Two new species and a new record for *Colocasia* (Araceae: Colocasieae) from Arunachal Pradesh, Northeast India

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ABSTRACT. Two new species of *Colocasia* (Araceae: Colocasieae), *C. boyceana* R.Gogoi & S.Borah and *C. dibangensis* R.Gogoi & S.Borah are described and illustrated from Arunachal Pradesh, NE India. *Colocasia lihengiae* C.L.Long & K.M.Liu is reported as a new record for the Flora of India. All three species are illustrated from living plants. A key to the *Colocasia* of India is provided.

Keywords. Aroid, Arunachal Pradesh, *Colocasia boyceana*, *Colocasia dibangensis*, India

Introduction

The genus *Colocasia* Schott, includes about 20 species mainly confined to tropical and subtropical Asia (Li & Boyce 2010). One cultivated species *C. esculenta* (L.) Schott (taro) had tremendous economic significance since time immemorial, but taxonomically the genus is still poorly known. As a part of tropical and subtropical Asia, India is home to multiple wild species of *Colocasia*, but the full number of such species is not known, due to inadequate survey and study.

While working for the "Flora of Anjaw District" under the annual action plan of the Botanical Survey of India, the authors discovered and collected three *Colocasia* species in Lohit Valley and Lower Dibang Valley district of Arunachal Pradesh. After critical study, including of the relevant literature (Schott 1854; Hooker 1893, 1900; Karthikeyan et al. 1989; Mayo et al. 1997; Li & Wei 1993; Li & Long 1998, 1999, 2000; Cao & Long 2003; Long & Liu 2001; Yin et al. 2004; Cai et al. 2006; Li & Boyce 2010), two of the species were found to be new. These are described and named here as *Colocasia boyceana* R.Gogoi & S.Borah and *Colocasia dibangensis* R.Gogoi & S.Borah. The third species has been determined as *C. lihengiae* C.L.Long & K.M.Liu and is presented here as a new addition for the Flora of India.

Colocasia boyceana R.Gogoi & S.Borah, **sp. nov.**

Colocasia boyceana is readily distinguished from *C. fontanesii* Schott (a dark purple species commonly grown as ornamental) by the dense hairy male flower zone, although

both lack an appendix. Overall, *C. boyceana* differs from *C. fontanesii* by the dwarf habit and in forming massive colonies; the velvety leaf blades with venation impressed adaxially; the (frequent) presence of a conspicuous purple spot at the junction of the petiole and adaxial side of the blade; the purple blade margins; and a purple line from the blade sinus to the dorsal junction of the petiole. *Colocasia boyceana* approaches *C. lihengiae* C.L.Long & K.M.Liu but differs by the dense hairy male flower zone and formation of massive colonies, by the pink cataphylls to the stolons, green petiole, up to 9 pairs of leaf lateral veins, blade with purple lining along the leaf margin, purple lining of pink cataphylls in stolons, and the presence of a conspicuous purple spot at the junction of the petiole and adaxial side of blade.
TYPE: India, Arunachal Pradesh, Lohit district, just crossing Udayak Pass towards Salangam, 1600 m, 27º55'59.33"N 96º21'18.48"E, 5 September 2012, *Gogoi & Borah 21807* (holo CAL; iso ASSAM). (Fig. 1A–C, 2)

Herb, medium sized, stoloniferous. ***Corm*** subcylindric, not massive, erect or slightly horizontal, 11–17 cm long, 4–6 cm across, fusiform, much rooting, roots thick, white; ***stolons*** horizontal, non branching, light pink, with pink cataphylls, internodes cylindric. ***Leaves*** 3–6, petiole glabrous, green, 47–82 long, 0.8–1cm wide, dull green towards base, sheath to less than ½ length, bract to 32 cm long; blade ovate-cordate to sagittate-cordate, peltate, 27–40 cm long, 14–21 cm wide, velvety, glossy, dark green adaxially, pale green abaxially, with a purple spot at the ventral junction of petiole, apex acuminate or caudate; lateral veins 5–9 pairs, raised abaxially and impressed adaxially, margins with purple colouration, purple lining from sinus to junction of the petiole dorsally. ***Inflorescence*** 1, peduncle green, cylindric, shorter than petiole, 34–43.5 long, 0.6–0.8 cm across, spathe constricted between tube and limb; tube green, oblong, 3.2–5.5 long, 1.8–2cm wide, subcylindric; limb erect, yellow on both surfaces, lanceolate, 13–16.5 cm long, apex acuminate. ***Spadix*** shorter than spathe, to 7 cm long; female zone whitish green, cylindric, c. 2 × 0.8 cm, with inter-pistillar staminodes; ***ovary*** ovate or obovoid, c. 2 mm long, 1.5 mm wide, green, stigma inconspicuously 3-lobed, sessile, disciform, translucent white, staminodes yellow, ovate, erect, c. 2 mm long and 1.5 mm wide; sterile zone yellowish white, 2.5 × 0.5 cm, cylindric; male zone c. 2.5 × 0.8 cm, synandria c. 6-androus, polygonal, creamy, with white hairs; appendix absent. ***Infructescence*** green, elliptic, 5.5–6 cm long, 2.3–2.6 cm across; berries green when young, many seeded, obovate, 6 × 5 mm, seeds many.

