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Vietnamocasia, a new genus from Central Vietnam belonging to the *Alocasia-Colocasia* clade (Araceae)

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Abstract

Vietnamocasia, a new monotypic aroid genus in the *Alocasia-Colocasia* clade, is described with the type species, *Vietnamocasia dauae*. *Vietnamocasia* is distinguished by possessing free individual staminate flowers, lacking expanded synconnectives, and having nodding inflorescences. Vegetatively *Vietnamocasia* is reminiscent of species of the distantly closely related *Alocasia* Cuprea Group, although *Vietnamocasia* is so far only known from the type locality in Central Vietnam, over 1200 km NE from the nearest representative of the *Alocasia* Cuprea Group. The phylogenetic analyses of *Vietnamocasia dauae* together with representative taxa from all genera of the *Alocasia-Colocasia* clade recovered *Vietnamocasia* as a strongly supported clade sister to *Alocasia*, together nested in a clade to which *Leucocasia* is a sister taxon. *Vietnamocasia dauae* is illustrated from living plants and with a line drawing. A key to all genera of *Alocasia-Colocasia* clade is included.

Key words: Endemics, Indochina, Malesia, phylogeny, *Vietnamocasia dauae*

Introduction

The Araceae is one of the largest families of monocots with an estimated 6000 species (of which about 3500 are formally described) in 128 genera (Mayo *et al.* 1997, Boyce & Croat 2011). The highest diversity concentrated in the humid tropics of the Neotropics, Afrotropics, and IndoMalaya. Many aroid genera remain taxonomically poorly understood, with fieldwork consistently discovering undescribed taxa.

The *Alocasia-Colocasia* clade comprises about 110 species diminutive geophytes to massive pachycaul-arborescent terrestrial or epilithic mesophytes, rather rarely helophytes, distributed from the subtropical eastern Himalayas throughout subtropical and tropical parts of Asia into the western pacific and eastern Australia. The most recent phylogenetic analyses of Araceae (Cusimano *et al.* 2011, Nauheimer *et al.* 2012a,b) revealed Colocasieae (sensu Mayo *et al.* 1997) as a polyphyletic assemblage with *Leucocasia gigantea* (Blume 1823: 103) Schott (1857: 34) forming a well-supported separate clade along with *Alocasia* (Schott 1832: 18) G.Don in Sweet (1839: 631). Consequently the rank Colocasieae can no longer be used for the *Alocasia-Colocasia* clade since it lacks phylogenetic support. While Alocasiinae formally exists (Schott, 1856: 43) its rank is inappropriate and in any case its historical usage is incongruent with the retrieved phylogeny. Therefore we opt to use rankless *Alocasia-Colocasia* clade which includes the *Colocasia* clade (Cusimano *et al.* 2011, Nauheimer *et al.* 2012a,b) with *Alocasia* and *Leucocasia* Schott (1857: 34) in the *Alocasia* clade. The *Alocasia-Colocasia* clade includes *Alocasia*, *Ariopsis* Nimmo in Graham (1839: 252), *Colocasia*, *Englerarum* Nauheimer & Boyce (2014: 713, epublished 2013), *Leucocasia*, *Steudnera* Koch (1862: 114), *Remusatia* Schott (1832: 18), and *Vietnamocasia* from this study.

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During a 2010 floristic investigation of Mount Dầu, specifically the Khánh Giang-Trường Lệ community forest in Nghĩa Hành District, Quảng Ngãi Province, Central Vietnam, a small population of a highly unusual colocasioid aroid was encountered sterile by the first and third authors. Subsequently between May and August 2015 five fertile collections were made by the first author. Comparison with herbarium specimens and relevant taxonomic literature revealed these plants to not belong to any described species. In addition, these plants possess separate staminate flowers which comprised of 2–3 stamens (not formed into synandria) and lack an expanded synconnective. Although confident that these plants represented an undescribed species it remained unclear to which, if any, existing genus they should be assigned. To establish the generic position sequences were generated from three chloroplast loci, the *trn*L-F intergenic spacer, the *rpl*20-*rps*12 intergenic spacer, and the *trn*K/*mat*K region, and one nuclear gene, *phytochrome* C (*phy*C), and analysed along with representative sequences of all genera of the *Alocasia*-*Colocasia* clade sensu Nauheimer *et al.* (2012a). The result of these analyses revealed that the plant represented a new genus as well as a new species of the *Alocasia*-*Colocasia* clade, here described as *Vietnamocasia dauae* N.S.Lý, S.Y.Wong, T.Haevermans & D.V.Nguyen.

Materials and methods

Taxonomic study:—Measurements and descriptions were made from mature living plants, herbarium specimens (VNM, P), and spirit material preserved in 70% ethanol. A taxonomic key is constructed based on living materials where possible and combined with Nauheimer & Boyce (2014). Conservation status was assessed using the IUCN Red list Categories and Criteria version 3.1 (IUCN 2012).

TABLE 1. Species of *Alocasia*-*Colocasia* clade included in this study with their author names, geographic origin of material, herbarium vouchers, and GenBank accession numbers for all sequences.

