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Hoya undulata* (Apocynaceae, Asclepiadoideae), a new myrmecophytic species from Borneo, and typification of *H. darwinii

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ABSTRACT. In this paper we document the discovery of a new *Hoya* species from Borneo, *H. undulata* S.Rahayu & Rodda. The leaves of the new species form domatia, specialised structures harbouring ants, previously only observed in *Hoya mitrata* Kerr and *H. darwinii* Loher. The corona is unique among Bornean *Hoya* species as its lobes develop two lateral hooked appendages, also present in *H. griffithii* Hook.f, a species from mainland Asia. A lectotype for *Hoya darwinii* is also selected.

Keywords. Ant plant, domatia, heath forest, *Hoya mitrata*, Indonesia, myrmecophyte, West Kalimantan

Introduction

Hoya R.Br. is a poorly known tropical genus for which a modern revision is lacking. Extensive field investigations and accurate documentation of new species are essential before a generic revision can be compiled (Rodda & Ercole, 2014). In Borneo, Merrill (1921) listed only eight *Hoya* species and more recently Forster et al. (1998) described the diversity of the genus in Borneo as 'unknown'. Recently, new taxa have been described based on collections from Sabah (e.g. Lamb et al., 2014; Rodda et al., 2013) and to a lesser extent, Sarawak (Rodda & Simonsson, 2011a, b; Rodda & Simonsson Juhonewe, 2013a). The higher number of novelties described from Sabah is directly linked to efforts by the staff at Kipandi Park (Kampung Kipandi, Moyog, Sabah) to cultivate wild-collected sterile specimens until they bloom so that they can be identified (Lamb et al., 2014), an approach successfully adopted by Rintz (1978) in Peninsular Malaysia. Among the species described in Lamb et al. (2014) only *Hoya sammanniana* A.Lamb et al. is also found in Kalimantan. Two further species, *Hoya rintzii* Rodda & Simonsson and *Hoya beccarii* Rodda & Simonsson can be found throughout Borneo and are widespread elsewhere in SE Asia (Rodda & Simonsson

Juonewe, 2013b; Rodda et al., 2014). The diversity of *Hoya* in Indonesian Borneo is least known due to the scarcity of recent collections; the only information on *Hoya* diversity in Central Kalimantan can be found in Rahayu (2006) who lists only nine species. Lamb et al. (2014) suggested that 60 to 70 *Hoya* species may occur in Sabah alone and it is becoming apparent that the diversity of *Hoya* of Borneo is expected to be comparable to or exceeding that of the Philippines with 104 species (Aurigue et al., 2013) or of New Guinea with 74 species (Forster, 1996).

During a recent expedition in West Kalimantan Mr Sulaiman Hasim discovered a new *Hoya* species that we formally describe and illustrate here. It is compared with the vegetatively similar *Hoya darwini* and *H. mitrata*. The latter was lectotypified in Rodda (2012) while the former is here lectotypified.

***Hoya undulata* S.Rahayu & Rodda sp. nov.**

Similar to *Hoya mitrata* Kerr and *H. darwini* Loher when sterile because it has specialised convex leaves forming multileaved domatia. Easily separated when fertile because the flowers have a rotate corolla formed by almost completely free corolla lobes, while *Hoya mitrata* and *H. darwini* have reflexed corollas with a tube almost as long as the lobes. – TYPE: Indonesia, West Kalimantan, Putussibau, 300–380 m, on a slope above a stream, February 2014, *Sulaiman Hasim s.n.* (holotype BO). (Fig. 1, 2)