Distribution and habitat. Colocasia boyceana grows in massive colonies in moist shady places along streams. It is so far endemic to the Lohit and Lower Dibang valley district of Arunachal Pradesh, at 1200–1600 m, recorded only by the type. The habitat is shared with *Steudnera colocasiifolia* C.Koch. another colocasioid.

Phenology. Flowering and fruiting July–September.

Etymology. The specific epithet is given in honour of Peter C. Boyce for his outstanding contributions to the Araceae of South East Asia.

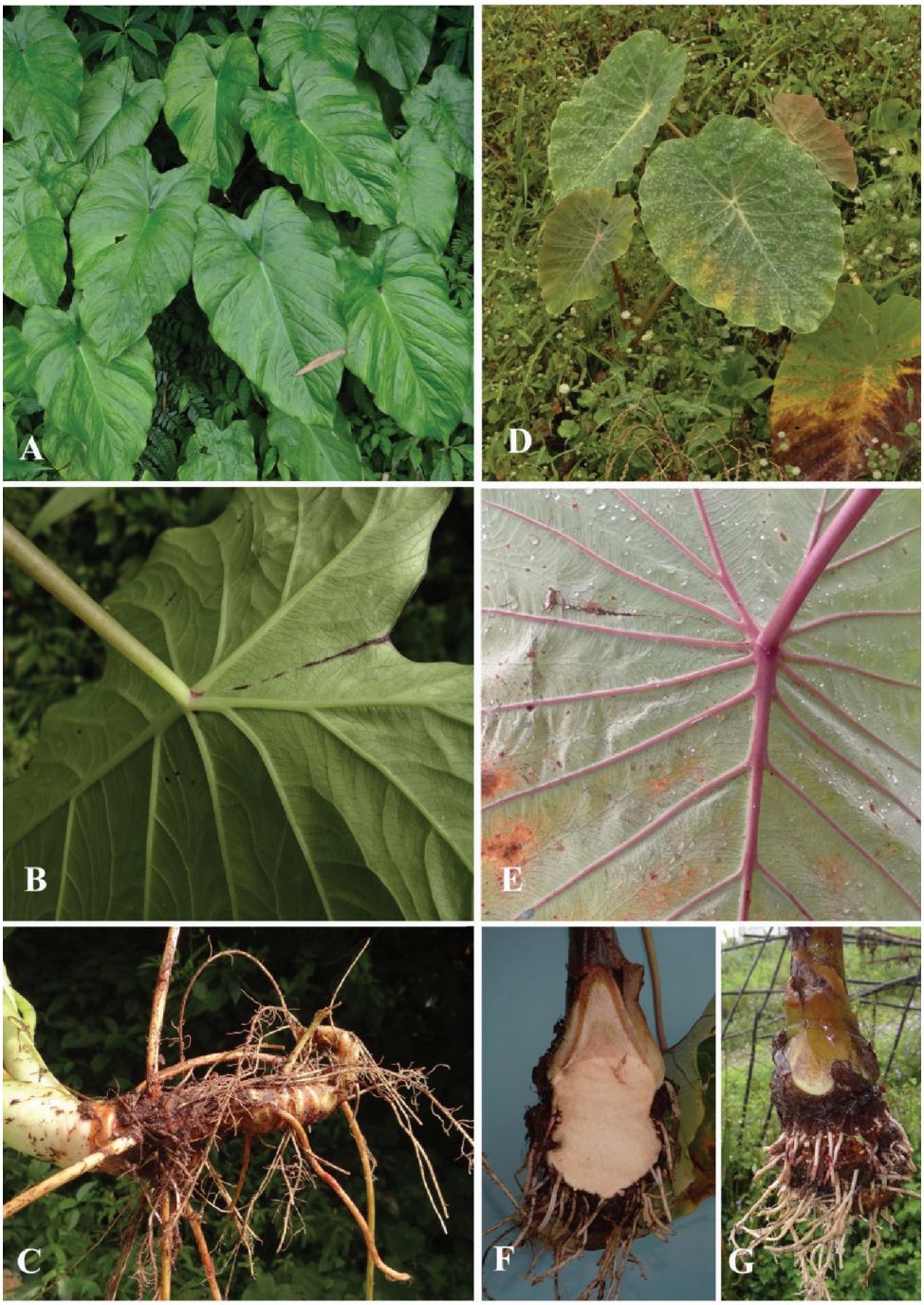

Fig. 1. A–C. Morphological features of *Colocasia boyceana* R.Gogoi & S.Borah. **A.** Habit of the plant. **B.** Abaxial side of the leaf purple lining in the sinus. **C.** Corm of the plant. **D–G.** Morphological features of *Colocasia dibangensis* R.Gogoi & S.Borah. **D.** Habit of the plant. **E.** Abaxial side of the leaf showing pink veins. **F & G.** Corm of the plant. (Photos: R. Gogoi & S. Borah)