Name	Voucher	*trn*L-F	*trn*K / *mat*K	*rpl20-rps12*	*phy*C
Alocasia alba Schott	NSW 4171562	JQ238728	JQ238814	JQ238901	JQ083497
Alocasia beccarii Engl.	P. Boyce AL-194 (SAR)	JQ238731	JQ238817	JQ238904	JQ083500
Alocasia boa A.Hay	J. Bogner 2621 (M)	JQ238732	JQ238818	JQ238905	JQ083501
Alocasia cucullata (Lour.) G.Don	J. Bogner 2638 (M)	JQ238738	JQ238824	JQ238910	JQ083506
Alocasia lauterbachiana (Engl.) A.Hay	J. Bogner 1769 (M)	JQ238750	JQ238835	JQ238919	JQ083513
Alocasia longiloba Miq. (#2)	P. Boyce AL-193 (SAR)	JQ238751	JQ238836	JQ238920	JQ083519
Alocasia navicularis (K.Koch & C.D.Bouché) K.Koch & C.D.Bouché	T. Croat 78014 (MO)	JQ238761	EU886581	AY248925	JQ238981
Alocasia odora (Lindl.) K.Koch	P. Boyce s.n. (QSBG)	JQ238764	JQ238848	JQ238931	JQ083530
Alocasia peltata M.Hotta	L. Nauheimer 66 (M)	JQ238766	JQ238850	JQ238933	JQ083532
Alocasia sarawakensis M.Hotta	P. Boyce AL-199 (SAR)	JQ238779	JQ238865	JQ238947	—
Ariopsis protanthera N.E.Br.	H. Hara 1960 (TI)	AY248947	EU886587	AY248910	JQ083567
Colocasia esculenta (L.) Schott	J. Bogner 2958 (M)	JQ238804	JQ238890	JQ238972	JQ083569
Colocasia fallax Schott	J. Bogner 1139 (M)	JQ238805	JQ238891	JQ238973	—
Englerarum hypnosum (J.T.Yin, Y.H.Wang & Z.F.Xu) Nauheimer & P.C.Boyce	D. Prehsler 175 (WU)	JQ238746	JQ238831	JQ238916	JQ083582
Colocasia menglaensis J.T.Yin , H.Li & Z.F.Xu	J. Bogner 2274 (M)	JQ238808	JQ238894	JQ238976	JQ083572
Leucocasia gigantea (Blume) Schott	J. Bogner 427 (M)	JQ238807	JQ238893	JQ238975	JQ083571
Protarum sechellarum Engl.	J. Bogner s.n. (M)	JQ238810	—	—	JQ083576
Remusatia pumila (D.Don) H.Li & A.Hay	K. Vainio-Mattila 90-201 (M)	JQ238811	JQ238896	JQ238978	JQ083577
Steudnera assamica Hook.f.	J. Bogner 2588 (M)	EF517214	JQ238898	EF517224	JQ083579
Steudnera discolor W.Bull	J. Bogner 1582 (M)	—	—	—	JQ083580
Steudnera kerrii Gagnep.	J. Bogner 1891 (M)	EF517213	JQ238899	EF517223	JQ083581
Vietnamocasia dauae N.S.Lý, S.Y.Wong, T.Haevermans, D.V.Nguyen & P.C.Boyce	Ngọc-Sâm Lý Lý-654 (VNM)	KY196233	KY196229	KY196231	KY196235
Vietnamocasia dauae N. S.Lý, S.Y.Wong, T. Haevermans, D.V.Nguyen & P.C.Boyce	Ngọc-Sâm Lý Lý-655 (VNM)	KY196234	KY196230	KY196232	KY196236

Phylogenetic study:—Twenty one accessions of twenty species representing *Alocasia*-*Colocasia* clade with the inclusion of two accessions (the type collection and a separate collection made 0.5 km away) of *Vietnamocasia* were included. The genera *Alocasia* and *Colocasia* were represented by multiple taxa. *Protarum* Engler (1901: 42) was used as outgroup taxon based on the results of the family phylogeny presented by Nauheimer *et al.* (2012b). Sequences of

several chloroplast loci were used for phylogenetic analysis: *trn*L-F, *rpl*20-*rps*12, and *trn*K/*mat*K, as well as one nuclear gene, *phy*C. Sequences of *Vietnamocasia* were newly generated in this study following the primers and protocol in Nauheimer *et al.* (2012a). All other sequences were obtained from Nauheimer *et al.* (2012a). Voucher information and GenBank numbers for all accessions are shown in Table 1. Data matrices were deposited to TreeBASE (study number S20168).

The sequences were aligned using MUSCLE (Edgar 2004) as implemented in Geneious Pro v5.6.4 (Biomatters Ltd., Auckland, New Zealand; www.geneious.com, Drummond *et al.* 2012) followed by minor manual adjustment with indels treated as missing data. To infer phylogenetic relationships we used maximum likelihood (ML) optimization with the software RAxML (7.3.2, Stamatakis 2006) and RAxMLGui (Silvestro & Michalak 2012), as well as a Bayesian Markov-chain Monte Carlo (MCMC) approach with the software MrBayes (3.2.1; Ronquist & Huelsenbeck 2003). All analyses were performed using the generalized time-reversible substitution model with gamma rate heterogeneity. The MCMC analyses were conducted twice to check for parameter convergence. The MCMC algorithm was run for 2,000,000 generations with one cold and three heated chains, starting from random trees and sampling one out of every 100 generations. Convergence was assessed by using the standard deviation of split frequencies as convergence index with values < 0.005 interpreted as indicating good convergence. The first 10% of trees were discarded as burn-in. The remaining trees were used to construct 50% majority-rule consensus trees. Statistical support was assessed via 1000 bootstrap (BS) replicates for the ML approach and via posterior probabilities (PP) for the Bayesian approach. Throughout this paper, BS values of 70–84% and PP of 0.9–0.95 support is considered as moderate, a BS value of 85–100% and PP of 0.95–1 considered as strong support.

Results

Alignment:—The aligned *trn*L-F sequences were concatenated to comprise 400 nucleotides while the length of the *rpl*20-*rps*12 alignment was 630 nucleotides. The *trn*K/*mat*K alignment was used for its entire length of 2,309 aligned positions. The combined chloroplast matrix included 3,403 base pairs. The alignment of the nuclear low-copy gene *phy*C comprised 1,068 nucleotides. Since the position of *Englerarum* (Nauheimer & Boyce 2014) in both phylogenies differs, we opted for not combining nuclear with plastid data.

