

# First record of Anura (*Dendropsophus columbianus* -Anura: Hylidae-) as floral visitors of Araceae (*Zantedeschia aethiopica* (L.) Spreng)

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## ABSTRACT

No amphibian has yet been reported among the many interactions between Araceae and their flower visitors. This paper reports the possible use of the inflorescences of *Zantedeschia aethiopica* as a habitat for *Dendropsophus columbianus*, and suggests that further exploration of this kind of interaction would be of interest.

## KEY WORDS

Araceae, Amphibian, habitat use, plant-animal interaction.

## INTRODUCTION

The interactions Araceae – vertebrates are mainly documented for herbivorous mammals (Altricher et al., 2000; Hibert et al., 2013) or frugivorous animals such as bats, primates, marsupials or birds (Santori et al., 1995; Thoisy & Richard-Hansen 1997; Vieira & Izar, 1999; Galetti et al., 2000;

Cockle, 2001). It appears that vertebrates are not associated with the pollination of Araceae and in fact the pollinators and floral visitors of Araceae are almost exclusively invertebrates (Gibernau, 2011; Chartier et al., 2014), although there is one known case of vertebrates visiting and probably pollinating an aroid; *Anthurium sanguineum* by hummingbirds (Kraemer & Schmitt, 1999).

Among the vertebrates, anurans are not particularly associated with Araceae, but in Brazil, the only known case studied, the frugivorous frog (*Xenohyla truncata*) eats berries of *Anthurium barrisii*, and they form the main source of fruits for this frog during its fruiting season from August to December (Da Silva et al., 1989; Da Silva & de Britto-Pereira, 2006; Galindo-Urbe & Hoyos-Hoyos, 2007). These fruits represent an important complement to the insect diet collected in water tanks and could represent a source for particular defensive toxins such as saponins and calcium oxalate crystals in the case of *Anthurium* (Da Silva & Britto-Pereira, 2006). Many Aroid species are known to be used as leafhangers by various species of anurans and thus be part of their habitat (Rojas-Morales et al., 2011; Escobar-Lasso & Rojas-Morales, 2012).

*Zantedeschia* is a genus distributed mainly in South Africa, but introduced in the Neotropics and well adapted to the new environments. They grow close to water bodies. In its natural habitat, its main floral visitors and pollinators are beetles of the families Scarabaeidae and Scydmaenidae (Letty, 1973; Singh et al., 1996; Mayo et al.,

1997; Gibernau, 2011), but no observations have been published so far in the introduction zones. In *Zantedeschia*, the spathe is usually persistent, and closed at the bottom with the top of wide open making an obconic subcylindric tube, (Mayo et al., 1997). So the inflorescence represents a wide cone large enough for a copulation site or shelter of certain anurans similar to what can be found in bromeliads. Here we present the first record of an Amphibian as a floral visitor of *Zantedeschia aethiopica*, in the Department of Risaralda, Colombia.

### Detail of the record

Observations were done during November 24<sup>th</sup> and December 3<sup>rd</sup> of 2013, at the Hacienda Lisbran located on the western flank of the Colombian Central Cordillera in the Department of Risaralda, between 1750 to 2250 masl, at the Swiss village of La Florida, municipality of Pereira (4°44'20" N 75°35'23" W). The average annual temperature is 16.8°C with an average annual rainfall of 2638.5 mm (MAVD, 2010). The habitat in the living area is a lower montane wet forest bmh-MB (Holdridge, 1971). Three sightings were recorded of *Dendropsophus columbianus* a terrestrial frog, endemic to Colombia (Ruiz-Carranza et al., 1996), visiting inflorescences of *Zantedeschia aethiopica*. Individuals of *Z. aethiopica* were located within 5 m of a water body.

The first sighting was on November 25<sup>th</sup> 2013 at 23:20 h. A male individual was



**Figures 1-2.** The first sighting. -1. A male of *D. Colombianus* within the inflorescence of *Z. aethiopica*. Inside the white circle, at the bottom of the floor is a female possibly conspecific. -2. Detail of the male frog inside the inflorescence.



**Figures 3-6.** Detail of the third sighting. -3. Individual of *D. columbianus* coming out of the young infructescence. -4. Location at the top of the young infructescence. -5. Slippage on the spathe. -6. Slippage on the outside of the young infructescence.

vocalizing at a height of 114.3 cm, and nearby on the basal leaves of the same plant, a female individual was observed that could be by its size a female of *D. colombianus* (**Figures 1, 2**). The second observation took place on November 31<sup>st</sup> 2013 at 20:00 h, the same individual of *D. colombianus* was found vocalizing and perched on the same spathe of *Z. aethiopica*. The third sighting was on December 1<sup>st</sup> 2013 at 23:40 h, the individual of *D. colombianus* was on the outside of a young maturing infructescence. This individual was observed to leave the inflorescence and later to slide down along the peduncle (**Figures 3–6**).

We present here the first record of an anuran making more than one visit to inflorescences of an Araceae. Our observations appear to indicate that the frog *D. colombianus* uses the inflorescence of *Z. aethiopica* as a resource location for vocalization, copulation and maybe feeding. This terrestrial frog has found in the inflorescence of *Z. aethiopica* a limited space in which to shelter but also easy to access from the ground and which offers an elevated singing site., It is an advantage for the males of *D. colombianus* to sing from some height since their calls can be heard from a longer distance (Wells & Schwartz, 1982). Spending long periods of time within the inflorescence, the frogs might influence the night reproduction of *Z. aethiopica* positively by achieving potential pollination or negatively by feeding on visiting insects. It's not known if the frogs stay within the inflorescence during the day and could

affect reproduction during the day. The inflorescences occupied by frogs were pollinated, as indicated by the swelling of the base of spadix (ovaries) and the surrounding spathe and by wilting of the upper parts (male flowers, flagging of the spathe), which in Araceae is indicative of flower fertilization (Garcia-Robledo et al., 2005).

We think that since *Zantedeschia aethiopica* is an introduced species in the Neotropics, it may well be displacing other native aroids, but may now allow other types of interaction with animals (Amphibious) that were not possible in many native aroids due to the shape of the inflorescence. We recognize that this represents a small number of observations, but they were consistent enough to suggest that further field work is needed to study the frequency and the outcomes of this new and original interaction between *D. colombianus* and *Z. aethiopica* in Colombia. Even more important would be to find a similar interaction involving an aroid native to the area. This could then lead to investigating an evolved pathway, which could scarcely be possible when the plant component is a recent introduction like the *Zantedeschia*.

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# Studies on Schismatoglottideae (Araceae) of Borneo XXXIV – The Fruits of *Schottariella mirifica*

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## ABSTRACT

The fruits of *Schottariella mirifica* P.C. Boyce & S.Y. Wong are described and illustrated for the first time and shown to be dehiscent berries, the second recorded example of this fruit type for tribe Schismatoglottideae, and the third for the family Araceae. The berries of *Schottariella mirifica* dehisce basally with the shed portion of the berry containing 3–5 comparatively large seeds, each fully enclosed in a fleshy white aril.

## INTRODUCTION

*Schottariella mirifica* P.C.Boyce & S.Y.Wong (Boyce & Wong, 2008, 2009, 2012a) is a recently described species of obligate rheophytes known from four localities on the Kanowit and Ai river catchments of western Sarawak, Malaysian Borneo.

When *Schottariella* was described (Boyce & Wong 2008, 2009) complete mature infructescences were unknown, although subsequently these were found and described (Boyce & Wong 2012). Recently plants in cultivation in Kuching have





**Figure 1.** Mature infructescence of *Schottariella mirifica* P.C.Boyce & S.Y.Wong



**Figure 2.** Dehisced fruits of *Schottariella mirifica*. See text for explanations.





**Figure 3.** Seeds of *Schottariella mirifica*. **A.** the seed has the aril in place; **B.** the seed has the aril removed.

produced infructescences that developed to full maturity (ripe fruits), revealing that the berries ripen to glossy medium green (**Figure 1**) at which stage the pericarp of each berry is basally circumscissile with the distal margins reflexing (**Figure 2A, B**), with the upper three quarters of the berry shedding still enclosing the 3–5 seeds (**Figure 2C, D**).

The seeds of *Schottariella mirifica* are pyriform, ca 3 mm long and ca 2 mm wide, and each completely enclosed in a fleshy white aril ca 0.5 mm thick (**Figure 3A**). Each seed has a conspicuous hyaline extension at the chalazal end (**Figure 2E, arrow**), the function of which is not clear although it may serve a similar purpose as the micropylar appendage of many Schismatoglottideae by assisting to anchor the seeds prior to germination (Wong, 2013). Removal of the aril reveals seeds to be ellipsoid, ca 1.5 mm long and 1 mm wide (**Figure 3B**).

## CONCLUSIONS

The dehiscent berries reported here for *Schottariella mirifica* is the third such record for the family Araceae, and the second record for tribe Schismatoglottideae (sensu Wong et al., 2010), the other being *Bakoa nakamotoi* S.Y.Wong (Boyce & Wong, 2012b). Dehiscent berries were first recorded for the Araceae in *Lagenandra* Dalzell (tribe Cryptocoryneae) – see Mayo et al., 1997, p. 195.

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# Studies on Schismatoglottideae (Araceae) of Borneo XXXVII – Three enigmatic new species of *Schismatoglottis* from the "Heart of Borneo"

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## ABSTRACT

Three new species of *Schismatoglottis* of uncertain taxonomic affinity (*S. camera-lucida* P.C.Boyce & S.Y.Wong, *S. gampospadix* P.C.Boyce & S.Y.Wong, and *S. gui* P.C.Boyce & S.Y.Wong) are described and illustrated from the north western part of the "Heart of Borneo".

