5.5–6.5 mm diam., apically obtuse, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, more or less rectangular seen from above, ca. 1.1 mm across, pubescent, pale pink; connective hardly visible; thecae opening through apical pores; pollen extruded in thick strings, cream. Fruiting spathe funnellform, deep reddish brown, initially pendent, becoming erect with the persistent spathe nodding as fruits develop; infructescence not observed.

Specimens examined: **INDONESIA**. Indonesian Borneo. Kalimantan Selatan, Tanah Bumbu, foot of Gunung Besar, Ratan Arai from Bato Kamba, 21 Feb. 1979, G. Murata, M. Kato & Y. P. Moge 4250 (BO, KYO); Tanah Laut, Pelaihari, about 75 km south of Banjarmasin, and about 10 km from Pelaihari town, Air Terjun Bajuin 03°47'21"S 114°53'31"E, 15 Oct. 2014, H. Budiarto AR-4997 (BO).

**Distribution:** Known only from the southern part of the Meratus Mountains, SE Kalimantan.

**Ecology:** Rheophytic on exposed granite and andesite waterfalls under wet hill forest between 50–760 m above sea level.

**Eponymy:** Named for Friederich Grabowsky (1857–1929), a zoologist, who between January 1881 and July 1884 travelled extensively in SE Borneo.

**Notes:** *Ooia grabowskii* is readily separable from all other species with which it has been confounded by the strongly pubescent pink staminate flowers, and by the spathe limb

deliquesting-rotting to about half its length to leave a funnel-form persistent lower spathe surrounding the developing fruits. Initially the inflorescence peduncle is pendulous, but later during fruit maturation it becomes semierect, but with the persistent lower spathe remaining nodding. It is not yet clear if the spathe itself becomes erect once the fruits ripen.

***Ooia havilandii*** (Engl.) S. Y. Wong & P. C. Boyce, **comb. nov.** [Fig. 7]

Basionym: *Rhynchophyle havilandii* Engl. in Bot. Jahrb. Syst. **37**: 125 (1905) – *Piptospatha havilandii* (Engl.) Engl., Pflanzenr. **55** (IV.23Da): 128 (1912) – *Schismatoglottis havilandii* (Engl.) M. Hotta in Mem. Coll. Sci. Univ. Kyoto, Ser. B **32**: 233 (1966).

**Type:** **MALAYSIA**. Malaysian Borneo, Sarawak, Kapit Division, Rejang, Belaga, Nov 1892, G. D. Haviland 2191 (BM!–holotype; CAL, K!, SING!–isotype).

Medium sized to rather robust rheophytic herb to ca. 50 cm tall but usually half of this. Stem erect, 10–20 cm tall, internodes to 1.5 cm long, ca. 1.5 cm diam., roots copious, strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous pale yellow gel cap; adventitious plantlets numerous, often occurring more than one meter from the mother plant. Leaves ca. 12 together on each stem; petiole dark brownish red, minutely scabrid, 8–16 cm long, 2–4 mm diam., weakly D-shaped in cross-section, adaxially with two very narrow keels extending from the blade insertion to ca. 1/3 the length of petiole, sheathing only at the base, with wings extended into a deliquesting narrowly triangular ligular portion 3–5 cm long, basal-most part of wings persisting as weak fibres; blade softly coriaceous, lanceolate to broadly elliptic, occasionally somewhat oblique, 13–25 cm long × 5–9 cm wide, matte medium olive-green adaxially, occasionally blotched pale green, medium green, and silver either as single colour or marbled, abaxially pale olive green, occasionally somewhat pinkish suffused, base



Fig. 4. *Ooia grabowskii* (Engl.) S. Y. Wong & P. C. Boyce. A. Plant in habitat. B. Inflorescence at early staminate anthesis, spathe limb falling. C. Inflorescence at staminate anthesis, spathe limb fallen. D. Spadix at early pistillate anthesis, nearside spathe artificially removed. A–F from AR-4997. Image A © K. Nakamoto, used with permission. Images B–D © P. C. Boyce.

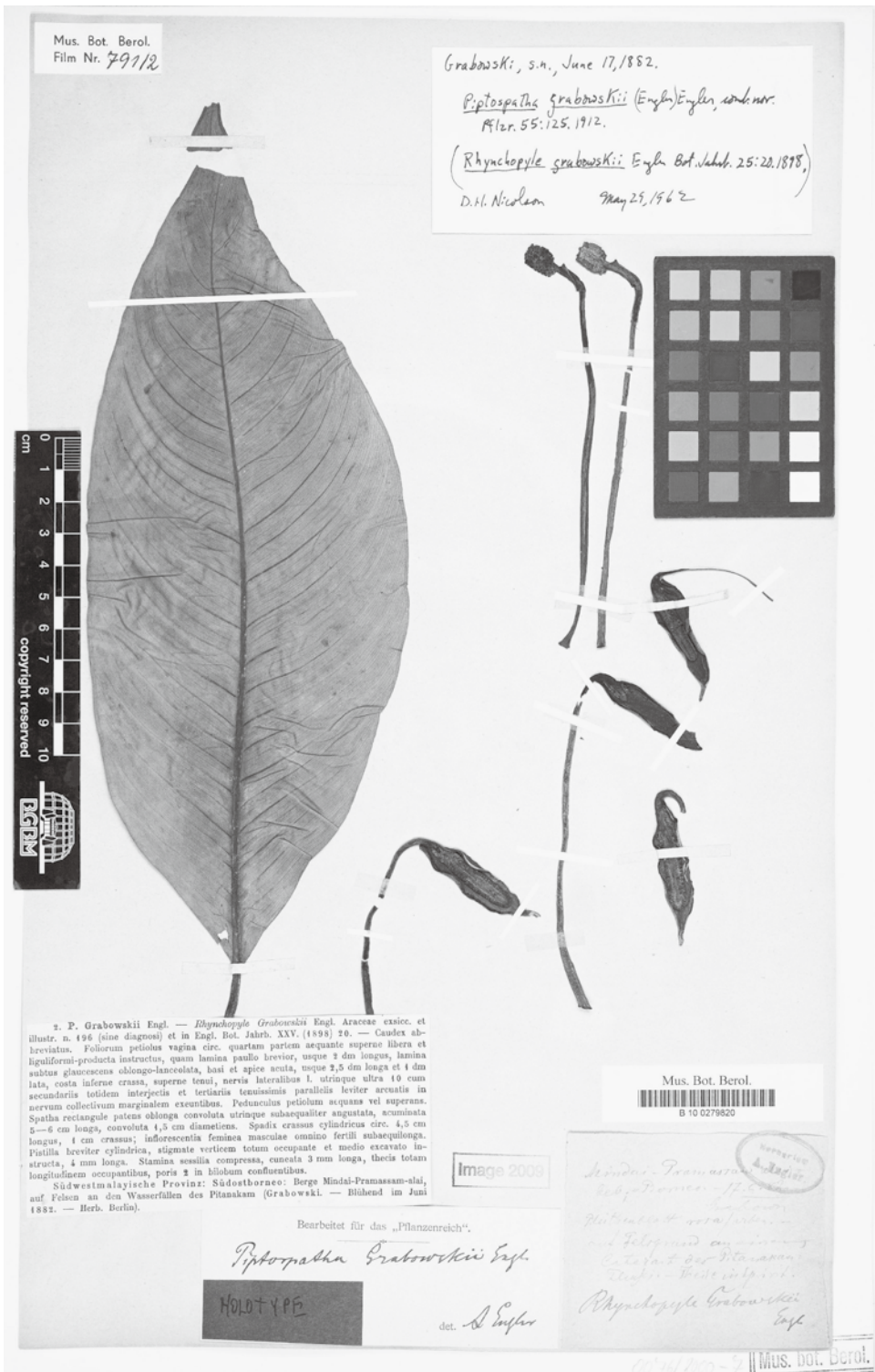


Fig. 5. *Ooia grabowskii* (Engl.) S. Y. Wong & P. C. Boyce. Holotype of *Rhynchosytle grabowskii* Engl. (F. Grabowski s.n., B).