Phylogenetic analyses:—A comparison of the topologies of chloroplast and nuclear phylogenies revealed almost no disagreements of supported clades except with the position of *Englerarum* (Figure 1 and 2). *Englerarum* is sister to the rest of *Alocasia*-*Colocasia* clade in the chloroplast dataset but sister to the *Vietnamocasia* +*Alocasia* clade in the nuclear region, with low supports. Two major clades (I) *Alocasia* and (II) *Colocasia* were recovered with moderate to high support in both chloroplast and nuclear datasets. The internal resolution in the chloroplast regions for the *Colocasia* clade is not well resolved which is similar to the results obtained in Nauheimer *et al.* (2012a), and *Colocasia* is revealed as polyphyletic. In the *Alocasia* clade, two accessions of *Vietnamocasia* are grouped and form a sister relationship with the genus *Alocasia* in both chloroplast and nuclear datasets, with strong support.

Morphological differences:—On the basis of morphology *Vietnamocasia* resembles species of the not closely related *Alocasia* Cuprea Group sensu Hay 1998 (represented by *A. beccarii* Engler (1879: 300) and *A. peltata* Hotta (1967: 156) in the phylogenetic analyses above) with strongly peltate leaves, a spadix shorter than the spathe, and a staminate zone mostly or completely contained within the lower spathe. The Cuprea group includes seven species which are all Malesian endemics, including a recently described species, *A. azlanii* Wong & Boyce (2016: 185). Several species in the Scabriuscula Group (i.e., *Alocasia infernalis* Boyce (2007: 145)) is superficially similar to the species belonging to the Cuprea Group but is readily distinguished by the leaves not interspersed with cataphylls (Boyce 2007). *Vietnamocasia* is so far only known from a very restricted area of central Vietnam, over 1200 km NE of the nearest representative of the *Alocasia* Cuprea group. Moreover, *Vietnamocasia* is unique in the *Alocasia*-*Colocasia* clade by having free staminate flowers without an expanded synconnective. In addition, fruit of *Vietnamocasia* 1-seeded while fruit of *Alocasia* is 1–5-seeded.

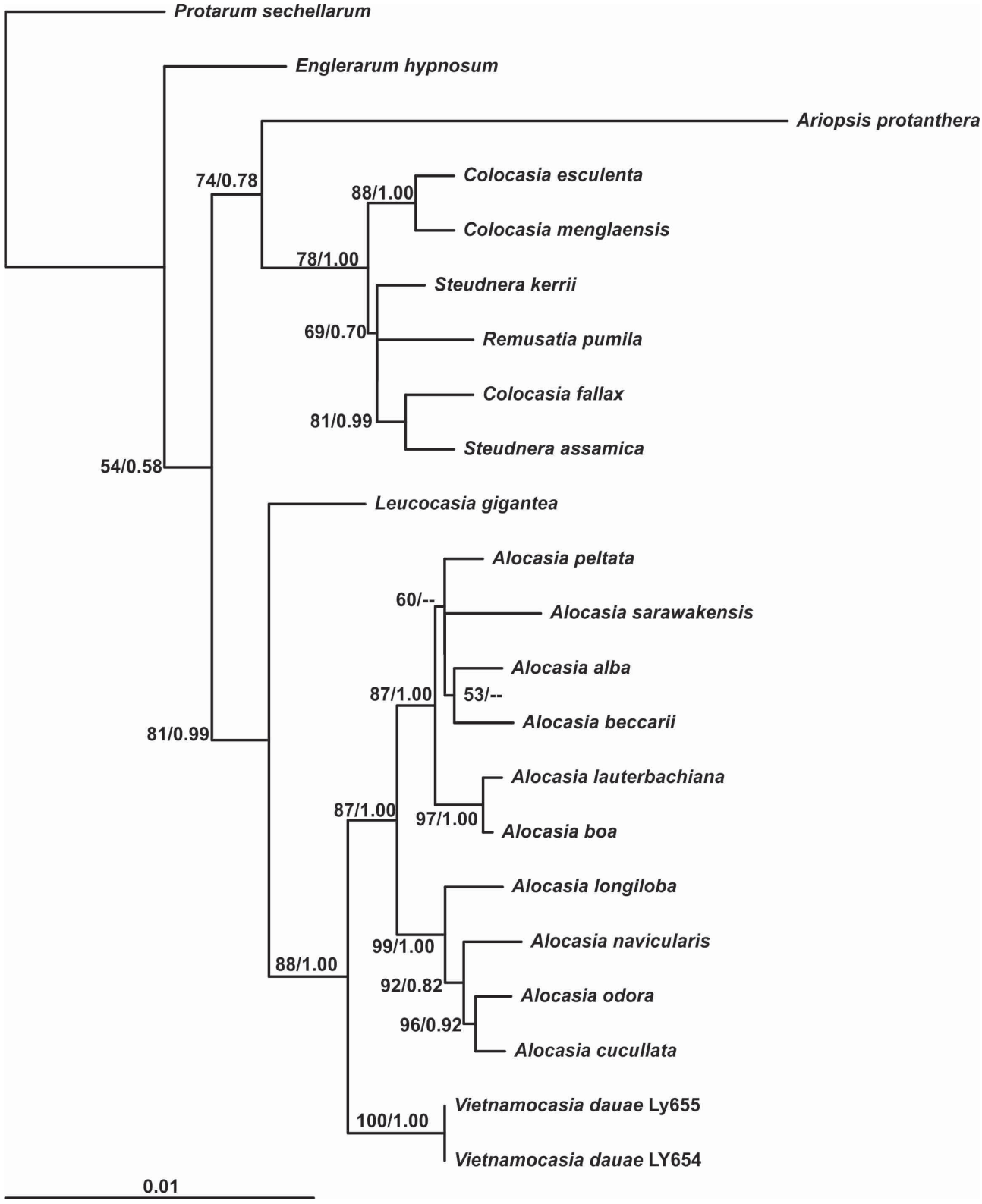

FIGURE 1. Bayesian tree of 21 taxa based on the *trn*L-F intergenic spacer, the *rpl*20-*rps*12 intergenic spacer, and the *trn*K/*mat*K region. Posterior probability (PP, above 0.7) and bootstrap (BS, maximum likelihood, above 50%) values are shown above/below/next to each internal branch.