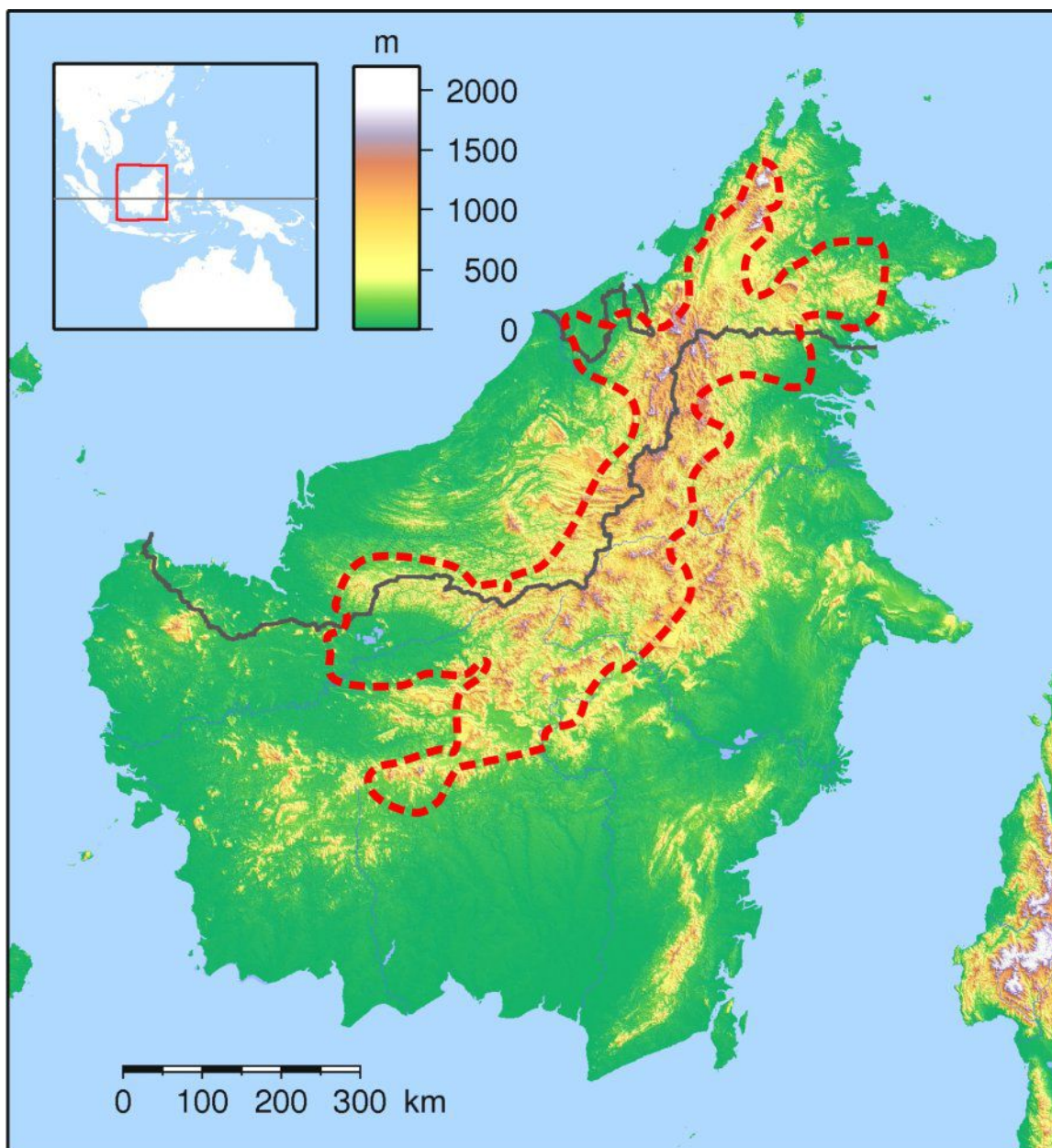
## KEY WORDS

Araceae, *Schismatoglottis*, Borneo, Malaysia, Indonesia, Sarawak, Kalimantan.

## INTRODUCTION

The World Wide Fund for Nature's "Heart of Borneo" initiative – [http://wwf.panda.org/what\\_we\\_do/where\\_we\\_work/borneo\\_forests/](http://wwf.panda.org/what_we_do/where_we_work/borneo_forests/) – sets out to both protect and undertake research in an extensive area of Borneo (**Figure 1**). While a significant part of the HoB initiative focusses on animals, there is a plant element

– [http://wwf.panda.org/what\\_we\\_do/where\\_we\\_work/borneo\\_forests/about\\_borneo\\_forests/borneo\\_animals/borneo\\_plants/](http://wwf.panda.org/what_we_do/where_we_work/borneo_forests/about_borneo_forests/borneo_animals/borneo_plants/) – which agreeably includes flora other than



**Figure 1.** Map showing the extent of the ‘Heart of Borneo’ area. Wikimedia Commons.



carnivorous plants, horticulturally significant orchids, and giant-flowered holoparasites.

Aroid-focused fieldwork in the northern part of the HoB area has revealed numerous taxonomic novelties, some of them perplexing as to affinity, of which we are here describing three intriguing species of the genus *Schismatoglottis*.

***Schismatoglottis camera-lucida*** P.C. Boyce & S.Y. Wong, **sp. nov.** Type: Indonesian Borneo, Kalimantan Barat, Melawi, Nanga Pinoh, 97km south of Nanga Pinoh Camp 97, 4 April 2012, K. Nakamoto AR-3849 (holo SAR!; iso SBC). **Figure 2.**

### Diagnosis

*Schismatoglottis camera-lucida* most closely approaches *S. gui* but is diagnosed by the translucent (not opaque) lower spathe walls, the longitudinally ridged (vs smooth) spathe exterior, the spathe with two constrictions (one below and one above the staminate flower zone), and by the fusiform staminate flower zone equalling in length and (at the widest point) exceeding the appendix in width (vs. staminate flower zone obconic and only half as long as, and entirely narrower than, the appendix).

### Description

Small, tufted evergreen, mesophytic herbs to 20 cm tall. **Stem** abbreviated, epigeal, erect, densely leafy. **Leaves** arching-

ascending, thinly chartaceous, ca 4 per module but modules very closely aggregated, subtended by a short, stiff **prophyll** ca 2 cm long, with the prophyll sheath wings hyaline and transparent; **petioles** up to 8 cm long, sheathing for ca 1/3 their length, ascending, petiole above the petiolar sheath carinate, the dorsal edges sharp, petiole bright dark green; **petiolar sheath** persistent, margins hyaline, more-or-less transparent, open, tips oblique with one side extended into a rounded auricle ca 3 mm long; **blade** up to 20 × 3 cm; elliptic, base cuneate, apex attenuate with a very short tubular mucro, bright green on first emerging, maturing deep semi-glossy green adaxially, matte pale green abaxially; midrib conspicuous, bluntly raised adaxially, rounded-raised abaxially; primary lateral veins about 5 per side, weakly impressed adaxially, slightly raised abaxially; interprimary veins barely distinguishable from the much less numerous primaries; secondary conspicuously tessellate abaxially and darker than surrounding tissue, weakly raised adaxially. **Inflorescences** solitary or occasionally two together; **peduncle** stoutly compressed obconic, ca 5 mm long × 2 mm wide at the base, sub-equalling the lower spathe in width at the top, not emerging from the sheath, white; **spathe** with two weak constrictions, one below and one above the staminate flower zone, the exterior with several conspicuous longitudinal ridges; **lower spathe** compressed-ellipsoid, ca 1 cm long × 8 mm wide, fleshy, whitish green, translucent (pistillate flower zone clearly discernible through the walls); **spathe limb** very



**Figure 2.** *Schismatoglottis camera-lucida* P.C.Boyce & S.Y.Wong. **A.** Plant in habitat, Type locality. **B.** Inflorescence at pistillate anthesis. Note that lower spathe walls are translucent and that the staminate flower zone is clearly visible; note, too that the spathe limb barely opens. **C.** Spadix at pistillate anthesis, spathe artificially removed. **D.** Detail of the appendix and the upper part of the staminate flower. All from *K. Nakamoto AR-3849*. Images: A. © K.Nakamoto; B – D © P.C.Boyce.

narrowly triangular, ca 3.5 cm long, white, the tip green, spathe limb barely opening, weakly inflating during anthesis to form a very narrow slit the length mid-portion of the spathe limb, limb soon deliquescing into a brownish white slime, lower spathe persisting. **Spadix** sub-equalling the spathe, ca 3.5 cm long, sessile; **pistillate flower zone** ca 1/3 the length of the spadix, ca 1cm × 3 mm, weakly obconic; **pistils** somewhat loosely arranged, compressed-globose with three or four distinct sutures, ca 1 × 0.6 mm, bright green; **style** very short, slightly narrower than the ovary; **stigma** ca ¼ width of the ovary, impressed, capitate, greyish white, papillate at pistillate anthesis; **interpistillar staminodes** occurring as an incomplete row at the base of the pistillate flower zone, rhombic-clavate on a short, very slender stipe, ca 0.5 mm wide, and slightly exceeding the height of the associated pistils, waxy white; **interstice** ca 2 mm long, about the same diameter as the top of the pistillate flower zone, covered with rhombic staminodes ca 0.7 mm diam., the tops somewhat impressed with the rims raised, waxy white; **staminate flower zone** ca 9mm × 3mm, fusiform, the mid-point wider than the rest of the spadix; waxy white; **staminate flowers** very densely arranged, probably 2-staminate, but almost impossible to distinguish individual flowers; stamens globose, vaguely dumbbell shaped, connective embedded and ± invisible; thecae opening by a tiny single pore; **appendix** ca 1.5cm long, slender-conical, the base minutely truncate, appendix composed of irregularly rhombohexagonal

staminodes, ca 2 mm diam., the tops flat, ivory. **Infructescence** not observed.

**Distribution** — *Schismatoglottis camera-lucida* is known only from the Type locality.

**Ecology** — *Schismatoglottis camera-lucida* occurs on lightly shaded earth river banks over granite under perhumid lowland gallery forest at ca 250 m asl.

**Etymology** — The trivial epithet is from Latin *camera lucida* (which translates as ‘bright room’), and chosen by way of allusion to the translucent walls of the lower spathe enabling light to enter the lower spathe chamber.

**Notes** — *Schismatoglottis camera-lucida* is taxonomically enigmatic. While the overall morphology, and especially the inflorescence structure and spathe limb senescence, appears to assign it to Nervosa Complex of *Schismatoglottis* (Wong, 2010) the tissues lack the terpenoid smell that characterizes the Nervosa Complex. Molecular analyses are needed to address the correct placement.

