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Araceae of Mulu National Park II: A new karst-obligated *Homalomena* [Chamaecladon clade]

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ABSTRACT: *Homalomena hottae* is described and illustrated as a new species of microscopically scintillating-velutinous leaved aroid from the Karst limestone of Mulu National Park, to where it is locally restricted. *Homalomena hottae* is compared with the two currently described Bornean species with similarly scintillating foliage. Notes on the pollination biology of *Homalomena hottae* are given, and the three described Bornean species of scintillating Chamaecladon clade species are compared in a key.

KEY WORDS: Aroids, Borneo, *Chamaecladon*, *Colocasiomyia*, Drosophilidae, *Homalomena*, Malaysia, pollination biology.

INTRODUCTION

The Homalomena Chamaecladon clade (Wong *et al*., 2013) is perhaps the least well studied of the four clades comprising the most speciose genus of aroids in SE Asia (Boyce and Croat, 2011). Species are mostly diminutive plants, often lithophytic, with small to tiny blooms opening fleetingly before the spathe recloses and persists until fruiting. Post-anthesis the blooms resemble buds except the spent florets and staminodes have deliquesced, in the process eliminating critical characteristics required to facilitate recognition.

All Chamaecladon clade species have pistillate florets wherein the associated staminode is at most half as tall as the pistil. The majority of species have a more or less parallel-sided narrowly oblong spathe not exceeding two centimetres long, occasionally only half this, and staminate florets comprised of two stamens. Plants are glabrous, or some or all of the plant, including the spathe exterior, may be scintillating-velutinous, i.e., with the leaf blade epidermis microscopically papillate and refracting light, or ornamented with minutely scabrid to asperous or with a strigose indumentum, or with extraordinary dense scale-like or soft shaggy trichomes. To date by far the most extreme ornamentation is known from Sumatera (Boyce and Wong, 2016).

The scintillating-velutinous species of the Chamaecladon clade in particular have been ill-served taxonomically. Largely for the reasons noted above much of the available herbarium material, including most of the historical Types, is inadequate, and as result so, too, are most of the protologues. Additionally, the distinctive epidermis texture, which is well-preserved in herbarium specimens, has encouraged uncritical determining of almost all material as *H. humilis* (Jack) Hook.f., a species seemingly endemic to Pulau Pinang. The problem in Peninsula Malaysia is further exacerbated by Furtado's attempts to "clarify" the taxonomy (Furtado, 1939) wherein a plethora of subordinate taxa, to the level of subvariety and form, were proposed while leaving many taxonomic issues unanswered or partially solved. For the past 15 years the authors have been making progress with the larger growing *Homalomena* species on Borneo, but aside from describing two very clearly new species of scintillating-velutinous Chamaecladon species (Kartini *et al*., 2019; Wong and Boyce, 2011), we have largely shied away from working on the group in Borneo since the bulk of the historical names have been described from Peninsular Malaysia and Jawa (Java). Recently however, a we have been forced to revisit the taxonomic status of one species occurring at Mulu (which we have hitherto referred to as *H. humilis* sens. lat.) owing to a pollination biology project carried out by one of the first author's graduate students (Chai, 2020; Chai and Wong, 2019).

Geological occurrences in this paper are corroborated using Tate (2001).

TAXONOMIC TREATMENT

Homalomena hottae S.Y. Wong, S.K. Chai & P.C. Boyce, ***sp. nov.*** **Figs. 1 & 2**

Type: MALAYSIAN BORNEO. Sarawak, Miri Division, Marudi, Long Lama, Mulu National Park, trail to Deer Cave, 4°02'23.8"N; 114°48'54.6"E, 60 m asl. 10 Dec. 2011, *Tung Lay Soon et al. AR-3716* (holotype SAR!; isotype TAI!).

Fig. 1. ***Homalomena hottae***. **A–D.** plants in habitat. Note: **C.** shows a plant occurring in limestone slurry. **D.** a plant occurring terrestrially in humus accumulations at the base of Karst limestone. Deposited limestone on the leaf blades is clearly visible in **A–C**.