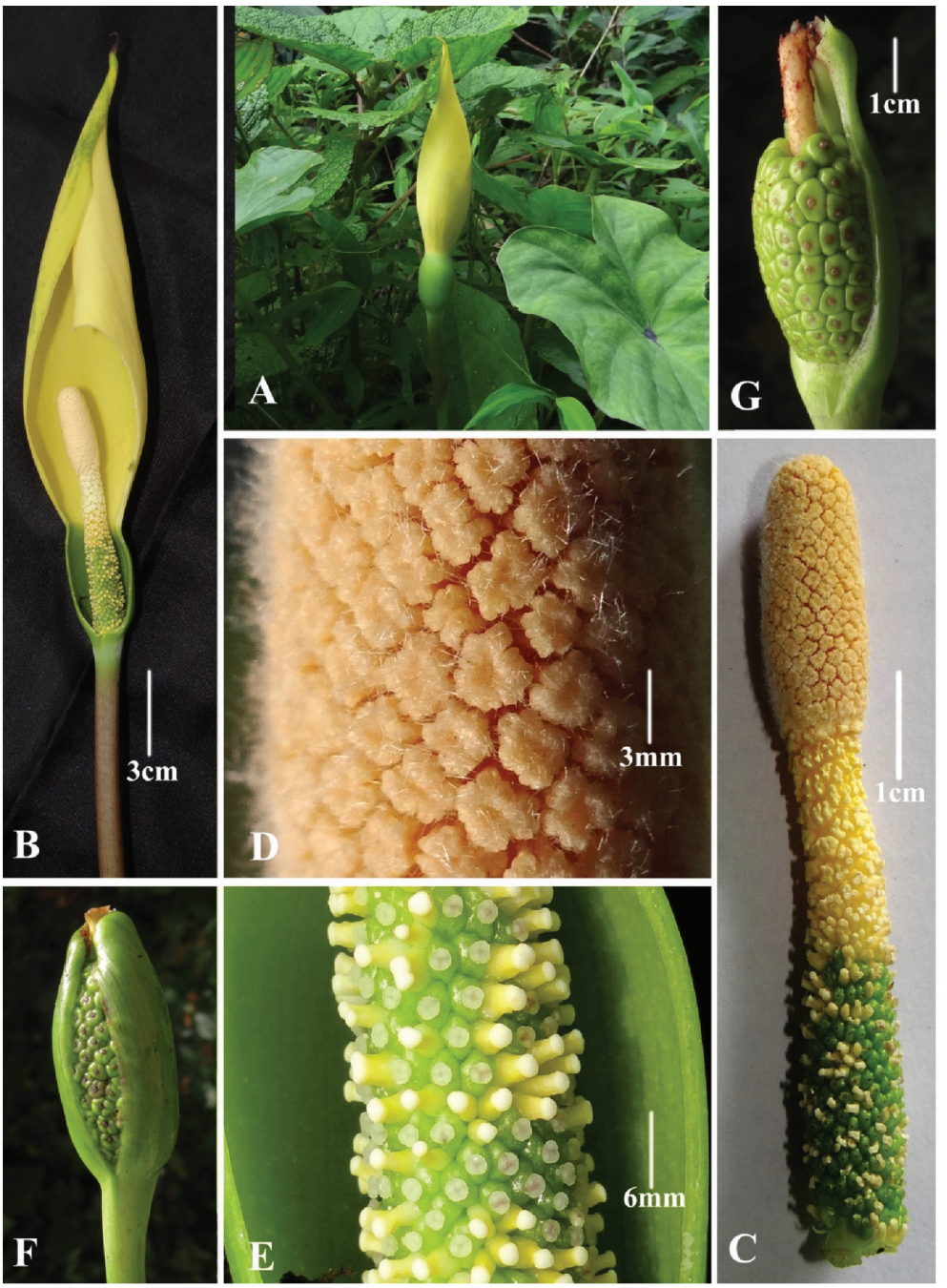

Fig. 2. Habit and reproductive parts of *Colocasia boyceana* R.Gogoi & S.Borah. **A.** Habit of the plant. **B.** Inflorescence showing spathe and spadix. **C.** A complete spadix. **D.** Portion of the male zone showing synandria with white hairs. **E.** Portion of the female zone. **F & G.** Infructescence with green berries. (Photos: R. Gogoi & S. Borah)

IUCN conservation status. Presently there is no perceived threat to this species.

Notes. *Colocasia boyceana* is distinct among species of *Colocasia* as it bears a hairy male zone, which is the first record of such a character within the genus. This new species is close to *C. fontanesii* and *C. lihengiae* but differs significantly as discussed above. *Colocasia fontanesii* is treated here as legitimate in place of *C. antiquorum* (Li & Boyce, 2010) as the issue is one of typification. When Schott described *C. antiquorum* he intended the name to apply to a stoloniferous plant with glossy leaf blades, and a spathe limb opening almost fully and then reflexing. Unfortunately, in selecting a type he chose a sterile and incomplete Linnaeus collection that is without doubt referable to *C. esculenta* (hydrophobic leaf blade epidermis). Thus *C. antiquorum* is a synonym of *C. esculenta*. Given this, the next available name for the glossy-leaf plant is Schott's *C. fontanesii*.

Colocasia dibangensis R.Gogoi & S.Borah, **sp. nov.**
Colocasia dibangensis differs from *C. yunnanensis* C.L.Long & X.Z.Cai (another Himalayan species found at similar elevations) by its reduced female zone, the lack of a constriction at the interstice, and characters of the male zone, synandria (and connective), and the synandrodes of the interstice. It is also distinctive by its purple or pink young leaves, pink veins on the abaxial blade surface, and reddish-pinkish spathe. Overall, *C. dibangensis* differs from *C. yunnanensis* by the absence of colour patches between the veins of the adaxial blade surface, the presence of purplish or pinkish colouration of the young leaf blades and petioles, pinkish veins on the abaxial surface of the blade, and the markedly more shallow sinus.
TYPE: India, Arunachal Pradesh, Lower Dibang valley distict, 5 km ahead of 65 point from Mayodia towards Hunli, 28°17'40.84"N, 95°55'11"E, 2129 m, 19 Sep 2012 *Gogoi & Borah 21877* (holo CAL; iso ASSAM, ARUN). (Fig. 1D–G, 3)