The translucent lower spathe walls have no direct equal in the Araceae, although the combination of a *dark* spathe limb and much paler lower spathe occurs in many aroid genera, where it is presumably linked to a light-trap pollination syndrome, although direct studies are lacking, a combination of a pale spathe limb and



**Figure 3.** *Schismatoglottis gampospadix* P.C.Boyce & S.Y.Wong. **A. & B.** Plants in habitat. Note that the rosettes of leaves in B are each attached to a common rhizome-like stem. **C.** Detail of the petioles, showing the ligular extension to the petiolar sheath and the crispulate dorsal edges to the petiole. **D. & E.** Inflorescence at pistillate anthesis. **F.** Spadix at staminate anthesis, spathe artificially removed. Note the large staminodes at the base of the pistillate flower zone. **G.** Detail of the deliquescing spathe limb margins, inflorescence at late staminate anthesis. **H.** Spathe limb with dry-marcescent margins, end of staminate anthesis. **I.** Inflorescence at end of staminate anthesis, nearside half of spathe artificially removed. A, C – G from P.C.Boyce, Wong Sin Yeng & Jepom ak Tisai AR-2420; B, H – I from P.C.Boyce & Jepom ak Tisai AR-540. Images: © P.C.Boyce.

translucent lower spathe is so far unique for *S. camera-lucida*.

***Schismatoglottis gampospadix*** P.C. Boyce & S.Y. Wong, **sp. nov.** Type: Malaysian Borneo, Sarawak, 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-2420 (holo SAR!; iso SBC). **Figure 3.**

### Diagnosis

*Schismatoglottis gampospadix* combines morphological characteristics otherwise known to occur in taxa of quite different species-complexes. The leaf blades in appressed rosettes are reminiscent of those of *Schismatoglottis gamoandra* M.Hotta and *S. puberulipes* Alderw. although the leaf blades are fleshy (not stiffly chartaceous), and lack the strongly raised tessellate secondary venation diagnostic for *S. gamoandra* and *S. puberulipes*. Leaf blades and petioles of *S. gampospadix* are most similar to those of species related to *S. asperata* Engl., although the inflorescences (of *S. asperata*) are quite different, most notably in the entire spathe limb deliquescing as it senesces, whereas in *S. gampospadix* only the spathe limb margins are marcescent. This type of marginal senescence, together with the overall spathe and spadix shape, is in turn closely matched by *Schismatoglottis tectorata* (Schott) Engl., although the shoot architecture of *S. tectorata* is quite dissimilar to that of *S. gampospadix* by having the petiolar sheath reduced to a tiny collar and the protective

role of the sheath taken on by the large prophylls subtending each leaf (i.e., monophyllous modules). The large staminodes present at the base of the pistillate flower zone in *S. gampospadix* are very similar to those occurring in *S. tectorata*, *S. gamoandra*, and *S. puberulipes*, although these latter three species are vegetatively quite dissimilar. The elongated rhizome-like stem with leaf rosettes forming at intervals has no parallel in the genus.

### Description

Small mesophytic herbs with leaves in dense rosettes along a sub-epigeal rhizome-like stem. Stem (in nature) rhizome-like, in cultivation remaining erect, ca 25 cm tall. **Leaves** appressed to the ground, up to 10 per module; **petioles** up to 4 cm long, sheathing for ca ¼ of their length, spreading, petiole above the petiolar sheath stoutly crispulate, petiole dull dark green; **petiolar sheath** persistent, open, tips extended into unequal ligules, the longer ca 1.5 cm long, rounded auricle; **blade** 8–11 × 3–7 cm; fleshy, broadly elliptic, base cordiform, apex rounded, medium to deep semi-glossy green adaxially, matte pale green abaxially; midrib conspicuous, bluntly raised adaxially, rounded-raised abaxially; primary lateral veins about 5 per side, weakly impressed adaxially, slightly raised abaxially; interprimary and higher order veins more-or-less invisible. **Inflorescences** solitary; **peduncle** stout, ca 1 cm long × 3 mm wide, not emerging from the sheath, pale green; **spathe** hardly constricted, strongly curved forwards; **lower spathe** broadly globose-



ellipsoid, ca 1.7 cm long  $\times$  1.5 cm wide, thinly fleshy, white; **spathe limb** triangular, fornicate, ca 3 cm long  $\times$  1.5 cm wide, rather fleshy, spathe limb inflating and opening by a narrow slit at pistillate anthesis, gaping and remaining fornicate at onset of staminate anthesis, then the margins deliquescent and drying-marcescent, limb white, all except the marcescent margins persisting into at least early fruiting (observations wanting). **Spadix** sub equalling the spathe, sessile; **pistillate flower zone** ca 1/5 the length of the spadix, ca 5  $\times$  5 mm; **pistils** dense, ovoid, ca 1  $\times$  0.6 mm, bright green; **style** nipple-like, much narrower than the ovary; **stigma** capitate, greyish white, papillate at pistillate anthesis; **interpistillar staminodes** very conspicuous below the pistillate zone, oblong, with the long sides perpendicular to the spadix axis, ca 3 mm long  $\times$  1.5 mm wide, waxy white; **staminate flower zone** contiguous with the pistillate flower zone, ca 1.5 cm  $\times$  4 mm, curving-cylindrical, ivory; **staminate flowers** tiny, (<0.3 mm), probably mainly 2-staminate, but chaotically arranged and some seemingly forming lines of up to 10 stamens, lowermost staminate flowers somewhat irregularly scattered, those further up very dense; stamens elongate-globose, connective embedded and  $\pm$  invisible; thecae opening by a two coalesced pores; **appendix** ca 1.5 cm long, very slightly wider than the staminate flower zone, curving, blunt-tipped, covered with very many tiny (> 0.3mm) irregularly polygonal staminodes. **Infructescence** not observed.

**Distribution** — *Schismatoglottis gampsospadix* is known only from area of the Batang Ai drainages, where it occurs as scattered populations.

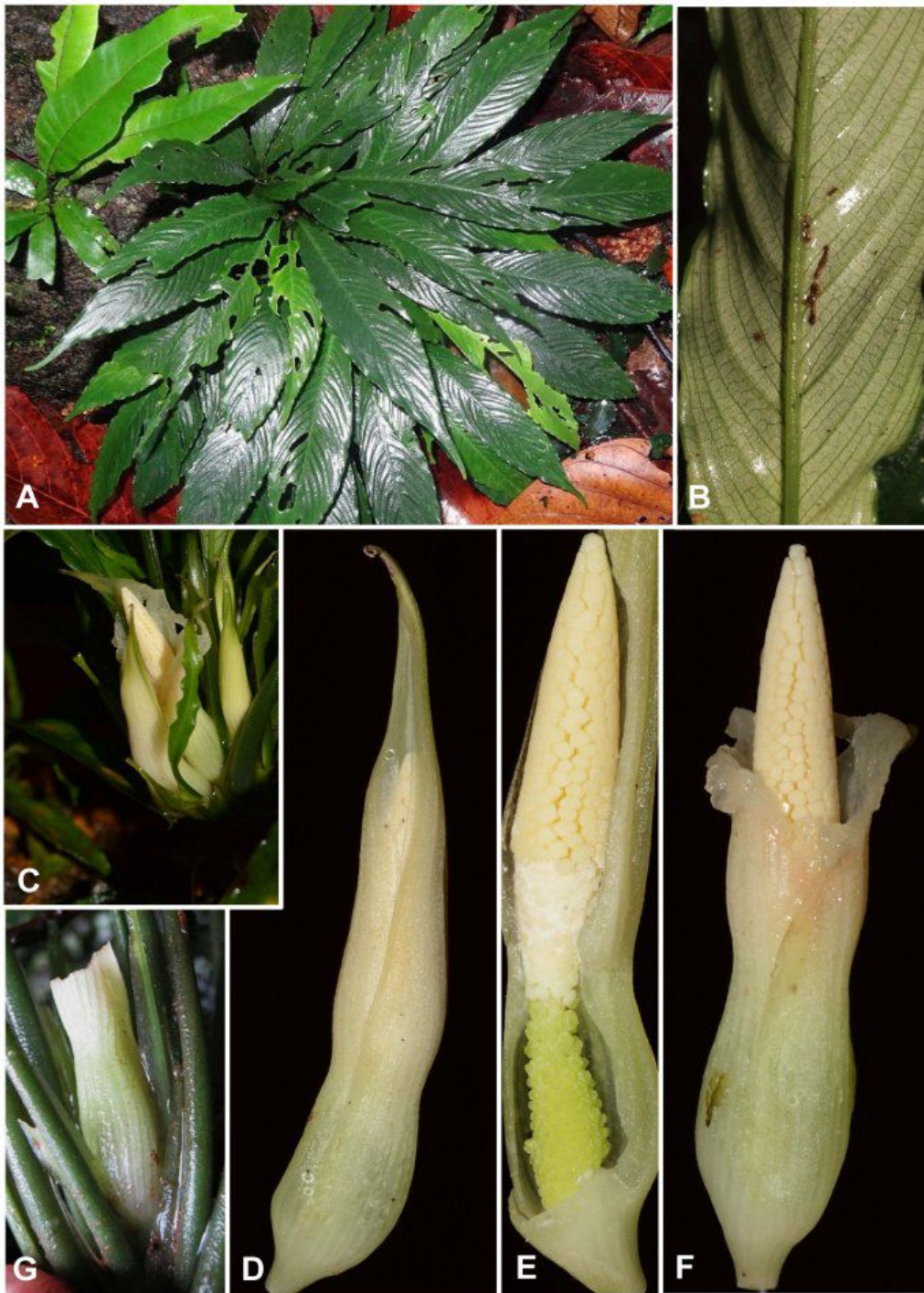
**Ecology** — *Schismatoglottis gampsospadix* occurs on earth banks over shale in moist to wet lowland gallery forest between 100–120m asl.

**Etymology** — From Greek *gampsos* (crooked, curved), and *spadix* – hence ‘curved spadix’, alluding to the spadix in this species.

**Notes** — *Schismatoglottis gampsospadix* is a most peculiar species combining distinctive morphologies of four species occurring in widely separated parts of the genus (Wong et al., 2010), in addition to a so far unique growth habit in which the stem forms a sub-epigeal rhizome along which arise rosettes of leaves. Oddly, plants in cultivation retain an erect stem bearing tufts of leaves along its length, the older plants reaching to 25 cm or more tall and somewhat resembling an *Aglaonema*.

*Other material examined:* MALAYSIAN BORNEO: **Sarawak**, Sri Aman, Lubok Antu, Batang Ai, 01°13'18.0"N 112°03'21.2"E, 28 July 2004, P.C.Boyce & Jepom ak Tisai AR-539 (SAR, SBC) & P.C.Boyce & Jepom ak Tisai AR-540 (SAR, SBC).