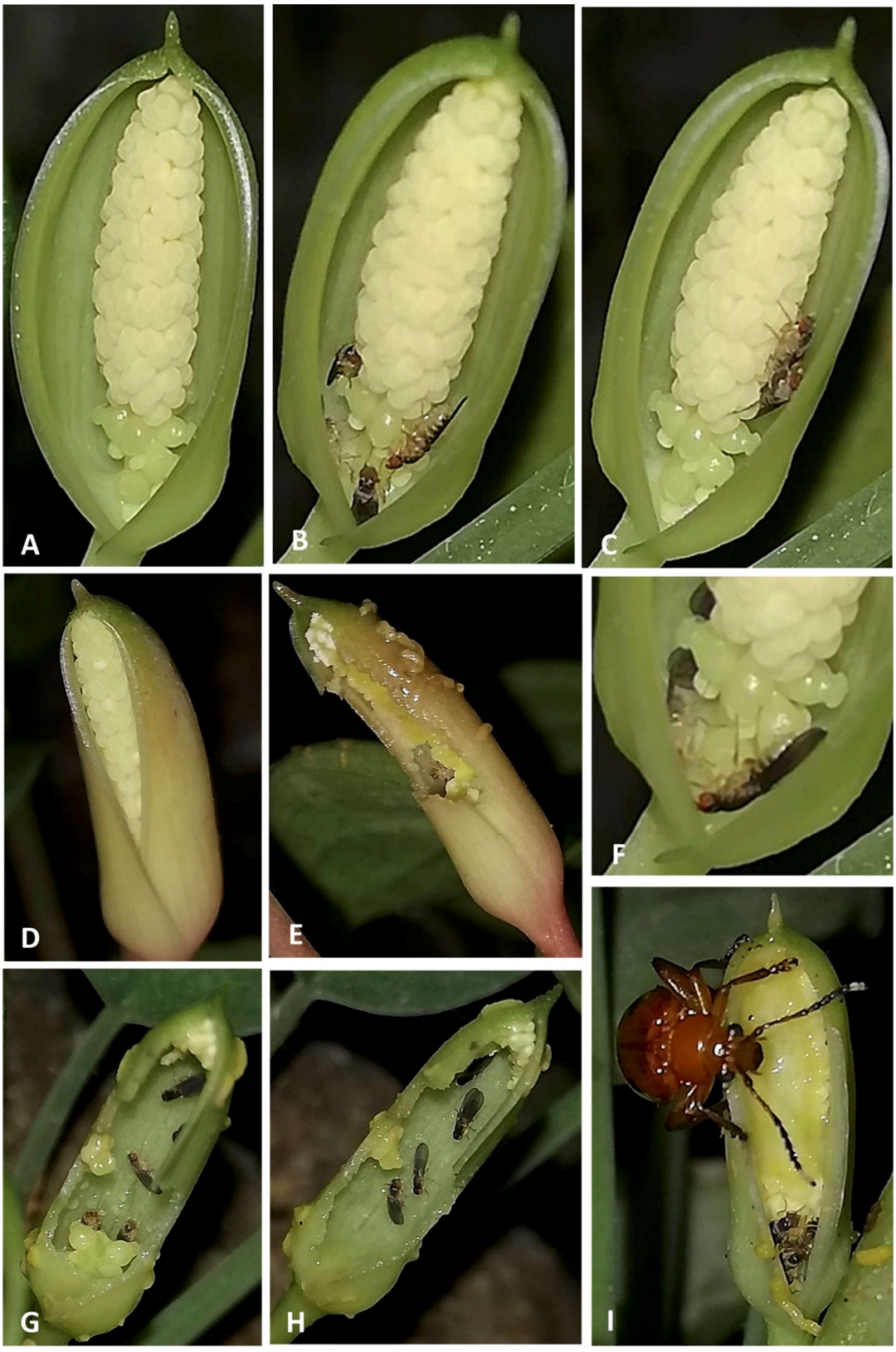

Fig. 2. ***Homalomena hottae*** blooms at various stages. **A–C.** Pistillate anthesis, spathe opened. **B.** Fruit flies (Drosophilidae) move on pistillate florets. **C.** Fruit flies mating on spadix. **D.** Post pistillate anthesis, spathe close back. **E**. Staminate anthesis, pollen released. **F.** Fruit flies at pistillate zone (zoom). **G–H**. Fruit flies in bloom destroyed by *Chaloenus* beetles. **I.** *Chaloenus* beetles (Chrysomelidae) consume staminate zone before staminate anthesis.

Synonym: *Homalomena humilis* var. *ovatifolia* M.Hotta, Acta Phytotax. Geobot. 22: 153 (1967). ***Type:*** MALAYSIAN BORNEO. Sarawak, [Miri], Marudi ["Mardi"], along S. Payau, at the foot of G. Mulu, on shady limestone cliff, 22 Mar. 1964. *M. Hotta 15298* (holotype KYO!).

