



Hoya buntokensis (Apocynaceae, Asclepiadoideae), a new myrmecophytic species and *Hoya wallichii* subsp. *tenebrosa*, a new subspecies from Borneo (Kalimantan, Indonesia)

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Key words

ant plant
epiphyte
heath forest
Hoya darwinii
Hoya mitrata
Hoya undulata
Hoya wallichii
megadomatium
myrmecophyte
Southeast Asia

Abstract We describe a new *Hoya* species from Central Kalimantan, *H. buntokensis*, and a new subspecies of *H. wallichii* from West Kalimantan, *Hoya wallichii* subsp. *tenebrosa*. *Hoya buntokensis* is part of a group of four species that form specialised leaf structures harbouring ants (here defined as megadomatia), and it is most similar to *H. undulata*. *Hoya buntokensis* differs from *H. undulata* in lamina margin (flat vs undulate); shape of corona lobes outer processes (fan shaped vs elliptic), and in the pollinarium morphology (corpusculum larger than pollinia vs corpusculum smaller than pollinia). Both *H. wallichii* subsp. *wallichii* and *H. wallichii* subsp. *tenebrosa* are slender plants with ovate to oblong, thinly coriaceous glabrous leaves, slender peduncles with 1 or 2 flowers open at a time, and broadly campanulate corollas. *Hoya wallichii* subsp. *tenebrosa* differs from *H. wallichii* subsp. *wallichii* in corolla colour (dark purple with a paler edge vs white-cream), corona lobe shape and surface (broadly elliptic, spreading and with a minute inner process, almost black with a velvety surface vs kidney-shaped, erect and with a well-developed acuminate inner process, purple with a shiny surface).

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INTRODUCTION

Hoya R.Br. (Apocynaceae, Asclepiadoideae, Marsdenieae), with 350–450 species, is the largest genus of Apocynaceae in Asia (Rodda 2015, Endress et al. 2019). Species of *Hoya* are found throughout Indomalaya-Australasia, with a few extending to southern India/Sri Lanka, the Himalayan foothills, southern China and Japan (Forster et al. 1998). They are generally climbing or pendulous epiphytic plants, of which a few with an emipiphytic climbing habit, but in recent years numerous unusual species with a shrubby habit were also described (Rahayu & Rodda 2020). The most recent list of *Hoya* of Borneo includes 72 taxa (71 species and one subspecies) (Rodda 2017). However, Lamb & Rodda (2016) speculate that more than 80 taxa might eventually be found on the island. Since 2016 the number of species known from Borneo has increased with the description of new species, i.e., *H. narcissiflora* S.Rahayu & Rodda from West Kalimantan (Rahayu & Rodda 2017), *H. borneoensis* (Kloppenb. (Kloppenb. 2018a), *H. sarawakensis* Kloppenb. (Kloppenb. 2018b) both from Sarawak, *H. fauziana* Rodda, Simonsson & A.Lamb subsp. *angulata* A.Lamb, Gokusing & S.Rahayu (Rodda et al. 2018) from Sabah and West Kalimantan, and with the transfer of the monotypic *Anatropanthus* Schltr. to *Hoya* (as *H. insularis* Rodda & S.Rahayu; Rodda et al. 2020) from Sarawak and West Kalimantan.

We here describe one additional new *Hoya* species from Central Kalimantan and one new subspecies of *H. wallichii* (Wight) C.M.Burton from West Kalimantan, bringing the total number of *Hoya* in Borneo to 76 species and three subspecies.

The new species, *H. buntokensis* S.Rahayu & Rodda, was collected in heath forest, and when sterile it resembles *H. mitrata* Kerr, a species that co-occurs in the same heath forest habitat. The two species have oblong to lanceolate entire leaves and share the peculiar feature of forming modified leaves to harbour ants within, which have been so far been defined as domatia (Weissflog et al. 1999, Rahayu et al. 2015). However, what constitutes a domatium is not yet clearly defined (e.g., Tepe et al. 2007 and references therein). We adopt the definition given by the Kew Plant glossary (Beentje 2010): “small cavity, usually in the lower surface axils of the leaf veins but sometimes on stem or root, that are often linked to the presence of ants or mites”. The definition is therefore ill fitting to describe the multi-leaved structures observed in species of *Hoya*, or the modified whole leaves harbouring ants observed in some species of *Dischidia* R.Br (e.g., *Dischidia major* (Vahl) Merr.). We therefore suggest to use the new term megadomatium (plural megadomatia), defined as a chamber consisting of one or more modified leaves harbouring an ant colony.