Herb, medium sized, tubercled. ***Corm*** erect, subglobose, 9–11 cm long, 6–8 cm across; densely rooted, roots thick, white with reddish coloration. ***Leaves*** 2–4, young leaves pinkish or reddish, old ones green adaxially; petiole pale green with pinkish or reddish colouration, cylindric, 65–80 cm long, 4–5 cm diam., sheathing is up to ½ length of petiole; leaf blade cordate-peltate, orbicular-cordate, 42–75 cm long, 40–75 cm wide, membranous, apex slightly apiculate, lateral veins 7–8 pairs, raised abaxially, pink. ***Inflorescence*** 1–3 together; peduncle light pinkish, cylindric, to 17 cm, slender. Spathe constricted between tube and limb; tube reddish pink, to 5 cm long, 2.5 cm wide, oblong; limb reddish black externally, light yellow internally, subcylindric, to 13 cm long, to 2.5 cm wide, oblanceolate, margins entire, erect or slightly curved apically, apex acuminate, never relaxed on anthesis. ***Spadix*** sessile, to 17 cm long, shorter than spathe; female zone reduced, green and yellow, cylindric, to 2.3–2.5 × 1.4 cm, green fertile flowers mixed with light yellow staminodes, synandrodes broadly oblong to depressed ovate or depressed obpyramidal, apex subtruncate; ovary green, subglobose or ovoid, 1.5–2 mm diam., 1-loculed, parietal, placentae 3, ovules many; stigma sessile