Homalomena hottae differs from all other described Bornean *Homalomena* [Chamaecladon] species with scintillating-velutinous epidermis by the large disc-like stigmas and oblong lime green staminodes.

Small usually lithophytic, very occasionally terrestrial, mesophytic herbs up to c. 13 cm tall. Stem epigeal, erect, but in older plants becoming pendulous-decumbent with the active tip ascending, rooting from the lower-most nodes through the petiole bases; roots c. 1–3 mm diam., tough, flexuous, pale brown, slightly velvety. Leaves up to c. 12 together per stem, petioles spreading with the blades held more or less parallel to the ground; petiole 4–10 cm long, c. 2 mm diam. midway, dorsally very narrowly channelled, either green or flushed with maple red, or wholly maroon, epidermis scintillating-velutinous and minutely asperulous; petiolar sheath 1.5–3 cm long, extending c. 1/3 length of the petiole, clasping at the base, width between both margins c. 1 mm, wings persistent; leaf blade elliptic oblong to ovate, 6–12 cm long by 3–6 cm wide, thinly coriaceous, microscopically scintillating-velutinous and occasionally with deposited limestone on the upper surface, blades either deep green adaxially and paler green abaxially, or deep green to brownish maroon adaxially and pale maroon abaxially, base cuneate, apex acute with a brief (c. 1.5 mm long) tubule, margins smooth or slightly sinuous; abaxially all veins darker than surrounding tissues, either medium green against pale green or plum-purple against pale maroon; midrib adaxially slightly impressed, abaxially slightly prominent; primary lateral veins 4–6 on each side of midrib, adaxially slightly incised, abaxially slightly prominent, alternating with much fainter regularly interspersed interprimaries, diverging at ca. 20°–60° from the midrib; secondary venation obscure; tertiary venation forming a tessellate reticulum, this most clearly visible in living plants with sunlight falling on the blades (Fig. 1D); all veins running into a very slightly thickened intramarginal vein. Blooms up to 4 together, produced sequentially in a simple synflorescence; peduncle terete, slender, 2–5 cm long by c. 3 m diam., coloured as for petiole; spathe narrowly ellipsoid, not constricted, at anthesis 2 cm long by 5–8 mm wide, with a terminal short mucro to 1–2 mm long, exterior medium green or slightly flushed pale red, interior medium green, spathe gaping at anthesis with the margins recurving and opening to expose the pistillate florets, then closing post staminate anthesis and persisting until basal dehiscence at fruit dispersal. Spadix almost equalling spathe limb at anthesis, 1.8 cm long by 3–4 mm diam., sessile; pistils in two spirals, globose; stigmas large, ca. 0.5 mm diam., disc-like on a short stipe; associated staminodes oblong, almost sessile, lime green; staminate zone c. 1.5 cm long, apex acute; staminate florets each consisting of two stamens, anthers rounded, c. 0.5 mm tall, 1–1.5 mm long by 0.5–0.8 mm wide, white; post anthesis blooms pendulous by bending of the peduncle. Infructescence, fruit, and seed not observed.

Distribution: Known only from Mulu National Park where it is restricted to the Karst formations.

Habitat & Ecology: Lithophytic or very occasionally terrestrial on shaded to somewhat exposed Melinau (Eocene-Miocene) karst limestone, occasionally growing in rock surface limestone slurry; 60–100 m asl.

Eponymy: Named for Mitsuru Hotta (1937–2015), justly regarded as catalytic in the renaissance of interest in tropical Asian Araceae beginning in the 1960s and who on the 1963–1964 Kyoto University Borneo Expedition, in a little over one week spent at Gunung Mulu towards the end of March 1964 made the first systematic collections of the remarkably rich aroid flora of the Mulu limestones, and of the surrounding sandstone and alluvial riverine forests.

Notes: The three species discussed here are very similar in overall appearance, to the extent of being effectively indistinguishable from one another as herbarium speimens, although as living or spirit-preserved material readily separable by characteristics of the spadix. Furthermore, each species is geographically and ecologically discrete. *Homalomena kionsomensis* (Figs 3, 5B) and *H. terajaensis* (Figs 4, 5A) both have a shortly stipitate spadix, as compared to a sessile spadix in *H. hottae*. While *H. kionsomensis* has up to four spirals of pistillate florets and orthotropic pistils, *H. terajaensis* has a single of florets and acroscopic pistils. Both *H. kionsomensis* and *H. terajaensis* have a tiny pointed stigma, quite different to the large disc-like stigma of *H. hottae*.