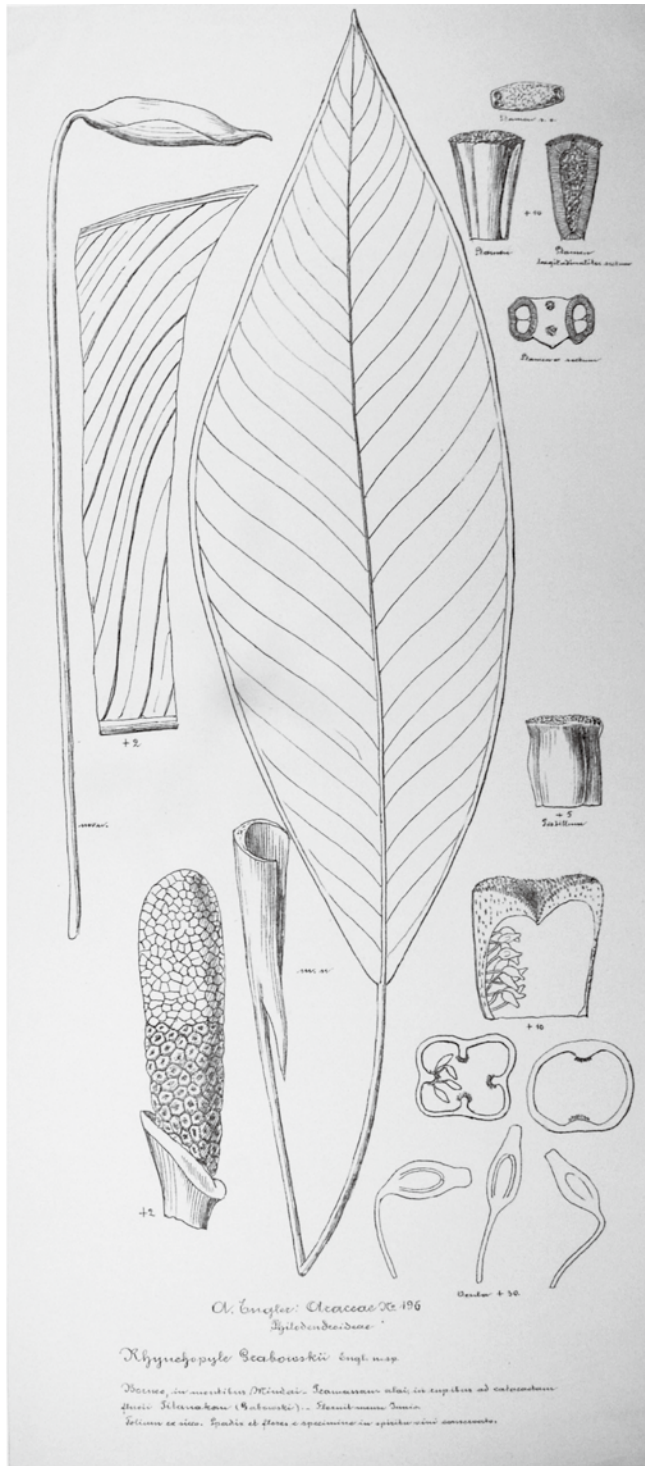


Fig. 6. *Ooia grabowskii* (Engl.) S. Y. Wong & P. C. Boyce. Engler *Araceae Exsiccatae et Illustratae* 196 depicting *Rhynchopyle grabowskii* Engl., taken from F. Grabowski s.n. Holotype.

rather broadly to narrowly cuneate, apex acute and apiculate for 2–3 mm; midrib prominent and finely scabrid abaxially, occasionally reddish, adaxially bluntly raised; primary lateral veins ca. 14 on each side, somewhat raised, tinged reddish brown; interprimaries finer, more-or-less regularly alternating with primaries, together diverging at ca. 45–60° and reaching a somewhat conspicuous intramarginal vein; secondary venation abaxially very fine, adaxially obscure; tertiary venation obscure. Inflorescences 2–3 together alternating with prophylls; no detectable fragrance; peduncle erect, exceeding petioles, 10–18 cm long, ca. 2 mm diam., from medium green to deep brownish red. Spathe ovoid-subcylindric, 3–4.5 cm long, ca. 1.5 cm diam., apically beaked for ca. 5 mm, all but extreme incurved margin persistent, spathe mostly semi-glossy medium bright pink, rarely deep purplish pink, exceptionally pure white; nodding on an erect peduncle at anthesis. Spadix 2.5–3.5 cm long, weakly fusiform, sessile; pistillate flower zone stoutly cylindrical, 6–7.5 mm long, ca. 4 mm diam.; pistils ovoid ca. 1.2 mm diam., whitish; stigma sessile, discoid, narrower than ovary, very pale pink; pistillodes in 3–5 rows below the pistillate flower zone, individually stipitate, about as tall as pistils, ca. 1.2 mm diam., irregularly polygonal flat-topped on a stout stipe, glossy creamy white; sterile interstice absent; staminate flower zone 10–12 mm long, ca. 4.5 mm diam., bullet-shaped, apically obtuse, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, more or less rectangular seen from above, ca. 1.1 mm across, minutely pubescent, pale creamy yellow; connective nor visible; thecae opening through apical pores; pollen extruded in thick strings, white. Fruiting spathe ovoid-subcylindric, reddish green to deep reddish brown, pendent, becoming erect as fruits develop; fruits ellipsoid, ripening dirty white, ca. 3 mm long.

Specimens examined: **MALAYSIA**. Malaysian Borneo. Sarawak, Kapit, Pergunungan Hose, 02°14'47.2"N

113°41'24.9"E, 22 Apr. 2004, P. C. Boyce & Jeland ak Kisai AR-294 (SAR) & ibid. P. C. Boyce & Jeland ak Kisai AR-296 (SAR); Nanga Gaat, Rejang Wood Concession, km 65 road to Camp Gahada, 01°42'01.1"N 113°31'14.8"E, 12 May 2004, P. C. Boyce, Jeland ak Kisai & Jepom ak Tisai AR-371 (SAR); Nanga Gaat, Rejang Wood Concession, km 55 road to Camp Gahada, 01°44'44.5"N 113°28'32.3"E, 13 May 2004, P. C. Boyce, Jeland ak Kisai & Jepom ak Tisai AR-390 (SAR); Belaga, km 10 Bakun-Bintulu-Miri road junction, 02°50'51.7"N 114°01'57.6"E, 11 Oct. 2005 P. C. Boyce, Jeland ak Kisai & Jepom ak Tisai AR-1414 (SAR) & ibid. P. C. Boyce, Jeland ak Kisai & Jepom ak Tisai AR-1422 (SAR); Kapit, Taman Rekreasi Seabai, 01°56'45.6"N 112°54'16.8"E, 3 Apr. 2009, P. C. Boyce & Wong Sin Yeng AR-2430 (SAR); Nanga Gaat, Rejang Wood Concession, Sungai Piat, 01°38'09.1"N 113°24'09.9"E, 14 Oct. 2003, P. C. Boyce & Jeland ak Kisai AR-2474 (SAR); Kapit, Taman Rekreasi Seabai, 01°56'39.4"N; 112°54'16.8"E, 29 Aug. 2011, P. C. Boyce & Wong Sin Yeng AR-3635 (SAR) & ibid. P. C. Boyce & Wong Sin Yeng AR-3636 (SAR) & ibid. 30 Aug. 2011 P. C. Boyce & Wong Sin Yeng AR-3643 (SAR).

**Distribution:** *Ooia havilandii* occurs throughout the Rejang Basin of Kapit Division Sarawak as far north as Belaga, although appearing not to cross the Lumut Range, and as far west as, but not beyond, the Batang Song. To the west of the Rejang basin *O. havilandii* is 'replaced' by allopatric *O. secta*.

**Ecology:** Rheophytic on exposed sandstones and shales under most lowland to hill forest between 50–760 m above sea level.

**Eponymy:** Named for George Darby Haviland (1857–1901) who during his short life was Director of the Raffles Museum, Singapore, a Medical Officer of the Sarawak Government, and between 1892 and 1895 Curator of the Sarawak Museum, Kuching.

**Notes:** In many localities *Ooia havilandii* dominates the shaded banks of forest streams to the exclusion of all other rheophytes. In nutrient-rich run-offs under medium shade (as for example at the Type locality) plants can attain 50 cm tall and create pure stands 10s of square metres in area. In brighter areas on poor soils, for example sandbanks at the confluence of streams, *O. havilandii* becomes dwarfed.