Epiphytic climber with white latex in all vegetative parts, glabrous. **Stems** slender, internodes very variable in length, from 0.5 cm in the parts of the vine forming domatia, to 20 cm long in climbing stems, 3–5 mm diameter, green with darker spots; **adventitious root** sparsely produced along the stem. **Leaves** petiolate; petiole broader than stem, 0.5–2.5 cm long, 3–5 mm in diameter, light green to purple; lamina dimorphic, the first type ovate, obovate or oblanceolate, usually almost flat, located along climbing stems, 10–20 × 5–10 cm, the second type almost round to elliptic, usually convex and forming domatia with 4–10 leaves each 3–7(–10) × (2–)4–5 cm, base cordate with numerous minute basal colleters forming a convex line on the adaxial surface at the base of the lamina, apex acute or acuminate, margins minutely undulate but appearing minutely dentate in the proximal half of the lamina, sometimes entire along the distal part of the lamina; venation pinnate, secondary veins 4–5 pairs, diverging at c. 70°, anastomosing, tertiary venation reticulate; dark green above with grey to purple spots, below lighter green, occasionally all purple, midrib depressed above, raised below, light green, sometimes purple. **Inflorescence** positively geotropic, pseudo-umbellate, convex, 2–5-flowered(–12 flowered in cultivated material); peduncle positively geotropic or ageotropic, 1–2(–5) cm long, 3–5 mm in diameter, green with dark purple spots, glabrous. **Flowers** unscented, lasting 4–5 days in cultivation; **pedicel** 2.5–4.5 cm long, 1.5–2 mm in diameter, white-light green with red spots, glabrous. **Calyx** lobes ovate, 2–2.5 × 1.5–2 mm, light pink to purple, glabrous with ciliate translucent margins, **basal colleters** one in each calyx lobe sinus, 0.3–0.5 × c. 0.3 mm, ovate to triangular with a round tip. **Corolla** rotate, concave, with corolla lobe tips inflexed, 2.5–4 cm in diameter, 4–5 cm when flattened; corolla lobes almost free, ovate to oblanceolate,