***Additional specimens of H. hottae examined*: Malaysian Borneo**: Sarawak. **Miri.** Marudi, Long Lama, Mulu N.P., Clearwater Cave, 4°03'49.2"N 114°49'51.7"E, 75 m asl, 8 Aug 2006, *P.C.Boyce et al. AR-1961* (SAR); Mulu N.P., Fastlane trail to Gua Lagang, Gua Lagang, 4°02'48.6"N 114°49'32.5"E, 72 m asl, 16 Mar 2012, *Wong Sin Yeng & P.C.Boyce AR-3830* (SAR). **Limbang.** Nanga Medamit, Mulu N.P., Sungai Empangau, tributary from Sungai Mendalam, 4°13'41.6"N 114°52'50.5"E, 90 m asl, 30 Sep 2007, *P.C.Boyce et al. AR-2245* (SAR) and *AR-2246* (SAR); Nanga Medamit, Mentawai Research Station, Mulu N.P., Sungai Abun Kiri, tributary from Sungai Terikan, 4°14'07.4"N 114°52'27.6"E, 85 m asl, 2 Oct 2007, *P.C.Boyce et al. AR-2295* (SAR); Nanga Medamit, Mulu N.P., Melinau Gorge, 4° 8'7.43"N114°54'3.89"E, 150m asl, 3 Oct 2007, *P.C.Boyce et al AR- 2318* (SAR).

Key to species of scintillating-velutinous *Homalomena* on Borneo

1a. Spadix stoutly ellipsoid, briefly stipitate, stipe with conspicuous red or green glands; pistillate florets in single row, pistils acroscopic; stigma tiny, pointed. Lambir (Sarawak) and Belait (Brunei) on wet Belait Formation (Early-Late Miocene) sandstone outcrops ……. ……..…... ***H. terajaensis***

1b. Spadix cylindrical to weakly ellipsoid, sessile or briefly stipitate, if stipitate then stipe lacking glands; pistillate florets in two to four spirals, pistils orthotropic …… 2