In *H. mitrata* the megadomatia are formed by ‘cabbage-like leaves’, while in the new species they are globose. Upon flowering in cultivation, it became clear that the peduncles of *H. buntokensis* are positively geotropic or laterally held and the flowers are positively geotropic and with a rotate corolla (*H. mitrata* has negatively geotropic peduncles and flowers, and a corolla with reflexed lobes) and, therefore, more similar to the flowers of another species forming leaf megadomatia,

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H. undulata S. Rahayu & Rodda. Since it clearly differs from both *H. undulata* and *H. mitrata*, *H. buntokensis* is here described as a new species.

The new subspecies, *Hoya wallichii* subsp. *tenebrosa* S. Rahayu & Rodda, was found in West Kalimantan, Putussibau, in an oil palm plantation. It is indistinguishable from *H. wallichii* subsp. *wallichii* in vegetative morphology, but differs in flower colour and corona shape and surface.

Hoya buntokensis S. Rahayu & Rodda, *sp. nov.* — Fig. 1, 2

Similar to *Hoya undulata* S. Rahayu & Rodda in corolla shape (rotate) and in the presence of lateral appendages of the corona lobe. The two species can be separated on the lamina margin (undulate in *H. undulata*, flat in *H. buntokensis*) and in the shape of the corona lobes (outer processes elliptic in *H. undulata*, fan shaped in *H. buntokensis*), and in the pollinarium morphology (corpusculum smaller than pollinia in *H. undulata*, corpusculum larger than pollinia in *H. buntokensis*). — Type: S. Rahayu 873 (holo BO), Indonesia, Central Kalimantan, Buntok, lowland heath forest, 100–300 m, July 2017.