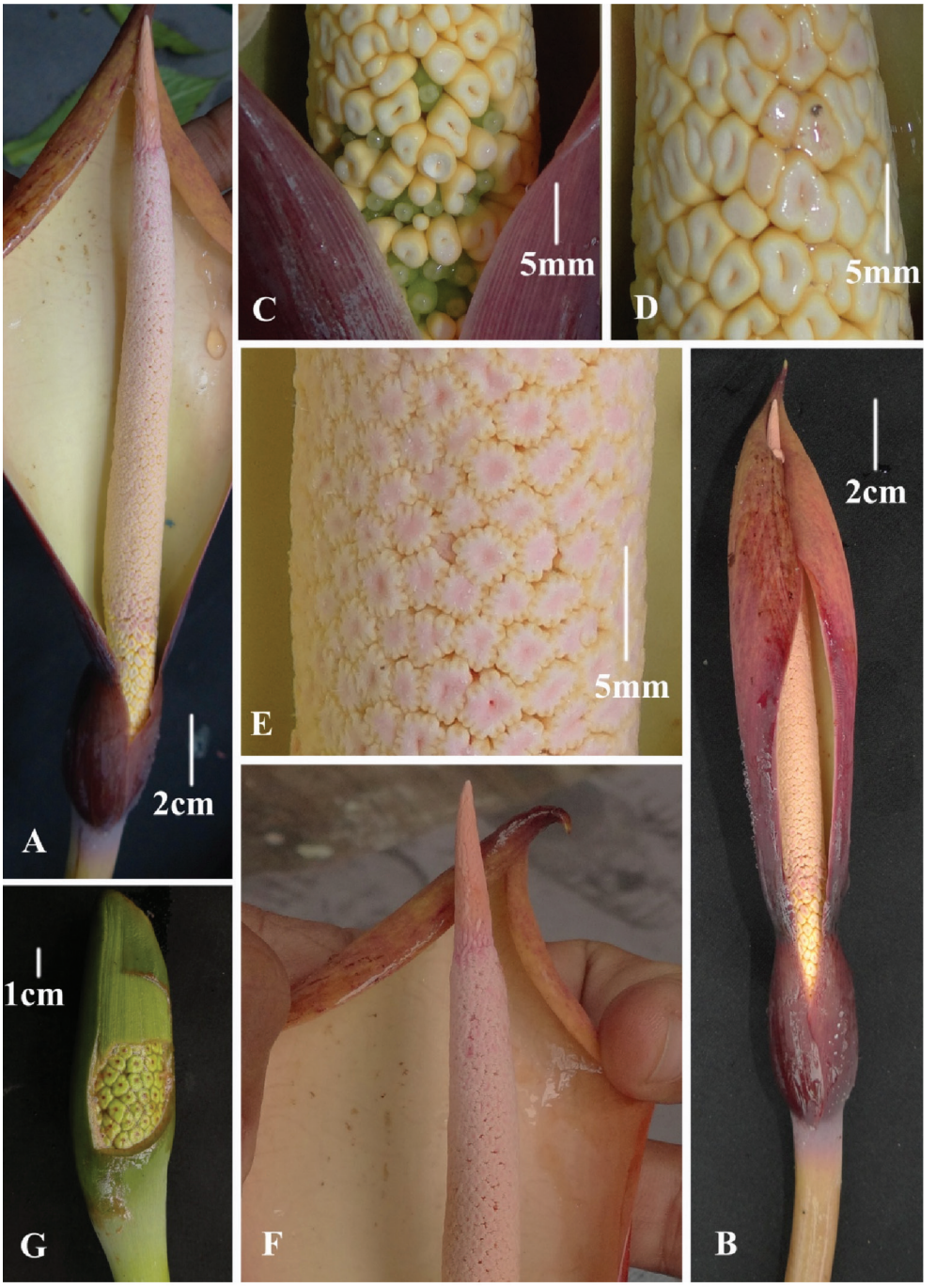

Fig. 3. Reproductive parts of *Colocasia dibangensis* R.Gogoi & S.Borah. **A & B.** Reddish-purple coloured spathe and spadix of the plant. **C.** Reduced female zone. **D.** Portion of sterile zone. **E.** Portion of male zone showing synandria. **F.** Appendix of the spadix. **G.** Infructescence with green berries. (Photos: R. Gogoi & S. Borah)

or subsessile, translucent white, globose, 0.5 mm wide; sterile zone starts continually from female zone up to male zone, no constriction or slightly constricted between the zones, 2–2.5 cm long, to 1.3 cm wide, cylindric, synandrodes yellowish white, 2–3 mm long, 2–5 mm wide; male zone pinkish, synandria yellow with pink tinge, polygonal, 6–10-androus; appendix pink, conic, 2.5 × 0.5 cm, apex acute. ***Infructescence*** green, c. 7 cm long, 5 cm across, berry green when young, obovoid, 4–6 mm, seeds many.

Distribution and habitat. Colocasia dibangensis grows in large colonies or isolated small populations in cool open places on hill slopes or along roadsides. It is so far endemic to the lower Dibang valley district of Arunachal Pradesh; elevation 1800–2200 m, recorded only by the type.

Phenology. Flowering and fruiting July–September.

Etymology. The species is named after its type locality.

IUCN conservation status. Not evaluated, but while collecting we found no obvious threat to this species.