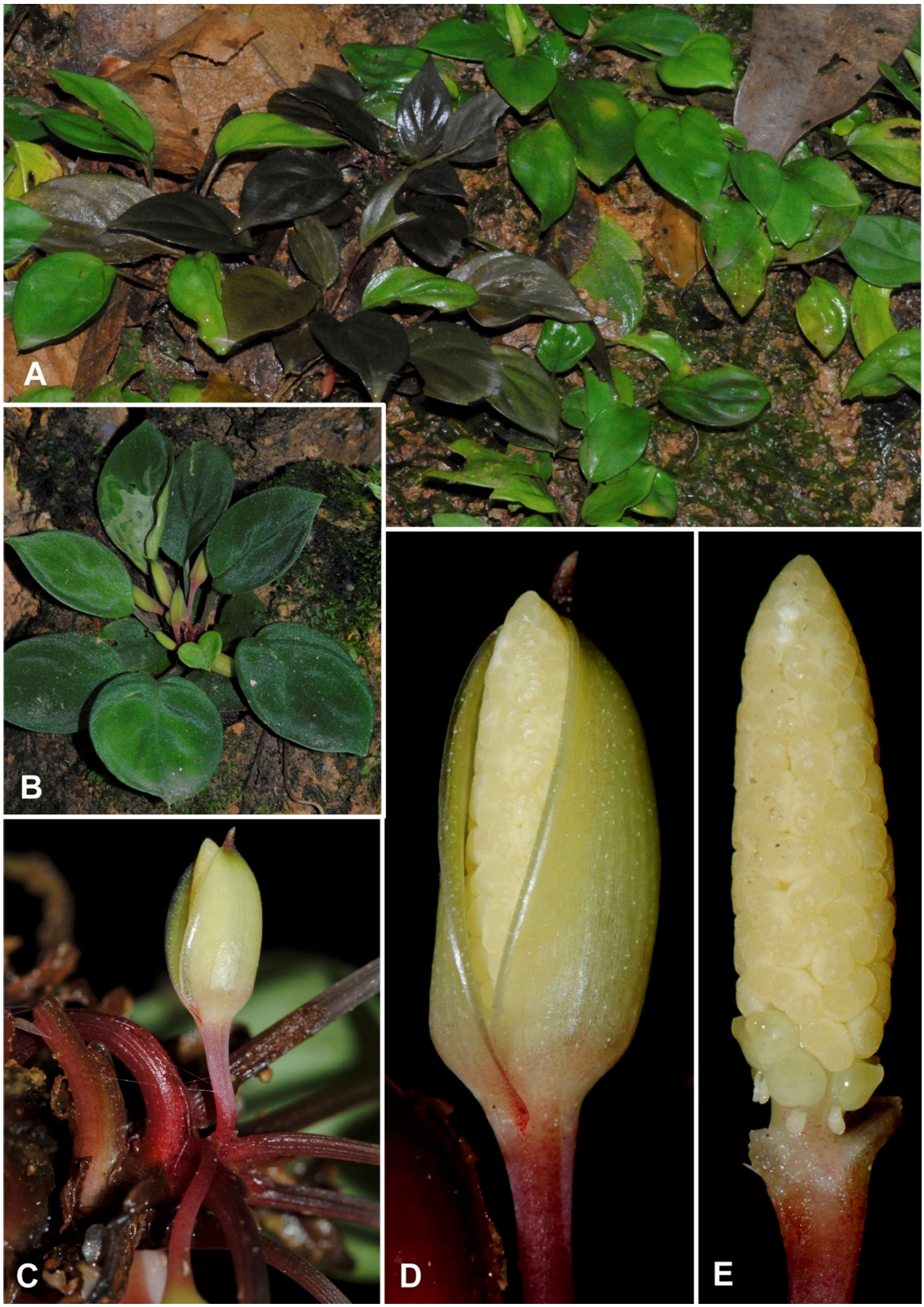

Fig. 3. *Homalomena terajaensis*. **A.** Population of the species showing a mixture of different colour morphs: green and red. **B.** Whole plant. **C & D.** bloom at pistillate anthesis. **E.** spadix at pistillate shown with spathe removed artificially.