*Ooia havilandii* shares with *O. secta* the occurrence of individuals with spattered-marbled



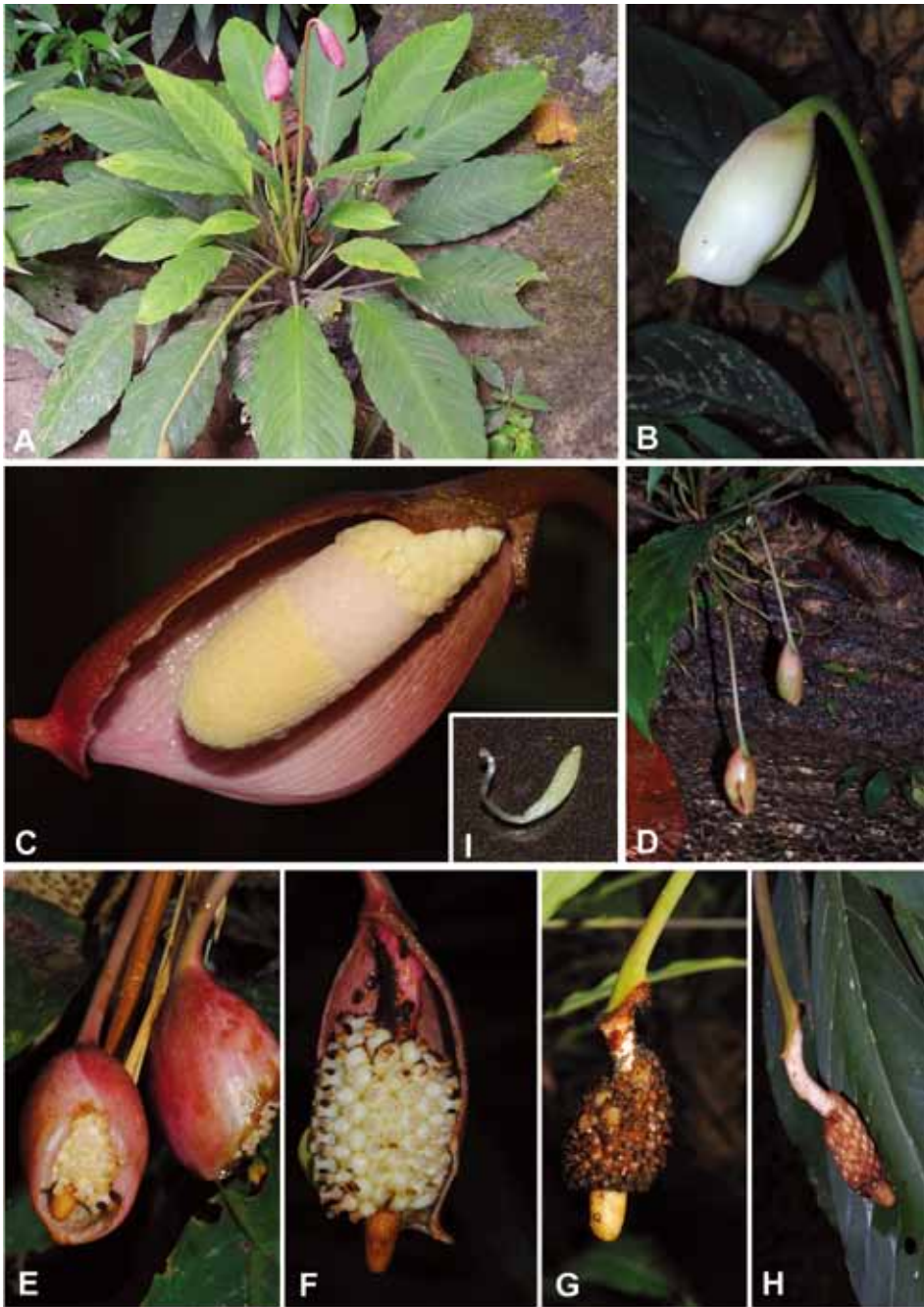


Fig. 7. *Ooia havilandii* (Engl.) S. Y. Wong & P. C. Boyce. A. Plant in habitat. B. White form, inflorescence at late pistillate anthesis. C. Inflorescence at pistillate anthesis. Nearside spathe artificially removed. D. Developing infructescences. Note pendulous peduncle. E. Sub-mature infructescences. F. Sub-mature infructescence, nearside spathe artificially removed. F. Detail of pistillate flower zone and lower part of staminate flower zone. G. Mature infructescence, spathe artificially removed; note fruits degrading and naked spadix axis below and above fruit zone. H. Post-dispersal infructescences, spathe artificially removed; note expanded area with rhomboidal scars from fallen fruits. I. Seed, micropylar appendage to bottom and left. A. Unvouchered. B from AR-3636. C from AR-3643. D–I from AR-2430. Image A © Julia Sang, used with permission; Images B–I © P. C. Boyce.



Fig. 8. *Ooia kinabaluensis* (Bogner) S. Y. Wong & P. C. Boyce. A. Plant in habitat. B. Inflorescence at pistillate anthesis. C. Inflorescence at pistillate anthesis. Nearside spathe artificially removed. D and E. Sub-mature infructescences; note erect peduncle. F. Sub-mature infructescence, nearside spathe artificially removed. A–F from AR-4718. Images © P. C. Boyce.

leaf blade variegation.

***Ooia kinabaluensis*** (Bogner) S. Y. Wong & P. C. Boyce in Bot. Stud. (Taipei) **51**(4): 548 (2010) – *Hottarum kinabaluense* Bogner in Pl. Syst. Evol. **145**: 161 (1984) – *Piptospatha kinabaluensis* (Bogner) Bogner & A. Hay in Telopea **9**(1): 216 (2000). [Fig. 8]

**Type:** MALAYSIA. Malaysian Borneo, Sabah, Pantai Barat Division, Kota Belud District, S slope of Mt. Kinabalu, E tributary of Sungai Mesilau, at old trail between Mesilau Cave and Janet's Halt, 7 Sep. 1963, S. Collenette 21634 (L!–holotype; K!–isotype).

Diminutive to moderately robust rheophytic herb 10–50 cm tall. Stem condensed, 1–10 cm long, 0.4–1.5 cm diam., often reddish; roots strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous gel cap; adventitious plantlets not observed. Leaves up to 15 together; petiole 2.5–30 cm long, 0.9–3 mm diam., sheathing only at the extreme base, the wings extended into a narrowly triangular ligular portion 2–16 cm long; blade coriaceous, narrowly elliptic to ovate, 3–21 cm long × 1.3–9.5 cm wide, base cuneate, apex acute to shortly acuminate and apiculate for 1–4 mm, blades semi-glossy dark green adaxially, abaxially paler; midrib robust, abaxially somewhat prominent; primary lateral veins (3–)4–12 on each side, in very robust specimens more or less regularly alternating with lesser interprimaries, diverging at ca. 60°, often somewhat reddish brown; secondary venation fine, adaxially more or less obscure; tertiary venation forming a faint tessellate reticulum abaxially. Inflorescences 2–3 together alternating with prophylls; fragrance strongly of isoamyl acetate; peduncle 4–18 cm long, slender, pale green to reddish brown. Spathe ovoid-subcylindric, 1.6–2 cm long (to 3.2 cm in fruit), reddish, persistent, held more or less erect, more or less obovoid, apiculate for 1–4 mm. Spadix 1.5–1.8 cm long, obliquely adnate to the spathe at the base; pistillodes absent or very rarely one or two at the dorsal edge of the

pistillate flower zone; pistillate flower zone 6–8 mm long, ca. 3 mm diam.; pistils 1–1.2 mm high, ca. 0.6–0.8 mm diam.; ovary ellipsoid, white; stigma sessile, discoid, slightly narrower than the ovary, ca. 0.5 mm diam., glassy white; interstice absent; staminate flower zone ca. 1 cm long, more or less ellipsoid, apically obtuse; stamens crowded, truncate, elongate to more or less rectangular from above, papillate, 0.8–0.9 mm across. Fruits completely contained within the persistent spathe; berry depressed-globular 2–4.5 mm diam., crowned by old stigma remains, white; seed elongate, 2–3 mm long, brown, longitudinally ribbed, with a curved long translucent micropylar appendage up to twice the length of the seed.

Specimens examined: See Wong and Boyce (2010).

**Distribution:** Primarily on Mount Kinabalu, Sabah, where in places *O. kinabaluensis* dominates the rheophytic flora, and with a smaller disjunct population ca. 240 km to the SW on Gunung Retak, SE Brunei.

**Ecology:** Rheophytic (occasionally facultatively so) on shaded granite stream margins, riverine boulders, and small waterfalls under wet upper hill to very wet lower montane forest between 750–2300 m above sea level.

**Etymology:** From Kinabalu + *ensis*, a suffix denoting a place of origin.

**Notes:** It is not readily apparent to which other described species *O. kinabaluensis* is most closely related. By lacking pistillodes *O. kinabaluensis* has no equals in the genus, although the much-reduced zone of pistillodes in *O. paxilla* (as well as sharing inflorescences smelling of isoamyl acetate) might be phylogenetically significant.

On Mt Kinabalu *Ooia kinabaluensis* dominates the rheophytic plant niche to the exclusion of all other aroids.

***Ooia manduensis*** (Bogner & A. Hay) S. Y. Wong & P. C. Boyce, **comb. nov.** [Fig. 9]

Basionym: *Piptospatha manduensis* Bogner & A. Hay in Telopea **9**: 207, fig. 4 (2000); Boyce

& Wong in *Aroideana* **36**: 98–103 (2013).

**Type:** **INDONESIA.** Indonesian Borneo, Kalimantan Timur, Sangkulirang, Kutai Timur, Sungai Mandu region, north of Sangkulirang, 14 Aug. 1957, A. J. G. H. Kostermans 13493a (L!–holotype; BO!, K!, SING!–isotype).