Notes. Colocasia dibangensis is a species growing at high elevation and with pink or purple coloured veins abaxially. The pink-coloured spathe and pink male and highly reduced female zone (1/12th of the spadix) distinguish it from all other species of the genus. This species is with the group bearing a conspicuous appendix in the spadix, but its comparatively reduced conic appendix separates it from other species like *C. esculenta, C. fallax* and *C. affinis* which are commonly found in NE India.

Colocasia lihengiae C.L.Long & K.M.Liu in Bot. Bull. Acad. Sin. 42: 313–317. (Fig. 4)

Herb, medium sized, stoloniferous. ***Corm*** subglobose, not massive, erect, 3 cm in diam. ***Leaves*** 3–5, petiole glabrous, 60–100 cm long, green with purple reticulation, blade peltate, saggitate-cordate, abaxially light green, adaxially dark green, leathery, shining, 25–35 cm long, 14–21 cm wide, lateral veins 4–5 pairs, green. ***Inflorescences*** up to 5, peduncle green with purple reticulation, cylindric, shorter than petiole, 40–45 cm long, 0.7–0.8 cm across, spathe constricted between tube and limb; tube green, elliptic, subcylindric, 5.5–6.5 cm long, 1.6–2 cm wide; limb erect, golden yellow both dorsally and ventrally, ovate, 14–16 cm long, apex acuminate. ***Spadix*** sessile, shorter than spathe, to 8.5 cm long; female zone green, cylindric, 2.5–2.8 cm × 1–1.3 cm, 1/3 of the spadix, with inter-pistillar staminodes, yellow; ovary oblong, 2–2.5 × 2 mm, green, 1-loculed, placentae 2, stigma sessile, 3-lobed, disciform, white, staminodes yellow; sterile zone yellow, 2.5–3 cm × 0.8–1 cm, cylindric; male zone yellow, 3.8–4 cm × 0.7–0.8 cm, synandria 3–10-androus, polygonal, creamy, without hairs; appendix absent. ***Infructescence*** green, elliptic, 5–7 cm long, 2–2.5 cm across; berries green when young, ovate, c. 3–4 mm diam., seeds many.