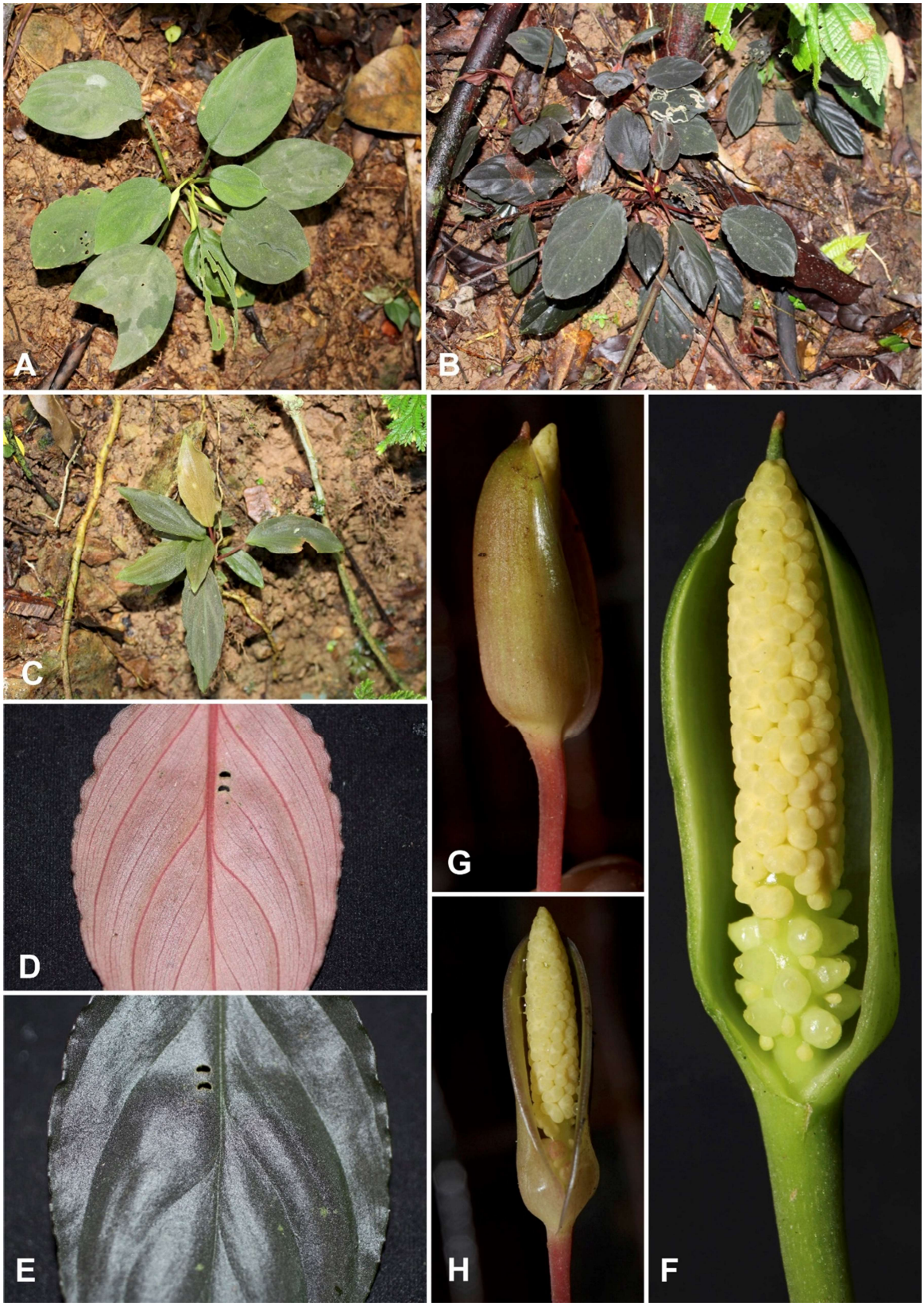

Fig. 4. ***Homalomena kionsomensis***. **A.** Green plant in habitat. **B.** Maroon purple plant in habitat. **C.** Juvenile plant in habitat. **D.** Leaf blade abaxial view. **E.** Leaf blade adaxial view. **F.** Bloom at pistillate anthesis; nearside of spathe artificially removed. **G & H.** Bloom at pistillate anthesis.