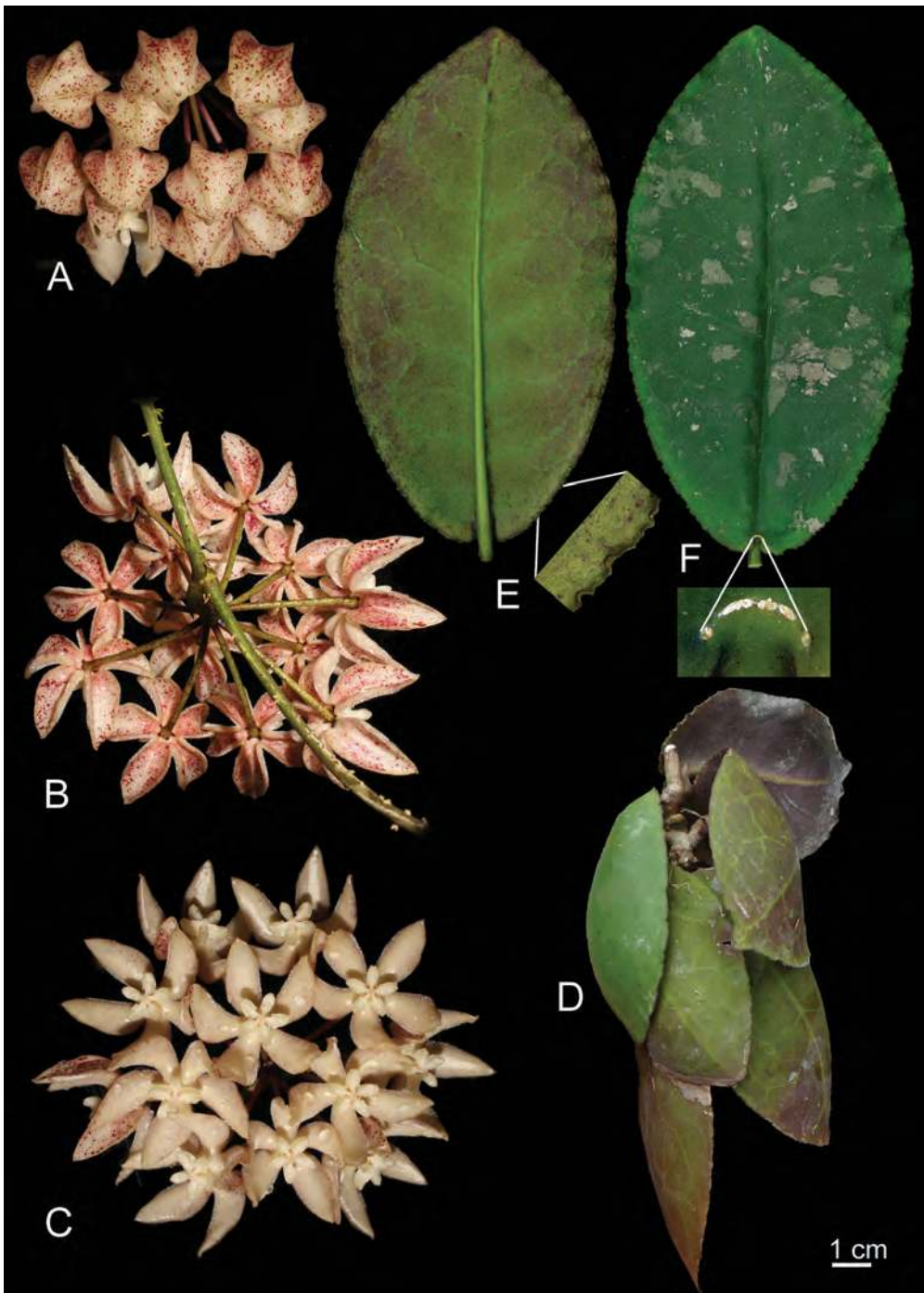


Fig. 1. *Hoya undulata* S.Rahayu & Rodda (from *M. Rodda MR650*, SING) **A.** Buds. **B.** Inflorescence, top view. **C.** Inflorescence from underneath. **D.** Domatia; **E.** Leaf, abaxial, with a magnification of the minutely undulate margin. **F.** Leaf, adaxial, with a magnification of the basal colleters. (Photos: A, B, E, F, Michele Rodda; D, Surisa Somadee)