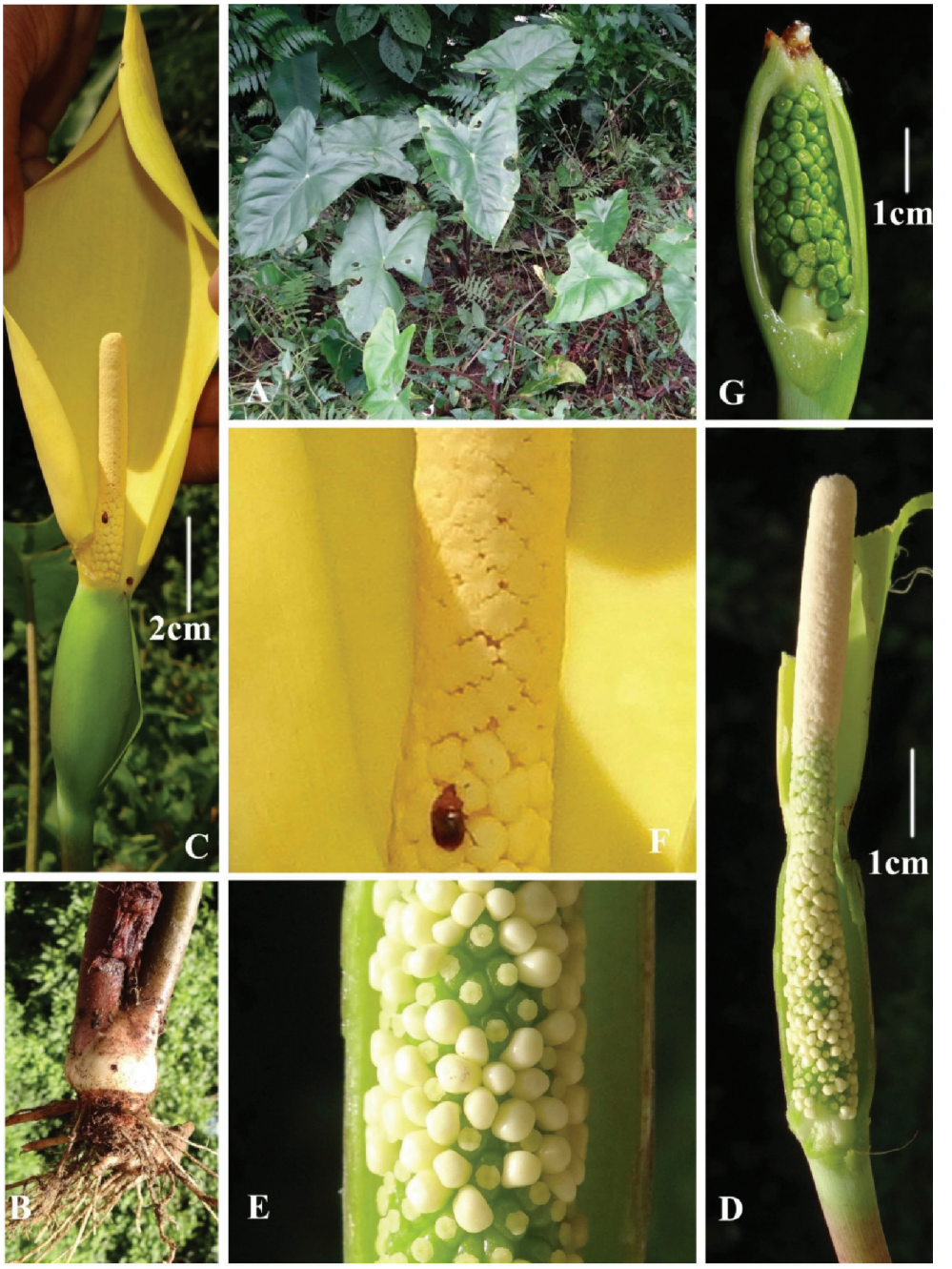

Fig. 4. Habit and reproductive parts of *Colocasia lihengiae* C.L.Long & K.M.Liu. **A.** Habit of the plant. **B.** Corm. **C.** Inflorescence. **D.** View of a complete spadix. **E.** Portion of the female zone showing ovaries and interpistillar staminodes. **F.** Portion of the male zone showing synandria and possible pollinator. **G.** Infructescence with green berries. (Photos: R. Gogoi & S. Borah)

Distribution. India (Assam: Dihing Patkai Reserve; Arunachal Pradesh: road to Parasuram Kunda from Chowkham in Lohit district); China (Yunnan, Mengla, Mengxing River watershed).