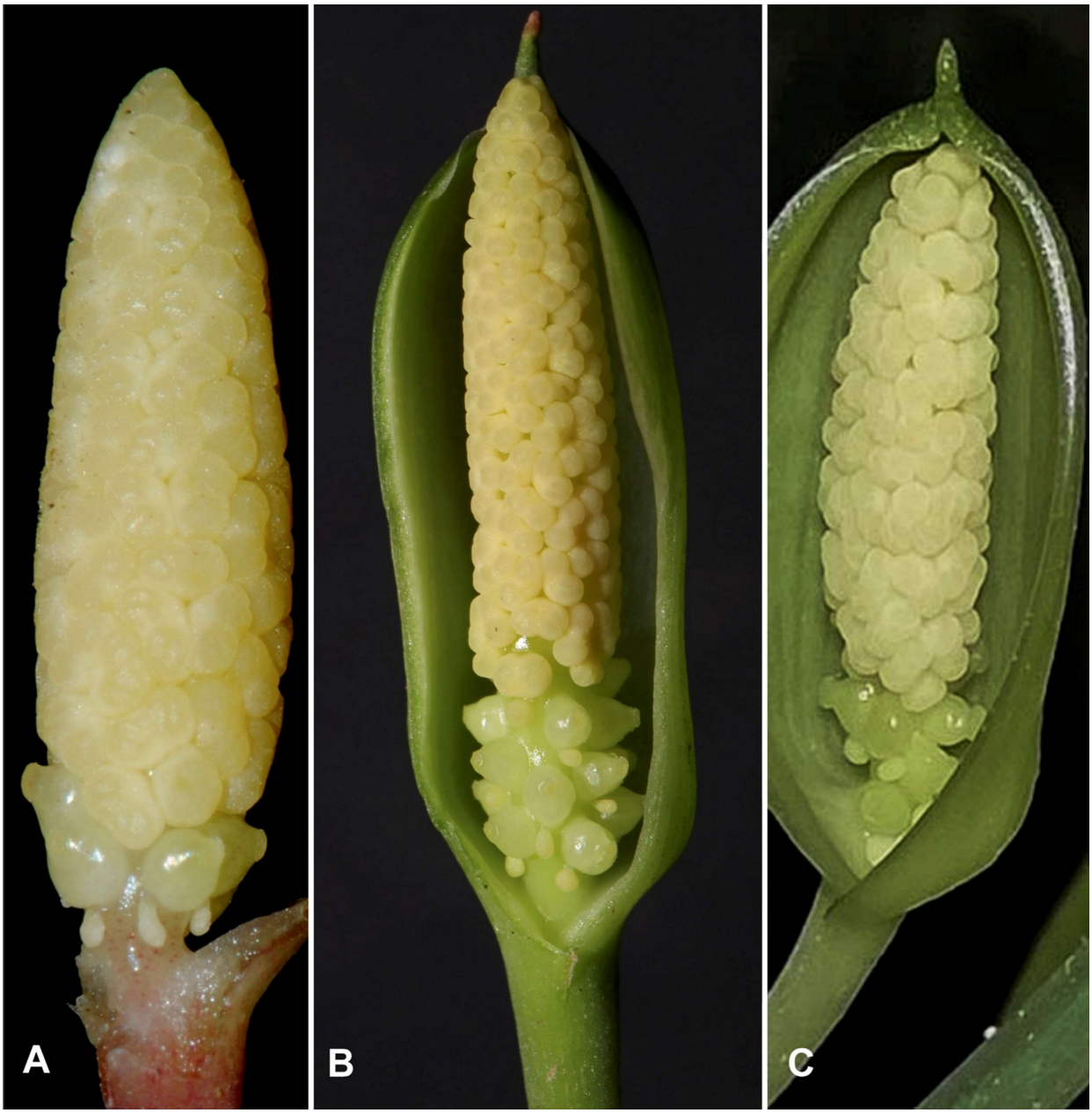

Fig. 5. ***Homalomena terajaensis***. **A.** ***Homalomena kionsomensis*** **B.** and ***Homalomena hottae*** **C.** spadix compared. In **A.** spathe artificially removed; in **B.** nearside of spathe artificially removed.

2a. Spadix briefly stipitate; pistillate florets in three or four spirals, ovary conical; stigmas minute, pointed; associated staminodes almost globose on a brief hair-like stipe, pale yellow; staminate florets cream. Kionsom Waterfall (Sabah: Inaman) on Oligocene deepwater sandstones …… ***H. kionsomensis***

2b. Spadix sessile; pistillate florets in two spirals, ovary globose; stigmas large, disc-like on a short stipe; associated staminodes oblong, almost sessile, lime green; staminate florets white. Mulu (Sarawak) on Melinau (Eocene-Miocene) karst limestone ..... …… ***H. hottae***

Notes on pollination

Although there are several published studies of pollination for *Homalomena* (Chai and Wong, 2019; Hoe *et al*., 2011, 2016; Kato *et al*., 2000; Kumano and Yamaoka, 2006; Kumano-Nomura and Yamaoka, 2009; Tung *et al*., 2010; Wong and Boyce, 2017) until recently there have been no pollination studies undertaken for species of the Chamaecladon Clade, although Mori and Okada (2001) published a detailed study of the very closely related *Furtadoa sumatrensis* M.Hotta. The second author's Masters study managed to amass partial information, summarized here.

Anthesis in *Homalomena hottae* lasts about 24 hours. Before pistillate anthesis (c. 0200 h, on the first day), a c. 2 mm gap opens along the spathe, with pistillate

anthesis, indicated by the production of a droplet from the stigmatic surface, and the release of sweet citrus alcohol/mint floral odour from the staminate zone, starting at about 0600 h (Day 1). By 0700 h the spathe gap extended up to 5 mm and spathe inflation provided a 2 mm space between the spathe and spadix. The duration of the full spathe opening is very short, and gradually the spathe recloses until c. 2 mm by 0900 h, marking the end of pistillate anthesis ended by 0900 h (Day 1), with the floral odour weakening. Thereafter follows a 19 hours intersexual phase with the spathe remaining open only by a c. 1 mm gap (Fig. 2D). Staminate anthesis started at 0500 h (Day 2) with the release of powdery pollen inside the almost closed spathe (c. 1 mm gap); anthesis ended at 0600 h (Fig. 2E). Post anthesis, the spathe reclosed to protect the developing fruits, the peduncle bent downwards.

Homalomena hottae is pollinated by *Colocasiomyia* (Drosophilidae) flies which arrive at open blooms between 0620 to 0630 h, during the first day of anthesis, and remain on the pistillate zone (Fig. 2B,F), occasionally mating on the staminate zone (Fig. 2c) before leaving the bloom around 0620 h after pollen release on the second day (Fig. 2E). *Chaloenus* beetles (Chrysomelidae) predate blooms of *H. hottae*, chewing the staminate zone of the spadix (Fig. 2I), and occasionally the entire bloom (Fig. 2E, G, H).