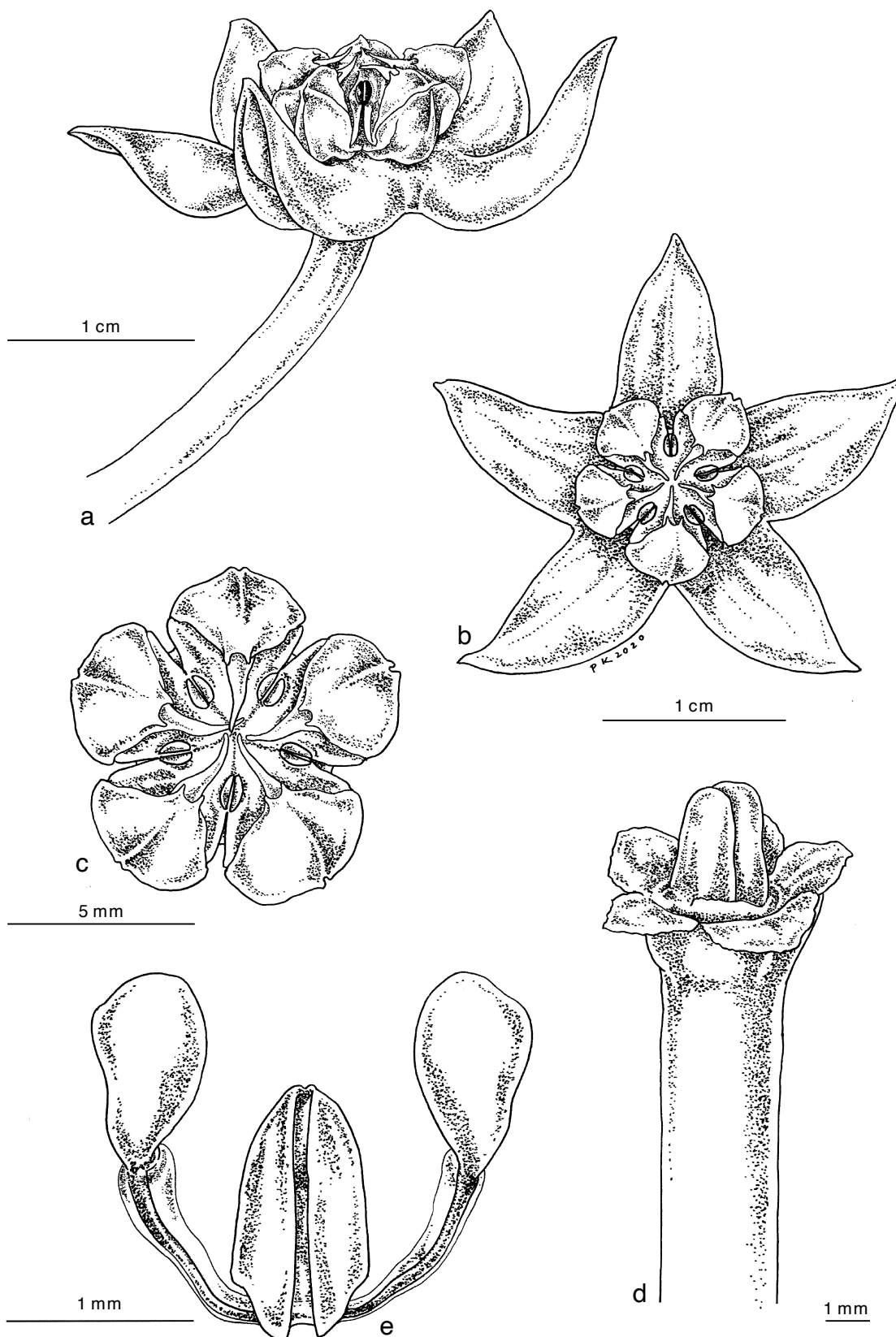


Fig. 1 *Hoya buntokensis* S. Rahayu & Rodda. a. Flower, side view; b. corolla and corona, top view; c. corona, top view; d. pedicel, calyx and ovary, side view; e. pollinarium (Rodda M. MR1961; SING). — Drawn by Puay Koon Cheng.