Diminutive rheophytic herb to ca. 14 cm tall. Stem decumbent-creeping, much branched with individual stems to ca. 15 cm long, ca. 3 mm diam., internodes 2–6 mm long, reddish brown, rooting profusely from undersurface. Leaves to 15 together, loosely clustered at shoot tips and also distributed along stem; petiole 3–8 cm long, ca. 1.3 mm diam., adaxially somewhat canaliculate and narrowly crisped-alate, reddish brown, sheathing at extreme base, wings extended into a narrowly triangular somewhat persistent-drying ligular portion to 2 cm long; blade weakly coriaceous, elliptic, 4–6 cm long × 2–3 cm wide, margins somewhat undulate, base broadly acute to obtuse, apex acute and apiculate for 1–2 mm, blade adaxially slightly glossy medium green, abaxially whitish green with mid-rib and major veins reddish; midrib slightly prominent abaxially, adaxially flush with blade; primary lateral veins 2–3 on each side, irregularly alternating with lesser interprimaries, diverging at 45–60° and joining a conspicuous sub-marginal vein; secondary venation adaxially obscure, abaxially fine and somewhat distant (ca. 1 mm apart); tertiary venation adaxially obscure, abaxially obscure or forming a very faint tessellate reticulum (most easily seen in dry material). Inflorescence solitary, with up to four produced in sequence each interspersed by a foliage leaf; fragrance weakly isoamyl acetate; peduncle sub-equalling to exceeding leaves, 7–11 cm long, reddish brown. Spathe narrowly ovoid at onset of anthesis, inflating to become ovoid-globose during staminate anthesis, 2–2.5 cm long, apex constricted with an up-turned rostrum ca. 3 mm long with incurved margins, spathe pale to medium pink with darker red stripes comprised of dense, minute speckles, lower part of spathe (equating to adnation of

stipe) reddish brown and very slightly scabrid, upper ca. 1/3 of spathe caducous-deliquestent. Spadix 0.8–1.2 cm long, subcylindric, shortly stipitate; stipe mostly adnate to spathe, dark red, terminal part of stipe and fertile portion of spadix free; pistillate flower zone 2–3.5 mm long; pistil ovoid, 1–1.2 mm diam., white; stigma sessile, discoid, about as wide as ovary, papillate at anthesis, pale pink, drying dark brown; pistillodes confined to 3–5 congested to rather lax oblique whorls at base of pistillate zone, individually flat topped, irregularly polygonal, shortly narrowly stipitate, slightly wider than ovaries, glossy deep yellow, stipe much paler; sterile interstice absent; staminate flower zone shortly cylindric, apically obtuse, fertile throughout, ca. 0.6 cm long × ca. 4 mm diam., ivory; staminate flower crowded, individually comprised of two stamens, truncate, rectangular ellipsoid from above, 0.9–1 mm across, apically minutely and densely pubescent; theca opening through an apical pore; pollen extruded in thick strings. Fruiting peduncle pendulous, not much elongating, reddish brown; fruiting spathe initially narrowly conical, later funnel-shaped, ca. 1.5 cm long and 1 cm wide at mouth; berries clustered, free, subcylindric to obovoid with persistent stigma remnant, 3–3.3 mm long; seed subcylindric with a curved micropylar appendage as long as body of seed, appendages interlinked in fruit holding seeds together; testa light brown and slightly longitudinally ribbed.

Specimens examined: **INDONESIA.** Indonesian Borneo, Kalimantan Timur, Kutai Timur, Sangkulirang Mandu Dalam 01°06'45.64"N 118°0'24.83"E, 3 Feb. 2012, K. Nakamoto AR-3757 (BO, SAR).

**Distribution:** Known only from the type locality, where it is abundant.

**Ecology:** Mineral spring-fed streams and exposed waterfalls under lowland perhumid to moist forest. Plants are obligated to travertine deposits, with the creeping stems and roots frequently encrusted with limestone deposits at approximately 50 m above sea level.

**Etymology:** The species epithet is contrived



Fig. 9. *Ooia manduensis* (A. Hay & Bogner) S. Y. Wong & P. C. Boyce. A, B. Plants in habitat on travertine. Note (B) that creeping stem and roots are encrusted with limestone deposits. C. Cultivated plant. D. Inflorescence at pistillate anthesis. E. View of end of spathe, pistillate anthesis; F. Spadix at pistillate anthesis, spathe artificially removed. G. Inflorescence at finish of staminate anthesis, distal half of spathe beginning to shed. C–G from AR-3757. Images A, B © K. Nakamoto, used with permission. Images C–G © P. C. Boyce.

from the Sungai Mandu, the Type locality, with the suffix *-ensis* (to originate from).

Notes: Spathe senescence mechanics of *Piptospatha manduensis* combined with the highly atypical (for *Piptospatha*) fragrant inflorescences, pubescent staminate flowers, and deciduous non-pistillate flowers, and typical (for *Ooia*) creeping/rooting stems and pendulous infructescences occurring prompts removal of *P. manduensis* from *Piptospatha* and incorporation into *Ooia*. Molecular support is provided by Low et al. (in prep).

***Ooia paxilla*** S. Y. Wong & P. C. Boyce in *Webbia* 68(2): 87 (2013). [Fig. 10]

**Type:** **INDONESIA.** Indonesian Borneo, Kalimantan Utara, Malinau, Malinau Selatan, Sembakung, 80 km southwest of Malinau, Tempat Wisata Riam Loreh, 3 km north of Long Loreh, 3°9'24"N, 116°29'36"E, 3 May 2012, K. Nakamoto AR-3926 (BO!–holotype; SAR–isotype, ethyl alcohol preserved!).

Small rheophytic herb ca. 10 cm tall. Stem ca. 4–8 cm long, moderately elongate with internodes to 1 cm long, 0.6–1.5 cm diam., roots strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous gel cap. Leaves ca 10 together; petiole brownish purple, 3–12 cm long, ca. 3 mm diam., adaxially very shallowly canaliculate, sheathing only at very bottom of the base, wings extended into a narrowly triangular ligular portion 2–3 cm long; blade elliptic to elliptic-oblong, 5–11 cm long × 2–3.5 cm wide, bright mid-green adaxially, abaxially paler, base cuneate, apex acute and apiculate for 2–3 mm; midrib prominent abaxially, adaxially somewhat impressed, sometimes purple-tinged, primary lateral veins 8–11 on each side; interprimaries much finer than and more or less regularly alternating with primaries, diverging at ca 45–60°; secondary venation abaxially fine, adaxially obscure; tertiary venation obscure. Inflorescences 2–3 together alternating with prophylls; fragrance isoamyl acetate peduncle pendent, exceeding petioles, 8–12 cm long,

ca. 2 mm diam., reddish brown. Spathe ovoid-subcylindric, ca. 2.5 cm long, 1 cm diam., apically beaked for ca. 4 mm, persistent, semi-glossy reddish brown, orthotropous on a pendent peduncle at anthesis. Spadix 1.8–2.5 cm long, subcylindric to slightly clavate, shortly stipitate; stipe adnate to dorsal side of spathe, deep glossy reddish; pistillate flower zone weakly obconic, 6–7.5 mm long, ca. 4 mm diam.; pistils ovoid ca. 1.2 mm diam., pink; stigma sessile, discoid, narrower than ovary, pink; pistillodes confined to a single row below the pistillate flower zone, individually stipitate, about as tall as pistils, ca. 1.2 mm diam., irregularly polygonal flat-topped on a very slender stipe, glossy white; sterile interstice absent; staminate flower zone 9–11 mm long, 5.5–6.5 mm diam., bullet-shaped, apically obtuse, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, more or less rectangular seen from above, ca. 1.1 mm across, minutely pubescent, pale orange; connective not visible; thecae opening through apical pores; pollen extruded in thick strings, white. Fruiting spathe ovoid-subcylindric, deep reddish brown, initially pendent, becoming erect as fruits develop; infructescence not observed.

Distribution: Known only from the type locality.

Ecology: Growing on constantly river-splashed shale river boulders and on permanent waterfalls under wet lower hill forest at an altitude of about 200 m.

Etymology: From the Latin noun, *paxillus* (masc.), a peg or small stake, in reference to the highly distinctive infrapistillar staminodes which are diagnostic for this species.