***Schismatoglottis gui*** P.C. Boyce & S.Y. Wong, **sp. nov.** Type: Malaysian Borneo,



**Figure 4.** *Schismatoglottis gui* P.C.Boyce & S.Y.Wong. **A.** Plant in habitat, Type locality. **B.** Detail of venation, abaxial surface of leaf blade; note the tessellate secondaries. **C.** Synflorescence. **D.** Inflorescence at pistillate anthesis. Note that the spathe limb barely opens. **E.** Spadix at staminate anthesis, spathe artificially removed. **F.** Inflorescence post-anthesis. Note that the spathe limb has largely deliquesced. **G.** All from P.C.Boyce & S.Y.Wong AR-3536. Images: © P.C.Boyce.



Sarawak, Kapit, Ulu Batang Baleh, Nanga Septi, 4 April 2012, *P.C.Boyce & S.Y.Wong AR-3536* (holo SAR!; iso SBC). **Figure 4.**

### Diagnosis

*Schismatoglottis gui* most closely resembles *S. camera-lucida* but is easy to distinguish by the opaque (not translucent) lower spathe walls, the smooth (not longitudinally ridged) spathe exterior, the spathe with a single constriction, and by the obconic staminate flower zone only half as long as and narrower than the appendix (vs staminate flower zone fusiform, equalling the appendix, and at the widest point exceeding the appendix in width)

### Description

Small, dense-clumping evergreen, mesophytic herbs to 20 cm tall. **Stem** much-abbreviated, epigeal, erect, densely leafy. **Leaves** spreading, thinly chartaceous, ca 6 per module but modules very closely aggregated, subtended by a short, stiff **prophyll** ca 2 cm long, with the prophyll sheath wings hyaline and transparent; **petioles** up to 4.5 cm long, sheathing for ca ½ their length, ascending, petiole above the petiolar sheath carinate, the dorsal edges sharp, petiole dull dark green; **petiolar sheath** persistent, margins hyaline, more-or-less transparent, open, tips oblique with one side extended into a rounded auricle ca 3 mm long; **blade** up to 20 × 3 cm, very narrowly elliptic, base decurrent to weakly cuneate, apex long-attenuate, tip truncate, with a very short tubular mucro, bright

green on first emerging, maturing deep semi-glossy green adaxially, matte pale green abaxially; midrib conspicuous, bluntly raised adaxially, rounded-raised abaxially; primary lateral veins about 5 per side, weakly impressed adaxially, slightly raised abaxially; interprimary veins barely distinguishable from the much less numerous primaries; secondary conspicuously tessellate abaxially and darker than surrounding tissue, weakly raised adaxially. **Inflorescences** up to 6 together, produced sequentially in a very dense synflorescence that barely extends from the subtending petiolar sheath, individual inflorescences alternating with much reduced leaves; **peduncle** slender, very short, ca 3 mm long × 1 mm wide, not emerging from the sheath, white; **spathe** weakly constricted; **lower spathe** ellipsoid, ca 1 cm long × 3 mm wide, somewhat fleshy, very pale green; **spathe limb** narrowly triangular, ca 3 cm long, of which ca 1 cm a slender stiff rostrum, spathe limb opening only slightly, weakly inflating during anthesis to form a narrow slit the length mid-portion of the spathe limb, limb white, rostrum green, limb soon deliquescing to ca half way down (not to the constriction), into a brownish white slime, lower spathe persisting. **Spadix** shorter than the spathe, ca 3.2 cm long, sessile; **pistillate flower zone** ca ¼ the length of the spadix, ca 6mm × 3 mm, weakly obconic; **pistils** somewhat dense, compressed-globose with three or four distinct sutures, ca 0.9 × 0.6 mm, pale green; **style** very short, narrower than the ovary; **stigma** ca ¼ width of the ovary, impressed, capitate, greyish white, papillate at pistillate anthesis; **interpistillar**

**staminodes** absent below the pistillate flower zone; **interstice** ca 2 mm long, slightly narrower than the pistillate flower zone, covered with mushroom-shaped staminodes ca 1 mm diam., the tops rounded, dull white; **staminate flower zone** ca 7mm × 3mm, obconic, waxy white; **staminate flowers** very densely arranged, seemingly 2-staminate, but very difficult to distinguish individual flowers; stamens globose, vaguely dumbbell shaped, connective embedded and ± invisible; thecae opening by a tiny single pore; **appendix** ca 1cm long, slender-pointed, composed of irregularly oval staminodes, these shallowly concave with a raised rim, ivory. **Infructescence** enclosed within a fleshy persistent spathe, the orifice of which is only slightly constricted and does not coincide with the spathe constriction; **fruits** not observed.

Distribution — *Schismatoglottis gui* occurs from central Kapit (the Type) to northern Kalimantan Barat, an extensive distribution for a terrestrial Bornean aroid, the majority of which show high levels of localised endemism. Given this extensive range it is curious that *S. gui* appears to be unrepresented in any of the major herbarium collections of Bornean plants (i.e., BO, L, SAR, and SING).

Ecology — *Schismatoglottis gui* occurs on very shaded riverside granite boulders under moist lowland to hill gallery forest between 65–400m asl.

Etymology — From *gui* (simplified Chinese 鬼), pronounced as ‘gwee’, and meaning a ghost. The trivial epithet is in quaint allusion to the unopened inflorescences that could be likened to huddles of small ghosts among the leaf bases.

Notes — *Schismatoglottis gui*, like *S. camera-lucida* (see this paper), is puzzling as to taxonomic placement, combining characteristics of three species complexes (Asperata, Patentinervia, and Nervosa). Molecular analyses are needed.

The deliquescent spathe limb is reminiscent of *Schismatoglottis nervosa* Ridl. and allies (Nervosa Complex), but in those the limb melts back to the spathe constriction. Similar partially degrading spathe limbs occur in *Schismatoglottis barbata* Engl. (Asperata Complex), which are otherwise quite distinct in the form of the foliage.

*Schismatoglottis gui* grows exclusively on heavily shaded riverside rocks, although it is not a rheophyte (Wong, 2013). It seems to require the constant humidity that the habitat provides.

*Other material examined:* INDONESIAN BORNEO. **Kalimantan Barat**. Sekadau, Nanga Taman, south east of Nanga Taman, Gunung Taman, east slope, 00°27'35.41"S 111°02'3.21"E, 5 Feb. 2012, *K. Nakamoto* AR-3779 (SAR, SBC) & AR-3793 (SAR, SBC); Sekadau, Nanga Taman, west of

Nanga Taman, Gunung Canayang, east slope, 4 Feb. 2012, *K. Nakamoto AR-3783* (SAR, SBC); Sekadau, Hulu Kayu Lapis, 2 hours walk to west from Simpang Tp Perodah, Kampong 23km south of Kayu Lapis, 19 km main road west of Sekadau, 00°9'56.64"S 111°3'28.67"E, 22 May 2012, *K. Nakamoto AR-3943* (SAR, SBC); Melawi, Gunung Saran, Kampung Entebah, 02°00'25.24"S 111°17'42"E, 25 Aug. 2012, *K. Nakamoto AR-4013* (SAR, SBC).

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# New Species of *Philodendron* (Araceae) from South America

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## ABSTRACT

Nine species of *Philodendron* (Araceae) are described as new: *Philodendron alanbrantii* Croat, *P. arbelaezii* Croat, *P. bayae* Croat, *P. bernardoi* Croat, *P. bomboizoense* Croat, *P. brantii* Croat, *P. camarae* Croat, *P. candamoense* Croat and *P. fosteri* Croat.

## KEY WORDS

*Philodendron*, Araceae, South America

## INTRODUCTION

*Philodendron*, with an estimated 800 species, remains a focus of studies at several levels throughout the neotropics but the genus still remains poorly known at the sectional level and many species remain undescribed. The last complete revision of the genus was by Engler and K. Krause (1913) which included 222 species. Several important partial revisions have been completed since 1913; *Philodendron* subgenus *Meconostigma* was revised by Mayo (1991); *Philodendron* section *Macrobelium* has been described for Brazil (Sakuragui et al., 2005) and Central America has been well covered for *Philodendron*. Croat

revised subgenus *Philodendron* (Croat, 1997) and the remaining species were covered by Grayum in his revision of subgenus *Pteromischum* for the Andean region, Central America and the West Indies (Grayum, 1996). A revision of *Philodendron* species with 3-lobed leaves is nearing completion (Croat & Zhang, in prep.). Despite these efforts the largest portion of the species in the neotropics remains unrevised. This paper is intended to be part of a series of publications dealing with new species of *Philodendron* which are resulting from ongoing investigations at the Missouri Botanical Garden.

***Philodendron alanbrantii* Croat, sp. nov.**

Type: COLOMBIA. Antioquia: Municipio Granada, Granada-San Carlos Road, 8.2 km E of Granada, 13.8 km W of San Carlos, disturbed forest just S of road, 06°10'N, 75°05'W, 1900 m, *A. E. Brant, J. Betancur & A. V. Ayala 1764* (holotype, MO-3583496–97); isotype, JAUM). **Figures 1–2.**

The species is a member of subgenus *Philodendron* section *Macrobelyium*, subsection *Macrobelyium*, series *Ovata* and is characterized by its scandent hemiepiphytic habit, internodes moderately longer than brown, drying finely ribbed on younger stems and with thin light brown smooth but flaking in age, deciduous cataphylls, terete blackish drying petioles which are shorter than the blades, narrowly ovate-subcordate dark brown-drying acuminate blades with 4 pairs of basal veins, the 1<sup>st</sup> and sometimes 2<sup>nd</sup> pair

free to the base with a very short posterior rib which is not at all naked along the sinus, 3–4(5) pairs of primary lateral veins, fine minor veins as well as by pairs of two inflorescences per axil with moderately long pedunculate inflorescences with the spathe green, red-tinged at the base of the tube and a creamy white blade and pink berries.

The species is closest to *Philodendron oligospermum* Engl. which differs by drying greenish or yellowish brown with the dried leaf blade surfaces more minutely folded, the veins more deeply sunken-etched with the posterior lobes more broadly rounded and stems with the youngest portion largely irregularly and minutely folded. In contrast, *P. alanbrantii* has the blades drying dark brown with the upper blade surfaces smooth, the veins only weakly sunken, the posterior lobes more narrowly pointed with at least one side having a concave margin near the tip of the lobe as well as by having the younger stems deeply, closely and irregularly ridged.