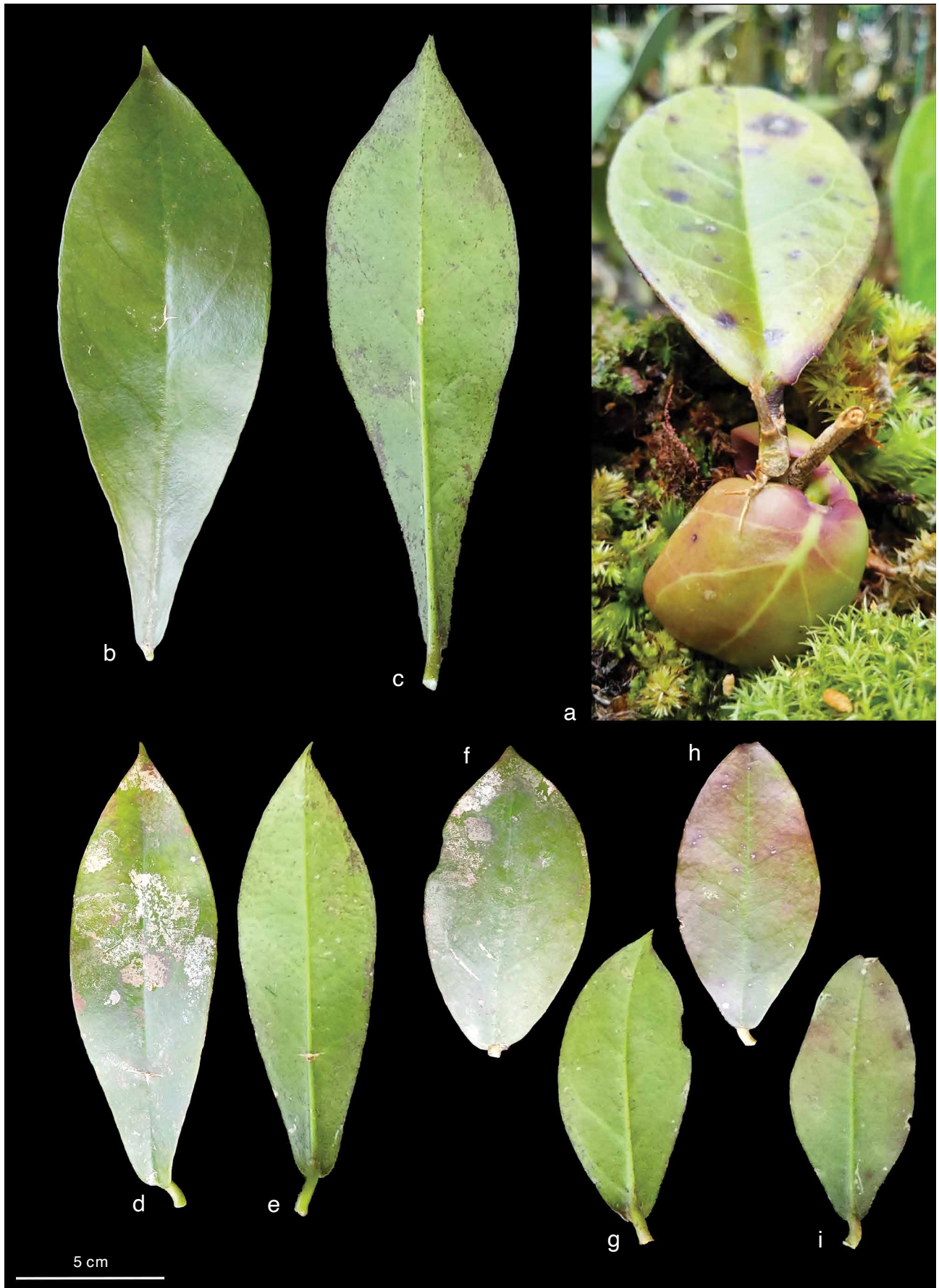


Fig. 2 *Hoya buntokensis* S.Rahayu & Rodda. Morphological variation of leaves. a. Two convex leaves forming a megadomatium, and one unmodified leaf; b, d, f, h. flat leaves photographed from above; c, e, g, i. same leaves photographed from underneath. The larger leaves are produced on internodes > 5 cm long, while the smaller ones are produced on shorter internodes and are similar to the ones forming megadomatia, showing transition between the two leaf types. Living plant in cultivation in Bogor. — Photos by: a. Abdul Lalang; b–i. Sri Rahayu.

Etymology. The specific epithet '*buntokensis*' refers to the type locality: Buntok, Central Kalimantan, Indonesia.