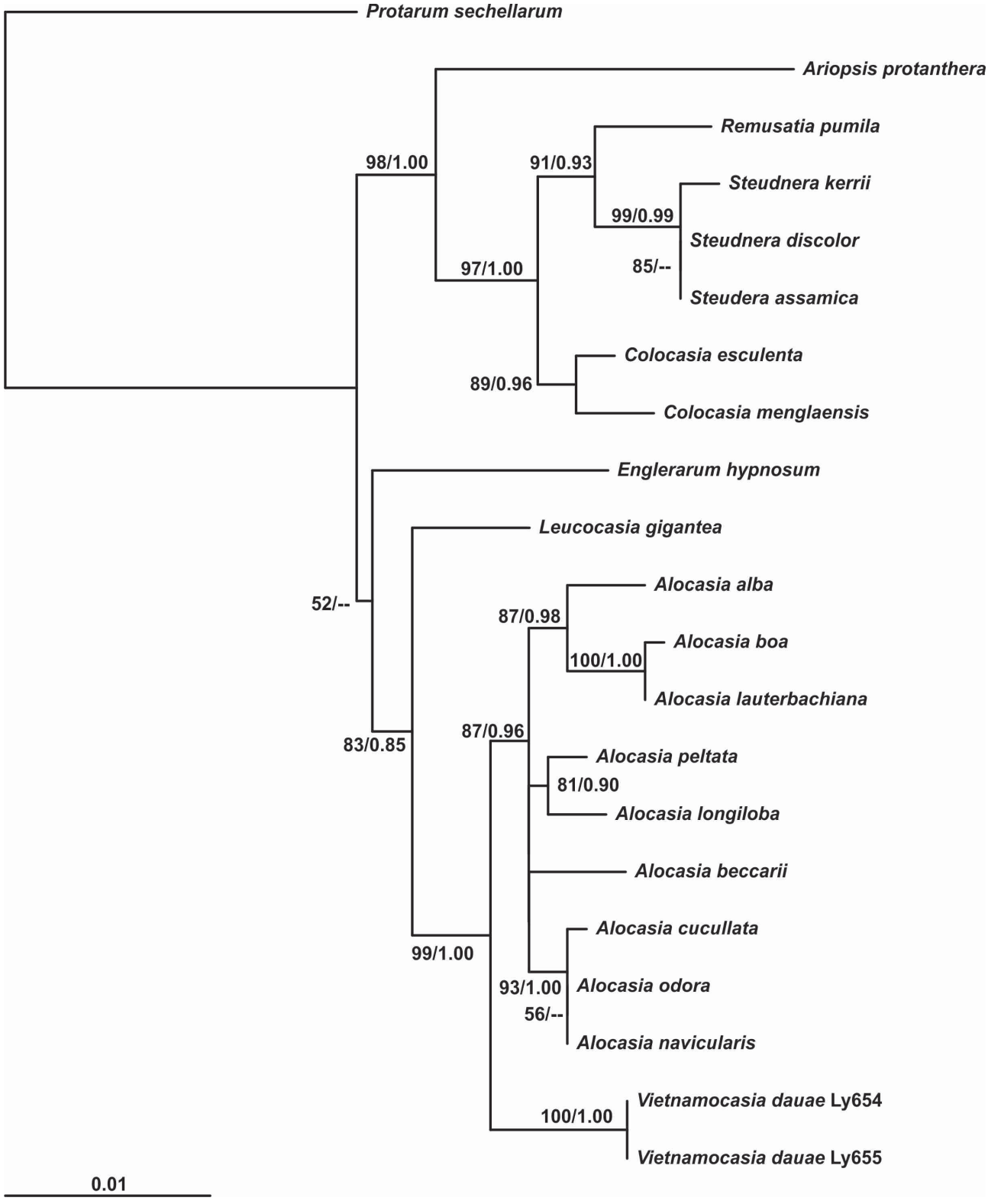

FIGURE 2. Bayesian tree of 20 taxa based on the *phy*C nuclear region. Posterior probability (PP, above 0.7) and bootstrap (BS, maximum likelihood, above 50%) values are shown above/below/next to each internal branch.

Key to genera of the *Alocasia-Colocasia* Clade

1. Staminate flowers aggregated into synandria with a conspicuous synconnective **2**
– Staminate flowers not aggregated in synandria, lacking a conspicuous synconnective ..... ***Vietnamocasia***

2. Synandria connate, thecae of adjacent synandria encircling pits in the spadix ..... ***Ariopsis***
– Synandria not connate; spadix lacking pits **3**

3. Plants producing erect or spreading stolons bearing small tubercles covered in hooked scales ..... ***Remusatia***
– Stolons usually absent, if present then never with hooked tubercles **4**

4. Pistillate flowers each with staminodes **5**
– Pistillate flowers without staminodes or with single scattered small ones in a few *Colocasia*) **6**

5. Spathe limb with a wide overhanging shoulder at constricted junction with lower spathe **7**
– Spathe limb merging smoothly with lower spathe **8**

6. Large to massive pruinose arborescent evergreen pachycauls lacking stolons; leaf blades peltate; inflorescences up to 12 in a circumferential fan; spathe limb glistening white ..... ***Leucocasia***
– Medium-sized green geophytes with a protracted deciduous dormant phase, stem a tuber; leaf blades not peltate; inflorescences 2–3 together; spathe limb reddish pink to pinkish white ..... ***Englerarum***

7. Infructescences erect, fruits medium-sized, ripening orange-red, odourless ..... ***Alocasia***
– Infructescences pendent, fruits small, ripening yellowish brown, smelling variously of overripe fruit or vomit ..... ***Colocasia***

Taxonomic treatment

Vietnamocasia N.S.Lý, S.Y.Wong & P.C.Boyce, *gen. nov.*

—Type: *Vietnamocasia dauae* N.S.Lý, S. Y. Wong, T.Haevermans & D.V.Nguyen, *sp. nov.*

Vietnamocasia and its sole species *Vietnamocasia dauae* is a small to moderate terrestrial herb with elongated epigeal stems, watery white latex, a coriaceous peltate leaf blade lacking conspicuous waxy glands in the axils of the main veins of the abaxial surface, nodding inflorescences with a deciduous spathe limb and persistent lower spathe, a shortly stipitate spadix, a free pistillate flower zone, a staminate flower zone not enclosed by the lower spathe chamber spathe constriction, independent staminate flowers not aggregated into synandria and lacking an expanded synconnective, declinate infructescences, and single-seeded fruits. *Vietnamocasia* differs from all other genera of the *Alocasia-Colocasia* clade by independent staminate flowers not aggregated into synandria and lacking an expanded synconnective.