Notes: *Ooia paxilla* is a remarkable species in occurring under constant water flow (Fig. 1A, B). It is speculated that the entirely pendent inflorescences are adapted to this ecology by obviating water entering the spathe during anthesis. Developing infructescences are erect-arching, as in the similar *O. kinabaluensis*. Ripe infructescences, however, have not been

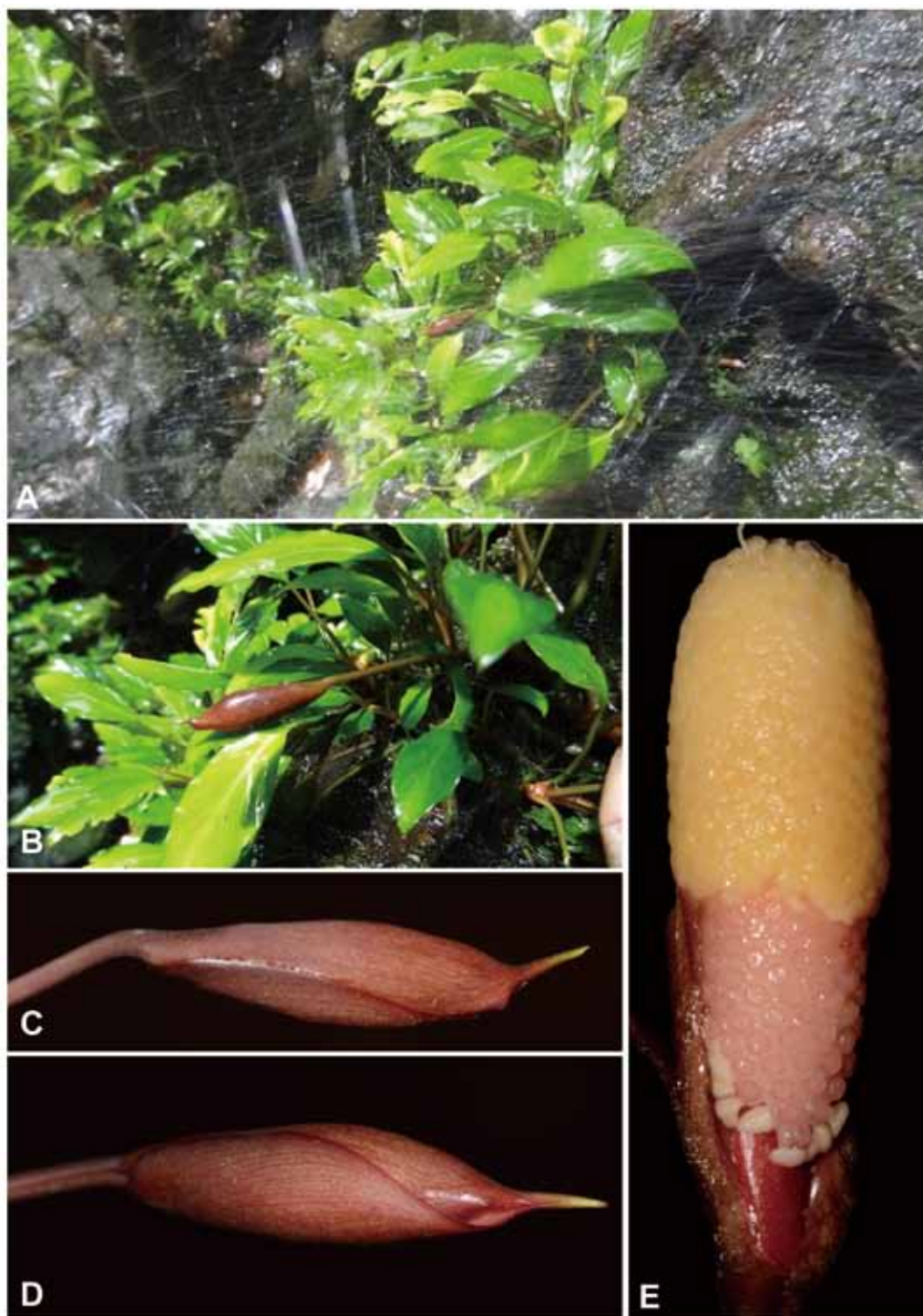


Fig. 10. *Ooia paxilla* S. Y. Wong & P. C. Boyce. A, B. Plants in type habitat on constantly water-washed shales. C and D. Inflorescence at staminate anthesis, lateral (C) and ventral (D), views. Note that spathe limb hardly opens. E. spadix at pistillate anthesis, spathe artificially removed. Note distinctive subpistillar staminodes. All from AR-3926. Images A, B © K. Nakamoto, used with permission. Images C–E © P. C. Boyce.

observed, and thus spathe senescence mechanics and fruit/seed dispersal are unknown. The unique ecology of *O. paxilla* compared with all other described species makes it highly probable that a different dispersal mechanism is employed; observations are wanting.

***Ooia secta*** S. Y. Wong & P. C. Boyce, **sp. nov.** [Fig. 11]

*Ooia secta* is differentiated from *Ooia havilandii* by the inflorescences powerfully fragrant of benzaldehyde–almond oil (vs odourless), and by the different proportions of the pistillate and staminate flower zones.

**Type:** MALAYSIA. Malaysian Borneo, Sarawak, Sarikei, Sungai Lepong, 01°57'14.0"N 111°30'35.2"E, 27 Dec. 2012, P. C. Boyce & Wong Sin Yeng AR-4099 (SAR!–holotype; SAR!–isotype, ethyl alcohol preserved).

Large rheophytic herb ca. 35 cm tall. Stem ca. 10–14 cm long, moderately elongate with internodes to 1 cm long, 0.6–1.5 cm diam., roots strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous gel cap; adventitious plantlets copious. Leaves ca. 10 together; petiole dark brownish green, minutely scabrid, 9–14 cm long, 2–4 mm diam., sub-terete, adaxially with two very narrow keels extending from the blade insertion to the sheath, sheathing only at the base, with wings extended into a soon deliquescing narrowly triangular ligular portion 3–5 cm long; blade softly coriaceous, lanceolate to elliptic, 15–21 cm long × 5–7 cm wide, dark olive-green adaxially, occasionally blotched pale green and silver either as single colour marbled, abaxially pale olive green, base rather broadly cuneate, apex acute and apiculate for 2–3 mm; midrib prominent and finely scabrid abaxially, adaxially bluntly raised; primary lateral veins ca. 12 on each side, somewhat raised, tinged reddish brown; interprimaries finer, more-or-less regularly alternating with primaries, primaries and interprimaries diverging at ca. 60° from the midrib and joining a well-defined intramarginal vein ca. 0.5 mm in from

the blade edge; secondary venation abaxially very fine, adaxially obscure; tertiary venation obscure. Inflorescences up to 10 together, each separated by a prophyll, or a prophyll and a foliage leaf; strongly fragrant of benzaldehyde (almond oil); peduncle erect, exceeding petioles, 10–18 cm long, ca. 2 mm diam., from medium green to deep brownish red. Spathe ovoid-subcylindric, 3–4.5 cm long, ca. 1.5 cm diam., apically beaked for ca. 5 mm, all but extreme incurved margin persistent, spathe semi-glossy medium pink; nodding on an erect peduncle at anthesis. Spadix 2.5–3.5 cm long, weakly fusiform, sessile; pistillate flower zone stoutly cylindrical, 6–7.5 mm long, ca. 4 mm diam.; pistils ovoid ca. 1.2 mm diam., whitish; stigma sessile, discoid, narrower than ovary, creamy white to very pale pink; pistillodes in 3–5 rows below the pistillate flower zone, individually stipitate, somewhat exceeding pistils, ca. 1.2 mm diam., irregularly polygonal flat-topped on a stout stipe, glossy creamy white; sterile interstice absent; staminate flower zone 10–12 mm long, ca. 4.5 mm diam., bullet-shaped, apically obtuse, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, more or less rectangular seen from above, ca. 1.1 mm across, minutely pubescent, pale creamy yellow; connective not visible; thecae opening through apical pores; pollen extruded in thick strings, white. Fruiting spathe ovoid-subcylindric, reddish green to deep reddish brown, pendent, becoming erect as fruits develop; fruits ellipsoid, ripening dirty white, ca. 3 mm long.

Specimens examined: MALAYSIA. Malaysian Borneo. Sarawak, Sarikei, Ulu Sarikei, 01°55'05.4"N 111°29'35.8"E, 7 Dec. 2005, P. C. Boyce et al. AR-1580 (SAR); Sarikei, Maradong, Rumah Dakun ak Jenang, Sungai Matob, 01°52'06.1"N 111°55'30.7"E, 8 Dec. 2005, P. C. Boyce et al. AR-1618 (SAR); Sarikei, Ulu Sarikei, Rumah Nyuka, 1°54'22.92"N 112°14'13.29"E, 23 Oct. 2006, Wong Sin Yeng AR-2043 (SAR!) & Wong Sin Yeng AR-2043 (SAR!); Sri Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Rumah Gumbang, Sungai Delok, 01°12'16.2"N 112°03'26.0"E, 24 May 2008, P. C. Boyce, Wong Sin Yeng & Jepom ak Tisai AR- 2374 (SAR); Sri