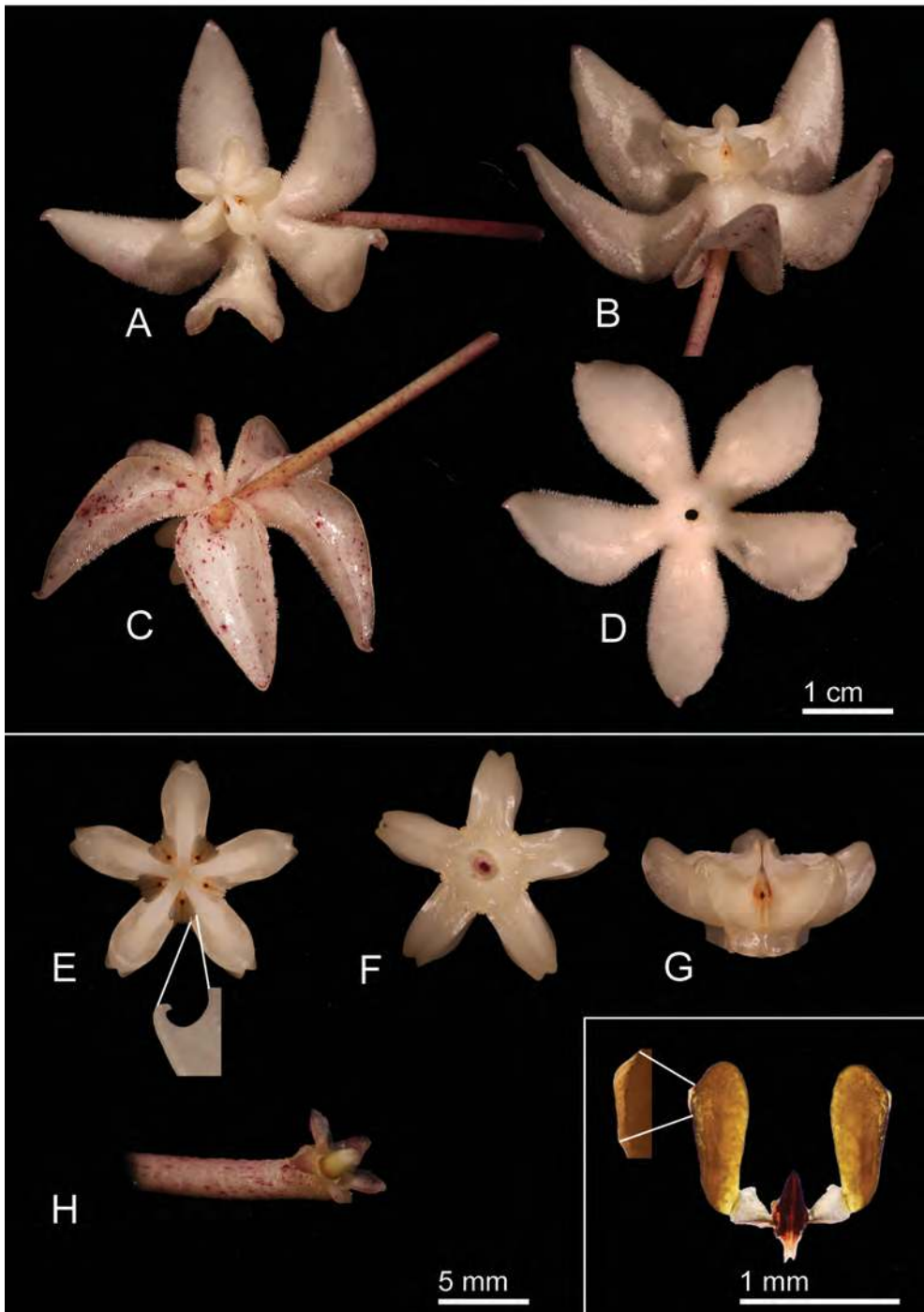


Fig. 2. *Hoya undulata* S.Rahayu & Rodda (from *M. Rodda MR650*, SING). **A, B, C.** Flower. **D.** Corolla after removing the corona. **E.** Corona, top view. **F.** Corona, from underneath. **G.** Corona, side view. **H.** Calyx and ovaries. **I.** Pollinarium with twin pollinia, with a magnification of the much reduced sterile edge. (Photos: Michele Rodda)

2–2.5 × 1–1.5 cm, white with purple red dots outside, cream-light pink inside, margin recurved predominantly in the proximal half of the lobe, apex acute, curved toward the adaxial surface, pilose inside with glabrous apex, glabrous outside. **Corona** staminal, 12–13.5 mm in diameter, 5–7 mm high; **lobes** spreading, when observed from above clavate, 5.5–6.5 × 2.5–3 mm, carinate above, below sulcate with revolute margins, outer process concave, inner apex rounded, upcurved, abruptly narrowing into a terete linear inner process with upcurved acuminate tip; two lateral hooked appendages at the junction between outer and inner process. **Anthers** ovate to almost round, c. 1.5 × 1.5 mm, with apical round membranaceous appendage just exceeding the style-head apex. **Pollinia** oblong, 900–1000 × 350–400 μm, narrowing towards the base, apex round, sterile edge much reduced, limited to the upper outer part of the pollinium; **corpusculum** rhomboid with acute tips, 500–600 × 200–250 μm; **caudicle** broadly triangular, hyaline, unwinged, 250–300 × 250–300 μm at the widest. **Style-head** 5 angled in cross section, with 5 lobes alternating with the stamens, style-head apex round, 1.5 mm long, c. 3 mm broad at the base. **Ovaries** 2, conical with round tip, 1.5–2 mm long, c. 1 mm wide at the base, light green, red at the base and at the apex. **Fruit** and **seed** not seen.

Distribution. Only known from the type locality in West Kalimantan, close to Putussibau. A second unlocalised collection is widely available in cultivation.

Etymology. The specific epithet refers to the characteristic undulate leaf margin.

Habitat and ecology. Observed in lowland heath forest at 300–380 m above sea level on a slope above a stream, epiphytic on small tree trunks about 1.5 m above ground, growing in about 80% humidity and 50% sunlight. (Sulaiman Hasim pers. comm.). According to the epiphytic zonation by Johansson (1975), the species grows in zone B. The zonation of epiphytes is mainly correlated with their light, nutrients and water requirement. Some species are restricted to strongly illuminated sites, some to shady sites, while some avoid both strong light and deep shade and yet others have a wide range of tolerance (Benzing, 1990). Usually, occupying the B zone means that the species is adapted to moist shady habitats. The leaves of *Hoya undulata* can adapt to high light levels, but they have been observed to develop a purple colour in intense sunlight. At the type locality, the plants were rooting in ant nests and, on casual observation, the leaf domatia harboured ants.

Provisional IUCN conservation assessment. Known from only one locality, the preliminary conservation status of *Hoya undulata* is Data Deficient (DD, IUCN 2014). *Ex situ* collections are present in Bogor Botanic Gardens (from the type locality) and in Singapore Botanic Gardens (SBG acc. no. 20132428).

Notes. Two species, *Hoya mitrata*, from Thailand, Peninsular Malaysia, Sumatra, Borneo, Sulawesi and Java, and *H. darwinii*, endemic to the Philippines, both commonly associated with ants (Kleijn & Donkelaar, 2001), are similar to *H. undulata*.