Small to moderate evergreen mesophytic herbs with irritant watery white sap; *stems* epigeal, elongated, initially erect, becoming decumbent in older plants, leafless portions with distinctive annulated scars, *prophyll* and *cataphylls* conspicuous during with flowering events, soon degrading and lost; *leaves* several together; *petiole* slender, spreading, green; *leaf sheaths* fully attached, persistent; *leaf blade* elliptic to oblong-elliptic, peltate, thickly coriaceous, glabrous, margin entire, adaxially glossy dark green, abaxially medium green, without waxy glands in the vein axils on lower leaf surface, anterior lobe with 5–6 sub-opposite primary lateral veins on each side; *secondary venation* conspicuous, not forming inter-primary collective veins; posterior lobes almost completely connate except for a shallow acute notch, tips divergent. *Inflorescence* nodding, usually 2–3 together interspersed with cataphylls; *spathe* constricted; *spathe limb* caducous; *spadix* distinctly shorter than spathe, shortly stipitate; *pistillate zone* free, cylindrical, many pistils; *ovaries* 1–locular; *style* very short; *stigma* discoid-subcapitate, inconspicuously three to four-lobed; *sterile interstice* subcylindric, gradually narrowed distally corresponding to the spathe constriction; lower synandrodia morphologically differentiated from the upper; *staminate zone* cylindrical, above constriction, slightly tapering distally; *staminate flowers* 2–3 androus, stamens free, oblong-linear, connective flat, conspicuous; *appendix* obvious, with more or less conspicuous brain-like patterning of longitudinal grooves. *Infructescence* declinate; *fruits* many, globose, single-seeded.

Etymology:—*Vietnamocasia* is compounded from the Greek classical name *kolokasia*, itself from an old Middle Eastern name *qolqas* (Nicolson 1987) and the root of *Alocasia* and *Leucocasia* (and the more distantly related *Colocasia)* + Vietnam.

Distribution:—*Vietnamocasia* is so far known only from the type locality and its vicinity.

Ecology:—At Mount Dầu *V. dauae* grows in moist shady understory of hillsides in secondary broadleaved forest dominated by dipterocarps at 150–490 m elevation. At the other known locality, Cà Đam, it occurs in primary evergreen broad-leaf forest at about 790 m elevation.

Vietnamocasia dauae **N. S. Lý, T. Haevermans, Y. S. Wong & D. V. Nguyen, *sp. nov.* (Figs. 3, 4)**

Type:—VIETNAM. Quảng Ngãi Province, Nghĩa Hành District, Hành Tín Đông Commune, Trường Lệ Village, Mount Dầu, Nhự hill, 14°51.45'N, 108°48.59'E, 317 m, 20 May 2015, *Ngọc-Sâm Lý, Lý-654* (holotype: VNM! (including spirit), isotypes: P!, VNM!).

Small to moderate evergreen mesophytic herbs to 50–80 cm tall, stem 35–50 cm long, internodes distinct separated by conspicuous annulated scars, 2–3.5 cm diam., sometimes wider than long, green somewhat slender, erect, later decumbent and rooting along underside, active shoot tip ascending in age to 15–30 cm tall, older parts without remains of old leaf bases, un-branched; prophyll with two keels, cataphyll 4.5–8.8 cm long and ca. 1.2 cm wide at base, soon deciduous. *Leaves* (6–)9–19 together, erect, spreading with age, individually long-lived; *petioles* slender, D-shaped in cross-section, (8–)13–41 cm long, green; leaf sheaths fully attached, (7–)8.5–23 cm long, ca. ¼–½ length of petiole, exterior green, interior paler, wings of sheath persistent, slightly open; *leaf blade* elliptic to oblong-elliptic, peltate, thickly coriaceous, glabrous, 22–39 × 7–14 cm, adaxially glossy dark green, abaxially medium green, without waxy glands in the axils on the lower leaf surface, margin entire, apex broadly acute with an apiculate 3–5 mm long; *anterior lobe* widest usually $^{1}/_{3}$ of the way distal to petiole insertion, occasionally ¼ way distal to petiole insertion; anterior costa with 5–6 sub-opposite primary lateral veins on each side, diverging at ca. 45°–60°, running curved upwards or straight into a conspicuous sub-marginal vein < 0.5 mm from margin; secondary venation not forming inter-primary collective veins; *posterior lobes* mostly connate save for a shallow acute notch, ($^{1}/_{4}$–)$^{1}/_{5}$–$^{1}/_{7}$ the length of the anterior lobe, 4.8–5.5 cm long, together attenuate with tips diverging. *Inflorescence* nodding, solitary or 2–3 together, subtended by a *cataphyll*; *peduncle* rarely exceeding the cataphyll at anthesis, slightly slender, about ½ to ¾ the length of the petiole, 11–34 cm long, medium green, erect; narrowly ovate to oblong ovate, 8–24 cm long, 2–3.5 cm at widest point, medium green, margins winged, opened, apex mucronate, apiculate with mucro 7–15 mm long*; spathe* 12–12.5 cm long, slightly constricted between lower spathe and spathe limb; *lower spathe* cylindrical or slightly ovoid, 3–4 cm long, 1.3–1.5 cm wide, medium green outside, paler inside, margins convolute; *spathe limb* oblong-lanceolate, 8–13 cm long, 3.3–3.8 cm at widest point, externally pale green, internally white, smooth and shiny in both surfaces, apex shortly acuminate 3–5 mm long, spathe limb deflexed at base when anthesis, turning opaque straw-coloured, soon caducous at fruiting stage; *spadix* distinctly shorter than spathe, 7–8.7 cm long, very shortly stipitate, < 1 cm long, white; *pistillate zone* cylindrical, 15–21 × 4–5 mm, pistils c. 160 pistils, slightly loosely arranged; *ovaries* sub-globose, 1.2–1.5 mm long, 1.4–1.5 mm diam., ivory-white, apex gradually tapering to the style, 1–locular, 5(–6) ovules, anatropous, funicle distinct, very short ca ¼ length of the ovary, placenta basal; *style* very short 0.2–0.4 × 0.3–0.6 mm, ivory-white; *stigma* discoid-subcapitate, inconspicuously three to four-lobed, slightly concave, pale cream, 0.2–0.3 mm thickness, 0.6–0.7 mm in diam.; *sterile interstice* subcylindric, 12–16 mm long, 4–4.5 mm at widest point near the pistillate zone, gradually narrowed distally corresponding to spathe constriction; synandrodes in 5–6 whorls; lower synandrodia often irregularly angular at both ends, the remainder elongate rhomboid-hexagonal, 2–3 mm long, 1.2–2 mm thick, creamy yellow to white, flat-topped; *staminate zone* cylindrical, above the constriction, slightly tapering proximally, 10–12 × 5–7 mm diam.; staminate flowers each comprised of 2–3 stamens, *stamens* free, oblong-linear, creamy white, 1–1.1 mm long, 0.3–0.5 mm wide; thecae oblong-linear, dehiscing by apically pores ca 0.2 mm long, connective conspicuous, flat, creamy white; *appendix* sub-cylindrical, weakly fusiform, blunt-tipped, equaling to considerably exceeding half the length of the spadix, 3–4.6 × 0.5–0.7 cm, dull ivory-cream, with more or less conspicuous brain-like patterning of longitudinal grooves. *Infructescence* declinate; *fruiting spathe* narrowly triangular-ovoid, 6–7.2 cm long, 2.3–2.7 cm at widest point, externally dark green, internally whitish; *fruits* ca 40, globose, inconspicuously quadrangular at the top, 4.1–6 × 5–5.5(–8.5) mm, 1(–2)-seeded, probably ripening red, but to be confirmed; seed testa costate, embryo shortly cylindrical, endosperm copious.