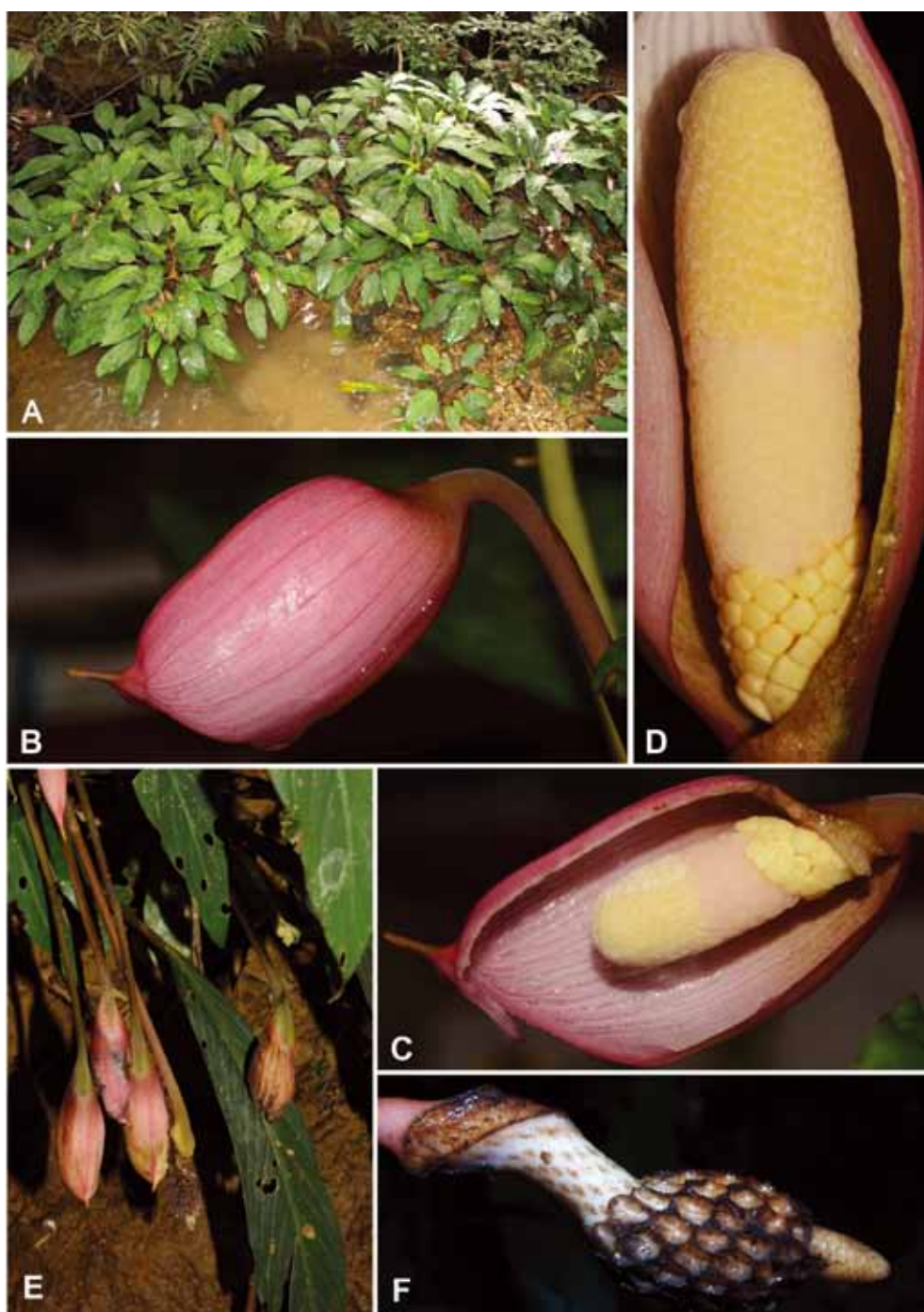


Fig. 11. *Ooia secta* S. Y. Wong & P. C. Boyce. A. Plants in habitat. B. Inflorescence at pistillate anthesis. C. Spadix at pistillate anthesis. Nearside spathe artificially removed. D. Detailed view of spadix, pistillate anthesis. E. Developing and old infructescences. Note pendulous peduncle and spathe degrading on furthest right (post-dispersal) infructescence. F. Post-dispersal infructescence, spathe naturally fallen removed. Note expanded area with rhomboidal scars from fallen fruits. A from AR-1580. B and C from AR-4099. D from AR-4150. E from AR-4003. F from AR-2147. Images © P. C. Boyce.

Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Sungai Pedali, 01°11'58.9"N 112°03'27.0"E, 25 May 2008, P. C. Boyce, Wong Sin Yeng & Jepom ak Tisai AR-2391 (SAR!); Sri Aman, Lubok Antu, Batang Ai, Nanga Sumpa, Wong Ensalai, 01°11'51.0"N 112°03'39.9"E, 26 May 2008, P. C. Boyce, Wong Sin Yeng & Jepom ak Tisai AR-2417 (SAR!); Sarikei, Pakan, Jalan Pakan–Rumah Padin, Sungai Kura, 01°56'46.2"N 111°38'54.7"E, 1 Sep. 2011, P. C. Boyce & Wong Sin Yeng AR-3655 (SAR!); Betong, Spaoh, Jalan Ulu Paku, Nanga Penum, 01°37'11.5"N 111°35'34.4"E, 16 Nov. 2011, P. C. Boyce & Wong Sin Yeng AR-3684 (SAR!); Sri Aman, Lubok Antu, Engkilili, Tempat Rekreasi Sungai Raya, Sungai Raya, 01°06'47.7"N 111°31'02.3"E, 19 Jul. 2012 Hoe Yin Chen AR-4003 (SAR!); Sri Aman, Lubok Antu, Engkilili, Tempat Rekreasi Batu Ngabau, 01°11'8.61"N 111°40'11.83"E, 9 Aug. 2013, Jepom ak Tisai AR-4205 (SAR!) & Jepom ak Tisai AR-4206 (SAR!); Sarikei, Pakan, Pasar Pakan, Sungai Patut, 01°48'33.3"N 111°43'23.9"E, 21 Apr. 2014, Ooi Im Him & Bakong ak Frinsa AR-4705 (SAR!); Sri Aman, Lubok Antu, Batang Ai, Batu Lintang, 01°11'19.6"N 111°56'02.6"E, 27 Jul. 2014, S. Y. Wong & P. C. Boyce AR-4867 (SAR!); Sri Aman, Lubok Antu, Batang Ai, Dunang, 01°12'53.2"N 111°57'06.9"E, 27 Jul. 2014, S. Y. Wong & P. C. Boyce AR-4885 (SAR!). Indonesian Borneo. Kalimantan Barat, Kapuas Hulu, Putussibau, 20 km NW of Matoso, 17 May 2013, K. Nakamoto AR-4150 (BO, SAR).

**Distribution:** *Ooia secta* occurs on the Kanowit, Sarikei and western Song drainages of west Sarawak, south though the Ai and Entabai drainages, crossing the saddle in the Klingklang Range (Kapuas Hilir–Kapuas Hulu of Kalimantan Barat) as far south as the northern banks of the Kapuas river. To the east in the Rajang basin *O. secta* is 'replaced' by allopatric *O. havilandii*.

**Ecology:** Rheophytic on somewhat exposed Cretaceous–Paleogene deepwater sediments, primarily on shales, occasionally on hard sandstones, along forested streams and river banks, only very seldom on waterfalls, between 50–150 m above sea level.

**Etymology:** From the Latin adjective *sectus* (masculine – *secta*, feminine) meaning alone, separated. The epithet is coined to emphasize the geographical separation of *Ooia secta* from the further-eastwards allopatric distribution of *O. havilandii*.

**Notes:** *Ooia secta* is overall very similar to *O. havilandii* from the Rejang basin; herbarium

material being indistinguishable. However, *O. havilandii* and *O. secta* are separable on the differences relative proportions of the fertile and sterile zones of the spadix and critically, in our opinion, by the inflorescences of *O. secta* being powerfully fragrant of benzaldehyde (almond extract), while inflorescences of *O. havilandii* have no detectable odour. Although floral fragrance is not the most readily quantifiable characteristic for taxonomic delimitation there is ample evidence that when combined with morphological distinctions it is a compelling tool (see Whitten 1985, and notably Hills 2000, 2012, Hills and Weber 2012).

***Ooia suavis* S. Y. Wong & P. C. Boyce, sp. nov.** [Fig. 12]

*Ooia suavis* differs from all other *Ooia* by the combination of large glossy yellow infrapistillar pistillodes, scattered pistillodes separating the pistillate and staminate flower zones, and inflorescences smelling powerfully of methyl cinnamate.

**Type:** **INDONESIA.** Indonesian Borneo, Kalimantan Tengah, Murung Raya, Puruk Cahu, Sungai Barito, 4 Apr. 2012, K. Nakamoto AR-3844 (BO!–holotype; SAR!–isotype).