Perennial climber, epiphytic, latex white. **Stems** cylindrical, slender, 2.5–5 mm diam, pubescent, glabrescent when mature, internodes 1–4(–10) cm long. **Roots** adventitious, produced along the stem, especially when in contact with substrate as well as growing within megadomatia. **Leaves:** petiole terete, 0.5–1.5 by 0.25–0.5 cm, pubescent to glabrescent; lamina of two types: the ones produced along internodes generally > 5 cm long are flat, ovate, oblong to lanceolate (5–)9–17 by (2–)3.5–6 cm, apex (rounded) acute to acuminate, base cuneate, minutely cordate; the ones produced along internodes < 5 cm long, forming megadomatia, ovate to obovate 5–10 by 3–4 cm, apex rounded to acuminate, base rounded, minutely cordate, edges inrolled; both types fleshy and glossy, pale to dark green, turning reddish when exposed to bright sunlight above, pale to dark green underneath, often with blackish markings, glabrous; venation pinnate, secondary veins 3–7 on each side. **Megadomatia** globose, 4–7 cm diam, formed by 2–6 leaves; basal colleters 2–5, aligned perpendicularly to leaf axis, broadly conical, 0.4–0.6 mm long. **Inflorescence** one per node, pseudo-umbelliform, consisting of 2–5 or up to 12 flowers in cultivation; **peduncle** extra-axillary, positively geotropic or laterally held, terete, 0.5–1(–7) cm by 3–5 mm, pubescent, older peduncles forming a rachis from previous flowerings, **pedicels** stout, 30–35 by 2–3 mm, pale pink with purple spots to purple, glabrous. **Calyx** 5–6 mm diam, calyx lobes semi-circular, 1.5–2.2 by 2.5–3 mm, apex rounded, pink to purple, glabrous, margin irregular, ciliate; basal colleters one at each calyx lobe sinus, narrowly conical, c. 0.4 mm long. **Bud** globose. **Corolla** rotate, 2.5–3.5 cm diam when flattened; tube c. 5 mm long, inside white-cream to pale pink, outside white, white with purple spots to purple, inside very finely pubescent, outside glabrous; lobes elliptic-ovate, 10–12 by 8–11 mm, margins recurved, apex acuminate, inside white-cream to pale pink, outside white, white with purple spots to purple, inside very finely pubescent, outside glabrous. **Corona** staminal, c. 5 mm high, 10–12 mm diam, white-cream; lobes spreading, 5–6 by 4–5 mm, inner process oblong, incumbent on style head, c. 1.5 mm long, outer processes fan shaped, 3.5–4 by 4–5 mm, carinate above, below sulcate with revolute margins, apex truncate, two lateral straight appendages at the junction between outer and inner process. **Pollinia** kidney-shaped, 1.3–1.5 by c. 0.8 mm, with a very reduced apical pellucid margin; corpusculum oblong, 1.8–2.2 by 0.9–1.1 mm; caudicles attached to the base of the corpusculum, c. 1.5 mm long. **Style head** 5-angled, c. 3.5 mm across, flat with a slightly raised style head apex. **Ovary** conical, c. 3 by 1.5 mm, apex truncate, glabrous. **Fruit** and **seed** not observed.

Distribution — *Hoya buntokensis* has only been once collected in Central Kalimantan near Buntok.

Habitat & Ecology — Lowland heath forest habitat above a stream and wetland, at 100–300 m above sea level. It was growing epiphytically on small tree trunks about 5 m above ground, growing in 50–70 % sunlight. Based on observations *in situ* as well as in cultivation *H. buntokensis* can grow in low as well as high light levels, but the leaves develop a red or purple colour when exposed to intense sunlight. At the type locality in Buntok, the plants were observed to form megadomatia, with ants nesting within. Roots were also observed forming inside the megadomatia. The formation of megadomatia has not yet been observed in cultivation. In the heath forests in the vicinity of Buntok numerous other *Hoya* species could be found including *H. mitrata*, *H. elmeri* Merr., *H. scortechinii* King & Gamble and *H. waymaniae* Kloppenb.

Conservation status — Data Deficient (DD; IUCN 2012). *Hoya buntokensis* is known only from the type locality in Buntok,

Central Kalimantan, and we do not have information on population size, threats and possible decline. *Ex situ* collections are present at the Bogor Botanic Gardens (from the type locality). The species is also widely cultivated elsewhere as it is easily propagated by cuttings.

Additional specimen examined. Cultivated in Thailand, Nakhon Si Thammarat, Nov. 2019, S. Somadee in M. Rodda MR1961 (SING), paratype.

Notes — 1. *Hoya buntokensis* belongs to a small group of species that can develop megadomatia that includes *H. mitrata* from Thailand, Peninsular Malaysia, Sumatra and Borneo, *H. darwinii* Loher, endemic to the Philippines, and *H. undulata*, endemic to Borneo. The four species develop two types of leaves, the first with a flat or slightly convex lamina, occurring at widely spaced nodes on climbing stems, the other convex, occurring on stems with shorter internodes. The latter form megadomatia with the plant roots growing within and harbouring ant colonies. The first type of leaf is generally oblong to lanceolate in *H. buntokensis*, *H. darwinii* and *H. mitrata*, with an entire edge, while in *H. undulata* leaves can be ovate, obovate or oblanceolate, with a minutely undulate margin. In *H. darwinii* and *H. buntokensis* the megadomatia are globose, 4–7 cm diam and formed by 2–6 convex leaves with an inrolled edge. The megadomatia of *H. mitrata* are instead cabbage-shaped, usually larger, formed by broadly obovate convex leaves without inrolled edges (Weissflog et al. 1999, Kleijn & Van Donkelaar 2001) and these of *H. undulata* are generally looser than those of *H. mitrata*, *H. darwinii* and *H. buntokensis* and formed by 4–10, round to elliptic convex leaves, 3–7(–10) cm long.