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LITERATURE CITED

Boyce, PC. and T.B. Croat. 2011 and onwards. The Überlist of Araceae: Totals for published and estimated number of species in aroid genera. Available from: https://www.aroid.org/genera/120110uberlist.pdf. DOI: 10.13140/RG.2.2.24820.09605

Boyce, P.C. and S.Y. Wong. 2016. Studies on Homalomeneae (Araceae) of Sumatera IV: Three new species of ornamental *Homalomena* [Chamaecladon clade]. Willdenowia **46(2):** 253–260.

Chai, S.K. 2020. Pollination guilds of aroids in Mulu National Park. Unpublished M.Sc. thesis. Universiti Malaysia Sarawak.

Chai, S.K. and S.Y. Wong 2019. Five pollination guilds of aroids (Araceae) at Mulu National Park (Sarawak, Malaysian Borneo). Webbia **74(2):** 353–371

Furtado, C.X. 1939. Notes on some Indo-Malaysian Homalomena species. Gard. Bull. Straits Settlem. **10(2):** 183–238.

Hoe, Y.C., S.Y. Wong, P.C. Boyce, M.H. Wong and M.C.K. Yok. 2011. Studies on Homalomeneae (Araceae) of Borneo VII: *Homalomena debilicrista* a new species from Sarawak, Malaysian Borneo, with observations on its pollination. Pl. Diversity Evol. **129(1):** 77–87

Hoe, Y.C., M. Gibernau, A.C.D. Maia and S.Y. Wong 2016. Flowering mechanisms, pollination strategies and floral scent analyses of syntopically co-flowering *Homalomena* spp. (Araceae) on Borneo. Pl. Biol. (Stuttgart) **18(4):** 563–576.

Kartini, S., P.C. Boyce and S.Y. Wong 2019. Studies on Homalomeneae (Araceae) of Borneo XXII: A new species of *Homalomena* [Chamaecladon Clade] from Kionsom Waterfall, Sabah, Malaysian Borneo. Webbia **74(2):** 247–250.

Kato, M., T. Itioka, S. Sakai K. Momose, S. Yamane, Abang Abdul H. and T. Inoue. 2000. Various population fluctuation patterns of light-attracted beetles in a tropical lowland dipterocarp forest in Sarawak. Popul. Ecol. **42(1):** 97–104.

Kumano, Y. and R. Yamaoka. 2006. Synchronization between temporal variation in heat generation, floral scents and pollinator arrival in the beetle-pollinated tropical Araceae, *Homalomena propinqua*. Pl. Spec. Biol. **21(3):** 173–183.

Kumano-Nomura, Y. and R. Yamaoka. 2009. Beetle visitations, and associations with quantitative variation of attractants in floral odors of *Homalomena propinqua* (Araceae). J. Pl. Res. **122(2):** 183–192.

Mori, Y. and H. Okada H. 2001. Reproductive biology and pollen flow of a rheophytic aroid, *Furtadoa sumatrensis* (Araceae) in the Malesian wet tropics. Pl. Syst. Evol. **227(1-2):** 37–47.

Tate, R.B. 2001. The geology of Borneo island CDROM. Kuala Lumpur: Persatuan Geologi Malaysia / Geological Society of Malaysia.

Tung, L.S., S.Y. Wong and P.C. Boyce. 2010. Studies on Homalomeneae (Araceae) of Borneo VI: *Homalomena giamensis*, a new species from Sarawak, Malaysian Borneo, with notes on its pollination. Aroideana **33:** 201–211.

Wong, S.Y. and P.C. Boyce. 2011. Studies on Homalomeneae (Araceae) of Borneo X: Two new *Homalomena* species from Brunei, and a new informal species complex for Supergroup Cyrtocladon. Webbia **66(2):** 133–141.

Wong, S.Y. and P.C. Boyce. 2017. Studies on Homalomeneae (Araceae) of Borneo XX: *Homalomena lambirensis*, a new locally endemic species from Sarawak with well-recorded pollination biology. Nordic J. Bot. **35(5):** 557–562.

Wong, S.Y., P.J. Tan, K. Ng, A.S. Othman, H.B. Lee, F.B. Ahmad and P.C. Boyce. 2013. Phylogeny of Asian *Homalomena* (Araceae) based on the ITS region combined with morphological and chemical data. Syst. Bot. **38(3):** 589–599.