Medium-sized rheophytic herb ca. 25 cm tall. Stem ca. 10 cm long, moderately elongate with internodes to 1 cm long, 0.6–1.5 cm diam., roots strongly adhesive, 2.5–3 mm thick, active tips with a conspicuous gel cap; adventitious plantlets few. Leaves ca. 8 together; petiole very dark brownish green, minutely scabrid, 9–10 cm long, 2–4 mm diam., D-shaped in cross-section, proximally with dorsal surface shallowly concave, and distally rather deeply canaliculate, sheathing only at the base, with wings extended into a soon deliquescing narrowly triangular ligular portion 3–5 cm long; blade softly coriaceous, elliptic, 15–18 cm long × 5–6 cm wide, very dark velvety olive-green adaxially, abaxially pale olive green, base rather broadly cuneate, apex acute and apiculate for 2–3 mm; midrib prominent and very finely scabrid

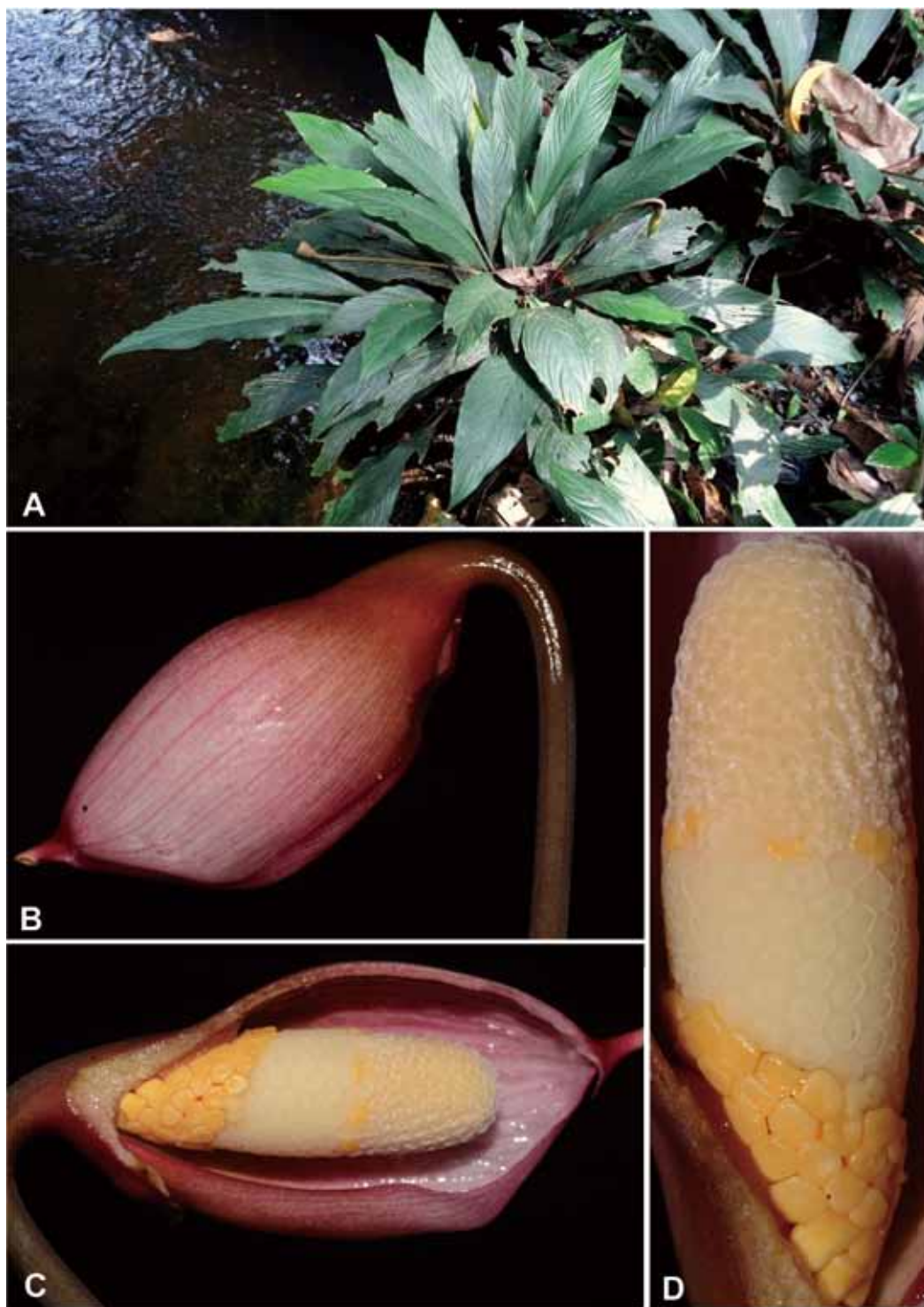


Fig. 12. *Ooia suavis* S. Y. Wong & P. C. Boyce. A. Plant in habitat. B. Inflorescence at early pistillate anthesis. C. Inflorescence at early pistillate anthesis, nearside spathe artificially removed. D. Spadix at pistillate anthesis, spathe artificially removed. A–D from AR-3844. Images © P. C. Boyce.

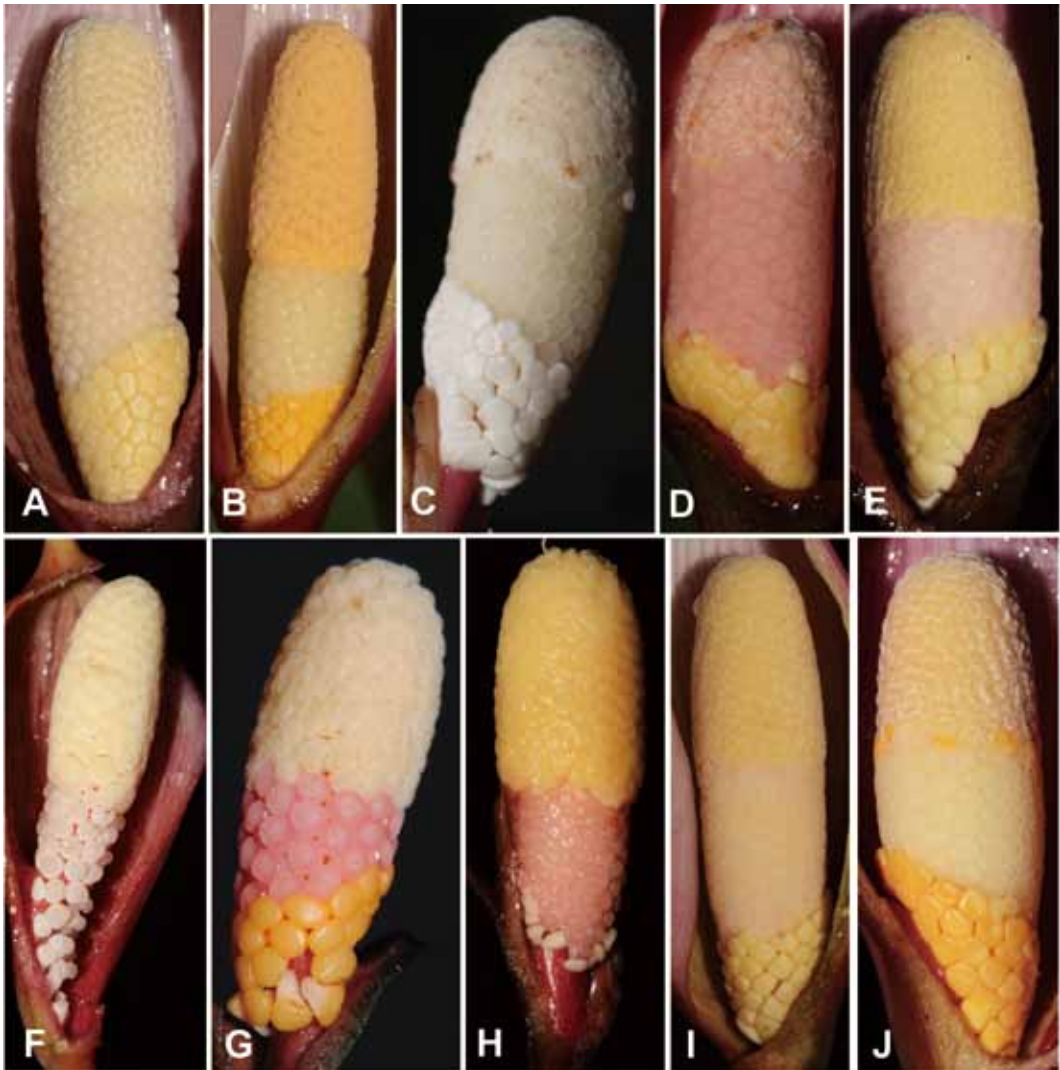


Fig. 13. Spadices of *Ooia* compared. A. *O. altar* S. Y. Wong & P. C. Boyce. B. *O. basalticola* S. Y. Wong & P. C. Boyce. C. *O. glans* S. Y. Wong & P. C. Boyce. D. *O. grabowskii* (Engl.) S. Y. Wong & P. C. Boyce. E. *O. havilandii* (Engl.) S. Y. Wong & P. C. Boyce. F. *O. kinabaluensis* (Bogner) S. Y. Wong & P. C. Boyce. G. *O. manduensis* (A. Hay & Bogner) S. Y. Wong & P. C. Boyce. H. *O. paxilla* S. Y. Wong & P. C. Boyce. I. *O. secta* S. Y. Wong & P. C. Boyce. J. *O. suavis* S. Y. Wong & P. C. Boyce.