2. The inflorescences of *H. darwinii* and *H. mitrata* are flat to slightly convex, negatively geotropic, bearing 10–15 flowers, the corolla has a tube longer than the lobes, and the lobes are reflexed. The inflorescences of *H. undulata* and *H. buntokensis* are instead positively geotropic or laterally held, and bear 2–5 flowers (up to 12 in cultivation); the corolla is rotate, concave, with almost free lobes.

3. Other common features of the four species are pollinia without pellucid margin (present but much reduced in *H. undulata* and *H. buntokensis*). For these reasons *H. buntokensis* appears to be more similar to *H. mitrata* in vegetative morphology, and more similar to *H. undulata* in inflorescence and flower morphology.

4. *Hoya buntokensis* differs from *H. undulata* by the size of the corolla (2.5–3.5 cm diam when flattened in *H. buntokensis* vs 4–5 cm in *H. undulata*), but they have a similar rotate shape. The corona of *H. buntokensis* is smaller (c. 5 mm high, 10–12 mm diam vs 5–7 mm high, 12–13.5 mm diam in *H. undulata*); the outer process of the corona lobes is fan-shaped, with two lateral straight appendages at the junction between outer and inner process vs elliptic, with two lateral hooked appendages at the junction between outer and inner process.

***Hoya wallichii* (Wight) C.M. Burton subsp. *tenebrosa* S. Rahayu & Rodda, subsp. nov.** — Fig. 3

Similar to *Hoya wallichii* subsp. *wallichii* in habit (slender plant with ovate to oblong, thinly coriaceous glabrous leaves) and inflorescence and corolla type (slender peduncle with 1 or 2 flowers open at a time, broadly campanulate corolla). It can be separated on corolla colour (white-cream in subsp. *wallichii* vs dark purple with a paler edge in subsp. *tenebrosa*); corona lobe shape and surface (lobes kidney-shaped, erect and with a well-developed acuminate inner process, purple with a shiny surface in subsp. *wallichii* vs broadly elliptic, spreading and with a minute inner process, almost black with a velvety surface in subsp. *tenebrosa*). — Type: S. Rahayu 1251 (holo BO), Indonesia, West Kalimantan, Putussibau, Kapuas Hulu, lowland, 100 m alt. Sept. 2018.

Etymology. The specific epithet '*tenebrosa*' refers to the dark colour of the corolla and corona (Latin *tenebrosus* = dark).

Perennial climber, likely epiphytic, slender, latex white, all vegetative parts glabrous. **Stems** cylindrical, slender, 1–2 mm diam;