Vining epiphyte to 5 m; **internodes** longer than broad at base, diminishing in size towards the apex of the plant, 1–14 cm long, 0.8–2.0 cm wide, drying finely ribbed on younger stems and with epidermis thin, light brown and smooth but flaking in age; **cataphylls** 9.7 cm long, unribbed, deciduous. LEAVES scattered along stem with petioles erect-spreading and with blades pendent; **petioles** 12.2–19.7 cm long, erect-spreading, shorter than blades, terete blackish drying; **blades** narrowly ovate-subcordate, 23.0–31.5 cm long, 12.9–14.3



Figure 1



Figure 2

**Figure 1.** *Philodendron alanbrantii* Croat (Brant 1764; MO-3583496, sheet 1). Herbarium specimen showing leaf blade, adaxial surface on right, abaxial surface on left; one detached inflorescence.

**Figure 2.** *Philodendron alanbrantii* Croat (Brant 1764; MO-3583497, sheet 2). Herbarium specimen showing leaf blade, adaxial surface in upper right, folded leaf in lower left with adaxial surface exposed at base, petioles, cataphylls and inflorescences.

cm wide, 2 times longer than wide, 1.8 times longer than petioles, dark brown-drying, gradually acuminate blades, cordulate at base; **anterior lobe** 20–27.5 cm long, broadly convex to weakly concave on the margins; **posterior lobes** 4.5–7.5 cm long, directed at ca. 130° angle, narrowly rounded at apex, sometimes weakly constricted midway on one side; **basal veins** 4 pairs, 1<sup>st</sup>

pair and sometimes 2<sup>nd</sup> pair free to the base, 2<sup>nd</sup> pair sometimes fused 5–10 mm, 2<sup>nd</sup> & 3<sup>rd</sup> pairs fused 7–17 mm long; **sinus** 3.3–4.4 cm deep; **midrib** narrowly rounded and concolorous above, broadly rounded and drying darker than surface below; **primary lateral veins** 5–7 pairs arising at a 60° angle, sunken and concolorous above, narrowly rounded and darker below; **minor veins**

fine and close, moderately indistinct. INFLORESCENCES 1–3 per axil; **peduncle** 2.5–3.5 cm long, 2–3 mm diam. upon drying; **spathe** 4.5–6 cm long, 1 cm diam., green with red blush at base, yellowish green to cream distally; **spadix** 4.2 cm long; pistillate portion 2.3 cm long, 2.6 mm diam. at base, 1.8 mm diam. at apex; pistils 2 mm long, 1.5 mm diam.; ovary 4–5-locular, ovoid-ellipsoid; styles 1.2–1.4 mm diam., the margins narrowly raised, drying pale brown, markedly undulate; stigma 0.2 mm diam., button-shaped, depressed medially; ovules oblong, 1–2 per locule, 0.4 mm long (including funicle), funicle about as long as ovule; staminate portion cream, 2.3 cm long, 2.5 mm diam.; sterile staminate portion 2.5 mm long, 1.8 mm diam. INFRUCTESCENCE with berries pink, green distally.

*Philodendron alanbrantii* is endemic to Colombia, known only from the type locality in Antioquia Department in the Municipio Granada at 1900 m in a *Premontane rain forest* life zone.

The species is named in honor of American botanist, Alan Brant, formerly of the Missouri Botanical Garden who collected the type specimen. Brant is a specialist on the Flora of Missouri and regularly works on inventories for the State of Missouri.

***Philodendron arbelaezii*** Croat & F. Cardona, **sp. nov.** Type: COLOMBIA. Caquetá: Parque

Nacional Natural Chiribiquete, Estación Puerto Abeja, left margin of Río Mesai, 0°5'N, 72°35'W, 180 m, F. Cardona, M. V. Arbelaez & J. C. Berrío 627 (holotype, HUA; isotype, MO-5155791). **Figure 3.**

The species is a member of subgenus *Philodendron*, section *Macrobelyium*, subsection *Glossophyllum*, series *Glossophyllum* characterized by its hemiepiphytic habit, slender yellow-brown-drying internodes, deciduous unribbed green cataphylls, long-petiolate leaves, sulcate petioles, subelliptic grayish brown-drying blades which are narrowly rounded at the base with a prominent lower midrib and 6–7 weak primary lateral veins as well as by having solitary long-pedunculate inflorescences with a green spathe weakly constricted above the tube with the greenish pistillate portion of the spadix.

*Philodendron arbelaezii* keys in the Lucid Philodendron Key to *P. heterophyllum* Poepp. differing in having generally more elongated, blackish-drying blades that are broader well above the middle and typically cordulate rather than merely narrowly rounded at the base; *P. paxianum* K. Krause which also differs in having much more elongated blades broadest well above the middle and with a rounded leaf base, usually drying more greenish and the stem thicker with loose epidermis as well as 3 or 4 inflorescences per axil; *P. sphalerum* Schott differing by having greenish-drying blades broadest toward the base and with the base somewhat attenuated onto the petiole and





Figure 3

**Figure 3.** *Philodendron arbelaezii* Croat (*Cardoma* 627; MO-5155791). Herbarium specimen showing leaf blade, adaxial surface in upper right, folded leaf in lower left with adaxial surface at base; inflorescence solitary in lower leaf axil; cataphyll at stem apex..

*P. wurdackii* G.S. Bunting differing in having blades which are grayish green to green-drying, much longer with the leaf base usually conspicuously cordulate.

Hemiepiphytic, appressed climber; **internodes** slender, 10–12.2 cm long, drying ca. 7 mm diam., yellow-brown, drying longitudinally closely fissured, often

transversely cracked; **cataphylls** ca. 8.6 cm long, green, unribbed, deciduous. **LEAVES** long-petiolate, widely spaced; **petioles** 11.9–16.9 cm long, erect-spreading, sulcate; **blades** 22.5–23 cm long, 10–10.4 cm wide, 2.2 times longer than wide, 1.6 times longer than petioles, subelliptic, broadest slightly above the middle, acuminate at apex, narrowly rounded at base, drying grayish brown and weakly glossy above, weakly glossy and yellow-brown below; **midrib** prominent, drying broadly rounded, and slightly darker above, finely acutely and ribbed and slightly paler below; **primary lateral veins** 6–7 pairs, arising at a 55–80° angle (2 pairs arising from base), weakly visible, concolorous above, drying wrinkled, concolorous below; interprimary veins few; minor veins fine, clearly visible; cross-veins close, moderately inconspicuous; laticifers apparently lacking. **INFLORESCENCES** 1 per axil; **peduncles** elongate, 7.2–11.1 cm long, 3–6 mm diam., dark brown upon drying; **spathe** green, weakly constricted above tube, ca. 10.3 cm long, ca. 1.4 cm diam. upon drying; **spadix** 9.8 cm long, staminate portion 6.7 cm long, 9 mm diam. at base, barely constricted, 7 mm diam. toward apex, bluntly pointed; sterile staminate portion 4 mm long, 9 mm diam., scarcely apparent compared to the fertile staminate flowers; pistillate portion 3.1 cm long in front, 8 mm diam.; ovary ovoid-ellipsoid, 5-locular; ovules basal, 1 per locule, ca. 0.15 mm long, about as long as the funicle, the funicle densely glandular in lower ½; **berries** not seen.

*Philodendron arbelaezii* is endemic to the Sierra de Chiribiquete, an isolated mountain range on the border of northern Caquetá and southern Guaviare, known only from the type locality along the Río Mesae at 180 m elevation in a *Tropical moist forest* life zone.

The species is named in honor of Maria Victoria Arbelaez who along with Felipe Cardona and J.C. Berrio collected the type specimen.

***Philodendron bayae*** Croat, **sp. nov.** COLOMBIA. Valle del Cauca: Vicinity of Bajo Calima; along road from Buenaventura to Málaga, Km 49, 04°02'N, 77°04'W, 150 m, 17 July 1993, T. B. Croat & D. C. Bay 57810 (holotype, MO-4570657,4619385; isotype, CUVC). **Figures 4–8.**

The species is a member of subgenus *Philodendron* section *Philodendron* subsection *Achyropodium* characterized by its generally epiphytic habit, short moderately thick internodes, unribbed to weakly 1–2-ribbed cataphylls which persist more or less intact with thin red-brown epidermis overlying a network of pale brownish fibers, eventually becoming semi-intact, petioles subterete midway and obtusely flattened and purplish violet toward the apex with a medial rib toward the apex and sparsely greenish-scaly at least near the apex (extending throughout petioles on younger plants), narrowly ovate-sagittate brownish -drying narrowly long-acuminate blades with hippocrepiform sinus, 8–11 pairs of basal veins with



Figure 4

**Figure 4.** *Philodendron bayae* Croat (Croat 80822). Habit with three leaves, two on left with adaxial surface exposed, one on the right with abaxial surface exposed; stem apex exposed.

interbasal veins present, 3–4 pairs of basal veins free to the base, a well-developed moderately straight posterior rib which is naked about  $\frac{3}{4}$  its length, 8–12 pairs of primary lateral veins with interprimary lateral veins present, frequently with moderately common cross-veins as well as by the 1–2 inflorescences per axil with the peduncle white and coarsely lineate toward apex, spathe white outside and maroon throughout within or tinged maroon on the basal half of the blade inside.

The species has long been confused with *Philodendron malesevichiae* Croat from Panama but that species differs by having a terrestrial habit, blades matte on the upper surface with 8 pairs of basal veins, the posterior rib naked for only 1–2 cm and for





Figure 5



Figure 6

**Figure 5.** *Philodendron bayae* Croat (Croat 80822). Leaf blade adaxial surface.

**Figure 6.** *Philodendron bayae* Croat (Croat 80822). Flowering plant on ground, both blades exposing abaxial surface.

less than half its length as well as by having the spathe greenish white and matte throughout on the inner surface. In addition the petioles of *P. malesevichiae* are scaly throughout most of their length whereas those of *P. bayae* are conspicuously scaly only near the apex.