abaxially, dark brown, adaxially bluntly raised; primary lateral veins ca. 11 on each side, slightly raised, tinged dark brown; interprimaries much finer, more-or-less regularly alternating with primaries, primaries and interprimaries diverging at ca. 65° from the midrib and joining a well-defined intramarginal vein ca. 0.5 mm in from the blade edge; secondary venation abaxially

very fine, adaxially obscure; tertiary venation obscure. Inflorescences solitary; fragrant strongly of methyl cinnamate; peduncle erect, exceeding petioles, 10–18 cm long, ca. 2 mm diam., from medium green to deep brownish red. Spathe ovoid-subcylindric, ca. 3 cm long, ca. 1 cm diam., apically beaked for ca. 3 mm, all but extreme strongly-incurved margin persistent,

spathe semi-glossy medium pink, darker pink towards base and at terminal beak, main part of spathe with conspicuous darker pink longitudinal veining. Spadix 2.5–3.5 cm long, weakly fusiform, sessile; pistillate flower zone stoutly cylindrical, 6–7.5 mm long, ca. 4 mm diam.; pistils ovoid ca. 1.2 mm diam., whitish; stigma sessile, discoid, narrower than ovary, white; pistillodes in 3–5 rows below the pistillate flower zone, individually stipitate, somewhat exceeding pistils, ca. 1.2 mm diam., irregularly polygonal flat-topped on a stout stipe, glossy medium to deep yellow; sterile interstice present as a few scattered yellow pistillodes; staminate flower zone 10–12 mm long, ca. 4.5 mm diam., bullet-shaped, apically obtuse, fertile to apex; staminate flowers crowded, each comprising one pair of stamens; stamen tops weakly domed, more or less rectangular seen from above, ca. 1.1 mm across, minutely pubescent, creamy yellow; connective not visible; thecae opening through apical pores; pollen extruded in thick strings, white. Fruiting spathe ovoid-subcylindric, reddish green to deep reddish brown, pendent, becoming erect as fruits develop; infructescence not observed.

Distribution: *Ooia suavis* is known only from the type locality.

Ecology: Rheophytic on Miocene volcanics under perhumid lowland forest at approximately 100 m above sea level.

Etymology: From the Latin adjective *suavis* –delightful– by way of reference to the particularly attractive spathe and inflorescences of this species.

Notes: The conspicuously veined spathe and methyl cinnamate fragrance are diagnostic. Pollination studies for *Ooia suavis* would be interesting since methyl cinnamate is linked to bee pollination in orchids (Williams and Whitten 1983, 1999), whereas bee pollination is currently unknown in Bornean aroids.

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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). Biodiversity Centre are gratefully acknowledged. Fieldwork was most recently under Sarawak Forestry Department Permission to Conduct Research on Biological Resources—Permit No. NCCD.907,4.4 (JLD.12) -51 and Park Permit No 121/2015. The collaboration and support of the Sarawak Forestry Department and the Sarawak Biodiversity Centre are gratefully acknowledged.

#### References

- Bogner J. and Hay A. 2000. *Schismatoglottideae* in Malesia II—*Aridarum*, *Bucephalandra*, *Phymatarum* and *Piptospatha*. *Telopea* **9**: 183–194.
- Boyce P. C. and Wong S. Y. 2012. Studies on *Schismatoglottideae* (*Araceae*) of Borneo XX: Beccari's «La Piu piccola delle Aracee» (*Microcasia pygmaea*) recollected and transferred to *Bucephalandra* Schott. *Webbia* **67**: 139–146.
- Boyce P. C. and Wong S. Y. 2013. Studies on *Schismatoglottideae* (*Araceae*) of Borneo XXIX—*Piptospatha manduensis*—the ultimate aroid calciphile? *Aroideana* **36**: 98–103.
- Boyce P. C. and Wong S. Y. 2015. Compendium Genera *Aracearum* Malesianum. *Aroideana* **38**: 40–177.
- Boyce P. C., Wong S. Y., Low S. L., Ting A. P. J., Low S. E., Ng K. K. and Ooi I. H. 2010. The *Araceae* of Borneo—The Genera. *Aroideana* **33**: 3–74.
- Hills H. G. 2000. New species of *Dressleria* (*Orchidaceae: Catasetinae*) from Central and South America. *Lindleyana* **15**: 171–175.
- Hills H. G. 2012. Taxonomic revision of *Dressleria* (*Orchidaceae, Catasetinae*). *Phytoneuron* **2012-48**: 1–28.
- Hills H. G. and Weber M. H. 2012. *Dressleria morenoi* (*Orchidaceae, Catasetinae*): A new species from Colombia. *Phytoneuron* **2012-103**: 1–5.
- Tate R. B. 2001. The geology of Borneo island CDROM.—Kuala Lumpur: Persatuan Geologi Malaysia / Geological Society of Malaysia, Kuala Lumpur.
- Whitten W. M. 1985. Variation in floral fragrances and pollinators in the *Gonqora quinquenervis* Complex (*Orchidaceae*) in Central Panama. Unpubl. PhD dissertation, University of Florida—retrieved from: [www.biodiversitylibrary.org/creator/32153#titles](http://www.biodiversitylibrary.org/creator/32153#titles).
- Williams N. H. and Whitten W. M. 1983. Orchid floral fragrances and male euglossine bees: methods and advances in the last sesquidecade. *Biol. Bull.* **164**(3):

355–395.

- Williams N. H. and Whitten W. M. 1999. Molecular phylogeny and floral fragrances of male euglossine bee-pollinated orchids: A study of *Stanhopea* (*Orchidaceae*). *Plant Species Biol.* **14**: 129–136.
- Wong S. Y. and Boyce P. C. 2010. Studies on *Schismatoglottideae* (*Araceae*) of Borneo XI: *Ooia*, a new genus and a new generic delimitation of *Piptospatha*. *Bot. Stud. (Teipei)* **51**: 543–552.

- Wong S. Y. and Boyce P. C. 2013. Studies on *Schismatoglottideae* (*Araceae*) of Borneo XXXII: *Ooia paxilla*, a new dwarf obligate rheophyte from Kalimantan Utara. *Webbia* **68**(2): 87–89.
- Wong S. Y. and Boyce P. C. 2014. Studies on *Schismatoglottideae* (*Araceae*) of Borneo XXX–New species and combinations for *Bucephalandra*. *Willdenowia* **44**: 149–199.

S. Y. Wong<sup>a,b</sup>, P. C. Boyce<sup>c</sup>: ボルネオ産 *Schismatoglottideae* 連 (サトイモ科) の研究 LI—*Ooia grabowskii* の見直しを含む *Ooia* 属の再検討 —

*Ooia grabowskii* (Engl.) S. Y. Wong & P. C. Boyce がボルネオ島の南カリマンタン州 (インドネシア) で再発見されたことにより、この学名が五つの異なる植物に対して誤って用いられてきたことがわかった。これらは新種であり、学名を *Ooia altar* S. Y. Wong & P. C. Boyce, *O. basalticola* S. Y. Wong & P. C. Boyce, *O. glans* S. Y. Wong & P. C. Boyce, *O. secta* S. Y. Wong & P. C. Boyce, *O. suavis* S. Y. Wong & P. C. Boyce として発表する。*Ooia grabowskii* は南カリマンタン州のムラトゥス山地南部に固有の植物である。さらに、これまで *O. grabowskii* の異タイプ異名とされてきた *Rhynchopyle havilandii* Engl. [= *Piptospatha havilandii* (Engl.) Engl.; *Schismatoglottis havilandii* (Engl.) M. Hotta] も、*Ooia* 属の独立種とするべきであることがわかったので、新組合せ *Ooia havilandii* (Engl.) S. Y. Wong & P. C. Boyce を提案する。*Ooia grabowskii* と *O. basalticola* の仏炎苞の花後の変化を観察したところ、*Piptospatha manduensis* Bogner & A. Hay の場合と全く同じであることが明らかとなった。*Piptospatha manduensis* は、*Piptospatha* 属と

しては極めてめずらしい芳香性の花序、有毛の雄花、そして雌花以外は早落性であるという特徴をもち、一方で *Ooia* 属では典型的な特徴である匍匐性または発根性の茎と懸垂する果序をもつことを合わせて考慮すると、*Ooia* 属として扱うのが適当であり、学名を新組合せ *Ooia manduensis* (Bogner & A. Hay) S. Y. Wong & P. C. Boyce とする。これらの新しい取扱いにより、*Ooia* 属は 10 種からなる属となった。本論文では、これらすべての種について生きた状態で撮影された写真を掲載し、*O. grabowskii* については、ベルリンのホロタイプの写真とエングラの *Araceae Exsiccatae et Illustratae* No. 196. の図も添えた。また、*Ooia* 属全種の検索表を作成した。

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