Etymology:—The specific epithet is for Mount Dầu, the type locality, treated as feminine.

Phenology:—*Vietnamocasia dauae* flowers in May, during when the young inflorescences are a food source for wild monkeys (*Macaca* spp.). Although fruiting spathe dehiscence and ripe fruit are yet to be seen, unripe fruit was found in mid September.

Distribution and preliminary IUCN conservation assessment:—Ten small populations each of 2–8 scattered mature individuals were observed on Mount Dầu with a total area of 6.5 km^2 (650 ha) while less than 100 individuals are known from Cà Đa Mountain with a total area of about 38 km^2 (3.800 ha) (Figure 3). The Extent of Occurrence (EOO) is estimated to be less than 20,000 km^2. Although this species is under the protection of the local authorities of Trường Lệ and Khánh Giang communes, and by the Department of Forest Protection of Tây Trà District, Quảng Ngãi province, these populations are nevertheless vulnerable and appear to be declining owing to human activities such as harvesting of non-timber forest products, and land use changes for *Acacia* plantations. According to the IUCN Red list categories and criteria (IUCN, 2012), this qualifies the species here to be listed as Endangered (EN B2ab (iii,iv,v)). Further exploration of the area around Dầu Mountain is necessary to fully assess the conservation status.

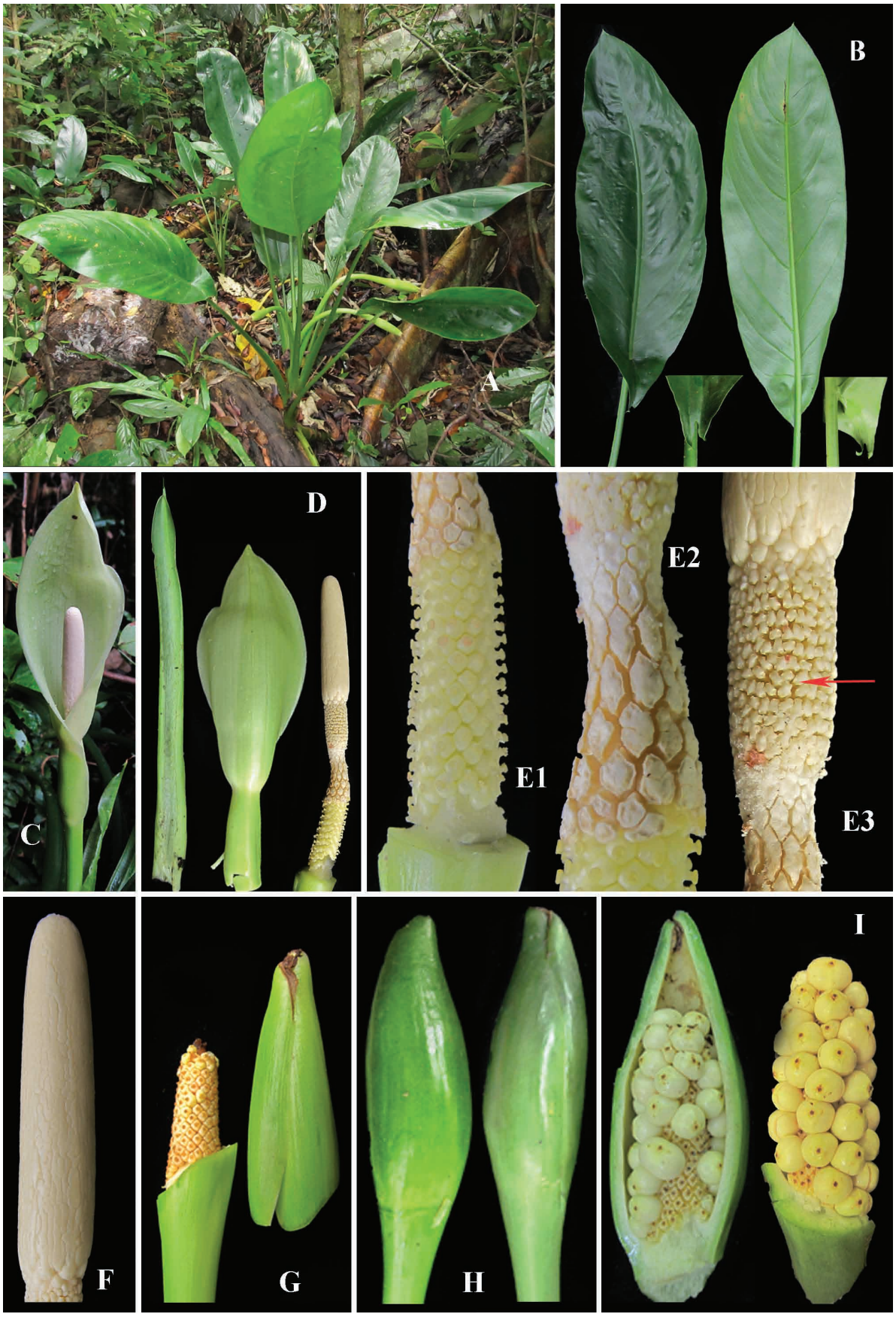

FIGURE 3. *Vietnamocasia dauae*. A. Habit; B. Leaf blades: adaxially and abaxially with their closed-up of the leaf bases (from left); C. Inflorescence (front view); D. Cataphyll, spathe (back view), and spadix (from left); E. Close-up of pistillate (E1), sterile interstice (E2) and staminate zones showing free individual staminate flowers (a red arrow, E3); F. Closed-up of appendix; G. pistillate zone after anthesis with lower spathe; H. Fruit spathe (back and front views); I. Longitudinal section of fruit spathe and infructescences (from left).

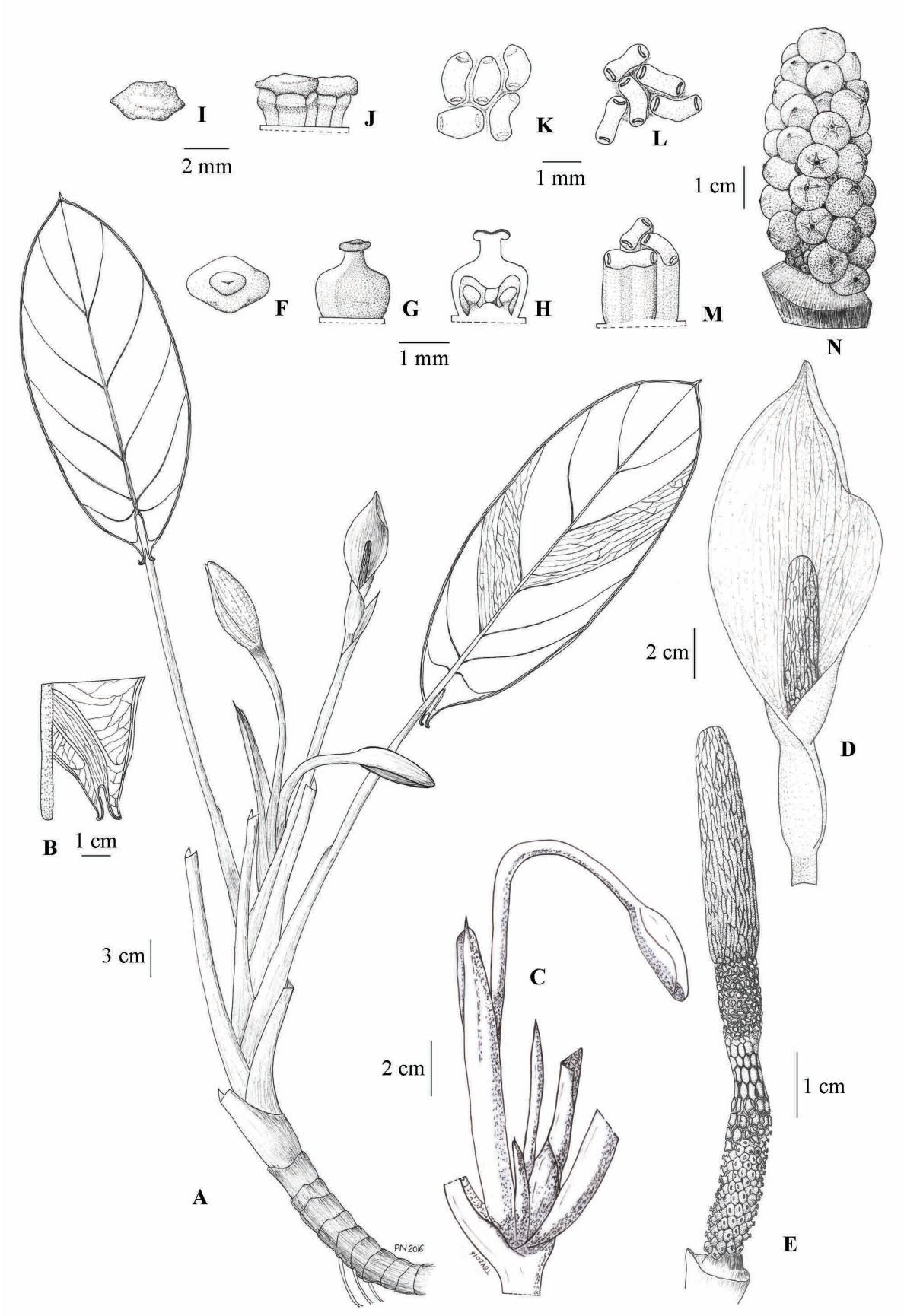

FIGURE 4. *Vietnamocasia dauae*. A. Habit; B. Details of leaf base; C. Apical part of stem showing cataphylls of infructescence and continuation shoot; D. Inflorescence; E. Spadix; F. Ovary (top view); G. Ovary (side view); H. Cross-section of ovary; I. Synandrodes, top view; J. Synandrodes, side view; K. Stamen, side view; L. Stamens, top view; M. Stamens, side view; N. Infructescence.