Habitat. Colocasia lihengiae grows in little colonies in moist forest floors of tropical evergreen forests at about 200–400 m. A quite good population was encountered in Dihing Patkai Reserve forest of Assam and on the way to Parasuram Kunda from Chowkham in Lohit district of Arunachal Pradesh. The apical shoots and petioles are sold in market as vegetable.

Phenology. Flowering and fruiting July–September.

Specimen examined. INDIA. **Arunachal Pradesh.** Between Wakro and Parasuram Kund, 250 m, 5 Sept. 2012, *Gogoi & Borah 21814* (ARUN).

Notes. Colocasia lihengiae was described from Yunnan province of China (Long & Liu 2001). In the *Flora of China* account (Li & Boyce 2010), it was treated as a synonym of *C. antiquorum*. As mentioned above *C. antiquorum* is a synonym of *C. esculenta* and *C. lihengiae* is a distinct species from *C. esculenta* by the absence of an appendix, and here it is treated as a valid species.

A key to the species of *Colocasia* is presented for NE India that includes and distinguishes *C. boyceana*, *C. dibangensis* and *C. lihengiae*, as follows.

Key to *Colocasia* species in NE India

1a. Appendix present and more than 2 cm long ……..…….. 2
b. Appendix absent or highly reduced, less than 1 cm long ……..... 5

2a. Young leaves pinkish, blade 42–75 × 40–75cm; spathe pink, tube reddish purple; spadix deep pink, appendix triangular conic ……...….. *C. dibangensis*
b. Young leaves whitish green or pale green, blade less than 10–45 × 10–35cm; spathe yellow or greenish white, or slightly purplish apically (*C. fallax*), tube green; spadix yellow or pale yellowish green, appendix narrowly conic to cylindric narrowly conic ……...….. 3

3a. Plant tuberous or rhizomatous, up to 100 cm tall; spathe dull yellow, spreading and open flat, not revolute; infructescence erect ……..…… *C. esculenta*
b. Plant stoloniferous, less than 75 cm tall; spathe bright yellow, not spreading, revolute; infrutescence pendent ……...……..……..……4

4a. Leaves with dark patches between primary lateral veins; female and male zones contiguous …….……. *C. affinis*
b. Leaves usually concolourous green; female and male zone separated by a zone of synandrodes ……...……..…… *C. fallax*

5a. Plant robust, up to 225 cm tall; petiole and peduncle deep purple red; spathe c. 25 × 11cm; appendix reduced, less than 1cm long ……..... *C. fontanesii*
b. Plant small, less than 130cm tall; petiole green or light purple reticulate; spathe less than 17 × 7cm; appendix absent ……..…..…….. 6

6a. Leaf margin with purple lining; purple spot at ventral junction of petiole; venation impressed; synandria with white hairs ……..….. *C. boyceana*
b. No purple lining and spot on leaf; venation raised; synandria without hairs 7

7a. Basal lobes of leaf obtuse; petiole green; spathe tube c. 2.5 cm; synandria stellately crenate; sterile zone c. 1.2 cm long ……...……...….. *C. manii*
b. Basal lobes of leaf usually acute; petiole light purple reticulate; spathe tube c. 5.5 cm; synandria polygonal; sterile zone c. 3 cm long ……...…...…. *C. lihengiae*

Conclusion

The present report establishes the existence of wild species of *Colocasia* that are shared between the western and eastern regions of Himalaya, in India and China. At the same time, it expands our understanding of a possibly unique assemblage of diverse *Colocasia* species growing wild in NE India, composed of *C. esculenta*, *C. boyceana*, *C. affinis*, *C. dibangensis, C. fallax, C. fontanesii, C. manii* and *C. lihengiae*. In S China, the overall assemblage of *Colocasia* species also appears to be unique with *C. affinis*, *C. bicolor*, *C. esculenta*, *C. fallax*, *C. fontanesii*, *C. gaoligongensis*, *C. gigantea, C. gongii*, *C. heterochroma*, *C. menglaensis*, *C. tibetensis* and *C. yunnanensis*. The existence of diverse assemblages of *Colocasia* species in different regions of Himalaya indicates that the genus has a long and complex history in the Himalayan region. The recent discoveries of two new *Colocasia* species raises a posibility of the further existence of undescribed species in the wild, and at the same time the existence of more Chinese species in the region of Indian Himalaya.

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