Epiphyte; **internodes** 2–4 cm long, ca. 4 cm diam., short moderately thick, glossy medium green, drying brown; **cataphylls**

unribbed to weakly 1–2-ribbed, 30.5 cm long with thin red-brown epidermis overlying a network of pale brownish fibers, eventually becoming semi-intact and with a mass of decomposed parts lower down. **LEAVES** dark green and matte above, much paler and weakly glossy below, subcoriaceous; **petioles** (27)46–82 cm long, terete, firm, becoming obtusely D-shaped with obtuse medial rib toward apex, medium green, densely pale-striate (not



Figure 7



Figure 8

**Figure 7.** *Philodendron bayae* Croat (Croat 80822). Petiole showing scales near apex.

**Figure 8.** *Philodendron bayae* Croat (Croat 80822). Immature infructescence with seeds exposed on left, exterior surface on right.

raised), densely and conspicuously scaly in distal 4 cm; **blades** (28)42–82 cm long, (17.2)32–46 cm wide, 1.2–2.8 times longer than wide (averaging 1.66), 0.66–2.2 times longer than petioles (averaging 0.92 as long), dark green and matte above, much paler and weakly glossy below, drying dark brown and matte above, light brown and semiglossy below; **anterior lobe** 31–47.4 cm long, broadly convex; posterior lobes directed toward the base, 14.6–24 cm long; **sinus**

spathulate to narrowly hippocrepiform, sometimes parabolic, 9.8–15.5 cm wide; (5)10–20 cm wide; **basal veins** 8–11 pairs, 3–4 pairs of which are free to the base; **midrib** flat, pale above, dark green and matte below, drying lighter, raised and finely ribbed above, raised, smooth and concolorous below; **primary lateral veins** 8–10(12) pairs, often alternating with interprimary veins, arising at a 58° angle, sunken above, raised below, dark green,

matte, drying raised, ridged and lighter with a slightly darker (deteriorating with age) epidermal layer present, sunken and lighter below; **basal veins** ca. 8 pairs arising at ca. an 80° angle; **minor veins** obscure. INFLORESCENCES 1–2 per axil, tube magenta, blade white; **peduncle** 4.0–5.0 cm long, 0.5–1.0 cm diam. upon drying, white then brown-drying, coarsely lineate toward apex; **spathe** white outside and maroon throughout within, or tinged maroon on the basal half of the blade inside; **spadix** 12–15.5 cm long; staminate spadix (4.7)9–10.5 cm long, drying 7–11 mm diam., narrowly pointed at apex; pistillate portion, 4.7–5.7 cm long, drying 6–8 mm diam. midway; pistils 6–7-locular, drying 2 mm long; ovary broadly triangular- ovoid, marked with dark lines marking the locules; style 0.5 mm long, drying darker brown; stigma 0.5 mm long, drying blackened; ovules 17–20 per locule. INFRUCTESCENCE with berries drying 5 mm long, 3.5 mm diam., pericarp drying medium brown with pale granules, 6–7-locular; style 1.8–2.2 mm diam., 0.1 mm thick, irregularly angular; stigma button-shaped, 1.4–1.5 mm diam., subrounded, dark brown, pale on margins, with 6–7 pits around the perimeter; seeds 0.6–0.7 mm diam., coarsely ribbed longitudinally, brownish, arranged in two rows with axile placentation.

*Philodendron bayae* is endemic to Colombia, known only from Chocó and Valle Departments at 40–150 m in a region of *Tropical rain forest* life zone or a transition zone between *Tropical wet forest* and *Tropical rain forest* life zones.

The species was first collected by the senior author in 1984 in the Bajo Calima area and was subsequently collected four times in the same region and in 1997 by Croat & Gaskin in the region of Las Animas in Chocó Department.

The species is named in honor of Dr. Dorothy C. Bay, a former student of Tom Croat who did her Ph.D. thesis studying the Araceae of the Bajo Calima Region in Valle Department. Dorothy is now a professor at Missouri Southern State University in Joplin, Missouri. She regularly visits the tropics where she teaches classes in Costa Rica.

*Paratypes*: COLOMBIA. **Choco**: Along road between Las Animas and Quibdó, 9.4 km N of Las Animas, 05°21'50"N, 76°37'14"W, 90 m, 17 Aug 1997, *Croat & Gaskin 80822* (MO). **Valle**: Along road from Buenaventura to Bajo Calima, ca. 4 km from Río Calima, near Km 14 marker, < 50 m, 03°56'N, 76°59'W, 21 Mar 1984, *Croat 57547* (MO); Bajo Calima, within forestry concession of Cartón de Colombia, between Buenaventura and Río Calima, 6.5 km beyond Porton Tomar (at km 27), 04°02'N, 77°07'W, 50 m, 8 July 1986, *Croat 61377* (MO); Along road between Buenaventura and Málaga, at Km 40; 04°04'N, 77°09'W, 100 m, 5 Feb 1990, *Croat 70162* (MO); Between Km 65 and 66; 04°10'N, 77°12'W, 40–65 m, 28 Feb 1990, *Croat 71057* (MO).

***Philodendron bernardoii*** Croat, **sp. nov.**

Type: COLOMBIA. Nariño: Municipio Barbacoas, vicinity of Junín, along road from Pasto to Tumaco, 1180 m, B. R. Ramírez 208 (holotype-PSO-015452). **Figure 9.**

The species is a member of subgenus *Philodendron*, section *Macrobelyum*, subsection *Glossophyllum*, series *Ovata* characterized by its cataphylls about half as long as its subterete petioles, narrowly ovate-elliptic, subcordate leaf blades which dry moderately glossy, dark brown above, yellow-brown below, acute at the apex, shortly lobed at the base with the narrow posterior lobes short and overlapping, a closed sinus with up to 6 basal veins all effectively free to the base, many close primary lateral veins drying darker than the surface as well as by the peduncle about half as long as the spathe, weakly constricted spathe and ovaries with 1–2 ovules per locule.

*Philodendron bernardoii* is probably most similar to *P. baudoense* Croat & D.C. Bay which differs in having blades that are acute or cordulate at base with smaller lobes, dried blade surfaces much paler, grayish to pale yellow-brown with the surfaces finely and conspicuously granular as well as pale short-lineate on the upper surface. In addition *P. baudoense* has fewer (5–8) primary lateral veins. *Philodendron bernardoii* is also similar to *P. pseudoauriculatum* Croat which differs in having much shorter posterior lobes and dries grayish with the primary lateral veins paler than surface. In the Lucid

Philodendron Key the species tracks to *P. asplundii* Croat & M. L. Soares, which differs by having cataphylls persisting as conspicuous fibrous with fragments of epidermis and blades which lack prominent cross veins; *P. clarkei* Croat, differing in having narrower blades which dry more blackened with the leaf base mostly rounded; *P. craspedodromum* R.E. Schultes, differing by having posterior lobes broadly rounded; *P. edenudatum* Croat, differing by having broadly ovate blades with the sinus more or less broadly V-shaped; *P. heleniae* Croat, differing by having blades which dry paler yellow green and weakly subcordate, more coriaceous and blades with much smaller reddish inflorescences; *P. pseudoauriculatum* Croat, differing by its narrowly rounded leaf bases with 2–3 inflorescences with a clearly demarcated spathe and *P. wittianum* Engl., differing by having blades typically much narrower with less conspicuous posterior lobes.

Epiphyte; **internodes** not seen; **cataphylls** to 13 cm long, about half as long as petioles. LEAVES with **petioles** ca. 24.6 cm long, erect-spreading, subterete; **blades** narrowly ovate-elliptic, subcordate, ca. 56.1 cm long, ca. 24.6 cm wide, ca. 2.28 times longer than wide, ca. 2.28 times longer than petioles, acute at the apex, shortly lobed at the base, drying moderately glossy, dark brown above, yellow-brown below; **posterior lobes** narrowly rounded 6.2–7.7 cm long, with lobes overlapping; **sinus** ca. 4.9 cm deep, closed; **midrib** drying slightly raised and darker above, slightly raised, ridged and darker below; **primary lateral**





Figure 9



Figure 10

**Figure 9.** *Philodendron bernardoii* Croat (*Ramírez 208*; PSO-015452). Herbarium specimen showing leaf blade with base showing abaxial surface, apex showing adaxial surface; detached inflorescence on right; detached spadix on right.

**Figure 10.** *Philodendron bomboizense* Croat & C. Cerón (*Cerón 14220*). Herbarium specimen showing leaf blade with base, abaxial surface, apex showing adaxial surface; open inflorescence with spathe and spadix.

**veins** ca. 24–26 pairs arising at a 60° angle, weakly undulated and concolorous above, drying finely ribbed and black-brown below; interprimary veins present and only scarcely weaker than primary lateral veins; **minor veins** weak, fine and many; **basal veins** ca. 6 pairs, all effectively free to the base. **INFLORESCENCE** probably 1 per axil; **peduncles** ca. 7.7 cm long, 7–8 mm diam.,

roughly half as long as the spathe; **spathe** greenish white, ca. 13.8 cm long, ca. 2 cm diam. upon drying; **spadix** 12.5 cm long; staminate portion, 7.7 cm long, the sterile staminate portion 1.1 cm long, 1.2 cm diam., the constricted area 9 mm diam., broadest portion in the upper 1/3 of the spadix 12 mm diam., bluntly tapered toward the apex; pistillate portion 5 cm long in



front, 4.3 cm long in rear, 1 cm diam. at base, 1.2 mm diam. midway, 1 cm diam. at apex; **pistils** 2 mm long, much constricted on the style; ovary ovoid, 5-locular, 1.5 mm diam.; stigma 0.8 mm diam., 0.4 mm thick; ovules basally attached, 1–2 per locule, 2–3 mm long, the ovules usually held at different levels, funicles correspondingly short, ca.  $\frac{1}{2}$  as long as ovules or elongated, ca. twice as long as ovule.

*Philodendron bernardoii* is endemic to Colombia, known only from the type locality in Nariño Department at 1180 m in a *Premontane rain forest* life zone.

The species is named in honor of Colombian botanist, Bernardo Ramírez who collected the type specimen. Bernardo formerly worked at the Universidad de Nariño and now is the Curator of the Herbarium at the Universidad de Popayán in Popayán in the Department of Cauca. He has collected extensively in Colombia, especially in Nariño and Cauca Departments and has collected many new species of Araceae.