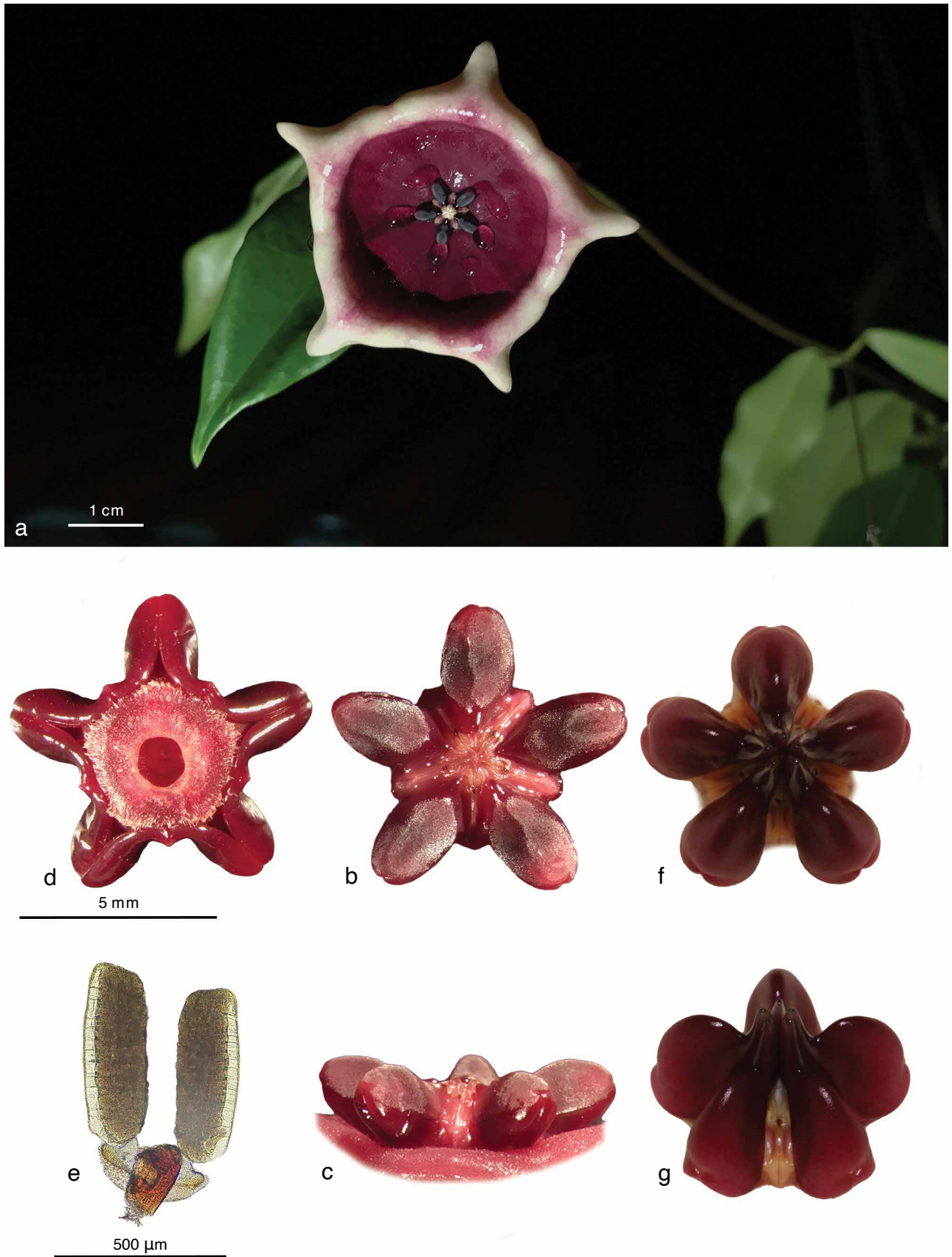


Fig. 3 a–e. *Hoya wallichii* subsp. *tenebrosa* S.Rahayu & Rodda. a. Living plant flowering in cultivation in Singapore; b. corona, top view; c. corona, side view; d. corona, from underneath; e. pollinarium. — f–g. *Hoya wallichii* subsp. *wallichii* (Wight) C.M.Burton. f. Corona, top view; g. corona, side view (a–e: Yap E.H YEH73; preserved in spirit in SING; f–g: living plant flowering in cultivation in Singapore). — Photos by Michele Rodda.