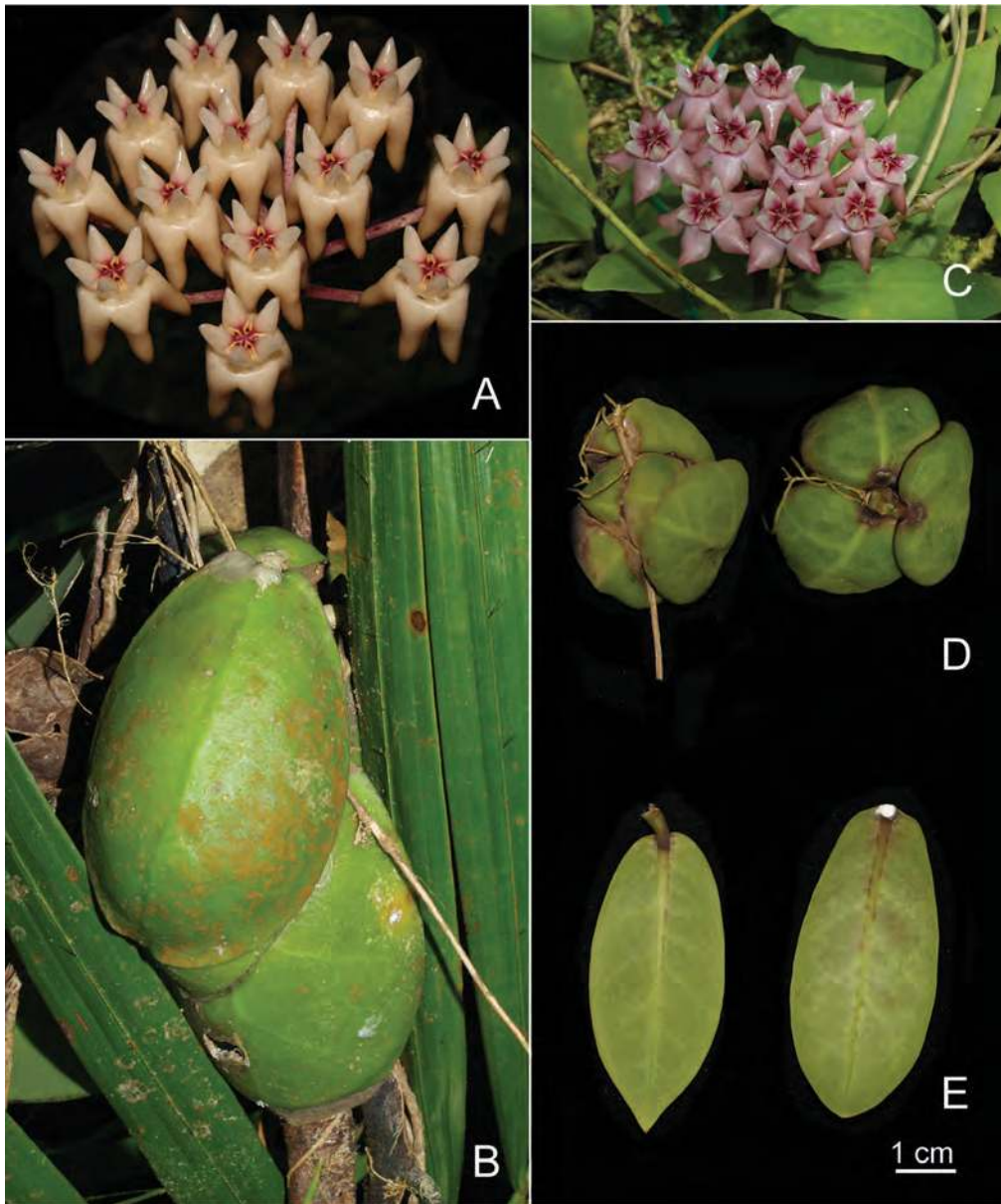


Fig. 3. *Hoya mitrata* Kerr (Photographed at Gunung Pantii, Johor, Malaysia) **A.** Inflorescence. **B.** A small domatium. *Hoya darwinii* Loher (M. Rodda MR421, SING). **C.** Inflorescence. **D.** Domatia. **E.** Leaves not forming domatia. (Photos: Michele Rodda)

In vegetative morphology, the three species have two types of leaves, the first with a flat or slightly convex lamina, occurring at widely spaced nodes on long climbing stems, the other convex, occurring on stems with shorter internodes, and these forming domatia harbouring ant colonies. The first type of leaf is oblong-lanceolate in *Hoya*

mitrata and broadly lanceolate in *H. darwinii*, both with an entire edge, while in *H. undulata* it can be ovate, obovate or oblanceolate, with a minutely undulate margin which may appear minutely dentate in the proximal half of the lamina, sometimes entire along the distal part of the lamina. In *Hoya darwinii* the domatia are globose, 4–7 cm in diameter and formed by 2–6 convex leaves with an inrolled edge (Fig. 3D). The domatia of *Hoya mitrata* are instead cabbage-shaped, usually larger, formed by tightly clustered broadly obovate convex leaves without inrolled edges (Fig. 3B) (Weissflog et al., 1999; Kleijn & Donkelaar, 2001). In its natural environment, the domatia of *Hoya undulata* are generally looser than those of *H. mitrata* or *H. darwinii*, formed by 4–10, round to elliptic convex leaves 3–7(–10) cm long, while in cultivation domatia rarely develop and are usually formed by larger leaves (Fig. 1D).