***Philodendron bomboizense*** Croat & C. Cerón, **sp. nov.** Type: ECUADOR. Morona-Santiago: Loma San José Grande-Sendero San José-Río Bomboiza, Topografía colinada, suelo negro, 02°38'S, 78°27'W, 1700–1750 m, 18 Apr 1991, C. Cerón 14220 (holotype, MO-5345560; isotype, QAP). **Figures 10–12.**

The species is a member of subgenus *Philodendron*, section *Macrobellium*, subsection *Macrobellium* characterized by its hemiepiphytic habit, dark brown-drying petioles, narrowly ovate-elliptic subcordate brown-drying weakly acuminate blades that have broadly rounded short lobes, 3 basal veins free to the base, 10–11 pairs of primary lateral veins, the lower dried surface minutely speckled but all together lacking signs of laticifers as well as by the inflorescence with the green tinged pink spathe.

The species is most similar to *Philodendron ruizii* Schott, a widespread species in the Amazon basin which differs in having much longer and proportionately narrow blades that are usually 2.5–5.6 times longer than broad and have conspicuous dark laticifers present on the lower blade surface.

Hemiepiphyte; **internodes** short; **cataphylls** 2-ribbed, deciduous; **petioles** drying dark brown; **blades** ca. 62.5 cm long, ca. 33.2 cm wide, ca. 1.8 times longer than wide, narrowly ovate-elliptic, subcordate, weakly acuminate, drying yellow-brown; **sinus** ca. 2.2 cm deep, ca. 5.9 cm wide, weakly arcuate; **lobes** short, broadly rounded; **midrib** broadly rounded and flattened with numerous ridges below, somewhat obscure above, drying darker below, concolorous above; **primary lateral veins** 10–11 pairs arising at a 70–75° angle, drying obscure and concolorous above, weakly raised, finely ridged and darker below; **minor veins** moderately indistinct, 3 basal veins free to base, obscure above, fine,



Figure 11



Figure 12

**Figure 11.** *Philodendron bomboizense* Croat & C. Cerón (Cerón 14220). Herbarium specimen showing portion of both blade surfaces and inflorescence, close-up in face view.

**Figure 12.** *Philodendron bomboizense* Croat & C. Cerón (Cerón 14220). Herbarium specimen showing synflorescence with 5 axils per spiral.

close and slightly lighter in color below. INFLORESCENCES 1 per axil; **peduncle** 4.5 cm long, 5–7 mm diam. upon drying; **spathe** pale green tinged pink, ca. 13.3 cm long, ca. 1.3–2.0 cm diam. upon drying, 5.7 cm wide when flattened; **spadix** 8.9 cm long in front, 8 cm long in rear; staminate portion 3.6 cm long, 1.3 cm diam. at broadest point; pistillate portion 5.7 cm long, 1.3 cm diam. near base, 1.0 cm diam.

at apex; pistils 2 mm long, 1.4 mm diam.; style 0.7 mm long, 1.4 mm diam.; stigma 0.8–1.0 mm diam., 0.15 mm thick; ovary ellipsoid, 1.4–1.5 mm long, 0.6–0.8 mm diam., 5-locular; ovules contained within a gelatinous sack filling most of the locule, the gelatinous sack 1.4–1.5 mm long, 0.5–0.6 mm diam.; ovules 2–5 per sack, 2–5 per locule, 0.6–0.8 mm long, funicle slender, equal of slightly longer than the ovule.

*Philodendron bomboizense* is endemic to Ecuador, known only from the type locality in Morona-Santiago Province at 1700–1750 m elevation in *Lower montane moist forest* or *Montane wet forest* life zones.

*Philodendron bomboizense* tracks in the Lucid Philodendron Key to *P. cruentum* Poepp. from Huanuco Department in Peru which differs in having proportionately much longer and narrower blades about 4 times longer than broad and only 10 cm wide and by having numerous lateral veins, and *A. pachycaule* K. Krause, from the western slopes of the Ecuadorian Andes, differing by its much smaller blades to only 28 cm long and 9 cm wide with rounded leaf bases and by its numerous lateral veins.

The species is named for the type locality near the Río Bomboiza.

***Philodendron brantii*** Croat, **sp. nov.** Type: COLOMBIA. Antioquia: Municipio Frontino, road to Murri, 15.0 km W of Nutibara (Altos de Cuevas), margin of primary forest ca. 1 km S of road, 06°45'N, 76°23'W, 1850 m, 17 Oct 1987, *A. E. Brant* & *G. E. Martínez* *A. 1369* (holotype, MO-3583498). **Figures 13–14.**

The species is a member of subgenus *Philodendron* characterized by its terrestrial habit, deciduous cataphylls, subterete dark brown-drying petioles, large ovate-cordate-sagittate dark brown-drying gradually acuminate blades with a narrowly

hippocrepiform sinus, 10–11 pairs of basal veins, a moderately short posterior rib which is about half naked, 6 pairs of primary lateral veins as well as a long-pedunculate inflorescence, an apparently solitary inflorescence with the spathe green externally and red on the inside in the tube.

*Philodendron brantii* is a member of subgenus *Philodendron* section *Macrobellium*, tentatively placed in subsection *Glossophyllum* series *Ovata*. In the Lucid Philodendron Key the species tracks to *P. marcocorreaanum* Croat, M. M. Mora & E. Trujillo differing by having a larger, more reddish brown-drying blade; *P. pseudoverrucosum* Croat, which differs in having petioles which are conspicuously warty-papillate throughout most of their length; *P. ornatum* Schott which has the petioles conspicuously warty near the apex and *P. strictum* G. S. Bunting, differing by having the lower surface drying whitish.

Terrestrial; **internodes** ca. 80–83.5 cm long, ca. 0.6–3.0 cm diam., dark brown and finely fissured upon drying; **cataphylls** deciduous. LEAVES moderately large; **petioles** 1.5–6.5 cm long, drying black-brown; **blades** 51–60 cm long, 45–47 cm wide, 1.2 times longer than wide, 12.6 times longer than petioles, large ovate-cordate-sagittate dark brown-drying gradually acuminate at apex, prominently lobed at base, dark green and semiglossy above, somewhat paler and semiglossy below, drying dark grayish brown above, yellowish brown below; **midrib** slightly raised and concolorous above, raised-flattened finely



Figure 13



Figure 14

**Figure 13.** *Philodendron brantii* Croat (*Brant 1364*, sheet 4; MO-3585251). Herbarium specimen showing leaf blade, adaxial at base, abaxial surfaces at apex.

**Figure 14.** *Philodendron brantii* Croat (*Brant 1364*, sheet 3; MO-3583500). Herbarium specimen showing stem, petiole and cataphylls with detached inflorescence.

ribbed and concolorous below; posterior rib short, moderately straight, naked about half its length; basal veins 8–9 pairs, 1<sup>st</sup> pair free to the base; posterior rib long and prominently curved with 3<sup>rd</sup> and higher order basal veins fused to 2–3 cm; **primary lateral veins** 5–6 pairs arising at a 40° angle with 11–12 pairs of basal veins, drying similar to midrib below, raised and concolorous above; **minor veins** indistinct, numerous, close. **INFLORESCENCE** 1

per axil, long-pedunculate; **peduncles** 10 cm long; **spathe** 26 cm long; **spadix** 22.5 cm long; pistillate portion 8 cm long, 1.7 cm diam.; staminate portion 15 cm long, sterile staminate portion 1.4 cm diam., ca. 3 mm long; pistils ovoid, 1.8–2.1 mm long, 2.2–2.4 mm wide, stigma 0.8–1 mm wide, disk-shaped with 6–7 pits around circumference and with a thin protruding mantle less than 0.2 mm wide; ovary 6–9-locular; ovules basal, 2 per locule, including funicle 0.9–1

mm long, funicle about as long as or slightly longer than ovule, thickened in lower 1/3 (presumably glandular), attached on lower outside edge of ovule. INFRUCTESCENCE 2.3 cm diam. upon drying, dark brown and finely ridged; **spathe** green externally and red on the inside in the tube; **spadix** in early fruit, pistillate portion 11.5 cm long, 3 cm diam., in early fruit with pistillate portion pale green, translucent; styles 3–4 mm diam., flattened apically, light brown-drying; stigma button-shaped, funnel-shaped, 0.8–1.0 mm diam.; seed oblong, 1.6 mm long, 0.6 mm diam.

*Philodendron brantii* is endemic to Colombia, known only from the type locality in the Department of Antioquia at 1850 m in a *Tropical wet forest* life zone.

The species is named in honor of Alan Brant, formerly of the Missouri Botanical Garden who collected the type specimen. Brant, along with his partner operate an organic farm. Alan works part time for the Missouri Botanical Garden and for the Missouri Department of Conservation as a plant collector on the Flora of Missouri inventorying Missouri parks.

***Philodendron camarac* Croat, sp. nov.**

Type: COLOMBIA. Chocó: Municipio Pizarro (Bajo Baudó) 30 m from Resguardo Indígena Emaberá del Río Purricha, along banks of the stream, 5°11'N, 77°09'W, 100 m, 26 Mar 2011, *Rodrigo Camara-Leret, Juan*

*Carlos Copete Maturana, Marybel Soto Gómez, William Conde & Virgilio Isabaré* 1782 (holotype, MO-6337200; isotype, COL). **Figure 15.**

The species is a member of subgenus *Philodendron* section *Philodendron*, subsection series *Philodendron*, characterized by its epiphytic habitat, internodes about as broad as long near the apex and drying yellowish brown with closely ridged dried surface, broadly spreading obtusely flattened adaxially and drying yellowish, glossy and irregularly folded and transversely fissured, an ovate-cordate-sagittate blade which is semiglossy above and very pale and matte beneath with numerous faint cross-veins in addition to the cluster of up to 4 inflorescences per axil, with the blade white outside tinged weakly violet-purple inside and with the spathe tube violet-purple outside and bright red inner surface.

The species is most closely related to *Philodendron strictum* which is also pale and matte on the lower surface and has petioles that dry yellowish brown and glossy. That species differs in having glossy rather than matte petioles, blades that dry grayish and glossy on upper surface with close prominent cross-veins (rather than yellow-brown, matte and with the cross-veins much less prominent for *P. strictum*) as well as by the spathe which is light green to whitish inside (though sometimes weakly tinged reddish inside) versus prominently reddish throughout inside for *P. camarac*). Though both species have blades that are whitish and matte on the lower surface, those of *P.*





Figure 15



Figure 16

**Figure 15.** *Philodendron camarae* Croft (*Cámara 1782*; MO-6337200). Herbarium specimen showing folded leaf blade, abaxial surfaces at apex and base, adaxial surface in mid blade, petiole and 3 inflorescences.