Additional examined material:—VIETNAM. Quảng Ngãi Province, Tây Trà District, Trà Trung Commune, Vàng Village, Cà Đam mountains, Nước Biếc stream, 15°08.96'N, 108°27.81'E, 783 m, 28 July 2016. Ngọc-Sâm Lý & Trương Bá Vương, Lý -759 (VNM); Nghĩa Hành District, Hành Tín Đông Commune, Trường Lệ Village, 14°51'38''N, 108°48'36''E, 28 May 2016, Du-Sy 04 (HN); Nghĩa Hành District, Hành Tín Đông Commune, Trường Lệ Village, Mount Dầu, Nhự hill, 14°52.06'N, 108°48.74'E, 378 m, 20 May 2015, Ngọc-Sâm Lý, Lý -655 (VNM, P); ibid., Chí stream, 14°52.70'N, 108°49.12'E, 153 m, 19 May 2015, Ngọc-Sâm Lý, Lý -648 (VNM); ibid., 14°51.36'N, 108°49.19'E, 486 m, 9 August 2015, Ngọc-Sâm Lý, Lý -660 (VNM); ibid., Đá Bông hill, 14°51.42'N, 108°48.35'E, 271 m, 18 May 2015, Ngọc-Sâm Lý, Lý -642 (VNM); ibid., Nhự hill, 14°52.06'N, 108°48.74'E, 350 m, 14 December 2010, Ngọc-Sâm Lý & Thomas Haevermans, Lý -528 (VNM).

Notes:—Neither *Alocasia* nor *Colocasia* have been revised for Vietnam since Gagnepain (1942).

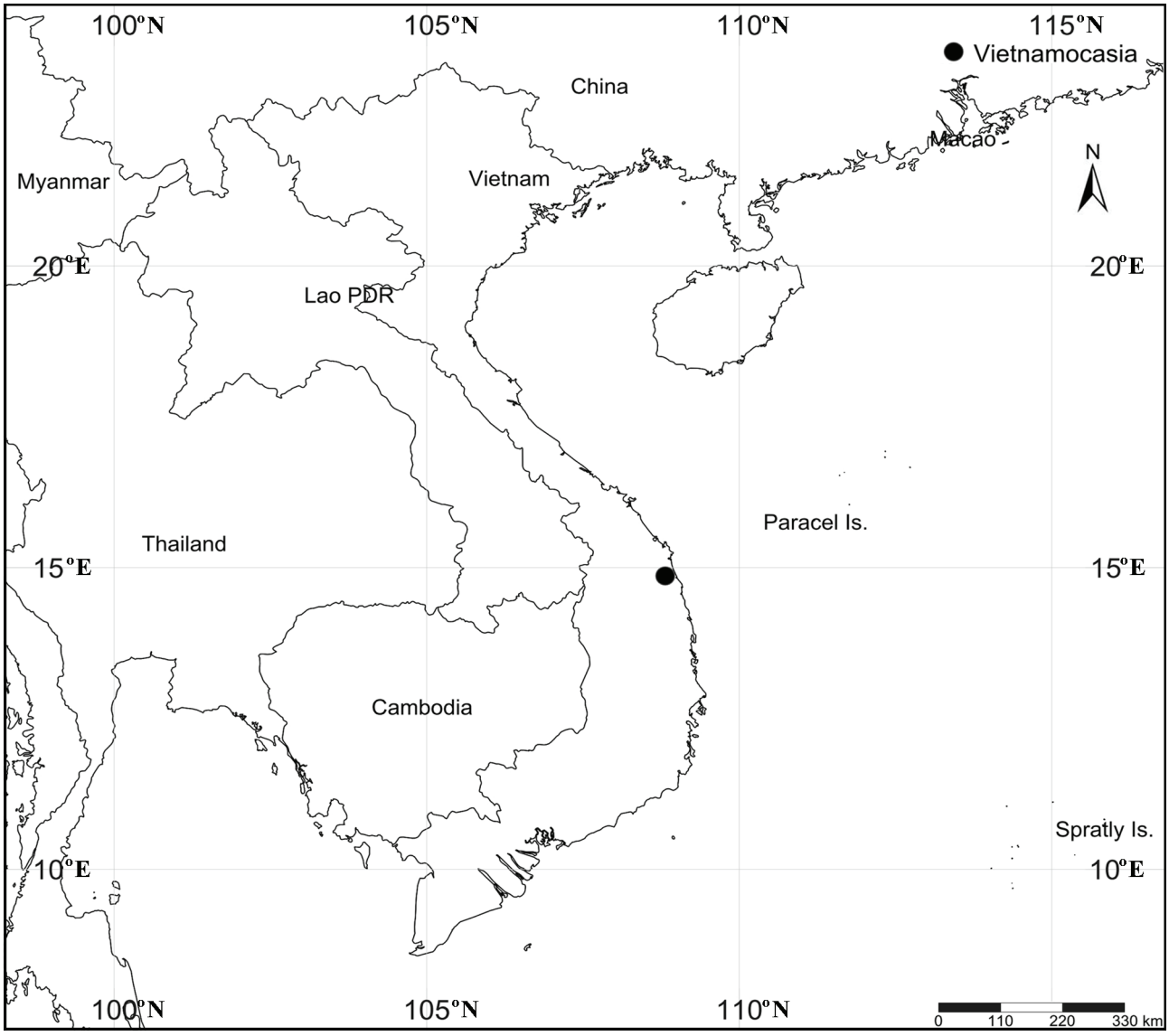

FIGURE 5. Geographic distribution of *Vietnamocasia dauae* with the locality represented by the circle.

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