The inflorescences of *Hoya darwinii* and *H. mitrata* are flat to slightly convex, negatively geotropic, bearing 10–15 flowers (Fig. 3A, C), the corolla has a tube almost as long as the lobes, and the lobes are reflexed; the outer process of the corona lobes is swollen, erect. The inflorescences of *Hoya undulata* are also flat to slightly convex but instead positively geotropic (Fig. 1A–C), bear 2–5 flowers (exceptionally 12 in cultivation); the corolla is concave, with almost free lobes, the corona lobes outer process is concave, spreading with an upcurved apex.

The pollinia of *Hoya darwinii* and *H. mitrata* do not have a sterile edge, a character that led Kloppenburg (1994) to accommodate both species in the new section *Rudimentalia* Kloppenb. The pollinaria of *Hoya undulata* are overall similar to those of *H. mitrata* and *H. darwinii* but its pollinia instead have a sterile edge, albeit much reduced, limited to the upper outer side of the pollinium (Fig. 2I).

A striking similarity can be observed between the corona of *Hoya undulata* and *H. griffithii* from mainland Asia. The corona lobes are clavate in both species, with two lateral hooked appendages at the junction between the outer and the inner processes. These appendages have not been documented in any other *Hoya* species.

A key to separate *Hoya darwinii*, *H. mitrata* and *H. undulata* is provided below.

Other specimens examined. Unlocalised, 30 March 2014, Rodda, M. MR650, collected from material cultivated at the Singapore Botanic Gardens, acc. no. 20132428 (SING).

Key to *Hoya* species forming domatia

- 1a. Inflorescence negatively geotropic with 10–15 flowers, outer process of corona lobes swollen, erect 2
- 1b. Inflorescence positively geotropic, with 2–5(–12) flowers, outer process of corona lobes concave, spreading with upcurved apex *Hoya undulata*
- 2a. Domatia globose, formed by concave leaves with inrolled edges *Hoya darwinii*
- 2b. Domatia cabbage-shaped, formed by vaulted leaves without inrolled edges *Hoya mitrata*

Lectotypification of *Hoya darwinii*

Hoya darwinii Loher, Gard. Chron. 47: 66 (1910). – TYPE: Philippines, Luzon, Rizal Prov., September 1909, *Loher, A. 14574* (lectotype UC [UC243291], designated here).

When Loher described *Hoya darwinii* he did not cite any specimens as belonging to the taxon. He only indicated that the species was collected in Luzon and that it bloomed in March and April. Loher collected in Luzon over a long period of time, from 1889 to 1915. His specimens collected before 1906 were deposited at K, with substantial sets of duplicates in PNH, US, M, CAL; his collections from 1908 to 1915 (numbers 12000 to 15170) were deposited in PNH (Merrill, 1925), with a first duplicate set sent to M and additional specimens to UC and A (orchids only) (Steenis-Kruseman, 1950). We have examined *Hoya* specimens at K, and made enquires to M, UC, PNH and US about the presence of any relevant Loher material. At K we located numerous early Loher specimens, none identifiable as *Hoya darwinii*; at M we found post-1908 Loher specimens, once again not belonging to *H. darwinii*. No *Hoya darwinii* specimens collected by Loher could be found at PNH or US. However, three specimens of *Hoya darwinii* were found at UC: two duplicates of *Loher 14990*, collected in Luzon, Rizal Prov., in 1915, one of which is also labelled *Bolster 395* (this label should be removed as it likely refers to a different *Hoya* species with yellow flowers, while *H. darwinii* generally has pink flowers), and *Loher 14574*, collected in Luzon in September 1909 (Fig. 4). The latter is the only available specimen collected before the publication date of *Hoya darwinii* and most probably belongs to the original material on which this taxon is based. Thus, it is the only specimen available for lectotypification. However, it must be noted that it does not fully match Loher's description as the flowering period was indicated as March–April. If new evidence were to be found to indicate this specimen is not original material, and in the absence of the discovery of alternative original material, then the lectotypification designated here would count as an effective neotypification under Art. 9.9 of the ICN (McNeill et al., 2012).

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