internodes 1–4(–10) cm long. *Roots* mostly basal, adventitious roots developing only when the stem is in contact with the substrate. *Leaves*: petiole terete, 2–3 by 0.4–0.8 mm; lamina ovate to oblong, thinly coriaceous when dry, 8–16 by 5–12 mm, apex rounded, shortly apiculate, base rounded; venation pinnate, secondary veins 3–5 on each side, barely visible; basal colleters 3–5, conical, 0.5–0.8 mm long. *Inflorescence* one per node, positively geotropic, with only 1 (rarely 2) flowers open at one time; peduncle extra-axillary, terete, 5–7 cm by 0.8–1 mm, glabrous; older peduncles forming a rachis from previous flowerings, pedicels positively geotropic, filiform, 15–22 by 0.6–0.9 mm, glabrous. *Calyx* 3.5–5 mm diam, lobes almost round, 1.5–2 by 1.5–2.2 mm, apex obtuse (round), glabrous, ciliate; basal colleters one at each calyx lobe sinus, ovate-oblong, 0.3–0.4 mm long. *Bud* globose, 5-ridged. *Corolla* broadly campanulate, 3–3.5 cm diam when fully open, glabrous; tube 1.5–2 cm long, deep purple inside and white or cream towards the base of the lobes, outside glabrous, inside very finely pubescent, more densely so towards the middle; lobes reflexed, broadly deltate, 0.6–0.8 by 1.8–2.2 cm, apex acute. *Corona* staminal, c. 2.5 mm high, c. 7 mm diam; lobes broadly elliptic and spreading, 2.8–3.1 by 1.6–1.8 mm, inner process acute, slightly raised apically, outer processes spreading, slightly raised apically, apex rounded, with basal revolute margins, almost black, with a velvety surface. *Pollinia* oblong, c. 500 by 200 μm , with pellucid margin; corpusculum oblong, c. 200 by 100 μm ; caudicles attached to the lower half of the corpusculum, c. 200 μm long. *Style head* 5-angled, c. 2 mm across, slightly depressed, apex apiculate, c. 0.5 mm tall. *Ovary* broadly conical, c. 1.5 by 0.7 mm, glabrous. *Fruit* and seed not observed.

Distribution — Only collected in an oil palm plantation in Kapuas Hulu, West Kalimantan at about 100 m above sea level.

Habitat & Ecology — *Hoya wallichii* subsp. *wallichii* was growing epiphytically about 3–5 m above ground. The area was formerly heath forest. In cultivation it grows best in shade, with 30–40 % sunlight.

Conservation status — Data Deficient (DD, IUCN 2012). *Hoya wallichii* subsp. *tenebrosa* is only from the type locality in Kapuas Hulu, West Kalimantan, and we do not know the population size, threats and possible decline. *Ex situ* collections are present in Bogor Botanic Gardens (from the type locality). The taxon is also widely cultivated elsewhere as it is easily propagated by cuttings. *Hoya wallichii* subsp. *wallichii* was first described from material collected in Singapore, where it is now extinct in the wild while it is still extant in Peninsular Malaysia (Johore) and Borneo (Brunei) and it is considered as critically endangered (CR B2ab(iii)) (Rodda et al. 2016).

Additional specimen examined. Cultivated in Singapore, Singapore Botanic Gardens, 20 Sept. 2019, Yap E.H YEH73 (SING), paratype.

Notes — *Hoya wallichii* subsp. *tenebrosa* is indistinguishable from *H. wallichii* subsp. *wallichii* when sterile: both are slender climbers with ovate to oblong laminae, thinly coriaceous when dry. They can be easily distinguished from their corolla colour and corona colour and surface, as mentioned in the diagnosis. Based on these differences, *H. wallichii* subsp. *tenebrosa* could have been alternatively classified at species rank. However, we chose to conservatively publish the new taxon at subspecies rank for the following reasons: both taxa co-occur in Borneo, only one collection of *H. wallichii* subsp. *tenebrosa* has been made, few collections of *H. wallichii* subsp. *wallichii* are available for study (Rodda et al. 2018), and we are not sure if the corolla colour and corona morphology are stable features.

The corona of *H. wallichii* subsp. *tenebrosa* is also similar in shape to that of *H. sammanniana* A.Lamb, Gavrus, Emoi & Gokusing. However, the colour is different (cream with red centre in *H. sammanniana*, dark purple with a paler edge in *H. wallichii* subsp. *tenebrosa*) and the corolla is a deeper bell-shape in *H. sammanniana*, while it is broadly campanulate in *H. wallichii* subsp. *tenebrosa*.

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