**Figure 16.** *Philodendron candamoense* Croft (*Gentry 77069A*; MO-4319904). Herbarium specimen showing folded leaf blade, lower part of blade adaxial surface, the remaining blade abaxial surface, petiole; inflorescence showing peduncle and spathe tube.

*strictum* dry reddish brown and with faint laticifers visible and the areoles lack any dark maculations whereas *P. camarae* has the lower surface drying gray-brown with no visible laticifers and with the areoles containing minute dark maculations.

Epiphyte; **internodes** ca. 16.0–23.5 cm long, ca. 1.5 cm wide, about as broad as long near the apex and drying yellowish brown with closely ridged dried surface, broadly spreading obtusely flattened adaxially and drying yellowish, glossy and irregularly folded and transversely fissured; **cataphylls** deciduous. **LEAVES** semiglossy

above and very pale and matte beneath with numerous faint cross-veins; **petioles** ca. 23.5 cm long, ca. 1.5 cm wide, drying similar to internodes, with light brownish yellow flaking epidermis, flattened slightly with age; **blades** ca. 63.0 cm long, ca. 36.0 cm wide, 1.75 times longer than wide, 2.7 times longer than petioles, ovate-cordate-sagittate, semiglossy above and very pale and matte beneath, drying light brown and semiglossy below, silver-brown and glossy above; **sinus** roughly as long as wide; **midrib** round-raised and fissured below, round-raised with less prominent fissuring above, drying darker above and concolorous below; **primary lateral veins** 9–11 pairs arising at a ca. 60° angle with 6–7 pairs arising from the base drying finely ribbed and somewhat darker both above and below; **minor veins** numerous and fine, cross-veins numerous, indistinct. **INFLORESCENCES** 4 per axil with the blade white outside tinged weakly violet-purple inside; **peduncles** ca. 5.0–5.5 cm long, ca. 0.5–1.0 cm wide, finely ridged and flattened, drying brown with similar flaking epidermal layer to internodes and petioles; **spathe** tube violet-purple outside and bright red inner surface; **spadix** 12 cm long; staminate portion 8.5 cm long, 1.6 cm wide, bluntly rounded at apex, the constricted area 1.5 cm diam.; sterile staminate portion 17–1.9 cm long, 1.6 cm wide at base and apex, 1.9 cm diam. in middle; pistillate portion 3.2 cm long in front, 1.7–1.9 cm long in rear; pistils 1.8 cm long, 1.3 cm diam.; ovary 5–6-locular; ovules axile, ca. 10 per locule, 0.2 mm long, the funicle about as long as the ovary, attached at one side at the base.

*Philodendron camarae* is endemic to Colombia in the Department of Chocó at 100 m elevation in *Tropical wet forest* to *Tropical rain forest* transition area life zones.

The species is named in honor of Spanish botanist, Rodrigo Camara-Leret, a palm specialist who is interested in tropical botany with an emphasis on ethnobotany, plant taxonomy and floristics of tropical forests and páramos. Most of Rodrigo's research has been focused in the Andes, Amazon and Chocó of northwestern South America.

***Philodendron candamoense* Croat, sp. nov.** Type: PERU. Puno Department: Puno Province, Río Candamo, ridge at the mouth of the Río Guacamayo, ridge top forest with cloud forest aspects, Transect 1, 13°30'S, 69°50'W, 790 m, 24 May 1992, *A. Gentry, C. Reynel, R. Ortiz & P. Nuñez 77069A* (holotype, MO-4319904; isotype, USM). **Figure 16.**

The species is a member of subgenus *Philodendron* section *Macrobelum*, subsection *Glossophyllum*, series *Glossophyllum* characterized by its epiphytic habit, long somewhat spongy petioles, oblong-elliptic grayish yellow-drying blades with a long-acuminate blades with a cordulate to subcordate leaf base and a pair of long-pedunculate inflorescences.

Epiphyte; **internodes** short, drying ca. 1 cm diam.; **cataphylls** deciduous. **LEAVES**



erect-spreading; **petioles** 23.5–33 cm long, ca. 0.7–1.7 cm wide, somewhat spongy, drying finely ribbed and brown; **blades** 45.7–50 cm long, ca. 10.3 cm wide, 4.4 times longer than wide, 1.5–1.9 times longer than petioles, oblong-elliptic, long-acuminate at apex, cordulate to subcordate leaf base, dark green and semiglossy above, paler and semiglossy below, drying greenish gray above, yellowish gray below; **midrib** broadly rounded and paler above, drying paler and yellowish above, darker below; **primary lateral veins** ca. 10–11 pairs arising at a 50° angle and broadly arcing to margins, drying slightly raised and darker above, weakly raised and darker below, basal veins 2 pairs; **minor veins** fine and indistinct. **INFLORESCENCES** 2 per axil, long-pedunculate; **peduncle** 14 cm long, ca. 0.3–0.6 cm wide, terete blackish drying; **spathe** green, 11–12 cm long, the tube 5.5 cm long, 2.5 cm diam.; **spadix** 9–10.5 cm long; staminate portion ca. 6 cm long; sterile staminate portion eaten and missing; pistillate portion, 4.5–5 cm long; pistils 2.5 mm long, 2.0 mm diam.; style ca. 1.5 mm diam., ca. 0.2 mm thick, densely papillate, whitish on reconstituted material; stigma funnel-shaped, round, 0.5 mm diam., markedly concave medially, brownish on reconstituted material; ovary 6-locular; ovules with basal placentation. **INFRUCTESCENCE** with pistillate **spadix** 5 cm long, 2 cm diam.; seeds 1 per locule, 1.8–2.0 mm long, 0.5 mm diam., funicle 0.2 mm long.

*Philodendron candamoense* is endemic to Peru, known only from the type locality in



Figure 17

**Figure 17.** *Philodendron fosteri* Croat (*Foster 12067*; USM-93642). Herbarium specimen showing 3 leaves, upper leaf blade with adaxial surface shown, the other leaves with abaxial surfaces shown; inflorescence showing spathe and spadix.

Puno Department at 790 m in a *Subtropical rain forest* life zone.

The species is named for the type locality at the Río Candamo in Puno Department, Peru.

***Philodendron fosteri*** Croat, **sp. nov.** Type: PERU. Madre de Dios: Province Manu, Cocha Cashu Station; growing over the top of shrubs in understory, 11°53'S, 71°23'W, 350 m, 31 Oct 1986, R. B. Foster & B. d'Achille 12067 (holotype, USM-93643; isotype, F). **Figure 17.**

The species is a member of subgenus *Philodendron*, section *Macrobellium*, subsection *Glossophyllum*, series *Glossophyllum* and is characterized by its scandent habit in the understory of the forest with elongated yellow-brown drying stems with prominent ridges, deciduous cataphylls, subterete petioles which are about 40% the length of the blades, the yellowish gray-green narrowly oblanceolate, abruptly acuminate blades as well as by the long pedunculate pale green inflorescence which has pistils bearing a broad style and a donut-shaped, funnel-form stigma and a solitary basal ovule in each locule

The species is probably most easily confused with *P. sphalerum* but that species differs in having usually narrowly ovate blades that are rounded then abruptly decurrent at the base.

Vine; stems elongated; **internodes** drying yellow-brown, with prominent ridges, the surface smooth, greenish yellow, moderately glossy; **internodes** longer than broad, 6.5–14.5 cm long, drying 5–6 mm diam.; **cataphylls** green, slender, deciduous. LEAVES scattered along stem; **petioles**

erect-spreading, subterete, 9–10.6 cm long, drying ca. 2 mm diam., gray-green, sheathed to less than 1 cm (to 2.5 cm long when subtending inflorescence); **blades** narrowly oblanceolate, 20.5–22.0 cm long, 6–6.4 cm wide, 3.4 times longer than wide, 2.3 times longer than petioles, drying yellowish gray-green above, moderately paler and gray-green below, abruptly and narrowly acuminate; **midrib** drying broadly rounded and finely ribbed, pale short-lineate, concolorous above, paler and finely ribbed below; **primary lateral veins** 6–7 pairs, arising at a 60° angle (1 directly from the base), drying concolorous, moderately obscure above, finely ribbed and lighter than blade below. INFLORESCENCES 1 per axil; **peduncle** nearly as long as spathe, pale green, ca. 8.2 cm long, drying 3 mm diam.; **spathe** pale green outside, ca. 9.3 cm long, ca. 1.1 cm diam. upon drying, flattening to 2.3 cm wide; **spadix** 9.8 cm long; staminate spadix 6.3 cm long, 4 mm diam. at base, 5 mm diam. toward apex; sterile staminate portion 6 mm diam., 3–5 mm long; pistillate portion greenish, 3.8 cm long, 4.8 mm diam. at base, 7 mm diam. midway, 5 mm diam. at apex; pistils 1.6–2 mm long, 1–1.2 mm diam.; style broadly flattened, irregularly 5- to 6-sided, densely granular, 1–1.6 mm diam.; stigma funnel-shaped with a prominently donut-shaped margin, 0.15 mm diam., 0.2–0.3 mm thick; ovary oblong-elliptic, 4-locular; ovules 1 per locule, 1.3 mm long, 0.2 mm diam.

*Philodendron fosteri* is known only to Peru but should be expected in adjacent Brazil and possibly northern Bolivia. It is

presently known only from the type locality in Parque Nacional Manu at 350 m elevation in a *Subtropical wet forest* life zone.

In the Lucid Philodendron Key the species keys out to *P. campii* Croat, differing in having short internodes, more elongate, usually blackish drying blades, closer and more numerous primary lateral veins and an inflorescence with a short peduncle and a globular spathe tube; *P. heterophyllum* differing in having longer, black-drying blades which are more typically rounded at the base; The species appears to be closest to *Philodendron grayumii* from the valley of the Río Iparia but that species has much larger leaf blades, dries nearly blackened and has a black matte petiole (in contrast to a yellow-brown, semiglossy drying petiole) and broader blades which dry gray-brown and are rounded at the base; *P. ruizii* which differs in having much larger blades with prominent laticifers and *P. wurdackii* which differs in having the spadix protruding from the closed spathe and in having the minor veins moderately prominent, fine and close on both surfaces.

The species is named in honor of Dr. Robin Foster from the Field Museum of Natural History in Chicago who collected the type specimen. Robin, an old friend from our days together on Barro Colorado Island in Panama, is a plant ecologist whose research in the neotropics has taken him to many parts of the tropics but especially in recent years to Peru.

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